Welcome

Welcome to Windhoek and to the 6th International Conference on Engineering and Business Education (6th ICEBE).

This conference is the sixth in a series of annual conferences on engineering and business education. It is organised by Wismar University, hosted by Polytechnic of Namibia and co-organised by University of Applied Sciences Jena. Our network attracts a wide international audience of scientists, representatives of industry and students committed to improving the collaboration between engineering and business sciences as well as between business and academia. This year they are coming from at least 10 countries, including a number of undergraduate and postgraduate students.

The conference began in Wismar in 2008, followed by 2nd ICEBE at Lucian Blaga University of Sibiu, Romania; 3rd ICEBE at La Consolacion College, Manila/Philippines; 4th ICEBE at Cape Peninsula University of Technology, Cape Town/South Africa; 5th ICEBE again in Romania last year. The 6th ICEBE promises to be academically stimulating, as well as offering exciting and entertaining activities and social events. It is being held at Windhoek Country Club Resort Hotel, which is situated in the Southern outskirts of Windhoek. It is the perfect destination for conference delegates such as us; it boasts impressive conference facilities, an impressive outdoor swimming pool, restaurants and bars, and a casino. The resort’s unique combination of exceptional service, luxury accommodation, and a tranquil setting make this Namibian Gem the perfect set-up for the 6th ICEBE.

We hope you will enjoy the chance to explore the countryside, which is a geologist’s paradise. Namibia is scattered with fossils and unique minerals, give one the feeling of stepping back in time, to the moment of the creation. The surreal landscape of endless ochre coloured sand dunes which tower over scattered trees and wildlife, contrasted against the crisp blue hues of the South Atlantic Ocean, makes this dreamlike country a must on every travelers list.

The theme of the conference is “Innovation, Entrepreneurship and Sustainability”, which describes the emphasis we want to lay on always using these three terms in combination, not only to consider one in isolation from the others. Therefore the primary goal of the conference is to provide the delegates with cross-disciplinary interests related to the three streams in engineering and business education an opportunity to meet and interact with others inside and outside their own discipline. In bringing people from more than 10 countries together we wants to create a truly diverse variety of viewpoints shaped by different cultures, languages, geography and politics.

Delegates will have the opportunity to choose from nearly 70 contributed presentations of papers and workshops during the three conference days. All papers will be also published in the conference proceedings. The presentations will be led by discussions of, and challenges to, practice from four keynote speakers as well as within the half day Business-Academia-Forum. This special event provides the chance to discuss the current challenges of harmonising the supply of academic knowledge with the demands made by industry. This year we want to discuss the topic “Exploring Work Integrated Learning in Emerging Markets”. We have invited well known business men and scientists experienced in that field.

A very important topical issue is encouraging the participation of new members. We want students to learn from international co-operation, exchange of information and intercultural experiences. By organising a students’ stream within the 6th ICEBE we want them to have the unique opportunity to meet scientists, business people and international students – all with the same aim – TO THINK GLOBAL AND TO ACT LOCAL.

We wish to thank all of the sponsors, without whom it would have been impossible to hold this conference with such an impressive programme; the large team of committee members, who have worked tirelessly to put the conference together, but surely most of all the presenters and you the participants. It is certainly true that any conference is only as good as the contributions of its participants.

Previous ICEBE conferences have set high standards, and we believe the deliberations at this conference will stimulate and interest all delegates as much as ever. We hope you will enjoy the conference as much as we anticipate, and invite you to join us once again in October 2014, when the 7th ICEBE will be held at Shijiazhuang University of Economics, China, from 13th – 15th October 2014.

Best wishes to you all.

N. Grünwald
Rector, University of Wismar, Germany

Professor Gabriele Belbst
Rector, University of Applied Sciences Jena, Germany

S. K. Gwembe
Professor Tjama Tjivikua
Rector, Polytechnic of Namibia, Windhoek

Proceedings of the 6th ICEBE 2013
Scientific and organising committee

The scientific committee consists of representatives of our partner universities who have an international reputation in the fields of engineering and business education:

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Mr. Chris van Zyl  
*Polytechnic of Namibia, Windhoek/Namibia*
The university chairmen who are the main organisers of the conference are represented by the following committee members:

Mrs. Regina Krause  
_Wismar University, Wismar/Germany_

Mrs. Margaret R. Bennett  
_Polytechnic of Namibia, Windhoek/Namibia_

Mr. Arndt Lautenschläger  
_University of Applied Sciences Jena, Jena/Germany_
These Proceedings are a collection of original selected papers, which were accepted after the abstracts and full papers submitted were refereed by a panel of local and international peer evaluators, each a specialist in his or her own field. Every effort has been made to include only those papers that are of a high, scientific standard. The organizers and publishers do, however, not accept any responsibility for any claims made by the authors.

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Enterprise Resource Planning (ERP) teaching for Africa

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Abstract: Business Information Systems started as reactive recording of business transactions, with “silo” systems and duplication/multiple capturing. The need for accurate real-time information led to the evolution of proactive systems, culminating in Enterprise Resource Planning (ERP), facilitating the flow of information among all business functions inside an organization, and managing contact to outside stakeholders.

ERP systems are total business solutions used around the world, and gaining in popularity thanks to improved accessibility and affordability (cloud computing). This leads to an increase in the demand for ICT skills, already far exceeding the supply, particularly in Africa.

Erp4school is a scenario enabling students to learn about companies and their processes as a whole. They learn how companies use ERP (SAP) software to run their processes, and how business processes fit into general business practice.

For a solution a working platform was created based on a standard SAP client, provided by SAP, CPUT and the Otto von-Guericke-University in Magdeburg, Germany.

CPUT was chosen as the lighthouse to roll out this initiative (the first outside Europe) across the whole Sub-Saharan Africa, to make a difference in the IT skills deficit, and empowering young job-seekers.

Keywords: ERP, Enterprise, Resource, Business, Information

I. PROBLEM STATEMENT

Addressing ICT skills shortages and human capital gaps in Africa (the urgent need for qualified personnel) is one of the biggest challenges facing African higher education institutions. Information and communications technologies (ICT) are key enablers of today’s development agenda and an important element in government efforts to foster knowledge-based economies and information societies. Investment in human resources, especially ICT skills, is crucial for the achievement of these national policies and development strategies. Consequently African countries have developed comprehensive national policies and strategies to transform their nations into knowledge-based economies and societies, in which the expansion of human capacity, especially in ICT, is critical. African governments are also increasingly aware of the need to employ multi-disciplinary and multi-sector strategies and tactics to put their countries onto an accelerated development path.

Sub-Saharan countries, especially resource-scarce landlocked nations, appear to be among the worst African performers while there also appears to be a significant digital divide between African countries as a whole and the emerging nations on the Asian and South American continents.

As a result of the IT skills deficit, companies have to outsource, recruit abroad and inflate salaries in order to obtain the required skills. When companies import skills or outsource functions, human capital development is undermined, creating dependency on
international service providers, and weakening the company’s competitiveness.

The IT skills shortage is perpetuated by insufficient capacity and know-how at institutions of higher education, and limited access to ICT resources. This restrains growth and income generation, reducing the tax base, which in turn limits governments’ scope to invest in higher education.

It is a vicious circle - the demand for ICT skills increasingly exceeds supply, and African countries face an uphill struggle to train the workforce in order to sustain and develop their economies, and to become more competitive.

Even in South Africa, ICT skills shortage is a burden on the economy. South African IT companies have to outsource, inflate salaries, and recruit abroad as the country continues to suffer from a serious lack of specialist skills. When companies either import skills, or outsource functions, human capital development is undermined, and the industry ends up being populated by non-South Africans (isiAfrica).

The World Bank uses a knowledge economy indicator (KEI) composed of ICT, education and innovation parameters, which shows that Africa’s knowledge economy indicator lags behind the Middle East, Latin America, East Asia, the Pacific and Western Europe. Sub-Saharan countries, especially resource-scarce landlocked countries, are among the worst African performers (KAM, 2012).

In addition to the ICT skills deficit, the populations of many African nations also suffer from a lack of access to knowledge-base services. For example about 80 per cent of Ghanaian adults do not have access to any financial services such as savings, loans and insurance investment, a survey conducted by the Ministry of Finance and Economic Planning (MoFEP) has shown. And in this context it is worth noting that there is a direct link between education and training and socio-economic improvement.

II. EVOLUTION OF ERP

Business Information Systems started off as being simply the (reactive) recording of business transactions, with no direct link between financial accounting, cost accounting, and fixed asset registers, therefore with separate systems (silo’s) and duplication/multiple capturing.

The increasing need for accurate real-time information and proper planning then led to the following evolution of (proactive) systems in sequence: Material Requirements Planning (MRP), Material Resource Planning (MRPII), Distribution Resource Planning (DRP), and finally Enterprise Resource Planning (ERP).

Wikipedia explains “Enterprise resource planning (ERP) systems integrate internal and external management information across an entire organization, embracing finance/accounting, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application. Their purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders.”

So ERP systems facilitate the managing and steering of all the following business processes in a fully integrated, real time system: Financial Accounting, Management Accounting, Logistics, Material Planning, Manufacturing, Lifecycle Data Management, Enterprise Asset Management, Customer Relations Management, Supplier Relations Management, Programme and Project Management, and Human Capital Management.

In short, ERP systems are total business solutions in widespread use around the world, and gaining in popularity thanks to improved accessibility and affordability (cloud computing), as well as globalization-led competition. This of course leads to an increase in the demand for information and communications technologies (ICT) skills, already far exceeding the supply, particularly in Africa.
III. THE CHALLENGE

Enterprise Resource Planning (ERP) skills are especially important to development because ERP systems are total business solutions, which support all major business functions. There is a skills and investment gap that needs to be bridged.

Business and development policy have a common interest in structuring political, legal and social framework conditions which promote development in emerging countries. It is therefore also important to produce well-rounded professionals who are ready to support the implementation of ERP applications in sectors that are of critical importance to Africa’s development (such as manufacturing, oil & gas, financial services and the public sector).

Recent research shows that ERP technology faces additional challenges in developing countries related to economic, cultural, and basic infrastructure issues (Molla, 2006). Therefore, a commercial approach alone is not effective. Rather, there is a strong case for a private public partnership to build skills, with the support of an agency that understands the issues and challenges of Africa.

In Africa, SAP University Alliances has a particularly important role as SAP has first-hand awareness and knowledge of the consequences of ICT skills shortage. In order to make progress, African countries (and foreign companies investing in Africa) currently have to import talent from abroad. This means Africa takes a “double hit” - first, the cost of importing talent is expensive, and second, the import of talent further inhibits the development of local African talent.

Unlocking the potential: breaking the circle - as part of the programme’s aim to improve ICT skills and graduate employability in Sub-Saharan Africa, CPUT is training students in the field of enterprise resource planning (ERP). ERP skills are especially important to development in ICT because ERP systems are total business solutions - they integrate internal and external information and enable information flow within and between all of the business functions and departments of an entire organisation. Because ERP systems are in widespread use around the world, they therefore also have particular significance for companies that have worldwide trading links.

IV. THE WAY FORWARD

The governments of South Africa and most other African countries have identified human resources development as a key area of intervention. This programme does not address the deficiencies in basic education, but aims at improving the capabilities at a bottleneck in higher education. It is in line with global development goals and the objectives of the BMZ (“Verantwortliche für morgen ausbilden”). It contributes to United Nations MDG 8 (F) as it fosters the application and utilization of ICT in close cooperation with the private sector.

As a direct impact, the programme should result in the graduation of a significant number of students that have improved their ICT skills, and especially their ERP capabilities according to market requirements. These graduates thereby improve their employability and should find employment according to their qualification (indirect impact).

As a result, companies and public institutions can fill vacant positions with qualified staff, thereby improving growth prospects and productivity (indirect impact). At an aggregated level, this measure enhances economic growth in and integration of African economies into international markets and networks. Capacities are being developed and strengthened for higher education institutions to participate in a global network, and to actively co-develop and deliver a state of the art curriculum.

V. COLLABORATION

Cape Peninsula University of Technology (CPUT), Faculty of Business, Keizersgracht, Cape Town, ZA.

As a key stakeholder in the programme, the Cape Peninsula University of Technology is motivated by its vision to be at the heart of technology education and innovation in Africa and its
mission to create and apply knowledge that contributes to development. There is also a distinct business case for its participation: CPUT expects to benefit from being the focal point of erp4school in Africa because of the associated reputation, additional international contacts within the network and consequently increasing enrolment numbers and growth.

Oberstufenzentrum Bürowirtschaft und Dienstleistungen (OSZ), Mandelstraße 6-8, Berlin, DE. It was at this vocational school that the erp4school scenario was developed by Jochen Scholz, and the OSZ has offered CPUT the license to use the curriculum developed for erp4school also in Africa.

Systeme, Anwendungen, Produkte in der Datenverarbeitung Aktiengesellschaft (SAP) AG, Dietmar-Hopp-Allee 16, Walldorf, DE. SAP’s support includes the integration of erp4school Africa into the global SAP University Alliances network, and the delivery and funding of the software platform free of charge, first as a learning platform and eventually as a development platform.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Dag-Hammarskjöld-Weg 1 – 5, Eschborn, DE. GIZ, operating on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), has directly supported the setup and operation of a competence centre at the CPUT. This has ensured a sound and appropriate structure with which to introduce erp4school, together with the capacity to grow the programme quickly both in and beyond South Africa.

VI. THE SOLUTION
In order to provide graduates with the relevant skills, CPUT and its collaborators have worked to create a marketable curriculum and learning/teaching programme adapted to the needs and environments of African higher education and training institutions. This will enhance the IT and business resource pool in Africa in a way that should become self-sustaining. The programme started in South Africa and it has already been expanded to four other countries - Botswana, Ghana, Kenya, and Nigeria.

The erp4school network in Africa is open to higher education institutions from other African countries. As the content and teaching methods of the erp4school programme are new to most African higher education institutions, a training of trainers/teachers programme (ToT) is being offered to give trainers and teachers the capability to deliver the complex curriculum in their institutions.

The purpose of the erp4school programme is to transfer marketable skills to African higher education and training institutions.

The curriculum is built around the erp4school software platform, which is closely linked to, and an aligned version of the applications provided through the SAP University Alliance (SAP UA) programme to universities around the world. This programme utilises blended learning (a time- and cost-effective mix of presence learning and web-based training). Students learn how companies use SAP and other software to run their ERP processes. erp4school is based on the latest applications and runs on a platform provided by the University Competence Centre (UCC) organization at the Otto von Guericke University in Magdeburg, Germany.

Students are the chief beneficiaries of the erp4school programme as they receive exposure to basic ERP skills, giving them increased and varied opportunities for employment and entrepreneurship, contributing to their own advancement and to their countries’ economic growth.

The approach of erp4school has two main features - Process orientation, and Integration of ERP software into curricula. And through this approach students are taught business content, process knowledge, ERP knowledge, as well as soft skills.
The erp4school is implemented using the SAP ERP application. Integrating software from the market leader, SAP, ensures that the programme teaches global standards based on the latest applications. The goal is to implement and learn a process-oriented way of working using an Enterprise Resources Planning (ERP) system. Centred on a virtual company, students learn how complex processes run in different parts of the organization. As a result, graduates of this training receive certification and improve their career opportunities.

VII. RESULTS

The impact of erp4school in Sub-Saharan countries will be significant, although the process is requiring significantly more time than anticipated. To identify the right decision-maker and “champion” at an education institution remains a challenge, and the implementation is often hampered by having to compete for resources with many other projects run at such institutions.

The successful implementation of the programme will on the one hand result in the graduation of a significant number of students with improved ICT skills, and in particular with ERP capabilities that have been developed in accordance with market requirements. On the other hand it will develop and strengthen the ability of African higher education institutions to participate in a global network and to co-develop and deliver a state-of-the-art curriculum.

The programme has been successfully adopted and implemented in South Africa, and has also already been applied in other African nations. Up to this point 22 higher education institutions have joined as members of this programme, including universities, colleges, and some schools.

Since the start of the programme in April 2011, a number of training workshops were held in South Africa – three in Cape Town, three in Johannesburg, and one in East London. Workshops were also held in Gaborone (Botswana), Nairobi (Kenya), Ile-Ife (Nigeria), and Kumasi (Ghana).

At CPUT the programme has been integrated into the curricula of five Business Faculty courses, with more to follow. And student interest and awareness of the value of the training is increasing steadily.

VIII. CONCLUSION

The implementation team at CPUT is pleased with the progress made up to this point, although a faster implementation will clearly require significantly more resources.

Feedback from lecturers and other teaching staff about the training workshops is, without exception, very positive.

Academics attending the training workshops all agree that this programme presents a great opportunity to empower students, and prepare them for the changing needs of the business world.

This programme has the potential to deliver a significant contribution to addressing the ICT skills shortage, but this can only be realised through more rapid expansion of the programme to other education institutions in Sub-Saharan Africa.

There is no doubt in the minds of the implementation team at CPUT, or for that matter any of the academics who were trained in any of the training workshops, that this programme is relevant for the business world.

So, what remains to be done is simply to expand the programme, reach more higher education institutions, and empower more and more students.

In addition CPUT has to delegate some of the responsibility of running the programme, eg by creating one “Hub” each in East-Africa and West-Africa.
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AN ICT SYSTEM FOR DECISIONAL SUPPORT IN UNIVERSITY MANAGEMENT

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Abstract: Informational systems are becoming essential for the success of the organization. A successful information system must utilize both global and local knowledge of both products and customers. This paper presents a Decision Support System that aims to be a grey-box system that combines specific knowledge in a certain domain, with the preferences of the user. It is addressed especially to university managers who wish to base their decisions on rigorous solid scientific methods. The Grey Decision Support System (GDSS) is a tool that helps decision makers choose from more possible decision alternatives the one that suits best their needs, based on a set of decision criteria of their choice and a set of recommendations given by the system. Thus the proposed system is a Business Intelligence system as it is a specialized tool for data analysis, query, and reporting, that supports organizational decision-making that potentially enhances the performance of a range of business and academic processes.

Keywords: organizational decision-making, business intelligence system, knowledge management, university management.

I. INTRODUCTION

Knowledge management is a relatively new concept that first emerged during the 1990s. Its main objective is to improve the way in which organizations manage one of their most important and intangible assets, Knowledge. One of the first definitions of knowledge management can be traced back to Davenport (Davenport, 1994) who defines the concept: “Knowledge management is the process of capturing, distributing, and effectively using knowledge”. Another more elaborate definition is given by King (King, 2009) “Knowledge management is the planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed”.

By conducting an analysis of the various definitions existent in the field (Boomer, 2004; Becca-Fernandez, 2008; Kiku, 2009; O’Dell, 2011) and those presented above we can state that the knowledge management process postulates the existent connection between knowledge and organizational performance. It is concerned with managing the steps required to effectively and efficiently utilize knowledge and also with the processes that support these steps.

Knowledge management has to contend with three types of knowledge:

- **Tacit knowledge** which is located within the mind of a human being and can be very difficult or even impossible to explicate and extract.
- **Implicit knowledge** which is held within the mind of a person and can be synthesized into
various forms (e.g. documents), but has not been thus far.
- **Explicit knowledge** has been codified and stored in a certain media and can be easily transmitted to others.

Lew Platt, ex CEO of Hewlett Packard emphasizes the importance of knowledge management in business thru the following statement: "If only HP knew what it knows it would make three times more profit tomorrow". O'Dell and Grayson (O’Dell, 1998) suggest that an ineffective knowledge management approach can lead to opacity within organizations and to a state in which “the organization does not know what it knows”. Knowledge management is important, in today's highly flexible and increasingly demanding marketplace in which the only constant is uncertainty, because it provides the only sustainable competitive advantage (Halal, 1999; Alavi, 2001).

II. TYPES OF DECISIONAL SUPPORT PROGRAMS

Knowledge management (KM) can have great efficiency, on an individual and organizational level, when it is implemented correctly thru decision support systems. This is because KM is closely integrated with information and communication technologies (Schmidt, 2005; Mihalca, 2008), which play a key role in enabling and supporting its practice (Becerra-Fernandez, 2008) and because of its capability of reducing bias in the strategies formulated by a decision maker. In this respect decision support systems are a key tool in KM, because they act like an expertise locator for the individual or organization, which is trying to ascertain a correct path of action. Decision support systems come in a varied array of shapes and sizes. They vary based on the way organizational and individual knowledge is located, extracted, organized and ultimately presented to the decision maker. We identify two types of support system: the “Black Box” and “White Box” systems and propose a third type the “Grey Box”. The “Black Box” DSS (BBDSS) is centered on automating knowledge by applying systems that tend to solve problems in the place of individuals (Zuboff, 1988). These have the propriety of reasoning in a limited and narrow field (Becerra-Fernandez, 2004). They are useful when applied to routine activities and in the case of rule based or case based reasoning. There are some drawbacks in the utilization of BBDSS. They tend to become cumbersome, unwieldy and error prone when the number of rules applied in a system increases, or when these cannot be specified precisely. The rigidity and frailty of such systems was eloquently displayed a few weeks ago when Wall Street’s BBDSS triggered an automatic response to the fake news that the president of the U.S. was shot, causing billions of dollars in losses to stock market investors.

The “White Box” DSS (WBDSS) takes the diametrically opposite approach. It is focused on guiding the decision maker by presenting relevant knowledge, thus enhancing their interpretation of it and facilitating problem solving (O’Leary, 2003). Sometimes though this system can overload the individual with information and create confusion and unnecessary time depletion in the process.

This paper presents a “Grey Box” Decisional Support System (GBDSS) as a tool in the KM arsenal that combines characteristics of the “Black Box” and “White Box” systems. It facilitates and explicates an individual’s decisions based on a set of personal, programmable criteria (BBDSS) and it presents recommendation and guidance (WBDSS) solely based on them. As a result the vast amount of information available is synthesized into knowledge based on which the decision maker can ascertain the best course of action in a shortened time span. The presented GBDSS can be used in various situations both by business administrators, but also by academics who have managing positions and are faced with daily challenges.

III. A GREY DECISION SUPPORT SYSTEM FOR KNOWLEDGE MANAGEMENT

Informational systems are becoming essential for the success of the organization, be it profit oriented or non-profit. A successful information
system must utilize both global and local knowledge of both products and customers. By
global customer knowledge we mean knowledge that is independent of the particular product
domain, such as knowing how people make purchase decisions or how best to “converse”
with them online. Global product knowledge includes the product’s attributes, their
functionalities, and anything else that is independent of the particular seller’s offerings
(Andonie, 2007). A domain expert in personal computers, for instance, knows video cards, their
performance capabilities (e.g., which type of card is needed for displaying photographs, playing
video games, or showing movies), their approximate prices, and even how rapidly their
technology is changing. Local customer knowledge refers to the ability to link a
customer’s personal needs, uses, and preferences to the focal product. Thus, a consumer may have
a high need for status among coworkers that might influence many purchases. However, local
consumer knowledge enables a DSS to direct the consumer toward a particular product, such as a
personal computer with the image of the latest and greatest technology or an automobile that
signals status (at least to the target audience of coworkers). Local product knowledge focuses on
the vendor’s offerings. Such knowledge not only includes models, styles, components, add-ons,
etc., but also which components can be configured with others and the moment-to-
moment availability of any recommended product or special offers.

We propose a Decision Support System that aims
to be a grey-box system that combines specific
knowledge in a certain domain with the preferences of the user. The Grey Box Decision
Support System (GBDSS) is a tool that helps
decision makers choose from more possible
decision alternatives the one that suits best their
needs, based on a set of decision criteria of their choice and a set of recommendations given by
the system. The GBDSS is based on an algorithm that combines two well-known methods: the
hierarchic-analytic process and the advanced multi-criteria analysis based on FRISCO formula
(Grecu, 2012). The GBDSS is applicable for an
unlimited number of decision alternatives and
selection criteria. For exemplification, we have
chosen to present the situation with 5 selection
criteria and 5 decision alternatives. The GBDSS
has a vast applicability and the set of
recommendations that the user should consider
when making a decision is different for each
specific domain.

Following we present an example of a
hypothetical situation that can be encountered in
a university. Let’s assume that the computer
infrastructure needs to be renewed and thus the
administrator is faced with the challenge to
purchase a certain number of computers for a
computer lab. The system allows him/her to
choose from a drop-down list the purpose of the
computers. Such a list can contain the following
options: buy the computer for gaming, video editing, 3D product design or text editing. If the
decision maker chooses that he/she wants to buy
the computer for video processing, for example,
the system returns a list of recommendations
regarding the configuration of such a computer.
Thus the decision maker can make informed
decisions. He knows now that he should consider
buying a computer that has a good video card and
that it’s also important to have a high speed
processor and RAM memory.

The system allows the decision maker to define
his/her own selection criteria and decision
alternatives. In table 1 there are presented the
ones used for exemplification.

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Code</th>
<th>Selection Alternatives</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>C1</td>
<td>HP</td>
<td>A1</td>
</tr>
<tr>
<td>Processor</td>
<td>C2</td>
<td>Dell</td>
<td>A2</td>
</tr>
<tr>
<td>RAM Memory</td>
<td>C3</td>
<td>Acer</td>
<td>A3</td>
</tr>
<tr>
<td>Video Card</td>
<td>C4</td>
<td>Lenovo</td>
<td>A4</td>
</tr>
<tr>
<td>HDD</td>
<td>C5</td>
<td>MSI</td>
<td>A5</td>
</tr>
</tbody>
</table>

Table 1: Selection criteria and decision alternatives
After naming the criteria, the decider has to define the relationships between every pair of two criteria. In other words, every criterion is compared against the others and a quadratic matrix that presents how these criteria relate to each other is filled in by the decider. When comparing two criteria the decision maker faces three possible situations:

- Criterion 1 is more important than criterion 2 – in this situation the score for criterion 1 is “1” and the score for criterion 2 is “0”
- Criterion 1 is equally important as criterion 2 – in this situation the score for both criteria is “0.5”
- Criterion 1 is less important than criterion 2 – in this situation the score for criterion 1 is “0” and the score for criterion 2 is “1”

In order to simplify the completion of the relationship matrix, a formula has been added to the cells below the main diagonal of the matrix, so if the decider believes that criterion 1 is more important than criterion 2, the formula automatically shows that criterion 2 is less important than criterion 1. Also the main diagonal has been automatically filled in with “0.5”, showing that each criterion is equally important with itself. This eliminates the risk of inconsistency of the relationship matrix. Table 2 shows how the matrix is filled in, highlighting with different colors the fields that can be filled in by the user and the ones that will be automatically filled in.

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>C1</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Processor</td>
<td>C2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>RAM Memory</td>
<td>C3</td>
<td>1.0</td>
<td>1.0</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Video Card</td>
<td>C4</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>HDD</td>
<td>C5</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 2: Relationship matrix

It is important to remember that the scores presented above are the choice of the decision maker. This choice can be based on recommendations from the literature, vision, mission and strategy of the university etc.

After the relationship matrix is complete, the SDSS will apply FRISCO formula (1) to rank the criteria and allocate an importance coefficient or weight factor ($\gamma_i$) for each of them. The FRISCO formula (an empiric formula given by a well-known creation group in San Francisco - USA) was chosen as it is recognized worldwide as being the best and most used formula for this type of analysis [18, p.1933].

$$\gamma_i = \frac{p + \Delta_p + m + 0.5}{-\Delta_p' + \frac{N_{crt}}{2}}$$

where:

- $p$ – is the sum of the points (on a row) scored by the analyzed element;
- $\Delta_p$ – the difference between the score of the analyzed element and the score of the element on the last level; if the regarded element is the element on the last level, $\Delta_p$ will have the value 0;
- $m$ – number of criteria outranked (standpoint of the score) by the regarded criterion;
- $N_{crt}$ – number of regarded criteria;
- $\Delta p'$ – difference between the score of the regarded criteria and the score of the first criteria (resulting in a negative value); if the regarded criteria is the one place on the first level, the result will be 0.

For the example given above, the weights for each criterion, calculated using the FRISCO formula are given in table 3.
Table 3: The weights for each criterion, calculated with FRISCO formula

Then, the decision alternatives are compared against each other, based on the extent to which they satisfy each criterion. Thus, in the example given, the alternatives have been compared to each other five times – once for each criterion. The same algorithm was applied when the quadratic matrix was generated and the scores 0, 0.5 and 1 were allocated as shown above.

In addition to the calculation of the weights based on FRISCO formula, which show how each alternative satisfies the criterion, there has been calculated the “array of importance”. The array of importance is calculated with the algorithm specific for the hierarchic-analytic process: (Rosca, 2009)

After the quadratic matrix has been generated, it is “normalized”, generating a new matrix, noted with A. Each value of each column is divided to the sum of the values of that column, using the formula (2):

$$b_{ij} = \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}}$$  \hspace{1cm} (2)

The array of importance, w, is calculated as the average of each line from the normalized matrix, using formula (3):

$$c_{ij} = \frac{\sum_{k=1}^{n} b_{ik}}{n}$$  \hspace{1cm} (3)

Given the fact that the quadratic matrix is filled in based on the algorithm presented above, it is consistent and thus the calculation of consistency is no longer required.

Table 4: The final decision

The final score for each decision alternative is calculated by adding the products generated by multiplying its score of the alternative for each criterion with the weight of the respective criterion. This is done both for the weights generated with FRISCO and the array of importance. Then the arithmetic average is calculated between these values, for each alternative and the one with the highest score is the optimal solution (table 4).

IV. THE ON-LINE GREY DECISION SUPPORT SYSTEM

The usefulness of the Grey Decision Support System is highlighted by the need to make decisions based on real facts and needs specific to each domain. However, the algorithm
presented requires good mathematical abilities for the decision maker, and this can therefore limit the usage of the proposed decision support system.

In order to ease the use of the GDSS and increase the number of potential users, the system was put online. The GDSS allows an indefinite number of criteria and decision alternatives in a user friendly interface. For this purpose an extension for the Content Management System Joomla! 1.5 has been developed. It can be easily integrated into any website created with Joomla! 1.5. (Grecu, 2011) First, the user is requested to enter the number of criteria and the name (or label) for each criterion (figure 1). Then the quadratic matrix is generated and the user has to compare each criterion against the others, having the option to choose whether it is more important, equally important or less important than other criteria (see figure 2).

Then, the user is asked to enter the alternatives and then to compare each alternative based on each criterion (see figure 3).

The software then uses the algorithm described in the previous paragraph and returns the optimal solution, as shown in figure 4.

V. CONCLUSIONS
The proposed decision support system allows university managers to choose the best alternative out of a set of possible ones, based on a group of custom-defined criteria. The system allows the use of an indefinite number of alternatives and criteria. However, in this paper
there was presented a scenario with five possible decision alternatives and five selection criteria.

Universities have different approaches of the management process. There are of course different challenges, budgets and opportunities and the decisions that a university manager has to deal with may vary substantially from one day to another. The grey box decision support system (GBDSS) speeds up the decision making process and increases the quality of the management process. It can be used both by university managers and by business administrators and is easily adaptable to any situation.

Underlying the GBDSS is an innovative approach that combines two well-known algorithms: the hierarchic-analytic process, used mainly in operations management, and the advanced multi-criteria analysis based on the FRISCO formula. The developed algorithm requires good mathematical abilities from the user, and this can therefore limit the real-life applicability of the proposed decision support system. In order to make it easier to use the GBDSS and increase the number of potential users, the GBDSS was implemented online with a user-friendly interface.

The aim of this paper was to assist decision makers and providing them a scientific instrument for an objective approach. The presented Grey-Box Decision Support System can be improved and adapted to various situations, according to the needs of the decision maker. The example that was used to exemplify the usability and utility of the system can be substituted with any other potential dilemma. Further research may mean creating a series of databases with recommendations based on knowledge, in order to guide the user when choosing the decision criteria and their importance for the project.

VI. References


FACTORS INFLUENCING TRANSFORMATIONAL E-GOVERNMENT READINESS: A PERSPECTIVE OF LOCAL GOVERNMENTS IN SOUTH AFRICA

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Abstract: In this paper, Structuration Theory (ST) was used and drew on the enactment of technology-in-practice (ETiP) concepts. ETiP was used as a lens to determine the factors influencing the readiness of municipalities to transform to deliver services to South Africans using ICT. It is these ICT based activities which I term “Transformational e-Government” (TeG). Through intensive investigation of e-Government initiatives at selected municipalities and using related analysis to map out the emergence of the evident socio-political conditions, it was found that there are a number of factors suggested by ETiP are influencing the readiness of these institutions to deploy any e-Government strategies to improve service delivery. The interpretive case study was used; the implications of the study are that, for socio-political phenomena such as TeG; ST is able to provide the lens through which to determine, understand and interpret the factors contributing to the readiness of municipalities to implement TeG to improve service delivery.

Keywords: Transformational eGovernment, Structuration Theory, Enactment, Municipalities, Readiness.

I. INTRODUCTION

E-Government gained significant popularity in developing counties at the beginning of the 21st Century. These were seen from the many governments’ websites, e-services and other electronic transformation strategies. However, these initiatives did not produce the desire results. Dada (2006) in his article “The failure of e-government in developing countries: a literature review” alluded to this observation. Furthermore, Heeks (2004) indicates that 35% of e-government projects in developing countries resulted in total failures and that 50% were partial failures. To increasing the benefits of such initiatives and improving e-Government strategies of developing countries, Transformational e-Government (TeG) which aims at addressing the cultural and organisational barriers which have hindered local government (Municipalities) benefits realisation is introduced (Irani et al., 2007). Irani et al. (op.cit) defined TeG as “the exploitation of e-government such that benefits can be realized” i.e., the use of ICT to enable radical improvement to the delivery of services (ibid). Although there has not been much literature in this area of research, literature reviewed thus far indicates that there are challenges which have hampered many municipalities in achieving improved service delivery through their technology investments.

This paper presents a preliminary understanding and interpretation of a real case study of challenges of TeG drawing on the concepts of duality of structures from Structuration Theory and in particular “enactment of technologies-in-practice” as a lens through which to determine the factors contributing to the readiness of Municipalities to implement TeG. The paper has two objectives: firstly, to present a theoretical understanding and interprets the concept associated with the point of view of using data from a real case study and secondly, to suggest a general framework that provides insight to the degree of readiness of Municipalities to adequately implement TeG initiatives and strategies. Given the above, this paper is structured as:
Overview of Structuration Theory

This overview will first trace the various attempts that have been made in literature to “reconcile” Structuration Theory (ST) with the very real challenge of gaining a deeper understanding of the challenge and the impact of eGovernment initiatives and strategies by municipalities - or to put it in the context of the subject of this study - the factors influencing the degree at which local governments in South Africa are ready to implement TeG. Twum-Darko (2011: 48-49) commented that ST allows for TeG to be seen as a structure. In order to deepen the understanding of ST and how it is applied in the field of technology innovations which is relevant to this research, one need to understand Giddens’ (1984:9-14) characterisation of sociological enquiry, specifically of agency and structure as described in this section.

Agency/Agent and Structure are two of the central constructs of Structuration Theory. Giddens (1984:14) argues that human agency is the ‘capacity to make a difference’ (also known as ‘transformative capacity’) i.e., the flow or pattern of people’s action and not people’s intentions of doing things. Giddens (1984:17,377) further describes structure as resources and guidelines frequently implicated in the ETiP. According to Giddens (ibid.) guidelines are techniques used in the enactment of social practices. Therefore on-going use of technology strengthens technology-in-practice and therefore becoming repeatedly used to carry out social life’s demands. Hence deducing from Giddens (ibid.), ‘rules and resources’ are recursively implicated in the reproduction of social systems. Thus, structure is what gives form and shape to social life, but it is not itself the form and shape (Giddens, ibid.). Structure exists only in and through the activities of human agents (Giddens 1989: 256). Walsham (1993: 34) describes action as having strongly routinized aspects which is both conditioned by existing cultural structures and also creates and recreates those structures through the enactment process. By theorizing this social system, Giddens (ibid.) urged for a conceptualization of the contextuality of duality of structure and hence argued that “the constitution of agents and structure are not two independently given sets of phenomena, a dualism, but represent a duality.” Thus, duality in ST refers to the way in which action and structure presupposes each other”. Giddens (ibid.) further argues that “the structural properties of social systems are both medium and outcome of the practices they recursively organise.” The latter is what this paper intends to address.

Drawing on Giddens’ argument, Twum-Darko (2011: 48-49) further argues that ST offers the window through which to analyse the structure and its formulation (action) as one that constitute a duality i.e., the structural characteristics affect the action, and in turn, the structure can be modified through action which results in a new structure which is the basis of the next change. Furthermore, Orlikowski’s structurational model of the ‘duality of technology’ (Orlikowski, 1992) goes somewhat further in explicitly introducing material technology into the structure/agency duality, and also suggesting that social rules may be ‘embedded’ in information technology solutions during their design, but insisting that they cannot be programmatically read off by humans in a determinist manner (interpretive flexibility) which outside the scope of this paper.

Orlikowski (2000:407) used ETiP (see Figure 1) to further elaborate on the two notions of emergent structures and enactment, and indicated that structures are embodied in technologies to be appropriated by users (municipalities); while users may appropriate these differently from time to time. “That is, rather than starting with the technology and examining how actors appropriate its embodied structures, this view starts with human (municipalities) action and examines how it enacts
emergent structures through recurrent interaction with the technologies at hand” (op.cit.). Therefore, this structurational model (Figure 1) which is based on Giddens’ model represents Orlikowski’s argument of technology appropriation.

To further elaborate on Orlikowski’s (2000:410) concise description of the structurational model, it is repeated verbatim: “When people (municipalities) use a technology, they draw on the properties comprising the technological artefact – those provided by its constituent materiality, those inscribed by the designers, and those added on by users through previous interactions (e.g., specific data content, customized features, or expanded software/hardware accessories). People (municipalities) also draw on their skills, power, knowledge, assumptions, and expectations about the technologies and its use, influenced typically by training, communication, and previous experiences. Users (municipalities) also draw on their knowledge and experiences with the institutional contexts in which they live and work, and the social and cultural conventions associated with participating in such contexts.”

Figure 1: Enactment of Technology-in-Practice

[Source: Orlikowski (2000)]

The Case Study

1) Methodology
Interpretive case (Walsham, 1995) was used to guide the collection and analysis of data. The underlying objective of this approach is to understand and interpret the social phenomenon, i.e., TeG and also to have a deeper understanding of this complex social reality in the light of the inherent influences and constraints of information technology solutions. Adapting ETiP concepts of ST, a theoretical understanding was developed which enabled a comprehensive interpretation of the results in terms of the contributions made by the inclusion and use of technology to institutionalise the factors contributing to the readiness of the organisation. Data collected included documentations such as Technology Infrastructure Policies, Corporate Governance Policy, Enterprise Architecture Strategy, Human Resources Policies, Legal Frameworks, Project Management principles and conducting unstructured interviews with staff of two (2) Metro Cities and fifteen (15) Municipalities at Senior, Middle management and clerical staff who have participated in or have implemented eGovernment initiatives to transform service delivery infrastructure. Most of the interviews lasted between one and half to two hours and they were all fully taped and transcribed.

2) The case in brief
The South Africa constitution (Act 108 of 1996) provides for a three-tier government system: National Government, Provincial Governments and Local Governments (Municipalities). The provincial governments are the nine (9) main regions of South Africa and each region has a number of Municipalities; about 235 in total across South Africa. The constitution mandates municipalities to deliver services to the citizens in their jurisdiction, with powers to raise revenue and to receive transfers from provincial and national governments i.e., service delivery accountability.

3) Creation of the enactment
In this section, we describe the TeG initiatives at Municipalities as a process of ETiP. The need for TeG was initially proposed by the Ministry and Department of Provincial and Local Government (dlpg, 2007:2) as a mandate from the January 2007 Extended Cabinet Lekgotla. Therefore, the analysis started with the identification of the pre-condition for TeG success in municipalities. We therefore assumed that protecting and enhancing the lives of citizens via ICT capabilities i.e., high performance in service delivery is a major ETiP pursued by the management of municipalities interviewed. We then traced the ETiP in the context of TeG at selected municipalities (see pre-condition below).
4) Pre-condition

a) Facilities

Technical Infrastructure: Are the computerised systems capable to interchange data? Is the data of quality and secured?

b) Norm

(a) Legal Infrastructure: Are policies, standards, SLAs, and guidelines in place to ensure compliance and accountability? (b) Institutional Infrastructure: Does the Municipality have effective governance structures in place particularly within the department e.g. Boards & Committees – Contract Management, Steering Committee, etc.? (c) Enterprise Architecture: Does the design of the e-government solution in line with best architecture standards, technical, incremental approach with feasible objectives and quick, scalable outcomes; participatory involvement of all stakeholders, leading to designs that meet real user needs and match real user contexts?

c) Interpretive Scheme

(a) Human Infrastructure: Does the Municipality have the necessary skills and knowledge, especially within the department itself - both management and IT skills and knowledge? (b) Leadership & Strategic Thinking: Does the Municipality have e-champions to provide incentives to create commitment to and to own e-government projects to also ensure stakeholder involvement to build support and minimise resistance?

Implications as a general framework, we considered some of the factors that prevented sufficient implementation of TeG across the selected municipalities which represents, fairly, the situation at the remaining 220 municipalities in South Africa. Given Table 1 (see Appendix A) in relation to the 15 municipalities interviewed, only 7% are READY for TeG initiatives, 60% are NEAR READY and 33 are NOT READY to implement TeG initiatives. There are only 7 Metro Cities in South Africa and given Table 2, it appears they are all ready to implement TeG initiatives. These factors which prevented sufficient implementation of TeG across the municipalities interviewed fall into 3 broad categories as follows:

d) Facilities

Unaligned business processes and limited integration of systems; physical presence of citizens required at Municipal offices for basic transactions and service queries; limited payment options for services delivered; and paper-based filing systems and extensive manual processes;

e) Norm

The absence of eGovernment champions and inadequate ICT leadership; lack of coherent strategy for ICT for service delivery; non-aligned governance structures impacting on ICT decisions; lack of formalized reporting and management information system; and the new legislation promulgated to ensure improved service delivery inadequately implemented e.g., Municipal property rates Act, 2004;

f) Interpretive scheme

Nepotism and favouritism in service delivery due to inadequate knowledge; bad judgment to rollout service types; poor data recording of service types and for which community; and limited access points to obtain services or query services delivered and long queues?

II. CONCLUSIONS

Municipalities and Metro cities are like any organization whose main mandate is to deliver basic services to the public. And as such are to extent driven by ICT enabled organizational transformation initiative like TeG. Therefore, the readiness of these organizations to implement TeG initiatives can be studied using the concepts of EtiP: a perspective of ST as a lens through which to understand and interpret the factors impacting on TeG initiatives in organizations. It further demonstrates that TeG can be studied using technological determinism, social construction of technology perspective as argued by Twum-Darko (2011: 46-50). The outcome of the study suggests that the concept of “Scaling” is appropriate to address the highlighted challenges of TeG initiatives in this paper. According to Sahay and Walsham (2005:43), “Scaling” is the processes and embedded practices by which heterogeneous
networks around a technology (or TeG) are spread, enhanced, scoped, and enlarged. The argument is that scaling concerns aspects of geography, software architecture, people, processes, infrastructure, technical support, and political support. In the context of TeG, scaling could imply the improvement of the pre-condition criteria from an indication of 2 or 3 to 4 or 5 i.e., from NOT READY to READY. In other words, as argued by Twum-Darko (2011:202-203) scaling is the process of taking what is “global” into a “local” framework that ensures that local consensus and conditions are considered, i.e., “glocalization” (Robertson, 1992; Rolland and Monteiro, 2002).

As such “scaling” the TeG may be problematic for the well resourced and well developed Metros in South Africa (e.g., the City of Johannesburg, the City of Tshwane and Ekurhuleni in Gauteng, Nelson Mandela in Port Elizabeth and eThekwini in Kwazulu-Natal). These Cities are ready for TeG initiatives. However, “scaling” would be suitable for the less resourced and less developed municipalities which are looking up to national government and their Provinces for capability and capacity support. This presupposes that each Province (global) may have to decide to have a centralized system of core “global” functionalities that is uniform across the province for the less developed and resourced municipalities but with “local” customizations that allow for local requirements or expectations. By scaling, the pre-conditions for sufficient implementation of TeG can be improved.

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THE EVOLUTION AND IMPACT OF THE KAIZEN CONCEPT AND KAIZEN MANAGEMENT IN THE ECONOMIC AND SOCIAL ENVIRONMENT IN ROMANIA

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Abstract: Kaizen Concept and Kaizen Management means evolution under innovative form supported by a frame solid enough to face changes but at the same time, flexible enough to adapt rapidly thus obtaining competitive advantage. According to Masaaki Imai, the founding father of the Kaizen Management, the model has a universal character being able to be applied in any country and company, regardless of its field of activity. This paper follows the evolution of the Kaizen Management in Romania from both an economical and social point of view. Considering that the approach of the Kaizen Management in Romania follows the social development, too, the paper will finish with the analysis of the first two 5S Public actions done in Romania and Europe in order to identify the impact of the Kaizen philosophy up to this moment and shaping some provisions related to the Kaizen Management evolution in the following years in the economic and social direction.

Keywords: Kaizen concept, Kaizen management, Social environment, Philosophy, Quality.

I. INTRODUCTION

The present paper approaches a field to which the interest of practitioners has increased constantly since it appeared around the 1980’s and up to the present. Created based on the evolution of the quality concept and in the favourable context of the appearance and development of organizational culture, national culture and intercultural management concepts, currently, Kaizen Management is considered to be the most advanced management system in the world (Țîțu, 2011).

The concept is under continuous interdependency with the terms “muda” (loss/waste) and “gemba” (place of work). Because gemba represents the place where value is added on the one hand, by the good maintenance of the equipments and on the other hand, by eliminating muda, in Kaizen Management one aims at a practical approach with low costs in which continuous improvement is based on the involvement of the entire staff (Imai, 2006). The evolution’s success factor is maintaining harmony (Kaizen Conference, 2011) both in the work environment and in the private life of the Kaizen practitioners, for Kaizen is a philosophy which aims at the improvement of all environments it comes in contact with.

Regardless of the country they come from, culture or level of life they enjoy, people share a common need to work in a clean, safe and inviting space, in which they can find in the shortest possible time the necessary objects with minimum effort. Kaizen does nothing else than to transpose in common-sense rules these needs. Regardless if we are talking about the economic or private environment the principles of the Kaizen philosophy are easy to apply once they are understood. However, for its good functioning one requires enthusiasm, consistency and especially, discipline. Under the guidance of the Kaizen consultants and through top
management, a company’s structure, culture and management can be restructured, improved and brought to excellence. In the context presented, this paper follows the evolution of the Kaizen Management philosophy in Romania, offering a general frame for the future companies, which are going to embrace Kaizen techniques and practices.

II. A GENERAL OVERVIEW ON THE KAIZEN MANAGEMENT CONCEPT

Kaizen, Japanese term of Buddhist origin can be summed up by the following words: “Renew your heart and make it better (Banu, 2006)”. The Kaizen Management concept, which first appeared in 1986, has Professor Masaaki Imai as main author, internationally renowned specialist, acknowledged in the field of management, presently, founding president of the Global Kaizen Institute with its main headquarters in Switzerland and with branches in the United States of America, Europe, Africa and in the Asia-Pacific area. Professor Masaaki Imai has implemented the “the Kaizen” concept promoting respect for human intelligence and creativity.

The most often used antonym for this concept is the well known “never mind, it works anyway!”, because Kaizen can be illustrated by the phrase “always better (Banu, 2006)”.

According to Imai, Kaizen (kai – continuous, ocean – and zen – well, improvement, wisdom) means continuous improvement not only in the professional life but in the social and personal one, too. Applied in the working place Kaizen Management means the continuous improvement of all, both managers and workers (Imai, 1986). As opposed to the European and American philosophy, both focusing on innovation through significant costs, Kaizen promotes constant improvement, performances being obtained by progressing with “small steps”, day after day, with minimum investments, the entire activity being done by active participation of all employees in the improvement process.

According to Masaaki Imai’s plastic formulation “a step forward made by a hundred people is more valuable than a hundred steps made forward by their leader” (Imai, 1986). This evolutionist, perpetual process generates a series of advantages: productivity increase, loss elimination, general production/services cost reduction and breakeven point reduction, sustainable quality, delivery dates and work conditions improvement, employees’ motivation and involvement in the continuous improvement of the company’s performance through discipline and standardization.

Due to the benefits it brings in the structure of the organization in which it is involved, Kaizen management is considered the most viable alternative of our days under the conditions of labour market development and competition. Based on a solid structure, with very clear principles, Kaizen represents the perfect balance between adaptability, continuous improvement through change and reliability. Kaizen Management evolution has been tightly connected to that of quality management, process in which many experts in the field of quality have taken part (W. Edward Deming, Joseph M. Juran, Philip B. Crosby, Armand V. Feigenbaum, Walter Shewhart, Kaoru Ishikawa, Taguchi and Groocock (Țifu, 2011)).

After the fusion of their ideas kaizen techniques and practices have been created, strategically thought to be implemented anywhere in the world, regardless of the country’s or company’s culture in which they end up working. Masaaki Imai subscribes to this idea saying that Kaizen Management can be applied in a wide range of fields other than the economic ones such as governmental services, schools and other institutions, this thing being useful even in countries characterized by controlled economy.

Kaizen Management’s main methods, practices and techniques are:

- for organizing the work space and reducing losses or defects: Gemba, 5S, Visual Management, Muda, Mura, Lean, 6 Sigma and Kanban;
- for identifying the roots of the problems: the Cause-effect chart (Ishikawa), 5Why Analysis;
- for motivating employees it uses the suggestion system, tetan.
The purpose of these techniques acknowledged at international level as continuous improvement methods, through small steps, of economical results of the companies in which they were implemented, is to bring together all of the company’s employees for improving the communication process and cementing the feeling of belonging. On a tough competitive market, such as for example that of the European Union, the benefits of the Kaizen Management offers a significant competitive advantage (Țîțu, 2010).

III. KAIZEN PHILOSOPHY IN ROMANIA

After the year 2000 one could notice an intensification of the relationships between Romania and Japan economically, as well politically, socially and culturally. Even though the quality management culture has had a stronger support in the last decade through bodies such as the Romanian Society for Quality Assurance (S.R.A.C.), the Romanian Movement for Quality (M.R.C.), the Romanian Association for Quality (A.R.C.), Romanian Foundation for Quality Promotion and the Foundation Romanian Prize for Quality “J.M. Juran”.

After establishing the Romanian Kaizen Institute in 2004 the gate to Japan and implicitly Kaizen Management was opened. Even though the list is non-exhaustive currently one can assert that at national level there are 15 main bodies that support the promotion of quality management for the benefit of natural persons and legal entities. Out of these Quasaro, Braco, IKaR, Kaizen Manager Club, Kaizen Training and Consulting offer consultancy, certification and expertise in the field of Kaizen Management, facilitating the development of the Romanian-Japanese economic and social environment.

The Clean Up Japan Association, in collaboration with Kaizen Institute Romania, Kaizen Manager Club and AOTS Alumni Society Romania help promote the Japanese culture in the Romanian environment through activities they make in collaboration with local authorities and companies that function according to the Kaizen Management techniques and practices. Japanese Romanian Business Association facilitates the commercial and economic collaboration with Japan promoting Romanian products on the Nippon market while the two Embassies offer the framework for the development of bilateral relations between Romania and Japan both on economic, political and cultural level.

Through the activity these bodies have annually, the Kaizen philosophy and quality culture gains more and more interest. Only eight years after the Kaizen Institute Romania was established its portfolio encloses a diversity of services offered to companies, employees and societies alike. Thus, one can speak about Kaizen for companies and SMEs through the consultancy, training and qualification services, Kaizen staff for the personal and professional development of managers and employees, Kaizen for youths for their harmonies development and social Kaizen through the 5S public actions. The Kaizen philosophy slowly becomes for companies and employees, youths and society alike, a life style in which performance and efficiency as well as the value of each individual is truly cherished.

One can assert that presently Romania is living the experience of some complex changes identifiable at the level of all organizations types (Huțu, 2003). The bureaucratic type culture highly political until 1989 is slowly being replaced by the entrepreneurial type culture which can especially be found within private share firms established after the creation of free market mechanisms in Romania. Together with this change the shaping of values preoccupied with setting realistic goals and creating pragmatic action strategies that will generate product and services performance and quality, taking into consideration the care for the environment, began (Huțu, 2003). This change determined that more and more Romanian employees leave the traditionalist, inertial and change resistant bureaucratic institutions in order to work in entrepreneurial organizations in search of accomplishments, prosperity, significance and direction. More so, even though the vast majority of new entrepreneurs do not possess the knowledge and skills necessary for creating a coherent strategic perspective or dynamic adaptation to the external environment yet they are enthusiastic and dedicated to their firm, essential characteristic for Kaizen leaders. One requires credibility, that is why reforming visions regarding the development of their firm are communicated to the employees with enthusiasm, thus generating a sense of belonging (the organisation “as a family”), of the involvement and commitment of solving the organization’s problems (Huțu, 2003).
These complex transformations are developed on a social foundation in which with every day that goes by an acute need for the promotion of real values and for their correct hierarchy in which the employees know the meaning of belonging to a certain organization, the purpose and direction of the activity they render is pointed out. And this particular social background justifies the Kaizen Management implementation.

IV. THE ELEMENTS OF KAIZEN MANAGEMENT IN ROMANIA

In a broad sense, Kaizen techniques and practices implementation in the companies in Romania has as purpose the performance culture development on all organization levels by involving the entire staff and preparing the Romanian companies to become competitive on the global market. In the industry field, the general purpose of the Kaizen Management implementation is represented by the continuous improvement of product quality, costs reduction and shortening delivery dates, requests brought mainly by customers. As far as the general objective is concerned, it aims at increasing productivity and reducing production implementation. In the field of public services, the main purpose consists of increasing services performance and implicitly, reducing internal costs, the objective being reducing the process development duration (Lead time – Lt) with minimum 20% and synchronizing the service rendering activities and the informational flux.

In Romania, the Kaizen Management practices have been implemented in a very wide range of companies, from banking institutions and local councils to companies that offer products and services, or academic institutions. Among them there are companies that activate in the car industry (Takata-Petri, BOS Automotive, Star Transmision Cugir), transport (Bucharest Airports (Kaizen Institute Romania, 2011), Signus RO Distribution, Damen Shipyard Galati), banking (Romanian Commercial Bank, Transylvania Bank, Volksbank Romania), companies that offer design services (National Land Register Agency, Cambric Consultancy), architecture (Architect Services), but also public services in county councils (County Council Arges, Bucharest Mayoralty), or national state agencies. Also, other significant sectors are production (Grup Romet, Artic Târgoviște, Pirelli România (Kmen, 2010), 10th Bearing Plant, Aromet, Bega Electromotor, Contor Zenner, Romstal, Swedwood România, SAFT Power Systems, RAAL) and products/services (Biborțeni, Murfatral România, Martelli Europe, Japan Tabacoo International (JTI), Romdrinks Eurotrade (About Kaizen, 2007)).

Regarding Kaizen Management implementation in the firms in Romania, at the chapter obstacles in the path of quality improvement and company’s profitability increase through Kaizen, at the top of the list “mentality” and “staff’s resistance to change” are placed at the top of the list. However, according to those in charge with Kaizen Management implementation both obstacles are significantly influenced by the lack of information, reason for which a decisive factor in ensuring the successful implementation of the Kaizen Management is held by the company’s management. “The company’s management does not always assume the role of employees’ mentality shaper” says Julien Bratu, director of Kaizen Institute Romania. In order to solve this aspect, seminars are held (workshops) destined for top/middle management training for increasing the speed of employees’ mentality change and reducing resistance to change.

After having analyzed some companies in Romania that have implemented Kaizen Management it was identified that once the work techniques and practices are explained the employees end up embracing the company’s organizational culture and supporting Kaizen Management. The majority of the employees consider that the biggest change Kaizen Management brings is the organization’s openness toward new, underlying the importance of team work and stimulating imagination, long term planning and practicing common sense rules that require the commitment of all, regardless of the level. An aspect pointed out regarding the companies in Romania that apply Kaizen Management is that they are characterized by a culture perceived more at the level of practices, the mentality of the Kaizen philosophy is not always adopted in the employees’ life style.

In other words, Romanian employees adapt to the work style of a culture as long as they can benefit from it. The Romanians do not take the basics of certain work practices (regardless of culture), they only take the form because of the advanced system of motivation and reward. However, properly identified and used, this particularity of Romanian employees can bring benefits to employees and company, customers, end consumer and, last but not least, to society and the natural environment. The management of one
of the companies with the most efficient type of Kaizen Management in Romania stated that for the facilitation of Kaizen Management implementation courses and activities maintenance are prioritised, these two favouring staff integration (to these adding the visible know-how transfer, benchmarking, efficient communication between levels and understanding the concept of “team work”). The credibility of Kaizen managers and referents is essential in involving employees in company activities, and that is why the motivational and rewarding system needs to be generous, as a consequence, employees living up to the level of expectations.

The informational transfer is done between levels facilitating activity maintenance, supervision and solving problems in the shortest period of time. In general terms, it was determined the Kaizen techniques implementation requires a period of at least 6 months for ensuring activities stability and continuity. It is believed that in deed cultural differences can be harmonized by the organizational culture, the statement being based on the argument according to which promoting a healthy organizational culture based on truth, justice and mutual respect is applicable in any company because employees react in the same manner everywhere on the globe, at the core their needs being the same.

However, in case they are requested, small differences can be agreed upon. Due to the fact that the Kaizen Management here in Romania is adapted to Romanian market particularities, companies end up making certain concessions for employees (regarding uniforms or style of work) yet keeping the integral structure of work practices and techniques. However, the main vision is that once the work conditions are changed, the employees’ behaviour will change as well. By changing the work manner and environment, people and culture change, too. As a consequence, the differences regarding national cultures are not noticed as a significant influence factor.

A recommendation regarding Kaizen Management implementation by companies would be the following. For starters, one has to consider the argument according to which “management” in itself is a cultural system which, many times, is incompatible with “native’s” predetermination. This is why the recommendation refers to the correct identification of cultural differences that influence the company’s management for the continuous improvement of working systems. It is considered that one type of intercultural that is efficient in Romania is a management that acts according to a hybridization logic thus taking into consideration elements of the “general intercultural management” adapted to the reality in Romania and the post-socialist work ethics as a fundamental cultural difference (Mateescu, 2008).

In order to facilitate this aspect, company management needs to be able to transmit employees the idea that cultural differences are an inexhaustible improvement source, aspect manageable by intensifying benchmarking processes in firms in the same area in order to support the rise of competitiveness level. If we take into consideration the argument according to which “there is no good management which produces a good management, only a good management, adequate to the suggested culture”, it is understandable why when the reproduction of success, it is not the management system that needs to be reproduces but to create management systems adapted to management because, as Peter Dupriez states, “all management is cultural (Mateescu, 2008)”.

V. SOCIAL KAIZEN IN ROMANIA

In the moment in which the individual decides to continuously improve his life, the effects of his actions are firstly seen on the environment in which he develops his activity. This environment, whether we are talking about the infrastructure of the work space or we refer to the persons it comes in contact with day after day, it ends up perpetually changing according to the evolution of the person in case. In time, the effects can be noticed in the community, then in society and last but not least, on nature.

The natural environment is the most pragmatic reflexion of human action. One has to be aware of the fact that each individual and company is part of a vast system which, in order to develop and reach performances in total harmony with the environment, requires the involvement of every sub-system. As a consequence, small improvements are required, sprung from activities done at reduced intervals and to which an increasingly larger number of people can participate. In the virtue of these ideas, Kaizen Institute Romania has undergone in October of
2011 the first social Kaizen activity through a series of 5S public workshops in three of the most important cities in Romania. The project “Japanese glow for the cities of Romania” which took place in Brasov – 11th of October, Timisoara – 13th of October and Alba Iulia – 14th of October pointed at the development of individual conscious in order to raise the community’s awareness regarding the care toward public space.

The project organizers were Kaizen Institute Romania, Kaizen Manager Club Romania and AOTS – Japanese Management Association in Romania who were joined by Clean Up Japan Association, Kaizen Institute Japan, local authorities and a series of experienced kaizen companies (e.g. Hirschmann, Assa Abloy, Takata-Petri etc) but also kaizen companies found in the beginning stages (e.g. Supremia, Stabilus, Eldon etc). Last but not least, asked to participate were volunteers from interested NGOs, associations, clubs, as well as representatives of the local community. The project was considered a success due to the fact that, aside from visible physical results (250 volunteers including 6 mayors and vice-mayors, 7 news posts and 1500 km travelled in one week), a first step was done in removing two of the most acknowledged obstacles previously mentioned in the Kaizen practices implementation: “disbelief in the Kaizen philosophy” due to lack of information and “peoples’ resistance to change” due to the mentality “it also works like this”. Through the project “Japanese glow for the cities of Romania”, the volunteers were able to realize that 5S is a way of expressing the Kaizen spirit in the public life space, but also a lifestyle which helps them and those around them to grow.

Regarding the project’s impact on the community and society, the results are considered through the perspective of purpose accomplishment. The proposed purpose was to improve cooperation relations between the public partners of a city’s life. Thus, one could notice that people started thinking in “Kaizen style” right after they become aware of its significance. Either if by Kaizen one understands the attitude of always being better and to change for the better the things around, which depend on each individual, or if it is perceived as a philosophy in which justice, peoples’ value, common sense and order represent the most important pillars, it is important that the philosophy begins to take shape in peoples’ minds. The management of the Kaizen Institute Romania considers that the purpose was mostly reached if one takes into account the participants’ reaction and especially the national and local mass-media echoes from after the event. Even though the “Kaizen – 5S Public” type workshops are considered to be able to change, in time, the behaviour and mentality of Romanians developing individual conscious, according to Julien Bratu, in this incipient phase one can only speak about creating an opening toward a behavioural change and of consolidating the hope that society can change if it wants to. He added that based on the experience he has acquired in working with partner companies, he was able to note that Kaizen Management shapes and improves in a harmonious way the life and thoughts of those who practice it, individually, as well as collectively. None the less, the director of the Kaizen Institute Romania believes that in order to be able to talk about a real change in the society’s mentality the realization of a 5S Public action at least once a month is necessary in a systematic manner for 3 consecutive years. Thus, the extrapolation of the 5S Public actions at national level could be done in 10, 20, 50 or 3 years, according to the comprehension power of the Kaizen values manifested from the political level.

Due to the fact that the need to develop social awareness projects by using Kaizen Management techniques, practices and methods was understood, in the period of 13th – 14th of March 2012, the Kaizen Institute Romania has organized in collaboration with KAIZEN Manager Club, AOTS Romania (Japanese Management Association), County Council Alba, RNP ROMSILVA – Forestry Directorate Alba, “Axente Sever” Local Centre of the “Romanian Scouts” National Organization and with the support of the companies SUPREMIA GRUP, HIRSCHMANN Romania and ASSA ABLOY Romania, the project “Kaizen for Alba County”. The project focused on two directions within which two new programs for the development of the economic environment and society were launched. The first of the direction took place on the 13th of March and addressed the economic sector. The product “Kaizen for SMEs” is destined to support the continuous performance development of small and medium Romanian companies in the context of an environment in which one still feels the effects of the financial crisis. The Implementation program has objectives structured on 3 levels (Kaizen for SMEs):
• Level 1: implementation of basic standards from the Kaizen culture;
• Level 2: developing performance in processes by applying Kaizen techniques;
• Level 3: obtaining top performance in its business field from the point of view of quality, efficiency (low costs) and delivery speed.

It is considered that once more and more SMEs will adopt Kaizen Management the results obtained by them will facilitate the promotion of Kaizen Management in the field. Presently, promoting management in order to raise the concept’s visibility level is equally important as implementation itself. The project continued on the 14th of March when the program “Individual Kaizen for youths” was presented, the first personal development program offered by the Kaizen Institute Romania focused on obtaining personal performances through the individual strategic management. What makes it different from the “Gemba Kaizen College” and “Kaizen for employees and organization” is the fact that it is not focused strictly on the development of the employees in the organization but it addresses all persons with a “young spirit”.

This imitative was born out of the Kaizen Institute Romania’s desire to focus on the civil society’s durable change. At the basis of this program was the premise according to which mentality change can be done easily from the young level of the population because young people are the most permissible to change, adopting an open and non-discriminator attitude in relation to innovative ideas. It is believed that this program directed toward raising personal productivity and disciplining the mind and spirit could bring, in time, a significant change at the social level in Romania. The changes would be first felt at behavioural level and at the level of the attitude towards work then, in the mentality to work and in the expected results and last but not least, regarding the life style. Starting from a young generation, the next generations could promote a lifestyle based on equity in actions, performance and care for the environment and fellow humans.

Even though the title of the program suggests that the target group is exclusively that of “youths”, due to the high number of requests the Institute’s management has declared that the program shall address all those “with a young spirit” so that all those who are interested, regardless of age, can participate in the courses offered by KI Romania. The last stage of the project “Kaizen for Alba County” consisted of making the action “Kaizen for People and Nature” which has followed the harmonious development of youths and implicitly, the increase of the value brought by them to society, by applying principles of natural evolution. The action aimed at planting seedlings in Oarda locality, 5 km from the city of Alba-Iulia, with the help of 118 volunteers willing to contribute to the harmonious development of the environment. The leaders of the local public authorities were also present – President of Alba County Council, the Prefecture, the Mayor and Vice-Mayors of Alba-Iulia Municipality.

The entire action took place based on the structure of a Gemba Kaizen workshop. Among the results of this activity are: the planting of 700 seedlings 5 km from Alba Iulia, raising the interest related to Kaizen philosophy, raising the level of awareness regarding responsibility for the environment and future generations, raising individual conscious, a better collaboration between state institutions, private institutions, NGOs, media and society and last but not least, enthusiasm. From the feed-backs offered by the participants in the actions one could identify the fact that the volunteers have passed along to their families and friends the information regarding the utility of Kaizen Management in private life. Thus, acquaintances have discovered that they can organize their daily activities better, maximizing their potential and ending up working more efficient. As an effect, Kaizen philosophy has extended its boundaries outside undertaken actions.

VI. CONCLUSIONS

Kaizen Management implementation and functioning in companies from Romania is possible. Everything starts in the mental. As long as there are no pre-conceived ideas and stereotypes, cultural diversity is not perceived as a disadvantage and believable support is offered in implementation, Kaizen Management can be implemented in a large spectrum of fields (Țîțu, 2011).

It is not about changing Romanians into Japanese, but of adapting a management style whose performance and viability have repeatedly been proven to a system in which improvements are necessary, can be continuously created and require the involvement of all employees.
Resistance to change and disbelief in the Kaizen philosophy reliability are favoured mainly by the lack of information. As a consequence, in order to change mentalities and improve society by means of Kaizen techniques and practices, the increase of the philosophy’s visibility at national level is necessary.

Regarding the future of the Kaizen philosophy on national level, experts in the field consider that it will have an ascendant direction, ending up to be found in organizations as well as in the employees’ everyday life and those interested in continuous improvement. The key of the Kaizen philosophy’s evolution, both on economic and social level, consists in promoting the philosophy as management style and life style.

A. References


A STUDY ON THE NEO CONFUCIAN SPIRIT CULTIVATION IN ENTREPRENEURSHIP EDUCATION OF COMMERCIAL UNDERGRADUATES

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Abstract: In the process of globalization, business has gradually become the pioneer of sustainable and healthy development of economy and society. Entrepreneurial intellectuals have become the commanding heights of market competition and development, and the core is to cultivate the values of good and ethics. With China's economic and social development, entrepreneurship, entrepreneurial ability and comprehensive quality are the bases for the education of business undergraduate, which should be based on neo-Confucian spirit and occupation morality. For the practice in Shijiazhuang University of Economics, through the spreading the essence of Confucianism, and probing neo-Confucian spirit connotation, a mode has been established, that is, ‘Neo-Confucian Spirit + Entrepreneurial sense + Entrepreneurial Knowledge + Entrepreneurial Capacity + Business Practice’. The implementation of the neo-Confucian business project penetrates the neo-Confucian spirit into the education reform, which cultivates the distinct characteristics and advantages.

Keywords: Business; Undergraduate Students; Entrepreneurial Education; Neo-Confucian Spirit; Cultivation

I. INTRODUCTION
In CPC Central Committee and State Council on Deepening the Reform of the Comprehensive Promotion of Quality Education Decision, it’s pointed out “Higher education should give weight to cultivating students in innovation, practice, and entrepreneurship”. In the meantime, in economic globalization and knowledge economy, such qualities as honesty and commitment are more demanded. The world pays attention to the moralities of a person, and it is thought that being integrity and honest is the guarantee of success for a man or an organization. According to the statistics of an authoritative magazine, of ten kinds of qualities shared by 100 mainland wealthiest people, honesty is on the top. Therefore, it is important and necessary to introduce the quality construction such as honesty into entrepreneurial education, and cultivate neo-Confucian spirit.

II. THE RELATIONSHIP BETWEEN ENTREPRENEURIAL EDUCATION AND PERSONAL CHARACTER AND QUALITIEES
2.1 Entrepreneurial education: the necessity to adapt to globalization
In Guang Ya Shu Zheng, the Chinese character “creation” means “beginning” or “start”. It can mean “starting to do”, or “doing something for the first time”, or “doing something as a pioneer”. The Chinese character “Profession” refers to “a career”, “a business”, or “accomplishments”, etc. Briefly, the two characters “creation + profession” (entrepreneurship) means starting one’s business. Entrepreneurship is defined in Baidu encyclopedia as: the process to produce more economic and social values where the entrepreneur optimizes and integrates the resources which he owns or could own through efforts. Back to 1965, Cole defined it as “an action with an objective to start, maintain and
develop a corporate oriented to profit”. Jeffry •A• Timmons defined it in New Venture Creation, “a way of thinking, reasoning, and acting that is opportunity obsessed, holistic in approach, and leadership balanced for the purpose of value creation and capture”. (P101)

In recent years, with the acceleration of globalization and education internationalization, entrepreneurial education is not only the issue of concept and theory, but a way for the youth, especially the college students, to live and develop themselves. Entrepreneurial education is a course in colleges and universities, but also a new educational concept, thinking mode and educational mode. Its purpose is to cultivate college students in the sense of entrepreneur, entrepreneurship, entrepreneurial ability and comprehensive qualities, and help them to recognize and effectively take advantage of opportunity so as to realize their dream through scientific planning and decision-making.

2.2 Character and qualities: the cornerstone of entrepreneurial success

Cui Meng (2000) points out that among the graduates, character, such as morality and qualities, distinguishes 20% with the most accomplishments from 20% with least accomplishments. Zheng Bingzhang (2005) believes that entrepreneurial education should give prominence to character development, and combine with campus culture. Yang Youwen (2005) holds that the base of success is the character of the entrepreneur, including such psychological qualities as entrepreneurship and enterprising etc. Jia Wenhua (2006) points out that character education complements the education on entrepreneurship and entrepreneurial ability. In recent years, quite a number of scholars introduce Confucianism into entrepreneurial education. Ma Jianxin (2012) holds “general education” is the aim of entrepreneurial education, and “honesty education” is the base of success. Xie Wenqing (2013) believes that such personal qualities are very important as “studying the nature of the things, acquiring knowledge, sincerity, rectifying one’s minds, and cultivating character”, which are advocated by Confucianism. And such ideas of Confucianism as benevolence and honesty can nourish entrepreneurship.

III . THE BASIS OF ENTREPRENEURSHIP THE VALUS OF GOOD

3.1 The values of good

Mencius said, “The ability possessed by men without having been acquired by learning is intuitive ability, and the knowledge possessed by them without the exercise of thought is their intuitive knowledge”. (Mencius•Jinxin I) Zhang Zai, a scholar during North Song Dynasty, said, “Intuitive knowledge is something known by nature”. (Zheng Meng• Cheng Ming) Zhu Xi said, in Mencius Variorum, “Good is the human nature”. And he quoted from Cheng Zi, “There are no causes for intuitive knowledge and intuitive ability. They are nature, not artificial”. Wang Yangming said “Intuitive knowledge is the noumenon of the mind”. Wang Fuzhi said “Nature itself is from automation to being, the combination of Yin and Yang can bring about different intuitive ability”. Zhang Taiyan said, “Intuitive knowledge is the sense of right or wrong, the conscience”. If a man has the intuitive knowledge, he can tell the right from wrong. On the contrary, if he can’t tell right or wrong, he has lost his intuitive knowledge. Of the so called “the justice of nature and conscience”, the justice of nature is disinterested, and conscience refers to intuitive knowledge, the kindness of mind, that can tell right and wrong. The intuitive knowledge and ability used by Confucian sagas like Mencius are the endowed moral sense and ability.

According to the relationship between body and function in philosophy, it is thought that conscience is the body, and it is natural, whereas, intuitive knowledge and ability are the function. The nature of conscience can be reflected by intuitive knowledge and ability. In other words,
conscience is inherent character of human beings endowed by nature. It is the root of intuitive knowledge and ability, the core of values of good. Therefore, conscience, intuitive knowledge and ability, which are the inherent kindness and morality of human being, should be developed in cultivating students.

3.2 The values of good—the duty of a corporate
A corporate, like a man, should have the good qualities endowed by nature, that is, “the justice of nature and conscience”. In his book entitled The Protestant Ethic and the Spirit of Capitalism, Max Weber emphasized duty. The duty of a person and an organization is to follow God’s decree, observe ethics, create and obtain wealth. Weber’s protestant spirit includes such virtues as diligence, thrift, honesty, and creditability, and a man is required to be self-control, introspective, diligent, and fulfilling duty. Whether it is a small private business or an industrial corporate, it should orient to values of good so as not to do harm to others or itself. A corporate, as a legal person, can be a good person, or be reduced to a bad person. And as a man, one can be a good person, or be reduced to a wicked person, a rabble, or an evil person, which results from the different values or ethics. A corporate can make a decision among the four value orientations, “beneficial to others and self, harm to others but beneficial to self, beneficial to others but harm to self, harm to others and self”.

3.3 The values of good: the bases of entrepreneurship
The values of good should be attached importance for a good beginning of a business to success and sound development. In other words, the values of good is the base of starting a business. Liu Hong’an, born in 1980s, started a breakfast stall. He is bringing a ladle when he fries puffs so that people can examine the quality of oil. Besides, he conscientiously fries puffs, and claims that he is not selling puffs, but a way of life. Although the price is higher, the customers are increasing. His story becomes a focus on internet, and he is named “a puff-frying man with conscience”. In fact, whatever a person does, he should feel for others, be conscientious. So does an entrepreneur. Those, who only chase for profit, profit self at the expense of others, or lose the good nature, are contemplated and will be eliminated from the society.

IV. CULTIVATING NEO-CONFUCIAN SPIRIT IN ENTREPRENEURIAL EDUCATION
4.1 Neo-Confucian spirit and entrepreneurial education
In 1980s, 75 Nobel Prize winners made the assertion in Paris that if human beings want to live in peace and prosperity in the 21st century, they must look back 2,500 years and seek the wisdom of Confucius. In recent years, many domestic and foreign scholars heed attention to the studies on Confucianism and business, and Confucianism and management. Confucianism is extensive and profound, and its influence has a long history, and pass through China and western countries. Fan Li and Zi Gong in Qin Dynasty are the shining examples of the ancient Confucian businessmen. Yang Disheng (2000) holds that people attach importance to the studies, cultivation of Confucian and neo-Confucian businessman, while the definitions on Confucian businessman are various. Miao Zehua (2003) put forward a mode to cultivate the neo-Confucian businessman who adapt to globalization and development of socialist market economy. Li Hongliang & al (2005) made studies on the cultivation of neo-Confucian businessman. Entrepreneurial education must develop the traditional culture with the mainstream of Confucianism, and make the past serve the present. Traditional culture not only includes “benevolence, righteousness, courtesy, intelligence, sincerity”, but also such thoughts as oneness of nature and human, equality of all the creatures in nature, respect of life, and universal love. Neo-Confucian spirit has been introduced into entrepreneurial education to cultivate the
entrepreneurial intellectuals who have the characters of honesty, benevolence, being practical, being patriotic, and being harmonious, and who can adapt to the economic globalization and socialist market economy. Cultivating the entrepreneurial intellectuals not only needs to attach importance to cultivating sense of innovation, entrepreneurial ability, but also the neo-Confucian education, and neo-Confucian spirit. The following table reflects the relationship between entrepreneurial education and neo-Confucian spirit. (Figure 1)

Figure 1: The relationship between entrepreneurial education and neo-Confucian spirit

4.2 Cultivation mode of entrepreneurial intellectual in SJZUE
Cultivation on the sense and thinking of innovation is highly valued in entrepreneurial education. Specifically, one, cultivating the sense of innovation is highly stressed. Some activities are introduced to raise the ideology or sense of innovation, such as entrepreneurial education (experimental class), and the Provincial and National Challenge Cup of entrepreneurial plan. Two, cultivation of innovative thinking, innovative affection, and innovative personality is paid attention. Three, cultivating entrepreneurial knowledge (various related courses) and entrepreneurial ability are highly valued. In addition, entrepreneurial practice is frequently organized. After some years of research, the Business School in SJZUE has developed a cultivating mode, “neo-Confucian spirit + entrepreneurial sense + entrepreneurial knowledge + entrepreneurial ability + business practice” (See Figure 2)

Figure 2 Entrepreneurial intellectual cultivation mode

4.3 The practice of cultivating entrepreneurial intellectuals in Business School, SJZUE
(1) Defining the aim of entrepreneurial education. The aim is to cultivate entrepreneurial sense, develop entrepreneurial spirit, and promote entrepreneurial ability and comprehensive qualities. Besides, Business School considers cultivation of the entrepreneurial businessman the important aim.
(2) Executing neo-Confucian businessman project. The business school is making research on and executing neo-Confucian businessman project. Neo-Confucian businessman project, a complex social systematic project, mainly includes such subsystems as object, value, knowledge, ability, and practice, etc. Since 2003, the Business School has held ten annual contests of Neo-Confucian Businessman Cup. Only the Business majors took part in the previous contests, while the recent contests have attracted the students not only from Business School, but also from other schools, such as Accounting School, the School of Economy and Trade, the School of Management Science and Engineering, and so on. The contests have brought about larger influence and more benefits.
(3) Paying attention to education of different stages. The Business School put forward Four-Stage Theory in neo-Confucian businessman education. That is, different ideologies are
applied according to the different stages of undergraduates. Education on benevolence is applied to the freshmen, education on sincerity to the sophomores, entrepreneurial education to juniors, and education on gratitude to seniors. Although different stages focus on different aspects, all these are involved in the neo-Confucian education. The different focuses in different stages can help the students to improve comprehensive entrepreneurial qualities.

(4) Strengthening extracurricular construction of entrepreneurial education
For more than a decade, SJZUE has attached great importance to the contests, such as Challenge Cup for the College Students, and Entrepreneurial Planning, thus an entrepreneurial education mode has been developed. Furthermore, the university highly values the extracurricular construction of entrepreneurial education, and an experimental class is formed for cultivating entrepreneurship, which has brought about great effects. In the contests of Challenge Cup, the students from SJZUE have won two national silver medals, 10 national bronze medals, and many provincial awards. Due to the systematic education many graduates have succeeded in their business.

V. CONCLUSION
With the core of neo-Confucian spirit, cultivating entrepreneurial intellectuals is a systematic project which requires continuous study and practice. It is believed what is most important in the project is to establish the values of good. It is necessary to cultivate and awaken such human nature as conscience, intuitive knowledge, and intuitive ability, design the course system and reform the cultivation mode, participate in the extracurricular activities and organize various activities so as to form the good environment for the students’ growth.

Projects: ①Chinese Higher Education Association “Eleventh Five-year” education science research program “The Study of New Confucian talents cultivation pattern based on integrity and It’s Evaluation system” (ID : 06AIJ0240040 ), hosted by Ze-hua, Miao. ②The Second round of national innovation and entrepreneurship training project in 2012: the study of New Confucian business cultivation on entrepreneurship education in institutions of higher learning " ( ID: 201210077002 ), hosted by Shuai Shao, instructed by Ze-hua, Miao.

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CHALLENGES AND BENEFITS OF KNOWLEDGE AND TECHNOLOGY TRANSFER IN REGIONAL FRAMEWORK

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Abstract: UNIVERSITIES CANNOT EFFICIENTLY COMMERCIALISE KNOWLEDGE AND TECHNOLOGY TRANSFER WITHOUT CONSISTENT GOVERNMENT SUPPORT AND SPECIFIC INSTRUMENTS HELPING STIMULATE THE INTEREST OF RESEARCHERS TO GET ENGAGED IN APPLIED RESEARCH. THIS PAPER ANALYSES OUTCOMES OF THE CURRENT EMPIRICAL SURVEY OF TECHNOLOGY TRANSFER OFFICES AT UNIVERSITIES AND RESEARCH INSTITUTES IN SELECTED CENTRAL AND EASTERN EUROPEAN COUNTRIES CHARACTERISED BY UNDERDEVELOPED INNOVATION CULTURE (I.E. CZECH REPUBLIC, HUNGARY, SLOVAKIA AND POLAND) BY THE AUTHORS. THE RESEARCH SCOPE COVERED: THE MAIN BARRIERS (ON THE SIDE OF THE UNIVERSITY/RESEARCH INSTITUTE) PREVENTING EFFICIENT COMMERCIALISATION OF UNIVERSITY INTELLECTUAL PROPERTY AND KEY SUCCESS FACTORS OF KNOWLEDGE AND TECHNOLOGY TRANSFER TO INDUSTRY. FURTHER IT EXAMINED THE INTERDEPENDENCY OF KNOWLEDGE AND TECHNOLOGY TRANSFER FACTORS AS WELL AS THE EXPECTED BENEFITS IN REGIONAL FRAMEWORK IN ORDER TO PROVIDE RECOMMENDATIONS FOR UNIVERSITIES AND RESEARCH INSTITUTES ON BOOSTING THEIR COLLABORATION WITH THE INDUSTRY AND ITS RESULTS IN COUNTRIES WITH UNDERDEVELOPED INNOVATION CULTURE.

KEYWORDS

knowledge transfer, technology transfer, entrepreneurial university, regional innovation

I. INTRODUCTION

Knowledge and technology transfer (KTT) has been an inherent part of many universities’ activities over the last 30 some years. Commercialisation of knowledge and technologies has become an important instrument to increase university income in times when many governments gradually reduced their funding. As universities are one of the core sources of knowledge, it has become their responsibility to create effective mechanisms to transfer knowledge to businesses and public via several channels (Feldman, Stewart, 2006). Universities’ departments, most often referred to as Technology Transfer Offices (TTO), are a part of their infrastructure and provide legal, marketing and admin support to academics with research findings and inventions to collaborate with industry partners in their commercialization.

Typical knowledge transfer channels from universities to the regional economy cover:
- formal research collaborations;
- scientific publications and conference papers;
- consultancy;
- collaboration with industry;
- commercialisation of research via licensing and spin-offs.
TTO as an establishment originates mainly from US research universities which accelerated the commercialisation of their research largely after the passage of the Bayh-Dole Act in 1980 (Friedman, Silberman, 2003). The act gave US universities the right to patent inventions resulting from federal funded research and required that all discoveries originating from national research grants be disclosed through the university TTO. The number of US TTOs increased from about 25 around 1980 to the current number of about 200 (Reiner, 2010).

In Europe, TTOs as internal intermediaries, started to appear as specific organizational units within universities in the mid 1990s as a result of adoption of Bayh-Dole like legislations in several countries. They were created to advise on intellectual property (IP) issues, business planning and financing early stage inventions (they are often prone to market failure due to lack of financing at this stage, etc.). TTOs are able to accumulate inventions across research units and promote them to technology buyers. Hence to be efficient, they need to possess a portfolio of knowledge from different industry sectors, understand both - academic and business cultures (Mowery, Sampat, 2006), be well connected and have adequate capacity. The establishment of TTOs that improve the efficiency of knowledge diffusion seems therefore justified from an innovation system and economic development perspectives. Commercialisation success varies across the board and is heavily dependent on a number of variables – e.g. quality of research, university strategy and leadership, management of KTT (implementation of an IP policy which motivates researchers to disclose their inventions), university’s organisational culture, financial resources and demand for new knowledge and inventions (Feldman, Stewart, 2006, p.3). Some higher education (HE) and research institutes are successful in setting up and making good progress at KTT where others lag behind. In this paper we analyze the development of TTOs based predominantly at universities in the CEE region (Central and Eastern Europe). Based on the results of the RU Innovation Union Scoreboard¹ we consider the countries ranked as modest and moderate innovators as countries with underdeveloped innovation culture unlike countries ranked as innovation leaders and followers. We have found very limited research available in KTT management and development in ex communist countries with innovation systems that are underfinanced and lack strategy and consistency. The aim of our research was to investigate various factors and their interrelations in respect of effective KTT from HE and research institutions to industry.

The paper will in the following sections present the overview and method of the survey. It will be followed by the section focused on outcomes and comparisons with outcomes from other surveys and analyses. The last section includes conclusions and recommendations for improvements on various levels.

II. SURVEY OVERVIEW AND METHODOLOGY

The research was conducted between February and June 2013 using archival, survey and interview data relating to selected TTOs at eleven education and research institutions in the Czech Republic, Hungary, Austria, Poland, United Kingdom and Slovakia. The survey scope covered:
- three universities in the Czech Republic,
- three Slovak universities and one government research institute - the Slovak Academy of Sciences,
- one university in Budapest (Hungary),
- one university in Cracow (Poland),
- one university in Vienna (Austria), and
- one university in York (United Kingdom).

Six out of the surveyed institutions are technical universities, four are universities incorporating humanities, life sciences, natural sciences and economics and management. The Slovak Academy of Sciences has a portfolio of 56 subordinated institutes covering the most areas of science.

The questionnaire addressed to TTO managers enquired about:

- when and how the TTO was established and what was its legal structure;
- the size of the TTO;
- type services it offers to researchers and external companies and organisations;
- the type of contracts it administers;
- support the management of the institution’s management provides to knowledge and technology transfer activities;
- the TTOs budget for IP protection, marketing and business development, legal services, education/training and proof of concept;
- the institute’s intellectual property policy;
- results achieved in terms of enquiries from researchers, utility model and patent (applications and granted), consultancy and research contracts, and spin-offs established;
- the type of marketing activities they engage in and how often;
- whether they use a project and client management software to make their work more effective;
- the type of support and networking organisations they work with;
- the membership in professional organisations/associations;
- barriers that the TTOs have faced and how they overcame them.

Our objective is to confirm that the university management plays a key role in developing an effective TTO and its relationship and linkages with the university researchers, partners/other intermediaries and the industry. Knowledge and technology transfer is a relatively new initiative at universities and research institutes in the CEE region (mostly less than 10 years), hence university leaders and policymakers seek guidance on specific organisational practices related to strategic objectives, incentives, internal structure and processes, and measurement and monitoring mechanisms in order to improve technology transfer effectiveness (Phan, Siegel, 2006).

In the U.S. technology transfer has become a multi-billion dollar industry and figures for Western Europe show the same trend of a very fast increase (Sterckx, 2009), particularly in the number of academic patents and licences (ProTon Europe 2009). The European network of ‘Knowledge Transfer Offices’ and companies affiliated to universities and other public research organisations, ProTon Europe, provides an overview of ‘knowledge transfer’ in Europe across 17 European countries, however, only one of the TTOs we researched was a member.

III. SURVEY OUTCOMES

1. TTO maturity stage. Only one of the eleven institutions surveyed, Technical University in Zilina (Slovakia) was in the process of setting up a formal TTO and presently employs one person to advise researchers on IP protection. Three TTOs (universities in Krakow, Ostrava and York) were established over 10 years ago, two over eight years ago and five were set up approximately 4 years ago. All surveyed TTOs operate as university departments. Except for the Austrian and British TTOs, those in the CEE region were set up with the help of the EU funds. At institutions where the EU funding supporting TTO operation ceased, they struggle to survive and produce any meaningful outputs.

2. TTO size. The largest TTOs were at the university in Krakow (20 FTEs), University of York (17 FTEs), Czech Technical University (16 FTEs and 15 part time employees), Technical University in Ostrava (16 FTEs) and the Technical University in Vienna (13 FTEs). Mid size TTO was located at the Technical University in Brno, Czech Republic (9.3 FTEs). The remaining five TTOs were small having one or two FTEs.

3. TTO activity profile. 73% of TTOs surveyed manage license agreements and R&D contracts, 45% manage consultancy agreements, 27% manage material transfer agreements and spin-offs and 18% manage national and international R&D project contracts. Two universities in Slovakia (University in Zilina and Comenius University in Bratislava) do not manage contracts related to knowledge and technology transfer. 73% of TTOs manage the combination of license agreements and R&D contracts and 45% of TTOs manage the combination of license agreements, R&D contracts and consultancy agreements.
4. TTO support by institution’s top bodies. All respondents stated the top management of their institution supported the establishment and/or the sustainability of the TTO to some extent. The TTO managers evaluated the measures taken by the institution’s management to improve TTO outputs (i.e. the number of patent/utility model applications, the number of patents/utility models granted consultancy agreements, research contracts), acceptance of the TTO (i.e. better TTO recognition by researchers, university funding of TTO operations) as follows: 18% (2) strongly agreed the measures were effective, 45% (5) agreed the measure were effective, 27% (3) gave a neutral response and 9% (1) disagreed.

The TTO managers who appreciated the support by university management listed the following areas of support as significant for the TTO’s progress:

- Building of trust between the TTO staff and researchers;
- Implementing an IP policy with a motivating reward system for researchers;
- Provision of funding - to employ experienced professional staff (primarily IP and commercial law specialists, support staff helping to obtain research project funding and TTO operational funding, project managers with PhDs in relevant scientific fields and with commercial experience to help commercialise technologies) and to fund IP protection and activities (networking, training, marketing, business development etc.). Those TTOs that have grown to strength were financed by the university during periods when no or insufficient public funding was available;
- Developing working contacts and networks with businesses and other players within the region;
- Granting authority to the TTO manager to allow for flexibility and speed in processing clients’ requirements (internally and externally). E.g. the Slovak TTO managers have almost no decision making authority on IP commercialisation.

5. Cross-institutional IP policy. The adoption of a cross-institutional IP policy for IP protection and commercialisation including a reward scheme are the key elements of effective knowledge and technology transfer and require strong top management support. The IP policy was adopted at 73% (8) of the surveyed institutions and the IP commercialization part of the policy was adopted at 64% (7) of the surveyed institutions. The three institutions where no policy has been adopted are the three Slovak universities; however, the Slovak University of Technology plans to adopt these policies in 2013.

6. TTO budgets and funding structure. In comparison to other countries TTOs at Slovak institutions disposed of the lowest budget for all main areas of their operation – IP protection, legal services, education, marketing and business development, and proof of concept. Currently they can only access funds for IP protection and IP evaluation services provided by the National centre for TT (national project funded by EU Structural funds until the end of 2014); there are no other specific sources of public funding for the main areas listed above and the institutions’ management more or less does not provide any funding apart from match funding should there were any relevant projects available. The Slovak TTOs have only one employee with the exception of the Slovak Academy of Sciences which has two. They do not have a budget to recruit experienced professionals in IP commercialisation, to develop TTO staff’s knowledge and skills or for networking (incl. memberships in international KTT support or industry associations).

The TTOs at Czech universities benefit from EU funded projects which enable them to finance approx. 90% of their expenditures on the main areas of operation. Legal services at the Hungarian and Polish TTOs are paid for by the university, IP protection is financed as a combination of EU, national and university funding. Marketing, education and proof of concept at the Hungarian TTO are predominantly financed by the university (50%). The industry covers about a third of education and proof of concept costs, the rest is met from national projects. The Polish TTO uses merely EU funding for marketing, business development and education. National projects pay for proof of concept needs.
At the British and Austrian TTOs the majority of costs are funded by the institution and TTOs business earnings, they do not use. Out of the nine other TTOs, five TTO managers stated their experience with using the EU Structural funds was good, three said it was neither good nor bad and one said it was bad. In a follow up interview all said the EU money came at high cost due to extensive administration requirements and restrictions, but they could not progress without it. In addition, British and Austrian TTOs are not restricted by the limitation posed by regulations of projects funded from EU Structural funds (i.e. they do not allow any devices or equipment purchased to be used for producing a commercial output; IP generated in the course of such project cannot be commercialised without penalisation).

7. The experience level of TTO management. At most institutions in the CEE region, the TTO staff have either no or very limited experience in managing KTT projects. However, the effectiveness of TTO is very dependent on the culture and ability of the institution to support commercialization (Bergman, 2009). The Czech TTO staff (14 employees on average) structure consists of project and business development managers with scientific or engineering background, lawyers, IP advisors, business advisors and administrative support.

The survey also enquired whether TTOs use project management and client relationship management (CRM) software to effectively manage their work. Only three TTOs used project management software (one was in the process of testing a bespoke product) and only two TTOs used CRM software.

8. TTO performance results. In terms of measurable results, we excluded the British and Austrian TTOs from the comparative analysis since they have considerably higher level of output than the rest due to significantly higher research budget and these TTOs also benefit from higher income provided by the university and considerable government support. The Austrian government for instance offers SMEs innovation cheques worth up to EUR 10,000 to enable them to collaborate with selected research institutions. Similar scheme has also been implemented in the Czech Republic. Other Austrian schemes include giving EUR 50,000 - 150,000 to selected innovative projects from universities, feasibility studies funding as well as funding for launching product or service innovations following a successful R&D project. There are specific programmes in Austria and in the UK which support technology-oriented spin-offs from the academic sector, e.g. Knowledge transfer partnerships scheme (supports academic placements in R&D departments in companies in the UK) has been very successful in developing long-term collaborative partnerships between industry and academia.

The most active (the highest number of granted patents and utility models and applications) out of the nine institutions based in ex communist countries is the Czech Technical University in Prague. Masaryk and Krakow Universities have also been successful in gaining patents and utility models. Since they were established all three Czech and the Polish TTOs have shown continuous growth and development - staff skills, capabilities and the number and portfolio of results. The Slovak TTOs struggle in all their operational aspects mainly due to lack of financing and commitment from the institutions’ management. All TTOs but the Slovak ones organise internal and external seminars on a monthly basis and take every opportunity to promote their university’s research results at partners’ professional events. Likewise, they attend international tradeshows and conferences at least twice a year.

9. Membership in international TT associations. Only four TTOs are members of international KTT related associations. Two are members of the Licensing Executives Society (www.lesi.org), one is a member of ASTP (www.astp.net) and ProTon Europe (www.protoneurope.org) and one is a member of the European Business and Innovation Centre Network (EBN, www.ebn.be). Majority of the TTOs do not have funds allocated for such memberships.
10. Propositions for universities based on the survey findings. TTOs need to concentrate on:

a) Developing TTO services based around researchers needs, i.e. legal and business advice and IP valuation services, to build up relationships with researchers;

b) Setting up clear rules which make the KTT easier for researchers and include motivating rewards;

c) Generating KTT results from high quality research of researchers who are willing to cooperate with the TTO and in those areas of expertise where they can compete on international markets.

d) TTOs need to have the support of different types of innovation intermediaries including the support of well designed financial instruments deployed by the government;

e) TTOs also have focus on developing a range of university–industry linkages in terms of the scope of activities and the types of firms with which they interact.

f) Lack of researchers’ mobility – foreign researchers or researchers returning from study stays or work experience from abroad tend to bring new ideas and dynamism;

g) Insufficient time and capacity of TTOs which are short of staff, funding and skills;
h) Problems in communication between academics and business representatives (i.e. understanding industry needs and timescales).
i) Limited interest of companies to innovate and to collaborate with universities. Particularly in Slovakia and Hungary there are no schemes to stimulate partnership working on developing innovations.

IV. CONCLUSIONS AND RECOMMENDATIONS

The TTOs activities aimed at IP commercialization is activity are driven, in part, by anecdotes relating to the financial promise of university technology transfer, i.e. the lucrative stream of licensing revenue and IPO-related wealth resulting from Internet search engines and browsers etc. (Phan, Siegel, 2006). Some universities pursued commercialization due to reductions in government funding and increased costs. Many HE and research institutions have however not been able to achieve planned results. It was clear from the survey outcomes that institutions making good progress in KTT understand the importance of consistently investing resources in all areas listed in point 10 “Propositions for universities” of the Survey outcomes section. These areas are interdependent as well as long-term consistent government support to HE and research institutions to develop their KTT operations. Equally important are government funded mechanisms supporting business innovation and stimulating university-business collaboration.

Conclusions from our research can be summed up in the following 4 points.

1. Consistency in organisational management and design, culture and values across the whole institution, incentive schemes and entrepreneurial attitude are among the sine qua non critical success factors of KTT (Clark,
Thus the following recommendations to improve KTT:

a) Develop and maintain good relations with the institution’s management to gain and nurture their KTT support;
b) Implement a cross-institutional IP policy which motivates and rewards researchers who disclose their inventions and collaborate with the TTO across the whole institution;
c) Use champion researchers who succeeded in commercialisation of their research results as TTOs advocates within and outside the institution;
d) Respond to researchers’ needs, i.e. start by supporting them on research projects which may entail legal support in relation to IP protection from the very beginning of the project, help them draft agreements and contracts with project and industry partners;
e) Do not miss any opportunity to promote TTO’s services internally and the university’s or research institute’s know-how and IP externally.

The non-profit Association of University Technology Managers (www.autm.net) carried out a survey and in-person interviews of 100 university technology transfer stakeholders (i.e. academic and industry scientists, university technology managers, and corporate managers and entrepreneurs) at five research universities in the U.S. and concluded that IP policies and organizational practices can potentially enhance (or impede) technology transfer effectiveness (Siegel, Waldman, Link, 2003). Further, it found that strong business and marketing experience in the TTO and incentive compensation were very important.

2. Universities and research institutions in the UK and in Austria benefit from significantly higher level of R&D funding distributed by various government innovation intermediaries and funding awarded by the government for research outputs transferred to businesses or other organisations. Furthermore, the respective governments deploy various tools to incentivise both academic institutions and businesses to collaborate for mutual gain. It also boosts the social relevance of the KTT and increases the HEI’s competitive edge. The innovation ecosystems of these countries ought to inspire fast and efficient response by the countries with underdeveloped innovation culture.

3. It is futile for the HEIs’ management to expect any relevant KTT outputs without adequate funding for TTO staff development – the key driver of informed decisions in the knowledge and technology transfer process.

4. The European and US best practice prove beyond any doubt that establishing and maintaining functional TTO which can effectively respond to the needs of researchers’ and businesses, eventually bringing financial benefits to a HEI requires a strong and long-term commitment on the part of HEIs concerned, e.g. Oxford University or Massachusetts Institute of Technology.
a. References:


Entrepreneurship – Pippi Longstocking or Sustaining a Tommy-Annika Principle?

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ABSTRACT: If you take a look at the OECD-Reports or at the Global Entrepreneurship Monitor, you can state that it’s not far by all countries, that entrepreneurship is accepted as it should be. Intra- and Entrepreneurs are easily considered as being odd, strange, all for independent, short: not being in line. Of course: They are not in line, they are not mainstreamed. They start their thinking with a No. In this context they stand in line with the thinkings of Gaston Bachelard and Paul Feyerabend, who postulated, that new ideas derivate from saying No to what is existing. Pippi Longstocking does the same. She is flexible, social creative, she has a great inner locus of control, she takes risks, she is innovative, she is independent. She has a high self-esteem, that puts people’s backs up. And that heads to the fact that those people rarely find jobs, though it’s obvious, that societies do need those people. Though Pippi Longstocking is a book for children, it’s a power of symbol “that lead far beyond. Its ideas show intra- and entrepreneurs that it’s worth to fight for their own ideas. For Human Resource Managers it’s the mirror, how they react on unconventional people.

Keywords: entrepreneurship, character, crystallized knowledge, principles, challenge and responce, traditional learning

1. Introduction
At first sight, the subject of Pippi Longstocking doesn’t seem to be directly related to the issue of entrepreneurship. Many would say: that’s a children’s book, nothing more and nothing less. My answer is: children’s books don’t appear out of thin air – they arise within political, and in a narrow sense, politico-cultural limitations. For example, the Danish newspaper “Jyllands Posten” recently reported that Pippi Longstocking books had been stopped at the Turkish border. The Turkish customs officers declared that the customs papers were not filled out correctly, but some observers have suggested that the real reason may have been the books were written in Kurdish.

2. Pippi Longstocking Nowa days
In the early days of the Federal Republic of Germany, Pippi Longstocking books were also reviewed somewhat critically: after all, in 1946 the country was still learning to be a democracy. Even in Sweden there have been reservations voiced about Astrid Lindgren. And that from no less than P. C. Jersild, writing: “Where does Astrid Lindgren stand politically? Does she know what she’s doing? Does she write from a gut feeling, or does she write with her mind? If the latter, is that a social democratic mind, a centrist mind, a communist one, a Glistrup mind – or what is it?” At the end of his essay he offers the following politically educational advice. “Since Astrid Lindgren is a witch, she didn’t place warning signs on her books. That’s why it is necessary to keep the witches under control by painting a cross or a hammer and sickle on the door for the gingerbread house.” So that’s the opinion of P. C. Jersild. However, it is true that Astrid Lindgren has a talent for saying unusual things with usual words.

Some time ago German television showed the American comedy film “Legally Blonde”. In this film Reese Witherspoon is brilliant in the role of Elle, a pink Barbie who shows the admissions board of Harvard University and her sceptical fellow students that it is not a person’s appearance which counts but what they have inside them – their inner
values. In her role as Elle, Reese Witherspoon takes all of the standard clichés about dumb blondes to their extreme, and lives by the motto “Don’t judge a book by its cover” or “Walk your talk”.

It’s fun to be Pippi. Even if you lose sight of this during the years of becoming an adult. However, it is never completely forgotten: just think of carnival time. How many Pippis can you meet there? With the charm of an enfant terrible and the sex appeal of the young adult they remember being, these Pippis show us another side of themselves. Since it is clear: Pippis are different, somehow stronger and more selfconfident, they break free of the confines of everyday life, they are diverse, humourous, and interesting. These attributes are fine for the carnival, but are they an important factor for a career in enterprises, for the everyday life of an enterprise? Surely these Pippis – as a symbol for both men and women – are more likely to belong to the générée précaire – young people doomed to an endless sequence of unpaid placements and temporary jobs? Does the elder generation allow anything new or unusual to come through at all? Or do they simply have too much inertia and block the flow of time.

Imagine you work in the Human Resource Management and are in the happy position of being able to advertise for an external candidate to work in the Department of Innovative Management. After having advertised the post nationwide, you have drawn up a shortlist: there had been so many promising applications. After much deliberating, you have finally selected three chosen candidates for an interview. On the day of the interviews, each member of the jury has a portfolio with the data of the invited candidates, each member has again been briefed on watching out for criteria in the interview such as responsibility, social commitment, imagination, alternative thinking, risk taking, creativity management qualities etc., etc.

As far as appearance is concerned, all candidates coming for the interview – in their manner – are clean, styled, gelled, or otherwise formed, the females have pushed their personality charismatically, the males ... well, there is of course a natural problem there.

On the whole the three candidates fulfilled the requirements linked to the position of an innovations manager. Only one young lady failed to fit into the smooth framework of candidates. She was initially in appearance – not streamlined, or a protagonist of an official mainstream:

Red plaits, a face full of freckles, short skirt, one ringed sock, one black sock, suspenders hanging out, oversized black Doc Martens, a girdle which peeked out from beneath her blouse, shining eyes which exuded joviality. This was Pippilotta Delicatessa Windowshade Mackrelmint Efrais’s Daughter Longstocking, single, independent in every way, including financially, the salary was not important, she wanted to apply her talents for the good of the country, she was individual and emancipated, even though she liked to cook for others, curious and responsible, after all she had a horse on her veranda and a monkey, Mr. Nilsson, did it disturb anyone that she was so talkative, if not, that was good, if yes, okay, she couldn’t change anything in that respect, after all she liked herself as she was, and nothing could change that, and, oh yes, she was pragmatic too, no tendency to blinkered vision, what counted was everyday life with its challenges which had to be mastered, she was positive, open to new things, always willing to re-order her lifestyle and set different priorities, she searched for things and you could always find something, she was humorous, and, was she talking too much, no-one was asking any questions, good, after all she was the important person here, she didn’t think much of plutimikation, that was a sort of crystallized knowledge, fluid intelligence was what mattered, knowledge of adaptation, whether they’d like to hear her motto in life?"

Everyone creates his world the way he/she likes it. Were there any questions, this was clearly not the case, then she could go on. She was philanthropic, social, busy, imaginative, creative, a team player, she could stimulate passionate enthusiasm in others, but she would most of all have preferred to be a pirate in the Straits of Malacca, or a negro princess, she’d been that once before, back when she led the island children out of the clutches of criminals. She had places her feet in the large Doc Martens onto the table, it is healthy to wear big shoes, because the big toe needs freedom too, that’s just the way it
is, but now she had to go and care for her horse ... and Mr. Nilsson. To sum up: she was completely at ease with herself.

Pippi is a flamboyant personality, she keeps people in suspense, she is conscious of her pure identity, she is remarkable. That is to say, she is worthy of remark.

Remarkable behaviour provokes and irritates other people. Above all, it provokes people who never step out of line and who themselves are unremarkable. Criteria such as individual charisma or management quality played a subordinate role, appearances seemed to be more important, and with her freckles, the large mouth with ceaseless, but humorous, comments, the red braids and suspenders, she was not able to score many points.

Although her personality embodied the spirit of living entrepreneurship as well as the spirit of the future, and on account of her fluid intelligence she was best equipped for the scope of tasks to be handled, criteria such as crystallized knowledge, reliability, punctuality and general conduct were valued higher than action, imagination, creativity, networked thinking and social responsibility. The decision makers were also unable to find 100 % devotion to work and 100 % perfection. It was also feared that Ms. Longstocking could live more for imagination and shaping the future than for socialization in a hamster wheel.

In 1821 Goethe had already expressed his view that to be creative, perception must be accompanied by the power of imagination. Otherwise, perception occurs only at the initial level of imitation – a copy of the object is made in the mind’s eye. In order to be productive, creative imagination then has to be applied by vitalising, developing, enhancing and transforming that which has been perceived. Creativity, according to Prof. Dr. Hinderk Meiners Emrich of the Medical University of Hannover, seems to have something to do with a ‘surplus production’. To find new relations when solving problems, to produce and generate fluent and flexible innovation ideas and original solutions is an expression of creativity.

In contrast to conventional thinking (convergent thinking), creativity is an expression of divergent thinking which, as far as support is concerned, is extensively co-determined by socialization factors. “A person who does not like reality already has the key to creativity in his hands,” was how he formulated it in MHH (Medical University of Hanover) Info of February/March 2006.

In turn, and in the case of a decision against imagination, business, creativity, and charisma this can only mean that the decision-makers are satisfied with the world as it is, and would like to be spared any innovation with regard to objects and persons alike. Most personnel managers don’t really know what they want. Why not? On the one hand, it can be seen as the desire to conform. On the other hand there is a simple psychological answer: they spend too much time concentrating on what they don’t want. And the astonishing thing is that when it comes to the list of what they don’t want, they manage to describe it in every little detail and to provide meticulous justifications for each item.

Does this perhaps reveal a basic problem not only of personnel management, but a dilemma in society? Shouldn’t we sense life itself in man, the legitimacy of life to unfold as it is? What is better? To support strength or to wipe out weakness? Should the duck learn to climb, and the rabbit to fly? Should we support crystallized intelligence or enable man to apply his fluid intelligence?

That crystallized intelligence is still primarily promoted was made clear by department manager of the Minister-President’s Office in an interview, when he asked a candidate who had already shown evidence of competence in managerial positions, why he had received certain grades in his school

참고: “The IQ can relate to fluid or crystallized intelligence. The latter corresponds to the experience, knowledge and skills which have been acquired in the course of intellectual debate with the world. Schooling and professional training in the past aimed at forming and consolidating crystallized intelligence in the first two decades. As from that point, most citizens considered themselves sufficiently educated for later life. However, modern states are today increasingly challenging and supporting persons who are quick, prudent and adaptive, and who can successfully handle new situations swiftly. This ability corresponds to “fluid intelligence”. (Siegfried Lehrl, Psychology of Psychiatry and Psychotherapy at the University of Erlangen)
leaving certificate of 1972. Indeed, a former state secretary used to passionately conduct such examinations of postgraduates during job interviews.

In terms of entrepreneurship and in view of the tasks involved for an innovations manager, the decision made by the selection committee needs some critical analysis. In fact, Pippi Longstocking, the friendly, but occasionally stubborn rebel, would have been the most suitable candidate. And yet, instead of choosing her, persons were selected with the charisma of a brick wall, who can fill and thrill others with enthusiasm like a concrete block, who are as eloquent as a koi carp, as active, creative and imaginative as the Obélisque at the Place de la Concorde in Paris. As Uta Glaubitz, vocational consultant and author of the book, ‘The job that fits to me’, would say: the committee had chosen people you wouldn’t even want to steal horses with. For reasons of convenience and conformity as well as considering the issue of producing a minimum in resistance and a maximum in conformity, the ‘Pippilotta Principle’ is often sacrificed for the “Tommy-Annika Principle”, and tidy, pretty, nice and conformist people were selected, who perceived innovation and progress in the perpetuation of the hamster wheel.

While Annika gives the impression of a trinity of Julie Andrews, Doris Day and Heidi Klum, Tommy embodies the trio of Chris de Burgh, Hugh Grant and Cliff Richard. The fact that future and innovation cannot nearly be mastered by such trinities should already have become patently clear. Shouldn’t a courageous enterprise and an even braver personnel development, in terms of diversity management and in contrast to the traditional setting of gender mainstreaming, have been interested in integrating persons who initially appear to fall outside the norm, in the sense of a future challenge?

Entrepreneurship is to be understood as a strategic task: it has to offer the society new perspectives of wealth and growth. Organization can no longer understand itself to be a closed system, but an interaction between internal and external. 100 % devotion to work and 100 % perfection are not virtues which remind us of a glorious past, but are motors of boredom and monotony. “Nothing is more boring and rigid than one hundred per cent accuracy, since nothing may then be changed or adapted to the respective situation. Imagine a frame which is filled with balls. If the frame is packed full, no ball moves. Imperfection means removing one ball so that the overall picture can move – and yet it still remains. Only through this gap, this supposed imperfection, something new can develop”, writes Christine Weiner, author of the book ‘The Pippilotta Principle’.

Another related principle is that of the Dutch author, Maarten ’t Hart, who pointedly remarks in his book ‘The Sundial’: “All happiness turns so quickly into sorrow. If you do not have happiness, you are spared suffering. In the case of gain, loss threatens. If you do not gain, you cannot lose.” In other words, if one tries to avoid suffering, what sets in is motionlessness, rigidity, the levelling down of existence. Where this immobility has been achieved, there is, per se, no motion, and thus the smallest movements are seen as an act of extreme swing, as an act of extreme action. The desired avoidance of motion creates a situation where everything basically stays as it is and you don’t have to worry about yesterday, today or tomorrow.

Pippi Longstocking puts it in a nutshell, when Astrid Lindgren has her say: “Grown-ups never have any fun. All they have is a lot of dull work and stupid clothes and corns and ninecum tax.” As such, Astrid Lindgren not only symbolically describes the cosmos of many existing enterprises but the world of adults in general, in which, despite a demand for individual initiative and creativity and objective necessity, there is hardly any place for being different and thinking differently.

‘The limits of my language are the boundaries of my world,’ explains Ludwig Wittgenstein. In order to exceed these limits, or to be able to exceed these limits, creativity is required or – not only in an ethical sense – the constructive lie, the escape, an aid which Pippi Longstocking deliberately and consciously uses to selflessly exceed reality, when it comes, and show the way to new, different dimensions which she believes are possible. In this
sense, the escape is a creative action, a counter-draft. According to Plato, the liar (escaper) requires a better memory, stronger imagination and far more intelligence and fantasy than a person who merely spins out what he has really experienced.

The motor to escape this is the will for pretence, a notion which could be linked to Friedrich Nietzsche.

“Nihil est in intellectu, quod non fuerit in sensu”, wrote the British philosopher, John Locke about the process of realization within sensualised theory. Nothing can be in the mind which was not previously in the senses. Open senses and a talent to link that which has been experienced, thanks to the senses, to something new, distinguishes the open and courageous person, a person who is not satisfied with the ‘that’s-just-the-way-it-is’, who sees himself as a draft, as his own architect. In accordance with this, the will to be enterprising, the will to entrepreneurship stems from the possibilities arising from perception.

A person who does not see, hear, feel taste or smell this, is closed to the will to create, and sticks rigidly to that which in personnel issues operates at the Tommy-Annika Principle.

While globalization reduces time and space to residual values, many countries have mostly decided on persistence, on an anxious, national motionless utopia in a world of change. The pulled brakes combined with the inability to outline even a very rough draft of a political future society, can decisively ring in the question of destiny, ‘Challenge and response’, is the way the Britain, Arnold Toynbee, described a universal historical law. Where there is no challenge, there is no response, or at least no complex responses to the complexity of the challenge. ‘Wealth makes you stupid and anti-innovative”, explains Michael Stürmer, until 2003 Prof. for Middle Age and Modern History at Erlangen University in his presentation “Homo ludens forever.”

The British journalist, Nico Colchester, star of the London magazine, ‘The Economist’, described this in a very simple manner using his concept of “crunchiness”. “Crunchiness brings wealth. Wealth leads to sogginess. Sogginess brings poverty. Poverty creates crunchiness.” The land of milk and honey makes you stupid, and necessity is the mother of invention. In this respect the question has to be asked: Are the majority of decision-makers in politics, economy and administration still in the land of milk and honey, or have the simply blended out reality? In the 18th century, Samuel Johnson (1709 – 1784), called Dr. Johnson on account of his comprehensive erudition, stated: “Nothing sharpens the mind as wonderfully as the thought of being hanged in a fortnight.”

You can’t buy innovation, but by making regulations – internally and externally – you can impede or stifle it. A management-based, risk-avoidance state is a master in this. “Freedom is more favourable to innovation than servitude”, writes Michael Stürmer. And it can be added that such freedom also means freedom of the spirit. Freedom is more favourable to the spirit than servitude. Doesn’t the predominance of the Tommy-Annika Principle mean placing the freedom of spirit and entrepreneurship under the norms a traditional society.

“The secret of the entrepreneurial game is innovation. The secret of innovation is freedom. And the secret of freedom is courage,” states the historian, Michael Stürmer. Astrid Lindgren and Pippi Longstocking could endorse this credo without hesitation, whereby, however, they are both laughing. As Martin ‘t Hart writes: “Laughter is an expression of what’s going inside a person.”
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An evaluation of the Multi-disciplinary Students Research Teams (MRST) at the Polytechnic of Namibia

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Abstract: Multi-disciplinary Students Research Teams research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspective, concepts, and theories from two or more discipline. It enables students to work on real business solutions and encourage innovative entrepreneurial thinking through putting business ideas to light. The multi-disciplinary project enables the academic, students and the business community to work together to find solutions to innovative ideas. (Arnold and Mabel, 2005). The Polytechnic of Namibia and two local businesses in partnership with the Robert- Schmidt-Institute in Germany have entered into an agreement to run a pilot project, testing the effectiveness of multi-disciplinary project. The project consists of two Multi-disciplinary Student Research Teams, each team working on a business idea or problem which was presented to them by the two businesses. The students are required to apply theoretical knowledge in practice with the assistance from the academics supervisor and the industry mentors. The purpose of this paper is to share experience, challenges, expected outcome and progress of the project.

Key Words: Student Research Development Teams, Multi-disciplinary Research, Entrepreneurial thinking, Innovative, Collaborative, Teamwork, Partnership

1. Introduction

Research and development is defined as investigative activities that a business chooses to conduct with the intention of making a discovery that can either lead to the development of new products or procedures, or to improvement of existing products or procedures. Research and development is one of the means by which business can experience future growth by developing new products or processes to improve and expand their operations. (www.investopedia.com)

Universities view research as an imperative component of teaching and learning as well as the foundation of knowledge, that makes provision for new innovation and curriculum improvement. Universities are always interested in combining curriculum and industry needs, to ensure that academic programmes are more meaningful and relevant to industry needs. This is in line with the Polytechnic Curriculum Framework which requires students undertaking undergraduate programme to be exposed to practical work environment. Students are expected to obtain 10% of practical work through Work Integrated Learning or Service Learning Polytechnic of Namibia Curriculum Framework (Anon., 2009:18).

2. Literature review

The multidisciplinary project engages students and faculty in interdisciplinary thinking and increases their ability to work effectively in teams (http://www.ecologyandsociety.org/voll2/iss2/art8). It also fosters creativity, flexibility, knowledge generation across
disciplines. Interdisciplinary teams include people from different backgrounds, perspectives who bring diverse ideas to solve the problem (Olsson: 2011).

According to Pirrie and Wilson 2000; interest in multidisciplinary team working has increased during the past decades. One of the main ‘drivers’ is a shift in emphasis from providers of services to a greater focus on ‘client-centeredness’. This articulates well with educational concepts as educational institutions are expected to produce well-rounded graduates which are consumed by industry. Pirrie and Wilson further stated that, although the concept of multidisciplinary team working, however ambiguously it may have been defined, it is well-established in the literature of Health and Social care. They further made references to a research project which was undertaken by a team of researchers from the Scottish Council for Research in Education in collaboration with the University of Dundee Centre for Medical Education and the University Of East Anglia School Of Nursing.

Multi-disciplinary research like other form of practical experience are the best way of exposing students to real work environment, thus enhancing their chances of employability. The Polytechnic of Namibia has introduced Work Integrated Learning and Service Learning as a mean of affording students an opportunity to gain practical experience before they graduate. During Work Integrated Learning, businesses are able to keep up with daily work by handing over additional tasks to students that is supervised by an academic supervisor. In this way the partnership provide reciprocal benefits; business receive fresh ideas from the students while students receive real life experience which also assist academic to improve curriculum.

3. Methodology

The primary purpose of this paper is to present the progress and experience of the Multi-disciplinary Students Research Teams in Namibia, undertaken by Polytechnic students. The paper will provide an insight regarding the challenges experienced during the process of establishing partnership with industry, preparation workshops, selection and recruitment of students to work on the project, as well partner’s expectations during the project. The authors will make recommendations for a new model implementing a multi-disciplinary student research teams in Namibia.

The study was conducted through two case studies of different organisations where students were placed for multi-disciplinary research team. The paper will include both the academic and industry views regarding the multi-disciplinary project.

4. Findings: Case Studies

4.1. Case 1: Company A

4.1.1 Student’s selection

Students were selected based on the problem/idea that was presented by the business. Company A presented a business based on lifestyle segmentation research for various age groups in Windhoek. An advert was placed around Polytechnic campus as well as on CCE Webpage. Students applied based on willingness and availability. Students were taken through a work readiness workshop which covered four areas self-branding, physical preparation, emotional intelligence and team dynamics. Interviews were conducted by Polytechnic CCE staff together with the business partners. Students in the following disciplines were selected Marketing, Economics, and Mathematics & Statistics for the group A. Successful students were taken through orientation and started working on the project on 15 August 2013. Reporting templates were designed to assist business to record daily activities for students and reflect their learning outcomes. Students were also advised to log the reflection and keep portfolios of evidence for their learning outcomes. Students will be required to compile reports at the end of the project, reflecting their experiences.

4.2. Case 2: Company B

Company B is based in Walvisbay. Students were selected according to the problem/idea presented by the company. Company B’s problem was based on improving manufacturing/processing standards.
Adverts were designed and posted around the campus. Students were selected according to willingness, availability as well ability to secure accommodation in Walvisbay. Interviews were conducted together with business partners and students in the following disciplines were selected for the group B; Mechanical Engineering, Environmental Health Science and Accounting and Finance. As for group A, Reporting templates were designed to assist business to record daily activities for students and reflect their learning outcomes. Students were also advised to log the reflection and keep portfolios of evidence for their learning reflection. Students will be required to compile reports at the end of the project, reflecting their experiences.

5. Challenges

The challenges experienced during the multi-disciplinary students research team started from establishing partnership. Business needed to understand the concept before they sign the partnership agreement, as it was the first time a project of that nature is conducted in Namibia. Students needed to understand the project as well, and its impact on their studies. On the other hand faculty members were interested in understanding their roles and responsibilities in the project, how it will benefit their departments, and how will it affect their daily work.

There were many delays caused by issues such communication therefore affected meeting deadlines. The project being the first, there is little experience in terms of working in teams and across disciplines. Logistical arrangements in terms of transportation of students, accommodations affected estimated time to complete the project.

Other challenges included allocation of resources to be used by students during the project. It was not clear as to what will the Polytechnic provide to students, and what will the industry provides. However, the Polytechnic provided laptops, as well as other stationeries.

6. Monitoring and evaluation

The CCE team shared monitoring and evaluation responsibilities with the industry supervisors. CCE visited students while on project to monitor and evaluate the progress. This was also done regularly through telephones and emails to discuss pertinent issues. On-going coaching and monitoring was conducted to manage interpersonal relations during assessment visits.

7. Assessments

Assessment for multi-disciplinary research can differ according to situation. According to Woods (12:2000), comprehensive assessment methods for a team’s research project must be developed and should include the following listed fundamental principles:

- Assessment is based on performance
- Assessment is a judgment based on evidence rather than feelings
- Assessment must have a purpose and have clearly defined performance goals
- Assessment is done in the context of published goals and measurable criteria
- Assessment should be based on multidimensional evidence

The Polytechnic of Namibia however foresees assessment for the multi-disciplinary project to be conducted with the assistance of faculty members at the Polytechnic of Namibia, as they are subject matter experts. Documents such as Portfolio of Evidence which students gather during the entire project (including log sheets, reports, learning activities) will be used for assessment. Students are expected to do a final report before a panel of industry expertise and faculty members (including CCE members).

8. Recommendations

It is evident that each multi-disciplinary project differs according to its nature, and also to the fact that different parties have different expectations. However proper planning is essential to ensure that all parties understand what is expected, that clear
guidelines is clarified to ensure the success of the project.

The following points could serve as recommendations:

- Education and awareness should be carried out, to ensure readiness, commitment, buying-in from all parties.
- Proactive planning and continues reflection during the project is vital to minimise challenges experiences.
- Deadlines and timelines should be drawn up, respected, and adhered to by all project participants.
- Reporting structures and lines of communication should be clearly articulated to avoid ambiguity.

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THE SUSTAINABLE INNOVATION CAPABILITY EVALUATION OF THE INNOVATION-ORIENTED ENTERPRISE

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Abstract: Innovation is fountainhead of gaining competitive power for the enterprise. The sustainable innovation ability of enterprises is the determining factor of the enterprise's sustainable development. Innovative enterprises model belongs to new things, innovative enterprises model has not yet formed an acceptable system theories. So the study of the innovative enterprise is still in the initial stage at home and abroad. This article focuses on the sustainable innovation capability of innovative enterprise. At first it introduced the concept of the enterprise sustainable innovation, the impetus of enterprises continual innovation and the elements of enterprises continual innovation. And then on this basis, it proposes the evaluation index system of enterprise innovative ability, then use analytic hierarchy process (AHP) to determine evaluation index weights of the innovative enterprise innovation ability. Finally, in order to facilitate quantitative analysis gives the unified innovative enterprises sustainable innovation dynamic evaluation system of evaluation criteria. The purpose of the full thesis leads it realistic meanings in that, it is offering important assessment method to formulate development strategy for enterprises and promote the sustainable development.

Keywords: sustainable innovation; index system; analytic hierarchy process (AHP)

INTRODUCTION

With the rapid development of science and technology, Technological innovation is the base for enterprises to achieve sustainable development, and also is an important factor for a country to bring about a sustained growth in the national economy. Looking around the world, technological innovation is a powerful motive force of economic development and social improvement, as well as one of the most important measures of the comprehensive national strength. Throughout the well-known Chinese and foreign enterprises, the U.S. General Electric, IBM, Japan's Toyota, Sony, China's Haier, Lenovo ...... they been able to become a leader in the Chinese and foreign enterprises, and both are in the market competition ongoing technological innovation, small to large development results. All this prove that, during the times of knowledge economy, Technological innovation has become a great power to promote enterprise development, social progress and national prosperity.

In China, there are many companies rely on the rapid rise of technological innovation, but they soon disappear, to become the so-called "short-lived enterprise." Data shows that average life expectancy of Chinese enterprises is only 7-8 years; private enterprise is only 2-9 years. This phenomenon effectively illustrates a considerable number of Chinese enterprises in the long-term development of its competitiveness is declining, while the deeper reason is that Chinese enterprises in the traditional concept of technological innovation mode can not meet the more complex and dynamic competitive environment, thus can no longer bring a sustainable competitive advantage. Look at the foreign many well-known companies such as Intel Corporation, through continuous reform and innovation in the face of fierce market competition, won a place. In the competition, before completely imitate any generation of chip products, it has developed and launched a new generation of products, and always let competitors catch up. No matter what the reason why these companies are in the competitive environment has always been able to create high performance,
forming a wave of competitive advantages precisely because of sustainable technological innovation of enterprises.

It’s not optimistic for Chinese enterprises’ technological innovation situation overall. The main reason is that these enterprises lack sustainable innovative power. Because of the limitation of China’s economy system and technology system over the years, Chinese enterprises have not really become mainstay of technological innovation. In terms of technological innovation of enterprises, be short of power, limited input, Difficult to obtain due to technological innovation enterprise formed by the monopoly profits, and all things restrict the development of Chinese enterprises and make it hard for enterprises to win market competition by technological innovation. There’s no power for enterprises to earn high profits and improve the technological innovation, let alone keeping strongly sustainable innovative power.

For the above reasons, the author chose the sustainable innovation of Chinese enterprises motivation to study, and on this basis to establish the evaluation model, trying through theoretical analysis and empirical research to find out the mechanisms for sustainable innovation dynamic problems, influencing factors and constraints, proposed countermeasure encourage enterprises to continuous innovation, so as to put Chinese enterprises in the advantageous position in the global market competition.

II. COMPREHENSIVE THEORY

1. Innovative Enterprise

Hu Jintao at the Seventeenth Party Congress report clearly pointed out that to enhance the independent innovation capability and building an innovation-oriented country. Ministry of Science, SASAC and ACFTU jointly implemented the "scientific and technological innovation to guide project". As a major scientific and technological innovation to guide the project work, the ministry, the SASAC and ACFTU joint pilot innovative enterprises. Innovative pilot work aims is to pick good companies continue to innovate, by reducing taxation and other policy support to promote the launch of its continuous innovation projects, the implementation of continuous innovation, to achieve sustainable development of enterprises.

In the above context, many experts researched on innovative enterprises, and they point out that the essential task of innovative enterprise is to achieve sustainable innovation. But most innovative enterprises one-sided emphasis on the technological innovation power and ignore the motive factors of promoting enterprises achieving sustainable innovation. While the author holds the idea that innovative enterprise means enterprises with strong and lasting innovation power, developing the independent innovation strategy as a guide, carrying out new items including technological innovation, institution innovation, management innovation, organization innovation, market innovation and culture innovation.

2. Enterprise Sustainable Innovation Theory

The idea of sustainable innovation derived from Joseph Schumpeter. Schumpeter believes that technology comes from the enterprise internal innovation department. Successful technological innovation enables the enterprises to reap excessive profits, thus they can get stronger and form temporary monopoly. While the participation of so many imitators impaired the status of monopolists, excessive profits disappear, and new opportunities will come up again. It is clear that Schumpeter affirmed that modern enterprises can and must keep making innovation. He explicitly put forward the idea of sustainable and technological innovation.

Recent years, the importance of sustainable innovation has been gradually known to theory community, the business community and the government. Based on the thoughts of Schumpeter, some scholars already researched on sustainable innovation theory. They think that sustainable innovation means during a long time, enterprises promote and carry out innovative items (including products, processes, materials, organization, management, systems and market innovation and internal diffusion) and it is a journey of achieving innovative profits. Enterprises Sustainable Innovation has constant, benefit increase constant and enterprise develop constant, 3 pieces of basic characteristics.
There are two types of enterprise sustainable innovation. One is specific entrepreneur oriented continuous innovation. Through the process of Chinese and abroad enterprises sustainable innovation, we can find out that most successful enterprises’ sustainably innovative process is led by a specific outstanding or excellent entrepreneur, such as Zhang Ruimin from Qing Dao Haier, Ni Runfeng from Si Chuan Changhong, Acri from U.S. Chrysler. No one can replace these outstanding entrepreneurs’ dominant and promoting status in the process of keeping sustainable innovation. Anyway, due to various reasons, they didn’t found effective cultivation, selection and appointment system of successor. It can influences the innovative process very much, so often appear that due to the specific entrepreneur abdication lead to sustainable innovation process large fluctuations, even terminate. The other type is mechanisms oriented sustainable innovation. During the practice of sustainable innovation of Chinese and foreign enterprises, a few especially excellent enterprises do achieve sustainable innovation surpassing enterprises of an age. This type of enterprises forms an effective system during the long-term sustainable innovation. And this system can encourage the entrepreneurs promote the enterprises’ sustainable innovation on the one hand, and on the other hand cultivate and select outstanding entrepreneur successors. At the abdication time of entrepreneurs of a generation, enterprises can have a new generate entrepreneurs to carrying on the sustainable innovation to ensure the enterprises can develop more than 20 years even 100 years. For instance, American general electric company is such an acknowledged enterprise. Although this type of enterprise is not much, they have already become a model of outstanding enterprises at home and abroad, they represent the basic direction of the sustainable innovation and development of the enterprise.

3. Sustainable Innovation Dynamic Elements
The relationship between the dynamic factors of innovation is interaction, mutual influence, and mutual dependence. Understanding the role and relationship of the various elements in the sustainable innovation can help to better adjust and use them to promote enterprise technological innovation activities.

Entrepreneurs’ initiative spirit is a key element of deciding enterprise's performance and its long-term development. However, the spirit of human subjectivity and consciousness just something that is difficult to quantify and to be evaluated. Refer to other experts’ research results; we can induce them to three specific aspects: First, the enterprises promote the formulation of independent technological innovation and long-term strategic objectives and planning. Sustainable innovation is thing that needs long time and heavily, and it even needs entrepreneurs’ strong will. Under the control of entrepreneurs’ spirit, they can carry out a target and plan of promoting the independent innovation of science and technology. Second, the effective system’s found of innovation strategy and the significant project. The essential condition of promoting the strategy possesses a sound decision-making mechanism. Entrepreneurs should have the spirit of adventuring, get fully prepared and take precautionary measures in the future. The last, it carrying out production innovation, culture innovation, market innovation, organized system innovation sustainably. It can be seen from the implementation of innovative projects in recent years, enterprises innovation driven entrepreneurship enterprises.

Material interests are the source and ultimate destination to promote the sustainable innovation of entrepreneurs. It is necessary to associate the interests of entrepreneurs and their management team key employees, but their inspiration is different from normal employees’. They take the risk of the adventure of innovation and all the uncertainty. Besides, they trace not only profit, but also the spiritual fulfillment. Further, long-time invest is essential for enterprises to achieve sustainable innovation. If core management staff are unstable, this long-time behavior is either simply impossible to start or the start will soon be mortality. Thus, the elements of a concrete manifestation of the establishment and implementation of key employees of the entrepreneurs and their management team options, equity interest held by system; technology innovation leader in intellectual property sharing,
the establishment and implementation of reward systems; high-level talent introduction, training, selection and appointment system was established and the implementation of the three.

Enterprise culture is the form with enterprise spiritual wealth and material characteristics during the long-time management, including enterprise values, spirit, ethics and code of conduct material and cultural environment, etc. As everyone knows, enterprise culture has some influence on employees’ subjective activity, and this subjective activity is the important source of enterprises achieving sustainable innovation. The elements embodied in the establishment of enterprises with independent innovation as the core values of the spirit of enterprise or corporate culture of innovation system; workers' rationalization proposals been adopted (the average annual per 100 employees in the last three years raised the rationalization proposals the number of enterprises to adopt the rationalization proposals number);

Table 1: enterprise continuous innovation dynamic evaluation system evaluation standard

<table>
<thead>
<tr>
<th>First grade index</th>
<th>Second Grade index</th>
<th>Evaluation Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[0-2]</td>
</tr>
<tr>
<td>B1</td>
<td>C11</td>
<td>No goals and planning</td>
</tr>
<tr>
<td></td>
<td>C12</td>
<td>No effective decision system</td>
</tr>
<tr>
<td></td>
<td>C13</td>
<td>No successful implementation of a wide range of innovative projects</td>
</tr>
<tr>
<td>B2</td>
<td>C21</td>
<td>Non-the option equity incentive mechanism, and recently planning</td>
</tr>
<tr>
<td></td>
<td>C22</td>
<td>No intellectual property sharing regime</td>
</tr>
<tr>
<td></td>
<td>C23</td>
<td>No high-level personnel system</td>
</tr>
<tr>
<td>B3</td>
<td>C31</td>
<td>No sustainable innovation, entrepreneurial spirit and culture</td>
</tr>
<tr>
<td></td>
<td>C32</td>
<td>No goals and planning</td>
</tr>
<tr>
<td></td>
<td>C33</td>
<td>No effective decision system</td>
</tr>
</tbody>
</table>
establishment and implementation of the enterprise system to encourage employee innovation activities in three areas.

III. INNOVATIVE ENTERPRISE DRIVING FORCE FOR INNOVATION EVALUATION MODEL

1. Sustainable Innovation Dynamic Evaluation Index System

Under the scientific and practical principle, and according to the dynamic factors of sustainable innovation above, found the innovative enterprise dynamic evaluation index system below. And this system concludes three first-grade indexes, nine second-grade indexes, concrete situations are showed in table 1.

2. Evaluation index weight determination

Subjective weighting method and objective weighting method determine the weights. Subjective weighting method is derived based on the subjective judgment of the experts, and the main methods are AHP, Delphi method experts’ survey which are more mature, the derived weights more in line with the actual situation, but the disadvantage is the objectivity is poor. Objective weighting method of raw data by each of the indicators in the evaluation of the actual data, it is generally not dependent on the subjective judgment of the people, thus the objectivity of this method is strong, but the objective weighting method is too dependent on the sample data, and the weights we get may be inconsistent with the reality.

In the process of innovative enterprise dynamic evaluation, we adopt the weight using AHP to determine every evaluation. AHP was put forward by T.L.Saaty, a famous American operation researcher in 1970s. It is a simple qualitative system analysis and effective method to deal with the complex problem of multi-target, multi-criteria, multi-factor, multi-level. This article references many experts’ suggestion and associates actual enterprises’ situation, and we get the weight value showed in table one. Entrepreneurs and their leadership team’s spirit of sustainable innovation and consciousness weights 0.41; Entrepreneurs and their management team key employees incentives created by the weight of 0.32, and the weight of the construction of sustainable culture of innovation is 0.27. The same reasons we can get the second grade showed in table one.

IV. INNOVATIVE ENTERPRISES’ SUSTAINABLE INNOVATION POWER EVALUATION ASSESSMENT STANDARDS

After the innovative enterprises’ sustainably innovative dynamic evaluation index is determined, in order to ensure the fairness and reasonableness of the dynamic evaluation of innovative sustainable innovation, the evaluation indicators with reference to the uniform standards for qualitative variables into quantitative variables lateral correlation analysis to facilitate a number of enterprises. This article founds innovative enterprises’ sustainable innovation power evaluation assessment standards, and the concrete situations are show below in table two.

V. CONCLUSIONS

This paper focuses on innovative enterprises for sustainable innovation dynamic evaluation. Start with the connotation of innovative enterprises, the power factor of sustainable innovation theory and sustainable innovation elaborate three-parts: Offer a stability theoretical foundation for building the index system. Then build a sustainable innovation dynamic innovative evaluation index system, using AHP to determine the specific weight of the indicators. Finally, in order to facilitate the practical application, enterprises should use innovative sustainable innovation dynamic evaluation system evaluation standard. It provides the effective assessment method for correctly understand of their
own sustainable innovation for the enterprise power, carrying on the crosswise comparison between enterprises, formulating development strategy.

However, there are still many inadequacies need to be improved in the future study. Firstly, innovative enterprises continuous innovation evaluation index system power needs further improvement. Indicators established in this paper are basically qualitative indicators; the evaluation work has a certain degree of difficulty. Above all, the article proposed the next research way. For example, to make a more detailed evaluation, the evaluation has better maneuverability. Secondly, there are no pilot innovative enterprises to carry out evaluation. In the future when conditions permit, we should work in outstanding innovative enterprises pilot evaluation, make theory accepted practice test, in order to better promote innovative enterprise sustainable innovation power evaluation research.

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Management Training Tools in Education
Development of entrepreneurial skills through practice learning tools

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Abstract: The demand on managerial functions of the new generation necessitates a review of teaching tools. The lecture introduces proven management training tools, to show, how the University of Applied Sciences in Wismar imparts knowledge about business acumen, entrepreneurial skills and abilities. Which kind of competences do students and junior managers actually need? What are the main challenges and the marginal changes in the daily routine of junior managers? How are we able to direct students towards topics like taking on responsibility for business decisions as well as complexity and sustainability? Experimental learning could be an answer. By letting management contents become cognitive, you are able to enforce the sustainable transfer into practical experience. The training tools used are interactive exercises. Authentic team processes occur in team interaction, in a protected environment, free from the challenges of daily life. Participants master a demanding task together, through efficient and effective communication. By using the management training tools participants are able to translate contents and theory on a level that can experienced with all senses. In particular the tools encourage student’s authentic interpretation. Students are able to draw their own conclusions and develop solution strategies. The variety and complexity of subjects which the exercise can be used on depend significantly on our own creativity. The conception of trainings including new educational methods and theoretical foundations are the object of the lecture.

Keywords: Educational methods, praxis simulation, Management Training Tools

Since educating the leaders of a company of tomorrow is one of the major goal of business science universities of today, we first of all have to take a look at our target audience …. the students of today and of course of tomorrow. Who are these students and what are they like? What are their values and what kind of expectations guide their actions? What kind of study offers do universities have to propose to their clients in order to optimize the matching of what is learned to what is needed. How do we get them fit for working life? The new Y GENERATION is the target audience of our education offers and they will be the (hopefully good) business leaders and entrepreneurs of tomorrow.

Generation Y is in sociology that part of the population that were teenagers around the year 2000. They are called „Digital Natives“. It is the population part that followed the generation X who themselves are the children of the baby boomers.

The average of those born after 1980 are classified as well educated, often graduates or with similar qualifications. Their way of life went along surrounded by technology, internet and mobile communication. Within 10 years the generation Y will make up 70% of companies´ staff. Their values and their ambitions concerning creativity, cooperation, engagement, flexibility, work life balance, self-control and challenge will change the face of work. Therefore the understanding of leadership will change as well. If we can trust a study of the „manager-barometer“ from Odgers Berndtson, Leaders in Germany take content of their job more seriously than their job to lead. They are a lot less willing to take responsibility. On the one hand they want to have good potential of personal growth but on the other hand they have a
lack of vision and a lack of willingness to take responsibility.

Should not that kind of information be our guide to a thoughtful rethinking of the way of teaching? Shouldn’t we ask ourselves as teaching staff - did we tune ourselves in to the new work needs? Do we support the students properly? Do we change our competence developing offers quickly and exactly enough to fit the needs of the work market correctly?

It will be a big challenge - for companies and universities alike - now and in all following generations to always have a good view ahead and guide - in this case the generation Y- optimally and intelligently into their new leading role.

Teaching of leadership competences

Communicating vision and strategy of a company, management of diversity, knowledge transfer of individuality and self-organization, motivation of staff and transfer of network intelligence leadership will remain a complex task. Complexity, responsibility, loyalty to the company and towards the environment, feedback culture and communication are more and more skills that are placed on managers. Flexible working hours, individual office equipment and home office options demands a new kind of skill, called virtual leadership. This requires a lot of discipline, knowledge about behavioral tendencies of individuals and opportunities for intervention in conflict situations. Therefore, we need methods to make the implications of personal actions and decisions clear. Training exercises should make issues visible and above all comprehensible. Students should be made aware, encouraged to question topics and they should be guided along the steps of self-experience in their courses.

As part of the leadership training, offered at the University of Wismar, we integrate management training tools from the specific field of experiential education with the object of sharpening the personality profiles of students and announcing the importance of leadership tasks. Experimental learning as a sub-discipline of science education is one of many action-oriented methods. This kind of education allows transferring learned from the exercises to life situations.

The figure below shows how the knowledge gained from the exercises can be transferred into the respective life situations. The learning process can be represented schematically as follows:

Fig. 1: Scheme Learning Process

First the Teacher has to arrange the action and prepares the participants. At the first view this action has not anything to do with management tasks. The Teacher announces the terms and conditions, the participants have to respect them. When the time starts, the group tries to find out solutions and answers. It is not important which way they go, each way to solve the problem is worth the effort. Once the group has finished, the transfer starts. Questions like: who played which role? How did everybody handle the complexity of the task assigned to them? How did the leaders experience the exercise? Which phases were difficult to manage and how did the group finally succeed? The group collects the answers and often they have the first moments of enlightening. The Transfer of the results into management situations brings the exercise to the end. This type of education is directed at the advancement of the participants in their personal development by questioning their own experience. Three statements describe the meaning of experiential training activities:

- Developing their own personality: through experiencing a challenging situation or activity, participants gain skills they might not have noticed about themselves before. Also they have the possibility to get to know their own strengths and weaknesses. They can realize where their borderlines are and question known values, existing lack of confidence may be achieved in created situations and new solutions are made visible.
• **Pushing social and in our case business competences:** the experiential teaching methods are mostly used in groups. Therefore it is necessary to start out with at least a small amount of capability to solve communication-, team- and conflict situations. These competences will be trained and improved in the group. One more important feature is to learn to trust and trustfully guide. Tolerance and acceptance of the participants will be brought forward because every capability and every incapability will appear to each member of the group.

• **Transfer of the experience into the daily routine:** the reflection before, during and after each activity allows each participant the transfer of knowledge acquired into his/her daily routine. Because of continuous questioning „How the benefit of the experience may be used in the near future?” the experimental pedagogic gets its main relevance.

Methods of that kind are used in a number of companies such as Deutsche Bahn, Volkswagen or Lufthansa. They are a great contribution to the common teaching methods and help close the gap of understanding between work and study.

At the University of Applied Science and Business in Wismar we have been using these kinds of teaching methods in the course „Leadership Training for students“ for 3 years now.

It is proposed to hold an inter-departmental training programme over a period of 6 days, including an evening event with local business leaders. Main aspects are a self-analysis of the own personality, group dynamic processes, types of communication and leadership such as a better understanding of how conflicts may arise and how to solve them. Even students without any leadership experience are able to transfer massive know how out of the training into their personal daily life situations.

**INTRODUCTION OF A MANAGEMENT TRAINING TOOL**

"The Tower of Power" is a learning project, which can illustrate a couple of these topics as a living metaphor. It makes interaction visible, audible and tangible. This tool can be used to address and illustrate the following issues: listening techniques, team interaction, communication between executives and employees, problem solving within groups, determining factors in success and lack of success, cooperation, roles within groups, feedback processes, and systemic correlations. Attention should be paid to the introduction of the exercise. At first, the project has to be given a clear aim. In addition to explaining the framework and rules, teacher has to take time initially to briefly explain the content and its relevance for the group. Second: conducting the exercise: in this phase the group activity takes precedence. The trainer plays the role of observer. In some cases it is necessary to interact with the group. If the group gets stuck in a dead end for what feels like too long time, trainer can interrupt the process and help the team arrive at their own solutions. During the debriefing stage the trainer collects the various responses to the learning project. This stage offers multiple opportunities for transfer to real-world situations.

**CONDUCTING THE EXERCISE**

*The group’s task is to create a tower by piling up the blocks vertically, using all the blocks if possible.* Each participant holds one wooden ball in his/her hand (or two, depending on the number of participants). The participants may neither shorten the ropes, nor enter the marked area. The wooden blocks may not be touched with hands or feet but only with the arresting device. *Ideas for debriefing could be:* During the exercise: Who played which role? How did you cope with the complexity of the task assigned to you? How did the leaders experience the exercise? Which phases were difficult to manage and how did you finally succeed? Which role did communication play? Which needs did the team have (e.g. clear information and directions, positive feedback etc.) and how did management fulfill these needs? It depend on the team play of the group how effective and meaningful is the experience.

Working with experience-oriented learning methods is more effective the more the trainer uses a competence and solution-oriented attitude. This positive solution focus enables to make the resulting experience during the interaction tasks relevant.
CONCLUSION

1. In addition to the focus on teaching technical skills colleges and universities it is necessary to address the use of social, communicative and entrepreneurial skills. Responsibility and complexity must be tangible and comprehensible. Students must recognize the important role played by responsibility and initiative in the context of complex issues. Practice must be integrated into lessons, the dialogue with senior executives must be supported. Self-awareness as a key to the transfer of what is learned must complete the appropriate teaching. The teaching of key competences should be taken out from the corner of the "annoying" block courses and should get the same weight as the specialized teaching.

2. Universities need to adapt more to the new digital natives and teaching methods to check acceptance and sustainability. In the age of digital media knowledge is available at a high level at any time. The science of education must find ways to motivate the next generation to care and achieve interactive practice orientation.

3. In the age of increasing digitalization and rising importance of media networking, young professionals should get especially prepared for leadership roles and their challenges.

4. Interactive methods should encourage the introduction of social skills within the exercises so that behavioral tendencies are visible and can be challenged in their effectiveness. The methods and training tools create reflection opportunities in a safe environment.

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A STUDY OF INNOVATIVE WAYS TO COMBINE ENGINEERING EDUCATION AND COMMERCE EDUCATION

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Abstract: In the new global economy, the issue attracts more and more concern from the society that engineering graduates who only have related knowledge and skills but not the market, operations, services, and management skills of commerce are lack of not only professional awareness but also communication and teamwork ability. This paper focuses on the combination of engineering education and commerce education with emphasis on education innovation, bringing the objectives and requirements of the knowledge of commerce into engineering training objectives, advocating the cross-penetration between engineering and commerce knowledge by a series of means: to construct a scientific commerce knowledge system, to build training rooms, to arrange various forms of training projects, to establish innovation and entrepreneurship experimental class, to reform the personnel training mode.

Keywords: engineering education; commerce; training mode; innovation.

I. INTRODUCTION

Engineering education is the main channel to provide talents with engineering technology and enterprise management for national economic construction. Engineering plays an important role in higher education system. Indeed, China's higher engineering education has obtained obvious achievements since opening up to the world, but it also has problems. There has been a phenomenon that a large number of students are "escaping from engineering" and flooding into finance, management and other popular majors like other countries, on the one hand; engineering graduates with less or without business knowledge or skill cannot properly or fully exert role in social and economic development construction, on the other hand. How to face up with this situation is the major task for higher engineering education. To meet economic and social development needs, strengthening university engineering education by introducing commerce education into engineering education may be a workable solution, innovating and enhancing engineering education so as to educate engineering talents suitable for the needs of economic and social development at the modern age.

This paper first describes the background of the combination of engineering education and commerce education, then puts forward the principles of the combination of engineering education and commerce education, and proposes innovative ways of combining engineering education and commerce education in terms of curriculum setting, teaching mode, teachers training, academic research, educational
environment by taking the Shijiazhuang University of Economics as an example.

II. REASONS FOR THE COMBINATION

1. Engineering Talents’ Drain Promotes the Adjustment and Reform of Engineering Education

In the 21st century, the rapid development of science and technology, the globalization of economy and market and fierce competition on the international scale has had a tremendous impact on engineering education. Many countries have the phenomenon of "escaping from engineering". The current state in China is that a large number of top-notch students are no longer interested in the majors related to the tough engineering like water conservancy or hydroelectricity projects, mining, geological prospecting, surveying and mapping professions and they are flocking to finance, banking, management, legal and other popular commercial industries; many outstanding engineering students switch to other profession by taking civil service examination, postgraduate-entrance exam, trying to "escape" Engineering; There are some excellent engineering talents have gone abroad to European and American developed countries. Engineering talents’ drain leads to a decrease in the quantity and quality of China's engineering talents.

2. The Combination may be an Innovative and Proper Way to Produce Talents for China's Economic and Social Development

Engineering talents’ drain and the training quality make China’s engineering education into a corner, difficult to meet the new needs of a large number of high-level engineering and technical talents in industrialization, urbanization and modernization. How to handle the awkward situation of students "escaping from engineering" becomes a major challenge for high-level engineering education. The problems reflect some problems in the high-level engineering education, which calls for the adjustment and reform of engineering education. It is believed that aiming at cultivating interdisciplinary talents with solid foundation, broad knowledge and ability, good at adapting to society, high-quality, innovation and entrepreneurship is supposed to become the fundamental goal of high-level engineering education.

With the globalization of market going on, the engineering graduates with only skills, not knowing the market, operations, services, management and other commercial skills are lack of not only career awareness but also communication and teamwork skills. Nowadays, China is trying to achieve transformation from "Made in China" to "Created by China" in the economic development mode. Manufacturing industry is facing the change from the "big manufacturing" to " powerful manufacturing ". Educating a large number of engineers mastering modern advanced manufacturing industry technology and having some economic and management of engineering, will be an important factor to the success of this transformation. Therefore, the establishment of engineering education with commercial training will be an innovative way for the sustainable development of high-level engineering education.

III. THE PRINCIPLE OF THE COMBINATION

1. The Moderation of Curriculum and Teaching Content

It is very important to control the moderation in adding or designing commercial knowledge and courses to integrate with engineering curriculum, which cannot totally adopt the pattern of commerce majors. More efforts should be made to the careful selection and arrangement of commercial knowledge and skills, concerning the characteristics of engineering. For example, in time arrangement, if introducing too much commercial knowledge and adding too many business courses into engineering majors, it will take up too much teaching time and affect engineering major learning; In curriculum arrangement, more attention needs to be paid to the adequacy of commercial knowledge without involving too much detail, high standards and requirements for engineering students, otherwise, it will have opposite teaching and learning effect. The authors believes that it is relatively proper to introduce some commercial course and training which take up 10% - 15% credits into engineering majors in the curriculum.
2. The Broadness and Frontiers of Knowledge

To integrate commercial knowledge into engineering education, more consideration should be given to its moderate broadness. This is due to the inconsistence between our talents training and employment. Higher education in China is the curricula/academic education, not like Western countries where higher education is likely to keep close connection with schools, carrying out ‘order training’. Chinese university students are not sure of his employment during campus life and there is often a bilateral choice between enterprises and graduates before getting jobs. Even when the graduate finds the job in his major, s/he may be frequently required to switch to other positions doing what has less to do with his major or has some to do with commerce due to the need of work. Given this, it is necessary to moderately add and broaden commercial knowledge to engineering students’ curriculum if the conditions are permitted.

With the fast speed of knowledge updating in current world, commercial education for engineering should pay more attention to the advancement and frontiers in knowledge and information, otherwise engineering students will be difficult to meet the future job requirements.

3. The Diversity of the Combination Form

There are many ways to combine engineering education and commerce education, such as adding some economics, management or legal commercial knowledge to the related professional courses, setting up some modules of some commercial courses in engineering curriculum to reach the aim of the combination, arranging training session in the class for engineering students to participate in commercial practices including business simulation, innovation and entrepreneurship training, etc.

IV. THE INNOVATIVE WAYS TO COMBINE ENGINEERING EDUCATION AND COMMERCE EDUCATION

1. To Establish Professional Group to Guarantee the Condition of the Combination of Engineering Education and Commerce Education

For colleges and universities, the coexistence of engineering and commerce is the safeguard condition to blend commerce knowledge into engineering education, and vice versa. Especially the establishment of the professional groups of engineering and commerce can help to promote the atmosphere of the combination of the two disciplines, beneficial to penetrating commerce knowledge into curriculum, practical training, innovation and entrepreneurship training and faculty team. The students’ knowledge of engineering and commerce will be complementary and mutual at the meantime.

Shijiazhuang University of Economics(SUE) has formed into the professional groups of engineering majors and commerce majors in the long course of development. In order to better develop engineering and commerce majors, and to adapt to social and economic development, the university has attached great importance to the feature of the “penetration between Geology and Economics, the combination between Technology and Management”. That is to say, to make the curriculums of engineering majors and commerce majors infiltrated and combined, such as resource exploration engineering, exploration technology and engineering, hydrology and water resources engineering, surveying and mapping engineering, gem and material technology, engineering and business administration, marketing, human resource management, international economy and trade, statistics, accounting and other. The engineering students are required to command the related business knowledge useful for the market, which has proved to be beneficial for the graduate to find a job. As far as the school is concerned, the combination of engineering and commerce education enhance the strength and characteristics of running the university.

2. To Create Atmosphere to Guarantee the Combination of Engineering Education and Commerce Education in Concept

Any kind of reform and innovation needs the change of people’s concept. If you expect engineering students to choose to study commerce knowledge, the first step is to change their concept, helping them realize the importance and necessity of studying related business, thus creating corresponding atmosphere is of great importance. Shijiazhuang University of Economics has actively created the atmosphere for the combination of engineering and commercial majors, setting
corresponding commerce knowledge educating windows, providing relevant text and pictures using modern educational technique such as computer and campus network, inviting entrepreneurs to give lectures, organizing engineering students to participate in activities such as business simulation, innovation and entrepreneurship training, visiting enterprises and financials museums, carrying out a series of programs and activities to create the atmosphere for the combination.

3. To Establish Reasonable Teaching Modes for the Combination

Establishing a reasonable teaching mode is helpful for the engineering majors to acquire commercial knowledge. After several years of exploration and practice, Shijiazhuang University of Economics has established the reasonable teaching mode to combine engineering education and commerce, mainly reflected in the following aspects:

To have co-existence of both compulsory and optional business courses in engineering curriculum

For some engineering majors having specific training orientation, some compulsory courses of economics and management and law are set up; some optional courses of commerce are open to engineering students, accompanied by some leading edge subject in the combination of engineering and business.

To strengthen the practical training, combining theoretical teaching and training operation

It is suggested to organizing engineering students to participate in commercial activities such as business simulation, innovation and entrepreneurship training, visiting enterprises and financials museums and encourage engineering majors to participate in social commercial practice, combining campus study with social practice. In this way, students not only get to know relevant productions, but also understand relevant knowledge of operation and management of business. Through social practice, students are expected to realize the importance and necessity of studying commercial knowledge.

To establish Entrepreneurship Education School

Shijiazhuang University of Economics has just established Entrepreneurship Education School, which is also open to engineering major students, encouraging them to participate in innovation and entrepreneurship practicing programs. The curriculum for “Experimental Class of Innovation” include the courses of project management, table simulation of innovation, value chain and competitive advantages, the employment training, the role of innovative enterprises and management of enterprise organization, and etc. The instructors consist of teachers with rich business teaching experience and excellent managers or bosses with abundant practical experience in running business, greatly improving the teaching and learning effect, beneficial to students.

4. To Enhance the Training of Teaching Staff

The quality of faculty is the decisive factor for the combination of engineering education and commerce and for seeking innovative ways to educate the high qualified and interdisciplinary talents. Building engineering and commerce disciplinary groups and having high quality professional teachers can provide a fundamental support of the combination. In recent years, Shijiazhuang University of Economics has mainly taken the following measures in reinforcing the teaching staff in charge of the combination of engineering and commerce: engineering teachers are encouraged to obtain business certificate trough training; engineering teachers are provided with more opportunities to involve the practicing in enterprises management and take part in the practice training in business; off-campus business managers, CEO and professional technicians are often invited as visiting lecturers or part-time teachers or supervisors for some courses. Meanwhile, consideration is given to the candidates with business education background.

5. To Use the Combination’s Research Team and Platform to Promote the Construction of Disciplinary, Majors and Talents Education

In order to cultivate interdisciplinary talents, colleges and universities should carry out interdisciplinary research, and gradually establish and guarantee the system of “double supervisors”, “double degrees”, “double titles’ to promote the comprehensive development of engineering and
commercial education. For instance, Shijiazhuang University of Economics has taken the engineering or commerce research projects as bonds, regarded the major interdisciplinary research projects as push, gathering all the manpower, assets and fund, and goods of the two disciplines to promote the mutual blending and study of the basic theories of engineering and business and to promote the combination between different disciplines so as to form into advantages in all round by giving a full play to the comprehensive advantages of the above mentioned.

Universities can also establish interdisciplinary laboratories and research centers to provide platforms for interdisciplinary research and establish engineering-commerce interdisciplinary research centers cooperated with enterprises to directly serve the enterprises. For example, Fudan University has set up three interdisciplinary research centers, which are Technology Research Center, Mathematics-Computer Science-Management Science Research Center and Economics Science Center. Engineering and business disciplines’ development and talents training can also benefit from the establishment of the platforms.

V. CONCLUSION

Facing the new chance and opportunities brought by the development of society, higher engineering education must be clear about the target and be innovative in its system. On the basis of current achievement, university should deepen the reform and improve the quality in terms of curriculum, education environment, teaching methodology, the teachers training, academic research so as to promote the combination of engineering and commerce education and enable engineering education to well meet the needs of the society in the new century.

References
REFLECTIONS ON DESIGNING A COMPUTER BASED SIMULATION FOR INNOVATION MANAGEMENT EDUCATION

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Abstract: The realisation of innovations is an essential task for firms to compete successfully in a globalised economy. However, knowledge and abilities to manage innovation are often imperfect or even completely absent, especially in small and medium-sized enterprises. For this reason, higher education institutions should also have an emphasis on the education in the realm of innovation management when preparing their students for the business world. The objective of this paper is to present and discuss a new educational approach to foster students’ awareness for the importance to innovate and their ability for successful innovation management. Our paper is conceptual in nature and describes a process model that can be used for implementing a computer-based simulation. The underlying scenario consists of an oligopolistic market with companies selling products and competing against each other. We use a set of contingency factors, in particular four decision parameters: expenditures for R&D, customer integration and communication as well as product price. Several recommendations for the implementation of the model and further research are presented.

Keywords: Innovation management, Educational method, Computer-based simulation

1. INTRODUCTION
The development of new products or the improvement of existing products is an essential task for firms to ensure their competitiveness. Constant innovation is a key factor for the survival and growth of business organisations (Capon et al. 1990; Forsman 2006; Maravelakis et al. 2006; Lin & Chen 2007). In order to systematically support opportunity recognition and target group related product development, several management methods and tools exist. Creativity techniques, market analysis, feasibility studies, planning techniques, prototyping and so far are examples for such instruments that can be used in innovation management.

Universities as a source of workforce for the regional economy (Franco et al., 2010) often comprise a bundle of such methods in order to enable students to succeed in innovation management. The teaching of such tools is often included in the academic curricula of business management education. Teaching students the know-what, namely the hard facts of innovation management is surely important; however, it is also necessary to make them experience the relevance of innovation in the business context.

In this regard, we differentiate between passive methods and active methods. The former stand for the traditional approach in higher education, formal lectures and self-directed readings. In contrast, active methods are based on the principle of learning by doing, emphasising experiential learning. Especially in entrepreneurship education, the relevance of training soft skills by simulation has been discovered since some decades (Feldman, 1995; Haase and Lautenschläger, 2009; Hindle, 2002; Low et al., 1994; Thavikulwat, 1995, 1999; Wolfe and Bruton, 1994). However, innovation management education rather relies on passive teaching schemes; simulations in particular are almost completely absent.

The purpose of this conceptual paper is to develop a process model of the innovation management that can be used in a computer-based simulation. We put forward an approach for illustrating how innovation
management in manufacturing companies can be captured and modelled. To attain this, Section II shows a literature review on simulation in management education and a screening of existing simulation tools. Section III discusses the requirements of a simulation that can be used in innovation management education. Furthermore, we develop a basic scenario that depicts contingency factors on innovation management and potential outcomes. We also present a set of functions describing the model. The paper ends up with Section IV, providing a summary and discussion of the model as well as suggestions for its implementation.

2. COMPUTER-BASED SIMULATIONS IN MANAGEMENT EDUCATION

Traditional business management education is based on conventional forms of teaching, conveying ‘hard facts’ on several disciplines of business administration like finance, accounting, marketing, human resources, business law etc. However, also skill building components in negotiation, leadership, creative thinking and exposure to technological innovation can be found. Especially since the rise of entrepreneurship education at universities (Katz, 2003), the instilling of such soft skills has considerably gained importance. Haase and Lautenschläger (2009, p. 331) summarise that “experiential learning is expected to accelerate the pedagogic effect, since motivation is increased and emotional and intuitive dimensions of entrepreneurship are experienced”. Thus, action-based learning concepts (Leitch and Harrison, 1999; Rasmussen and Sørheim, 2006) have become an important part of modern entrepreneurship education within the last decades.

Especially since the rise of entrepreneurship education at universities (Katz, 2003), the instilling of such soft skills has considerably gained importance. Haase and Lautenschläger (2009, p. 331) summarise that “experiential learning is expected to accelerate the pedagogic effect, since motivation is increased and emotional and intuitive dimensions of entrepreneurship are experienced”. Thus, action-based learning concepts (Leitch and Harrison, 1999; Rasmussen and Sørheim, 2006) have become an important part of modern entrepreneurship education within the last decades.

Within such concepts, simulations are increasingly becoming important. In a general view, Keys and Wolfe (1990) describe a simulation as a simplified situation that contains enough similarities with reality to elicit real-world responses from the participants. In this way, the participants unconsciously process all types of information including emotions, relationships, strategies, and feelings (Petranek et al., 1992). Nowadays, simulations can be found in nearly every field of management education, for example in banking, logistics, general administration, business start-ups and also in innovation management. However, as such simulations are often commercially used, there is no academic discussion possible regarding the underlying concepts and models. Therefore, with the present paper we aim at overcoming this research caveat in innovation management education.

3. DELIBERATIONS ON SIMULATING INNOVATION MANAGEMENT

a. Requirements and objectives

The integration of a simulation tool in innovation management education has to consider the following aspects: Firstly, students should experience the importance of innovation and the effects of lacking investments in this field, such as declining sales etc. Secondly, students should learn that innovation efforts are related with high expenditures and the availability of resources. On the one hand, they should evaluate the cost of innovative activities; on the other, they should get awareness of the potential outcomes. In a more detailed manner, a simulation tool in innovation management should be designed in such way that students experience that:

- The level of R&D expenditures might affect the future quality of the respective product
- The integration of costumers is a precondition for improving products quality
- The improvement of a product’s quality is a precondition for attaining competitive advantages
- Marketing expenditures are essential for the product’s successful introduction in the market

At the same time, these above-mentioned aspects represent the learning objectives of such a simulation tool.

b. Setting up a scenario

We assume an oligopolistic market with a few established companies, each of them selling the same product. The number of firms is assigned to \( n \). The potential market volume \( \text{vp} \) is independent from external influences but may vary according to the average price level, indicated by \( p \). The sales
potential for each firm $sp_i$ in a certain period is a function of the overall market volume, the number of firms competing in this market, the price level and the firm’s reputation and image, expressed by $ri$. In a nutshell, this relation is expressed by the following function:

(1) $sp_i = f(vp, n, p, ri)$

The product has already been introduced to the market, having a certain quality, represented by $q_i$. Furthermore, we assume that the product has a certain prohibitive price $pp_i$ being constant over time, but it may increase in the event that the quality $q_i$ of the product improves. Thus, the prohibitive price is likely to vary between the different companies, depending of their unique product characteristics. We figure this relation as follows:

(2) $pp_i = f(pp, q_i)$

In order to calculate the sales of each company $s_i$, we suppose a classical linear demand function (price-quantity-function) as illustrated by Figure 1.

**Fig. 1: Demand function for a single company i**

Using the functions (1) and (2) and based on this demand function, we assume a relation expressed as follows:

(3) $s_i = f(sp_i, p_i, pp_i)$

Summarising the functions (1) to (3), the sales volume of a single firm $i$ is a function of seven factors: the number of firms competing in the market, the firm’s specific product quality, the average level of product quality, the firm’s specific product price, the average price level and the firm’s relative reputation and image. We assume that the sales volume of a firm is positively related to its product quality and its relative reputation and image, whereas it is negatively related to the product price.

In the simulation, the task is to successfully compete against the other companies, setting the ‘right’ product price and improving the product’s quality to increase the market share. In addition, the simulation requires decisions on which expenditures should be made for the different activities in order to develop an improved product.

c. Modelling innovation management

In general, innovation management is characterised by a range of activities, composing a process by following a certain sequence. These are, for example, market research to analyse customer needs, product development and testing to improve its quality and to adapt it to the customer needs and, finally, the introduction of the product to the market.

**Fig. 2: Contingency factors, modes of action and outcomes of the scenario**

For the purpose of this paper, we proceed from the assumption that this process can be characterised by a number of decisions on which expenditures should be made for the different activities. We suppose that expenditures in R&D and customer integration determine the future quality of the product, which again is strongly related to the number of sales. Moreover, it is likely that in each business period miscellaneous efforts can be realised in order to improve product quality. However, the outcomes of these efforts only become effective in the following and subsequent
business periods because of the time lag underlying the product development process.

Figure 2 illustrates the contingency factors and their effects on the company’s number of sales. The product quality is positively linked with the expenditures for R&D, signed by \( r_{di} \), and integrated customer management (ICM), expressed by \( icm_i \). This function can be formalised as follows:

\[
(4) \quad q_i = f(r_{di}, icm_i)
\]

For both contingency factors, we apply a saturation function as displayed by Figure 3. Product quality is measured by an index that increases according to the growth in R&D and ICM expenditures. Nonetheless, product quality cannot be infinitely improved and is, therefore, limited to a certain value.

**Fig. 3: Function for product quality improvement of company i**

4. **SUMMARY AND CONCLUSION**

The objective of our paper was to develop a process model for innovation management education, suitable to be implemented a computer-based simulation. The proposed scenario uses **four** innovation-related decision parameters, namely expenditures for R&D, customer integration and communication as well as product price. **Triggering these contingency factors** allows simulating their influence on business success, the latter captured by the number of sales.

When applying the model in a simulation, the scenario is reiterated during a number of business periods. In this way, participants will assume the role of a business manager and experience the outcomes of their acting by competing with other firms. From a pedagogic perspective, the simulation is an active education method, based on the principle of learning by doing, emphasising experiential learning.

Since the model consists of a range of functions, it can be computer-based. In its easiest form, table calculation software is suitable to fulfil the pedagogic objectives; however, its implementation in a separate software and user interface is likely to enhance its didactic effect.

Concerning the suggestions for further development, we recommend including more contingency factors in the scenario. On the one hand, the simulation could include company-internal factors such as firm size, previous experiences in innovation management, patenting activities, stage in the product life cycle, process formalisation, employee qualification, motivation and remuneration as well as the existence of promoters (Vahs and Brem, 2013).

Among the external factors that could influence innovation management activities, we suggest considering factors like market size and dynamics, cooperation partners (Vahs and Brem, 2013), external networks (Tödtling and Kaufmann, 2002), in particular to academic institutions (Edwards et al., 2005). Last of all, simulating the real-world innovation management also requires to take into account Innovation Lottery Theory (Scherer, 2001).
This approach argues that innovations possess a low probability to pay off, but they are very valuable if they do. We invite researchers to discuss these and other aspects when developing a useful and realistic simulation for innovation management education.

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b. References

Innovative Methods for Tertiary Education for Sustainable Development

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Abstract: Experiential orientation in Education for Sustainable Development (ESD) can provide innovative methods to foster sustainable development through formal and informal education. We present several methods for tertiary education and experiences from the cooperation between Aalen University and CUT during the UNESCO Decade ESD. We concentrate on planning games and projects for socioeconomic development and responsible use of natural resources.

The relation between planning games and sustainability is mainly given by the aspects of education for sustainable development and sustainable training. The Method of Prepared Projects (PPM) is the basis for an efficient use of students’ projects to achieve training and educational effects as well as tangible results. In cooperation with local authorities and communities, results can be achieved that foster sustainable development directly and via ESD. Moreover, mathematical modelling projects can make important contributions to ESD.

Keywords: education, sustainable development, project method, research education

1. INTRODUCTION

Education for Sustainable Development (ESD) has been identified by the UN as the most important measure to reach Sustainable Development (SD). In the basic Brundtland-Report, SD is defined as “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (WCED, 1987).

The question is: how can ESD be implemented in a university and in tertiary education? When we consider this, we must distinguish between two aspects:

1. The organisational aspect of introducing ESD in a university. This will be published in (Jordaan, Uwah, 2014) and (Holzbaur, Jordaan, Wenzel, 2014).
2. The educational methods for ESD. In several papers we have analysed the role of educational methods for education for sustainable development.

Although Sustainable Development may be a taught subject like any other academic subject, we think that the orientation towards the future and the shaping of competences need and deserve innovative methods of teaching and learning. Amongst these, we will focus on the experiential methods Project Learning and Planning Games but also consider Mathematical Modelling.

2. BASICS

To understand ESD, we summarise the main pedagogical concepts.

a. Shaping Competences

The term “Gestaltungskompetenz” (shaping competence) has been coined by de Haan (2008) to describe the relevant competences in education for sustainable development. In brief, these are the competences needed to shape a sustainable future. Throughout the years, there have been a lot of definitions and lists of competences. Most of the authors list between 8 and 12 elements of shaping competence. In (Holzbaur, Bühr, Venus, 2013) we have summarised the shaping competences to five core areas:

- ethics: competency to deal with own, and other people’s and group’s values
• knowledge: competency to acquire and integrate new knowledge
• planning: competency to plan
• action: competency to implement plans and to participate in decision making processes
• reflection: competency to analyse and reflect on processes

b. Projects

Project learning is more than just doing a project in the course of lectured material. Project learning needs to be planned in two aspects:

• project success with regard to the project outcome of the students’ project
• learning outcome as a result of the didactical project including preparation and evaluation.

A more concise description that also introduces the double triangle of students’ project and learning project is given in (Holzbaur, Bühr, Venus 2013).

Projects are separately identified tasks that are handled by a dedicated team within a well-defined time and with limited resources. In brief: projects are anything that is non-routine. Projects are mostly seen as a means of achieving some goals. In education and training they can also be used to acquire knowledge and skills in an action oriented setting. To apply projects successfully, there must be good preparation and a balance between theory and practice.

General competences gained via projects comprise the ability to:

• plan in a result-oriented way, considering the requirements with respect to quality, resources and timelines and their interaction.
• structure the aims and the tasks to be accomplished in order to achieve these aims and to organise the work.
• argue and preview argumentations and counter-argumentation in advance making sure that the result can be argued in a written documentation and defended in an oral presentation.
• document the results and processes leading to these results.

Inquiry based learning is similar to PPM, but concentrates more on the increase of knowledge and the improvement of models than on real world project outcomes and effects.

c. Planning Games

A planning game is a model of the real world where the players interact with the game and other players and have to make decisions. Planning games have a didactical purpose and hence a pedagogical background. Mainly the (evaluation of) the consequences of these decisions contribute to the main learning effect.

There are several types of games:

• role based games based on role descriptions and the interaction of the players.
• simulation games that run on a computer
• haptic games where physical materials are handled by the players.

d. Modelling

In (Holzbaur, 2010, Jordaan, 2010) we have pointed out that modelling itself is a competence that must be studied over the course of an academic career. The modelling skills acquired during the course of (academic) education can be structured along the general skills development of researchers. The skills identified were:

• Use notations and connect them to real world phenomena.
• Analyse and use notions for various concepts.
• Interpret and use available models.
• Reflect on the relation between model and reality.
• Determine the parameters of a given model.
• Integrate the notations from several similar models.
• Create new models as instances of a given generic model.
• Create new models from a given model class or by integrating existing models.
• Reflect on the modelling process and on the impact of model semiotics.
• Derive own models and compare model classes.
• Derive own model types, classes or modelling methods.
3. PROJECTS FOR ESD

In several publications (Holzbaur, 2008, Bühr, Holzbaur, 2012) we have described the use of the projects method in ESD: Here, we give short summaries of several examples of projects.

a. PPM PROJECTS FOR SUSTAINABLE DEVELOPMENT

From the aspect of learning effects, learning projects with the method PPM are most important. In the context of the ESCPRESSO project, we concentrate on those projects that give first year students a valuable insight into real world projects. This is an example for transdisciplinary research in a real world (Schneidewind, 2013) lab and also contributes to (education for) sustainable development outside the university.

i. Green Eel

Green Eel is an environmental management system developed by the Aalen Local Agenda 21 and Aalen University. Students contribute

- to the development and documentation of the system
- to the participation of schools with respect to environmental, pedagogical and social aspects
- to the documentation of the environmental statement of the schools.

The lessons learned by the students were not only in the fields of sustainability and management, but also in working with teachers and learners from a new perspective.

ii. Regional Marketing

A lot of projects considered regional marketing as an important factor for local sustainable development. A marketing website and special events were planned and implemented.

iii. Events

The planning of events is one of the tasks that students usually like. Nevertheless, the explicit consideration of sustainable development is a challenging task for the teams. It is important to include aspects of resource conservation, environmental protection, accessibility, participation, integration, prevention and regional marketing into the event planning.

The programme “Experience a Sustainable City” transports concepts of sustainability via a series of special events. On the occasion of the 10th anniversary of the local Agenda 21, a students’ team compiles a programme under the name of “Aalen nachhaltig-er-leben” which can mean “experience sustainability in Aalen” or “live more sustainable in Aalen” as a year programme. This concept proved to be very successful and was then taken as the motto and the core concept for the activities of the Local Agenda 21.

iv. KARN

KARN is a virtual sustainability learning trail that runs along the rivers Kocher, Aal, Rombach and Nesselbach. Students’ projects consider aspects of sustainability, communication and the use of social media, smartphones and other modern devices. The KARN projects comprise tasks to make trains barrier-free and usable by senior people. Also the documentation of wheelchair accessibility and of industrial history was a project subject in recent years.

v. Integrational and intercultural aspects

An important aspect of demographic change is the increase of people with immigration background – in the students’ and school learners’ communities. Diversity management, participation, inclusion and integration were also considered in projects with schools, city administration and with respect to the own university.

Intercultural aspects are also analysed in special events management and in educational projects.

b. LEARNING PROJECTS AT CUT

There is a huge variety of learning projects implemented at the faculties of CUT in regular teaching, community services and service learning.

One of the focuses of projects is the Product Development Technology Station (PDTS) at CUT. Product development can improve socioeconomic development (empowerment, support for communities, equipment for food production) equal opportunity and barrier free access (special
equipment), protection of natural resources (water, mining, energy saving) or renewable energy production.

Students can be involved in the technical aspects (requirements analysis, devising and development, production, operation) and in parallel activities (documentation, training, marketing, sponsoring).

4. PLANNING GAMES FOR SOCIOECONOMIC DEVELOPMENT

Sustainability has two major pillars; protection of resources and the environment, and socioeconomic development. Planning games can support both aspects as we pointed out in (Holzbaur, 2003).

All types of games can support ESD and shape competence:

- role based games mainly for competences and knowledge reflection.
- simulations mainly for knowledge acquisition and skills
- haptic games mainly for competences and experiential learning
- strongly controlled projects (PPM) can also be seen as planning games.

a. Albuchmühle

Albuchmühle is a set of planning games on environmental management and general management (Holzbaur, 2000). It covers all important aspects from technical and financial calculations to marketing and human ressources. Role players have goals and (hidden) agendas and they have to interact to come to a solution.

A first phase in which the holders of the same role jointly develop their ideas and concepts strengthens the identification with the role and hence the challenge of the following discussion phases.

b. Micro Eco Nomy

The outline given here is a short summary of (Bühr, Holzbaur, 2013).

In this project we concentrate on empowerment for action-taking in an economic setting. This can be for a small scale enterprise, entrepreneurship or individual financial competences.

In many discussions within recent years, the need for basic training in economics skills came to the fore. Entrepreneurs and intrapreneurs, small scale farmers, shopkeepers and wholesalers, as well as craftsmen and traders, need basic knowledge in accounting. The same holds for young academics: no one should graduate without elementary knowledge about the functioning of an enterprise. Starting from a 2002 discussion in a community development project of CUT, the idea of the planning game emerged, and the game was implemented via several students’ projects. We describe the planning game that has been developed as a basic and the concept for taking it to a deployable tool to support entrepreneurship education to foster socioeconomic development in developing countries.

The planning game Micro-Eco-Nomy was designed for education in schools and in emerging countries (Van den Berg et al. 2009). The goal of the planning game is to introduce the players to the fundamentals of business management. “Through a sophisticated concept of the game the participating players are able to get to know the basic managerial coherences and skills while playing the game” (Vogelgsang, 2008).

The cross-cultural planning game has been developed for all people without or with limited previous experience in economy, e.g. pupils of advanced schools or founders of a new business in emerging markets. Of course, anybody has some previous knowledge gained during their life.

The game was developed for one trainer and about 20 participants. During the game the players should first plan their own company’s operations. In a later stage, competition can be included and the players strive to have the most profitable company. You can play the game anywhere in an easy way, because only a printout of the templates and some materials (e.g. pieces that stand for the product and for the money) are needed. It’s also possible to create physical products (mechanical, electronic), texts (brochures, leaflets) or some type of food or drink (e.g. as soup, hamburgers or lemonade) as part of the game.
c. **Success in Small Business**

The planning game “Success in Small Business” will have several training phases. Each phase itself runs through several business periods depending on the educational demand. These periods can also be interweaved with theoretical lessons and practical training.

- Elementary economics.
- Product and material prices
- Fixed and variable costs, bookkeeping
- Marketing and sales, risk management
- Depreciation and interest
- Investment and financing
- Project management and teamwork
- Competitive pricing

5. **MODELLING AND ESD**

In addition to the experiential methods discussed up to now, we want to highlight another method that has been mainly neglected in the discussion on Education for Sustainable Development: Mathematical Modelling.

Modelling has been raised by (Barth, 2007) but only in the context of mental models: “The development of higher stages of consciousness as an indication of increased cognitive complexity and thus enhanced cognitive components is traceable, considering the construction of mental models.”

Modelling projects can be integrated in mathematics lectures with a focus on modelling or simulation.

a. **Modelling and shaping Competences**

Modelling is essential for perception, communication, knowledge creation and planning. Hence, modelling supports the following shaping competences:

- foresighted thinking;
- interdisciplinary work;
- planning and implementation;
- reflection on individual and cultural models.

Linking to the shaping competence cluster from (Holzbaur, 2013), modelling is linked to:

1. ethics as a very abstract level of thinking.
2. knowledge: competency to acquire and integrate new knowledge based on mental models or on formal modelling.
3. planning is creating a model of the future
4. action: competency to implement plans and to participate in decision making processes
5. reflection: competency to analyse and reflect on processes

In our opinion, the competence of analysing the huge complexity of our world has been underestimated by ESD researchers. The discussions on measures and actions to be taken e.g. on climate change and carbon footprint, renewable energy and ecobalance, virtual water and global justice, global value creation and planned obsolescence cannot only be based on empathy and values but also needs to integrate facts and scientific analysis. To analyse a complex system and to communicate with other people, we need to model it.

b. **Modelling for ESD**

In (Holzbaur, Jordaan, Wenzel) we have documented the role and importance of mathematical models for planning, doing and controlling the implementation of (education for) sustainable development at a university. Wherever you want to implement ESD, you need some models such as portfolios, network schedules, shareholder analyses and layered models.

Mathematical modelling projects are well suited for Prepared Projects Method. The outcome should be an “atlas” of the real world problem. So e.g. mobility is connected to networks and flows, behavioural models, optimisation of an individual and government model and dynamics on a small (vehicle) and large (modal split) scale in space and time.
6. CONCLUSIONS AND RECOMMENDATIONS

We have seen that there are several didactic methods that can be recommended for Education for Sustainable Development.

At a first glance, there seems to be a gap or even contradiction between modelling – abstract, dry matter – and experiential methods. But from an educator’s point of view, we consider experiential orientation not as some funny exercise but as an intensively prepared didactic piece of work that depends on planning and on considering human behaviour. Experiential orientation and event management need to be based on a huge variety of models. But also the process of modelling is a good example for experiential orientation since it is based on real world problems, runs through a multi-step process and leads to quantitative or qualitative problem solving.

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INNOVATION AND CHANGE AGENTS IN AFRICA: 
THE FUTURE ROLES OF KEY DRIVERS IN TECHNOLOGY PROJECTS

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Abstract: Globalisation drives an increasing number of competitors. In the contemporary highly competitive environment, organisations are under pressure to innovate in a short period of time. Innovation is usually initiated, managed and implemented in projects. Recent studies suggest that innovation is challenging to deal with due to its abnormal, disorderly and non-linear nature. This is particular the case in technology projects depending whether the radical or incremental innovation is introduced. Consequently, organisations envisage employing so-called “innovation agents” to master their new challenges. Innovation agents are the key drivers of technology projects who initiate, design, create, manage and implement novelty. In spite of enormous demand for innovation agents, there has been limited documentation of their approaches. It is evident that a large number of studies investigate change agents. In particular, innovation agent research is scarce in the African context. As a result, this paper is based on an extensive comparative literature review in order to construct the future roles of innovation and change agents in African technology projects.

Keywords: Innovation agents, change agents, technology, projects, Africa

1. INTRODUCTION

In his book The Myths of Innovation, Berkun (2010) proposes that innovation is still viewed as the supernatural phenomena. Indeed, the controversy surrounding innovation commences with its definition. According to Wood et al. (2006: 508) innovation is defined “… as the process of creating new ideas and putting them into practice”. In contrast, other scholars such as Rogers (2003) argue that innovation implies novelty without intense emphasis on the practical relevance. The novelty can be a process that demands a new way of learning (Dodgson et al., 2005) or outcome. The process of innovation is messy that brings disturbance (Dodgson, 2000), uncertainty (Storey & Salaman, 2005) and demands a significant amount of discontinuous knowledge (Frenken, 2006).

Although, other researchers argue that organisations have difficulties to deal with innovation depending on whether its degree is radical or incremental. Radical innovation is disconnected to previous approaches, while incremental novelty is an update of already implemented technology (Tidd et al., 2005). Regardless of its degree, Dodgson et al. (2005) propose that Information and Communication Technology (ICT) allows for the experimentation and that could help to deal better with the non-linear nature of innovation. Due to the challenges with innovation, usually organisations adopt novelty that has been developed outside of their organisational settings (Kanter, 1983). More generally, Porter (1998) concludes that innovation assists companies to gain competitive advantage. This is especially the case in the rapid changing global environment where the increasing number of
competitors use innovation to get ahead of their rivals.

Innovation implies change (Urabe, 1988), but not vice-versa. Usually, organisations initiate change for the purpose of problem-solving and/or increasing operational effectiveness (Cummings & Worley, 2009). However, change for strategic management differs from innovation (Osborne & Brown, 2005) in many aspects. This strategic change is a planned process conducted by change agents (Cummings & Worley, 2009) that includes the continuous development of already existing vision, idea, strategy, concept, process, product or service. Consequently, change can be trained and managed systematically by applying a defined standard framework. An example of a set standard is applied in project management. In every project, change is reflected in four distinct phases that are named: initiation, planning, execution and closure (Westland, 2006). This means that a project is the temporary system (Bolton, 2006) that is formal by nature which demands the planning of objectives, tasks, human resources, budget and timelines (Hartley, 2003; Keeling, 2000).

While a great number of scholars (Kerzner, 2003; Hartley, 2003; Keeling, 2000) stress that every project can be initiated, planned, managed and executed in accordance with set standard criteria, this is not the case in praxis. Charvat (2003) underpins that technology projects are different. In a technology project, innovation takes place. Technological innovation has a short life cycle and therefore requests on-going updates that need to be implemented at an ad hoc basis (Tidd et al., 2005) and fit into organisational infrastructure. Due to this distinct nature of technology projects, innovation agents use a standard project framework and at the same time spread innovation via informal networks in order to deliver a set outcome (Jagodick et al., 2013). Innovation agents initiate new projects, develop, communicate, manage, consult and implement novelty (Jagodick et al., 2013).

The number of technology projects is increasing dramatically in Africa. The global competition for resources makes Africa an attractive place to invest. Project Management Journal (2013) states that China, India and some of Middle-East nations invest considerable amount of money in African projects. In 2006, they invested approximately US$8 billion, compared to prior spending of about US$1 billion per year. It is reasonable to assume that also other countries with strong financial resources will invest in African technology projects over the next 10 years. In this context, O’Brien & Shennan (2010) suggest that innovative activities need to be viewed in the cultural context, thus, this paper aims at constructing future roles of innovation and change agents in African technology projects.

2. INNOVATION AND CHANGE AGENTS IN THE LITERATURE

Innovation agents are the key drivers (Larrea et al., 2012) who act as promoters (Bessant, 1999) and facilitators (Van Geenhuizen & Nijkamp, 2003) of newness. Hallgren (2013) suggests that their main purpose is knowledge transfer. Due to the complexity of knowledge transfer, innovation agents need to perform multiple linker roles (Larrea et al., 2012). Prior to research of the aforementioned scholars, innovation agents had not been named as such, instead their roles have been merely highlighted. For example, the role of a gatekeeper in the innovation process has been discovered by many authors (Katz & Lazarsfeld, 1955; Tushman, 1977; Tushman & Scanlan, 1981; Allen, 1977). A gatekeeper is “… a high technical performer” (Allen, 1977: 163) who occupies formal and informal roles aimed at gathering technological information via networks.

In the study conducted by Rogers (2003), the term “change agent” is synonymously used for an innovation agent. Rogers (2003) underlines the influencer and linker role by diffusion of innovations. Diffusion is a unique type of the communication process in which the target group needs to adopt innovation (Rogers, 2003). Diffusion itself is risky because it is challenging to predict whether people will adopt or reject introduced new ideas. In that interactive process, much promotion is needed. Baker (1994) writes that a change agent performs the role of a marketer. Another possibility to increase the probability of adoption of innovation is to engage opinion leaders who understand the social system in terms of language, values and preferences of a target group (Rogers, 2003). In the
context of diffusion and adoption, Rogers & Shoemaker (1971) emphasise the roles of initiator, relationship builder, diagnostician, motivator, promoter, stabiliser and terminator.

When it comes to culture, change agents need to become paradigm shifters by encouraging others to adopt new beliefs and relearn old practices (Barker, 1992). In the same vein, Meyerson & Scully (1995: 586) highlight the significance of “tempered radicals” who are part of a minority group that possess distinct values within community due to their different ideology. The ideology drives them to trigger the cultural change. Nieuwenhuizen & Nieman (2009) conclude that the African cultures are characterised by strong risk averse behaviour that hinders innovative approaches. This implies that more change agents will be needed in African settings.

In the organisational process, change agents are initiators, promoters, supporters, sponsors, implementers and deliverers of change (Buchanan & Huczynski, 1997). Hamlin et al. (2001) propose that change agents are also supervisors, managers, trainers, developers and advisers, whereby Grant & Cibin (1996) suggest the role of a Chief Executive. As such, the change agent role in an organisational structure is visible in an organisational chart and is described as internal or external. The internal role discloses that an individual is employed permanently, whereas the external role underpins that a staff member works on a temporary basis. More often, internal change agents are executives (Gibson et al., 2006) or managers (Saka, 2003), while external change agents are usually consultants. Both internal and external change agents are engaged in technology projects.

Kendra & Taplin (2004) emphasise that project managers are change agents. The role of a project manager is to build a team, plan and monitor activities, budget and time lines in order to achieve set objectives. In technology projects, other team members could be ICT professionals. Weiss & Anderson (2004) underline that ICT professionals are change agents who act as designers, implementers and consultants (Winston, 1999). In the African context, Grobler (2013) suggests that innovation agents are consultants who initiate new projects, design and implement novelty. In other words, change and innovation agents operate as a team by playing distinct roles in technology projects.

Many studies neglect differentiation between business and technology projects. This is especially the case in the African context. Nicholas & Steyn (2012) neglect to highlight that infrastructure and ICT projects are different. As a result, they predominately focus on change. An effect of this is that they claim that many African projects fail due to project managers being appointed by accident and lack proper training in planning, management and monitoring (Nicholas & Steyn, 2012).

Despite the importance of innovation and change agents, many studies are unable to distinguish between innovation and change. An effect of this is that an African writer (Grobler, 2013) claims that innovation is synonym to change. Thus, he suggests that innovation agents need to have a profound knowledge in change management (Grobler, 2013). The consequence of this misunderstanding is that it is apparent that innovation is very often created in the advanced economies and applied in African settings. An example of this approach pertains to innovation agents in agriculture (Reij & Waters-Bayer, 2001). Nevertheless, there is urgent demand to conduct more research that allows for the training of innovation and change agents in a team context for African settings.

3. COMPARATIVE LITERATURE REVIEW

A comparative literature review is conducted in the manner of Ma & Nickerson (2006) and Klaic & Hadjina (2011), to distill the distinguishing differences between innovation agents and change agents, in order to be able to apply these differences to the future roles of such agents for the application of technology projects in Africa.

Tables 1 and 2 compare innovation agent and change agent studies, respectively, by extracting from these distinct bodies of literature the critical roles they play. In particular, Table 1 shows six innovation change agent studies while Table 2 illustrates fourteen change agent studies. Both tables describe the type of agent, role, area and
source. The focus is on examining the differences between these two types of agents in their roles that they play.

Table 1: Innovation agent roles

<table>
<thead>
<tr>
<th>Study</th>
<th>Agent type (innovation agent)</th>
<th>Role</th>
<th>Area</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>Innovation agent</td>
<td>Gatekeeper</td>
<td>Innovation process</td>
<td>Katz &amp; Lazarsfeld (1955); Tushman (1977); Tushman &amp; Scanlan (1981); Allen (1977)</td>
</tr>
<tr>
<td>S4</td>
<td>Called a change agent, but in the function of an innovation agent</td>
<td>Influencer</td>
<td>Diffusion and adoption of innovation</td>
<td>Rogers (2003)</td>
</tr>
<tr>
<td>S5</td>
<td>Called a change agent, but in the function of an innovation agent</td>
<td>Initiator</td>
<td>Diffusion and adoption of innovation</td>
<td>Rogers &amp; Shoemaker (1971)</td>
</tr>
<tr>
<td>S6</td>
<td>Innovation agent</td>
<td>Consultant</td>
<td>Project management</td>
<td>Grobler (2013)</td>
</tr>
</tbody>
</table>

Table 2: Change agent roles

<table>
<thead>
<tr>
<th>Study</th>
<th>Agent type (innovation agent)</th>
<th>Role</th>
<th>Area</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7</td>
<td>Change agent</td>
<td>Paradigm shifter</td>
<td>Cultural change</td>
<td>Barker (1992)</td>
</tr>
<tr>
<td>S8</td>
<td>Change agent</td>
<td>Tempered radical</td>
<td>Cultural change</td>
<td>Meyerson&amp; Scally (1995)</td>
</tr>
<tr>
<td>S9</td>
<td>Change agent</td>
<td>Initiator</td>
<td>Organisational process</td>
<td>Buchanan &amp;Huczynski (1997)</td>
</tr>
<tr>
<td>S10</td>
<td>Change agent</td>
<td>Supervisor</td>
<td>Organisational process</td>
<td>Hamlin et al. (2001)</td>
</tr>
<tr>
<td>S11</td>
<td>Change agent</td>
<td>Chief Executive</td>
<td>Organisational process</td>
<td>Grant &amp;Cibin (1996)</td>
</tr>
<tr>
<td>S14</td>
<td>Change agent</td>
<td>Executive</td>
<td>Organisational structure</td>
<td>Gibson et al. (2006)</td>
</tr>
<tr>
<td>S17</td>
<td>Change agent</td>
<td>Project manager</td>
<td>Project management</td>
<td>Kendra &amp;Taplin (2004)</td>
</tr>
<tr>
<td>S20</td>
<td>Change agent</td>
<td>Consultant</td>
<td>Project management</td>
<td>Winston (1999)</td>
</tr>
</tbody>
</table>
4. FINDINGS AND DISCUSSION IN AN AFRICAN CONTEXT

The identified cases pertaining innovation and change agents from Table 1 - Table 2 will be discussed in the context of three specific aspects:

Culture

Many studies highlight that culture impacts on innovative approaches (Nieuwenhuizen & Nieman, 2009). Due to that African cultures are more likely to be centred on security that hinders new practices (Nieuwenhuizen & Nieman, 2009), more change agents will be needed at the beginning than innovation agents aimed at changing old assumptions. In particular, change agents need to act as the paradigm shifters (Barker, 1992) and tempered radicals (Meyerson & Scully, 1995). Research conducted by Meyerson & Scully (1995) underpin that individuals who belong to the minority are more likely to embark on cultural change due to their distinct perceptions, values and experiences within local settings. Cultural change can be initiated via projects.

Technology project management

Due to global investment, African projects are more likely to play the key role in regional development. A technology project needs to engage change and innovation agents because they complement each other in their distinct multiple functions. The following change agent roles need to be considered: a project manager as highlighted by Kendra & Taplin (2004), but also initiator, promoter, supporter, sponsor, implementer and deliverer of change as suggested by Buchanan & Huczynski (1997) because in every project phase change takes place. Change is a process that can be planned ahead (Cummings & Worley, 2009), therefore, all discovered process roles by Buchanan & Huczynski (1997) apply to project management as well. Some of roles have the same name such as consultant (Winston, 1999; Grobler, 2013), designer (Weiss & Anderson, 2004; Grobler, 2013) and implementer (Weiss & Anderson, 2004; Grobler, 2013). In spite the same role, the function is different. For example, change agents as consultants plan and advice the alteration operations, whereas innovation agents as consultants initiate and drive new technological activities that request learning processes because of newness. Similarity, designer and implementer of change, are more focused on systematic and standard processes, while innovation agents in these roles are challenged to create and implement something new that discontinuous with previous practises. The difficulty of carrying out projects depends on a type of innovation.

Innovation

Innovation itself is difficult to deal with. Especially, when radical innovation occurs (Tidd et al., 2005) that demands a considerable degree of learning (Dodgson et al., 2005) and knowledge (Frenken, 2006). Apart from the difficulties with the process of innovation, also diffusion of new ideas brings uncertainty. It is impossible to plan whether and when people will adopt innovation. Therefore, innovation agents need to engage opinion leaders who help them by convincing others to take on board innovation (Rogers, 2003). Usually, opinion leaders are familiar with a social system and they understand better how to approach individuals in a way that makes innovation more appealing to them. In the process of diffusion and adoption, innovation agents need to play the role of an initiator, relationship builder, diagnostician, motivator, promoter, stabiliser and terminator as proposed by Rogers & Shoemaker (1971). Apart from performing these roles, they need to use informal networks for diffusion and adoption purposes (Jagodick et al., 2013). Within informal networks, innovation agents need to become gatekeepers in order to monitor what type of new ideas are diffused in order to prevent the setback to previous practises as recommended by a great number of scholars (Katz & Lazarsfeld, 1955; Tushman, 1977; Tushman & Scanlan, 1981; Allen, 1977).

5. CONCLUSION

Projects in Africa will play the key role in economic development of the region. In particular, there will be a strong demand for technology projects. Technology projects include innovation and therefore, they are more difficult to carry out. As a result, organisations need to engage change and innovation agents. In African context, the roles of change and innovation agents are embedded in
culture, technology project management and innovation. African culture is centred on security that can hinder innovation. Consequently, change agents need to embark on changing the culture first in the roles using paradigm shifters and tempered radicals. Once, the culture is more welcoming to innovative approaches, technological projects need to be initiated. In technology projects, change and innovation agents need to work hand in hand in distinct functions. In that context, change agents are requested to focus on alteration that can be planned, whereas innovation agents need to drive novelty that is more complex by its nature. Change agent roles include project manager, initiator, promoter, supporter, sponsor, implementer and deliverer of change. In contrast, innovation agents need predominately to perform the roles of consultants, designers and implementers of innovative practices. Due to that innovation occurs in every technology projects to different degree, innovation agents need to pay attention to diffusion and adoption. In that process, they need to perform the roles of initiators, relationship builders, diagnosticians, motivators, promoters, stabilisers, terminators and gatekeepers. Especially, they are advised to engage opinion leaders who have unique knowledge about the social system and use informal networks in order to increase the speed of diffusion and adoption of innovation.

a. References


41. Michael L., Tushman., Thomas J., Scanlan., Boundary spanning individuals: Their role in information transfer and their antecedents.
ENGINEERING STUDENTS’ DIRECT EXPERIENCE IN ENTREPRENEURSHIP

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Abstract: Entrepreneurship is a key driver for economic growth, innovation, employment and social integration. Entrepreneurship for engineering students becomes a viable solution to overcome the unemployed or migrant status engineering students are exposed to in the context of enormous socio-economic and unprecedented demographic challenges. The integration of engineering and entrepreneurship (Esbach, 2011), teaching entrepreneurship to engineering students (Baum, McHargue, 2003, etc) and entrepreneurial potential (Wolfgramm, Grünwald, Bassus, 2011) have been investigated. However, engineering students’ direct experience in entrepreneurship has not been analysed. The aim of the research is to analyse engineering students’ direct experience in entrepreneurship underpinning elaboration of a hypothesis on engineering students’ entrepreneurship. The meaning of the key concepts of entrepreneurship and direct experience in entrepreneurship is studied. The empirical study was conducted within Baltic Summer School Technical Informatics and Information Technology held at Tartu University, Tartu, Estonia, in 2012. The findings allow drawing the conclusion on the engineering students’ direct experience in entrepreneurship. The hypothesis has been elaborated.

Keywords: Entrepreneurship, engineering students, direct experience, entrepreneurship education for student engineers

INTRODUCTION

Everyone may at some stage need to become an entrepreneur, or to display entrepreneurial behaviour or to have the opportunity of creating his/her own business regardless of background or location (EU Commission, 2004). Entrepreneurial skills are becoming an essential factor in creating welfare (Seikkula-Leino, Ruskovaara, Hannula, Saarivirta, 2012). Therefore, entrepreneurship has increasingly gained interest in the European Union (Seikkula-Leino, Ruskovaara, Ikävalko, Mattila, Rytkölä, 2009). Particularly, entrepreneurship for engineering students is of paramount importance as entrepreneurship becomes a viable solution to overcome the unemployed or migrant status engineering students are exposed to in the context of enormous socio-economic and unprecedented demographic challenges, including regional disparities, aging populations, high rates of low-skilled adults and of youth unemployment, low birth rates, changing family structures and migration (Lifelong Learning for Creativity and Innovation, 2008: 3). Therefore, teaching entrepreneurship to engineering students (Baum, McHargue, 2003; Bassus, Wolfgramm, 2009) has been widely analysed. However, engineering students’ direct experience in entrepreneurship has not been analysed empirically.

The research question is as follows: what is the engineering students’ direct experience in entrepreneurship?

The aim of the research is to analyse engineering students’ direct experience in entrepreneurship underpinning elaboration of a hypothesis on the development of engineering students’ direct experience in entrepreneurship.

I. THEORETICAL FRAMEWORK

The meaning of the key concepts of entrepreneurship, entrepreneurship education and
direct experience in entrepreneurship is studied in the present part of the paper.

In a broad sense, entrepreneurship should be considered as a general attitude that can be usefully applied in all working activities and in everyday life, such as creativity and innovation (Sarri, Bakouros, Petridou, 2010). Regarding entrepreneurship as an individual’s ability, it means to turn ideas into action (European Commission, 2012: 7). It includes creativity, innovation and risk taking, as well as the ability to plan and manage projects in order to achieve objectives (European Commission, 2012: 7) as shown in Figure 1.

Fig. 1: Components of entrepreneurship as an individual ability

This supports everyone in day-to-day life at home and in society, makes employees more aware of the context of their work and better able to seize opportunities, and it provides a foundation for entrepreneurs to establish a social or commercial activity (European Commission, 2012: 7).

In short, entrepreneurship education means developing a culture which is through, for and about entrepreneurship (European Commission, 2011). Entrepreneurship education seeks to prepare people to be responsible, enterprising individuals who have the knowledge, skills and attitudes necessary to achieve the goals they set for themselves to live a fulfilled life (European Commission, 2012: 44). Entrepreneurship education focuses on knowledge, skills and attitudes of students which all together make up the entrepreneurship key competence (European Commission, 2012: 44).

Entrepreneurship education is not necessarily directly focused on the creation of new businesses, although graduate start-ups are one of a range of possible outcomes (European Commission, 2012: 44).

The challenge of entrepreneurship education requires significant changes in the way students are educated (European Commission, 2011). One of the suggested ways is to adopt innovative methods to train students in entrepreneurship (The Oslo Agenda, 2006). These would include case studies and other interactive methods as demonstrated in Figure 2. The innovative methods include involving students in real work on enterprise projects or even in running themselves a mini-company (The Oslo Agenda, 2006) as illustrated in Figure 3. In the present research the terms business, enterprise, company are used synonymously.

Fig. 2: Innovative methods to train students in entrepreneurship

Fig. 3: Interactive methods to train students in entrepreneurship

In the present research, students’ direct experience in entrepreneurship means students’ knowledge, skills and attitude obtained in the entrepreneurial process. By acquiring direct experience, students will be more effective when running a business.
II. EMPIRICAL STUDY

The present part of the paper demonstrates the design of the empirical study, survey results and findings of the empirical research.

Research design

The design of the present empirical research comprises the purpose and question, sample and methodology of the present empirical study.

The empirical study was aimed at analyzing engineering students’ direct experience in entrepreneurship.

The research question was as follows: What is engineering students’ direct experience in entrepreneurship?

The definitions of interactive methods to train student engineers in entrepreneurship such as involving engineering students in real work on enterprise projects or even in running themselves a mini-company (The Oslo Agenda, 2006) and entrepreneurship as an individual’s ability, that includes creativity, innovation and risk taking, as well as the ability to plan and manage projects in order to achieve objectives (European Commission, 2012: 7) led to the following domains of engineering students’ direct experience in entrepreneurship as depicted in Figure 4:

- running own business,
- planning to run own business and
- having an aim to run own business.

These domains of students’ direct experience in entrepreneurship shown in Figure 4 serve as a basis for designing the survey to be carried out within the present empirical research.

The present empirical study involved 21 engineering students who took part in the Baltic Summer School Technical Informatics and Information Technology held at Tartu University, Tartu, Estonia, July 28 - August 12, 2012. All the students have got Bachelor or Master Degree in different fields of computing science. The engineering students are from different countries. Therefore, the sample is multicultural as the respondents with different cultural backgrounds and diverse educational approaches were chosen. Thus, the group (age, field of study and work, mother tongue, etc.) is heterogeneous.

Interpretative research paradigm that corresponds to the nature of humanistic pedagogy (Luka, 2008) has been used in the present empirical study. Explorative research has been employed in the empirical study (Mayring, 2007). Explorative research is aimed at developing hypotheses, which can be tested for generality in following empirical studies (Mayring, 2007). The explorative methodology proceeds as demonstrated in Figure 5

- from exploration in Phase 1
- through analysis in Phase 2
- to hypothesis development in Phase 3.

![Methodology of the explorative research](image)

Fig. 5: Methodology of the explorative research

The qualitatively oriented empirical study allows the construction of only few cases (Mayring, 2004). Moreover, the cases themselves are not of interest,
only the conclusions and transfers we can draw from these respondents (Mayring, 2007). Selecting the cases for the case study comprises use of information-oriented sampling, as opposed to random sampling (Mayring, 2007). This is because an average case is often not the richest in information. In addition, it is often more important to clarify the deeper causes behind a given problem and its consequences than to describe the symptoms of the problem and how frequently they occur (Flyvbjerg, 2006). Random samples emphasizing representativeness will seldom be able to produce this kind of insight; it is more appropriate to select some few cases chosen for their validity.

Survey Results

In order to analyse the engineering students’ direct experience in entrepreneurship, the survey was based on the following questionnaire:

Question 1: Please, indicate the name of the country of your origin. The evaluation scale is nominal.

Question 2: Do you run your own business? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 3: Do you plan to start your own business? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 4: Do you aim to run your own business for your own financial profit? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 5: Do you aim to run your own business for promotion of innovative products or service? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 6: Do you aim to run your own business for well-being of people around (peoples’ employment, income, interests, etc)? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 7: Please, specify other aims of running your own business. The evaluation scale is nominal.

Question 8: Do you need more knowledge to run your own business? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 9: Do you need more skills to run your own business? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

Question 10: Do you need more practice to run your own business? The evaluation scale of two levels for the question is given where “0” means “no” and “1” - “yes”.

21 questionnaires were distributed.

The results of Question 1 of the questionnaire used in the survey show that the engineering students represent the following countries: Finland, Sweden, Ukraine, Canada, Pakistan, Estonia, Nepal, Lithuania, Russia, Turkey and China. The results of Question 2 on engineering students’ running an own business reveal that only one out of 21 engineering students runs his/her own business. The results of Question 3 of the questionnaire used in the survey show that 11 engineering students had planned to run his /her own business. The results of Question 4 on students’ running business for their own financial profit demonstrate that nine engineering students responded positively. 13 engineering students replied positively to Question 5 (Running business for promotion of innovative products or service). Eight engineering students out of 21 students gave their positive replies to Question 6 (Running business for well-be ing of people around). The results of Question 7 (Other aims of running your own business) demonstrate that the other aims to run own business were pointed out by three engineering students as following: personal growth, job satisfaction and development of local electronic government. 14 engineering students responded positively to Question 8 (More knowledge to run own business). Eight engineering students out of 21 students who responded to Question 9 (More skills to run own business) consider that they need more skills to run their own business. 12 engineering students supposed that they need more practice to run their own business while answering to Question 10 (More practice to run own business).

Findings of the Empirical Study

The engineering students’ responses from the questionnaire were systematized according to the construct of students’ direct experience in
entrepreneurship and its three domains as demonstrated in Table 1:
- the construct of students’ running own business,
- the construct of students’ planning to run own business, and
- the construct of students’ aim to run own business.

Table 1: *Inter-relationship between construct, construct domain and questionnaire*

<table>
<thead>
<tr>
<th>Construct</th>
<th>Construct domain</th>
<th>Number of the question</th>
</tr>
</thead>
<tbody>
<tr>
<td>students’ direct experience in entrepreneurship</td>
<td>running own business</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>planning to run own business</td>
<td>3, 8, 9, 10</td>
</tr>
<tr>
<td></td>
<td>having an aim to run own business</td>
<td>4, 5, 6, 7</td>
</tr>
</tbody>
</table>

The data were processed applying *Excel* software. The determined construct domains were systematized into the codes corresponding to a domain. Only positive answers were taken into consideration for the analysis: answers which were marked as “1” in Question 2, 3, 4, 5, 6, 8, 9 and 10. The number and percentage of the positive answers from the questionnaire completed by the engineering students as reflected in Table 2 were analysed.

**Table 2: Frequency of the engineering students’ positive answers**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Construct domain</th>
<th>Number of the question</th>
<th>Number of answers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>students’ running own business</td>
<td>2</td>
<td>1</td>
<td>4.7%</td>
<td></td>
</tr>
<tr>
<td>students’ planning to run own business</td>
<td>8</td>
<td>14</td>
<td>66.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>8</td>
<td>38.1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>12</td>
<td>57.1%</td>
<td></td>
</tr>
<tr>
<td>students’ aims to run own business</td>
<td>4</td>
<td>9</td>
<td>42.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>13</td>
<td>61.9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>38.1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>3</td>
<td>14.2%</td>
<td></td>
</tr>
</tbody>
</table>

All of the students’ answers were categorized to the construct *Students’ Direct Experience in Entrepreneurship*. Frequencies were determined to reveal the students’ positive experience in entrepreneurship. The survey showed that the number of engineering students who run their own business is very low (4.7%). However, the engineering students plan to start their own business (52.4%).

The interpretation of the survey’s results reveals that there are two types of engineering students: one type of students includes those who have their own business, and the other – who have no their own business. However, more types of engineering students could be described: most engineering students have never been entrepreneurs, some engineering students are failed entrepreneurs who went to engineering as a more secure career, the others do not just have the right mindset to run a business (Ashmore, 2012).
The interpretation of the engineering students’ types allows revealing engineers’ typology based on their direct experience in entrepreneurship as shown in Table 3.

### Table 3: Typology of engineers based on their direct experience in entrepreneurship

<table>
<thead>
<tr>
<th>Type of the engineering student</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Entrepreneurial engineer</td>
<td>Engineer who has his/her own efficient business</td>
</tr>
<tr>
<td>2. Ex-entrepreneur</td>
<td>Engineer who is a failed entrepreneur who went to teaching as a more secure career</td>
</tr>
<tr>
<td>3. Engineer</td>
<td>Engineer who has never been an entrepreneur</td>
</tr>
<tr>
<td>4. Non-entrepreneur</td>
<td>Engineer who does not have the right mindset to run a business</td>
</tr>
</tbody>
</table>

Regarding entrepreneurship as an individual’s ability, it should be noted that abilities develop lifelong. Further on, the change in the relationship between functions (engineering and running business) for the development of an individual’s ability is significant in entrepreneurship education for engineering students, and not the development of each function (Jønassen, 1982: 38).

The results of the survey demonstrate that engineering students need more knowledge (66.6%), skills (38.1%) and practice (14.2%) in order to run their own business. As engineering students’ needs are a subjective component of motivation, the students have a critical level of their intrinsic motivation to run their own business. Therein, motivation comprises (Harmer, 2001: 52) extrinsic motivation caused by a number of outside factors and intrinsic motivation that comes from the individual and is especially important for encouraging as shown in Figure 6.

Further on, aims are a component of need and, consequently intrinsic motivation, too. Therein, need is defined by the reasons for which the student is learning, which will vary from study purposes such as following a postgraduate course in an English-speaking country to work purposes such as participating in business meetings or taking hotel bookings (Dudley-Evans and John, 1998: 3). The results of the survey demonstrate that the engineering students run own business for getting their own financial profit (42.8%), for promotion of innovative products or service (61.9%), for well-being of people around (peoples’ employment, income, interests, etc) (38.1%). The engineering students have other aims to run their own business (14.2%). The interpretation of the survey’s results reveals that the engineering students’ intrinsic motivation in entrepreneurship is of a critical level. That allows explaining a critical level of engineering students’ direct experience in entrepreneurship, or student engineers rarely have entrepreneurial experience (Ashmore, 2012). The summarizing content analysis (Mayring, 2004) of the data reveals a critical level of the engineering students’ direct experience in entrepreneurship. There is a need for the increase of the engineering students’ direct experience in entrepreneurship by supporting the engineering students’ extrinsic motivation.

### III. CONCLUSIONS AND RECOMMENDATIONS

The research findings allow drawing the conclusion on a critical level of engineering students’ direct experience in entrepreneurship as demonstrated by the survey results shown in Table 2.

The following hypothesis has been formulated: students’ direct experience in entrepreneurship develops if students identify their own needs to run their own business, students are externally motivated by involving them in their personal career.
exploration, a favourable educational (teaching, peer-learning and learning) environment for the enrichment of students’ direct experience in entrepreneurship is organized that results in students’ improved knowledge, skills and practice to run their own business, students participate in running their own business.

The present research has limitations. The interconnections between entrepreneurship, entrepreneurship education and students’ direct experience in entrepreneurship have been set. Another limitation is the empirical study conducted by involving only the engineering students of one tertiary institution.

Students’ participation in running business has to be investigated. Pedagogical support for students who are failed entrepreneurs and who do not have the right mindset to run a business has to be discussed. Empirical studies in other institutions are proposed to be carried out. Another direction of further investigation is considered as evaluation of efficiency of engineering students’ running their own business. A comparative research of different countries could be carried out, too.

References


Abstract: The curriculum “two degrees for the price of one” provides diversity, synergy and creativity for promotion of students’ intellectual flexibility, a certain amount of adventurousness and plain hard work (Achterhold, 2012). By “two degrees for the price of one” two national (for example, German and French Degree in Engineering) degrees are meant. Against this background, another approach is proposed - acquiring two professions (for example, engineer’s and entrepreneur’s professions) within one curriculum or bi-professional curriculum. The aim of the research is to analyse the macro-level context underpinning elaboration of bi-professional curriculum in higher education for promotion of students’ innovativeness. The theoretical framework includes psychological and pedagogical findings analysed. For the macro-level context analysis, the exploratory study has been applied (Phillips, 2006). The exploratory study aims to generate new hypothesis (Phillips, 2006). The research findings allow drawing the conclusions on relevance of bi-professional curriculum to the local contexts of the countries of the European Union. The hypothesis has been proposed.

Keywords: Bi-professional curriculum, profession, psychological system, exploratory study

IV. INTRODUCTION

As innovation is the source of competitiveness (Meyer-Stamer, 2000), innovation remains a hot topic for scientific discussions among researchers of many research fields. Many researchers agree that innovation is promoted by diversity, synergy and creativity.

The curriculum “two degrees for the price of one” provides diversity, synergy and creativity for promotion of students’ intellectual flexibility, a certain amount of adventurousness and plain hard work (Achterhold, 2012). By “two degrees for the price of one” two national (for example, German and French Degree in Engineering) degrees are meant. The “two degrees for the price of one” approach demands on partner universities’ internalization, intensive international cooperation and staff mobility.

Against this background, another approach is proposed - acquiring two professions (for example, engineer’s and entrepreneur’s professions) within one curriculum or, in other words, bi-professional curriculum.

The aim of the research is to analyse the macro-level context for bi-professional curriculum underpinning elaboration of a hypothesis on bi-professional curriculum in higher education for promotion of students’ innovativeness.

The methodological background of the present research is based on the System-Constructivist theory introduced as the New or Social Constructivism Pedagogical theory. The System-Constructivist theory and, consequently, System-Constructivist approach to learning introduced by Reich (Reich, 2005) emphasizes that human being’s point of view depends on the subjective aspect (Maslo, 2007): everyone has his/her own system of external and internal perspectives (Ahrens, Zaščerinska, 2010), that is a complex open system (Rudzinska, 2008), and experience plays the central role in the knowledge construction process (Maslo, 2007).
The meaning of the key concepts of profession, curriculum, bi-professional curriculum, and psychological system is studied. Moreover, the analysis demonstrates how the key concepts are related to the idea of bi-professional curriculum in engineering education and shows a potential model for development, indicating how the steps of the process are related following a logical chain: psychological system → profession → curriculum → bi-professional curriculum → empirical study within a multicultural environment. Exploratory research has been used in the empirical study.

The novel contribution of this paper is the combinations of professions for promotion of students’ innovativeness within bi-professional curriculum which are to be proposed in the hypothesis of the present research.

Our target population to generalize the combinations of professions for promotion of students’ innovativeness within bi-professional curriculum are engineering students in formal higher education.

Our empirical results obtained by carrying out non-structured interviews with four successful entrepreneurs and four experts from different countries in February – April 2013.

The remaining part of this paper is organized as follows: Section 2 introduces the definition of psychological system and profession as well as the concept of bi-professional curriculum. The associated results of an empirical study will be presented in Section 3. Finally, some concluding remarks are provided in Section 4 followed by a short outlook on interesting topics for further work.

V. THEORETICAL FRAMEWORK

The meaning of the key concepts of profession, curriculum, bi-professional curriculum and psychological system is studied in the present part of the paper. Moreover, the analysis demonstrates how the key concepts are related to the idea of bi-professional curriculum in engineering education.

Shaping the theoretical framework of the present research on bi-professional curriculum has been based on the idea that everyone or, in other words, teachers, engineers, etc. may at some stage need to become an entrepreneur, or to display entrepreneurial behaviour or to have the opportunity of creating his/her own business regardless of background or location (European Commission, 2004). As learning entrepreneurial skills is becoming an essential factor in creating welfare (Seikkula-Leino, Ruskovaara, Hannula, Saarivirta, 2012), entrepreneurship education has increasingly gained interest in the European Union (Seikkula-Leino, Ruskovaara, Ikävalko, Mattila, Rytölä, 2009). Particularly, entrepreneurship education for teachers is of paramount importance as teachers are a critical success factor in the entrepreneurship development (European Commission, 2011). Entrepreneurship for engineering students is of paramount importance, too, as entrepreneurship becomes a viable solution to overcome the unemployed or migrant status engineering students are exposed to in the context of enormous socio-economic and unprecedented demographic challenges, including regional disparities, aging populations, high rates of low-skilled adults and of youth unemployment, low birth rates, changing family structures and migration (Lifelong Learning for Creativity and Innovation, 2008: 3). That led to the idea of learning two or more professions where one of the professions is entrepreneurship as shown in Figure 1:

![Professional domains of an individual](image)

Fig. 1: Professional domains of an individual

The generalization of the idea of learning two or more professions where one of the professions is entrepreneurship has brought the present researchers to the concept of bi-professional curriculum as demonstrated in Figure 2.
The concept of bi-professional curriculum is founded on the Leonti’ev findings on the psychological system (Леонтьев, 1982: 38). Leonti’ev theory of the psychological system reveals the change in the relationship between functions for the individual development, and not the development of each function (Леонтьев, 1982: 38).

Regarding a function as a profession, profession means a calling, vocation, or employment requiring specialized knowledge and often long and intensive academic preparation.

Traditionally, learning a profession is organized within a curriculum of different levels such as vocational and higher education or, in other words, pre-service as well as in-service training. The interaction of synonyms of the term curriculum, namely, approach, plan (often in Germany and Russia), design, way of thinking as well as strategy and programme (Bassus, Zaščerinska, Ahrens, 2011: 84) has been revealed. Curriculum is determined to be a central, organizing stance (Portelli, Vilbert, 2002: 39). Curriculum comprises the following components as shown in Figure 3.

VI. EMPIRICAL STUDY

The present part of the paper demonstrates the design of the empirical study, survey results and findings of the empirical research.

Research design

The design of the present empirical research comprises the purpose and question, sample and methodology of the present empirical study.

The empirical study was aimed at analyzing the macro-level context of bi-professional curriculum for promoting students’ innovativeness.

By macro-level context analysis, broad, upstream analysis is understood (The World Bank, 2007: 53). In the present research, macro-level context analysis examines the social landscape that can be complemented by expert evaluation as more specific analysis of the context for the development of the concept of bi-professional curriculum as a particular type of reform (The World Bank, 2007: 53).

The research question was as follows: What is the macro-level context for bi-professional curriculum?

The present empirical study involved eight respondents from different countries in February - April 2013:

- four respondents who are successful entrepreneurs and
- four experts.

All the respondents have been awarded Bachelor, Master or PhD Degree in different fields of science. As the respondents with different cultural backgrounds and diverse educational approaches
were chosen, the sample is multicultural. Thus, the group (age, field of study and work, mother tongue, etc.) is heterogeneous.

The sample of four male respondents who are successful entrepreneurs involves
- a British inventor on the beauty of engineering who comes from the UK.
- a 30-year old man who has a net worth of at least $600m and has been involved with two of the most successful start-ups of recent years. The country of his origin is the USA.
- a former president of an internationally popular company of electronics products. Before the respondent was an opera singer. The respondent comes from Japan.
- the respondent was a co-founder of the company that designs and creates iPod and iTunes, laptop and desktop computers, the OS X operating system, and the revolutionary iPhone and iPad. The respondent comes from the USA.

In order to save the information of the present research confidential, the respondents’ names and surnames were coded as follows:
- a British inventor was given the code of R1 (Respondent 1).
- a 30-year old man was pointed as R2 (Respondent 2).
- a former president – as R3 (Respondent 3).
- a co-founder of the company - R4 (Respondent 4).

The sample of four experts consists of
- two researchers in the field of educational research, Educational Research Association, "Freie Universität" (Free University), Berlin, Germany.
- a researcher in the field of educational research, Latvia University of Agriculture, Jelgava, Latvia and
- a researcher in the field of applied research in education, CAH-Vilentum University of Applied Sciences, Dronten, the Netherlands.

In order to save the information of the present research confidential, the respondents’ names and surnames were coded as follows:
- two researchers from Germany were given the codes of E1 (Expert 1) and E2 (Expert 2).
- a researcher from Latvia was pointed as E3 (Expert 3),
- a researcher from the Netherlands was considered as E4 (Expert 4).

Interpretative research paradigm that corresponds to the nature of humanistic pedagogy (Luka, 2008) has been used in the present empirical study. Exploratory research has been employed in the empirical study (Phillips, 2006). Exploratory research is aimed at generating new questions and hypothesis (Phillips, 2006). The exploratory methodology proceeds from exploration in Phase 1 through analysis in Phase 2 to hypothesis development in Phase 3 as demonstrated in Figure 4.

The qualitatively oriented empirical study allows the construction of only few cases (Mayring, 2004). Moreover, the cases themselves are not of interest, only the conclusions and transfers we can draw from these respondents (Mayring, 2007). Selecting the cases for the case study comprises use of information-oriented sampling, as opposed to random sampling (Mayring, 2007). This is because an average case is often not the richest in information. In addition, it is often more important to clarify the deeper causes behind a given problem and its consequences than to describe the symptoms of the problem and how frequently they occur (Flyvbjerg, 2006). Random samples emphasizing representativeness will seldom be able to produce this kind of insight; it is more appropriate to select some few cases chosen for their validity.
Further on, the choice of experts was based on two criteria, namely, recognized knowledge in the research topic and absence of conflict of interests (Lopez, Salmeron, 2011: 202) as depicted in Figure 5.

![Criteria of choosing experts](image)

**Fig. 5: Criteria of choosing experts**

The number of experts depends on the heterogeneity of the expert group: the greater the heterogeneity of the group, the fewer the number of experts (Okoli, Pawlovski, 2004: 20). Thus, four is a good number of experts for the study (Lopez, Salmeron, 2011: 202). Therein, the non-structured interviews comprise four experts who are researchers from different countries. It should be noted that all the researchers are professors in the fields connected with educational research. All the four researchers have decisively contributed to their fields of research. All the four researchers have got extensive research experience.

**Survey Results**

In order to analyse the macro-level context for bi-professional curriculum, non-structured interviews were carried out. Non-structured interviews are conducted in order to search for the main categories of the research field (Kroplijs, Raščevka, 2004: 99).

Respondent 1 outlined that one of his/her heroes had been an engineer and architect and designer and inventor all enrolled in one. He/she could see the excitement of inventing a new bit of technology and making it happen. Respondent 2 revealed that the computer and psychology student had began to develop a popular social networking site.

Respondent 3 assumed that his/her love of music and keen ear for quality audio had defined his career and play a key role in the company establishment as a leading name in the audio industry.

Respondent 4 stresses that if he/she had never dropped in on that single calligraphy class in college, the computer would have never had multiple type-faces or proportionally spaced fonts.

Expert 1 thanked the authors for the interesting abstract submitted to the conference where Expert 1 were acting as a reviewer.

Expert 2 underlined that the authors had tried to summarize a study and identify the main characteristics of this study.

Expert 3 was interested in the continuation of the study.

Expert 4 suggested the study to be focused only on the profession of entrepreneur as a secondary profession.

**Findings of the Empirical Study**

Summarizing content analysis (Mayring, 2004: 269) of the data reveals that the macro-level context for introducing bi-professional curriculum to promote students’ innovativeness is positive.

Further on, the entrepreneurs who took part in the non-structured interviews were involved in engineering of different types. Thus, the conclusion can be drawn that bi-professional curriculum enhances engineering students’ innovativeness.

The responses given by the successful entrepreneurs from the non-structured interviews allow outlining the following secondary professions to be provided in curriculum in higher education: architect, designer, psychologist, opera singer and calligraphy professional.

Summarizing content analysis (Mayring, 2004) of the data from the non-structured interviews reveals that there is a need for introducing bi-professional curriculum for the promotion of students’ innovativeness.
VII. CONCLUSIONS AND RECOMMENDATIONS
The theoretical findings of the research allow drawing the conclusions that bi-professional curriculum is relevant to the local contexts of the countries of the European Union in terms of educational policy and curriculum innovation.

The empirical results reveal the concept of bi-professional curriculum in engineering education as shown in Figure 6.

Bi-professional curriculum in engineering education is not necessarily directly focused on bi-professional employment or the creation of new businesses, although graduate start-ups are one of a range of possible outcomes (European Commission, 2012: 44).

![Bi-professional curriculum in engineering education](image)

**Fig. 6: Bi-professional curriculum in engineering education**

The following hypothesis has been formulated: bi-professional curriculum in engineering education is successful if

- as a secondary profession, the professions of designer, architect, opera singer, calligraphy professional and psychologist are offered,
- a favourable educational environment for the enrichment of engineering students’ bi-professional experience is organized,
- engineering students actively participate in learning within bi-professional curriculum in engineering education.

Validity and reliability of the research results have been provided by involving other researchers into several stages of the conducted research.

External validity has been revealed by international co-operation as following:

- the research preparation has included individual consultations given by other researchers,
- the present contribution has been worked out in co-operation with international colleagues and assessed by international colleagues, and

- the research has been presented at international conferences.

The present research has limitations. The interconnections between the psychological system and bi-professional curriculum have been set. Another limitation is the empirical study conducted by involving the entrepreneurs and experts only.

Further research tends to focus on modelling a favourable educational environment which could proceed from teaching through peer-learning to learning for the enrichment of engineering students’ bi-professional experience.

Engineering students’ participation in bi-professional curriculum within engineering education has to be investigated. Pedagogical support for engineering students who are failed entrepreneurs and who do not have the right mindset to run business has to be discussed.

Empirical studies in other institutions are proposed to be carried out. Another direction of further investigation is considered as evaluation of efficiency of engineering students’ bi-professional experience. And a comparative research of different countries could be carried out, too.

**References**


THERMOELECTRIC OXIDES – A VERSATILE CLASS OF MATERIALS FOR CERAMICS-BASED THERMOELECTRIC GENERATORS

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Abstract: Thermoelectric generators (TEGs) have been in the focus of science and engineering in the last decade. TEGs exhibit high potential as renewable energy sources transforming waste heat into electricity. Most devices are based on semiconductor materials, however, a lot of different materials classes have been explored for their thermoelectric behavior highlighting the role of materials science and engineering in the search for a new generation of TEGs. Oxides represent a versatile class of thermoelectric materials with promising properties, e.g. stability at increased temperature. Examples of n- and p-type conducting oxides include CaMnO$_3$ and BaSnO$_3$ perovskites, Al-doped ZnO, Li-substituted NiO and Ca$_3$Co$_4$O$_9$. Some aspects of the sintering behaviors and thermoelectric properties of thermoelectric oxides are discussed. A concept of an oxide-based ceramic multilayer thermoelectric generator will be presented. The adaption of the oxide materials to the requirements of the ceramic multilayer process will be demonstrated.

Keywords: thermoelectrics; energy conversion; oxides; ceramic multilayer components, thermoelectric generator

1. INTRODUCTION

Thermoelectric generators (TEGs) based on the Seebeck effect can be utilized to transform thermal energy directly into electrical energy. Thermoelectric energy conversion is considered especially attractive for harvesting electricity from renewable energy sources, e.g. solar heat, or to recover waste heat. This is thought to be an interesting emerging technology for diverse application fields ranging from self-sustaining sensing systems to energy conversion from combustion engines. The use of waste heat as source of electrical energy in vehicles with combustion engines or furnaces is an attractive option to contribute to a better energy efficiency. Major automotive manufacturers are actively pursuing this technology to implement TEGs in the cars exhaust systems.

Although significant research and development efforts have been dedicated to this field in the past, there are still limitations hindering thermoelectrics to become a major source of renewable energy. One of the major research directions is the search for better thermoelectric materials. The improvement of thermoelectric materials properties is the essence of thermoelectric materials science, however, other factors including materials stability under operation conditions, long life cycles, cost efficiency and compatibility to existing technologies are being increasingly considered. Existing thermoelectric commercial devices are based on doped semiconductors which suffer from high cost, small energy output and limited thermal stability. Thermoelectric oxides, on the other hand, are a versatile class of materials for application in TEGs.
The aim of the paper is to give an overview on thermoelectric materials, and to introduce the concept of ceramic multilayer-based thermoelectric generators. Several classes of thermoelectric oxides will be reported and their properties as well as compatibility to the multilayer technology will be highlighted. The theoretical background of thermoelectricity has been summarized in another paper of this conference [Teichert, 2013].

2. THERMOELECTRIC MATERIALS

A major challenge for the implementation of thermoelectric energy conversion is the low conversion efficiency. This is directly related to material properties: the voltage generated by a thermoelectric material placed in a temperature gradient is related to the thermopower (Seebeck coefficient S), which should be large. Electric current must pass through the material, hence the electrical conductivity $\sigma$ (resistivity $\rho = 1/\sigma$) should be high (low). Simultaneously, the thermal conductivity $\kappa$ of the material should be low, so that a large temperature gradient is maintained. These parameters are summarized in a dimensionless figure of merit:

$$ZT = \frac{\sigma \cdot S^2 \cdot T}{\kappa}$$  \hspace{1cm} (1)

The dimensionless value $ZT$ is typically used as an indicator of the potential of a certain material for thermoelectric applications. A $ZT \approx 1$ is considered as high-performance thermoelectric material for commercial applications. Bi$_2$Te$_3$, Sb$_2$Te$_3$ and PbTe are semiconductors which are typically used in commercial thermoelectric devices. Top values of $ZT \approx 2.5$ have been reported for nanostructured semiconductors at room temperature [Rowe, 1995]. However, these materials are composed of toxic, naturally rare and heavy elements that are not stable at higher temperature. To convert sufficient energy from heat to electricity, both p- and n-type materials should have a high $ZT$ over a wide temperature range.

One of the crucial points for materials research results from the coupling of thermal and electrical resistivity. The lowest resistivity can be expected in the crystalline state and the lowest lattice thermal conductivity will be realized in the amorphous state. Using these ideas, the concept of a phonon-glass electron gas (PGE) for materials with large phonon scattering and good electron conductivity has been derived. For crystalline materials an extensive effort to prepare dense bulk samples with nanometre grain size using novel technologies, e.g. spark plasma sintering [Ren, 2012] was undertaken. A different approach was developed by Dresselhaus and Hicks [Hicks, 1993] proposing the effect of reduced dimensionality on the figure of merit. This has been demonstrated for superlattice multilayers based on the PbTe [Hicks, 1996].

Oxides have also been explored as an interesting group of thermoelectric materials within the last decade. The figure of merit of oxides is considerably smaller so far, however, they are usually non-toxic, more cost-effective and high-temperature stable. Reviews of thermoelectric oxides have been published recently [Fergus, 2012], [Koumoto, 2013]. Nanoscale materials with intrinsic anisotropic electrical properties have attracted special attention, e.g. layered metal oxides such as NaCo$_2$O$_4$ [Terasaki, 1997] or Ca$_3$Co$_4$O$_9$ [Funahashi, 2000; Masset, 2000; Miyazaki, 2000].

3. CERAMIC MULTILAYER THERMOELECTRIC GENERATORS

A typical thermoelectric generator design consists of some thermocouples of p- and n-type materials connected in series (Fig. 1). At bottom and top an electrically insulating...
material is used to couple the TEG to a heat sink and source, respectively.

Fig. 1: Schematic setup of a TEG with p/n-conducting thermocouples

Bulk material samples are used to construct unicouples of p- and –type materials, or e.g. 140 pairs of unicouples 1.3×1.3×5 mm³ were combined to construct a plate-shaped thermoelectric module that reaches an open-circuit voltage of 4.5 V at a $T_{th} = 1072$ K in air [Funahashi, 2007]. Similar concepts include the use of porous materials for the construction of bulk-type oxide TEGs [Noudem, 2008].

A different concept has been proposed based on the cofired ceramic multilayer technology [Hayashi, 2010]. This technology relies on the cofiring of tapes of different ceramic materials and metal pastes in one temperature anneal to create a ceramic multilayer structure. This technology is widely used in the fabrication of passive electronic components, e.g. multilayer capacitors, inductors, varistors, etc. The basic concept is shown in Fig. 2. The p- and n-type thermoelectric oxides are prepared as tapes of thickness from 20-500 µm by tape casting. Metal electrodes are applied onto the individual layers. Thin insulating ceramic layers are placed inbetween the thermoelectric layers in order to avoid electric short-circuiting. After stacking the various layers, the stack is laminated and cofired at temperatures ranging from 900 to 1300°C depending on the used material combinations.

Fig. 2: Schematic setup of a multilayer oxide TEG with multiple p/n-conducting thermocouples

Potential advantages of this approach are:
- thermoelectric oxide materials are produced without toxic heavy metals
- oxides are chemically stable up to high temperatures
- suitable scalability of geometrical dimensions
- ceramic multilayer technology is an established production process in the passive component fabrication.

However, to successfully apply this multilayer approach, a variety of material science problems have to be solved:
- thermoelectric oxide materials have to be sintered simultaneously which requires adapted shrinkage and sintering behaviors
- avoid mismatch of thermal expansion of different materials
- different materials must be chemically inert to avoid formation of new phases upon cofiring
- thermoelectric properties of individual materials must not change upon cofiring of multilayer stack.

The sintering behaviors of the oxide materials might be tailored by using liquid-phase sintering additives. If the main shrinkage of the materials (p- and n-type thermoelectric, insulator, metal) appears at approximately the same temperature, the whole multilayer stack can be cofired without formation of defects, delaminations and cracks.
4. OXIDES FOR MULTILAYER THERMOELECTRIC GENERATORS

We have studied a variety of thermoelectric oxide materials that have been discussed in the literature in the last years, and have evaluated their potential regarding the multilayer process compatibility. Examples of n- and p-type conducting oxides include CaMnO$_3$ and BaSnO$_3$ perovskites, Al-doped ZnO, Li-substituted NiO and Ca$_3$Co$_4$O$_9$. The preparation of selected materials, their sintering behaviors and thermoelectric properties are discussed in the following.

The shrinkage behavior of n-type La-doped BaSnO$_3$ is shown in Fig. 3. The shrinkage of the pure stannate sets in at about 1000°C and has its maximum at $T > 1400°C$. Addition of a Ba-borate as sintering aid shifts the shrinkage to lower temperatures: the temperature of maximum shrinkage rate decreases to 1100 and 1050°C for 2% and 3% additive concentrations, respectively. Addition of LiF/CaCO$_3$ further reduces the shrinkage maximum to below 900°C. This illustrates that the shrinkage vs. temperature behavior of this n-type thermoelectric oxide can be adapted to the other materials in the multilayer stack.

The thermoelectric properties of oxide materials are effected by substitution and/or doping of constituents. Ca$_3$Co$_4$O$_9$ is one of the popular p-type oxide thermoelectric materials. Substitution of Bi$^{3+}$ for Ca$^{2+}$ is followed by a change in the Co ion charge distribution for charge compensation. This leads to a significant change in the Seebeck coefficient, since the Seebeck coefficient depends upon charge carrier concentrations. The samples of Ca$_3$Bi$_x$Co$_4$O$_9$ exhibit positive values of the Seebeck coefficient, increasing with temperature (Fig. 4). Moreover, S increases with Bi concentration.

These examples illustrate that the sintering behavior as well as the thermoelectric properties of oxides can be designed in order to enable multilayer processing and cofiring.

V. CONCLUSIONS

The concept of a multilayer thermoelectric generator has been demonstrated.
Thermoelectric materials, insulators and metal contacts have to be compatible to the multilayer process. Our studies show that some of the possible thermoelectric oxides might be designed for application in such a ceramic cofiring technology. However, a lot of materials science issues have to be solved to identify optimum n- and p-type thermoelectric oxides and to fabricate a multilayer TEG. The potential of this approach using a well-established technology for the preparation of oxide-based thermoelectric generator modules is considered to be high.

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THERMOELECTRIC ENERGY CONVERSION

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Abstract: Direct conversion of waste heat into electrical energy by thermoelectric generators is an interesting opportunity among the techniques of renewable energy generation. The worldwide research and development activities in the field of thermoelectric applications have been intensified over the last years, mostly driven by the improvement of thermoelectric materials as well as system solutions.

The paper will give an introduction to fundamentals of the thermoelectric energy conversion. Material developments are briefly reviewed; existing as well as potential application fields are discussed. Furthermore, a currently running research project on the application of a common ceramic technology for the preparation of thermoelectric generators is presented.

Keywords: thermoelectrics; energy conversion; thermoelectric materials, thermoelectric generator

Introduction

The discovery of an electromotive force induced by the temperature difference between the contacts of two different materials published by Thomas Johann Seebeck in 1823 [Seebeck, 1823] was the starting point of the investigation of thermoelectric effects. In an extremely simplified picture the observed effect can be understood as a result of the thermal diffusion of electrical charge carriers in an electrical conductor which is higher at the hot side compared to its cold side. The thermoelectric or also called Seebeck effect can be utilized to transform thermal energy directly into electrical energy. Taking into account limited primary energy resources and the need for renewable energy thermoelectric energy conversion offers an interesting opportunity, particularly for waste heat recovery. Although significant research and development efforts have been dedicated to this field in the past there are still limitations hindering thermoelectrics to become a major source of renewable energy. However, especially in the last decade the worldwide activities this research area have seen significant growth. On one hand side this development was driven mainly by material innovation but on the other side also by the increasing economic pressure.

The aim of the paper is to give a rough overview on the field of thermoelectrics, particularly on thermoelectric energy conversion. Taking into account more than thousand scientific publications per year using the keyword “thermoelectric” the paper here may give only a brief introduction on certain research and development results in the interesting field of thermoelectric energy conversion with no attempt at completeness.

1. Fundamentals of Thermoelectric Energy Conversion

Physical Background

The fundamentals of thermoelectric energy conversion will be discussed for the setup of a single thermocouple consisting of two different materials A and B with contacts kept at temperatures \( T_1 \) and \( T_2 \) (Fig 1). The temperature difference \( \Delta T = T_2 - T_1 \) results in the voltage difference \( \Delta V \) proportional to \( \Delta T \). For small temperature differences the corresponding
Fig. 1: Thermocouple

proportionality factor is the difference of the Seebeck coefficients \( S_A \) and \( S_B \) of the materials involved:

\[
\Delta V = (S_B - S_A) \cdot (T_2 - T_1)
\]

(1)

Obviously, a large difference of the Seebeck coefficients \( S_A \) and \( S_B \) will result in an increase of the created electrical potential difference \( \Delta V \). The sign of the Seebeck coefficient depends on the charge carrier type of the material used: electron conduction gives a negative Seebeck coefficient whereas hole conduction results in a positive Seebeck coefficient. Therefore the materials A and B are selected typically with opposite conduction types to create a large difference \( \Delta V \).

In order to discuss the thermoelectric energy conversion in more detail one has to consider an electrical load \( R_L \) that closes the electrical circuit. For the estimation of the thermodynamic efficiency of the energy conversion for the setup further material properties have to be considered: the electrical resistivity \( \rho \) as well as the thermal conductivity \( \lambda \). Following the discussion of Ioffe [Ioffe, 1957] an optimum electrical load \( R_L \) will result in the maximum thermodynamic efficiency \( \eta \):

\[
\eta = \frac{(T_2 - T_1) \cdot (M - 1)}{T_2 \cdot (M + T_2/T_1)}
\]

(2)

with

\[
M = (1 + Z_{AB} T_m)^{1/2}
\]

(3)

\[
T_m = \frac{T_1 + T_2}{2}
\]

(4)

The influence of the material properties are condensed here in the figure of merit \( Z_{AB} \), defined as:

\[
Z_{AB} = \frac{(S_B - S_A)^2}{(\lambda_A \rho_A)^{1/2} + (\lambda_B \rho_B)^{1/2}}
\]

(5)

If \( M \) becomes large compared to unity equation (2) transforms to the thermodynamically limited maximum efficiency of the Carnot cycle. Following the definition of \( M \) in (3) the performance of the thermoelectric energy conversion is directly related to the material properties. The Seebeck coefficients should be large and of opposite sign, the thermal conductivity as well as the electrical resistivity should be small. For practical purposes the commonly defined figure of merit \( Z \) for a single material should be introduced as well:

\[
Z = \frac{s^2}{\lambda \rho}
\]

(6)

The dimensionless value \( ZT \) is typically used as an indicator of the potential of a certain material for thermoelectric applications.

For illustration, figure 2 shows the plot of the thermoelectric conversion efficiency vs. the dimensionless value \( Z_{AB} T_m \) for a thermocouple held at \( T_1 = 300 \) K and \( T_2 = 400 \) K. For comparison, the Carnot limit \( \eta_c \) determined by the second law of thermodynamics using the same conditions is 0.25.
Fig. 2: Maximum thermodynamic conversion efficiency of a single thermocouple \((T_1 = 300 \text{ K}, T_2 = 400 \text{ K})\)

One has to note here that typically realized values of \(Z_{AB} T_m\) are not much larger than 1, for many material systems the value is rather smaller than 1. The resulting low thermodynamic efficiency has to be considered as the main limitation for the application of thermoelectric energy conversion. Therefore a large fraction of the world wide research and development activities are dedicated to materials development in order to improve the dimensionless figure of merit \(ZT\).

However, the parameter conversion efficiency is not the only deciding one, particularly if TEGs are used for waste heat conversion. In this case the key parameter is rather the system price vs. electrical energy output during the lifetime of the system. Additionally, under certain circumstances thermoelectric energy conversion may be in the role of an enabling technology.

**Technology aspects of thermoelectric generators**

A thermoelectric generator consists generally of some ten thermocouples (Fig 3). These thermocouples are connected in a serial way, hence the thermoelectric potential adds up to reach a useful voltage at the outer contacts. At bottom and top an electrically insulating material is used to couple the TEG to a heat sink and heat source, respectively. It needs to be mentioned that fig 3 shows only the basic setup of a TEG, in practice the design might be more complicated. However, as a common point remains the inherent advantage of the thermoelectric energy conversion especially in comparison to other conversion technologies using heat flow: the TEG contains no moveable parts; therefore the TEG can work on long time scale without maintenance.

Fig. 3: Schematic setup of a TEG with p/n-conducting thermocouples

Furthermore, TEGs can be scaled to a large extent. The scaling comprises size as well as output power. On one hand side microtechnologies have been used to produce commercially TEGs with a footprint of some square millimeter and a power output on the µW to mW range. On the other hand large scale applications providing electrical power on the kW scale have been realized as well.

**Application fields of thermoelectric energy conversion**

An early significant application of thermoelectric energy conversion is the usage in so called atomic batteries. In this case a piece of radioactive material acts as heat source inside of a cylindrically shaped TEG setup. Such type of atomic batteries found their application in space crafts, automatic measurement stations. A famous example is the spacecraft Voyager I [NASA, 2012; JPL, 2012] which has been started in 1977. Even after nearly 36 years Voyager I is still sending data. Another application of atomic batteries are pacemakers with a radioactive Plutonium source which have been implanted to a significant number of heart patients in the time around 1970.

TEGs with an output power in the range of several 10 Watts driven by primary energy sources are used especially in rural environements, for example as energy source of gas pipeline measurement stations or as combination of heaters and electrical supplies.

The development of miniaturized TEGs allowed the application in wireless sensing systems. Combined with low power radios the TEGs allow the construction of completely self-contained sensing systems [Nurnus, 2009].
A strongly investigated future application field is use of waste heat in transportation based on combustion engines. Major automotive manufacturers are working on solutions to implement TEGs in the exhausting system. Just to give an example, Ford, GM, Renault and BMW presented their results at the 2nd Thermoelectric Application Workshop in January 2011 in San Diego [USED, 2011].

The use of thermoelectric technologies for waste heat recovery on a large industrial scale is discussed as a long term option. For example, within the strategic project "Energy technologies 2050" in Germany thermoelectric energy conversion has been identified as a potential technology to use waste heat in different areas; corresponding research needs have been addressed [Energy, 2009].

Current focus of research and development in thermoelectric energy conversion

Although a number of applications have been commercialized in the past there are significant research and development activities throughout the whole technology chain for TEGs. The targets of the research and development activities can be classified as follows:

- solid state theory of thermoelectric materials
- search for new thermoelectric materials; optimization of known materials
- application of mathematical simulation tools
- system optimization to improve efficiency and reliability
- electrical system integration
- exploration of new application fields
- improvement of characterization techniques for research and production

The overwhelming fraction of these activities rely still on public funding. For illustration, some recent funding activities within the European Union and Germany should be listed [Böttner, 2012]: The European Union supports between 2011 and 2014 projects to enhance ZT values with a volume of about 15 Mio Euro. The German research foundation (DFG) started in 2009 a 6-year priority program "Nanothermoelectric" with the focus on basic research supporting the activities with 8.7 Mio Euro. The Federal Ministry of Education and Research provides in a similar time frame additional 5.5 Mio Euro for fundamental research. In the field of applied research in thermoelectrics the Federal Ministry of Education and Research as well as the Federal Ministry of Economics and Technology in Germany will spend in total 36 Mio Euro during the frame 2008 – 2015.

2. Materials for Thermoelectric Energy Conversion

As mentioned already the key for a further advancement of thermoelectric energy conversion is the quality of the thermoelectric active material. Following the discussion above one can easily formulate the requirements for thermoelectric active materials: The Seebeck coefficient should be high, the thermal conductivity and the electrical resistivity should be small. Non-conducting materials need to be ruled out because of their high resistivity, metals suffer typically from a low Seebeck coefficient and a high thermal conductivity. Best suited are materials in between these two major groups, i.e. semimetals as well as rather highly doped semiconductors.

Taking into account the needed low thermal conductivity material developments until the 80th of the last century were concentrated on Silicon-Germanium compounds, on telluride (Bi$_2$Te$_3$; Pb$_2$Te$_3$) and on semiconducting silicides (FeSi$_2$, MnSi$_{1.7}$; Mg$_2$Si).

One of the crucial points for materials research results from the coupling of thermal and electrical resistivity. The lowest resistivity can be expected in the crystalline state and the lowest lattice thermal conductivity will be realized in the amorphous state. Based on this Slack [Slack, 1979] proposed the search for materials with large phonon scattering and good electron conductivity also referred to as phonon-glas electron gas (PGE). Such behavior can be expected from materials with fairly complicated crystalline structure, exemplary systems are such as skutterudites or clathrates. Another approach to follow this idea is the reduction of the grain size in common crystalline materials. This can be reached by the application of speical preparation methods, such as spark plasma sintering [Ren, 2012].
In 1993, Dresselhaus and Hicks [Hicks, 1993] analyzed theoretically the effect of reduced dimensionality on the figure of merit resulting in the proposal for the investigation of nanostructured materials. For superlattice multilayers based on the PbTe system the expected increase of ZT could be experimentally demonstrated [Hicks, 1996]. Beyond the artificially growth of multilayers on the nanoscale materials with intrinsic strongly anisotropic electrical properties have been identified as interesting alternative. Here, layered metal oxides such as NaCo$_2$O$_4$ [Terasaki, 1997] or Ca$_3$Co$_4$O$_9$ [Funahashi, 2000; Masset, 2000; Miyazaki, 2000].

Summarizing the short material overview one can state that the number of material systems under investigation for thermoelectric applications is still increasing. However, almost all of the commercially available thermoelectric devices working near room temperature still rely on the classical material system Bi$_2$Te$_3$, space applications are mostly realized with SiGe compounds.

3. research Activities at the University of Applied Sciences Jena in the Field of Thermoelectrics

Based on the resources of the European Social Fond the Thuringian Ministry of Economy, Work and Technology released a program to establish research groups, which work in a close relationship with the local industry. The idea of the program is the creation of new technologies along with the education of young scientists in the corresponding working fields. The close contact of the research group to the industry is realized by an advisory council staffed by the industry partners of the individual projects.

In the framework of this funding program a research group for thermoelectric energy conversion has been established in 2012 at the University of Applied Sciences in Jena together with the Fraunhofer Institute for Ceramic Technologies and Systems Hermsdorf. The researchers engaged in the group form a interdisciplinary team covering material preparation, electrical, thermal and structural characterization as well as simulation. In total five local companies contribute to advisory council to guide the activities.

The target of the project is the preparation of a prototype of a TEG using a common metal oxide multilayer technology. Some potential advantages of this approach are the following:

- thermoelectric oxide materials can be produced without toxic heavy metals
- the oxides are chemically stable up to high temperatures
- suitable scalability of geometrical dimensions
- the ceramic multilayer technology is an established production process in the corresponding industry

The starting activities within project are related to materials selection and preparation. Technical details on these running activities will be given in the presentation of Jörg Töpfer at this conference.

4. Summary and Conclusion

Although the basic principles of thermoelectric energy conversion are known for a long time further scientific efforts will be needed on a long term scale to improve the efficiency of such systems. The major limit for a significant implementation of this green technology to large scale waste heat recovery is determined by the properties of the thermoelectric active material. Recent theoretical and experimental studies revealed that materials engineering on the nanoscale provides significant potential for the needed improvements.

Acknowledgement:

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RESULTS OF THE BOLOGNA PROCESS AND THE IMPACT ON THE ENGINEERING EDUCATION IN GERMANY

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Abstract: The Bologna process has become one of the major drivers for modifications in higher education institutions in Europe. Today, some 10 years after the launch of the process I will show the state of development achieved up to now.

I will do this from two perspectives – first from the perspective of the person responsible at the university and from the perspective of the peer in the accreditation process.

On the 19th of June 1999, in the Italian University City of Bologna the Minister of Education from 29 European countries signed the so-called “Bologna Declaration” and expressed their aim to establish a common European Higher Education Area by 2010.

First, I would like to point out the aims of this reform and subsequently regard to the results achieved and problems encountered.

The Bologna Declaration and the Communiqués of the Conferences of Ministers specify the following points of the Bologna Process:

- Introduction of a system of comprehensible and comparable degrees (Bachelor and Master) meaning the introduction of degrees everybody is familiar with and can compare to degrees from other countries.
- Introduction of the two-cycle degree structure (undergraduate/graduate)
- Transparency of study contents by means of credit points (ECTS) and the Diploma Supplement
- Recognition of degrees and phases of study
- Promotion of mobility of students and academic staff
- Safeguarding of quality standards at national and European levels
- Implementation of a qualifications framework for the European Higher Education Area
- Increase in the attractiveness of the European Higher Education Area, including for those outside the EU
- Promotion of lifelong learning
- Linking of the European Higher Education Area and the European Research Area

How has this process evolved in the recent 10 years?

The higher education institutions in the currently 47 partner countries are undergoing a demanding and at the same time very promising process of development.

The previous experiences are presented as part of the Follow-up Conferences in Prague (2001), Berlin (2003), Bergen (2005), London (2007), Leuven/Louvain-la-Neuve (2009), Budapest/Vienna (2010) and Bucharest (2012) and new priorities had been set and changes had been made.

Following the Conference of Ministers in Leuven (2009), representatives from 15 non-European countries took part for the first time in a Bologna Forum to figure out the opportunities for greater cooperation. A focus of the work in the coming years will be strengthening the international mobility of students. It was agreed in Leuven that
20% of all graduates Europe-wide should have completed part of their studies or an internship abroad by the year 2020. The next Bologna Conference to discuss targets and progress will be held in Armenia in 2015.

Many of the aims listed above have already been largely implemented in the Bologna countries. Nevertheless, there are a number of tasks yet to be implemented: not only in countries which did not join the Bologna Process until a later date but also in long-standing member countries. These tasks include enhancing mobility, improving employability, and recognizing qualifications, academic achievements, and skills and knowledge acquired outside higher education. In the future, changing circumstances, particularly regarding demography and globalization, must also be taken more seriously into account. Further measures must be taken to encourage equal opportunities and permeability in the higher education system - the social dimension of the Bologna Process.

85 per cent of all courses of study at German institutions of higher education (13,000 of a total of 15,300 courses) had been converted to two-cycle Bachelor/Master courses by the beginning of the 2011/2012 winter semester. The universities of applied sciences in particular have virtually completed the reform. The majority of the courses that have not been converted lead to state or ecclesiastical qualifications.

Most Bachelor courses have been designed with a standard period of study of six semesters. However, approximately 20 per cent of Bachelor courses are designed to have a standard period of seven semesters, and a further eight per cent a period of eight semesters. The Master courses are mainly designed to take four semesters; but there are also Master courses lasting three or two semesters.

At the UAS Jena (University of Applied Sciences Jena (EAH Jena) from 2005 up to 2007 all courses of study had been converted to the Bachelor/Master-system and had been successfully accredited.

Which criticisms of the process need to be considered?

- At universities the diploma courses (usually 10 semesters) had been changed to Bachelor courses with usually 6 semester and Master courses with 4 semesters, which would lead to a lower qualification level and to a less practical and professional qualification (for example elimination of internship semesters and periods abroad).
- As consequence of the shortened study periods, it is more difficult to integrate periods abroad (in our department the problem had been overcome by introduction of a course of studies including a semester abroad).
- Students complain about the work overload caused by the high number of examination during the course of studies (corrective action needed: only one exam per module).
- The short standard periods of study are not always observed (lack of money, children, care of relatives, etc.). To accommodate those situations studies with different time schedules are required.
- At some universities the curriculum content from the four years Magister’s degrees had been compressed to the three years Bachelor, which leads to work overload and frustration. Frequently the workload was wrongly assessed.
- The Master’s degree requires 10 semesters, which leads to problems changing to another university for a Bachelor’s degree with 6 semesters and a Master’s degree with 3 semesters (mobility).
- The high costs of the accreditation process place heavy financial burdens on universities.
- Some peers verify through the accreditation excellence instead of a minimum standard.
- The German “Diplomingenieur” is a well known and distinguished trade mark that was given up lightly.
- Finally it can be assessed that the reform had caused significantly less problems at universities of applied sciences than at universities. Especially in the field of the engineering education the conversion had been successful. Even the industry has meanwhile well-attuned (well-accepted) to the changed Bachelor’s degrees. The level of our graduates is certified as very good and practically oriented.
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Influences on the Sustainability of Renewable Energies from a Social Scientific Perspective

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Abstract: Innovations in renewable energies are not only a question of technical or economical factors. From a social scientific point of view there are several influences for example from culture, social structures and everyday habits that may promote or interfere with the sustainability of renewable energies. Starting from a systems theoretical approach the paper will try to give an answer to the following questions:

- What are the difficulties in perception and communication for example from a technical, economical, social and ecological perspective?
- What unintended side effects for social systems may follow the implementation of renewable energies?
- How may changes in the use of energy by private households interfere with the effectiveness of renewable energies?

As a conclusion it will be necessary to enhance the sustainability of renewable energies by also taking into account the social scientific perspective.

Keywords: renewable energies; systems theory; Africa; unintended side effects

1. Introduction

Technical innovations may fail not only because of functional errors or economical miscalculations. The question whether the technology fits to the culture or the everyday life of a special country is at least equally important. Techniques of renewable energies are quite worthless if the people do not accept them or if they change their behaviour in an undesirable way. The sustainability of renewable energies will be restricted if people do not use them, use them in a wrong way or waste energy because it is “renewable”.

2. Sustainability from an interdisciplinary perspective

The term “sustainability” is originally an expression from the forestry of the 18th century. It means that a system is able to regenerate itself from within. Nevertheless it needs inputs from its environment to be able to regenerate and act autonomously. Concerning the output of the system to the environment the amount of output may only reach its outcomes (“earnings”) but not its substance. Otherwise it would not be possible to maintain the sustainability of a system. In a perspective on “Our Common Future” in the eighties of the last century the Brundtland Commission put out its famous definition of sustainable development: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations World Commission on Environment and Development, 1987:51). One of the consequences of the relation to “needs” in this definition is that sustainability has to be seen in a holistic and interdisciplinary perspective. For example it has ecological, economic, technical and sociological dimensions but also philosophical, psychological or even theological elements. From a sociological or economic point of view there are many examples for a lack of sustainability: Economic crises, high rates of poverty and unemployment, high rates of criminality or a large social inequality indicate that a society does not work in a sustainable way (Grunwald; Kopfmüller, 2006). But how can renewable energies be not sustainable? Isn’t this a contradiction in itself, almost an oxymoron?
3. Communication between systems and acceptance of renewable energies

One of the most famous German sociologists, Niklas Luhmann (1997), has described the difficulties in communication between several societal systems. One of his main theses is that every system, like economic, political or social systems has its own code of communication and its own perception of issues that make sense or not. The communication code of the economic system is money, of political systems it is power and of social systems it is moral. The communication code of technical systems is the ability of function and ecological systems understand the language of life. In his book “Ecological Communication” (1989) he described that for example the economic system is not able to understand social or ecological argumentations, because they are not concentrated on money but on moral or life. Only, for example, if ecological or social arguments can be expressed in monetary terms, will the economic system understand them.

Concerning renewable energies this means that they will only be accepted economically if they are more efficient than others. From a political point of view the acceptance depends on power. If renewable energies may increase the power, for example, of societies, of governments or of non-governmental organizations they will be accepted by them. From a social or ecological perspective with communication codes of moral or life renewable energies will be accepted if it is possible to enhance the living conditions for people and nature. This leads to the following conclusion: Renewable energies will only be sustainable, if their acceptance is multidimensional. To avoid communication gaps between societal systems it is necessary to strengthen interdisciplinary perspectives, to understand the special “language” of each system and to find options of translation. For example it is possible to translate “moral” into “money” in the case that increasingly large consumer groups prefer products, which have been produced under morally or ecologically acceptable circumstances. Let’s have a practical concluding hypothesis: Big solar parks in Africa, constructed by Euro-pan enterprises with the only target of European energy supply will fail, if they do not con-trIBUTE to the economic welfare of the African countries for example by electricity and jobs. Projects besides the interests and needs of the local people are based on long term colonial heritage and will be seen as forms of a new colonialism. The relations between colonized people and the colonialists are, as the sociologist Max Weber (1968) would say, “power rela-tionships”. These are, in contrast to “rule relationships”, characterized by conflicting interests, non-acceptance of the other part and struggles. The amount of security investments for such solar parks will be high and this is, no more morally, but purely economically spoken: very expensive. Consequently “… large infrastructure projects like CSP [Concentrated Solar Power, U.L.] have to prove their participatory character, while simultaneously they have to be economically successful and sustainable. *...+ ...every European effort to collaborate with African countries will always be suspicious to be a one-way business” (Schüssler, 2008:226 f.).

4. Unintended side effects and contradictions in the implementation of renewable energies

First we have to ask the following question: Could renewable energy in the perception of the user have an infinite availability, so that it is not necessary to be careful and efficient, that means “sustainable” in its use? This could be a conclusion that leads to the “rebound effect”: It “…describes increases in resource or energy efficiency that do not result in a correspond-ing decrease in energy or resource use” (Binswanger, 2001:120). The rebound effect de-scribes an increase in consumption that is evoked by one or more benefits in productivity (Santarius 2012:8). As a consequence there is no reduction of energy consumption, but sometimes even an increase. Second we have to look at the social consequences of renewable energies. Let us take as an example the “Solar Village” near Adama in Ethiopia. It is a project of the University of Ulm. In the village the former light production by kerosene lamps for some households which could afford it, was replaced by solar panels. Hanna Müggenburg (2011) has analysed the effects on the people and the social community. On the positive side it was possible to avoid eye and respiratory diseases. The children...
could do their homework in the evening. The social life and the security in the village were strengthened by solar light and the working outcomes increased. As an unintended side effect the social status of the owners of solar panels increased. As a result social tensions and envy between owners and non-owners also increased. The third side effect is symbolized by the abbreviation NIMBY, which means “Not In My Back Yard”. There is empirical evidence that a majority of people supports the production of renewable energies. But most of them do not want to have wind plants or solar panels near their houses.

The fourth possible side effect concerning African-European partnerships in solar energy production has to be seen in Africa as a whole. Areas suitable for Concentrated Solar Power are mainly located in Northern Africa. An increasing difference in potentials for economic growth between North Africa and Sub-Sahara could be an unintended consequence. The Sub-Saharan countries will remain dependent on foreign aid or investments by others. The examples of oil production in African countries, for example Nigeria show that oil findings or even just presumptions thereof often were a source of violence and war (Speitkamp; Stange, 2008). Could similar developments be imaginable for the production of solar energy? The fifth effect outlines a structural contradiction: If it were a real intention to supply the African countries with renewable, for example solar energy made in Africa there would be nationwide power grids for its distribution, but there are not. Especially the rural regions but also some areas in the big cities do not have such preconditions (Speitkamp; Stange, 2008). Even in Europe the main technical problem is not the production but the distribution of renewable energies. There are not enough “smart grids” that would be able to regulate production, consumption and storage of renewable energies (Kemfert, 2011). In Africa this problem shows a completely other dimension: At the moment only a quarter of the African population has access to electricity. In rural regions it is even only 15%; in South Africa and Northern Africa the amount is higher (Drechsler, 2013). Even if international companies guaranteed the African participation in production and consumption of renewable energies, in many cases there would not be any networks for energy supply. This leads to the sixth side effect: One more structural contradiction concerns the sustainability of technical systems. In my short theoretical introduction I have said that sustainable systems regenerate themselves but need inputs from their environment. The sustainability of technical and socio-technical systems will not be guaranteed in a long term perspective if there is no technical support as knowledge for service staff and technical devices in the case of technical malfunction.

5. Conclusions and Recommendations

The sustainability of renewable energies will only be effective, if it fits to the processes of self-organization of societal systems. That means it has to correspond with culture, norms or everyday habits. As Eppler (2000) emphasises, the people have to decide for themselves what they need most, depending on the culture, climate or tradition. Every step that brings modern energy technologies nearer to the people’s needs is a step in the right direction. Every step which leads farther away from them will increase the risk of non-functioning or non-use. That necessarily leads to a new consciousness of foreign aid. It should be oriented to the strengths and therefore the resources of each so-called developing country. There are several ways to the prosperity of a country, but the ways chosen by Europe or the United States in the past need not be those which are effective for other countries and surely not for a modern, future-oriented and sustainable development. Sustainable growth in a resource-poor rural based economy as Ethiopia means something else than in a country like Peru, which has a large biodiversity (Ruta; Hamilton, 2007). Also the transfer of money sometimes is a weaker aid than the transfer of education and knowledge, which is more sustainable and opens the gates for independence (Moyo, 2009). Africa has many natural resources and it surely has the sun. The sun as our greatest energy supplier sends us ten thousand fold more energy than we use on the earth (Bund für Umwelt und Naturschutz, 2011).

Nevertheless the relations between people on the one hand and techniques of renewable energies on the other have to leave the processes and results
open and let them be unde-fined to a certain extent. Every strongly fixed target means less flexibility in the implementa-tion and increasing risks of failure. Furthermore it is necessary to take interdisciplinary perspectives and an interdisciplinary integration of knowledge to enable the sustainable power of renewable energies to its full efficiency. Isolated technical or economic approaches are not sustainable. Ecological knowl-edge based on natural science, social scientific data and the political or legal perspectives are additionally necessary.

Finally we need a system of indicators to describe the structures and processes of a sustain-able implementation of renewable energies. This system has to be quite complex, because the area of research is complex. As the cybernetics researcher Ashby put it: A complex sys-tem can only be controlled by a system which has at least the same level of complexity (Ashby, 1958). Such a system will also be a tribute to a necessary revision of risk perceptions. Is there a higher risk for investments in politically quite unstable countries than for example in financial products that cause a worldwide financial crisis or in nuclear power plants, where failure means catastrophe?

Renewable energies are an emerging market. If it will be possible to use its technical, eco-logical, economic and social conditions in an integrated perspective, it will be a huge poten-tial not only for Africa but for the whole world.

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Abstract: The fluidized bed combustion ashes emissions increased year by year, fluidized bed combustion ashes reuse is still in the research stage, utilization is very low. In this paper, through the analysis characteristics of fluidized bed combustion ashes, and summarizes the current situation and existing problems in fluidized bed combustion ashes reuse; proposed a new way reuse of fluidized bed combustion ashes - Treatment of Coking Wastewater, experimented the dosage, adsorption time, recyclability of fluidized bed combustion ashes on the use of coking wastewater treatment. The results show that, the fluidized bed combustion ashes for coking wastewater treatment is effect, better circulation.

Keywords: fluidized bed combustion ashes; characteristics; reuse; coking wastewater

I. INTRODUCTION

China's CFB ash emission at about 20 million t a year, along with some new fluidized bed boiler power plant put into operation and state control on SO₂ emission during coal combustion and high speed development of electric power in our country, FBC ash emissions will be rapid growth.

At present, utilization of FBC ashes of our country is extremely low, is still in the research stage. Some scholars researched the application of FBC ashes in agricultural soil improvement, traffic engineering, building materials cement concrete, mine environmental governance and city environment management etc.(Zheng Hongwei,2004; Huang Yubin,2011; Yang Juan,2006;Liu Huan,2011). However, FBC ashes have unhealthy behaviors such as expansion, lead to the application of FBC ashes in these areas are still exist some problems. The FBC ashes are rarely reported for wastewater treatment.

In this paper, analyses the characteristics of sulfur and ash, summarizes the status of FBC ash reuse, analyses the existing problems in the current application, and proposes a new way of FBC ashes recycling -- advanced treatment of coking wastewater, combined with the properties of coking wastewater and solid sulfur ash, through the experiment researched FBC ashes used for coking wastewater treatment and prospect.

II. PROPERTIES OF FBC ASHES

A. The physical and chemical properties of FBC ashes

FBC ash is flue ash of coal combustion in fluidized bed boiler, including the collected solid sulfur ash and discharge of sulfur slag at bottom. The FBC ashes with hematite with varying degrees of purple red, if the carbon content is high, is black or grey, the proportion is 2.4~2.8g/cm³, water absorption rate is large, more than 10% (Qian Jueshi,2008; Ji Xiankun,2007; Song Yuanming,2007).

Because the characteristics of fuel boiler operation, limestone properties and different environment, FBC ashes have different chemical properties. Contains CaSO₄, CaO, CaCO₃, CaSO₄ and sintered clay, quartz and iron compounds. And the boiling furnace ash and slag powder compared to traditional, sulfur residue fluidized bed with calcium and sulfur content is higher, but the content of SiO₂, Al₂O₃ and Fe₂O₃ lower. In general, sulfur residue fluidized bed lower volcano ash activity than fly ash, but because the presence of SiO₂, Al₂O₃, Fe₂O₃ and CaSO₄, CaO, and thus has a certain self hardening, and obviously is alkaline, pH value generally in 11.5 ~ 12.5. The solid sulfur ash main
Table 1: Test FBC ash chemical composition table

<table>
<thead>
<tr>
<th>Sample</th>
<th>SiO₂</th>
<th>Fe₂O₃</th>
<th>Al₂O₃</th>
<th>TiO₂</th>
<th>CaO</th>
<th>MgO</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>SO₃</th>
<th>f-CaO</th>
<th>L.O.I</th>
<th>Sum</th>
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<td>A</td>
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<td>22.38</td>
<td>0.77</td>
<td>13.75</td>
<td>1.51</td>
<td>0.71</td>
<td>1.05</td>
<td>6.31</td>
<td>2.70</td>
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<td>98.99</td>
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<tr>
<td>B</td>
<td>35.62</td>
<td>6.85</td>
<td>12.93</td>
<td>0.67</td>
<td>21.80</td>
<td>2.65</td>
<td>1.30</td>
<td>1.09</td>
<td>12.68</td>
<td>5.66</td>
<td>4.26</td>
<td>99.85</td>
</tr>
<tr>
<td>C</td>
<td>42.85</td>
<td>5.08</td>
<td>35.02</td>
<td>0.76</td>
<td>5.90</td>
<td>1.71</td>
<td>0.31</td>
<td>0.85</td>
<td>3.11</td>
<td>2.03</td>
<td>2.32</td>
<td>98.00</td>
</tr>
<tr>
<td>D</td>
<td>43.66</td>
<td>6.03</td>
<td>24.57</td>
<td>0.96</td>
<td>9.20</td>
<td>0.51</td>
<td>0.37</td>
<td>0.95</td>
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<td>1.16</td>
<td>9.42</td>
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<td>0.38</td>
<td>21.35</td>
<td>0.52</td>
<td>0.22</td>
<td>0.54</td>
<td>7.60</td>
<td>3.43</td>
<td>19.72</td>
<td>99.69</td>
</tr>
<tr>
<td>F</td>
<td>39.09</td>
<td>13.15</td>
<td>11.87</td>
<td>0.78</td>
<td>13.94</td>
<td>2.54</td>
<td>0.88</td>
<td>0.63</td>
<td>8.78</td>
<td>3.18</td>
<td>7.85</td>
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</tr>
<tr>
<td>G</td>
<td>25.04</td>
<td>5.82</td>
<td>13.33</td>
<td>1.02</td>
<td>28.47</td>
<td>2.94</td>
<td>0.19</td>
<td>0.65</td>
<td>17.87</td>
<td>8.87</td>
<td>3.10</td>
<td>98.43</td>
</tr>
<tr>
<td>H</td>
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<td>11.47</td>
<td>16.80</td>
<td>1.94</td>
<td>13.31</td>
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<td>0.25</td>
<td>0.71</td>
<td>8.50</td>
<td>2.45</td>
<td>10.73</td>
<td>99.20</td>
</tr>
<tr>
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<td>42.00</td>
<td>6.38</td>
<td>28.22</td>
<td>1.06</td>
<td>1.40</td>
<td>0.64</td>
<td>0.40</td>
<td>0.63</td>
<td>1.26</td>
<td>0.05</td>
<td>16.6</td>
<td>98.79</td>
</tr>
</tbody>
</table>

B. Basic characteristics of fluidized bed combustion ashes

Fluidized bed combustion ashes characteristics are mainly the following aspects:

(1) Water demand

The FBC ashes standard consistency water requirement is higher than sulfur slag; FBC ashes degree of standard consistency water demand is very high, generally in more than 50%, while the standard consistency water requirement of normal fly ash in general about 26%, the solid sulfur ash up to 1 times than fly ash; levigated sulfur slag standard water requirement is about 40%, although lower than fly ash, but still higher than that of fly ash is about 50%.

(2) Self-hardening

FBC ashes not only contain similar chemical composition with boiling slag, but also because of sulfur fixation, contains a lot of CaSO₄ (gypsum) and desulfurization agent remained f-CaO. F-CaO can be used as alkali activator to stimulate the activity of FBC ash active SiO₂ and Al₂O₃ turn into C-S-H and C-A-H gel, has certain hydraulicity; and the dissolution of anhydrite and then further reacts with C-A-H to form ettringite, increase system strength.

(3) Expansion

Compared with the conventional pulverized coal fly ash, FBC ashes contain high SO₃ and f-CaO in water at normal temperature, expansion performance is obvious at ordinary temperature. FBC ashes after mixed with water, II -CaSO₄ except hydrate into dihydrate gypsum, but also with the activity of Al₂O₃ and free CaO generate Ca (OH)₂ volcano ash reaction and the formate of ettringite. The study found, anhydrous gypsum formation dihydrate gypsum, solid volume increased 226%; free CaO hydrated to Ca(OH)₂ solid volume can be increased by 198%; ettringite formation of solid volume can be increased by about 125%.

(4) Volcano ash activity

FBC ash volcano activity refers to solid sulfur ash activity of SiO₂ and Al₂O₃ at room temperature and the reaction of calcium lime hydrated calcium silicate, hydrated aluminium capacity, which can be dissolved in the reaction of SiO₂, the content of Al₂O₃ is the key factor of volcano ash activity. FBC ashes are calcined clay hybrid materials, clay minerals in the thermal decomposition of glass transition and melting is the main reason of ash produced activity.

III. FLUIDIZED BED COMBUSTION ASHES RECYCLING AND PROBLEMS

A. Desulfurization ash recycling

Fluidized bed desulfurization slag physical and chemical properties and the structure of its mineral composition determine that it is not only a waste, in a sense, can be said to be a resource, and has been widely used in many fields. With the deepening of research, its applications will continue to expand, and the application level will continue to increase. At present, the utilization of
fluidized bed combustion ashes is mainly the following aspects (Yan Weiyong, 2000; Zhou Jing, 2007):

(1) Agricultural Application

Since the fluidized bed desulfurization slag contains CaO, CaSO₄, and Ca(OH)₂ component, it can provide a lot of calcium materials, which may be applied instead of Calcium in acidic soils, and play a role in production. Fluidized bed contains a small amount of magnesium slag sulfur, potassium, phosphorus component and these elements are essential nutrients crops.

(2) Management of mines and mine

Sulfur residue from the fluidized bed with a hard, can be used as a filler material waste pit, and because of its alkaline material it can be useful as lime to neutralize the acidic mine effluent, effectively control acidic sewage overflow problems.

(3) Urban Environmental Governance

In the treatment of municipal sewage sludge pipeline, the fluidized bed desulfurization slag can play high water absorption and self-hardening properties, stabilize sludge not to flow everywhere. It can also provide CaO and CaSO₄ ingredients, hydration heat, and create an alkaline environment, and play a bactericidal and deodorant effect.

(4) Construction

Since the fluidized bed desulfurization slag contains SiO₂, Al₂O₃ and Fe₂O₃ lower volume, and contains a high CaO and excessive SO₃ generally, it is not appropriate to be a mixture of cement concrete material, but it can be introduced as a component of the cement clinker manufacturing process and produce pozzolan cement. In addition, the fluidized bed desulfurization slag can be used as cement grinding aids and they can even replace the plaster to adjust the setting time.

(5) Traffic Engineering

Fluidized bed desulfurization ash residue with a certain activity and self-hardening, can be extensively used in traffic engineering backfill, embankment and roadbed.

B. Desulfurization ash recycling Problem Analysis

In the application of the above aspects, the most important thing is the fluidized bed combustion ashes used in construction. That the fluidized bed combustion ashes are used in construction, on one hand solves the waste disposal problem, on the other hand, also solves the problem of shortage of resources. However, because the ash contains more sulfur and calcium oxide and has expansion, its production exists strong expansion in producing cement production using fluidized bed combustion ashes, slag. Given fluidized bed combustion ashes expansion, there are still some problems in the producing of building materials.

IV. A NEW EXPLORATION OF FBC ASHES RECYCLING: TREATMENT OF COKING WASTEWATER

Coking wastewater is produced by high temperature carbonization in raw coal, gas purification and refining process of chemical products, its composition is complex, generally contain ammonia, cyanide, thiocyanate, phenol and other organic pollutants. These persistent pollutants caused great damage to the ecological environment, and the majority of polycyclic and heterocyclic compounds can be continuously transformed and carcinogenic. Treatment of coking wastewater is serious problem facing the domestic and foreign various countries at present. (ShunniZhu, 2008; Vazquez I., 2007; Qian Juesh, 2006).

At present, most of the coking plant of the coking wastewater generated by the removal of phenol pretreatment, biochemical treatment, then discharge. Biochemical oxygen demand (BOD) in coking wastewater quantity can meet the national wastewater discharge standard of second grade, but the cyanide, chemical oxygen demand (COD) value and ammonia nitrogen generally exceed the standard, not up to the national requirements of the emission standard. The ozone oxidation, activated carbon adsorption method can solve the above problem, but the cost is too high to limit its application. Therefore, looking for simple, low cost coking wastewater advanced treatment technology is a difficult and urgent problem.

Earlier research showed that: ordinary fly ash added a certain proportion of lime on the coking wastewater treatment effect than single fly ash is better. FBC ashes is expected to address the effect of fly ash is better than the ordinary of coking wastewater. In this paper, researched the FBC ashes for coking wastewater treatment through an experiment.

A. Experimental materials and methods

After biochemical treatment of coking wastewater from Tangshan coking plant, FBC ashes from Shijiazhuang Huabao fly ash Limited by Share Ltd. The LS230 laser granularity instrument analysis results show that, the average particle size of the FBC ash is 19.11μm. Use D/max2550VB3+/PC type X-ray diffraction instrument
analyse the structure and composition of FBC ashes, the results show that, FBC ashes containing anhydrite, mullite, limestone, calcium oxide and iron ore and other minerals. Figure 1 fluidized bed combustion ashes SEM photos showed: FBC ash particle size distribution is broad, and the particles showed irregular shape, with ordinary fly ash are mostly spherical particles of different density.

![Fig.1: SEM of FBC ashes](image)

The test water requirement of Coking wastewater COD, ammonia and color index is great, and the operation is complex. Organic matter can produce absorption in a certain wavelength range, and the absorbance of organic waste water is of value to a certain extent, reflect the content of the organic pollutants in wastewater. Using this characteristic, this research utilizes UV-Vis spectrophotometer (722S, Shanghai Precision Instrument Co., Ltd) evaluated adsorption treatment effect of agent of coking wastewater. After the test, the maximum absorption wavelength of coking waste water is 340 nm, the absorbance value of 0.398.

**B. Results and discussion**

(1) Effects of FBC ash dosage

Fixed adsorption time was 20min, the amount of FBC ashes from 20g/L to 100g/L decolorization of coking wastewater, the result is shown in figure 2.

![Fig.2: Effect of FBC ashes dosage on decoloration](image)

Figure 2 shows that, with the increasing amount of fluidized bed combustion ashes, coking wastewater decolorization rate rising. Dosage is higher than 60 g / L, the decolorization rate gradually stabilized.

(2) Effects of adsorption time

Fixed adsorbent dosage of 60g/L, adsorption time effects of different rates of Coking Wastewater, the results shown in Figure 3.

![Fig.3: Effect of absorption time on decoloration rate of coking wastewater](image)

Figure 3 shows that the solid sulfur ash of coking wastewater in a very short period of time can achieve high decolorization effect. Adsorption of 15min, coking wastewater decolorization rate reached 94.22%.

Fluidized bed combustion ashes dosage 60g/L, adsorption time 15min, coking wastewater COD, NH$_4^+$-N and color changes shown in Table 3.

<table>
<thead>
<tr>
<th>Value</th>
<th>COD(mg/L)</th>
<th>NH$_4^+$-N(mg/L)</th>
<th>Color(times)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB8978-19961A discharge standard</td>
<td>60</td>
<td>1.0</td>
<td>50</td>
</tr>
<tr>
<td>Before treatment</td>
<td>76.01</td>
<td>1.09</td>
<td>320</td>
</tr>
<tr>
<td>After treatment</td>
<td>5.76</td>
<td>0.62</td>
<td>&lt;5</td>
</tr>
</tbody>
</table>

Table 3: The quality of coking wastewater

Seen from Table 3, the FBC ashes after advanced treatment of coking wastewater, 3 indicators have reached the national discharge standard, and much lower than the content requirements of the national discharge standard.

(3) Recycling of FBC ash in coke wastewater treatment

Coking wastewater by adsorption of FBC ashes, calcined at a certain temperature to remove adsorbed organic pollutants, so that the FBC ash adsorbent activation and regeneration. In order to seek the activated roasting
temperature, researched the decolorization of coking wastewater of different calcination temperatures of FBC ashes, the results as shown in figure 4.

![Graph showing the effect of calcination temperature on decoloration rate of coking wastewater](image)

**Fig.4: Effect of calcination temperature on decoloration rate of coking wastewater**

We can see from Figure 4, when the calcination temperature is below 300°C, the decolorization of coking wastewater rate remained basically unchanged, >300°C, the rate of decolorization of coking wastewater sharply declined. May be due to high temperature roasting the FBC ashes of low melting point of minerals and other ingredients cemented together so that caused the adsorption performance degradation. In order to ensure the effect of treatment of coking wastewater after treatment of FBC ashes and FBC ashes can be fully activated, set the roasting activation temperature of 300°C.

After the treatment of FBC ashes suction, filtration, drying, activated roasting, recycling treat the coking wastewater. The coking wastewater can meet the national discharge standard can be discharged directly after the treatment of FBC ashes, which is not up to the standard continued until the target date. Recycling experiments as shown in figure 5. The results show that after 6 cycles treatment, FBC ashes on the coking wastewater decolorization rate still reached 49.5%, showing good recyclability.

![Graph showing recyclability of FBC ashes](image)

**Fig. 5: Recyclability of FBC ashes**

V. CONCLUSIONS AND RECOMMENDATIONS

Properties of FBC ashes are mainly four aspects: water demand, self-gardening, expansibility, volcano activity, these characteristics determine that there are some problems in the application process of FBC ashes. Especially self-gardening, making the application of FBC ashes in structural engineering and traffic engineering limited.

At present, used for FBC ash at home and abroad is mainly five aspects: used in agriculture, mining environmental governance, city environmental governance, city construction, transportation industry, among them, most widely used and studied in the construction industry, mainly as clinker component into the cement manufacturing process, produce volcano ash cement.

The solid sulfur ash used in coking wastewater treatment effect is obvious. The solid sulfur ash adsorbent dosage 60g/L, adsorption time 15min, the decolorization of coking wastewater was up to 94.22%; after treated, the content of COD, NH₄⁺-N and chroma in coking wastewater are obviously lower than the requirements of the national discharge standard. Recovering the FBC ashes After the treatment, roasting and activating recycle treat coking wastewater, show that after 6 cycles treatment, FBC ashes on the coking wastewater decolorization rate still reached 49.5%, showing good recyclability.

FBC ashes for advanced treatment of coking wastewater is a new exploration, showing broad application prospects. Thinking, analysis and research of its mechanism and reflected the characteristics of FBC ashes is focus on the next step.

ACKNOWLEDGEMENTS

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Empirical Research on the Relationship Between Renewable Energy Consumption and Economic Growth in China

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Abstract: Traditional fossil energy is the substantial base on human’s survival and development depends, it plays an important role for the human society progress and economic development. But the fossil energy reserves are limited, the constraints of economic and social development role gradually strengthened, so more and more attentions are paid on renewable energy sources. This paper first reviews the related research achievements of energy consumption and economic growth, then based on the economic data from 1980 to 2011, uses the method of Cobb-Douglas production function, studies China’s renewable energy consumption and economic growth through co-integration analysis, Concluded that renewable energy could be a drag on China's economic growth and industrial development, China at present is not suitable for large scale development of renewable energy industry.

Keywords: Renewable energy consumption; Economic growth; Co-integration analysis

I. INTRODUCTION
Energy is the important material basis of economic and social development. In both the energy, fossil fuels (such as oil, coal, etc.) is still the main object of energy consumption. Oil, coal, however, is not reproducible. The fossil energy is depleted, the energy supply has become an important factor restricting the rapid development of the global economy. In this background, the development and utilization of renewable energy is increasingly brought to the attention of the international community. Many countries have put the development and utilization of renewable energy as an important part of energy strategy, put forward a clear development goals, formulate regulations and policies to support renewable energy development, so that the level of renewable energy technology continues to improve, the industry gradually expanded the scale, to promote energy diversification and achieving sustainable development, renewable energy has developed rapidly.

China has also made the strategic planning of development and utilization of renewable energy, but most of China's energy economy research stays in the analysis phase over the total energy consumption, and less on the specific energy consumption and GDP between quantitative research, less people to study the relationship between renewable energy and economic growth, therefore, this paper tries to use time series data of China's renewable energy consumption and economic growth quantitatively the relationship between research, in order to draw valuable conclusions.

II. THE CHINESE RENEWABLE ENERGY CONSUMPTION
At the beginning of the founding of new China, the energy construction of the first priority is to regain energy left over from old China production, laying the foundation of China's energy industry.. In order to replenish energy supply is insufficient, in addition to vigorously exploration and exploitation of fossil energy, actively developing all kinds of renewable energy in China, started on small hydropower, biogas, solar oven, wind water machine, small wind machine, low-temperature geothermal and small tidal power station and other renewable energy development and utilization. Energy of the construction of the extensive and effective guarantee for China's rapid economic development.
Fig. 1: 1953-2011 China's hydropower, nuclear power, wind power energy consumption and annual growth rate

In the 1980s, with the worsening global environmental pollution, energy shortage and economic development contradictions increasingly prominent, the Chinese government deeply realize that renewable energy is a new kind of energy, the future will occupy more and more important position in the energy mix, to this end, China the development of new energy and renewable energy as an important part of China's energy policy. Starting from Seventh Five-Year Plan, the Chinese government established under the state council leading group for new energy and renewable energy, promote renewable energy development in China. Since the 21st century, China's renewable energy get fast development. Under the state council in 2003, the Chinese government enacted the national program for long and medium-term scientific and technological development (2006-2020), the scale use of renewable energy technology as a key research topic. In 2005, China passed the "renewable energy law in China. January 1, 2006, "The People's Republic of China Renewable Energy Law" will begin to implement. In 2006, China announced the "long-term renewable energy development plan" made it clear that renewable energy throughout the proportion of China's energy consumption in 2010 reached 10% in 2020 to reach about 15%. In January 2008, the Chinese ministry of science and technology, development and reform commission jointly launch the "renewable energy and new energy international technology cooperation plan, to promote renewable energy and new energy technology exchange, will

promote the Chinese renewable energy industry development as one of the important goals. 1953-2011, China's hydropower, nuclear power, wind power and total energy consumption is rising from the 974,000 tons of standard coal in 1953 increased to 278,401,600 tons of standard coal in 2011, the annual average growth rate of 11.04%. In that year the proportion of total energy consumption also improved from 1.80% in 1953 to 8.00% in 2011, but the proportion is still relatively low consumption of renewable energy in China is still a broad space for development.

III. RENEWABLE ENERGY CONSUMPTION MODEL OF THE EFFECT ON ECONOMIC GROWTH

The Liu Zhaoming, etc. (2006) using the three elements of the energy factor production function production is split into renewable energy and fossil fuels, can be improved as follows Cobb - Douglas (Cobb-Douglas) production function, namely

\[ Y = AK^\alpha L^\beta E^\gamma R^\delta e^\mu \]  \hspace{1cm} (1)

Among them, K is the capital stock, L for the working population, E for fossil energy consumption, R for renewable energy consumption, A, alpha, beta, gamma, theta as unknown parameters.

By logarithmic transformation can make the formula (1) linearization, i.e.

\[ \ln Y = \ln A + \alpha \ln K + \beta \ln L + \gamma \ln E + \theta \ln R + \mu \]  \hspace{1cm} (2)

On the derivative of time for t,

\[ \frac{dY}{dt} = \frac{dK}{dt} + \beta \frac{dL}{dt} + \gamma \frac{dE}{dt} + \theta \frac{dR}{dt} \]  \hspace{1cm} (3)

To meet the constant increase and the error of standard assumptions, type into

\[ \frac{\Delta Y}{Y} = C + \alpha \frac{\Delta K}{K_i} + \beta \frac{\Delta L}{L_i} + \gamma \frac{\Delta E}{E_i} + \theta \frac{\Delta R}{R_i} + U_i \]  \hspace{1cm} (4)

IV. TIME SERIES ANALYSIS

A. Innovation enterprise

According to the data obtained, this paper studied the time span of 1953-2011 years, data from the
calendar year, "China Statistical Yearbook". According to Cobb - Douglas production function requirements, select the gross domestic product (GDP) as the total output of China's economy, China's capital stock draw Fan Qiao (2012) and the results of research carried out to obtain an extension of the labor force using Chinese national payrolls data, fossil energy consumption and renewable energy consumption volume discount based on China's total energy consumption obtained. Among

<table>
<thead>
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<th>variable</th>
<th>test critical values</th>
<th>t-Statistic</th>
<th>Prob.</th>
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<td>-2.595033</td>
</tr>
<tr>
<td>Dlog(Y)</td>
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<td>-2.913549</td>
<td>-2.594521</td>
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<tr>
<td>Dlog(K)</td>
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<td>-2.913549</td>
<td>-2.594521</td>
</tr>
<tr>
<td>log(L)</td>
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</tr>
<tr>
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</tr>
<tr>
<td>log(R)</td>
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<tr>
<td>Dlog(R)</td>
<td>-3.550396</td>
<td>-2.913549</td>
<td>-2.594521</td>
</tr>
</tbody>
</table>

Note: * by examining under 5% significance level

**TABLE 1. RESULTS OF UNIT ROOT TESTS**

**TABLE 2. VAR LAG LENGTH BASED ON SEVERAL CRITERIA**

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
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<td>-0.593112</td>
<td>-0.705029</td>
</tr>
<tr>
<td>2</td>
<td>529.3410</td>
<td>103.8326*</td>
<td>2.28e-14*</td>
<td>-17.24876*</td>
<td>-15.24143*</td>
<td>-16.47251*</td>
</tr>
<tr>
<td>3</td>
<td>553.2813</td>
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<td>-14.29047</td>
<td>-15.569251</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion

**TABLE 3 - RESULTS OF JOHANSEN COINTEGRATION TEST**

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None *</td>
<td>0.476951</td>
<td>90.73244</td>
<td>69.81889</td>
<td>0.0005</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.380627</td>
<td>53.79191</td>
<td>47.85613</td>
<td>0.0125</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.301130</td>
<td>26.48616</td>
<td>29.79707</td>
<td>0.1148</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.100628</td>
<td>6.063594</td>
<td>15.49471</td>
<td>0.6880</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.000320</td>
<td>0.018255</td>
<td>3.841466</td>
<td>0.8924</td>
</tr>
<tr>
<td>Max-eigenvalue test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None *</td>
<td>0.476951</td>
<td>36.94053</td>
<td>33.87687</td>
<td>0.0208</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.380627</td>
<td>27.30575</td>
<td>27.58434</td>
<td>0.0542</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.301130</td>
<td>20.42257</td>
<td>21.13162</td>
<td>0.0626</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.100628</td>
<td>6.045338</td>
<td>14.26460</td>
<td>0.6074</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.000320</td>
<td>0.018255</td>
<td>3.841466</td>
<td>0.8924</td>
</tr>
</tbody>
</table>
them, the renewable energy sources by the United Nations development program (UNDP) definition includes: hydropower, solar energy, wind energy, biomass energy, geothermal energy, ocean energy, but China's renewable energy statistics only water and electricity, nuclear power and wind power energy, the use of renewable energy consumption is smaller than real renewable energy consumption.

B. Innovation enterprise

Regression analysis of time series, it is required sequence must be stable; there would be spurious regression problem. For this purpose, ADF test, the results shown in Table 1

It can be seen that the five variables of logarithmic form is not smooth, but their first order difference is smooth. Carries on the regression analysis, therefore, cannot be directly, consider using co integration analysis

C. Co integration test

Co integration test is to determine whether two or more non-stationary variables exist between long-run equilibrium relationships. Although two or more of the variables are each non-stationary, but they may be a linear combination of offsetting trend item, so that a smooth combination of variables. Meet co integrated variables cannot stray too far from each other, a shock can temporarily deviate from their equilibrium position, but the long-term, they will automatically return to the equilibrium point. Using Johansen co integration test methods for testing. During co integration test, you need to first establish the Log (Y), Log (K), Log (L), Log (N) and Log (R) constitutes a VAR model to determine the co integration test number of lags . Table 2 summarizes the various criteria for selecting the VAR lag order, you can see the number of lags VAR model is 2.

Co integration test lag order VAR model is actually a former first difference VAR model number of lags, since the original VAR model lag order is 2, so the co integration test should be a lag order. Then use the Johansen co integration test method for co integration between the variables tested, the test results shown in Table 3.

From Table 3, co integration test results can be seen, unconstrained co integration rank test and maximum Eigen value co integration tests are drawn at the 5% significance level co integrated. Obtain their equilibrium relationship is:

$$\log(Y) = -5.70 + 0.41\log(K) + 1.93\log(L) + 0.37\log(N) + 0.07\log(R)$$  (5)

These results suggest that economic growth, capital stock, labor force, total energy consumption of fossil and renewable energy consumption are co integrated, and the capital stock, labor force, total energy consumption of fossil and renewable energy consumption per 1% growth of China's economy grew by 0.41%, 1.93%, 0.37% and 0.07% of the labor force for China's role in promoting economic growth, maximum, and total renewable energy consumption on China's role in promoting economic growth in the minimum.

D. The establishment of vector error correction model

Establishment of economic growth, capital stock, labor force, total energy consumption of fossil and renewable energy consumption between the five
elements of vector error correction model. Vector error correction model is a constrained VAR model, which contains explanatory variables co integration constraints, so it is suitable for Co integration known to have non-stationary sequences.

As the number of lags VECM model is the original model of a first difference VAR lag order, since the original VAR model number of lags is 2, so the number of lags VECM model should be a. After the corresponding error correction test, VECM model parameter estimates obtained.

$$\begin{bmatrix}
\Delta \log(Y_t) \\
\Delta \log(K_t) \\
\Delta \log(L_t) \\
\Delta \log(N_t) \\
\Delta \log(R_t)
\end{bmatrix} = 
\begin{bmatrix}
0.083 & -0.03 & 0.02 & -0.18 & -0.19 \\
0.20 & 0.57 & 0.04 & 0.05 & -0.09 \\
0.04 & 0.06 & 0.09 & -0.05 & 0.01 \\
0.16 & 1.56 & 0.12 & 0.19 & -0.39 \\
-0.22 & 0.50 & -0.14 & 0.33 & -0.19
\end{bmatrix} 
\begin{bmatrix}
\Delta \log(Y_{t-1}) \\
\Delta \log(K_{t-1}) \\
\Delta \log(L_{t-1}) \\
\Delta \log(N_{t-1}) \\
\Delta \log(R_{t-1})
\end{bmatrix}$$

From the formula (6) can be seen, the short-term fluctuations in China's economic growth can be divided into two parts: one part is a lagging economic growth, capital stock, labor force, fossil energy consumption and renewable energy consumption of short-term fluctuations; another part is the error correction coefficient ECT_{s,1} on the long-term equilibrium adjustment.

E. Granger causality tests

To test the causal relationship between Grainger fossil energy consumption and economic growth of the causal relationship between Grainger and renewable energy consumption and economic growth, the results as shown in table 4. As can be seen, at the 10% significance level, economic growth does not necessarily promote fossil energy consumption growth, but promote renewable energy consumption growth; fossil energy consumption growth driven economic growth; renewable energy consumption growth does not necessarily promote economic growth.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>LY does not Granger Cause LN</td>
<td>1.28647</td>
<td>0.2874</td>
</tr>
<tr>
<td>LN does not Granger Cause LY</td>
<td>2.13663</td>
<td>0.0792</td>
</tr>
<tr>
<td>LY does not Granger Cause LR</td>
<td>2.04902</td>
<td>0.0907</td>
</tr>
<tr>
<td>LR does not Granger Cause LY</td>
<td>1.45045</td>
<td>0.2259</td>
</tr>
</tbody>
</table>

V. CONCLUSIONS

According to the Chinese 1953-2011 year long-term development, there is a long-term equilibrium relationship between economic growth, capital stock, labor force, fossil energy consumption and renewable energy consumption. Based on vector error correction model, Granger causality test to see the Chinese fossil energy consumption and economic growth there is one-way Granger
causality, namely the growth of fossil energy consumption to drive economic growth, but economic growth does not drive the growth of fossil energy consumption; Renewable energy consumption and economic growth there is one-way Granger causality, namely economic growth driven the growth of the renewable energy consumption, but the growth of the renewable energy consumption does not necessarily to drive economic growth.

REFERENCES


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Abstract: Urbanization is an important development trend in the world, to improve social innovation is the inevitable choice of urban development strategy. This article starts with the social innovation, according to the characteristics of the formation and keeping the urban competitiveness, establishes the model of the relationship between social innovation and urban competitiveness, Analyzes social innovation subject, social innovation object, the operation of the social innovation and diffusion. The subject system of urban social innovation system is constituted of five parts: social/public/ customer/individual, government, society/association/ community, enterprises, and the research institutes of universities. The object system of urban social innovation system includes technology innovation, system innovation, management innovation, organization innovation, and other subsystems. This study attempts to take the social innovation factors into the analysis of urban development. Therefore, it can establish a new explaining framework of the role of social innovation in the development of the city.

Keywords: Urban; Competitiveness; Social innovation

I. PROPOSINGIN OF THE ISSUE

Reviewing history of social innovations and urban development in developed countries, we can see every forward step of urban development occurs with great changes in social innovations. Throughout the world, social innovations show a high quality where there is a high level in urban development, such as in USA, in the EU. And vice versa, such as situations in African countries. The same cases can be observed within the territory of one country. As in China, there are large differences in social innovations among Eastern regions, Midland and West regions, and so do the level of the urban development among such regions. The economic issue behind the phenomenon is: how do social innovations affect the Urban Competitiveness? The essay will make a research on improving urban competitiveness from the view of social innovations.

II. FROM TECHNICAL INNOVATION TO SOCIAL INNOVATION

Schumpeter firstly gave a definition of “innovation” in a economic view in his book “The Theory of Economic Development” in 1912. In this book, he considered technical innovations as external factor
in economic innovations activities, and set “innovation” into an economic domain. Later, theorists in institutional economics advanced the theory of institutional innovation. North believed that the development of world economics came out of the process of mutual promotion between institutional innovations and technical innovations. In his theory, technical innovations depended on institutional innovations. A good institution would promote technical innovation, and a bad institution will prevent technical innovations.

From 1970s, econometrists and specialists in other area have realized that, exclusive emphasis on specified factor does no good either on helping understand the meaning of innovation, or on functioning of innovations. In 1980s, American scholar Freedman and Nelson developed the concept of social innovation system one after another. The research on innovation system came from study on technical innovations. After studying the history of developed countries, Freedman made a conclusion that technical innovations extended from the UK to Germany, the U.S. And then Japan. The chasing and surpass among the countries was the result of innovations in technology, system and organization, and also the result of evolution of national innovation system. Innovations were systematic activities established on a national level rather than isolated activities. The function of national innovation system was to improve the national competitiveness. However, the national innovation system ignores the characteristics in secondary economic territory such as urban areas, thus it can hardly meet the needs of regional development. The process of social realization of innovations cannot be explained by technical and systematic innovations. Social innovations should be regarded as national significant development strategies. Innovations are the interactions and overall promotions of all factors of a society. They also should be the process of a society to promote its autonomous innovation ability and to get an integrated development.

Making a survey of the founding on social innovations and economic developments of different schools, we will easily discover that, social and technical innovations are necessary conditions of economic developments, and that social innovations will improve industrial agglomeration furthermore achieve economic development by means of affecting social division and specializations of labor.

III. EFFECTS ON URBAN COMPETITIVENESS BY SOCIAL INNOVATION

A. Formation of urban competitiveness

Urban competitiveness is a kind of capability of a city compared with other cities in an external market to absorb, to concentrate various factors to improve economy and social developments, and optimize allocation of productive factors on the basis of its own circumstances thus to supply services for itself and the external market and creative more social assets.

Urban competitiveness originates from the competitive advantages which result from the adoptions of changes in external circumstances. To adapt to the environmentalism changes, it is important to master external information-- forecast external environmental changes-- identify and grasp opportunities-- react timely. Urban competitiveness also comes from innovations of a urban inner system. Such innovations including reset of inner
resources are a main rout to get urban competitiveness.

B. Maintaining of urban competitiveness

1) Fostering sustainable competitive advantages

Urban competitiveness is shown as the ability to absorb, to concentrate and to optimize the cultural factors. Forfeiture of urban competitiveness is often because of dynamic environmental changes, imitation or lack of innovative spirit. Therefore, when the urban resources and abilities are valuable and rare, and when the social nature is complex, they could become fountains of sustainable competitive advantages.

2) Enhancing management of urban core-competitiveness

The key process of core-competitiveness management includes fostering of competitiveness, competitiveness diffusion, competitiveness integration, competitiveness performance and competitiveness renewal. Urban competitiveness arises from resources, abilities and inner-organization practice, and grows with the interactions among resources, system, process and organizations. Social innovations provide a vital driving force on urban competitiveness. Whether a country, a city or an enterprise can improve its competitiveness depends most on its orientation of developing strategies, its distribution of resources and the innovations of its current technologies.

4) Social innovations on different urban developing stages

Social innovations emphasize the integrity, systematicness and diversity of innovations. Here social factors are seen as inner factors of innovations. Level of social development is valued by the integrity and systematicness of innovations. Promotions in structure and function of innovation factors are stressed when considering social innovations. In different economy ages, on different urban development stages, different social innovations are required.

In age of agricultural economy, urban competitiveness was shown as comparative advantages, and urban competitive ability relied on the geographic characteristics. Social innovations centered on the building of geographic advantages.

In age of industrial economy, what affected urban development most were capital, labor, the capability of gathering, process and exchange of
raw materials, as well as the facility of transportations. Social innovations helped to form urban aggregation and gave its influence on it.

In the post-industrial era, urban activities were divided by inner-urban functions and regional functions. Functions to supply services to outside of the region became the driving force of urban developments. Social innovations centered on the development of urban diffuseness ability.

Now in the information age, productive factors such as talents, information, high-tech together with good production and living environments have become core factors which affect urban competitiveness.

IV. URBAN SOCIAL INNOVATION SYSTEM

Urban social innovations system is a new concept in theoretical economics, urban economics, and theories of innovation, it includes technical innovations, institution innovations, knowledge innovations and management innovations etc.. It is a procedure contains the process from potential competitive ability to actual competitive ability. It is a system combining innovation subjects, innovation objects and innovation mechanism, which promotes the allocation and usage of innovation resources, furthermore fosters harmonious interactions among innovation organizations.

A. Model structure of urban social innovation system

As shown in Fig 1, model of urban social innovation system consists of three subsystems i.e. model of subjects system in urban social innovation, model of objects system in urban innovation and model of working-and-diffusion system in urban innovation. The three subsystems are coordinated developed to construct an organic whole. None of them will prevent the development of the others, and each of them will change according to the change of the others so as to develop coordinately. In the relatively stable circumstances of resource

Urban social innovation system aims to improve urban innovative ability thereby to improve urban competitiveness. In this system, the fundamental motivation for the factors to coexist, cooperate and co-develop is the pursuit of interests. The system is built and remains stable on the basis of complementary advantages of system functions and the approbation from system members for the same target. Drive by technology, environmental inducing and seeking for development bring changes to the system, which cause the transmit of information and energy in system. Intellectual economy not only internally changes governments, enterprises, researching institutions, social organizations and individuals in the social innovation system, but also completely changes the

Fig .1: model of urban social innovation system
interrelation and the ways of interaction among diversified subjects. It combines firmly the above mentioned subjects which are made an endogenous driving force, and turned into an inter-embedded, blended and co-operated state.

B. Model of subjects system in urban social innovation

As in fig.2, subjects of urban innovations are made of the following five subjects: society/public/customers/individuals, governments, leagues/associations/neighborhoods, enterprises, universities/researching institutions. These subjects play non-substitutable roles in social innovations. With the development of human society, subjects of social innovations will become more luxuriant and multiple, more inter-based and organized.

Fig.2: Model of model of subjects system in urban social innovation

Enterprises are the core subjects in social innovation, because they provide ways for the economic and social value of social innovations to be realized. And enterprisers are the core factors of enterprise innovations. This view of point is stressed in Schumpeter’s theory of innovations. Enterprise innovations include technical innovations, organization innovations, management innovations and system innovations.

Non-governmental organizations such as leagues and associations play a coordinating role between government and market. Furthermore, as important social resources, they help to actualize the economic and social value of social technologies by which social industries and social economies are established.

As the non-market subjects in innovations, governments are firstly supposed to create a good environment and resources optimization, to cultivate the market by setting developing strategies, legislating relevant laws/regulations, and playing as supervisors. Secondly, governments should take responsibilities to improve the people’s quality by education, so as to create the innovation culture. Thirdly, governments should develop national innovation system; harmonize relationship among innovation subjects, furtherance the combination of government, industry and researching. Fourthly, governments should guide the direction of innovations by direct investments. Lastly, governments should undertake to protect national technology in international competitions. Governments should create macroscopically systems and environments including mechanism, regulations, policies, and financing, taxing and market competitions. Productiveness of urban social innovations system depends on the balance between government intervention and market mechanism. Experiences in many countries have proved that the complementation of governments and markets provides the most effective systematic environments. Market and competitions provide conditions and resources for cooperative innovations. They control the behaviors of
cooperative subjects and interest allocation among them. In another way, government interventions and government managements help to reduce the potential opportunist behaviors and market risks, as well as cost of cooperative innovations.

Universities and research institutions are the main organizations that produce, accumulate and diffuse knowledge and technologies. They supply knowledge and technology in social innovations. They cultivate talents, and provide most creative thoughts.

Individuals are also the subjects of social innovations. Individual are becoming more and more important innovative sources. A person’s creativeness, his desire and motivation of creations has become an important part of motive force of innovations.

C. Model of objects system in urban innovation

According to fig.3, objects system in urban social innovations includes knowledge and technology innovations, concepts and culture innovations, institution and management innovations.

1) Urban innovations of knowledge and technology

The theoretic pattern of urban knowledge & technology innovations underwent a course from linear innovations to regional innovations, from recombination of factors to the form of innovation network.

From linear innovations to regional innovations

According to the descriptions by Mitchell in 1989, innovations took a process as following: an idea was brought out in the library, and passed on to the design section, and then produced by manufacturing sections on the basis of design drawing from design section, and finally be taken to the market for sale. When the new idea or new products was adopted by other firms, the innovation was regarded diffused. Model of products life circle and model of innovations diffusion are both based on a linear thinking. However, as shown by the fact, researching, producing and selling interacts during innovation process. The innovations do not always take the linear path from invention to diffusion. The fact is that, any activities from any starting point or from any value chains of an enterprise may contain innovations. So the range of innovations is developed. It can be national or within a business, it can be regional or urban. The regional economy development mode emerging together with urban industrializing process develops based on the economic and technical unbalance between different regions. It’s a kind of linear evolution. Theories of regional innovations adapt to the rules of intellectual knowledge and technology development. They provide rationale for jumping development in undeveloped regions. And also lay the foundation for the establishment of urban technical innovations system.

From recombination of factors to the form of innovative network. In a market economy, the...
recombination of innovation factors and resources lead to the optimization and fully usage of resources, thus to get a Pareto Optimality. Therefore, economy growth will be promoted by the ways how innovation resources allocated. The resources reallocation and recombination in urban economy development take on systematic chiaroscursists. Innovation is a social system, and it is the social result led by interactions among participants of the economy. It is also a system opens to its environments. The openness of the system brings firm connections among businesses, universities, governments and administrations hence an effective urban innovation network is built.

2) Innovations of urban concepts and culture
Concept and culture provide mental motivations, intellectual supports for urban innovations. They can bring economy values, and help to shape the image of cities. They are symbols of urban competitiveness. From the angle of history development, we can see moral and ethical values together with culture provide mental conditions for the development of market economy. They mentally drive the continual development of market economy. In Europe where market economy was born, concepts of Liberty, Equality, and Fraternity came into being during The Renaissance in 14 to 16 centuries and the Enlightenment in 17 to 18 centuries, which brought about the establishment of capitalism. In “The Protestant Ethic and the Spirit of Capitalism”, Max Weber studied the affects on capitalism by religion reform and religious culture. He thought some kind of invisible mental force hid behind every economy system. Under certain conditions, this kind of mental value of concept decided the fate of the economy system. In Asia, Japan's post-war economic miracle also showed that economy system in Japan was heavily supported by the Japanese national spirit and The Confucian culture.

Innovations of culture and concepts in urban social innovations bring about the culture of innovations. e.g. the urban spirit of New York is generalized as: high level of national amalgamation, tolerance in culture, restless innovations, sense of competition and intelligence responding to emergencies. Paris for another example, its government put forwarded in “the Big Construction Program” in 1994 that “the developing goal of Paris is a city not only with historic interests, architectures, and cultural heritages, but also a city with vigor, creativity and vitality”. The city announced to the world its urban characteristics and its pursuits. In such urban spirit, a kind of romantic mood of Paris even of France is exuded and shows its long-lasting vitality.

3) Innovations of system and management
Innovations of system and management are important contexts of social innovations, and they also are the vital guarantee of other social innovations. Yang Xiaokai(2002) said that undeveloped countries could imitate developed countries in many aspects, mainly in the following two ways: technology imitation and system imitation. It was much easier to imitate technically than systematically. Technology copy could help undeveloped countries make a booming growth in a short time, but it would strengthen the laziness to imitate in institution. Webber thought that four factors constituted capitalist market economy: privately owned productive means; free labors, no restrictions in transactions from irrational factors; computable laws in judicature and administration. Generally, these factors can hardly be found in traditional societies. To develop market economy, various obstacles must be cleared so that it is possible for the economy resources to flow and
transfer freely, then systematic structure to support large-scale markets could be built. It can be seen that good system structure and management can promote the development of economy, while bad system structure and management will restrict economy development. The society calls for innovations of system and management.

D. Model of processing-and-diffusion system in urban innovation

What are really meaningful and valuable is not innovations but the diffusion of innovations. Diffusion of urban innovations refers to the transmission and application of technological innovations any time through one or several channels among organizations or members of social system. As a kind of new thing introduced to a formerly stable social system, innovative technology will certainly cause instability or uncertainty, i.e. impacts on the previous orders and structures. There will be a potential request of adjustment to get a new balance. As the same, the diffusion of technical innovations is a result of all potential users’ choices which are made based on social network. It will lead the formerly stable social network to get a new balance. In this case, diffusion of innovations means a process that the social system transforms from one kind of stable structures to another one.

V. CONCLUSIONS

It is proved by theory and practice of innovations that, innovations are the final results of the complicated interactions among different subjects and institutions of the society. They’re also the final results of interactions and feedbacks among different internal factors of a system. Urban social innovation system is a organic combination of innovation subjects system, innovation objects system and innovation working-diffusion system. These systems cover all of the competitiveness factors and the factors of urban social development. They together build the basic social network of urban competitiveness. Conclusions of the essay are as follows:

Social innovations affect urban competitiveness greatly. They affect city groups and economy development through their effects on innovation subjects, innovations objects and innovation working-diffusion system. The subjects system of urban innovations consists of five subjects: society/public/ customers/ individuals, governments, leagues/ associations/ neighborhoods, enterprises, universities/ researching institutions. These subjects play non-substitutable roles in social innovations. The objects system of urban innovations contains three subsystems: knowledge and technology innovations, concepts and culture innovations, institution and management innovations. The motivation comes from governments, markets, enterprises, and the development of science and technology. Urban innovations network will play an important role.

In short, futures of the human being depend on the establishment of a continually social system by social innovations, so does the improvement of urban competitiveness.
REFERENCE


German best practice club “Family in higher education”

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Abstract: One of the educational priorities of the European Union is to increase the percentage of citizens aged 30 to 34 with a university degree or equivalent qualification up to at least 40% by 2020. In 2011 the portion of this target group was only 34.6%. An increase in the average age of the students has been observed with more and more students starting a family before or during their studies. Universities have to take this development into consideration and adapt their services according to the requirements of the new generation of students. The paper describes the successful work of a network of German universities in that aspect, the so called German best practice club "Family in Higher Education" which interacts with more than 60 universities and similar institutions. This network was evaluated on behalf of the Robert Bosch Foundation with regard to the positive and negative factors of "Family in Higher Education" in 2011. This paper shows the results of this survey and gives recommendations for the participating institutions.

Keywords: Higher education, family friendly, competition of universities

1. Introduction

The term "family friendly" describes all the needs and concerns of people with a family in different situations. At universities, family-friendliness includes all measures and actions that a university actively and consciously takes to facilitate the reconciliation of family and job/studies for their employees and/or students. The specific measures can be very different and may include time management, childcare services, psychological support, awareness of other employees, assistance in housing or job searches and much more.

Family friendliness is becoming a competitive factor between the universities, since it expands the pool of potential students for family-friendly universities.

The success in establishing family-friendly policies in the university depends on both the portfolio of offers and the anchoring of the structural unit of family friendliness. In this paper the results and conclusions of a survey of 63 German universities are presented regarding their institutionalization and structural anchoring within the theme "family".

2. Social challenge „family friendly“

One of the educational priorities of the European Union is to increase the percentage of citizens aged 30 to 34 with a university degree or equivalent qualification up to at least 40% by 2020. In 2011 the portion of this target group was only 34.6%. An increase in the average age of the students has been observed with more and more students starting a family before or during their studies. Universities have to take this development into consideration and adapt their services according to the requirements of the new generation of students.

This trend is reinforced by the demographic development in Germany. The number of school leavers will be further reduced, and thus the number of classical students. Industry and universities must therefore facilitate the compatibility of studies, work and family life for young women and men. In Germany today about 50% of students are women, however, they may still not be able to follow a professional career path to the same extent as men. All too often circumstances make it difficult for women to combine raising a family with a career in science. In addition, there are more and more dual career couples in which both seek professional or scientific advancement. To take advantage of these human resources universities
must establish appropriate conditions. These include making child care available at appropriate times of day, the sympathetic timing of courses and examinations, family-friendly places to study and much more.

Family-friendly universities have a clear competitive advantage. They allow target groups realistic access to an academic career, which often fail because of the conservative framework of other higher education institutions.

This competitive advantage not only has a positive effect on the national level, but also in international competition.

3. Database of the German best practice club „Family in higher education“ and objective of the evaluation

In 2007 the Federal Ministry of Transport, Building and Urban Development, the Robert Bosch Foundation and the Centre for Higher Education Development initiated the program "Family in Higher Education", the aim being to improve family friendliness at German universities. On 13 May 2008 eight selected universities founded a best practice club: "Family in Higher Education." This club aims to promote the work of universities and its public perception in the field of family friendliness. It is intended as a role model for the entire German higher education landscape.

The University of Wismar is one of the eight universities and has been certified as family-friendly since 2004. It has already achieved numerous improvements to the compatibility of family and studies /career. These include personal counseling, child care near campus and events for the whole family.

Since 2010, 12 universities nationwide have been working together on concepts and structures that support students and staff to improve the balancing of family with study or work. The three main topics of the programme are "Family Support offers and services", "Family Supported conditions for studying" and "Regional Alliances for family friendliness."

In the year from 2011 to 2012 63 German universities and colleges were asked to what extent the theme "family" was institutionalised and embedded in their organisations. This survey was part of the project "Family in Higher Education - Family Support Facilities and Services" and was commissioned by the Robert Bosch Foundation.

Using the results of the survey, recommendations of action were derived for institutions that wish to follow this path. The recommendations are not aimed primarily at the substantive proposals to improve family friendliness, but the establishment of advantageous structural roots in the entity concerned. New members of the best-practice club "family in the university" should therefore benefit from the experience.

At the time of evaluation, there were 374 universities and colleges in Germany. The investigation covered 16.84% of all similar institutions. All 63 universities surveyed already belong to the best-practice club "family in higher education" or are already certified as family-friendly. They were deliberately selected to be recipients of the recommendations of action.

4. Methodological approach of the survey

This survey was conducted in the form of a written questionnaire. The 17 questions were developed by the University of Wismar, which also evaluated the results.

1. Is there a structural unit at your institution, dedicated to the compatibility of studies, academic work and family?
2. If there is such a unit, what is it called?
3. When was the unit established?
4. How many students are enrolled in full-time study at your university?
5. How many staff and student assistants are currently employed in the unit?
6. Is the staff capacity sufficient to implement the tasks adequately?
7. Who runs the unit at the operational level?
8. Where is the structural unit or the topic “Family in higher education” involved in the university?
9. Who on the management level is directly responsible for this topic?

10. Do you use the audit tool "family-friendly university" for quality assurance?

11. Is this structural anchoring conducive to promoting family friendliness in line with the requirements of the audit?

12. How do you assess the relevance and accessibility of the different target groups?

13. Which factors do you see as the main advantages of the structural anchoring at your university?

14. Where do you see there is a need for improvement concerning the structural anchoring at your university?

15. Which departments in your university work together internally in the field of "family in higher education"?

16. With which external strategic partners do you work together regarding family support?

17. What general suggestions for anchoring of "family" in university do you have?

For questions 1 to 16 multiple-choice response options were offered. The survey participants were also able to add comments. In part, multiple answers were possible.

Data was recorded for each participating university. The decision as to which person or persons completed the questionnaire, was left entirely to the universities. As a result, the answers come from people from different hierarchical levels. Overall, it can be considered that the methodology used was generally well understood meaning there was hardly any misinterpretation of questions. The resulting data base enables assertions to be made concerning the usefulness and efficiency of various structural solutions with regard to "Family in Higher Education".

5. Results

In the context of this paper we can only list some of the more important results. The full evaluation report is freely available on the University of Wismar website (Domröse, 2012).

With respect to the portfolio of the participating universities on "family-friendly", there was no uniform picture. Some institutions focus on consulting services and cooperation with external service providers. However, the majority of the universities try to organise the support program on their own and close to its students or staff.

Child care services seem more likely to be the norm than a family-friendly scheduling of courses and examinations. There was little evidence of organised parent groups (self-help) or assistance in finding family-friendly accommodation or appropriate earning potential. All this may eventually lead to different requirements at the universities.

There is a difference between traditional universities and universities of applied sciences in the German higher education system. The traditional universities are often older and have on average a broader range of disciplines.

In our study 88% of the institutions possessed a unit of family friendliness that had existed for an average of 5.1 years. The traditional universities had, on average, begun earlier than the universities of applied sciences with the development of such structural units. In almost all other surveyed institutions such a structural unit was being developed.

The operational management at the working level was, in 37% of cases, assigned to the equal opportunities officer. This was more often the case the earlier the structural units were established. In only 7% of the institutions the structural unit was headed by a families officer, in a further 24%, by a project coordinator and in 32% by a department head, the chancellor or other employees. In general it was found that leadership by the equal opportunities officer was slightly better than by a families officer. A possible reason could be the closeness of the equal opportunities officer to the
university and its leadership. However, it appeared that leadership by a families officer achieved better contact with the target groups. Several respondents favoured an explicit separation between the issues of equal rights / equal opportunities and family-friendliness.

Frequently the naming of the unit reflected it's positioning within the institution. In 15% of our cases it was an integral part of equal opportunities office, i.e. it had no autonomy. As many as 24%, used the term family office. In most other cases, the term family appeared subordinated, eg "Department of equality and family." It can be appreciated that many of these names are not conducive to acceptance by the target group.

The management responsibility in 75% of the universities surveyed lay with the rector / president or a vice president. In many other cases, the Chancellor was the one responsible for this structural unit. It was found that the access to the highest levels of the hierarchy also led to better staffing. On the other hand the choice of management level had no discernible impact on reaching the target groups. Several survey participants pointed out that the personal commitment of leaders is crucial for the acceptance of the new structural unit.

The audit tool "family-friendly university" was used by 94% of the universities surveyed. It was suggested several times that the process be adapted to the size of the universities, to enable smaller institutions to raise funds for the certification.

Considering the target groups, it became apparent that the structural unit was appreciated mostly by the younger students and women. Men and older students were significantly less well addressed. This may be due to the frequent access to the equal opportunities officer and the main focus of childcare. It seems that several of the structural units do not focus on accommodating the need for older employees to care for dependent family members. In general students as a target group achieved an average score.

Multiple survey participants pointed out the need to involve the reconciliation of family and study / work continuously and equally in the decision making processes of the university.

6. Conclusion

The survey results led us to the following recommendations for the construction of a structural unit to improve the reconciliation of family and studies or family and work. These recommendations in many cases result in a meaningful sequence of steps.

1) Aims

Initially, the university must be aware of their specific objectives and target groups in the development of family-supportive services. Possible targets could be for example:

- The fluctuation in particular recent scientific / non-scientific staff should be stemmed.
- Its attractiveness as a place to study is to be increased (target future students).
- The dropout rate is reduced and the average performance of the graduates will be improved - later better chances on the labor market (target group already enrolled and future students).
- The working lives of older academic / non-academic staff is to be extended (keep professionals).
- For students from other countries, the conditions of studying become easier.

But note! The objectives of course have a significant impact on the required effort. High demand may require an internal redistribution of resources which could easily lead to conflicts within the university.

2) Structural leadership responsibility / Commitment

The present study has shown the importance of formal competence / leadership on "family" for its acceptance within the organisation. The wide acceptance is a prerequisite for the necessary restructuring and reallocation of resources (potential for conflict). Both are necessary for the successful implementation of the structural unit.
"family" and its offers. Therefore, it should be decided at an early stage who would take over this responsibility from the operational management levels of the university.

If necessary, this management member must acquire the necessary thematic expertise (e.g. Leadership Coaching on "family"). The direct supervisor of the structural unit "family" at the management level must be able and willing to fulfill the "function of a draft horse" for the theme of family / family-friendliness and significantly contribute to the strategic objectives.

The clarification of the responsibility of leadership at the highest level of the institution also often results in the specific case-relevant settlement of the structural unit "family", unless this issue is clarified in the following point.

 Responsibility for the organisation of work

The individual responsible at management level cannot control the daily operations in the structural unit "family" because of his other duties at the university. Therefore, the appropriate personnel for this solution must be found in the next step.

This task can be transferred to an existing position, e.g. the equal opportunities officer. Otherwise a new job should be created, for example, the families officer. The specific solution will depend on the availability of funds and the extent of the objectives to be achieved. Although the theme of the family should not be seen as a sub-theme to gender issues, the current practice of frequent organisation of work placement under the equal opportunities officer has shown absolutely no drawbacks. Only with regard to the accessibility of the target groups, the families officer were more effective than the equal opportunities officer.

Success is dependent on good interaction between leadership and the delegation of organisational responsibility. Particularly during the set up of a new unit the formal and informal positioning of the person responsible on an organisational level is important for overcoming resistance and the achievement of meaningful solutions.

 Awareness and participation of stakeholders

Subsequently, it is important to raise awareness for the issue in order to acquire stakeholders for participation. Moreover, suggestions for possible solutions must be discussed.

It is important to remember that various stakeholders have different connections to the topic. The target groups and sub-structures of the university affected by redistributions, have a particularly strong interest in the topic. It makes sense for this communication to radiate from the centre. The first agreement is made with those directly affected, and then later on the circle is expanded to take in the whole university and beyond. High transparency and the possibility to influence decisively promote the acceptance of the necessary changes later. The designing of the offers requires knowledge of the actual needs of the main target groups. To gauge these needs qualitatively and quantitatively it is recommended in addition to back up your own data, (e.g. strength of the target groups) as well as engaging in dialogue with the representatives of the target groups. (e.g. student representative, staff council, etc.)

Possible solutions and alternative are sought in cooperation with the key stakeholders. In this work, the following points should be considered: personal skills and resources, alternative external solutions, spatial solutions, temporal feasibility, urgent individual needs, experience in other comparable universities.

 Setting the content / Ensuring Resources / realization

After examination of all suggested possible solutions with the participation of stakeholders the most appropriate solutions are selected. As a selection criterion, the relationship between a required resource utilization and the degree of expected targets is recommended.

Finally the milestones for the implementation of these solutions are planned. There are resources to procure or to provide through e.g. project funding by grants. In some cases, employees have to be moved or re-employed. The rooms and equipment are provided for the long term. Schedules are necessary for the fulfillment of the tasks to develop...
(e.g. who informs whom at what points …) and staff are introduced to their new responsibilities.

© Success monitoring / feedback

From the outset, milestone planning should also take into account performance reviews in order to optimize the use of staff and resources in case of failure to achieve partial lines or changing requirements. For this purpose, indicators of success must be determined. And it is necessary to specify who is accountable to whom and at what time.

This sequence of steps need not be optimal in all cases and it does not have to be always run through completely. Thus, it can for example be useful first to clarify step © on structural responsibility. The individual responsible at the management level could then be more involved in the definition of objectives and target groups and gain a higher identification with the new responsibilities. In any case, the given situation, existing structures and networks, possibly also external service providers are taken into account in decisions on the future structure unit "family".

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SOCIAL BUSINESS AND ITS CAPABILITIES OF IMPLEMENTATION IN NAMIBIA

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Abstract: Social business is the compromise between the non-profit and the profit-oriented business model. This means working with socially and/or environmentally sustainable strategies so that profits are reinvested in other similar projects. Increasingly, business community and market dynamics are seen as vehicles for assisting to reduce or even solve social unfairness and not for maximising profits. It provides the institutional framework for entrepreneurship and innovation in new market segments. In developing countries this kind of business serves to address the struggle against poverty, in industrial countries it improves disadvantaged groups’ chances for a better future without discrimination. This paper gives an introduction and overview of this business model and focuses on the current situation in Germany. It provides suggestions on how to implement a social business model in different business areas, such as education, tourism, and health and nutrition in Namibia as a contribution to social problem solving.

Keywords: social business, entrepreneurship, social problems, sustainability, Namibia, Africa

1. INTRODUCTION

In this paper social business is described as a special type of enterprise, and examples of how it can be successfully practised in Namibia are given. Like many other countries Namibia also has many social problems that need to be solved. Globally we find many social businesses operating effectively, especially in a time with a lot of social ills, dwindling resources, and a noticeable climate change. The paper starts with a description of social business and gives a clear definition of the term so that the interpretation is clear. Successful social business implementations in Germany and in developing countries are discussed as well as possible approaches in Namibia. The conclusion summarises the potential of social business.

WHAT DOES "SOCIAL BUSINESS" MEANS?

Muhammad Yunus defined social business as an enterprise, that attempts to help other people without gaining a financial benefit from it. Because social business is economically viable, it is considered a genuine business, since it is generating enough earnings to cover its own operating costs. If the operating costs are covered and in addition a surplus is generated, one part of this surplus will be reinvested in the expansion of the enterprise, another part will be put aside as a reserve in case of economic difficulties. Social business-enterprises can also be defined as „out of deficit, non-dividend-producing enterprises“.

The corporate activities should both solve social and ecologic problems and compensate all concerned parties in a fair manner. Any realised profit remains within the enterprise. And because the business is linked to a social purpose the idea of a personal profit is erroneous. However, the investors should get back their invested capital. Social business as an innovative business model does work
without having the pressure to make profit. Therefore, it has the possibility to develop further and to expand their spectrum of new investment opportunities. These opportunities are not available to profit-orientated enterprises. Sustainability is paramount for social business, and all of its areas are geared towards it. This directly affects its environment as well as all elements of its value chain. The focus on sustainability is also expressed in its financial independence. The latter can be used to improve the living conditions of people in the long run. By operating a social business one is trying to achieve various goals. This is realised by combining social commitment with entrepreneurial thinking as well as solving sustainability problems in social, ecologic and economic areas.

a) Types of social business

1. Social business Type I
Social business of type I is generating social added value by producing inexpensive but high quality products, or by providing services such as food, housing, health care and education. There is no need to make profit but the accruing costs have to be covered. This type of social business helps people to get access to products and services they would otherwise not be able to afford.

2. Social business Type II
In contrast to type I, with a social business of type II a profit-oriented new enterprise is initiated. However, the profit will not be paid out as dividends to the investors but serves to improve the living conditions of the employees, their families and communities.

3. Social business vs. social entrepreneurship / corporate social responsibility
To avoid confusion between the terms social business, social entrepreneurship and corporate social responsibility (CSR) the following tables give a brief overview on their differences:

<table>
<thead>
<tr>
<th>social business</th>
<th>social entrepreneurship</th>
</tr>
</thead>
<tbody>
<tr>
<td>aim</td>
<td>solving social problems using a profitable model</td>
</tr>
<tr>
<td>resource</td>
<td>self-supporting</td>
</tr>
<tr>
<td></td>
<td>entrepreneurial innovative and scalable</td>
</tr>
<tr>
<td>profit</td>
<td>possible (social business type II)</td>
</tr>
<tr>
<td></td>
<td>not necessary (social business type I)</td>
</tr>
<tr>
<td>future</td>
<td>no dependence from outside</td>
</tr>
<tr>
<td></td>
<td>self-realisation of projects</td>
</tr>
<tr>
<td>pioneers</td>
<td>Grameen Bank</td>
</tr>
</tbody>
</table>

*Figure 1: Social business vs. social entrepreneurship (own illustration)*
<table>
<thead>
<tr>
<th>social business</th>
<th>corporate social responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>aim</strong></td>
<td>• accept social responsibility</td>
</tr>
<tr>
<td>• solving social problems using a profitable model</td>
<td>• improve the image</td>
</tr>
<tr>
<td>• to make profit is a resource but not the purpose</td>
<td>• increase competitiveness</td>
</tr>
<tr>
<td><strong>features</strong></td>
<td>• social responsibility of a profit-oriented enterprise</td>
</tr>
<tr>
<td>• entrepreneur campaigns for solving social problems</td>
<td>• charity funds of a profit-oriented enterprise (as donation)</td>
</tr>
<tr>
<td><strong>resource</strong></td>
<td>• maximal 5% of the profit reinvested in social projects</td>
</tr>
<tr>
<td>• self-supporting</td>
<td></td>
</tr>
<tr>
<td>• entrepreneurial innovative and scalable</td>
<td></td>
</tr>
<tr>
<td>• 100% of the profit reinvested in social projects</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Social business vs. corporate social responsibility (own illustration)

GERMAN SUCCESS MODELS

The concept of social business already became known to the public a few years ago. Since then much has changed. When talking about poverty, one immediately thinks of developing countries, not considering that it is found in developed countries as well. Social business is not limited to the poor of the "Third World" but can be applied to all areas with social problems. Here, social business provides the institutional framework for entrepreneurship and innovation in new market segments.

In Germany there are many companies successfully operating this way. For example Arbeiterkind.de is an initiative that successfully supports non-academic children to get a university education. As with this initiative there are various German companies and organisations which made it their business to fund social business projects. For many investors it is much more attractive to put capital into a business to do something good rather than to donate. One of the organisations doing so since 2006 is Betterplace Plattform which is focused on bringing together donors and projects within volunteer work and regional projects. The GLS Bank, a socially and ecologically orientated cooperative bank, invests both in social business and in certain projects. Mikrokreditfonds Deutschland is a platform for local organisations and networks which enables start-ups to access microcredits. The Berlin-based Phineo AG attempts to build a bridge among social investors, financiers and NGOs.

OPPORTUNITIES AND IMPLEMENTATION OF SOCIAL BUSINESS IN DEVELOPING COUNTRIES

By founding the Grameen Bank Muhammad Yunus proved how to solve social problems in a sustainable way (Spiegel, 2009). By issuing microcredits using customary market rates this bank provide millions of people with access to financing possibilities in order to secure their independent subsistence. One concept originally developed for the needs of the people in Bangladesh is nowadays successfully implemented worldwide. Beside access to funds there are further positive aspects to consider. Thus, the Grameen Bank has founded several social business projects and companies during the last years. With the help of these companies it is attempted to solve problems in the area of nutrition and health.

But what are possible ways of funding? The intention to run a social business is not sufficient alone. A lot of businesses fail on this. All over the world, there are many opportunities to fund businesses. However, there is a lesser chance to find an investor for a social business than for a typical profit-oriented business. For most of the
investors it is important that their rate of return is measurable. It is therefore important to convince people of this idea and to encourage them to invest their money. Useful tools are social impact indicators that demonstrate the effects of the social business to potential investors. Thereby, full transparency of the project and its financials is essential. There are many organisations and foundations worldwide who not only offer ways of funding but also support for such analyses and project advice. One example is kiva (www.kiva.org), a San Francisco based microfinance organisation that operates charitably and offers micro-credits to small businesses, especially in developing countries, via the internet. Opportunity International Deutschland (www.oid.org; www.opportunity.org) is a foundation that supports poor but people who are interested in entrepreneurship in 26 developing countries by means of micro-finance instruments. Amazee (www.amazee.com) is an international online platform with a global network of social business project ideas, exchange of experiences and financial funding and participation. Oikocredit (http://www.oikocredit.org/de/home) has been operating internationally for more than 30 years by supporting micro-finance institutions, cooperatives and small businesses in developing countries. Beside that there are several other organisations such as Impetus Trust (www.impetus.org.uk), Bridges Community Ventures (www.bridgesventures.com) and BonVenture GmbH (www.bonventure.de).

IMPLEMENTING SOCIAL BUSINESS IN NAMIBIA

Like many other developing countries Namibia has several social problems. One of them is malnutrition, especially in children. Here, for example, social business could reduce malnutrition by offering a product (e.g. multi-vitamin drink) using various products already locally available. The business could provide a source of income to local people by buying their products such as fruits and vegetables as a basis for manufacturing the final product. The completion of a factory would add new jobs in that region. The use of machines should be limited to the bare necessities in order to employ as many people as possible. When selling the final product any intermediary trade has to be avoided to keep the price affordable for the end-user. Distribution could be realised by direct selling at the factory, or via well-structured network of salesmen for door-to-door selling on a commission basis. The whole process would improve the living conditions of all people involved, and at the same time it counteracts malnutrition. As soon as the costs are covered and in addition a profit is made the latter has to be reinvested to another purpose, e.g. in education. In Namibia school attendance has been compulsory for a couple of years. However, education is not available for all children because in rural and remote regions schools are often too distant. With the profit made a school could be built, even a small one. Another good approach for social business is tourism. This area has a great potential for job opportunities even for people with a low educational level. Namibia is rich in beautiful countrysides, fauna and culture which is very attractive for tourists. The local people are very familiar with it and able to share their knowledge and experience as guides for tourists. This could be linked with a travel business that operates in the nearest bigger city or in the capital city, doing promotion and arrangements for tours. It could be linked further to a transport company or to private people offering transportation as well as to providers of accommodations. From such a cooperation established by using social business every involved part will benefit. Namibia’s richness is not only due to its nature and culture but also due to its mineral resources. It is one of the African countries with the most mineral wealth. Due to its valuable natural resources, Namibia’s mining industry significantly contributes to foreign trade amounting to approximately one fifth of the gross national product. Above all diamonds, uranium, gold, silver, and semiprecious stone are mined. Almost half of the export revenues are from mining diamonds. To run a social business here requires that the profit from export must not be maximised but instead reinvested into the improvement of infrastructure of the country, education, healt care and further training of employees and their relatives.
CONCLUSION

Since Muhammad Yunus began using the term "Social Business", he has accomplished a lot in this area. Many socially active people have made it their goal to transform their actions and transform this business model into something great. They are based on solving social problems and not on maximising profits. Social business can be practised all around the world to make peoples life a bit more comfortable. It acts solely for the people and considers aspects of nature and environment.

However, social business has to be practised the same way as a profit-oriented business to be able to subsist and recognise and analyse the needs of the respective objective. Consequently, social business will proceed to develop many innovative concepts in the future.
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Bio fuel Production and its implication on food security: case study from Zambia

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Abstract: The objective of this paper is to present a comprehensive review of the status quo of bio-fuels developments and the policy regimes including support measures driving the social, environmental and economic impacts of bio-fuels development. At it has been promoted by national policies markers still there is no common consciences its implication in achieving food security. The case study was based on a Meta evaluation carried out in Zambia; the key findings indicated that there is possible diversion of labour, land, extension service to Bio-fuel and competition of input use might lead to reduction of food production and high food prices if the biofuel market proves lucrative. However the price of bio-fuel feedstock from Jatropha in Zambia was not attractive enough to encourage farmers to grow more Jatropha and this has raised major concerns by both farmers and policy makers.

Introduction

For Africa access to secure, sustainable and affordable energy is pathway and critical for sustainable development; as it has an ability to vital services in improving quality of life that is essential inputs for socio-economic development at regional, national and sub-national levels(Singh and Sooch, 2004). In addition to this it can facilitate education and communication, further enhance health care services and good strategy in responding to climate change.

The biggest challenge in Africa, firstly the inability in providing adequate energy services has been a major constraint in achieving sustainable development. Secondly imported oil imposed heavy economic burden and reduces energy security in Africa. Therefore, renewable energy technologies (RETs) specifically bio-fuel is vital in offering prospect of self-reliant energy supplies at national and local levels, with potential benefit to economic, ecological, social, and food security benefits (Biswa, Bryce and Diesendorf, 2001).This implies that it is urgent need for substantial investment in domestic energy infrastructure for social improvement and economic growth. In addition to this, RETs can facilitate trade in energy by strengthening regional and intercontinental infrastructure such as electricity transmission lines, oil and gas pipelines within Africa and other continent (e.g., within Europe). Expanding national and regional infrastructure would also increase the efficiency of how Africa uses its energy resources, thus enabling Africa to increase its reliability of supply and reduce its dependence to oil imports (Amigun, Sigamoney, Von Blottnitz, 2008). This would improve energy security and increase access to energy services.

Bio-fuels development, particularly in the context of African development, is a controversial issue that has recently attracted considerable interest among policymakers, development practitioners, donors and other stakeholders. Bio-fuels can lead to a substantial reduction in greenhouse gases emissions. These reductions require careful measures in crop selection management, subsequent processing and transport of bio-fuels to the point of use, as the case of Zambia.

The principal source of energy in Zambia is wood fuel (i.e. firewood and charcoal), with the largest consumer group being households in both rural and urban areas. About 95% of the electricity supply comes from hydropower 97% of the rural people don’t have electricity (World Bio-energy Association, 2010).

The transport sector is fossil fuel-dependent 60-65% of the imported fossil fuel is diesel about 3 million litre/day bio-energy initiatives are mostly on liquid form; biofuels is principally Jatropha. Government promotes energy-efficient usage of bio-fuel, to encourage bio-fuel there is no sales tax or excise on bio-fuels in Zambia (World Bio-energy Association, 2010).

Zambia has very good arable land for both extensive and intensive cultivation of various crops. Some 22 % (16,5 million ha) of Zambia’s total land area is available for agricultural production and
only about one seventh of the total arable land is under cultivation, mostly by small-scale farmers. Water is in abundance (World Bio-energy Association, 2010).

Zambia have 43.6-million hectares of arable land, of which only 14% or 6.1-million hectares were currently being cultivated. The Jatropha plant has existed in Zambia for several decades. The plant has often been used as a hedge around gardens in order to protect the crops from animals. However in the last few years many activities have been undertaken to introduce Jatropha as a new crop to the small-scale farmers to improve income and to reduce the dependence on imported fossil fuels. Zambia imports annually around 700,000 tonnes of fossil fuels and about 10% of the GDP is used to pay for this import (World Bio-energy Association, 2010).

Methodological framework

In this study a Mega evaluation carried out for the case of Zambia to indicate possible diversion that might cause as a result of energy applications and benefit that might be driven taking few farmers as case study. The term ‘meta-evaluation’ was coined more than 40 years ago by Michael Scriven (1969). In simple terms, meta-evaluation means the ‘evaluation of evaluations’ (Gough and Martin, 2012).

Meta-evaluations are concerned with bringing together the evidence from a range of studies and exploring implications for policy and practice and so overlap in purpose and methods with broad-based systematic mixed-methods reviews (‘synthesis studies’) and methods for testing the evidence for policy programmes (Gough and Martin, 2012).

The starting point for this study is that meta-evaluation and combination of evaluation science and methods of research synthesis. It involves consideration of the methods for identifying relevant primary research studies, methods that assess quality, relevance and techniques that able to bring interpretation of empirical data collected and field visit observations the approaches openly discuss and communicating with the audiences for meta-evaluation of the target group.

The methodology has included:

International literature review: a detailed review of the existing academic literature on energy that were carried out before in order to clarify processes of meta-evaluation.

Roundtable discussion on methods: discussions mainly the main analysis of the evaluation in this study which was convened between the farmers experience on “Jatropha” in Zambia so that able to examine the strengths and weaknesses of their farming with bio-fuel. The outcomes of these discussions also inform the industry and police makers.

Consultation with the energy industry: primarily the research was designed with a special request of industry to engage farmers to increase production, further to document public and private perceptions toward bio-fuel. Therefore, in this study there was experts opinion included in the study those whom direct involved on bio-fuel in Zambia to assess in more detail the strengths and weaknesses of their experience and the practical lessons learnt, and to collate examples of useful lessen that able assist policy frameworks.

Analysis and reporting: using the findings from the literature review, roundtable discussions and primary research, a set of recommendations and guidelines on the stages and steps involved in conducting meta-evaluation were developed.

Literature review

Africa bio-fuel development

As indicated on Amigun, Musango and Stafford (2011), to date, only a few African countries have implemented effective support policies for renewable (biofuels) energy (those countries are Ghana, Angola, Mozambique, Nigeria, South Africa, Tanzania, Zambia, Zimbabwe, Uganda, Benin, Mali, Malawi, Senegal, Mauritius and Swaziland).

The supply and use of renewable energy have never been static subjects. Scientifically, technologies change; some are entirely new and others result in improved function and efficiency. Structurally, supply organizations vary, ranging from nationalised utilities to privately owned companies. As a result during policy dialog different countries engage different stakeholders. For example, in Nigeria and Uganda the government facilitates development, provides stimulus for private sector investment, and monitors and coordinates the
energy sector activities. Thus, the government and public universities play significant roles in the energy sector (Jumbe, Msiska and Madjera, 2009). In contrast, South Africa, Tanzania, Zambia and Malawi where the private sector, foreign companies, and non-governmental organizations are responsible for biofuels strategy and policy recommendation and formulation (Amigun, Musango and Stafford, 2011).

South Africa and Ghana have developed specific biofuel strategies with specific targets. The South African industrial biofuel strategy aims to achieve a penetration level of 2% of biofuels (400 million litres per annum) in the national energy supply by 2013 (Thomas and Kwong, 2009). The crops targeted for the production of biofuels include canola, soybeans and sunflower for biodiesel and sugar beet and sugarcane for bio ethanol (Thomas and Kwong, 2009). The Government of Ghana has set a target of substituting 20% of the national gas and oil consumption with biodiesel by 2015, and 30% of the national kerosene consumption with Jatropha oil by 2015. The policy also aims at improving the efficiency of biodiesel production in order to reduce production costs. In the case of Mozambique, the national energy policy is not yet finalized, but the country has already adopted preliminary regulations to foster the large-scale production of biofuels. The policy proposes the gradual introduction of blending of petrol (gasoline) with ethanol and biodiesel with fossil diesel, initially, at 5–10% (Thomas and Kwong, 2009).

As indicated on (Amigun, Musango and Stafford, 2011), South African synthetic fuels company, Sasol, which pioneered the use of petrol and diesel from coal and natural gas in a joint effort with the government’s Central Energy Fund, that able to build a biodiesel production plant based on soya beans. The benefits of the government’s plans are:

- Diversification in agriculture;
- Utilizing and transforming the countries’ expertise in producing oil from coal;
- 55,000 new jobs, mostly rural;
- Reduction in national unemployment by 1.3 per cent;
- Increase in GNP by 0.12 per cent (6 per cent of the rural fraction of GNP);
- Reduction of imported oil, improving balance of payments by nearly 0.5 billion USD per year;
- Meeting 75 per cent of the national renewable energy target of 10,000 GWh/year by 2013; and
- Reducing fossil-carbon emissions

The question is that, is there enough land for food and bio-energy in Sub-Saharan Africa? Today less than 9 percent of the total land area of 3 billion hectares is currently used for crop production: 45 percent of the land being water bodies, desert, barren, steeply sloped, or very marginally productive, 18 percent being forest and 6 percent otherwise protected land, and less than 1 percent urban and built-up areas in Africa. Pastures, savanna and bush cover 22 percent of the land, with a wide range of bio-productivity. It is estimated that about half of the annual biomass produced in these areas is currently needed to support ruminant livestock (see Figure 1) (Rajagopal and Zilberman, 2007).

Though it is key point to enhance food security by achieving sustainable yield improvement on current cultivated land, simultaneously it is possible to one third of savanna and bush, i.e. 175-200 million hectares, could be used for food and energy production. While conventional agricultural feedstocks currently used in first-generation biofuels production compete with food crops and perform poorly for environmental criteria (OFID, 2009). Second-generation technologies promise substantial greenhouse gas savings and may permit tapping into land resources currently not or only marginally used.
The question arising from the diversion of arable land from food production to bio-energy production, it is likely to cause food production and food security conflict. Biofuel proponents, and there is already a vocal ‘biofuel lobby’ argue that bio-energy crops would only be grown on degraded or wasteland, not fertile land.

But, if the wasteland is capable of supporting Jatropha cultivation, should it not be used for the cultivation of selected cereal or oil crops, or if not that, then fodder grasses? India and all of South Asia have large livestock populations, which serve as additional support for local food security. The region is deficient in fodder and all kinds of non-arable land should be diverted to fodder grasses, not crops to produce agro-fuels (IFPRI (International Food Policy Research Institute), 2008).

Critics fear that the growth of the agro-fuel sector will be detrimental to food production. The impact on food prices of diverting food crops to ethanol production is already becoming visible. Pork prices in China have begun to rise as a result of rising costs of animal feed consisting principally of corn and soybean, both crops that the US is diverting to its biofuel programmes. Less US corn and soybean on the market mean higher prices for animal feed and so higher prices for meat. Beijing is slowing down China’s ethanol production drive after increase in corn prices worldwide prompted concern about inflation and food security at home. China is the world’s number-three ethanol producer, after the US and Brazil, manufacturing 1.2 million tonnes of ethanol from corn and wheat feedstock. Chinese officials are waking up to the fact that they will not be able to produce enough corn to supply domestic food needs and support a biofuel programme. These officials realise that they cannot buy enough corn from the world market either, with the US, the world’s largest corn supplier, hoarding its corn and soybean for its own ethanol programme (IFPRI, 2008).

Warning signals about the consequences of the US led biofuel fad on food and feed availability are being sent by the FAO. A report prepared by the World Food Organization and the OECD predicts...

*Figure 1: Bio-productivity of grassland, woodland and Density of ruminant livestock*

Source: OFID, 2009
that the current trend will take land out of food production and increase the price of commodities such as sugar, maize and palm oils (OFID, 2009). The report anticipates that this will lead to a rise in food prices over the next ten years. While higher food prices will be profitable for food exporting countries and large farmers, they will threaten the economies of food importing countries, the livelihoods of their farmers as well as the food available to the urban poor in these countries (OFID, 2009).

The global rush to switch from oil to energy derived from plants is being led by the rich countries who want to see energy plants grown extensively for fuel as a way to reduce their own climate changing emissions. The UN is urging governments to beware the human and environmental consequences of the agro-fuel trend, some of which could be irreversible. They warn that taking the current agro-fuel route will lead to deforestation, push small farmers off the land, and lead to serious food shortages and increased poverty. India should review its biofuel policy and examine the natural advantages to see what kinds of strategies are viable for producing supplementary energy (OFID, 2009).

RESULT AND DISCUSSIONS

BIO-FUELS LANDSCAPE IN ZAMBIA

Since time immemorial Zambia has been a net importer of petroleum requirement that represents 9% of the total national energy demand. It is used mainly in the transport sector and a small percentage dedicated for thermal power plants in remote areas that are not linked to the national grid. The mining and agricultural industries are the major consumers of liquid fuels (Republic of Zambia, 2008).

The petroleum is supplied via a 1700km pipeline from Dar es Salaam in Tanzania to Ndola, on the Copperbelt, where the only refinery of Zambia with a total of 1.1million metric tons/annum is located. It is from this facility where LPG, HFO, Petrol and Diesel is produced and distributed throughout the entire country by Oil Marketing Companies (OMC) (Republic of Zambia Ministry of Energy and Water Development (MEWD), 2008).

In terms of consumption, the transport sector takes about 53% while the mining sector consumes 27% of the total production. Of this there is no contribution by bio-fuels as this sector is in its infancy except of some very few self consumption projects. The figure below shows the consumption of petroleum per sector (MEWD, 2011).

![Figure 2: Consumption of Petroleum Fuels in Zambia; Source: MEWD, 2008](image)

Biofuels development in Zambia

The Zambian government is aware that to have a sustained economy growth that currently oscillates at 6% GDP growth per annum, it is important for the country to have a sustainable energy supply that includes a very vibrant liquid fuels sector. While the main driver for biofuels development in the developed world is to curb green house gas emissions responsible for global warming and climate change, the main driver in most developing countries in sub-Saharan Africa is energy security, employment creation and rural development (MEWD, 2011).

With the recent sharp fluctuations in the crude oil prices and the increasing instability in the oil producing countries, the Zambian government has identified the importance and significance of biofuels potential to contribute to the energy security in the country. This is evidenced by the development of a Bio-fuels Industry Strategy and the inclusion of biofuels sector in the National Energy Policy of 2008. The recent pronouncements of voluntary blends by the Minister of Energy and Water Development, is a major indication that the government is ready to develop this young but important industry in Zambia (MEWD, 2011).

Status of Bio-fuels Development in Zambia

The National Energy Policy identifies biofuels as part of the national energy mix that currently is dominated by the use of biomass in terms wood fuel. Wood fuel is responsible for some 70% of total energy consumed in the country especially in rural areas and urban poor communities. Although Zambia is endowed with a very rich landscape covered by woodlands and forests, with the
is uneven distribution in terms of costs and benefits, as a result there is gap in knowledge, access to resources and the allocation of social and political influence, this compromise the sustainability in biofuel in Zambia.

**Choice of feedstock**

The draft Biofuels Industry Development strategy paper identifies six major sources of feedstock for biofuels production. For Ethanol, molasses coming from Sugar factories, cassava and sweet sorghum are the feedstock preferences in Zambia. Maize although produced in surplus is not to be considered as it is the stable food of the country and diversion of maize to biofuels can cause an imbalance in terms of food security and trade (MEWD, 2011).

As for biodiesel, palm oil, Soy Beans and Jatropha have been identified as the potential crops to provide the feedstock. Sunflower, being a food crop, must be approached with caution to avoid competition with animal feed production and vegetable oil for human consumption (MEWD, 2011).

Since the entire primary production is agro-based, the National Agricultural Development Policy plays a significant role in the development of this agro-based bio-fuels industry (MEWD, 2011).

The strategic paper promotes the concept of starting small and then rolling out the programmes as the country builds its knowledge base, infrastructure and experience necessary to upscale bio-fuels production (MEWD, 2011).

**Land, food security and Bio-fuels**

It is very well known fact that the greatest natural resource that Zambia has is land and its natural resources (especially mineral deposits). The Government has recognised the importance of this resource in the development of a strong and prosperous nation (MEWD, 2011).

Zambia is endowed with a good agro-climatic condition with abundant arable land and over 50% of total water resources of the SADC region. At present the country uses only 14% of the total arable land of approximately 42 million hectares (DFID 2001). The water resources that provides a huge potential for irrigation is currently under developed with only some 65,000 ha under irrigation which is less than 15% of total potential.

Although Zambia produce surplus maize (about 2 million metric tons during 2010/2011 farming season), majority of this production is by small-scale (commonly referred to as peasant) farmers.
This is a very labour intensive practice and therefore contributes about 60% of the total labour force in the country. However the agricultural sector is extremely inefficient leading to low productivity per hectare. Although there is plenty of land, the sensitive of the agriculture sector demands policy coordination between the energy and agriculture sectors.

In terms of land administration, land in Zambia is vested in the president. It is divided into two major categories: statutory land and customary land. Under statutory, land rights can be registered in form a lease of maximum period of 99 years. This is the highest form of tenure security possible. On the other hand traditional land, which covers most of the so called trust lands, can be perpetually held under customary law. There is a possibility to convert land from customary to statutory but not vice versa, a condition is has raised a lot of resistance especially by the chiefs. The Lands Act (1995) makes provision for such but the procedure is not as simple in practice as it is on paper (Chileshe, 2005).

Under the current system of tenure, Customary Land constitutes about ninety percent (90%) of the total land area of Zambia, which is seven hundred and fifty two thousand (752,000) square kilometres while State Land constitutes only 10 percent (10%) of the total land area (Chileshe, 2005)

A lot of land that is being targeted for bio-fuels development is therefore not surprisingly mainly customary which is not formally recognized by the financial system. Development of a vibrant bio-fuels industry will require a favourable land access system that benefits the local people but at the same time encourages the much needed investment without leading to “land grabbing” (Chileshe, 2005).

Market potential for Biofuels

The announced blending ratios and the biofuels regulations and standards (Ministerial speech, MEWD, 2010) has unlocked the biofuels market in Zambia. With about 1.0 million metric tons of diesel consumption, the 5 % blend provides some 250,000 metric tons assuming blending is mandatory. With the increase in mining and agricultural activities which subsequently pushes demand for transportation and energy, the market for biofuels promises an upward trend.

Despite the announcement of the blending ratios that was a major bottleneck in the development of biofuels, there is no project that is producing biofuels on a commercial basis. We may see an increase in investment now but alignment of other sectors would be crucial to the development a sustainable market and infrastructure. There is still a lack of blending infrastructure at the only refinery and national storage facility in Ndola

Field visit to assess Bio-fuel in Zambia

The visit to Kisalala area at Mbambiko village, this zone lead by Mr. Gladson Kyupa has 65 contract farmers under Bio-ex project, of which 12 are women. Of the 13 farmers interviewed, one farmer indicated that to have land size of 24 ha. The table below summarized the land ownership and the number of Jatropha planted. The farmers indicated that they had knowledge about Jatropha as an ornamental plant but not its use and economical value as they know it today.

Table 1: Size of Jatropha plantation in Zambia

<table>
<thead>
<tr>
<th>Land Size (ha)</th>
<th>No. of farmers</th>
<th>Jatropha planted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10</td>
<td>6</td>
<td>500 (i.e. 1ha at 5x5)</td>
</tr>
<tr>
<td>10 – 20</td>
<td>6</td>
<td>500 (i.e. 1ha at 5x5)</td>
</tr>
<tr>
<td>Over 20</td>
<td>1</td>
<td>1600 (i.e.3ha at 5x5)</td>
</tr>
</tbody>
</table>

In terms of income from other crops, the interviewed farmers indicated that millet gives the most income as it is processed into a local beer that sells better and for a longer time of the year, depending on the amount harvested. Of the interviewed farmers each farmer earned an average K3.5million per annum (equivalent to USD700/yr) from different farming activities.

When asked whether they have benefited economically from the project, most farmers indicated that it was too early to indicate this but were disappointed by the perceived low price of Jatropha offered by NWPB. At the same time, several of the 13 farmers indicated the willingness to expand their Jatropha cultivation and some have set up nurseries in readiness for the next season.

The main complaint that was heard was the labour demand of Jatropha. Farmers indicated that they had to divert labour to tend to the Jatropha plants

3 Customary land was before independence composed of reserves and trust lands established by the colonial master.
especially for weeding and pruning. Those that have harvested indicated the tedious and laborious picking and shelling process. This in their opinion, poses a potential labour competition with other crops especially if they expand their Jatropha fields.

In terms of training, farmers in this area expressed their disappointment that despite the promise that training would be given, they only received seeds and/or seedlings and not the promised training and field extension services. However, during meetings, tips on how to look after the plants like pruning and weeding were given. Basic knowledge about use of agriculture waste coming from Jatropha and other crops as composite fertilizer was conspicuously absent.

**MARKET DEVELOPMENT IN BIO-EX**

North West Bio Power (NWBP) and SNV were responsible for the organization and development of the mechanism to support Jatropha market development. The contract signed between NWBP and the farmers was aimed at guaranteeing a market for the Jatropha seeds at the agreed price of 8% of ruling diesel price. At the time of the visit, this worked out to be less than K500 /kg although NWBP was buying at a high price of between K650 and K1000 per kg.

As indicated earlier, over 8000 out-growers were recruited but only a few of the interviewed farmers indicated to have sold their first yields. The out-growers spoken to indicated that the price being offered for a kg of Jatropha seeds is below their expectation. This expectation could not be established well but was based on a mere comparison of Jatropha seed price to maize. Some even kept some seeds in anticipation of a higher offer later on. However, when compared to the other crops’ producer prices as shown in the table below, Jatropha price per kg did not compete well in terms of gross income. This price discussion, however, needs more analysis and information sharing for the farmers to understand the pricing structure of the Jatropha seed.

The table below indicates the producer prices of various crops as obtained from PACO in comparison with Jatropha.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Price in USD / kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beans</td>
<td>1.25</td>
</tr>
<tr>
<td>Cassava</td>
<td>0.42</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>1.04</td>
</tr>
<tr>
<td>Jatropha</td>
<td>0.14</td>
</tr>
<tr>
<td>Maize</td>
<td>0.23</td>
</tr>
<tr>
<td>Millet</td>
<td>0.42</td>
</tr>
<tr>
<td>Sorghum</td>
<td>0.42</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>0.35</td>
</tr>
</tbody>
</table>

At national level, the announcement of biofuels blend percentages has created the much needed market for biofuels due to sudden demand created to meet these targets. Market development requires that all stakeholders ranging from government, private sector, development partners, the farmers and regulators work together. The strategy that was adopted in Bio-ex could have been more effective if there was deliberate engagement of stakeholders to address issues related to pricing and logistics in particular. Working closely with BAZ, Energy Regulation Board and MACO would have improved these aspects. Such alliance would have assisted in pushing government to implementing some of the incentives as proposed in the Ministry of Energy and Water Development’s Biofuels’ Industry Strategy adopted by cabinet in 2008. Perhaps this will happen in the new future as compulsory blending targets are being discussed at the moment and may change the entire biofuels and agricultural landscape.

**FOOD PRODUCTION AND SECURITY IN BIO-EX AREAS**

The issue of food production and security is a very sensitive one especially in countries like Zambia where the targeted out-growers are responsible for over 75% of total food production in the country. Bio-ex was designed to supplement income of the subsistence farmers by introducing a cash crop in their farming system. In a project of this nature, there are a number of possible diversions that can lead to reduction in food production in the communities. These include:

- **Diversion of land** meant for food production to Jatropha, leading to reduction in the amount of land available to grow food. In Bio-ex, the issue of land diversion is extremely minimal as most farmers interviewed had more land than they could possibly use. They utilized under at least 50% of what they had in total. It means that Jatropha growing can be done on excess land that each farmer has.
However, this needs to be managed and monitored very closely and hence the need for good extension services. In this sense Bio-ex did not cause reduction in land meant for food production.

- **Diversion of labour** and other production tools to Jatropha and thereby creating labour conflicts with food production. In Bio-ex, this seemed to have been a major concern by the farmers. They expressed the tediousness and laborious aspects demanded by Jatropha from the time it is planted until harvesting. It seems to be competing with maize harvesting for example during fire-breaks creation and weeding. Harvesting, especially husking, seems to compete with other domestic and farming chores like food processing and harvesting sweet potatoes, beans and millet. This therefore could have led to the losses that the communities visited expressed. However, this needs to be analyzed further to avoid making uninformed conclusions.

- **Diversion and/or dilution of investment** to Jatropha. This means savings earned from other activities can be diverted to Jatropha for land preparation or input procurement as an example. This was evidenced in the amount of money spent on labour hire for weeding and husking. Bio-ex did not make any provision for appropriate manual husking tools that could have reduced labour input. This diversion has had a negative net effect in some cases when the average income of interviewed growers reduced by at least 40% due to diversion of income.

- **Diversion of agriculture extension services** from food to Jatropha. Jatropha is a new crop that needs to be understood further if it is to deliver benefits to the growers. It provides an opportunity diversify land utilization and intensified agriculture extension. However, it can be said that in Bio-ex, dedicated extension was required since the crop expansion was something new to the community. Little local knowledge was available on Jatropha and this meant that more close supervision was needed. The MACO extension services side was not forthcoming. If that happened, perhaps there was going to be a loss of extension services meant for food production. This was not evidenced since MACO did not divert their extension services to Bio-ex.

- **Diversion of markets** when price of Jatropha is way above that of food crops. In a situation where Jatropha or any energy crops become lucrative, farmers may decide to divert land, investments and whatever they possibly can to earn that extra income. This can cause serious food production reduction and maybe food price hikes. In Bio-ex, this was not the case as Jatropha price being offered was perceived by farmers to be lower than that of maize and other crops.

- **Fertiliser inputs** use to Jatropha might compete with crop production that can create price spike in future.

- **Attraction of foreign investment**: for example, China is negotiating for five million acres in Zambia to grow Jatropha (Amigun, Musango and Stafford, 2011). The large scale mechanised production of energy crops becomes a big concern in most African nations, as there is tendency of land grape by richer nations.

- **Impact on food prices**: Amigun, Musango and Stafford (2011) shows on their study that increased demand for biofuels is responsible for about 30% of the weighed grain price increase from 2000 to 2007. Many Africans spend over 50% of their share of income on food and many African countries import food to meet their domestic energy demands. In the year 2000, the average total imported cereal demand in sub-Saharan Africa was 33%, with Sudan, Gambia and Zambia reaching a high dependency level of more than 80%.

- **Multiplier effect on income**: Biofuels development is argued to have positive benefits in ensuring household food
security through increased incomes and the growing export markets for energy crops. There are however number of factors that are not explicitly accounted for in many of the partial-equilibrium frameworks that generate these conclusions. In some countries in Africa, concerns surrounding food security have resulted in governments actively cautioning the development of biofuels. In Tanzania for instance, as a result of mounting pressure from farmers and environmental groups, the government suspended all biofuel investments and halted land for biofuel development. In South Africa, maize was excluded from ethanol production amid food security concerns in the draft biofuel strategy. Biofuel developments also present a potential competition between biomass systems for biofuels production and the use resources for animal feed, bedding, fertiliser and construction materials. Of particular concern are threats from business orientated production of biofuels that may require opening of forests or acquisition of land from rural dwellers for growing energy crops. Additionally, the market prices of energy crops may be greater than for food and induce the diversion of resources away from food to biofuel production; thereby threatening food security (Amigun, et al., 2011). However, all this implication was not proven in the case of Zambia as the case study focus was only targeting the poor resource farmers.

The Bio-ex project made an attempt to demonstrate how development of a biofuels industry that can bring benefits to small farmers in Zambia. The following is an attempt to sum up visible achievements of Bio-ex Project in North Western province as observed during the evaluation of the field visit:

- The Bio-ex was designed to reach out to 3500 farmers at the end of implementation period. It was very overwhelming to notice that over 8000 farmers were reached. The exact figure was difficult to establish since the database which was to host all such information was not inspected but independent partners and field officers confirmed the figure of over 8000 farmers of which over 2000 were female out-growers. These farmers are divided into some 72 zones with under 10% female zone leaders. In order to increase access to benefits by women and other vulnerable groups, a project of such nature would need close collaboration with other projects and NGO or Civil societies working in the gender sector. Leaving such a task to a private sector in a fairly complex and ‘new’ industry would not be appropriate. The Biofuels Civil Society supported by Oxfam would have provided this watchdog role in the project to make sure farmers and investors achieve a win-win situation.

- Great awareness and expectations on Jatropha in the province has been created. Many even non-Bio-ex farmers and other no-project actors confirmed knowledge about Jatropha when asked. However the level of information possessed by different stakeholders varied greatly. Those involved in the project demonstrated a better knowledge than those who did not participate. One farmer interviewed independently indicated that he heard about this Jatropha project on radio and decided to join the project. This awareness needs to be sustained in order not to lose the momentum created in the province.

- The Bio-ex farmers benefited in terms of knowledge about Jatropha and its potential, gained experience of how to organize themselves in a farming zone or group, and general farm husbandry practices shared in meetings. The introduction of intercropping strategy with annual crops such as sunflower and other low crops like sweet potatoes, beans and groundnuts, may be an added benefit to the farmers as they can utilize the same piece of land for different things and save farm management labour and time as weeding one crop means the other ones are weeded too. However, the farmers needed more knowledge to increase the chances of reaping the benefits from Jatropha.

- At national level, the Bio-ex project enhanced the visibility of other Jatropha growers as there were a number of radio and TV adverts and some discussion programmes that included the announcement of markets.
Field officers gained more knowledge and practical experience about Jatropha and its production complexities. However they needed more in depth training on the agronomical to provide good extension services to improve effectiveness of their extension services.

The project also provided a platform to engage key stakeholders needed to develop a sustainable biofuels industry. After the Bio-ex project, MACO has a positive view now, and plans to include Jatropha growing in its expanded agriculture diversification programmes. MACO as a government ministry needs to develop a deliberate programme targeted at Jatropha farming in order to support the sector effectively but also avoid compromise in food production.

Involvement of BAZ in the project provided the link needed to establish develop networks that can enhance the young industry. However, the loose arrangements and the failure to integrate research institutions in the project caused an opportunity loss to carry various investigations needed to develop best practices. Institutions like UNZA’s agricultural school, CBU’s forestry school, CSIR and Mt. Makulu Research institute and GART for example would have provided the needed expertise to improve the plant and its value chain in the Bio-ex. Also this would have been an opportunity to test various Biofuels Sustainability principles and standards being proposed by RSB and other agencies.

Experience regarding how a private company can work with a development organization was a valuable lesson for both parties. Bio-ex project design from inception desired to see how this partnership can be achieved. Despite many hitches as recorded during the evaluation, the Bio-ex project demonstrated that it is possible but requires a different approach to classical government or NGO approach. Therefore it would be necessary to evaluate in detail this alliance and explore possibilities that can make this work better.

Another significant spin-off from the project is the formation of the North-western Out-growers Association (NOWEGA) in December 2009 aimed at providing one voice (hopefully stronger) for the growers. NOWEGA is determined to explore the possibility of (re)negotiating the contracts signed by the out-growers with NWBP and take over the mobilisation of the growers as a means of increasing efficiency. It also plans of taking over distribution of inputs, collection of seeds from growers and negotiation of future farming contracts for the growers. NOWEGA then would in turn sell the seeds to NWBP or any other company without compromising on the current contractual obligations to NWBP. SNV has indicated its willingness to support NOWEGA as this would complement their effort of developing the capacity of communities to engage in agricultural business effectively. NOWEGA expresses also the desire to explore possibility of procuring appropriate oil extraction technologies to localise benefits from Jatropha such as seed cake and husks re-use as organic fertilizers. This also may increase the profit margin since only the oil needs to be transported compared to seed which is very bulky. The knowledge of extraction would also remain in the community. Therefore NOWEGA as an initiative has potential to provide the missing link in Bio-ex implementation.

**Conclusions**

Food security, energy security and climate change mitigation are all critical to social, economic and environmental sustainability, not only at the national level but also globally. A successful resolution of these challenging issues requires the goodwill and commitment of all nations to work together.

Biofuel development polices have a direct impact on these triple challenges and yet it is national polices with national interests that have been the driving force of setting biofuel targets. The global and spatial agro-ecological and socio-economic methodology and assessments required to provide the analytical means and science-based knowledge to evaluate policy options towards making the right choices that recognise the pitfalls and mobilise the opportunities to make progress towards achieving national and global sustainable development.
Bio-fuel in Zambia created diversion of land meant for food production to Jatropha, leading to reduction in the amount of land available to grow food. However, in Bio-ex, the issue of land diversion is extremely minimal as most farmers interviewed had more land than they could possibly use. However this needs to be managed and monitored very closely and hence the need for good extension services. In this sense Bio-ex did not cause reduction in land meant for food production.

Diversion of labour and other production tools to Jatropha and thereby creating labour conflicts with food production. In Bio-ex, this seemed to have been a major concern by the farmers. They expressed the tediousness and laborious aspects demanded by Jatropha from the time it is planted until harvesting.

In future bio-fuel might create competition in the input use, especially in fertilizer input, that might lead to high production cost. Furthermore, feedlot industry might collapse; maize major feed lot major input might be used for bio-fuel.

References


ON THE ESTABLISHMENT OF PRACTICE-BASED ENGINEERING EDUCATION SYSTEM FOCUSING ON ABILITY TRAINING

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Abstract: The establishment of practice-based engineering education system is a systematic engineering education reform system which includes the transformation of ideology, reformation of system, and innovation of mechanism. To promote the reform and innovation of practice teaching and talent education mode, this paper insists that practice-based teaching should be very important part in engineering education, which can guide students to concern about hand-on skills, enhance the teachers’ sense of reforming practice teaching, and help school put the quality education in the first place. Thus special attention should be paid to experiments, exercitation, social practices, scientific researches, knowledge competition, and dissertation presentation so as to cultivate the innovation sense, entrepreneurship spirit, and practice ability of students.

Keywords: practice-based engineering education; teaching mechanism; administration system; talent education mode

INTRODUCTION

With higher education being transferred from the elite stage to the popular stage, the homogenization system of the traditional engineering education is being gradually differentiated, and the university classification as well as hierarchical training pattern is supposed to appear certainly, which indicates that there is a new differentiation for the higher education form and content, and the trend of diversification for talent training has naturally emerged. Therefore, talent training at local and ordinary colleges and universities need specific characteristics with diversified and personalized goals to meet the social demands for innovative talents with innovation consciousness and ability at various levels and in different areas. Applied talents mainly carry on technology innovation and secondary development in technology. Compared with skilled talents, the undergraduate applied talents should have more generous knowledge, stronger ability to apply knowledge and technology, social adaptability, and higher professional and overall quality, while compared with disciplinary talents, applied talents have faster operating and stronger practical abilities. The main talents standards include solid basis, wide knowledge, strong ability, high quality, strong innovation consciousness and professional ability.

It is believed that the basic direction of practical teaching is, closely based on the needs of regional economic construction and industrial development for practical, applied and skilled talents, to further strengthen the cultivation of students' practical ability and creative ability, and vigorously promote the combination of industry, university and research. The specific thinking is to further increase investment and strengthen the construction of practical teaching staff based on clarifying the laboratory management system and focusing on improving the practical teaching systems, thus, practical teaching can become an important way to achieve innovative education and cultivate the applied talents with innovation consciousness and practical ability.
TO ESTABLISH THE SCIENTIFIC AND RATIONAL PRACTICAL TEACHING AND CURRICULUM SYSTEM

Theoretical teaching and practical teaching are both organically combined and relatively interdependent. In the current talent training programs, some practical courses are offered individually, while some are attached to theoretical courses playing an assisting role, having not formed an integrated and systematic system of practical teaching. The optimization of practical training system should be combined with the reform and innovation of talent training mode, starting from the entirety of talent training system, focusing on improving students’ overall quality and cultivate their innovative spirit and practice ability.

Then, according to the requirements of cultivating innovative talents, in-depth study on the specifications and quality standards of talent training is conducted in terms of different categories and professions, identifying the different roles of different practice teaching links in the ability training. On this basis, it is very necessary to carefully revise or re-design the talent training program, curriculum syllabus and experimental teaching course syllabus for different majors, and build a scientific and rational practical teaching system and practical curriculum system.

TO OPTIMIZE AND INTEGRATE EXPERIMENTAL PROGRAMS AND PROMOTE THE REFORM OF EXPERIMENTAL TEACHING CONTENTS

The teaching content reform is the core of teaching reform, and experimental teaching is no exception. In terms of the systematic and integrity of knowledge and ability, schools should carefully select practical teaching content in order to provide students with practical teaching content that improves both their overall quality, and knowledge, ability and character. Determining the practical teaching content not only accords with curriculum system requirements, but matches the major professional teaching system to avoid repetition. Thus, the updating experimental teaching content can become the important effort of experimental teaching reform, encouraging the organic combination of practical teaching with theoretical courses, actual production, scientific research, innovation and entrepreneurship, and society and livelihood.

TO REFORM EXPERIMENTAL TEACHING METHODS AND MEANS TO IMPROVE THE PRACTICAL TEACHING EFFECT

The reform of teaching methods and means works well in improving the practical teaching effect. Firstly, we should reform the examination assessment methods and establish a student-centered diverse practical teaching models and assessment methods adapted to the students’ ability training and encouraging exploration. Meanwhile the assessment of practical teaching should focus on the students’ operational and innovative ability. Secondly, we should make full use of modern educational technology to improve the efficiency of the experiment, establishing experimental teaching management system and online experimental teaching platform, developing large amount of multimedia experiment courseware, and achieving the modernization, diversification and hommization of experimental teaching methods and means. Thirdly, we should increase students’ accessibility to laboratories, which is the key to the reform of experimental teaching methods. On the one hand, students should have more space and time in the laboratories, with less limitation to use of laboratories doing various experiments; on the other hand, students have more flexibility in the choice of experimental content, means and methods, as long as they obey the lab rules. The construction of open laboratory should be truly combined with the development of students’ autonomous learning ability and the training of students’ cooperative learning and team spirit awareness.

TO STRENGTHEN THE CONSTRUCTION OF PRACTICAL TRAINING BASES AND FULLY UTILIZE SOCIAL LABORATORY

Building a number of stable practical training bases with good conditions is the key prerequisite for successful implementation of practical teaching for various majors. Practical training bases include both campus and off-campus centers that complement each other and cannot replace each other. We should find ways to actively expand the students’
extracurricular practice channels. Currently, due to many reasons, the established practice bases are still mostly dependent on personal relationships, short of stable or long-term practice bases with the combination of industry-university-research mechanism. It is believed that with the consolidation of existing construction achievement, universities should constantly expand and develop new training bases, actively develop cooperation between schools and enterprises, schools and schools, schools and the cooperating research institutions, fully rely on industries and local government, bring industry-university-research efforts into full use in talent training and really establish a stakeholder-related and good relationship off-campus practice bases. Meanwhile, attention should be paid to further strengthening the organization of student practice affairs as well as the construction of safeguard mechanisms, ensuring “Five Aspects” including practice regulation, practice time, practice spot, practice fund and practice instructor.

TO ENHANCE THE CONSTRUCTION OF PRACTICE TEACHING TEAM AND IMPROVE THE QUALITY OF PRACTICE TEACHING

Practice teaching faculty is the human-resources guarantee for improving the quality of practice teaching. To ensure the quality of practice teaching, there must be a high level and stable faculty team for practice teaching.

Currently, due to the subordination of experiment teaching, university staff carrying on the experimental technique has long been regarded as auxiliary teaching staff and the mismatch of some policies affects their work enthusiasm. Therefore, effective measures should be taken to strengthen the construction of practical teaching team by following the principle of combining introduction and cultivation of staff, full-time and part-time staff, and on and off campus staff, increasing the number of teachers for practical teaching and improving the teaching practice quality.

Great efforts should be exerted to vigorously enrich experimental personnel, focus on training and introducing highly educated and skillfully experimental talents, to form an appropriate teacher echelon. In addition, it is important to enlarge the proportion of "Double-Profession" teachers and "Double-Certificate” teachers among all faculties, and vigorously strengthen the training for existing practice teaching team to improve their ability.

Meanwhile, it is not bad option to attract or introduce the excellent technical personnel from off-campus bases into campus teaching team, striving to build a practice technical team with appropriate size, reasonable structure and relative stableness, that are capable for fulfilling practice teaching, scientific research and technological development tasks, having commitment to the job and providing qualified teaching.

TO IMPROVE UNIVERSITY LABORATORY MANAGEMENT SYSTEM AND FURTHER ENHANCE THE STANDARD MANAGEMENT OF PRACTICE TEACHING PROCESS

University laboratories should implement the two-level management system that covers university level and school level with a focus on school level. It is recommended that the university should adjust all public basic courses laboratories, set up corresponding university-level experimental teaching center. For professional basic course laboratories of similar majors or the same group of disciplines, it is necessary to set up school-level experimental teaching center, while specialized laboratories are set up for quite different programs or projects. Under the frame of this University-school level management system, the original laboratory model that works by the unit of major must be broken; university should implement management by category on the basis of the necessary integration of its experimental resources, and clearly define the respective duties, rights and obligations of university, school and discipline.

Besides, university should implement corresponding employment policy for appointing directors of experimental teaching institutions at all levels and appointed directors of experimental labs should be fully aware of their responsibility for the construction and management of experimental laboratory.
For some off-campus practice sessions, the university should implement two-way management that requires the university and practice intuition work together to instruct and supervised students’ practice. Students should be provided with the appropriate guidance personnel in practice intuition so as to enhance the relevance of student practice to their majors, ensure the quality of graduation project, and improve the effectiveness of teaching practice.

CONCLUSIONS
Overall, regarding the quality as the development of higher education, ordinary universities should firmly take developing talent innovation ability as the core of education reform direction in order to maintain their competitive advantages and characteristics. Strengthening and reforming practice teaching is necessary for the university’s reform and development. Education management departments should focus on the quality of talent training, deeply research and promote the practice teaching reform in order to achieve the objective of fostering innovative talents.

References
Reform and Development of Talents Educating about Geology Academies

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Abstract: Educating practiced capability, improving talents practicability, is objective of academies. Base on the development situation and the illogicality between academies talents training and industry talents requirement, the talents training standard and goal of diversified geology academies have been researched in this paper. Be based upon the long-term experience and specialist composing characteristics of geology academies, the subject-specialist cluster system of geology academies, base on the core of mining industry chain has been established. Base on the practiced capability educating and training, the practiced system of geology academies has been designed.

Keyword: geology academies; talents training; subject-specialist cluster system; practiced capability

Introduction

Geology academies shoulder the task of talents education for the development of all walks of life, with the original education management system of fragmentation and department, Geology academies runs together with the industry. As national higher education management system reform, department and industry education had been cancelled, and then turns between national and local. Though considering the professional particularity requirement of knowledge and talents structure department and industry having, and set some affiliated professional in the original affiliated academies for the strong specialized knowledge required,

As subordinate relationship between the original industry and department changed, the combination of talents cultivation and industry in these geology academies turned dilute in certain degree. They couldn't timely understand the industry development, change, new requirements the industry development having for the talents demand, leading that the standard and type of talents education are divorced from industry actual demand to some extent. It is an important research subject for geology academies to find how to adapt to the new requirements and new change, to timely adjust the personnel training standard and model, and realize the reform and development of talents training. This paper proposes some shallow discussions on this issue.

I . Industry development situation and talents demand

1.1 The development and change in geological exploration

Along with our market and management system reform and deepening continuously, there has been a fundamental change in the geological exploration. Firstly, from the management system, commonweal and commercial two different geological exploration teams have appeared. Commonweal teams include teams directly under state and institutes of provinces and regions, which mainly managed as unites. However, abundant commercial teams fully come into the market, becoming independent accounting and self-financing entities, and realize its own survival and development with market competition. Secondly, from the business way, commonweal teams are dominated by national and regional
basic and public projects, some commercial projects as well. More than ninety percent tasks of commercial teams are commercial prospecting from the geological market. Thirdly, from the management focus, commercial teams are no longer limited to the geological exploration and prospecting, and most have been converted to “a team - a mine - a company”. In terms of value chain, they have achieved the transformation from resources exploration to mining processing, and to utilization, so the exploration is no longer the main source of their profits, instead of the mining processing, and the “exploration- mining” integrated company will be the trend of its future. Fourthly, from the business scope, with geological applications expanding continually, commercial teams engaged in the their exploration and exploitation at the same time, will constantly expand its scope to agricultural geology, environmental geology, urban geology, disaster management, and more new fields (Jicong Yu, 2008)

1.2. The illogicality between academies talents training and industry requirements

The development and change of industry in management system, management way, management focus, and business scope, etc., put forward new requirements of talents scale, level, knowledge structure, ability structure, etc., but geology academies failed to adapt to these new changes in time, leading to the structural illogicality between academies talents training and industry requirements, that as follows: (1) The illogicality between theory teaching and practice ability demand. According to the general process and laws of talents training, academies and units perform the cultivation function together. As the main body academies mainly undertake theoretical knowledge, application knowledge and certain practical ability training, while units bear the talents training and hands-on, use and growth, and continuing education, objectively existing a cross-interactive stage and link (Junyin Yan, 2002). Due to the funds, and experiments, practice conditions, the degree and depth of academies students practice ability training are insufficient, while under the market economic system, due to the serious lack of young and middle-aged backbone of geology and technical personnel, units have no intention to take more subsequent exercise and training duties, asking for directing taking charge of actual exploration and tasks, that leading to the stage loss and fault in the training process, objectively forming the illogicality between theoretical knowledge and practical ability. (2)The illogicality between specialized talents training and compound talents demand. Along with economy sustained and rapid developing since the reform and opening up, he size and strength of mineral consumption also rapidly grows. For geological prospecting, after the large-scale work since founding of the nation, shallow ore, surface ore, etc. ore bodies easy to prospect and mine have been basically found out, so the goal can only be located in high coverage and deep prospecting area, the difficulty increasing, and the integration and comprehensive of all aspects of theory, methods, techniques and means is needed to make breakthrough, which requires compound talents who can integrate all aspects of knowledge. However, based on the traditional setting with knowledge diversification, the knowledge system related to minerals exploration is divided into multiple segments professional, and persuading refinement of the setting can't match with the talents demand of current and future practical prospecting. Meanwhile, as abundant units becoming independent subjects under market condition, they not only pursue the excellence of technology, more care about the costs and benefits, when take on various tasks through market competition, and this way to survive in market determines the geological units need vast technical compound talents with various technology and methods, more understanding professional and mastering management, but the training of the academies still has not completely suitable for the realistic demand, leading to the illogicality between the specialized talents supply of academies and the compound talents demand of units. (3) The illogicality between the single types of talents supply and demand of diversity. Along with the reform and development of geological exploration industry, the units constantly expand their scope and field, longitudinally upgraded their scope and field, horizontally to agriculture,
environment, city, sea and so on. With business scope expanding, the units demand more diverse talents, but the professional settings and talent training of vast academies not only still stay in the exploration link at the beginning of industry chain, and follow traditional industry segment, there is professional field and setting fission, causing the talent training type single, which seriously can't meet the actual needs.

Figure1 academies division and talents training goal diagram
The talents training standard and goal of geology academies

According to the survey, there are about 100 geological academic outposts in our country at present, and they can be divided into the following four types by different nature and level, professional departments of comprehensive key academies, professional key academies, professional general academies, and professional vocational and technical schools. Overall, the talents training goal of diversified academies all can be summarized as "coordinated development of knowledge, ability and quality", but the difference of components or dominant elements in the structures, objectively forms the different division and positioning of academies in talents training series, and forms the different types and standards (Junyin Yan, 2006) (figure 1). Professional departments of comprehensive key academies are dominated by educating research talents, determining the main knowledge structure of training standard are basic theoretical and basic applied knowledge, and the main ability structure are the exploring study ability, focus issue ability, creative thinking ability, etc. Professional key academies aim at the applied talents training having certain research ability, with theoretical knowledge still as the main of the required knowledge structure, and properly add the practical cultivating and training. Professional general academies aim at the applied talents training having certain research ability, with theoretical knowledge still as the main of the required knowledge structure, and properly add the practical cultivating and training. Professional vocational and technical schools aim at professional skilled talents, requiring the process combined closely with the actual work, and carrying out abundant practice and training according to the skill requirements and operating norms of the actual work.

The construction of geology academies subject-specialist cluster system

The long-term experience of relying on industry and the professional composition characteristics of geology academies determine that they must follow the segmentation principle of talent market, and regarding the mining industry as the target market, based on the division and goal in the industry, reasonably synthesize and integration their professionals, meanwhile, around the "knowledge, ability, quality" the trinity of training goal, build the subject-specialist cluster system of geology academies including the resources industrial chain system, applied expand system, and cross penetration system (Junyin Yan, 2006, 2007) (figure 2). This system can be summarized as " I - II - III - IV" subject-specialist cluster system, while I represents a core, meaning expand along the industrial chain of "resource exploration-resource mining processing-resource utilization" on the basis of existing main geological subjects, forming the rational layout core of subject-specialist chain around each links of the industrial chain. II represents two advantage and characteristic, while one is the subjects advantage based on the traditional geology, and the other is the interdisciplinary penetration characteristics of geology and economic, management, humanities, computer, information, basic science, etc. III represents the three subject development fields. One is geology mining engineering and technology along the resource industry chain, another is constantly promoting and expanding to agricultural geology, urban geology, environment geology, marine geology and so on based on the geology mining technology, and the last is the cross penetration fields of geology and economy, management, humanities, computer, etc. IV represents educating four compound talents. One is around all kinds of knowledge integration of geological exploration, geochemistry, geophysical prospecting, rock-mineral analysis, exploration engineering, hydrogeology, engineering geology, etc. The second can integrate the related knowledge of exploration, mining, separation, processing, utilization, etc. The third integrates the knowledge system of traditional geology with expanding areas including agricultural geology, environment...
geology, urban geology, marine geology, etc. The last integrates the professional knowledge of geology and economy, management, humanities, computer, etc. The cultivation of compound talents can achieve by planning the course setting (subject basic level, professional level, public electives level, specialized electives level, etc.), the second degree, and mining in major and so on (Wenfang Zhou, 2008).

In order to improve the practicality and applicability of geology mining engineering professional, it is necessary to strengthen the practical ability through constructing the practice platform in the training process. The design and reform process of practice teaching training scheme must insist on the following three principles: one is to closely combine with the teaching plan. Practice teaching proceeds according to the demand of different stages and links of course teaching and professional study, with different goals and requirements. Thus, practice teaching must be coordinated with course and professional teaching, realizing the goals of different stages, links and the overall. The second is systemic principle. Practice teaching have strong purpose, and different practices have the common and general training functions and needs besides their unique functions and purposes, therefore, making practice teaching plan should fully consider the training goal, linking up, teaching needs, etc. factors of different stages and links, overall arrange and systematically design. The third is continuity principle. Practice teaching must satisfy the continuity requirements of cultivating and

IV. Construct the practice platform for talents training

The geology mining engineering professional have strong practicality and applicability, so strengthen and train the practical ability necessarily through constructing the practice platform in the training process. In the design and reform process of practice teaching training scheme must insist on the following three principles: one is to closely combine with the teaching plan. Practice teaching proceeds according to the demand of different stages and links of course teaching and professional study, with different goals and requirements. Thus, practice teaching...
training knowledge, ability and quality. The last is combining centralization and decentralization. Practice teaching with multiply forms and kinds has periodic practices, such as cognition practice, professional practice, graduation practice, etc., and scattered practices, as courses experiment, recess practices, etc. This requires organically combining the centralization and decentralization of practice links through practice modules and scattered arrangement, according to the requirements and purpose of different practice teaching (Danping Yan, 2009).

Based on the above basic principles, establish the overall framework of geological academies practice training project (figure3). From the above we can see, it is a complete systematic achieving process from a high school student entering college, and through the four years cultivation, to finally finish studies, and out of the campus becoming a qualified geological professional and technical talent. In this process, it is the key link for system operation to carry out theory and practice teachings combining with a professional or subject. The theory teaching focuses on course system design, teaching content update, reforms of teaching ways and methods, and this content constitutes the teaching platform of theoretical knowledge. Along with theory teaching gradually carrying out, practice teaching in turn develops the theoretical knowledge verification experiments (including individual and comprehensive contents), professional subject knowledge comprehensive experiments (including professional and subject knowledge experiments), centralized training and practice (including professional practice, production practice and the industry-university-research integration training). Different practice links have talent training mission from knowledge to ability and comprehensive quality, so we should build the corresponding practice platform for the purpose and requirements of different links. Course experiment platform aims at deepening the understanding of professional knowledge, and shall choose the standardization and representative experiment projects closely combined with teaching contents. Professional subject knowledge comprehensive experiments to train students to fully understand and master professional knowledge, the practical ability, should choose the realistic diversified projects. While training and practice platform aiming at the actual work skills and innovation ability of students, proceed industry-university-research integration training combined with the actual production, scientific research projects.

![Figure 6: The practice teaching system design scheme](Image)
Reference


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Multi-agent collaboration platforms: Are they feasible for the Namibian Transport Industry?

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Abstract: Namibia’s transport industry is seen as of key importance to the country’s growth seen by the emphasis in the National Development Plans NDP_4 (World Bank 2012). However collaboration among Namibian transport stakeholders is lacking (Jenkins, Savage et al. 2012), and could be a hindrance to these plans. This paper explores the feasibility of using Multi-agent systems (MAS) i.e. computers called agents that operate autonomously and carry out specific tasks on behalf of the users (Wooldridge, Jennings 1995, Robu, Noot et al. 2011), as a platform to promote collaboration.

The approach included literature studies on collaboration platform and on MAS solutions where the results were combined with part of a feasibility study/requirement guideline proposed for new business developments (Pergl 2010, Hofstrand, Holz-Clause 2009). Findings include regional transport collaboration solutions and sheds more light on features some possess. Feasibility of implementation within Namibian industry was seen to be possible, as regional solutions were accessible to the Namibian market.

Keywords: Multiagent systems, Feasibility, Collaboration, Transport

Introduction

Transport being such an important contributor to any economy, stands at the forefront of enabling development in Namibia. A good transport system ensures economic growth in any country, and this is shown to be the case in developed countries (Canning, Fay 1993, Banister, Berechman 2001). The establishment of such systems tends to be dawdling and unhurried in developing countries. The lack of urgency for developing good transport systems often lead to stagnated economic growth in many countries (Borndörfer, Grötschel et al. 1998). Namibia has to ensure that this does not happen, and harnessing available capacity through collaboration could be a way forward. Thus this paper looks at the feasibility of transport collaborative platforms in Namibia, specifically looking at Multiagent systems.

I. LITERATURE REVIEW

A. Technology adoption

In any environment, where new systems are proposed, there has to be an assessment done to get the current status and to determine the criteria for technology adoption. Adopting new systems or integrating with older ones requires understanding of previous systems and often needs complete “overhaul” or replacement (Premkumar, Roberts 1999). In developing countries the technology adoption could have two sides when introducing a new system. Firstly, the introduction of a system where no previous system exists is the most likely
scenario, as transporters sample from Savage et al (2012) indicates that systems are expensive to acquire, and the support is expensive due to limited local expertise (Holland 1999). Secondly with the introduction of new systems on top of others will render them either obsolete or would require extensive integration through customized solutions. Savage et al (2012) provides some indication of the Namibian ICT situation that varies among stakeholders providing environments like: proprietary business systems, stand-alone PC with excel workbooks, no ICT. Therefore the technology adoption for collaboration platforms would vary among stakeholders.

B. Transport Collaboration platforms

Some define a transport collaboration platform as ICT enabled platforms for supporting and optimizing integrations among transport and logistics business networks. Pramatari et al, (2005) calls it platforms for supply chain members that are connected through the Internet. The main aim though is to promote information sharing to utilize transport capacity. The information could start with basic company profile advertising. The knowledge of other company’s capabilities could help to identify means of collaboration. Many platforms exist and provide their own set of features to do this.

C. Freight-matching/collaboration systems

Freight matching sites or “loadboards” are what transport collaboration platforms are referred to in the USA and Canada (Internet Truckstop, 123loadboard.com 2013, USA Canada Loadup ). These portals bring forwarders and transporters together whom then advertise company profiles. Features include: finding and hauling loads, dashboard views of carrier movements, load monitoring, fuel prices, maps and weather updates. Similar systems are active in Africa growing in user numbers steadily (Laaimylorrie, Bid2Load 2013) Registering with these systems is required, allowing all profiles the flexibility of collaboration with others. Connection to these can be made through normal computers and/or smartphones. Customization of profiles ensures correct business notifications are received and can be responded to.

Systems could be categorized as either non-intelligent or intelligent platforms. The former allow stakeholders to visit the site to retrieve or share information on particular loads and trucks. This is done by posting or retrieving transport lines\(^1\) using Internet connected devices. Figure 1 below shows typical flow of information between forwarders and truckers, who can now match loads and choose to collaborate. What non-intelligent platforms can’t however perform, is handling unforeseen events in real-time. These systems capture a lot of data, but cannot analyse for further use and provide usable data to aid decision-making. A lack of certain automatic algorithms to identify load sharing and back haul opportunities is usually omitted in these systems. These systems are however a good example of where the two types of collaborations i.e. horizontal and vertical, can take place (Schmidt, Mbai et al. 2011).

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\(^1\) Transport lines are information on the particular transport jobs: i.e. in forwarders case, it indicates, the commodity/freight info, load info, start and destination and transporters case, it’s the truck info, capacity, current status and direction.
Intelligent platforms provide more than just access to view, post or retrieve information, it possesses the feature to carry out events independent from the user. The platforms not only perform matching, but also find the most appropriate ones (Dullaert, Van Landeghem 2007). The main difference is though as Bernaer et al (2006) describes that intelligent platforms handle events in the absence of the user. In order to achieve this users have to make use of computers referred to as agents, to interact with others on a specific platform, specifically a multiagent environment. Robu et al (2010), discusses that though these platforms has some intelligent behaviour the agents cannot be given the responsibility to post orders or requests. Confirmed by Dullaert et al. (2009), which says, their system is only autonomous to the extent that it changes the distribution of information. Thus users are left with some responsibilities in multiagent systems.

D. Multiagent systems (MAS)

An agent is referred to as an individual computer configured with user preferences, policies, algorithms and systems and carry out tasks on behalf of users (Kwon, Im et al. 2001, Ren, Beard 2003, Robu, Noot et al. 2011). The agents are set with certain algorithms to react to events from others, making this the key to an agent’s success (Robu, Noot et al. 2011). Weiss (1999) and Hong (2008) describe these as being derived from distributed artificial intelligence, where agents communicate with others to derive behaviour from its environment. This is referred to as Multiagent systems (MAS). Each individual agent might have different or similar interests within the environment but because it operates in a multiagent environment, through communication with other agents it can assist in providing an overall service. These agents have the characteristics of autonomy, reactivity, pro-activity and social ability (Wooldridge, Jennings 1995). Serna, Uran et al (2011) describes these states as follows:

- autonomy being when each agent operates without outside involvement, and controls its actions and in-house states.
- reactivity through actions taken when the environment changes.
- pro-activity by possessing the ability to send own behaviour changes to the surrounding agents.

![Figure 1 Flow of information between transporter and forwarder (Schmidt, Mbai et al. 2011)](image-url)
• social ability to represent the interaction that exists either between agents or agent and human.

Protocols used for interaction between agents are e.g. XML, UDDI, WSDL and SOAP (Curbera, Duftler et al. 2002).

Intelligent communication support platform do exist for transport multimodal scenarios (Dullaert, Neutens et al. 2009). One of the main aims of such a system is to act as an integrator that exchanges correct, reliable and relevant data (Dullaert, Neutens et al. 2009). These systems thus operating autonomously allow for potentially uninterrupted service delivery through its real-time event handling. This paper considers the feasibility of such systems within the Namibian transport industry.

E. Feasibility

A Feasibility study as described by Pergl (2010), sheds more light on the viability of implementation of a suggested system, by identifying crucial aspects related based on requirements. This study focuses on the requirement analysis of the system as suggested by Pergl (2010), together with the following selected aspects suggested by Hofstrand, Holz-Clause (2009):

• Market feasibility
• Technical feasibility
• Economic feasibility

1. Requirements

Pergl (2010) defines the requirement analysis as the identification and quantification of demand function of the system. This will allow the identification of infrastructure needs and sheds more light on the complexity of fulfilling these needs. A requirement derived from Savage, Jenkins et al (2012) through its sample was the need for collaboration among transport stakeholders. An example of this lack of collaboration was evident in the same study by the high percentage of empty running experienced by many. Another requirement is to obtain up-to-date corridor movements in Namibia, with the aim to help others to probe collaboration options.

2. Market Feasibility

The study looks at the size and scope of the industry, the competitiveness, and the market potential. The Namibian transport industry or operating members registered by Namibian Logistics Association, (2013), totals 46 and consists of various players. These are divided into transporters, freight expeditors or a combination of the two. This provides an indicator of the size of the industry. However this size could be doubled when considering users of the services within the industry. The scope of the industry could be inflated as any stakeholder with transport related information could be a potential collaborator.

Competitiveness with other stakeholder and similar platforms regionally and internationally needs to be considered. Savage, Jenkins et al (2012) reports that several South African (SA) registered companies operate in Namibia. There are several reasons for this with the reliance on imports being the most likely one. Collaboration platforms as suggested under (C), exist regionally and are accessible by the Namibia industry. The study lacks information on the extent of which the industry uses these systems.

Market potential considers the future emerging market, with the aim of Namibia to become a logistics hub through the Port of Walvis Bay. The port currently operates at +/- 350000 TEU per annum, but with the expansion aim to boost this to approximately 1Mil TEU’s. This could provide more opportunities for transport stakeholders to collaborate. A system to
provide such a platform could be better suited if housed in Namibia.

3. Technical Feasibility

Multiagent systems as defined earlier are technically a group of computers configured to communicate and operate amongst each other. To achieve this requires reliable connectivity within such an environment. Namibian ICT support has steadily increased and has shown stability and increases in the areas of fixed broadband subscriptions and secure Internet servers (Dutta, Bilbao-Osorlo 2012). The country’s population also had good mobile-cellular network coverage with international Internet bandwidth growing 10 times since 2005 (Dutta, Bilbao-Osorlo 2012). Developing a MAS environment requires several inputs, and most important probably is the technical ability or know how to support it. Regulatory frameworks need to be identified, as consensus dynamics are difficult to achieve within such an environment. Production inputs include electricity, backups and secure sites. Managing a MAS environment would require experts to ensure its continuance, thus training would be required in Namibia. The Polytechnic of Namibia transforming into the Namibian University of Science and Technology, could be at the forefront to provide this training to students and the industry.

4. Economic Feasibility

The capital needed to start such a project needs further investigation, as collaboration platforms are non-existent in Namibia. Data to determine the current technological capacity of stakeholders needs delving, as capital for equipment is difficult to estimate. The economic returns through sharing of capacity and work are considered. In European countries efficiency and cost gains have been between 6 and 10% (Graham 2011). The expected revenue of MAS would be from the facilitation of a platform for other agents and getting a fee from doing it. This study needs to further investigate the expected profit margin, sales and price levels.

II. Conclusion

Ensuring that Namibia has a good transport system does require input from all stakeholders. Introducing collaboration through a portal to share basic information could be a feat on its own in developing countries, but should be the way forward. The sharing of info and capacity are means that the industry can strive for increased efficiency. As determined from the technology indexes and some literature, there are various scenarios in Namibia to consider before proposing new system. There are however already possibilities of collaboration through freight matching and collaboration platforms/solutions in the region. This is the first step to sharing information and allowing the next level in multiagent systems (MAS) to make its way in. The setup of MAS does require certain technological capabilities within a stakeholder; computer system to act as the autonomous agents, and a secure and reliable network/internet connectivity. Information Communication Technology (ICT) adoption has shown an increase among developing countries (Dutta, Bilbao-Osorlo 2012), and Namibia does already possess to some extent established infrastructure and reliable connectivity. What is lacking is the knowledge and expertise on the management of a MAS environment. This does pose another barrier to overcome and might hinder the adoption of MAS in Namibia, however investment and training would be able to solve this. The transportation market in Namibia shows potential, and has the possibility to grow through the introduction of collaboration platforms. This growth can only be achieved through
sharing of capacity, and once achieved it could aid Namibia to compete globally as the gateway to Southern Africa. As far as being economically feasible it would require “buy in” from many of the stakeholders. A system that not only benefits the individual, but also others linked to it, opens up more economic opportunities. This paper concludes that there is a need for a collaboration system in the Namibian transport industry for both commercial and organisational benefit, and that MAS might a feasible platform.

III. REFERENCES


INVESTIGATING THE RELATIONSHIP BETWEEN PRODUCT MODULARITY AND SUPPLY CHAIN INTEGRATION

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Abstract: The purpose of this paper is to investigate the relationship between product modularity (PM) and supply chain integration (SCI), and to identify factors influencing this relationship. A case study approach involving in-depth interviews with module suppliers and module users in South Africa (Gauteng) was conducted. Within and cross-case analyses were adopted. Benefits of PM, shortcomings of PM and differences, if any in the understanding of seven success factors of PM were established. Success factors were identified from a critical literature review and survey approach has been used to collect relevant data from modular suppliers and users. The paper finds that success factors have different rankings in suppliers and users, but contractor comprehend that implementation of PM success factors is very important. Results prove that modular design in construction industry is related to a loosely coordinated supply chain.

Keywords: Supply chain management, Integration, modularity, South Africa

INTRODUCTION

In recent decades, many manufacturing firms have experienced an increase in competition in the marketplace due to globalization, increased demand in variety, and shorter product lifecycles. This has forced many firms to move away from the traditional world of mass manufacturing to the world of mass customization through flexibility and agility. However, in order to achieve agility, industries must adapt their product design and development processes to accommodate the rapidly changing needs of their customers. Product modularity provides flexibility and responsiveness that enables firms to serve a variety of customer needs. An advantage of modularity in relation to supply chain design is that pursuing product variations has only a limited impact on production and assembly processes. Modular design allows a firm to differentiate its product to a high degree by combining a limited number of standard parts (Muffato, 1999). There has been a considerable body of knowledge investigating the development of modular construction (Goodier et al., 2007), the impact of buyer-supplier relationships (Hsuan, 1999). Modularity has been extensively applied successfully in the in electronics and automotive sectors (Camuffo, 2000; Helper et al., 1999). This paper seeks to demonstrate the extent to which supply chain practices are aligned to modularization in furniture industry. Using loosely-coupled structures enables firms to achieve greater scope flexibility and scale flexibility. The supply chain must be aligned with product development decisions; it should be designed and managed, so that the products are delivered at the targeted cost, time, and quality (Margherita et al., 2010).

Using modular product design as your new product development strategy decreases time to market, increases the number of product variants, increased flexibility, reduced cost and decreases the number of unique parts in your product architecture (Sturgeon, 2002). Product modularity offers many advantages to the construction industry which are: reduced labor reduced waste, reduced inventory, increased quality, improved productivity and enhanced cost and quality performance (Pasquire et al., 2002). Modular supply chain and modular product design allows firms to link
together the capabilities of many organizations to support product development (Sanchez, 1995).

Several barriers exist for the increased use of modules in furniture industry, which include difficulties associated with complex interfacing between systems, the inability to unfreeze design decisions, site access constraints in kitchen fittings and high costs in importing modules like recliner mechanisms and refrigeration systems from China for the lounge suites. In the following sections the literature relating to modularity and supply chain management will be discussed. This will be followed by research methodology, analysis of case studies and discussion of findings. The implications of the research will be discussed, together with suggestions for future study, in the conclusion.

I. LITERATURE REVIEW

Sections 2.1 and 2.2 hereby review modularization and supply chain management, respectively. Section 2.3 reviews relationship between modularization and supply chain management.

2.1 Modularization

Modularity is an approach for managing and developing complex products and processes efficiently by decomposing them into simpler subsystems without compromising the system’s integrity (Baldwin CY et al, 1997; Garud et al, 1993). It is also considered as a new product development strategy in which interfaces shared among components in a given product architecture become specified and standardized to allow for “greater substitutability” of the components across product families (Mikkol, 2001). Therefore, Modular product architectures are used as flexible platforms for leveraging a large number of product variations (Sanchez, 1999; Robertson et al, 1998).

Modular design can be viewed as the process of producing discrete functional units that are connected together to provide a variety of product functions. Modular design emphasizes the minimization of interactions between components in order to design and produce those components independently. Each component, designed for modularity, is supposed to support one or more functions. When components are structured together to form a product, they will support a larger or general function (Salhieh et al, 1999).

Modularity is an example of architectural innovation that enables greater flexibility for mass customization but “without changing its components” (Sanchez et al, 1996). Modularization enables mass customization not only by providing a means for the repetitive production of components (Pine, 1993). One of the great advantages of modularization is the ability to assemble repetitive units in controlled conditions. Modular product architectures require physical independence and functional independence. Simply splitting up a product for later assembly is not necessarily termed a modular approach; there need to be a certain level of flexibility in the way that parts are recombined. Modularization requires standardized interfaces to provide embedded coordination that greatly reduces the need for overt exercise of managerial authority to achieve coordination of the product development process (Howard et al, 2007; Ulrich, 1995) states that a modular product or subassembly has “a one-to-one mapping from functional elements in the function structure to the physical components of the product” and that all interfaces between the components of different modules are decoupled. Modularized product architecture can be disintegrated into loosely coupled components offering high possibility to outsource design to suppliers. There is two types of product architecture: integral and modular.

Three rules that define Product architecture are (Baldwin et al, 2000):

1. Architecture, which specifies what modules, will be part of the system and what their functions will be.

2. Interfaces, describe in detail how they will fit together, connect, and communicate.

3. Standards, for testing a module’s conformity to the design rules and for measuring one module’s performance to another.

Two types of macro types of modular product architecture are function-based and manufacturing-based (Otto et al, 2001). Function-based is partitioning a product into discrete scalable, reusable modules consisting of isolated, self-contained functional
elements. Manufacturing –based modularity is the application of unit standardization or substitution principles to create modular components and processes that can be configured into a wide range of end products to meet specific customer needs.

Besides reduction in cost (due to lesser customization, and less learning time), and flexibility in design, modularity offers other benefits such as augmentation (adding new solution by merely plugging in a new module), and exclusion. Examples of modular systems are automotive industry (Jacobs et al, 2007), computers and high rise buildings. Earlier examples include looms, railroad signaling systems, telephone exchanges, pipe organs and electric power distribution systems. Computers use modularity to overcome changing customer demands and to make the manufacturing process more adaptive to change (see modular programming). Mechanical and electronic modules are now being incorporated in furniture products; the use of mechanical recliner mechanisms and electronic modules like refrigeration units and CD players has enabled furniture industry to increase its product variety.

Modular design is an attempt to combine the advantages of standardization (high volume normally equals low manufacturing costs) with those of customization. A downside to modularity (and this depends on the extent of modularity) is that modular systems are not optimized for performance. This is usually due to the cost of putting up interfaces between modules.

2.2 Supply Chain

Value-transfer theory states that in order to concentrate on its core business, a manufacturer will transfer non-core value-adding activities to its supplier also, the supplier reorganizes its own business to accommodate the increased production and management responsibilities and then passes down some value-adding activities to its own suppliers (Doran, 2003). Value-added activities are shifted from a single organization to the overall modular supply chain as the key modules are outsourced to technically competent module suppliers in modular product design (Doran et al, 2007).

Product modularisation cuts down too much variety in development by simplifying design activities, improving coordination and information sharing across production, sales and engineering (Danese et al, 2004). Modular design improves competitive performance, facilitates supplier, manufacturing and design integration by simplifying communication and information sharing and building trust among supply chain partners (Jacobs et al, 2007). Supplier proximity changes due to different types of modular product design. Ulrich et al (1999) argue that, under holistic customer requirements, when components are designed for a specific product, internal and external integration is required. The decisions about modular design have a substantial influence on the supply chain environment.

A modularized product has a set of independent modules, which allows standardization (Ulrich et al, 1991). Standardized modules can be better outsourced to suppliers (Novak et al, 2001), using a loosely integrated approach (Sanchez et al, 1996). Iterative communication and coordination among suppliers and manufacturers in the development process can be reduced when the supplier can focus on its predefined specifications without being too concerned about other modifications (Laseter et al, 2002).

Modular product design may reduce the need for extensive internal integration (Baldwin et al, 2000; Sanchez, 1999). The development of modular systems can lead to vertical and horizontal disintegration (Langlois et al, 1992).

In order to ensure the conformance of different product components the supply chain must be integrated as closely as possible for ease of communication and coordination. Extensive integration should help the suppliers to develop innovative new products through collaboration (Ragatz et al, 2002). Diez (2000) says close supply chain design improves information sharing, especially tacit knowledge sharing, e.g. physical co-location and face-to-face communication. The tacit knowledge then promotes innovation that leads to a competitive advantage (Mascitelli, 2000). Modular design can lead to more supply chain collaboration as it increases the supplier’s need for relationship-specific investments and for agreement on the design of common modules (Howard et al, 2007).
III. RESEARCH OBJECTIVES

The present study is a case study in South African (Gauteng) furniture industries and aims to find answers to the following questions:

1. What are the benefits and shortcomings of product modularization?
2. What is the difference in perception of furniture manufacturers and the module suppliers?

IV. RESEARCH DESIGN AND DATA COLLECTION

The first question above was answered in the literature survey, published work in reputed journals or conferences, through which we can gain knowledge of various benefits and shortcomings. Most people from procurement and operations were contacted to understand PM. Some of the people who were contacted were purchasing managers, purchasing officer, purchasing agents, purchasing associates, product engineers, etc. The various benefits of PM are:

- **Higher flexibility**: Changes in products due to market or new technology can be made more easily since they will influence limited parts of the product.

- **Reduction of product development time**: Parallel development activities are possible once the interfaces between the modules have been defined.

- **Parallel development of product and production system**: Product development plans can be translated into production plans for each module.

- **Reduction of production lead-time**: Parallel manufacturing of modules instead of manufacturing an entire product in a single sequence.

- **Less capital tied up in production**: Work-in-progress is reduced due to shortened lead times, less stock maintenance of ready-made products.

- **Reduced material and purchase costs**: The reduction in part numbers means less to purchase and less to administrate, and higher volumes per part number.

- **Improved quality**: Modules tested before final assemblies have shorter feedback links, allowing easier adjustments.

- **Easier service and upgrading**: Standardized interfaces make adding or replacing a module easy.

Similarly, from the user's point of view, the following are the advantages of having modular products (Pahl et al, 1996):

- Short delivery time
- Better exchange possibilities and easier maintenance
- Better spare parts service

- Possible changes of functions and extension of the range
- Almost total elimination of failures due to well-developed products

**Disadvantages**: From the manufacturer’s perspective, the following limitations are possible (Pahl et al, 1996):

- Adaptations of a special customer’s wishes are not as easily made as they are with individual designs.

- Product changes can only be considered at long intervals because development costs are high. The technical features are more strongly influenced by the design of modules and the modularity than they would be by individual designs.

- Increased manufacturing cost, for instances of locating surfaces as manufacturing quality, must be higher because re-machining is impossible.

- Increased layout cost is likely.

- Since the users as well as the manufacturer’s interests have to be taken into account, the determination of an optimal modular system may prove to be very difficult.

From the user’s point of view, the disadvantages could be as follows:

- Special wishes cannot be met easily.
Certain qualitative characteristics may be less satisfactory than they would be with special-purpose design.

These benefits ultimately culminate in a radical change in the performance standard of the organization and ensure continual growth in a competitive market situation.

To answer the second question set out in the last section, a hypothesis H0 was set and a questionnaire was prepared based upon the hypothesis:

H0. There are significant difference between the perception of furniture manufacturers and the module suppliers.

The questionnaire was based on the seven success factors which are responsiveness, effective communication, risk and reward sharing, management commitment, employees training, customer satisfaction, knowledge sharing. A total of 100 questionnaires were sent to furniture manufacturing companies and to ten suppliers of modules and the response rate was 50%. The module suppliers included recliner mechanism suppliers, refrigeration unit and CD players for sofas, suppliers of upholstery fabric. The first eight questions in the questionnaire were related to background of industry, number for employees, sector of the business, type of industry, position of respondent. The different questions were grouped into seven factors. Each factor was then divided into variables or statements. Each variable was measured on a Likert scale in the questionnaire. The contents of the questionnaire were decided after thorough discussions with experts and then subjectively judged by the researchers.

V. ANALYSIS OF DATA

A purposive sampling procedure was employed and prior knowledge was used in selecting the respondents or companies to be sampled. Questionnaires were prepared and sent to targeted individuals by e-mail and in print form. The data collected were analyzed by using SPSS Version 7.5 and Minitab Version 13 software in order to test the hypothesis H0 at the 5 per cent level of significance (the significance level based on the asymptotic distribution of a test statistic). A value of less than 0.05 was considered significant and was chosen to analyze the data. Table 1 illustrates the means, standard deviations and paired comparison for each factor for both manufacturers and suppliers. The paired-samples t-test is a statistical test of the hypothesis H1 (i.e. there are significant differences in understanding the success factors of CPRF in retailers and suppliers organizations). It is used when the observations for two groups can be paired in some way. The differences observed between the groups can then be attributed more readily to the variable of interest.

P-values are often used in hypothesis tests to either accept or reject a null hypothesis. The p-value represents the probability of making a Type 1 error, or rejecting the null hypothesis when it is true. The smaller the p-value, the smaller is the probability to make a mistake by rejecting the null hypothesis. A cut off value often used is 0.05, that is, the null hypothesis is rejected when the p-value is less than 0.05.

VI. KEY FINDINGS AND DISCUSSION

From Table 1, it can be seen that the p values of various factors are less than 0.05, except for Risk and reward sharing, which clearly rejects the null hypothesis (there is a significant difference in the understanding of success factors for PM in manufacturers and module suppliers). This observation shows that both parties understand management commitment, responsiveness, employees training, customer satisfaction, effective communication and knowledge sharing as success factors of PM system.
Table 1:
Factors, mean, standard deviation, paired t-value and p-value for 5 per cent significance level

<table>
<thead>
<tr>
<th>Success Factor</th>
<th>Mean</th>
<th>SD</th>
<th>Paired Comparison</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modular Manufacturer</td>
<td>Supplier Manufacturer</td>
<td>Modular Manufacturer</td>
<td>Supplier Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Responsiveness</td>
<td>3.55</td>
<td>3.93</td>
<td>0.469</td>
<td>0.482</td>
<td>2.45</td>
</tr>
<tr>
<td>Effective communication</td>
<td>3.42</td>
<td>3.20</td>
<td>0.451</td>
<td>0.470</td>
<td>2.25</td>
</tr>
<tr>
<td>Risk and reward sharing</td>
<td>3.07</td>
<td>3.43</td>
<td>0.459</td>
<td>0.451</td>
<td>2.10</td>
</tr>
<tr>
<td>Management commitment</td>
<td>3.48</td>
<td>3.31</td>
<td>0.575</td>
<td>0.297</td>
<td>2.29</td>
</tr>
<tr>
<td>Employees training</td>
<td>3.67</td>
<td>3.24</td>
<td>0.458</td>
<td>0.479</td>
<td>2.80</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>3.48</td>
<td>3.15</td>
<td>0.575</td>
<td>0.297</td>
<td>2.29</td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td>3.65</td>
<td>3.27</td>
<td>0.588</td>
<td>0.564</td>
<td>2.31</td>
</tr>
</tbody>
</table>
Risk and reward sharing in PM is very important for effective and efficient operations. Better risk and reward sharing and effective communication could reduce misunderstandings and confusion regarding the requirements from internal and external suppliers. The relationship between the manufacturer and the supplier may be collaborative or adversarial. In a collaborative relationship, an informal agreement is made (i.e in small enterprises); a formal agreement is made in small to large enterprise/middle enterprises. In the adversarial relationship, any ex-ante contract is worthless, since parties are assumed to renegotiate the terms after they invest in collaboration and design.

There is theoretical and anecdotal evidence that both types of relationships exist in practice. With regard to collaboration, the literature on relational contracts (Plambeck et al, 2006; Dyer, 2000; Levin, 2003) formally shows that even when it is not possible to write “complete” contracts, opportunistic action can be avoided, if the loss of potential future business is sufficiently large or such actions have the potential to negatively affect interactions with future trading partners. (Dyer, 2000) argues that the trust built in long-term relationships helps reduce opportunism and transaction costs significantly, and therefore leads to actions that maximize the total profit, for instance through location of supplier facilities in close proximity. (Stallkamp, 2005) observes that renegotiation is common in adversarial relationships; suppliers bid low to get the business, but increase the price once the manufacturer is locked in, for instance due to design changes. Contractors spent a much higher fraction of its face time with suppliers for conflict resolution and negotiation for profit sharing. Some suppliers they ignore the contract and adjust their design efforts based on the profits they expect to get.

By outsourcing the development of modules, the contractor leverages the expertise of an external supplier, which potentially leads to lower development costs (or a better product).

In an adversarial relationship the manufacturer and the supplier expect opportunistic action from each other; therefore, both parties determine their development efforts based on how much profit they expect from ex-post renegotiation. Profits are shared under the collaborative scenario, whereas the manufacturer only pays the supplier its reservation profit in adversarial relationship.

The ability to spread the fixed collaboration costs over a larger number of units shifts the trade-off between development complexity and performance in favor of performance. Second, all else equal, a modular architecture becomes preferable when the cost of collaboration between development teams is high, for instance due to geographic separation or differences in technical languages. In such a case, a strategy of modularization is preferable to that of intensive collaboration and communication.

Furniture industry lags behind in communication technology especially between small scale – medium business, an improvement in communication can increase the efficiency of the supply chain.

VII. CONCLUSION

One of the advantages of modular architecture is that it facilitates the development of structured supply chain that is less difficult to manage. Shared common modules have significant impact on the optimal configuration of the supply chain. This work can therefore be extended by considering the scenario of optimizing the configuration of the supply chain system for given modular strategies and commonality among multiple products. With this extended model, the impact of modularity, commonality, and platform sharing among a family of products on the supply chain configurations can then be examined.

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THE ROLE OF INNOVATION CONSULTING FOR SMALL AND MEDIUM-SIZED ENTERPRISES

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Abstract: Open Innovation and Lean Innovation are two major trends in innovation management. The use of external innovation services can be an opportunity for every company in order to open up the innovation process successfully and making it more efficient. This paper aims to determine the importance of external innovation services as a part of the innovation management in small and medium-sized enterprises (SME).

Based on an empirical study of the Jena University of Applied Sciences (EAH Jena), 25 local SME from technology-oriented industries were surveyed regarding their innovation management. Thereby, it was evaluated whether innovation service providers are consulted by SME in general and, more specifically, for which tasks. Another research question was if innovation service providers are consulted on a regular basis. Additionally, the reasons for or against the usage of external innovation service providers were analyzed. Besides that, the question was posed to what extent customers are currently integrated in innovation processes. In this context, it was also part of the survey whether companies will use customer integration as well as innovation research from university institutes to a greater extent in the future.

Keywords: Innovation Services, Innovation Consulting, Innovation Management, Small and Medium-Sized Enterprises (SME)

i. Introduction

The topics for research on innovation are diverse. Indeed, there is a continuous development, whether in the field of new materials or less expensive 3D-rapid prototyping, but especially for new methodological approaches such as open innovation (Buerke, 2013; Scheed/Falter, 2013; Wolfrum, 2013), integrated knowledge and innovation management (Franken/Franken, 2011) or reverse innovation (Fend, 2013). Innovation management as it is understood here includes the design, control and development of innovative projects and processes. Hofbauer (2013, p.13) describes innovation management as the management of new products and encompasses both internal and external innovation processes.

Against this background, the Ernst Abbe University of Applied Sciences in Jena (Germany) launched an exploratory study of the innovation activities, processes and management at local manufacturing SME. This paper focuses on the part of this study covering a detailed analysis of the use and evaluation of external innovation services in the context of innovation projects.

2. Research Context

Even though innovations, innovation processes and innovation management are topics which have been frequently researched and studied from various different angles, Willfort (2000) analysed the contribution of external innovation services in the innovation process in the German-speaking area for the first time. In particular, Willfort (2000) gave a holistic overview of the services which can be used in the different product innovation phases (see figure 1).
This explorative study conducted with 25 manufacturing SME in Jena (Thuringia) aims to apply Willfort’s (2000) approach in this context. In fact, two studies in the last decade have researched SME in Thuringia (Kugler/Zickert, 2005; Kaps/Pfeil/Sauer/Stoetzer, 2011). Worth mentioning is also Bönte (2003) who investigated the role of internal vs. external R&D for manufacturing companies of all sizes but limited to West Germany.

The studies “Innovation Activities study of SME in Southern Thuringia” (Kugler/Zickert, 2005) and “KompNet” (Kaps/Pfeil/Sauer/Stoetzer, 2011) surveyed manufacturing and other companies in a larger sub-region. Conversely, this Ernst Abbe University of Applied Sciences study focuses solely on manufacturing SME in Jena. Jena is characterized as a city with strong technology-oriented companies and is also the most important scientific center in Thuringia with two universities and a dozen renowned scientific research institutions.

The present study on innovation management in a broader sense takes into account the following four methodological approaches:

- Innovation management with integration of external innovation services
  - Use of specific types of innovation services
  - Frequency of the use of external innovation services

- Process management
  - Type of used innovation process models (single model vs. multiple models vs. individualized model)
  - Knowledge management
  - Specification of the use of external knowledge of local, regional or national innovation services

- Absorptive capacity
  - Current and future importance of customer and expert integration in innovation projects

Previous research already covered studies on innovation processes and management in SMEs (e.g. Verworn/Lüthje/Herstatt, 2000; Rüggeberg/Burmeister, 2008). However, the special innovation challenges of manufacturing SME have not been taken into account in detail so far. Hence, this exploratory study was set-up to fill this research gap.

Additionally, the results were compared to existing studies which investigated companies from the Thuringia region (Kugler/Zickert 2005, Kaps/Pfeil/Sauer/Stoetzer 2001) in order to ensure comparability of results.

In this study, a total of 30 companies were interviewed for about one hour. During the survey, CEOs and managers of the senior management were interviewed on the process of their internal innovation processes in their company. Besides the general design and requirements of innovation processes, special attention was given to the use of external innovation service providers.

Furthermore, the analysis was broken down to the particular functions covered by external innovation services and the frequency by which external providers are consulted by the company. The study also differentiated what in which frequency certain types of external innovation services providers are
consulted, for instance, public or private institutions as well as local, regional or nationwide active service providers.

Supplementary topics included questions on the issue of open innovation with regard to customer and expert integration (both offline and/or online).

In addition, the reasons for or against the use of external service providers, as well as where SME see the most common needs for external services in the future were determined.

The survey took place from December 2012 to March 2013. During each interview, two researchers were present for leading and recording the conversation. Before the actual data collection, two pretests were performed with companies.

The study included 25 technology-oriented, manufacturing SMEs from the B2B sector which represents the overall dominant industry in Jena in an adequate manner.

### Characterization of the companies surveyed

Small and medium-sized enterprises as defined by the European Union in 2008 are enterprises which employ less than 250 employees and either obtain a total turnover at a maximum of €50 million or an annual balance sheet total not exceeding €45 million. Furthermore, the company must be largely independent, meaning not to belong to a consortium.

The total sample of 30 companies consisted of 25 manufacturing companies and five software companies. As software companies exhibit a significantly different innovation behavior compared to manufacturing SME and were therefore excluded for further analyses presented in this paper.

The 25 manufacturing companies can be segmented in four categories due to clearly discernable sizes of the companies. This classification which is outlined in Table 1 differs from that of the EU Commission (micro enterprises with a turnover of ≤ €2 million, small enterprises ≤ €50 million, medium-sized enterprises > €50 million).

<table>
<thead>
<tr>
<th>Manufacturing types</th>
<th>Micro-enterprises</th>
<th>Small enterprises</th>
<th>Medium-sized enterprises</th>
<th>Large-scale enterprises</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>companies</td>
<td>(Turnover ≤ 1.5 million EUR)</td>
<td>(Turnover 1.5-5.5 million EUR)</td>
<td>(Turnover 5.5-15 million EUR)</td>
<td>(Turnover &gt; 15 million EUR)</td>
<td></td>
</tr>
<tr>
<td>Small enterprises</td>
<td>4</td>
<td>12</td>
<td>8</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Medium-sized enterprises</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All surveyed manufacturing companies fit into the EU definition of SMEs - with the exception of the largest enterprise. This company also belongs to a separate group of companies. However, as the number of employees is still close to the limit of 250 people according to the EU definition, this company is enclosed in the analysis. For the following analyses, only the groups "small enterprises" and "medium-sized enterprises" will be distinguished due to the limited overall sample size.

Most of the companies surveyed belong to the industry sector of measuring, control and regulation technology (n = 11). Furthermore, the optical industry as well as the glass and glassware manufacture is represented, each with three companies. Additional sectors are biotechnology (2), research & development (2) and medical technology (2). From the plastics engineering, and also the shaping of metal sheets and the sheet metal processing sector originates each one of the companies. This overview of the sectors shows that the surveyed companies predominantly operate in the B2B sector.

### Manufacturing Types

16 companies commented on the question which production methods they use primarily. The small series production dominates in comparison to individual, large-batch production and mass production. Yet mostly, companies use combinations of these four production methods which is shown in figure 2.
Vertical range of manufacture

Figure 3 shows that the majority of companies manufactures complete products (multiple answers were possible).

R&D expenditures

In the following, the amount of R&D expenses relative to the turnover are illustrated as well as the differences of this relation between small and medium-sized enterprises (see figure 4).

The figures indicate that all medium-sized enterprises invest at least 10% of their turnover in R&D. Yet in the group of small businesses, there are two companies that depart from this pattern. According to the “The global innovation 1000” report (Jaruzelski/Loehr/Holman 2012, p. 5), top global companies spend in average 8.3% on R&D activities. In the publication, large companies such as Toyota, Nokia, Volkswagen, Microsoft were examined. Hence, it is noticeable that in this survey a lot of companies surveyed have a very high proportion of R&D expenses.

When looking only at the R&D spendings of small enterprises in the year 2011 (see figure 5), it can be seen that there is no tendency in the proportion of R&D expenditures. It is interesting to note that some companies invest a significant portion of their revenues in R&D. For example, company No. 5 and No. 4 stated that they spend 60% and 45% of their sales on R&D. For seven other companies, R&D spendings were between 15% and 30%.

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From the group of medium-sized enterprises, only seven of the nine companies provided information on this. Figure 6 shows that R&D expenditures of the enterprises did not increase with sales. Furthermore, it should be pointed out that company 3 invests a considerable amount of its sales (60%) in R&D.

Fig. 6: R&D spendings in relation to sales in 2011 in medium-sized enterprises

Despite of a low number of employees in total, many small businesses hire a relatively large number of employees exclusively for R&D tasks. Apart from this finding, it can be seen that the number of people employed in R&D of small enterprises is not depending on the total number of employees within this sample group.

Strikingly, the proportion of R&D employees in medium-sized enterprises is even higher (see figure 8). Furthermore, the diagram shows that the majority of employees are entrusted exclusively to R&D activities. Only one medium-sized enterprise employs fewer than 10% of employees in the R&D department whereas three companies employ about half or more of their workforce in this area.

Fig. 8: Number of R&D employees compared to the total number of employees in medium-sized businesses
Tab. 2: R&D spending over 10% in comparison to the share of turnover of new products (small enterprises)

<table>
<thead>
<tr>
<th>Medium-sized enterprises</th>
<th>R&amp;D expenses in 2011 in relation to turnover (in percentage)</th>
<th>Share of turnover of new products in the last 3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 3.</td>
<td>60%</td>
<td>90%</td>
</tr>
<tr>
<td>Company 5.</td>
<td>25%</td>
<td>100%</td>
</tr>
<tr>
<td>Company 2.</td>
<td>15%</td>
<td>100%</td>
</tr>
<tr>
<td>Company 4.</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Company 1.</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

R&D expenditures and share of sales of new products

Finally, the R&D expenses are compared with the share of sales of new products in the last three years.

The following tables show all the companies which invest a double-digit percentage of its turnover in R&D. High R&D spending usually also represent a significant share of sales of new products. This observation is valid for the small (see table 2) and medium-sized enterprises (see table 3) with double-digit share of R&D spending relative to sales.

Tab. 3: R&D spendings over 10% compared to the share of turnover of new products (medium-sized enterprises)

<table>
<thead>
<tr>
<th>Small enterprises</th>
<th>R&amp;D expenses in 2011 in relation to turnover (in percentage)</th>
<th>Share of turnover of new products in the last 3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 5.</td>
<td>60%</td>
<td>90%</td>
</tr>
<tr>
<td>Company 4.</td>
<td>45%</td>
<td>100%</td>
</tr>
<tr>
<td>Company 12.</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>Company 2.</td>
<td>30%</td>
<td>15%</td>
</tr>
<tr>
<td>Company 9.</td>
<td>20%</td>
<td>65%</td>
</tr>
<tr>
<td>Company 15.</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Company 11.</td>
<td>15%</td>
<td>80%</td>
</tr>
<tr>
<td>Company 14.</td>
<td>15%</td>
<td>50%</td>
</tr>
<tr>
<td>Company 6.</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Company 7.</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>Company 8.</td>
<td>10%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Overall, these figures indicate that most of the companies participating in the survey are indeed very active in R&D.

RESULTS

To structure the reporting of results obtained in this study, key findings can be summarized as follows:

1. The usage of external innovation services is widespread in SME.
2. The range of used innovation services is broad.
3. The use of various external innovation services varies considerably.
4. The regularity in which external innovation services are used differs strongly.
5. In a business location with a strong presence of universities and research institutes, these are the most used innovation service providers.
6. Medium-sized enterprises currently use the existing science facilities more intensively than smaller companies.
7. The used external innovation service providers are almost equally local, regional and national providers.

8. The motives for or against the use of external innovation services are versatile.

9. In future, the use of online customer integration will significantly increase in importance in the use of external innovation services.

10. SME use (almost) no competing innovation development.

11. SME from the region provide for local universities a good potential for new innovation services contracts.

1. The usage of external innovation services is widespread in SME.

Of the overall 25 responding SME almost three-fourths stated that they consult external innovation service providers as part of their innovation activities to receive additional support.

Fig. 9: Use of external innovation services

Yet, it should be noted that the unaided awareness of the use of external innovation services is significantly lower compared to aided questions, i.e. giving the interviewed person hints what is meant by this type of innovation support. To standardize the conduct of the interview, the interviewer showed the chart developed by Willfort (2000; see figure 1).

Eight out of nine (88.9%) of medium-sized enterprises use external innovation service providers. In comparison, only about 62% of small enterprises take advantage of external innovation service providers (see figure 11). However, in the future, this difference might disappear as a significant increase of the importance of external innovation service providers among small businesses is detected (31.2%), while the demand for innovation services for medium-sized companies will remain at the same level in the future (see figure 11).

Fig. 10: Use of external innovation services at present

![Graph showing the use of external innovation services at present.](image)

Fig. 11: Use of external innovation services in the future

![Graph showing the use of external innovation services in the future.](image)
2. The spectrum of used innovation services is broad

Figure 12 illustrates the range of potential innovation services. For 18 out of the 19 services which were specified here, at least one company stated using external providers for this function.

3. The use of various external innovation services varies considerably.

Industrial property rights and patent research are among the most commonly demanded external innovation services (see figure 13). Looking at the use of external services in the field of services such as legal issues but also the core parts of an innovation development, for instance R&D activities, construction tasks or product design are often mentioned.

4. The regularity in which external innovation services are used differs strongly.

Figure 14 shows a ranking according to the intensity or regularity of the use of innovation services. When looking in particularly at services used most frequently (“always” or “often” of the response options never, sometimes, often, always), it becomes clear that some innovation services are used more regularly than others. Especially the areas application of property rights, industrial property rights, as well as patent research can be emphasized here. These topics register a regular use in the support of innovation projects in the companies surveyed.
5. In a business location with a strong presence of universities and research institutes, these are the most used innovation service providers.

The high demand of universities and universities of applied sciences is quite striking. These research institutions are even more often consulted than the companies’ clients which dominate normally (see figure 15). In contrast, in the KompNet 2011 study (see figure 29) customers are used similarly often but universities of applied sciences and scientific institutes are partly mentioned half as often. This poses the question whether this is ultimately due to an effect of the different survey groups or to the fact that mostly innovation-oriented enterprises have participated in this study. Given the very high R&D expenses of the companies involved in this study (see chapter 3), it can be suggested that the difference is due to the high innovation focus.

Fig. 15: Use of cooperation partners in innovation projects of manufacturing SME

If the small and medium-sized enterprises are considered separately, it becomes clear that the use of some cooperation partners is different. Figure 16 demonstrates that in medium-sized enterprises a higher percentage of companies worked with partners then it was the case among small enterprises. This is especially evident in the use of enterprises of upstream value chains (suppliers), enterprises of other value chains (companies from other sectors) and enterprises of downstream value chains (competitors; see figure 16).

Fig. 16: Use of cooperation partners in innovation projects

6. Medium-sized enterprises currently use the existing science facilities more intensively than smaller companies.

A closer look considering the company size reveals that the strong demand for scientific institutes and universities of applied sciences is driven mostly by medium-sized companies.

Medium-sized enterprises also stated a higher usage intensity, i.e. using external innovation services on a more regular base than small enterprises (see figure 17).
A comparison with the KompNet study 2011 leads to the conclusion that the use of external partners in innovation processes is indeed broad (see finding 1 and 2), but less intense than it might have been expected according to the KompNet study 2011 (see figure 19).

To ensure comparability with the KompNet study in 2011 (6-point scale from 0 to 5), the mean values of KompNet study are adjusted to the present study using a scale from 1 (never) to 6 (very often). Regarding the average intensity of use it has to be emphasized that the surveyed companies of the KompNet study claimed to cooperate more frequently with companies from other sectors and with competitors.

7. The used external innovation service providers are almost equally local, regional and national providers.

Figure 20 makes it evident that even at a strong business location such as Jena, SME work together with both local and nationwide providers.
This fact is due particularly to medium-sized enterprises where a majority uses services from national providers.

8. The motives for or against the use of external innovation services are versatile.

To fully understand the reasons for and against the use of external innovation service providers, both closed-ended and open responses were integrated in the survey. In the following figures 22 and 23, only the responses on the closed-ended answering options are shown.

The firms see both advantages and disadvantages of the use of external innovation service providers even though the benefits seem to overweight the reasons against the use of external innovation service providers.

9. In future, the use of online customer integration will increase in importance in the use of external innovation services.

In the study, prospective importance of the integration of customers questioned, first, in comparison to other areas of innovation management and, second, in comparison to the integration of experts.

The following tables show, that customer integration is probably the instrument which possesses the greatest importance for SME. 84% of SME surveyed give "more customer integration" a
high or very high importance (see table 4). All other innovation tools are of less importance. The second priority have "more formulated innovation processes" and "lean innovation".

**Tab. 4: Future meaning of different topics of innovation management (n=25)**

<table>
<thead>
<tr>
<th>„High to very high importance“</th>
<th>Priority level 1</th>
<th>Priority level 2</th>
<th>Priority level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>- more customer integration</td>
<td>84%</td>
<td>56%</td>
<td>44%</td>
</tr>
<tr>
<td>- more formulated innovation processes</td>
<td></td>
<td>52%</td>
<td>24%</td>
</tr>
<tr>
<td>- more lean innovation</td>
<td></td>
<td></td>
<td>24%</td>
</tr>
<tr>
<td>- more open innovation</td>
<td>44%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- more web-based innovation tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- more simulation in innovation projects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- more innovation service providers</td>
<td></td>
<td></td>
<td>16%</td>
</tr>
</tbody>
</table>

The prospective need for more cooperation with innovation service providers is rated only by 16% of the companies as a top priority. However, prioritizing customer integration and more open innovation will most probably include the use of different sorts of external innovation service providers (such as experts, suppliers, customers and universities).

It can be noted that the need for “more formulated innovation processes" was most frequently rated to have “very high importance" for SME. Almost every second medium-sized enterprise (44%) made this statement.

**Tab. 5: Importance of different topics of innovation management in the future for small enterprises**

<table>
<thead>
<tr>
<th>„High to very high importance“</th>
<th>Priority level 1</th>
<th>Priority level 2</th>
<th>Priority level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>- more customer integration</td>
<td>93.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- more formulated innovation processes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- more lean innovation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Breaking down the priorities of small vs. medium-sized enterprises shows that especially the small businesses stated a need for "more innovation service providers” in the future (see table 5 and 6).

Additionally, the integration of customer was compared to the integration of experts, differentiated by offline or online integration. The answers could vary between no / low / medium / high / very high importance. The following table shows the number of statements of high and very high importance (current and prospective).
Tab. 7: Current and prospecting importance of integrating customers/experts via offline/online (n=23)

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Prospective</th>
<th>Deviation (Δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer integration offline</td>
<td>16</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Expert integration offline</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Customer integration online</td>
<td>4</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Expert integration online</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7 shows that prospectively the integration of customers in innovation projects and processes is of particular importance for SME. Again, small and medium-sized enterprises set the priorities slightly different (see figures 24 to 27).

Fig. 24: Prospective importance of customer integration offline

Fig. 25: Prospective importance of expert integration offline

Fig. 26: Prospective importance of customer integration online
Online integration of customers and/or experts are for large parts of the small enterprises of low importance, both at present and in the future.

The offline customer integration plays a high to very high role for small as well as medium-sized enterprises. The other three forms are mainly for medium-sized enterprises of a medium to high importance.

10. SME use (almost) no competing innovation development.

Only 4 out of 25 (16%) of small and medium-sized enterprises assign a development task twice to competing external innovation service providers (see figure 28). Nearly none of the small enterprises uses competitive innovation development. Only one medium-sized enterprise stated to carry out such competitions in 35% of their innovation projects.

Although the reasons for the low number of parallel development remain unclear, the low competitive orientation of SME is surprising in the search for the “best idea” for their company. Yet, it might be that external services providers are used parallel to internal projects.

11. SME from the region provide for local universities a good potential for new innovation services contracts.

In the KompNet study 2011 over 200 SME from Thuringia were interviewed. Compared to this study it shows that manufacturing SME in the Science City Jena work together to a much higher degree with academic institutions such as universities and research institutes (see figure 29). At the same time, this indicates that a high potential for innovation service providers from the scientific institutions in Jena exists to cooperate with Thuringian SME.
CONCLUSIONS
In conclusion, three learnings should be emphasized in the discussion.

• SME need to use external innovation services to a greater extent

The present study displayed potentials for SME to intensify the use of external innovation services. For this purpose, there are two ways possible: On the one hand, the wider use of external innovation services and, on the other hand, the deeper use of good or excellent external innovation service providers.

• Competing innovation development

When competing for the “better” or “best” idea resp. innovation, SME should more frequently have the courage to award a development task twice. This can be done internally or by using external innovation service providers.

• Higher education institutions need to and are capable to position themselves better as potential innovation service providers

The “need” refers to the necessity to communicate the overall offerings of universities more effectively. This is exemplified by an overview of the Innovation Campus of EAH Jena (see figure 31).

Fig. 30: Future scenarios of the usage of innovation service providers

The pressure on SME to innovate will not decrease in the future. Hence, external innovation service providers are a great opportunity for resource-efficient innovation development.

• The “can” is related to the chance of universities, to cooperate with SME in innovation projects not only locally but also stronger in the larger region.

A possible challenge for universities as providers of innovation services, but also the education of its target groups (undergraduates, graduates, MBA students) lie in the mastery of open innovation. Universities can play a role in this field as advisors, supervisors or operating providers.

In theory, many universities cover with their economic and technical faculties, some universities also with design faculties, large parts of an innovation process with its range of innovation services (see fig. 32).
Looking at the potential benefits of external innovation services for SME it is recommended that the dialogue between scientific institutions and SME is intensified.

a. Acknowledgement

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b. References


TECHNOLOGY TRANSFER AND UNIVERSITY-INDUSTRY COOPERATION USING INNOVATIVE FAST TIME SIMULATION TECHNOLOGY FOR MANOEUVRING OF SHIPS AND TRAINING IN SIMULATORS

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World Maritime University, Maritime Risk and System Safety (MaRiSa) Research Group, Malmoe, Sweden

ABSTRACT: New concepts for using Fast Time Simulation technology to be used on board ships and specifically for lecturing and maritime training were developed at Maritime Simulation Centre Warnemuende MSCW at Wismar University. Dept. of Maritime Studies Warnemuende in research projects funded by the German Federal Ministry of Education and Research together with industrial partners. A concept for a Simulation Augmented Manoeuvring Design and Monitoring SAMMON tool box was made allowing for a new type of design of a manoeuvring plan as enhancement of the common pure way point planning and an unmatched monitoring of ship handling processes to follow the underlying manoeuvring plan. Within this paper investigations into the usability and potential range of application in lecturing and training practice of the new concept will be introduced. Examples will be given for results from test trails in the full mission ship handling simulator of MSCW. This project is an excellent example to demonstrate how universities can use technology to become more competitive. The results of the on-going research were used to found a new start-up company. Therefore it can be shown in the paper presentation what the implications of entrepreneurship and innovation on business and engineering education are.

Keyword: Fast time simulation, manoeuvring, ship handling, decision support, teaching technologies

1. INTRODUCTION – DESCRIPTION OF THE CONCEPT

Normally ship officers have to steer the ships based on their mental model of the ships motion characteristics only. This mental model has been developed during the education, training in ship handling simulator in real time simulation and most important during their sea time practice. Up to now there was nearly no electronic tool to demonstrate manoeuvring characteristics efficiently or moreover to design a manoeuvring plan effectively - even in briefing procedures for ship handling training the potential manoeuvres will be explained and drafted on paper or described by sketches and short explanations. To overcome these shortcomings a fast time simulation tool box was developed to simulate the ships motion with complex dynamic models and to display the ships track immediately for the intended or actual rudder or engine manoeuvre. These “Simulation Augmented Manoeuvring Design and Monitoring” - SAMMON tool box will allow for a new type of design of a manoeuvring plan as enhancement exceeding the
common pure way point planning. The principles and advantages were described at MARSIM 2012 specifically for the potential on board application for manoeuvring real ships.

This paper presents the potential of the new method specifically for the teaching and learning process at maritime training institutions. Manoeuvring of ships is a human centred process. Most important elements of this process are the human itself and the technical equipment to support its. However, most of the work is to be done manually because even today nearly no automation support is available for complex manoeuvres. Even worse, the conventional manoeuvring information for the ship officer is still available on paper only: the ship manoeuvring documents are mainly based on the initial ship yard trials or on some other selective manoeuvring trails for specific ship / environmental conditions - with only very little chance to be commonly used in the overall ship handling process situations effectively.

Ship Handling Simulation for simulator training has a proven high effect for the qualification, however, it is based on real time simulation, i.e. 1s calculation time by the computers represents 1s manoeuvring time as in real world. This means despite all other advantages of full mission ship handling simulation that collecting/gathering of manoeuvring experiences remains an utmost time consuming process.

For increasing the effectiveness of training and also the safety and efficiency for manoeuvring real ships the method of Fast Time Simulation will be used in future – Even with standard computers it can be achieved to simulate in 1 second computing time manoeuvres lasting about to 20 min using innovative simulation methods. This allows substantial support in both, the training process and the real manoeuvring process on board ships. In Figure 2 a comparison is given for some essential elements of the real manoeuvring process on ships and in training within the ship handling simulators as well. Additionally, in the right column some of the Fast Time Simulation (FTS) tools are mentioned and their roles to support each element of the manoeuvring process are indicated: These tools were initiated in research activities at the Maritime Simulation Centre Warnemünde which is a part of the Department of Maritime Studies of Hochschule Wismar, University of Applied Sciences - Technology, Business & Design in Germany. It has been further developed by the start-up company Innovative Ship Simulation and Maritime Systems (ISSIMS GmbH [6]).

A brief overview is given for the modules of the FTS tools and its potential application:

- **SAMMON** is the brand name of the innovative system for “Simulation Augmented Manoeuvring – Design, Monitoring & Control”, consisting of four software modules for Manoeuvring Design & Planning, Monitoring, Multiple Dynamic Prediction & Control and Simulation & Trial. It is made for both:
  - application in maritime education and training to support lecturing for ship handling to demonstrate and explain more easily manoeuvring technology details and to prepare more specifically manoeuvring training in SHS environment, i.e. for developing manoeuvring plans in briefing sessions, to support manoeuvring during the exercise run and to help in debriefing sessions the analysis of replays and discussions of quick demonstration of alternative manoeuvres and
  - application on-board to assist manoeuvring of real ships e.g. to prepare manoeuvring plans for challenging harbour approaches with complex manoeuvres up to the final berthing / unberthing of ships, to assist the steering by multiple prediction during the manoeuvring process and even to give support for analysing the result and for on board training with the Simulation & Trial module.

- **SIMOPT** is a Simulation Optimiser software module based on FTS for optimising Standard Manoeuvres and modifying ship math model parameters both for simulator ships and FTS Simulation Training Systems and for on board application of the SAMMON System.

- **SIMDAT** is a software module for analysing simulation results both from simulations in SHS or SIMOPT and from real ship trials: the data for manoeuvring characteristics can be automatically retrieved and comfortable graphic tools are available for displaying, comparing and assessing the results.

The SIMOPT and SIMDAT modules were described in earlier papers ([1] and [2]) for tuning of simulator ship model parameters and also the modules for Multiple Dynamic Prediction & Control [3] for the on board use as steering assistance tool.
In this paper the focus will be laid on the potential of the SAMMON software for supporting the teaching and learning process.


2.1 Ship dynamic model and SIMOPT / SIMDAT tools for fast time ship manoeuvring simulation and investigation

The following equation of motion was used as math model for the ships dynamic:

\[
X = m(\dot{u} - rv - x_G r^2)
\]

\[
Y = m(\dot{v} + ru + x_G \dot{r})
\]

\[
N = I_z \dot{r} + mx_G (\dot{v} + ru)
\]

(1)

\[
Q = I_{ME} \dot{n}_{ME}
\]

On the right side there are the effects of inertia where \(u\) and \(v\) represent the speed components in longitudinal and transverse direction \(x\) and \(y\), \(r\) is the rate of turn of the ship. The ship’s mass is \(m\) and \(x_G\) is the distance of centre of gravity from the origin of the co-ordinate system. \(I_z\) is the moment of inertia around the \(z\)-axis.

The ship’s hull forces \(X\) and \(Y\) as well as the yawing moment \(N\) around the \(z\)-axis are on the left side. Their dimensionless coefficients are normally represented by polynomials based on dimensionless parameters, for instance in the equation of transverse force \(Y\) and yaw moment \(N\) given as the sum of terms with linear components \(N_r\), \(N_v\), \(Y_r\) and \(Y_v\) and additional non-linear terms depending on speed components \(u\), \(v\), rate of turn \(r\) and revolution \(n\). Other forces as for instance rudder forces and wind forces are expressed as look up tables. There are other models, e.g. for the engine or thruster operation: for the sample in the fourth equation in (1) \(Q\) represents the sum of the torque components of engine, propellers and others; on the right side there is the inertia moment of the rotation parts around the propeller axis.

Additional differential equations represent the calculation of heading and position. The solution of this set of differential equations is calculated at least every second; some internal calculations are even done with higher frequency.

The quality of the math model for the simulation and the parameters in the equations are of high importance for the effectiveness of the simulation. There is a great need for fast and effective modelling / tuning processes both

- for the general operation of Ship Handling Simulators SHS where clients from several shipping companies need to be trained on their specific ship types and
- for the SAMMON dynamic predictor and manoeuvre planning modules.

The parameters of these equations of motions can be found by parameter estimation technology – some methods were described at MARSIM 2009 and 2006 using the SIMOPT and SIMDAT Programs. The advantage of the module is to be seen in the performance: it is remarkably faster than real time and the steering of vessels is organized automatically by prepared files from a library for Manoeuvre-Control Settings / Commands for standard procedures and individual manoeuvres. These software packages were developed to be used for the fast time simulation procedures by SIMOPT and assessment of the results by SIMDAT[1][2]. The Advantage and Capabilities of this software is: The Math Model reveals same quality for simulation results as the Ship handling simulations SHS, but it is remarkably faster than real time simulation, the ratio is more than 1/1000, the steering of simulator vessels is done by specific manoeuvre-control settings / commands for standard procedures and individual manoeuvres dedicated for calculation standard ship manoeuvring elements (basic manoeuvres) but moreover for the estimation of optimal manoeuvring sequences of some characteristic manoeuvres as for instance person over board manoeuvres.

Simulations can be done in SIMOPT either as single run or as simulation series for selection of up to 3 Parameter series to be simulated in parallel or sequential for: Simulation parameters, e.g. Manoeuvre series; Ship Parameters (L, B, T, or others); Hull / force parameters coefficient and Environmental data, e.g. wind force and direction. The SIMDAT software tool (see Fig. 3) was originally designed at the MSCW to supply the instructor with semiautomatic assessment of the recorded exercise data in ship handling simulator [1]. For the purpose of ships model parameter tuning, the optimisation of manoeuvres and for lecturing this SIMDAT tool was extended: The Data for the manoeuvring characteristics can be automatically retrieved for all manoeuvres; enhanced Graphic tools are available for displaying various types of results. Some results of particular evaluations are shown in the next figures.
Fig. 3 Comparison of turning circles for Hard Rudder (35° STB) and constant speed rates with kick turns (CV 2500, left: ships' tracks, right: speed history):

- Turning Circle with constant speed rate Full Sea Speed = 25.5 kn (blue)
- Turning Circle with constant speed rate Slow Ahead = 11.3 kn, (green)
- Kick-Turn from straight track with constant speed rate Slow Ahead = V_Start=11.3 kn) and change to Full Sea Speed (brown)
- Kick-Turn from STOP at zero speed V = 0 kn and change to EOT = 100 % (red)

b. Samples of Manoeuvre Demonstration and Optimisation with SIMOPT/SIMDAT

In order to explain ships dynamic simulations are very suitable to demonstrate the effect of specific manoeuvres. In Fig. 3 the effect of so called “Combined Manoeuvres” will be shown where both rudder and engine will be changed at the same time to give some advantage in comparison with standard manoeuvres: the turning circles with constant speed rates for Full Ahead and Slow Ahead have nearly identical tracks; in case of using so called Kick Turns from Slow Ahead to Full Ahead or even more for Stop to Full Ahead the advance and transfer of the tracks are much smaller. The final steady state turning diameter is the same in all four cases.

Also for crash stop manoeuvres with Full Astern the rudder can help to significantly reduce the speed and therefore the stopping distance: in Fig. 4 the standard crash stop manoeuvre is compared with a fishtailing manoeuvre where the ruder is used periodically from full starboard to port and vice versa additionally to the reversed engine to save nearly one third of the stopping distance. The smallest advance can be seen for the turning circle with hard rudder where also the speed
goes to zero after nearly half of the time goes to zero after nearly half of the time compared to the standard stop manoeuvre.

Another important issue is the behaviour of the vessel under wind impact which can be easily explained and investigated by means of the SAMMON System. The basic understanding of this effect can be given to the students by explaining the equilibrium conditions under wind impact on a straight track with constant ship speed. For this purpose a series of calculations were made varying the wind speed from 0-40 kn and also the wind directions from bow wind 0° to stern wind conditions 180°. In Fig. 5 the table can be seen for the input control of the calculation series for simple Constant Speed Manoeuvres in SIMOPT. The results are shown in Fig. 6 in 2D and - more comfortable – in 3D-representation respectively: it can clearly be seen that the rudder and drift angles to balance the wind moment and transverse forces are increasing with the wind speed, more precisely with the wind-to-tot-ship speed ratio. The effect of these equilibrium conditions will be demonstrated in the next chapter for the turning manoeuvres under wind.

Fig. 4 Comparison of Crash Stop Manoeuvre (red) with Fishtailing (grey) and Hard Rudder Turning Circle from Full Ahead to Full Astern (blue) (CV 7500, left: ships' tracks, right: speed history):

Fig. 5 Interface table for defining a parameter series in SIMOPT for calculation of wind effects on straight track with constant speed
a) Initial rudder angle versus Wind direction and Wind speed

b) Drift angle versus Wind direction and Wind speed

c) Speed loss versus Wind direction and Wind speed

Fig. 6 Balance of wind effects on straight track with constant speed in 2D & 3D presentation
3. Fast Time Manoeuvring Simulation for Manoeuvring Demonstration in ECDIS Environment

The same fast time simulation tools can be used for the demonstration of manoeuvres up to the design of complete manoeuvring plans. Some basic functions are shown in the next figures.

Fig. 7 explains the operational interface in a sea chart environment which combines the electronic navigational chart ENC window (centre), the status of the current actual ship manoeuvring controls (left) and the interface window for the steering panel of the ship (right).

The ship was positioned in a certain place to demonstrate the ships motion for a very simple manoeuvre kick turn from zero speed. The ships motion can be controlled by the settings in the control panel window where any manoeuvre can be generated to be immediately displayed in the ENC in one second with full length. The length of the track corresponds to the settings in the prediction window (left top corner): the range value represents the duration of the manoeuvre; the interval value controls the number of displayed ship contours on that manoeuvre track. The sample represents a kick turn from zero speed to full ahead with full rudder to Port.

For the demonstration of wind effect the wind speed and direction can be set in the right bottom window. The effect can immediately be seen is in Fig. 8 – The turning circle with full rudder to STB will be shifted in the direction with the wind from North (0°). This can be expected for low wind to ship speed because in the sample the engine order is set to 70%. If the EOT is set to only 30% the ship gains not enough speed and therefore she goes on a straight track with beam wind where the full rudder is just enough for the equilibrium to balance the forces and moment due to wind as discussed in Fig. 6.
Fig. 8 SAMMON Trial & Training Tool - Interface with sample for wind impact for low ratio of wind-to-ships speed

Fig. 9 SAMMON Trial & Training Tool - Interface with sample for wind impact high ratio of wind-to-ships speed
In extreme heavy weather it is recommended to reduce the speed and to transfer into the “lying abeam” situation where the ship is only drifting with no engine power used. It is of great importance that this situation can be reached very quickly, i.e. that the transfer time from ahead motion into full drift motion requires a minimum of time to take advantage from the pure drifting motion as quick as possible. These effects can be demonstrated in ECDIS environment separately for every manouevring variant, but for an overview the different approaches are summarised in a SIMOPT / SIMDAT presentation in Fig. 10: It can be seen that for a ship in stopping condition this procedure happens very fast: in about two minutes the ship reaches the full steady state transvers drift speed (green for a ship with superstructure in the middle, brown for superstructure at the stern); If the ship has a higher initial speed then it is recommended to use a full astern stopping manouevre because in this case she needs only 7-8 minutes the full drift compared to the coasting stop where more than 20 min will be needed for the same result.

4. Fast Time Simulation for Designing Manoeuvring Plans

4.1 Principle of fast time simulation of manoeuvres in ECDIS and sample data

The fast time simulation method is used to find out efficient manouevres and even more for the design of manoeuvring plans within the briefing for Ship Handling Simulator exercises and practically for route planning process on board [4]. The use of this tool will be explained by some sample scenarios:

The sample ship is the RO-PAX Ferry “Mecklenburg-Vorpommern” with Loa=200m, Boa=28.95m, Draft=6.2m, Displacement=22720t and Speed=22kn. She has two pitch propellers and two rudders located behind the propellers and additionally one bow thruster.

The test area is the Rostock Sea Port. The RO-PAX ferry is entering the fairway from north to be steered through the fairway and to be turned at the turning area followed by astern motion o the berth at west pier (as in in the sample Fig. 14).

Some basic functions and interface displays are shown in the next figures: Fig. 11 explains the method in a sea chart environment represented by an interface which combines the electronic navigational chart ENC window (centre), the interface window for the steering panel of the ship (right) for adjusting the controls for the selected
manoeuvring point MP and the interface to display the status of the current actual ship manoeuvring controls (left) at the position of the next manoeuvring point which is indicated as ship shape in red colour in the ENC.

For purposes of demonstration of a complex manoeuvre procedure the ship is initially positioned in the fairway (black contour) and is going to enter the turning area as objective for the first manoeuvring segment. For the planning procedure the ship’s motion can be controlled by the settings in the control panel window on the right side. Any manoeuvre can be generated and will be immediately displayed in the ENC in less than one second with full length. In this case the rudders are set 10° to STB to achieve a small turning rate \( \text{ROT} = 4.5^\circ/\text{min} \) to port. The length of the simulated track corresponds to the settings in the prediction window (left top corner): the range value represents the duration of the simulated manoeuvre and that means the track length of that manoeuvring segment; the interval value controls the number of displayed ship contours on that predicted manoeuvre track. The selected end position of the manoeuvring segment is indicated by the red ship’s contour. Its position can be shifted and adjusted using the slider at the bottom line which is adjusted to 165 seconds after the beginning of the manoeuvre at initial Manoeuvring Point MP 0. If this position is accepted it will be acknowledged as the next manoeuvring point MP 1.

This planning process guarantees the full involvement of the navigating officer: The best version of the manoeuvres can be found by trial and error but it is possible to bring in one’s full knowledge and to take advantage of one’s skills – it is possible to see and to verify immediately the results of the own ideas and to make sure that the intentions will work. This is import for safety and efficiency, but also for gaining experience for future manoeuvres.

![Fig. 11 Display for Manoeuvring Design by Fast Time Simulation](image-url)

**Fig. 11** Display for Manoeuvring Design by Fast Time Simulation for immediate presentation of manoeuvring results: Sample for entering the turning area with slight turning to STB from initial conditions in a fairway at initial Manoeuvring Point MP 0
c. Sample of designing a full manoeuvring sequence as training concept

The planning procedure for a complete manoeuvring plan follows the principles as described for a single segment in Fig. 11 as follows: Fig. 12 presents the situation after accepting the manoeuvre previously planned – now the next segment is to be planned from MP 1 to MP 2: the ship is going to enter the turning area and to slow down. Both engines are set to STOP (EOT 0).

In Fig. 13 the complex turning manoeuvre is to be seen: the ship is using in parallel engines, rudders and the bow thruster to turn as fast as possible. Afterwards the engines have to be reversed and the ship controls are adjusted to go astern to the berth.

In Fig. 14 the result for the full manoeuvring plan is to be seen with the whole set of Manoeuvring Points (MP) for the complete approach and the berthing manoeuvre.

The different settings of the controls and the track of the planned manoeuvre sequences are stored in a manoeuvre planning file to be displayed in the ENC.

For the execution of the manoeuvre this plan can be activated later to be superimposed in the ECDIS together with the actual position of the ship and, most important, with the prediction of manoeuvring capabilities for effective steering under the actual manoeuvring and environmental conditions.

![Fig. 12 Planning of the next segment from MP 1 to MP 2 – speed reduction](image-url)
Fig. 13 Planning of the next segment from MP 2 to MP 3 – complex turning and stopping with engines, rudders and thruster

Fig. 14 Complete manoeuvring plan for the route segment for passing the turning area and approaching the berth in astern motion
5. Manoeuvring Monitoring and Multiple Dynamic Prediction Module - Overlaid Prediction for On-line Manoeuvring Decision Support using Manoeuvring Plans

5.1 Presentation of dynamic predictions in ECDIS environment

For a compact presentation of information to the captain, pilot and responsible navigating officer respectively a new layout of a conning display was designed and implemented into the equipment installed on an integrated navigation system. For the purpose of testing the technical feasibility and user acceptance the new conning display with the integrated MULTIPLE MANOEUVRING PREDICTION MODULE was implemented in the INS equipment of the large full mission simulator bridge of the ship handling simulator of MSCW.

The sample ship is again the RO-PAX Ferry “Mecklenburg-Vorpommern”, the test area is the Rostock Sea Port. The RO-PAX ferry is leaving the berth to be steered through the fairway and to leave the port.

The layout of a dedicated prediction display integrated into an ECDIS is shown in Fig. 15. It contains conning information together with the prediction and the planned manoeuvring track. The centre window shows the ENC in Head up Mode together with motion parameter for longitudinal speed and transverse speed as well as a circle segment with the rate of turn is shown. The ships position is displayed in the centre of the ENC as ship’s contour where also the track prediction can be indicated as curved track or as chain of contours for the selected prediction time. The prediction parameters as range or interval of presentation can be set in the control window at the right side.

The Dynamic Path Prediction with the sophisticated simulation model is shown as chain of ships contours based on full math model (ship contours every 60 sec for 5 min with turning to STB). This dynamic prediction reflects already the effect of the setting of rudder and propeller control parameters shown in the left bottom window: In this sample the two rudders of the ferry used are set to 12° Starboard and the Engine Order Telegraph for the two controllable pitch propellers are set to 50% representing 130 rpm of the propeller. The actual pitch status is 19. This interface allows a
presentation of dynamic predictions of steering and stopping characteristics as an immediate response according to the current steering handle or engine order telegraph position. It can be perfectly compared with the planned manoeuvring track as a reference line or curve, shown as blue line in the ENC window along the chain of manoeuvring points MP.

The predicted track for the simplified static path prediction based on of current constant motion parameters (implemented as add-on in some ECDIS solutions) are shown as magenta curve: According to the actual/present small rate of turn to Port the predicted track is presented as a circle segment to the left side.

The use of path prediction with simplified models was already mentioned in previous papers, however, the use of this new multiple predictions based on the full dynamic model including the propulsion / engine process together with the result of preceding manoeuvring design is a great innovation and advantage. It was found that for the application of this dynamic prediction technology new strategies were found to save some minutes in this area which is very important in tight time schedules [5].

5.2 SAMMON Manoeuvring Trial & Training Tool

This module combines a full simulation module for the ship manoeuvring process with all the modules above for planning and monitoring in order to test and try out manoeuvring plans and strategies, to be used both:

- as training tool in maritime education
  - in briefing / debriefing sessions for ship handling simulator training,
  - as well as in lectures on ships manoeuvring in classes and
- as training tool on board ships.

In order to control the virtual ship during the simulation process a manoeuvring panel on the screen allows steering the ship in real time along the planned route supported by the Multiple Predictor.

6. Integration of SAMMON System into Education for Lecturing & Training Simulation

For training & education the SAMMON System is available as a portable version based on Tablet PCs for Planning of Manoeuvres in Briefing. Instructor stations and use on Simulator bridges. The SAMMON system is interfaced to the Rheinmetall Defence Electronics ANS 5000 Ship Handling Simulator (SHS) at the Maritime Simulation Centre Warnemünde by WLAN connection. All ships which are available for the SHS are also ready for use in the SAMMON system for the following Concept of Application for Ship handling simulation:

**Briefing:**

- Demonstrating ships manoeuvring characteristics by using SIMOPT for familiarisation
- Drafting Manoeuvring Concept as Manoeuvring Plan (using MANOEUVRING DESIGN & PLANNING tool) according to the training objectives
- Optimisation of the concept by several trials of the trainee (using MANOEUVRING TRIAL & TRAINING tool)

**Execution of simulator Exercise:**

- Training of conventional ship handling procedures and by using the by means of new FTS technology with underlying manoeuvring plan and dynamic prediction (MANOEUVRING MONITORING & MULTIPLE DYNAMIC PREDICTION tool)

**Debriefing:**

- Assessment of the exercise results from full mission SHS by comparison of exercise recordings with trainees own concept or optimised manoeuvring plan by using SIMDAT tool for displaying and assessing the results of the exercise, e.g. comparing the result with the initial concept developed by the student in the briefing session and additionally to discuss alternative manoeuvring solutions by using the
The SAMMON System has been implemented into the Ship Handling Simulator of MSCW with 4 Tablets, each of the computers can be booked into any of the exercises on the four simulator bridges to be used for planning, monitoring on the bridges or in the instructor room. Also it was installed in 2012 into the Ship Handling Simulator at the World Maritime University Malmoe. In 2013 it was implemented into the AIDA Academy CSMART Rostock of the cruise line company AIDA CRUISES. These samples indicate the success of the innovative idea and support the prospect of the whole Fast Time Manoeuvring Simulation concept.

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THE GAP BETWEEN RESEARCH AND COMMERCIAL PRODUCT IN APPLIED PHYSICS RESEARCH – AN ISSUE FOR SUSTAINABILITY AND AN OPPORTUNITY?

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Abstract: We selected the problem of micro- and nanointegration to explain that often a gap is observed between academic research and the transfer of research results into industrial technologies. Some technical aspects of nanotechnology and their potential impact on the microelectronic industry are discussed. Also some of the mechanisms that drive the evolution of today’s semiconductor industry are presented. Looking at the example of micro- and nanointegration we discuss potential reasons, both technical and economic, which could be responsible for the above mentioned gap. The discussed issue can also be linked to the problem of sustainability of public research funding. As a conclusion, for the specific problem of micro- and nanointegration it is suggested to organize this field of research such that the competences of both, academic institutions and industry, are brought together effectively. It is also suggested to strengthen research in universities of applied sciences, because due to their profile these institutions can serve in an ideal manner as a link between industry and academic research.

Keywords: Sustainability; Micro- and Nanointegration; Universities of Applied Sciences; Nanowires

INTRODUCTION

Research in physics and related fields is commonly divided into basic research and applied research.

Basic research is dedicated to gaining new insight into nature, i.e. understanding the creation of the universe. It also includes finding new physical effects in solids, finding new structures of matter, e.g. 1-d structures like nanotubes or real 2-d structures like graphene. So the expected and the real outcome is first of all purely academic, whereas application may be a faint idea of something far in the future.

Applied research however is clearly focussing on finding or evaluating new physical effects or new concepts with some potential application in mind. However we realize that not every applied research project is resulting in a new product or a novel technology.

It is instructive to take a look at the currently intensively discussed problem of micro- and nanointegration. Reasons for the observed gap between research and industrial usage will be discussed. Finally a conclusion concerning the role of universities of applied sciences and of suitable organizational research structures will be made.

I. THE PROBLEM OF MICRO- AND NANONTEGRATION

For the topic of micro- and nanointegration currently (VDE, 2013) there is a discussion going on about how to close the gap between achieved research results and their industrial usage. From previous experiences, like the
semiconductor technology it is well known, that basic research is an important precondition for envisaged industrial usage. But it is also known, that the identification of new exciting physical effects on laboratory scale is not sufficient to guarantee economic success. After the discovery of the very basic effect, usually very intense efforts in applied research are necessary, like e.g. the development of new equipment, managing upscaling and mass production with high yields at market accepted prices. The term “micro- and nanointegration” denominates the idea of integration of nanotechnology into microsystems. It describes systems where nanostructures are physically connected to a microsystem and define characteristic properties of the system or even form the functional core of it.

Let’s take a closer look to this issue. Enormous efforts have been put to the basic research in nanotechnology (Bushan, 2007). Many researchers think, that nanotechnology has the potential of revolutionizing (Bushan, 2007) many aspects of a wide range of technologies, in particular microelectronics.

But only a few products, like nanocoatings for windscreens etc., which rely on findings of nanotechnology, have entered our daily lives. The nanoparticles used in these coatings are not integrated into some more complex system, but they are more or less acting as one ingredient for a film forming chemical mixture, like dyes in some dispersion paint.

So we cannot speak of micro- and nanointegration in these cases.

Why do we see so little impact of modern nanotechnology research findings in our daily lives?

The task of basic research ends, when new effects have been discovered and investigated. Let’s look at the example of nanowires, one specific type of structure discovered and investigated in basic nanotechnology research.

![Fig. 1: Scanning electron microscopy image of isotopically purified SiNWs: (a) 29SiNWs; (b) 28SiNWs; and (c) 30SiNWs grown at 600 °C. The average growth rates are 21.15, 19.00, and 18.12 nm/min for 28SiNWs, 29SiNWs, and 30SiNWs, respectively. The scale bar denotes 1 µm. (Mountanabbir, 2009)](image)

In recent years many investigations have been dedicated to the understanding of fundamental properties of nanowires (Bushan, 2007; Lee, 2010; Chung, 2000; Zheng, 2004, Thelander 2006). Nanowires exhibit sometimes very promising transport properties, such that
transistors for electronic circuitry might become faster or more efficient.

Nanowires can be grown from a wide range of conducting, non-conducting or semiconducting materials. Sometimes the type of conductivity is depending on the growth conditions, like in carbon nanotubes (Schmiedl, 2010). So also the growth, i.e. understanding growth mechanisms, has been under thorough investigation (Wang, 2008).

Examples of nanowire growth experiments are shown in Fig. 1 and Fig. 2.

If nanowires in deed are offering extraordinary properties for e.g. microelectronic devices, why is the semiconducting industry so reluctant towards using these new structures?

We can identify mainly two reasons.

1. Semiconductor industry is a very conservative industry, because its main objective is to provide reliable, low cost, highly performing microelectronic devices to their customers. We have seen in the past decades a tremendous increase in performance of microelectronics and a dramatic reduction in price at the same time. The rate of improvement is unprecedented in the history of manmade technology. Another important aspect is the fact, that semiconductor fabs are extremely capital demanding. The cost for building a new high end wafer fab can easily exceed several billions US$. TSMC has announced to invest $9.3billion in its fab 15 (TSMC, 2012).

The International Technology Roadmap for Semiconductors (ITRS) (ITRS, 2013) is a consortium of major semiconductor and equipment manufacturing companies and research institutions. This consortium defines which kind of technology requirements will have to be met in the near and far future for keeping up the pace of microelectronic evolution. It defines, what is called Moore’s Law. This roadmap has turned out to be extremely successful, as consumers can see from ever increasing performance and decreasing prices of computers, laptops and smart phones. Since it has been an economic success, it also serves as a guideline for research. It tells industrial and academic researchers which topics will be of immediate interest for the conventional semiconductor industry in the near future.

However, in the past decades on several occasions, it has been predicted, that for physical reasons the improvement of the conventional technology will stop.

But each time workarounds for these issues have been found within the framework of conventional technology, i.e. without changing the basic approach of top down (Bushan 2007) manufacturing and the device physics of MOS transistor technology fundamentally.

So from previous experiences, industry does have some confidence that workarounds for whatever showstopper will be found such that conventional fabs, equipment and device concepts will prevail. It is thought that they will work long enough to make conventional investments pay off safely and that risky investments into unknown science can be avoided for the time being. There clearly is a tendency of pushing any known technology to the limits and industry is very reluctant towards investments into risky and uncertain ideas and technologies. Nanotechnology however is a technology that will require fundamental changes of device architecture, manufacturing strategies, manufacturing equipment etc. Very far reaching visions of nanotechnology researchers, which focus on a complete shift to nanotechnology require a complete paradigm shift of manufacturing, from today’s top down approach to nanotechnology’s bottom up approach (Bushan, 2007; Bin, 2009). But in fact it is these visions, which have fascinated
researchers and have kept them going for quite a while.

So very much simplified we can say, that at least today there is no need for the semiconductor industry to go for real nanotechnology.

2. Nanotechnology is not ready to use.

Fig. 2 shows grown nanowires in complete disorder. Please compare this with Fig.3, which depicts SEM cross sections through a conventional microelectronic chip. At first glance it becomes obvious, that the disorder of the grown nanowires does not compare well with the highly ordered structure in Fig.3. Let´s take the example of carbon nanowire growth (Schmiedl, 2011). The growth conditions determine, whether the wire is semiconducting or metallic. For manufacturing carbon nanotube transistors it is necessary to use semiconducting nanowire. So if we want to build a chip containing one billion transistors, we have to be sure, that EACH single transistor is working. But for the time being, nanowire growth technology is not even able to predict the nature of one single grown nanotube, let alone the problem of growing the nanotube in a predefined place, at a
predetermined chip position, with an accuracy of a few nanometers. Today an industrial reproduction with high yield of many real nanotechnology structures\(^5\) has not yet been proved. The production of e.g. nanowires with well controlled diameter, well controlled properties on billions of positions on one chip, on a wafer with thousands of chips with a wafer output of a few thousand per week has not yet been demonstrated. Connected to this, is the problem of integration. A nanowire transistor is made up of several ingredients, not only of a nanowire. Integration issues even in conventional technology can be very severe.

So we have two issues here, which apply for many nanotechnology structures, not only for nanowires. On the one hand industry that doesn’t see the necessity for a paradigm shift and on the other hand a technology that’s lacking maturity for mass production, which increases the barrier for industrial application.

Similar examples can be found for other branches of modern technology.

II. WHERE IS THE LINK TO SUSTAINABILITY?
The actual topic of this paper is sustainability of applied research projects.

Sustainability of research projects has to be measured in terms of the output of the research activity. Which kind of output is desirable? When we take the case of an university like ours, most projects are funded more or less directly by the government or EU etc., which means financial support by the tax payers.

What is their interest? Of course, they as the sponsors of research, are interested in the academic success (creation of knowledge), but especially for the case of applied research they would like to see some economic impact, like the creation of new jobs as a consequence of a new technology developed in the project.

Sometimes this works out well, sometimes, as explained above, there is a gap between what can be manufactured on a professional basis and what research has implemented on a laboratory scale.

Clearly what is missing is the link between research, basic as well as applied, and industrial partners who understand the impact of the new technology and are willing to participate both financially and (probably more important) with knowhow about production issues and market needs.

III. CONCLUSIONS - WHAT CAN BE DONE ABOUT THIS?
Let’s go back to microelectronics. Here we can find one very prominent example how applied research is very effectively linked to the development of actual products.

In 1986 the US government founded, (originally as a national initiative to keep the American semiconductor industry the pacemaker of development) an organisation called SEMATECH (Sematech, 2013). SEMATECH today, similar to ITRS \(^6\) is an international consortium of semiconductor and equipment manufacturers as well as research institutions. SEMATECH runs a couple of facilities among them a wafer fab in Austin Texas. In this fab equipment manufacturers and staff sent from all participating semiconductor companies conduct joint development of the next generation of process technology – supported by universities and academic research institutions all over the world. Please note, that within SEMATECH competitors cooperate with each other up to the point where the process has a certain maturity and can be rolled out to the member company fabs.

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\(^5\) Please note there is a difference between nanoscale structures and so called bottom up nanotechnology. We are referring here to the latter. (Bin, 2009).

\(^6\) In fact both organisations SEMATECH and ITRS work together very closely.
The example of SEMATECH tells us, that in certain fields of science it may pay off, to create structures which are capable of integrating the abilities and competences of both the academic world and industry. However, care has to be taken that the balance of power is maintained. An overweight of industry interests might lead to short sighted research programs and a subsequent loss of academic interest – and vice versa.

Apart from the special case of micro- and nanointegration, we can make a more general point here.

I think that universities like ours, dedicated to applied education and research should strive towards playing a more important role in research. Why, because we have some of the missing link in our hands. Many of our professors and staff do have industry experience and do have good relations to industry - they could help filling the gap.

However, for a “teacher” it is sometimes not so easy to find the time for research. But, I am convinced, that teaching as such will not suffer from increased research activities. On the contrary, I think students will profit because they will be involved into research activities right from the beginning of their studies. From many different perspectives universities of applied science do have the potential of contributing to more sustainable research and research funding.

Of course I am aware of the fact, that even the most intense activities from our universities cannot solve such a problem like bringing nanotechnology to industrial use – but we are able to contribute, since our close relations to the “real” world is an asset which many classical physics departments of universities don’t have to such an extent.

SUMMARY

In this paper we have taken the example of micro- and nanointegration to illustrate the gap between research and industrial production. In order to address this specific issue we suggest organising research with equal participation of industry and academic institutions. From a more general point of view we recommend to strengthen research activities in universities of applied science.
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STARTUP ECOSYSTEMS – USA vs. EU vs. SLOVAKIA

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Abstract:
Based on the characteristics of innovative companies and technostartups their main aspects are analysed, e.g. their definition issues, economic contributions, prerequisites of their success, startup company culture and business conditions favourable for startups. In this context the conditions for startup development in the USA are described as a benchmark for further evaluations. The existing metrics of startup ecosystems are evaluated. The current startup initiative in the EU responds to the development of startup cities in the USA and Europe and provides a favourable framework for the progress of startup ecosystems. In this context the startup scene in Slovakia (main players, issues, business conditions for startups, startup initiatives) is evaluated and its further development outlined.

Keywords
Startup, startup ecosystem, innovation, startup community

I. STARTUP CHARACTERISTICS AND THEIR BENEFITS
Innovative entrepreneurship is based on a systematic and consequent improvement of operation of all company components and products or services that depend to a large extent on application of results of R&D activities. Its characteristics are high value added of the products/services through their higher quality and more favourable price compared to that of their competitors (Svejda, 2007). Innovative and often technologically orientated company with a high growth potential in the seed phase of its development cycle (starting implementation of business idea, securing financing, launching operations and sale) is referred to in many languages as a startup. Though this term is often used, it is not clearly defined in terms of number of employees, duration in business, revenue amount generated or investment acquired from founders or external financing. Therefore a startup may be rather characterized by the search of its business model, which should be scalable and geographically orientated at a broad scope of customers (not local customers only). Startup may often change its business model several times and when found and taken up with positive revenue effect this company development phase is closed. The startup phase may also be closed if a company starts to generate regular return or if it finishes by an exit event (IPO, acquisition or fusion).

Startups bring the following main benefits:
- Generation of new jobs;
- Generation of revenues and thus also tax income for the state budget;
- Secure an above average income growth of the founders and employees.

This has been confirmed by the results of startup survey in the US by the Kauffman Foundation in the years 2004 – 2006 [2]. The companies surveyed achieved the following economic results:
- they created on average 5.5 jobs in the new company, thereof 4.1 paid employee ones and 1.4 managerial one,
- during the business launch in 2004 the evaluated startups generated estimated revenues of USD 575 mil. and in 2006 revenues of USD 879 mil. i.e., growth by 53%,
- the employee remunerations of the startups concerned increased during the period 2004 – 2006 by 56%.

These startups were characterized by the following features:
subject of enterprise of domestic startups in 2004: consulting services (31%), manufacturing (13%), construction (10%), administrative services (10%). For „non-domestic“ startups: manufacturing (23%), consulting services (17%), retail (14%), administrative services (6%),
- average rate of business survival in the period 2004 to 2005 was 94%, higher in e.g., real estate and rent businesses (97%) and lower in accommodation and catering services (89%), in the period 2005 to 2006 was the survival rate 93%,
- 59% of startups had no employees, others employed: up to 10 persons (2004: 91% employers, 2006: 88% employers), thus securing in 2004 61% and in 2006: 52% new jobs;
- In total the companies with employees were financially stronger than those without employees, and number of companies with employees went up from 41% in 2004 to 62% in 2006.

Main prerequisites of a successful startup are: qualities of team members, quality of product or service developed and favourable market conditions for market launch of the product/service (scope of market demand and its validation, right timing of market launch, and other), but also a stimulating startup culture. The common values recognized by startup team members and qualities of their interrelations can contribute to startup development or eclipse. According to the VC investor G. Gottesmann [3] a favourable startup culture is characterized by the following attributes:

1. evaluation of ideas by their qualities and not by their authors,
2. work in a startup is a mission not a job,
3. zero tolerance of mediocrity,
4. cost conscious attitudes to expenses - „watching pennies“, 5. equity-driven company strategy,
6. perfect alignment of company vision and strategy with roles and activities of team members,
7. open and clear communication in a team on strategy and hard issues, especially in bad times,
8. strong and positive team leader takes that responsibility seriously and leads by example,
9. mutual respect among the team members,
10. obsession for defining customer wants/needs, proactive learning and meeting customer needs,

11 high energy level in work, work is fun for team members,
12 honesty and integrity of team members.

II. STARTUP BUSINESS ENVIRONMENT IN THE USA

The Partnership Startup America, LLC is an independent alliance of companies [4] (sponsors, such as: Microsoft, NYSE Euronext, American Airlines, American Express OPEN, Dell, Intuit, partnering companies and members – startups), physical entities - regional champions, foundations (Case Foundation a Kauffman Foundation), universities and other leaders focused on support of American innovative startups with high growth potential. It was launched in 2011 at the incentive of the US Administration, however, it is not overseen or funded by it.

The US Administration and members of the Partnership concentrate their activities in the following five action areas:

1. Make easier access to capital for startup growth (5 measures);
2. Link mentors and education with entrepreneurs (5 measures);
3. Reduce startup barriers, so that administration works for their benefit (6 measures);
4. Accelerate the way from lab to market for the disruptive technological innovations (8 measures);
5. Make easier business conditions for entrepreneurs in the sectors: health care, clean energies and education (5 measures).

All measures stated above are augmented by concrete commitments of the US Administration to representatives of private sector on their implementation. The course of implementation of these measures is monitored in a transparent way in implementation reports and on the website of the US Administration The comprehensive support of startups in the USA is a part of the anti-crisis measures and is reflected in the national startup initiative supported by the Obama administration and in the rapid development of business incubators/accelerators and startup communities.

The Partnership is represented by the national network of startup communities orientated on fostering success rate of startups in the USA. The Partnership drivers are hundreds of enthusiastic founders, business leaders, investors, mentors and top managers in
the roles of startup champions, who work together on strengthening their local communities and fostering organic growth of young innovative companies. Their goal is building up in each federal state a strong startup ecosystem. Champions also build up and maintain positive public perception of startups as innovators and new job creators and celebrate entrepreneurship as a key American value. They also contribute to the image of the USA as the most attractive place in the world for launching and growing startups. Part of the NYSE Euronext initiative „Big Start Up“ is launch of the new platform of Corporate Connections [5] in collaboration with the Startup America. It makes more efficient the connectivity and collaboration of startup founders and top corporate managers in building corporate partnerships, mentor relationships, business relationships and licencing. Startup America also makes use of the main social media networks, such as Facebook, Twitter, LinkedIn, YouTube and Pinterest. The educational activities within the Startup America include national, regional and local events and also generally accessible archive of webinars of top entrepreneurship lecturers. Currently The Startup America Partnership covers 32 regions of USA, has 12 736 members, thereof 27% of startups are owned by women and 33% by members of national minorities. There are 40 startups per 1 million of inhabitants and annual revenue of startups achieved about USD 6 milliards and created 106 378 new jobs. The Startup America and business accelerator Techstars created in 2010 Global Accelerator Network (GAN) comprising 50 renowned accelerators in 63 cities in 6 continents. [6]. GAN has 3 to 6-months program focused on early stage startup mentoring s in classes from 10 to 20 companies. Some 600 companies have passed it so far and the total amount of investments acquired by them achieved USD 463 mil.

Building of sustainable startup ecosystems in the USA is purpose of the startup community. Based on the experience with building up such a community and activity of investment company in the region of Boulder, Arizona Brad Feld specified 4 main components of a vital startup community: (1) entrepreneurs and supporting companies, (2) long term interest of entrepreneurs in community development, (3) community inclusiveness for any interested ones and (4) programme of community activities engaging each community member [7]. The driving force of the community are the startup entrepreneurs as the startup community leaders. The structure of their relationships should not be a hierarchy but a network and community should be inclusive for anyone with active interest in it. The supporting community members provide to entrepreneurs services and products necessary for their business activities, such renting premises, financing services, legal, accounting, tax, R&D, media and advertising, ICT and other professional services. Further they provide also educational services (universities, secondary schools and mentors), qualified labour, municipal, regional and national authorities, suppliers of machinery, equipment and supplies. The sustainability of community depends on entrepreneurs long term interest to invest in their companies and in development of the community. The community should provide to all their members not only benefits but also a feeling of social relevance and cohesion through organization of activities all members may take part in, e.g. activities of business accelerator, incubator, entrepreneurial contests, etc. The business accelerator or incubator is the focal point of the activities of startup community. The assessment of Forbes magazine of 2012, based on the values of acquisition and investments acquired by incubator/accelerator is summarized in the ranking of the best US. startup incubators and accelerators stated in Enclosure 1 – Table 1 [8]. The ranking of urban spaces for startups based upon the assessment of conditions for startup founding and development in the U.S. cities by the National Venture Capital Association is stated in the Enclosure 1 - Table 2 [9]. Since 2011 the U.S. Senate has been dealing with a proposed amendment to immigration act to enable granting of temporary immigrant or conditioned residential startup visas to immigrant entrepreneurs, who obtain an investment commitment in their business idea. After two years these visas may be converted into a permanent residency if certain conditions are met.

III. STARTUP BUSINESS ENVIRONMENT IN THE EU
Current business environment in the EU consists of business environment of 27 member states and the EU legislation, set on creation of
unified internal EU market and influences up to 80% of legislative activities in the individual member countries. EU’s legislative initiatives strive to systematically improve the business environment for small and medium-sized enterprises (SMEs), thus also for startups. The startups and conditions for their growth are the focus of the Entrepreneurship 2020 Action Plan [10] passed by the DG Enterprise and Industry in January 2013. It sets out three action pillars:

1. Entrepreneurial education and training to support growth and business creation;
2. Create an environment where entrepreneurs can flourish and grow;
3. Role models and reaching out to specific groups.

Within the 2nd pillar the following measures on elimination of startup barriers in the business environment are recommended to member countries:

(a) better access to finance for entrepreneurs, e.g. initiative in microfinancing of SMEs (JASMINE), support in this field is also proposed in programmes COSME and Horizon 2020 for the period 2014 - 2020;
(b) support of businesses in crucial phases of their life cycle and helping them grow, e.g. making the national tax administration more favourable to early stage businesses, more favourable tax regimes for new businesses in loss, for innovation projects and business projects of commercialization of R&D results;
(c) unleashing new business opportunities of digital age, e.g. reinforcing national and regional support of digital/internet startups by means of ICT innovation vouchers schemes, launch specific actions for web entrepreneurs such as: i) a Start-up Europe Partnership to unlock expertise, mentoring, technology and services, ii) a Web Entrepreneurs Leaders Club to bring together world-class web entrepreneurs and strengthen the web entrepreneurial culture in Europe; iii) a European network of web business accelerators; iv) work with European investors in order to increase the flow of VC and crowd-funding in to web start-ups; and v) fostering web talent by stimulating the emergence of Massive Online Open Courses and the setting up of platforms for mentoring, and skill building,
(d) simplification of legal, administrative and tax aspects of transfer of businesses to new owners, in order to avoid unnecessary termination of businesses and job losses;
(e) bankruptcy and restructuring procedures and support of the second chance for honest entrepreneurs, who got into bankruptcy, e.g. advisory services on preventing bankruptcies and and successful business restructuring;
(f) reduction of regulatory and tax burden of businesses, e.g. savings from support of electronic invoicing, full implementation of the European Code of Best Practices facilitating SMEs’ access to public procurement by 2013,
(g) improved access of SMEs to national and cross-border public procurement tenders, extend the Points of Single Contact to more economic activities and make them more user-friendly;

The Entrepreneurship 2020 Action Plan responds to the fast development pace in business environment for startups, which is already a reality at the national and regional level in USA, some EU countries, e.g. Denmark may already offer inspiring best practices in this field, and in some other countries of the world (e.g. BRICS countries).

IV. EVALUATION OF PERFORMANCE OF STARTUP ECOSYSTEMS

The company Startup Genome published in October 2012 a report on the results of two years of ambitious collaborative research on main aspects of startup ecosystems performance in the world measured by means of 50 variables grouped in the following 8 indices:

1. Ecosystem Throughput Index – characteristic of ecosystem size and numbers of startups, being developed in it from the seed stage up to final high-growth stage.
2. Startup Output Index – represents the total business activity of the region in terms of population size, size and number of startups.
3. Funding Index – reflects scope and comprehensiveness of activities of VC investors in the startup ecosystem.
5. Mindset Index – reflects to what extent the population of startup founders in ecosystem think like big entrepreneurs (have vision,
stamina, risk tolerance, high work morale and ability to overcome obstacles).

6. Differentiation from SV Index – measures the level of ecosystem differentiation from the ecosystem of Silicon Valley (SV), whereas it considers demograpic factors and company type (assumption: other ecosystems will be more successful if they create their own strong points different from those of Silicon Valley).

7. Trendsetter Index – reflects how fast is ecosystem in application of new technologies, management processes and business models.

8. Talent Index – measures quality of support network of startup ecosystem including scope of mentoring, services provided and types of financing sources.

During the project some 50,000 startups from all over the world were evaluated and the result is a benchmarking tool Startup Compass. It enables for startups to compare its evaluation metrics with others, identify trends and concentrate on improvement of the main company process.

The startup median is a startup with 8 employees, revenues amounting to about USD 1 mil. and annual user growth of 18 000%. Approximately 45% of evaluated startups come from the USA, thereof 8% from Silicon Valley and others are from startup communities from all over the world. The authors themselves are aware of the difficulty in insufficient representation of the Asian startup communities.

One of the project outputs is the ranking of world cities by their startup ecosystem performance represented in Enclosure 1 – Table 3. There are some noteworthy conclusions following from it, e.g.:

1. Even the advanced startup ecosystems of New York and London dispose of 70% less available venture capital for startups in seed stage than Silicon Valley.

2. Silicon Valley cast a global influence on the startup ecosystems of the world by immigration and emigration flows. Berlin and Sao Paulo have the least founders living in Silicon Valley before (4% and 7%), whereas Singapore and Waterloo (Ontario) have the most of them (33% and 35%).

3. Sydney, Sao Paulo and Moscow are startup ecosystems with highest differentiation level from Silicon Valley in terms of startups developed.

4. Although Singapore has quite strong financial background the risk tolerance by founders is the lowest among 20 top ranking startup ecosystems.

V. STARTUP BUSINESS ENVIRONMENT IN SLOVAKIA

The development of business environment in Slovakia has been less favourable for entrepreneurs as represented in the development of the Index of Business Environment (IPP) sinking from the value of 127 (in 2007) to 75 (in 2012). The drop during the year 2012 is related to the negative assessment of impacts of increased due and tax load, and labour legislation by the Slovak entrepreneurs. These internal reasons follow from the focus of economic policy and anti-crisis measures taken by the Slovak governments since 2008. The external reason of the drop are the consequences of economic crisis in the USA and EU upon the highly open Slovak economy with sector structure sensitive to the economic cycles. As follows from the annual reports on Global Competitiveness Index by the World Economic Forum in this period, negative impacts of inefficient government administration, corruption, restrictive labour regulation and infrastructure deficiencies have increased as well. According to the annual report Global Competitiveness Index 2012-13 the year-to-year competitive ability of Slovakia went down by 2 levels to rank 71, whereas in 2008 it occupied rank 46.

Startups in Slovakia were set up already in 1990-ies without bearing this name, e.g. in 1992 was founded the most successful Slovak startup ESET s.r.o., later renowned in the world ICT market through its very successful antivirus software NOD. The events for building entrepreneurial mindset of the young people were organized by Bata Junior Achievement Slovakia, AIESEC or within the Global Entrepreneurship Week organized by the Institute of Management at the Slovak University of Technology in Bratislava. Startups and established companies started to fill in the science and technology parks and business incubators, among the first also the Technology Incubator of the Slovak University of Technology in Bratislava launched in 2005. Since 1999 the National Agency for Development of Small and Medium Enterprize (NADSME) has been organizing the annual contest „Woman Entrepreneur of the Year“. In 2006 started in Slovakia the international contest „Entrepreneur of the Year“ organized worldwide.
by Ernst and Young Slovakia including categories Best Slovak Startup Entrepreneur and Most Innovative Entrepreneur of the Year. Since 2007 has taken place the contest Young Innovative Entrepreneur organized by the Junior Chamber International – Slovakia in collaboration with Entrepreneurs Association of Slovakia and NADSME. After series of informal monthly meetings of the startup ICT entrepreneurs in 2010 (StartupCamps) in Bratislava and Kosice and vibrant working contacts to the startup community in Prague the proven international format of the first StartupWeekend took place in October 2011 (the rules of Kauffman Foundation and English as a working communication language, 14 projects with participation of 80 startupists fostered by professional mentors). The added values of these events were presentation skills, new professional networks and viral marketing. The first official startup contest in Slovakia „StartupAwards.SK“ took place in November 2011 as a joint initiative of company Neulogy a.s., state agency SARIO, companies DELL and KPMG (250 participants, 11 finalists), and winners were awarded among others a 3-months stay in the Plugand&Play Center in Silicon Valley. It was remarkable that three winners of the contests were spin-offs of successful Slovak ICT companies, i.e. these companies somehow substituted the investors. During the year 2012 the first “Coworking Startup Offices“ popped up as venues for networking, collaboration and education of Slovak and foreign startupists in Bratislava, Kosice and other towns. They were founded by non-profit organizations and financed from membership fees and rent income.

VI. CONCLUSION
Startup ecosystems as described in the U.S. and other advanced West-European and Asian countries came into being in Slovak cities by the usual bottom up way using international contacts to similar foreign ecosystems. It appears they develop some positive features of the startup communities as formulated by B. Feld necessary for their sustainability and growth. Central points of ecosystems are technology or business incubators or coworking offices with public access which may be or may not be a part of science and technology park. Since science and technology parks are built up with regard to strengthen the collaboration of universities with industry and foster innovations and their commercialization the scope of involvement of university teachers and researchers in the projects and activities of such an ecosystem may appear an open issue, especially their motivation.
The drivers in the ecosystems are and will be the young technopreneurs, especially internet entrepreneurs, e.g. some 15 Bratislava startups with global orientation are stated on the Quora website. Further important components of the startup ecosystem are and will be existing voluntary mentors with experience in business or corporate management and investors (business angels or equity investment companies or commercial companies interested in fostering community activities as sponsors or commercial partners. As indicated the launch and growth of startup ecosystems may also be significantly supported by the municipal and regional authorities driven by the interest for new jobs with high added value on their territories as well as by organizations and associations orientated at development of entrepreneurial mindset and entrepreneurial activities of the young, such as Junior Achievement Slovakia, NADSME, BIC/EEN Bratislava, SIEA, SARIO or associations of Slovak entrepreneurs, business angels and VC investors (ZPS, ZMPS, Klub podnikateľských anjelov Slovenska, SLOVCA, PAS), consulting companies (e.g. Ernst&Young, KPMG) or banks with less conservative business strategy towards innovative startups.
The current development of startup ecosystems is based on civil initiatives, personal financing, contributions of non-profit organisations and financial or on kind donations of supporting companies. Slovak startups lack tax, accounting or reporting reliefs that are common abroad. Ministries or regional authorities provide there various microloans and soft guarantees or national or international innovation vouchers in order to stimulate the development of startup ecosystems and fostering collaboration of academic and industrial communities at the same time.
The already mentioned Entrepreneurship 2020 Action Plan (2013) and measures in its three pillars create an interesting space for extensive support of the EU startups, including the Slovak ones in the next years, if the related administrative burden of the implementing government authorities/agencies will not make it much less attractive for entrepreneurs.
Considerable potential of intellectual capital for entrepreneurship and innovation may be released through appropriate educational programmes in these fields at primary, secondary and high education institutions. However, it requires also a training of teachers in development of entrepreneurial mindset and significant improvement of remuneration of teachers at all levels of educational systems neglected for a long time and more generous financing of educational infrastructure. There is no reaping without sowing. It should be viewed by the government authorities as an investment in the quality and creativity of future labour resources, entrepreneurs and tax payers of Slovakia. These aspects should be given a due consideration in the new Innovation strategy and policy of Slovakia for period after 2013, which is under finalization. A relevant contribution in building up startup ecosystems in Slovakia may also be the latest corporate initiative of Google Slovakia, ESET and Neology in founding the Slovak Alliance for Internet Economy (SAPIE) as a platform for fostering inovations, high added value exports and faster growth of internet economy in Slovakia. It refers to findings and recommendations of study „Online Chance for Slovakia“ prepared by Boston Consulting Group for Czech and Slovak Republics in 2011. It concluded that in 2011 the internet economy contributed to 3.3% of the Slovak GDP, i.e. € 2,3 milliards and forecast 4.5% contribution to the GDP in 2016, if Slovakia catches up in the insufficient broadband connection coverage, online B2B connectivity and in the eGovernment. The SAPIE has already launched an online platform for development of startup communities in collaboration with startup incubator TheSpot.sk in Bratislava. The initiative has a government support by the Digital Leader of Slovakia – State Secretary of the Slovak Ministry of Finance. (Note: position of Digital Leader was initiated by the European Commission as a recommendation for the EU member countries. Digital Leader should supervise the realization of the EU Digial Agenda at the national level).

ACKNOWLEDGEMENT
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References:
14. http://s.co/about/connect
15. http://gan.co/the-network
## Table 1: Ranking of the US. incubators/accelerators by performance in 2011 [9]

<table>
<thead>
<tr>
<th>Rank and name</th>
<th>Seat, year of founding</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Y Combinator</td>
<td>MountainView, California, 2005</td>
<td>Value acquired: USD 7.78 mlrd. 500 startups, e.g. Dropbox or Airbnb</td>
</tr>
<tr>
<td>2. Techstars</td>
<td>Boulder, Boston, New York, Seattle, San Antonio, 2007</td>
<td>Portfolio 161 companies, 18 acquisitions</td>
</tr>
<tr>
<td>3. DreamIt Ventures</td>
<td>Philadelphia, New York, Israel, 2008</td>
<td>Portfolio of 65 companies, e.g. SCVNGR or Level Up.</td>
</tr>
<tr>
<td>4. Angelpad</td>
<td>San Francisco, 2010</td>
<td>Portfolio of 26 companies</td>
</tr>
<tr>
<td>5. Launchpad LA</td>
<td>Los Angeles, 2008</td>
<td>Portfolio of 29 companies, 5 acquisitions</td>
</tr>
</tbody>
</table>

## Table 2: The most favourable urban spaces for startups in the USA (2011) [10]

<table>
<thead>
<tr>
<th>Urban space in USA Year 2012</th>
<th>Total startup investments (USD mlrd.)</th>
<th>Startup number/Startups with investment</th>
<th>Average startup investment (USD mil.)</th>
<th>Urban space in USA Year 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. San Francisco Bay (Silicon Valley)</td>
<td>11,8</td>
<td>3 442 / 430</td>
<td>27,4</td>
<td>1. San Francisco Bay (Silicon Valley)</td>
</tr>
<tr>
<td>2. Boston</td>
<td>2,77</td>
<td>700 / 285</td>
<td>11,7</td>
<td>2. Los Angeles</td>
</tr>
<tr>
<td>3. New York</td>
<td>2,73</td>
<td>1 844 / 332</td>
<td>10,3</td>
<td>3. San Diego</td>
</tr>
<tr>
<td>4. Los Angeles</td>
<td>2,0</td>
<td>1 507 / 129</td>
<td>9,7</td>
<td>4. Boston</td>
</tr>
<tr>
<td>5. Washington D.C.</td>
<td>0,979</td>
<td>261 / 146</td>
<td>9,5</td>
<td>5. Chicago</td>
</tr>
</tbody>
</table>

## Table 3: Ranking of 20 world cities by their startup ecosystem performance [11]
Abstract: The paper reports on the technological capability assessment of small, medium and micro enterprises operating in the South African motor body repair sector. Multiple case studies were done on six motor body repair workshops. The study focussed on two technological capabilities, namely tactical and supplementary. Tactical capability focussed on the small enterprise’s ability to carry out auto-body repair and service of motor vehicles. Supplementary capability focussed on training, planning, information support and networking. The technological capability assessment was done through a model with five factors. The research established that most small enterprises understood their value addition activities. Five out of the six studied enterprises had no business strategy and this was found to have contributed to their poor tactical technological capability. All six workshops had weak supplementary technological capability. This was due to non-supportive infrastructure for training and networking. The paper proposes training and setting up of supply chain networks to enhance business growth and sustainability of these businesses.

Keywords: Technology, capability, tactical, supplementary, business strategy.

I. INTRODUCTION

Small, Micro and Medium Enterprises (SMMEs) play an important role in the socio-economic stability of a country. These business outfits contribute significantly to the economy and have a strong potential for growth. In addition they tend to be innovative, productive and generate employment (Oosthuizen, et al, 2010). Local Economic Development (LED) programmes have been introduced across South Africa over the past decade to support the development of SMMEs (Nel et al, 2005). SMMEs have come into existence through small business development policies and the concept of incubators (Nel et al, 2005; Chalera, 2007), and the setting up of the National Strategy Framework also seeks among other things to develop and promote SMMEs’ activities in job creation, income generation, and economic growth (Chalera, 2007).

SMMEs in general face various barriers in their day-to-day activities, such as: non-supporting legal and regulatory environment which is connected with complicated and unstable legal regulations (Ntsika, 2001); lack of market access due to negative image of SMME work oftenly treated as an incompetent entity (Nowak, 2010); limited access to finance which contributes to low credit credibility that results with the impossibility of raising external capital (Ntsika, 2001; Nowak, 2010; Poutziouris et al, 1999); educational barriers which manifest itself in the imperfection in education especially in the scope of marketing, finances and managing (Poutziouris et al, 1999), limited business
premises, lack of access to resources and technology, poor infrastructure, bureaucratic hurdles and a lack of managerial competencies (Pechlaner et al, 2004).

It is estimated that 55% of small businesses fail in the first five years and 81% within the ten years [11]. Other studies have put the failure rate of small businesses at 78% [12], and the life span at 18 months. Survival and growth of SMMEs is anchored on implementing effective strategies that can adress the forseen barriers. Consequently in an attempt to assist SMMEs operating in the South African motor body repair (MBR) sector, the paper explores technological capability of these SMMEs by looking into what services and value addition activities they do. Every activity that a company performs requires some level of technological capability (Panda et al, 1996).Technological capability will be identified through measurement of various capability indicators such as acquisitive, supportive and steering activities as suggested by, (Panda et al, 1996) This paper focusses on a specific SMME sector as advocated by the, (SA Government White Paper,1995) on the development of SMMEs.

Managing new technology include acquiring and using new technology to create competitive advantage to improve economic, social and wealth quotient of enterprises, (Leachman, et al 2005); . The need to acquire new technology stems from the dynamics that evolve in a manufacturing/ service set up such as new materials, new products and the need to satisfy ever changing customers’ needs, (Sonia, 2005). In the case of auto-body repair there will be always new cars on the market and new technologies used to service and repair new cars. Technology management employs various concepts that include technology strategy, technology forecasting, technology roadmapping, technology project portfolio and technology portfolio, (Cohen, et al, 1990). These concepts require a lot of resources and skill which are not usually found in Small and Medium Enterprises (SMEs), [5]. Acquisition and use of new technology by SMMEs brings challenges that include staff resistance from fear of losing jobs, hostility from labour unions, poor sourcing due to lack of resources and scouting, poor identification due to lack of knowledge management, poor or weak absorptive capacity due to lack of skill,(Bhardwaj et el, 2005). The choice to acquire new technology is influenced by the company’s strategy. Strategy is the determination of basic long-term goals including objectives of an the enterprise, the adoption of courses of action and allocation of resources necessary for carrying out these goals (Chandler, 1962).

Various intervention measures to assist SMMEs have been proposed, ranging from financial assistance to training. However technological assessments of SMMEs in their field of application have not been done. Technological strengths and weaknesses of SMMEs is an important parameter that needs to be explicitly considered in understanding the nature and direction of SMMEs business including the entrepreneurial activities of business owners in the motor body repair sector.

This paper will focuss on two technological capabilities, namely tactical and supplementary. Tactical capability is the small enterprise’s ability to carry out auto-body repair and service of motor vehicles. The auto-body repair includes 1-general body repair, 2-structural repair and 3-advanced structural repair. Supplementary capability focusses on training, planning, information support and networking. This paper will also look into both internal and external factors that can affect technological capability of an SMME. Internal factors studied included resources available to the company, its culture, size, strategy and system. However this paper will not cover external factors that include size of the economy, its growth rate, financial and fiscal policies of the government and factor market conditions, state of related and supporting industries and market rivalry.
II. RESEARCH OBJECTIVES

1. To carry out technological capability assessment for SMMEs operating in the South African Motor Body Repair sector.
2. To propose intervention measures that can enable motor body repair SMMEs to acquire relevant technology.

![Image](Image)

*Figure 1, The Conceptual framework*

III. LITERATURE REVIEW

A. SMMEs OPERATING IN THE MOTOR BODY REPAIR SECTOR

SMME in the motor body repair sector’s major activity is the repair of motor vehicle bodies. These vehicles would have suffered collision damage or vandalism. Collision damage is usually caused by accidents which are an unusual event for most motorists. The shock and trauma motorists experience due to accidents are made worse by the need to pay the excess, the loss of no bonus claim and the loss of one’s vehicle sometimes for a very long period. (RMI, 2010). In most cases the vehicle ends up out of the owner’s control, but with the insurance company, towing, assessors and repairers.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of employees</td>
<td>10</td>
<td>14</td>
<td>32</td>
<td>9</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Value of fixed assets</td>
<td>2M</td>
<td>2.1M</td>
<td>6M</td>
<td>3.2M</td>
<td>3.8M</td>
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<tr>
<td>Annual Turnover</td>
<td>1.7M</td>
<td>1.2M</td>
<td>4.3M</td>
<td>1.8M</td>
<td>1.9M</td>
<td>2.5M</td>
</tr>
<tr>
<td>Types of repair done</td>
<td>1 and 2</td>
<td>1 and 2</td>
<td>1, 2 and</td>
<td>1 and 2</td>
<td>1 and 2</td>
<td>1 and 2</td>
</tr>
<tr>
<td>Network with Insurers</td>
<td>Partial</td>
<td>None</td>
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<tr>
<td>Network with OEMs</td>
<td>None</td>
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<td>None</td>
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<td>None</td>
</tr>
<tr>
<td>Registration with SAMBRA</td>
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<td>None</td>
<td>Yes</td>
<td>None</td>
<td>In-progress</td>
<td>In-progress</td>
</tr>
</tbody>
</table>

*Table 1, Summary of case studied companies*

B. BUSINESS STRATEGY

Business level strategy is concerned with a firm’s position in the industry relative to competitors. It encompasses actions that are taken by an organisation in providing its value to its customer’s in-order to gain a competitive advantage. Business strategy ensures a match or congruence between the company’s markets and the existing and future abilities of the production or service system (Owen, 1990). It addresses issues that include: manufacturing/ service capacity, production facilities, use of technology, vertical integration; quality; production planning / materials control; organisation and personnel. Four different types of manufacturing strategies exist namely market-based, product-based, capability-based and price-based (Smit et al, 1997) identified and examined four manufacturing strategy content issues which are cost, quality, delivery and flexibility.

Strategy enhances management’s focus on linkages between external market requirements and internal organizational and technological resources, capability and competitive advantage.
Enterprise strategies include corporate / business strategy and functional strategies (Sun et al., 2002). Business strategy is the common theme or strategic posture at higher levels of the organisational, encompassing all activities in an organisation. Functional strategies include manufacturing strategy, market strategy and Research and Development strategy. Manufacturing strategy is a pattern of decisions, both structural and infrastructural, which determine the capability of a manufacturing system and specify how it will operate to meet a set of manufacturing objectives which are consistent with overall business objectives (Williams et al., 1995). For the SMMEs in the motor body repair sector the repair of damaged vehicle bodies will be their value adding activities similar to manufacturing. However Porter’s 5 Forces Model that include; rivalry, customers, suppliers, entrants and substitutes as well as business-level strategies of cost leadership, differentiation, focussed low cost and focussed differentiation will not be covered in this paper.

C. TECHNOLOGICAL CAPABILITY
Technological capability is defined as a set of functional abilities that are reflected in a company’s performance through its various technological activities. The technological capability frameworks that will be used to assess SMMEs in the auto-body repair sector were developed by (Panda et al., 1997) and have been adapted for this study. SMMEs in the auto-body repair sector will be assessed through tactical, supplementary and steering capabilities. Tactical technological capability has three sections namely production capability, marketing and selling capability and service capability. Supplementary technological capability has two sections namely acquiring capability and supportive capability while steering capability has three components only which are focussed on management’s ability to lead and develop organisational excellence (Long et al., 1995).

D. ABSORPTIVE CAPACITY
Absorptive capacity is the company’s ability to recognise the importance of new, external information or technology, assimilate it and apply it to commercial ends, (Cohen et al., 1990; Lin et al., 2002). The level of a company’s absorptive capacity is usually a function of prior related knowledge which includes basic skills, organisational learning and knowledge of recent technological developments (Khan et al., 2008). Several models on how a company can manage its absorptive capacity have been presented by several authors. Investment in R & D as the driver of absorptive capacity was emphasised by (Cohen et al., 1990), while Van Den Bosch et al (1999) focussed on potential absorptive capacity (knowledge acquisition and assimilation capability) and realised absorptive capacity (transformation and exploitation capability). Other factors that affect absorptive capacity and that are a focus of this paper are: knowledge management, organisational structure (Lenox et al., 2004; Caloghirou et al., 2004), human resources, external interactions, social capital, and inter-organisational fit (Lane et al., 1998).

E. TRAINING
Training helps to avert failure through integrating technical, social and organisational factors (Harvey et al., 2004) as it assists subordinates to better understand their responsibilities, authority and accountability. Theriou (2008) suggested that training contributes to achieving the objectives and goals of the organisation. The aim of training is to impart new knowledge, skills and attitudes (KSA), on employees for the sole purpose of performance improvement. Training is enhanced by the application of KSA through factors such as goal setting, workload, peer support, coaching, supervisor feedback, individual motivation and job design (Griffin, 2011). Modern and competitive organisations enhance their capabilities by setting up structures that foster a culture of continuous learning and information sharing (Wickramasinghe, 2007).
VIII. METHODOLOGY

Multiple case study research was carried out on six SMMEs operating in the motor body repair sector. The aim of the study was to, “explore, describe, explain and compare”, (Yin, 2003) their technological capabilities. Case studies in business and management research offers opportunities for investigating and comprehending exclusive and different enterprises, with difficult and dynamic events and processes (Woodside, 2010) as those found in the motor body repair sector. The case study research was conducted through interviews, observations, analysis of business documents and a structured questionnaire. The technological capability assessment was done through a model with five factors as shown in figure 2 (Panda et al, 1997).

IX. FINDINGS

Value adding activities that are normally done in an auto-body repair workshop are as shown in figure 3 below.

The research established that state of the art SMME in the auto-body repair sector are those registered on the panel system. They have better infrastructure, recommended equipment, and are recognised by OEMs. Type of equipment found in a registered panel shop include spray booth, chassis straightening machine (correct machine), arc and gas welding machines, vacuum machines, drilling machines, correct chains and computers for mixing of paints. The correct machine comes in two standards manual and automatic ones.

VI. TACTICAL TECHNOLOGICAL CAPABILITIES

A. PRODUCTION CAPABILITY

The production capability (PRC) looked at the effective use and control of motor body repair technologies. The research also evaluated how issues pertaining to quality assurance, inspection and inventory control are organised and implemented in these small businesses. The scale that was used in constructing the web chart is as follows: 75-100 % capability is high, 50-74 % capability is medium, 25-49 % capability is
low and 0-24 % capability is very low. This scale was adopted and used in all capability assessments covered in this paper. The questionnaire used in assessing the technological capability of these SMMEs is attached as Appendix 1.

SMME C had a medium range capability followed by F and A who had low capability while B, D and E had poor production capability as indicated in the web chart below. SMME C had almost state of the art technology that enabled them to carry out all three repairs namely general repairs, advanced repairs and advanced structural repairs. SMME C maintained its quality through its registration with the industry body SAMBRA. All six studied SMMEs were found lacking on properly planned preventive maintenance as well as production planning. During interviews it was noticed that SMME C was putting in a place a maintenance plan for their equipment. The culture of maintenance is not well understood by SMMEs.

![Production capability (PRC1 and PRC2)](image)

**Figure 4, Production capability (PRC1 and PRC2)**

**B. MARKETING AND SELLING CAPABILITY**

The marketing and selling capability was found to be high in SMMEs C, followed by F and A, it was found to be low in SMMEs E, B and D. It was noticed that SMMEs E, B and D could not negotiate terms of product service with most of their customers due to high rates of referral work. These SMMEs showed limitation to their capacity to attend to advanced and structural repairs. SMMEs F and A had better partnership with other auto-body repairers in the industry and were marketing their services including advanced repairs that could be done in their partners’ workshop. Only SMME C had a coordinated marketing and selling activities that was done through their local newspaper.

![Marketing and selling capability (MSC1 and MSC2)](image)

**Figure 5, Marketing and selling capability**

**C. SERVICE CAPABILITY**

SMMEs C, F and A exhibited higher levels of service capability. Service capability was assessed as the SMME’s capability to carry out diagnostics on damaged auto-bodies and other engine parts including their capability to carry out the necessary repairs, maintenance and replacements. All SMMEs had the capability to provide sound technical advice to their customers. Major weakness that was noticed on these SMMEs was their inability to conduct research that would determine and monitor customer needs and customer satisfaction levels. There were no service level standards like standard duration required for particular repairs. In all the SMMEs except for C staff had no normal routines of carrying out their work. Staff were allocated duties as per need of the day. It was also noticed that these SMMEs have no capacity to schedule service personnel and equipment.
X. SUPPLEMENTARY TECHNOLOGICAL CAPABILITIES

A. ACQUIRING CAPABILITY
Supplementary technological capability looked into two areas namely acquiring and supportive capability. Acquiring capability focussed on the ability of management to negotiate and finalise terms for finance, spares, technology and human resources. All SMMEs indicated that they had no access to cheap finance and this was seen to affect their day to day operations. SMME C had better technology acquiring capability as was seen by its ability to carry out all the three types of repairs. This SMME was receiving a lot of referral work from other auto-body repair shops. The research established that SMME C, A and F had better acquiring capability. SMME B, E and D were still growing in this aspect. All SMMEs had the ability to negotiate and acquire spares. However it was noticed that all SMMEs except for C had very weak human resource management. Identification and acquiring new technology was found to have been good in SMME C, A and F. The research also observed that all SMMEs had no capacity to do vendor development due to the size of their businesses.

B. SUPPORTIVE CAPABILITY
Supportive capability focussed on the ability of SMMEs to carry out training, strategic planning, setting up information and networking as well as high standards of safety and security. In SMME C it was observed that the company was training its workforce towards multiskilling. This had helped the company to grow by having few workers being able to carry out different tasks. It was difficult to assess the absorptive capacity of workers in these SMMEs due to lack of some technology and equipment in most of the SMMEs. All SMMEs except for C had no strategic planning in place. Information support and networking was found to be poor. There was no use of internet facilities in all SMMEs. SMME C was well managed, it had a well structured organogram, followed by A and F. SMMEs B, D, and F were owner managed. These SMMEs were seen to be struggling in their day to day operations since the owners were over-burdened in both management issues and giving technical direction to the workforce. Safety and security was found to be of acceptable standards in all SMMEs studied.
XI. ABSORPTIVE CAPACITY
The research established that SMMEs in the motor-body repair sector have poor absorptive capacity, due to poor knowledge management (Chinho et al, 2002), weak organisational structures and poor human resource management (Caloghirou et al, 2004). Absorptive capacity was also affected by weak industry portals that can aggregate flexibility and agility despite their lack of resources. There was poor networking among SMMEs making inter-organisational interaction difficult.

XII. LIMITATIONS
The research was exploratory in nature and attempted to highlight the level of technological capability found in the motor body repair sector. Fewer SMMEs were studied making it difficult to generalise the results. More comprehensive research is required to cover other dimensions that affect technological capabilities of SMMEs in this sector.

X.RECOMMENDATIONS
Finance should be made available to enable entrepreneurs in this sector to access new technology. New training courses covering new repair technologies must be introduced and must involve use of computers since most diagnostic equipment is computer operated. Universities can participate in coming up with new training courses and curriculum that will help improve the absorptive capacity of workers in the auto-body repair industry. A supply chain network to source new technologies for auto-body repair sector must be set-up to ease searching and procurement. The supply chain framework must address the acquisition of repair equipment. Universities and colleges must set-up business management courses for entrepreneurs in the auto-body repair sector. Such courses will enhance their day to day operations such as manpower planning and general management skills. All registering SMMEs in this sector must be encouraged to prepare and present a business strategy on registration of the business.

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Appendix 1. Research Questionnaire

Tactical technological capabilities

Production capability (PRC)

PRC1. Capability to effectively utilise and control motor body repair technologies

PRC2. Capability for carrying out quality assurance, inspection and inventory control

PRC3. Capability for carrying out preventive, corrective, improving and productive maintenance

PRC4. Capability to perform production planning and equipment and maintenance scheduling

Marketing and selling capability (MSC)

MSC1. Capabilities to identify customers bid and negotiate terms of product/service selling

MSC2. Capability to supply product/service to customers, as per contract, either alone or through a consortium

MSC3. Capability to plan, monitor coordinate marketing and selling activities

Service capability (SEC)

SEC1. Capability of diagnosing problems and undertaking corrective actions (including repairs maintenance and replacements)

SEC2. Capability to provide technical advice to customers

SEC3. Capability to conduct research to determine and monitor customer needs, wants and satisfaction levels and to set service level standards

SEC4. Capability to plan, monitor and coordinate service capacity, service activities and schedule service personnel and equipment

Supplementray technological capabilities
**Acquiring capability (ACC)**

ACC1. Capabilities to identify, assess, negotiate and finalise terms of the technology to be acquired

ACC2. Capabilities to identify, assess, negotiate and finalise terms of acquiring spare parts and consumables

ACC3. Capabilities to identify, assess, negotiate and finalise terms of the finance to be acquired

ACC4. Capabilities to identify, assess, negotiate and finalise terms of the human resource to be acquired

ACC5. Capability for planning, monitoring and coordinating resource acquisition processes and vendor development

**Supportive capability (SUC)**

SUC1. Capability to provide training

SUC2. Capability to undertake strategic planning

SUC3. Capability of providing information support and networking

SUC4. Capability to adhere to high standards of safety and security

**Steering capability (STC)**

STC1. Capability for path finding

STC2. Capability for decision making and implementing

STC3. Capability to integrate the organisation’s activities
Structuring Project-Based Executive Education to Address the Opportunities of a Rapidly Changing Business Environment

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Abstract: While traditional management qualifications focus on academic learning and theoretical studies, global CEO surveys point to increasing operational complexity and technology management and deployment factors as the most important challenges facing business today. Executive education, therefore, needs to be re-aligned to focus on the interconnectedness of the organisation and must emphasise the role and impact of emerging information management technologies on rapid decision making, ongoing strategy development and creativity.

This paper proposes a structure for executive education that incorporates work-based projects to enable the executive more effectively to understand and interpret the organisation, its procedures and its management processes, so that practical contributions toward their improvement, optimisation and relevance to the bottom line can be made with immediate effect. The structure and scope of these projects are the key focus of the course, and the paper outlines the main features in their selection and management.

Keywords: Project-based Education, Informatics, Qualification Frameworks, Master

1. Introduction

Traditional management qualifications focus on academic learning and theoretical studies. While this may equip the executive participating in these courses with a broad understanding of the general issues facing the organisation, key opportunities presented by emerging technology, in particular information technology, are largely addressed with insufficient regard.

Surveys of CEOs globally reveal that rapid escalation of complexity is seen as the biggest challenge in the business environment, and many CEOs doubt their ability to cope with this development. Organisations are connected in multiple dimensions and are increasingly subject to systems-level failures. This requires systems-level thinking about the effectiveness of physical and information assets and infrastructures.

Technology overall has risen to number 2 in ranking of top external factors impacting on the organisation, however, the role of information management has become less about technology and more about strategy.

Executive education, therefore, must focus on the interconnectedness of the organisation and must emphasise the role and impact of emerging information management technologies on rapid decision making, ongoing strategy development and creativity.

It is crucial that during the course the executive learns how to interpret the organisation, its procedures and its management processes, so that practical contributions toward their improvement, optimisation and relevance to the bottom line can be made immediately.

This paper describes how an executive course should be structured to address this emerging complex environment.

Firstly, the content must focus on the dominant role that crafting data into actionable information and knowledge plays in the success of the organisation.
Course content to address the imperatives of business today is suggested.

Secondly, the course must integrate academic content with the rapidly changing real-world environment, and point to processes for ongoing and systematic strategic transformation. This is facilitated through specific workplace projects designed to offer the organisation demonstrable financial and operational benefit. The structure and scope of these projects are the key focus of the course, and the paper outlines the main features in their selection and management.

In this process the post-graduate then enters the organisation not only with the degree but also with relevant exposure to practical business conditions, leading to more rapid achievement of personal & organizational objectives. An existing course, the Master of Business Systems, has been structured according to these principles, and is also described in the paper.

2. IT-related Degree Programmes

Whereas in Europe the term “Informatics” is used, most of the rest of the world calls the subject “Computer Science”. “Informatics”, as the word suggests, puts information at the focus. Originally a French word, “Informatics” has become widely used in Europe. Computer science or Informatics basically refers to the processing of information, while computer science puts the machine, the computer, effectively in the centre and therefore includes a slightly more technical point of view.

As Groth and MacKie-Mason (2008) state “Informatics” is now used in the English speaking world as well and denotes a more application oriented point of view: “informatics is a discipline that solves problems through the application of computing or computation, in the context of the domain of the problem.” In this paper we focus on Business Informatics that is defined as Computer Science or Informatics applied in the business environment. More broadly Business Informatics deals with information technology in administration as well.

Although the term Informatics is used in Europe as a synonym for Computer Science in general the characterisation given by Groth and MacKie-Mason (2008) highlights an aspect that is especially true for Business Informatics: “Informatics, in general, studies the intersection of people, information, and technology systems”. Nevertheless Business Informatics as it is seen in Europe covers the more technical aspects like systems development or programming in the area of application as well.

Generally all study programmes in Germany related to information technology are application oriented. An analysis of degree programmes accredited by the German accreditation board ASIIN shows that more than 70 master programmes exists. Most of them show already by their names the area of application. Here are some examples:

- Business Informatics
- Bio-Informatics
- Digital Communications
- E-Business
- Informatics and Communication Systems
- Digital Media
- Computer Aided Process Engineering
- Engineering Informatics
- Informatics in Medicine
- Multimedia Engineering
- Geo-Informatics

In Germany an application area is generally included in the programme title. Even pure research oriented Informatics programmes at old universities are not completely focussed on Informatics only. As part of the degree programme students have to study a second, a minor subject as well, that can be chosen out of all other subjects the university offers.

All these facts indicate that at least in Germany Informatics is seen as an application-related science. Students have to be aware that they always have to apply their knowledge in Informatics to some other area of application. Informatics is a science that helps others.
3. QUALIFICATION FRAMEWORKS

How can theory and application be integrated in a master’s programme? Before we review our experiences the requirements will be discussed as outlined in the German National Qualification Framework (NQF). The German NQF lists eight levels where level 7 belongs to a Master degree (AK NQF, 2011). It is outlined that a Master graduate should possess “competences for the processing of new and complex professional tasks and problems set” as well as “competences for autonomous management of processes within a scientific subject or within a strategically oriented field of occupational activity”. Additionally “the structure of requirements is characterised by frequent and unpredictable changes.”

The German NQF is in alignment to the European Qualification Framework (EQF) which also has eight levels where a master qualification is at level seven.

The EQF specifies that the competencies rest on “highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research”. It also demands a critical awareness of knowledge in a field and at the interface between different subjects.

Master students therefore possess competences in solving problems in new, unfamiliar situations that are multidisciplinary and broadly related to their subject of study. These competences are based on critical thinking and deep knowledge in the area and include the ability to handle complexity and to come to decisions even if only insufficient background information is available. Self-management is mandatory in order to run application-oriented or research-oriented projects.

In South Africa a Master programme usually is at level 9 of the 10 level National Qualification Framework.

4. THEORY AND PRACTICE

In order to achieve the desired results as outlined in the qualification frameworks (see previous chapter) a master degree programme has to be structured in such a way that the competences can be acquired.

A full time master programme in Germany takes usually 2 or 3 theory semesters and ends with a semester dedicated for working on the dissertation, the master thesis. A distance learning or a part-time study programme can take more time, e.g. 4 to 6 semesters. We stress that a thesis has to be prepared in one semester only, and is therefore only a third or a quarter of the total work load for the student in a master programme.

A part time study programme especially offers many possibilities to combine academic theory and work place experiences of the students. In the field of Business Informatics there are a lot of such opportunities regardless of the business or the administration the students are in.

4.1 Modules and Term Papers

Instead of old fashioned transfer of knowledge in lectures and seminars we argue that a problem-based approach can achieve the desired competences from the very beginning. Thus ideally a “theory” module covers both parts: transfer of knowledge (theory) and the application of that knowledge to a real-world problem, preferably related to the work experiences of students (practice). The latter can be achieved by proper term paper tasks. “Proper” means that students are forced to go through the theory again in order to apply the knowledge to a problem at their work place. Since IT systems are used everywhere it is easy to identify such problems.

Beside the fact that students extend their knowledge, the knowledge is practised in the application problem at the same time. As well critical thinking, this trains research methodologies and also scientific and business writing. Every term
paper is a small piece of a scientific work and is therefore also the best preparation for the final dissertation.

4.2 Master Thesis

A master thesis is the final project a student has to complete in order to graduate as a master. The examination regulations of the Master of Business Systems or the Master of Business Informatics at Hochschule Wismar point out that “The master's thesis is an examination that concludes the study. It should demonstrate that the candidate is able within a given period to work independently on a problem in his field using scientific methods.”

Experience has revealed that most thesis topics are suggested by students: They have special interests or they work in companies and find topic ideas there. The latter is especially true for part time or distance learning students: people who study beside their normal occupations after hours.

Once a student has identified a problem that he or she would like to address in the master thesis the university has to affirm and ensure that such a topic meets the requirements for a master thesis. Common practice is that a university lecturer whose field of research is close to the proposed topic will supervise that master thesis. This guarantees that the topic and the whole work meet the university standards.

A difference can be detected between full time students and part time or distance learning students. Full time students are less influenced by long workplace experiences and are more open to the academic requirements. In contrast, part-time students with a long history of workplace experience tend to focus too much on solving a single problem at their workplace.

Usually the supervisor balances the practical problem and academic standards and forces the student to see at the problem from a broader, scientific point of view.

4.3 Examples

Knowledge Management has been an important topic for many years. Knowledge management can be seen from different perspectives. From the IT point of view knowledge management has to deal with the formal representation of knowledge, knowledge processing and the fast and universal access to knowledge. Many theses investigate IT based knowledge management applications in various companies or organisations.

For instance a semantic wiki system is used at the headquarters of DrägerMedical, known world-wide for their medical equipment, located in Lübeck, North Germany. The wiki is enriched by a graphical process modelling tool to define therapy processes and workflows. Gritje Meinke identified possible anomalies in process models and implemented algorithms for an automated anomaly check in her master thesis, (Meinke , 2011).

Other research topics focus on the improvement of knowledge management in tertiary higher education institutes in South Africa or the possibilities and expected benefit of knowledge management approaches in the wine industry of the Western Cape in South Africa.

Since most of the IT systems are implemented and used by human beings there are always problems to address at the interface between people and system or between groups of people as technicians and managers or technicians and users. Research currently under way focuses for example on:

- The use of event management systems,
- The contribution of contract clauses to mitigate project issues and failures in South Africa,
- An investigation of the communication challenges between technical professionals and managers,
- Information privacy and security processes at tertiary higher educational institutions,
- Business process design in various companies or organisations,
- Control of transportation infrastructure,
- Management of library systems

All these topics follow a main principle: how can theory applied to emerging technology help to solve real-world problems? In order to answer the question students analyse the situation and, via an
extended literature review, assess the current state of technology. Using this background an original approach to solving the problem has to be developed. Therefore the knowledge transferred in the many theory modules has to be applied again to this real-world problem and a solution has to be developed.

4.4 Benefits

Term papers or master theses related to real-world problems benefit all the parties involved:

The students expand their abilities and extend their competences in running a project and solving a problem. Students become more self-confident and are more ready to engage with their organisations and develop innovative solutions. Students get a degree for the work, not the least benefit of a thesis work.

Companies benefit significantly from the student’s projects. New techniques can be tested and analysed. Existing structures or processes can be critically analysed and ideas for improvement developed. Companies get to understand the impact on their business of new developments in science and technology. And, last but not least, work done by a student costs no or less money than a full professional doing the same work.

Universities through the better academic people involved as supervisors get to know the problems companies or administrations face. They learn how technologies really work and function in industry and receive direct feedback about how practical theories are. This influences further lecturing and helps to improve the higher education.

5. MASTER OF BUSINESS SYSTEMS

The Master of Business Systems is a new qualification that incorporates the concepts described above. It is recognised that business today is largely systems-oriented, and that success depends a great deal on the ability of the organisation to manage effectively the mass of information, derived from customers, suppliers, business processes and market intelligence, that floods current business operations. This flood, termed “big data”, is characterised by its volume, no longer measured in gigabytes, but rather in petabytes and exabytes, its rapidly increasing speed and speed of change, and the increasing need to ensure its correctness, accuracy and veracity.

These characteristic developments of the 21st century fundamentally change the way in which business operates. They change business operations, they change the approach to the way projects are managed, they compact the decision-making horizon, they change the way the organisation interacts with customers and the environment. They allow the organisation to operate in real time.

The Master of Business Systems provides the foundation for harnessing this new environment. Modules on data management and decision-making address how this flood may be tamed and utilised. Modules on information technology in business and the design of business processes identify how organisations can benefit from the opportunities presented by emerging technology.

Fig. 2: Structure of the MBS programme

Communication and management leadership play an even more important role in a rapidly changing and dynamic environment, and are an integral part of the course. Information management systems and the associated infrastructure are complex, and processes for identifying their scope and implementing them are included.

These modules, illustrated in Figure 2, are presented in one-week blocks during the periods shown. The semester time in between the blocks is used for self-study term papers.

Term papers as part of the theory modules and master thesis topics related to workplace
experiences are the components of a successful work-based learning approach that results in competences master students should have according to the EQF or the German NQF.

6. CONCLUSION
The paper describes the challenges facing executive education in a rapidly changing business environment, and concludes firstly that such education is imperative, and, secondly, that a new model for the presentation and delivery of this education is required.

It is argued that existing executive education programmes do not address the complexity of modern business operations, and the conclusion is reached that a restructuring, as outlined in the paper, will be more effective in delivering improved organisational performance, higher competitiveness, more efficient operations and increased profitability.

In addition, such restructuring results in benefits for the student, the organisation and academia, making the proposals relevant both to organisations and to the community.

6.1 References
The Inherent Tension of Innovation, Entrepreneurship and Sustainability: A Global Point of View

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Abstract: Until recently engineering has been a service profession, serving the military, civil society and corporate interest. This service has been enacted within a framework of social responsibility for the health, safety and well being of all. New ideas or inventions were often not the product of engineering per se, but a complementary activity to scientific discovery, corporate creativity and individual genius. In the present age much of this has changed. Engineers are now routinely encouraged and expected to be entrepreneurial, a change that eliminates or at least blurs the distinction between the engineer and the organization served. At the same time responsibility has taken on new dimensions (due to the fragility of the environment and the increasing power of technology) centering on sustainability or preservation of the world for the future. These three new standards for engineering, innovation, entrepreneurship and sustainability, do not easily fit into the established and existing social, political and economic frameworks, especially as the forces of globalization are reshaping them. There is an inherent tension that obtains among the principles of newness, growth and preservation, a tension that is also manifested quite differently around the world.

This discussion examines the necessary negotiations at play in engineering enterprise as this triad of ideals, innovation, entrepreneurship and sustainability, are jointly sought.

INTRODUCTION

Innovation, entrepreneurship and sustainability: these three terms characterize dimensions of engineering often highlighted in the context of a globalized economy. As a description of what engineers do they provide a striking contrast to the terms specified by a global organization dedicated to the improvement of engineering education: conceive, design, implement, operate. These terms overlap minimally and to an extent represent divergent views of engineering practice. How do the new IES objectives relate to the CDIO categories?

While the CDIO approach formalizes aspects that are acknowledged across most branches of engineering, the IES categories suggest a shifting agenda and new social role. This role delegates to engineers a degree of responsibility for the economic well being of society, not only with regard to the reliability of the infrastructure (a CDIO value), but for economic growth and competitiveness. Indeed within political rhetoric one now commonly hears the claim that innovation and entrepreneurship, more than other factors, hold the key to future prosperity and that they, in turn, are the expressions of engineering and technology. Under this conception engineering becomes a key to the growth of the global economy.

Without examining the truth of this line of thinking consider the implications it has for the nature of engineering work and inquire whether this represents an overall gain or loss for society, locally and internationally.

It is not at once obvious how one can harness the IES activities together in one yoke, but here is an attempt to do so. To innovate means to change
some existing thing; not simply to repair or repurpose but to improve through a process that maintains and extends functionality. The resulting improvement or upgrading implies marketability, as the extended or new functionality should offer value to consumers and users. Entrepreneurship in this case suggests that the economic benefits of marketing the innovation should accrue to the designer (engineer) herself, rather than to a corporation or other institution. Thus on this model, engineering becomes wed more tightly to business values, a change that may erode how engineers exercise their public responsibilities. Likewise, when sustainability is correlated with innovation and entrepreneurship, the emphasis becomes product continuity, that is the continuing marketability of a device – a perverse approach that could mitigate against other socially or environmentally beneficial changes.

If one assumes a transition of engineering to support IES priorities, there are two large issues that should be considered: 1) Will there be an effect upon the quality of engineering itself? 2) Will IES engineers serve the public interest as well as they might? Both issues will be considered from the perspective of engineering education.

TECHNOLOGY AND INNOVATION

A largely unexamined view presumes that technology is intrinsically innovative. By this it is understood that technology seeks new and better ways to perform actions and carry out processes. New and better often means little more than faster and/or more powerfully -- qualities that may not be improvements, but leaving that aside one should examine the notion that technology always augurs the new or novel.

The idea of technology is that of rational technique. In this case, rational means clearly and efficiently purposeful, a technique that accomplishes an objective without waste. The performance of athletes can said to be technological. Take for example the technique and understanding that together yield the most efficient and accurate way of returning the ball in a tennis match. This is a technological feat. The aspiring tennis champion will most likely learn this mimetically and there is little if any incentive to innovate. Of course some innovations may improve one’s game, but this would be a rare and unusual occurrence and not as aspect of technology per se. The rationally efficient when achieved does not seek its replacement by a new approach.

Of course engineering is not limited to technology and is driven by human and economic concerns as well as by the desired efficiencies of technology. But neither human choice nor economic well-being relies on innovation. Indeed resistance to change may be more normative. The view of technology in pre-modern India, for example, was in fact to preserve the status quo for the sake of social amity and economic stability.

Since innovation is not an intrinsic feature of technology, one asks if innovation is likely to enhance the quality of technological production? On the face of it, the answer appears to be no. To the contrary innovations, especially complex, high tech innovations, tend to require multiple preliminary versions and numerous trial rounds in order to achieve an acceptable quality standard. Examples as varied as the Microsoft Windows 8 operating system, the Boeing 787 Dreamliner or the iPhone 5 all reached the marketplace with serious problems associated with their innovations. It is a characteristic of technology that relies upon complex systems that there will be unanticipated “bugs,” not recognized in the design process, that become manifest only through regular use. The iterative process favored by engineering stands as a corrective to this factor.

This observation pertains to the quality of technology with reference to its prescribed function. The GPS software built into the iPhone 5 sometimes returned bizarre results as for example positioning one in Manhattan, Kansas rather than correctly measuring the phone’s location in New York City. This is a failure of the intended utility of the software, but how should unprescribed or unintended functionalities be regarded? In many instances the most widespread utilizations of a new technological product are not those intended or anticipated by the innovators. This is frequently the case with drugs designed for one condition but discovered, sometimes serendipitously, to be
effective against other, unrelated conditions, often to great benefit but sometimes tragically as was the case with Thalidomide disaster where the unintended use of the drug against morning sickness during pregnancy resulted in the widespread occurrence of tragic and seriously disabling birth defects. The Thalidomide disaster provides a cautionary tale against bringing a product to market prematurely, but also a reminder of a natural tendency to deploy (especially) new products in alternative ways.

Entrepreneurship strives for success in the marketplace. But this type of success ought not to be one of the core values of engineering as it may truncate the attention needed for other priorities. To guarantee the many aspects of product integrity that are part of the social contract engineers have with the public the possibility of pecuniary gains should be limited.

This leads directly to a philosophical point that is central to engineering practice. Given the acknowledged public responsibility of engineers, how should market forces be regarded? Some may hold the view that the market acts in response to public interest and that over time it presents the rational and most desirable choice. This free market viewpoint correlates with an entrepreneurial approach, but it is not clear that it works as well as its adherents maintain. The responsibility of engineers to serve the common good may in fact be abrogated by laissez-faire, free market theories.

These concerns suggest that the degree to which the entrepreneurship is incorporated into engineering needs to be governed by several constraints, namely those mandated by the implicit social contract with the public. This is necessary to promote the highest quality of technical engineering and technology development as well as to maintain the explicit expectations to guarantee the safety and reliability of engineered devices and systems.

**INNOVATION AND ENTREPRENEURSHIP**

Entrepreneurism is a natural outcome of innovation in the sense that innovation is for the sake of making change. Governments can perhaps impose change by fiat and the public can foment change through revolution. However, the avenue open to individuals and groups is more often that of rhetoric and commerce, that is, entrepreneurship. The motivations of what is generally understood as entrepreneurship are a bit narrower: it is to make money through change. Thus the meaning of innovation in engineering reduces to a strategy to make money. Is this the proper role for engineering? Does this threaten the integrity of engineering as a guardian of the safety of the built world?

In our time the opportunities to be compensated for one’s efforts have shifted so that in many economies starting a business is the most available way to earn a living. The set of skills and other resources that engineers possess means that they more than others are capable of organizing businesses that can offer new and desired products. Indeed, motivated engineers, without additional instruction or courses in such newly constructed fields as “leadership,” “innovation” or “entrepreneurship,” are capable of starting businesses. But the crucial question for engineering educators needs to be whether in the effort to support entrepreneurship, by whatever approach, the commitment to social responsibility and the public good is adulterated. In addition to key proficiencies what needs to be included in the modern engineering curriculum?

As an example, the Polytechnic Engineering School of New York University represents the core of its educational approach with the logo “i2e,” which stands for from innovation & invention to entrepreneurship. Although fundamentally this is a recruiting instrument and not a mandate for how courses should be taught, some faculty members have questioned just how central to the educational mission of the school this concept should be. The danger lies the potential dilution of course content, perhaps by replacing more demanding technical material in favor of teaching skills that lead to observable outcomes measured by such indices as patent applications or business plans written for a technology incubator.

**SUSTAINABILITY**
As already suggested, when sustainability is linked to innovation and entrepreneurship the focus of the meaning of the term shifts radically. The common uses of the term suggest a durability that is compatible with and supports the protection of the natural environment. Sustainability refers usually to renewable energy sources, devices that do not deplete resources, the minimization of costly maintenance, constraint when harvesting, and other strategies that establish a condition of (dynamic) stability. The idea of sustainability is that of preservation and longevity due to minimum stress. A sustainable lifestyle is one that does not require many resources, replacements or additions. Thus the fundamental meaning of sustainability is contrary to the basic premise of innovation/entrepreneurship.

Sustainable engineering, in the usual sense of the term, is not peripheral to engineering practice but on the contrary at the heart of good engineering. Engineering designs based upon the notion of planned obsolescence or a lack of durability need to be justified by some criterion other than an induced consumer demand for the newest or latest thing. Yet isn’t this what the coupling of innovation and entrepreneurship does?

The IES triad renders the idea of sustainability as little more than an issue of brand loyalty: the innovator-entrepreneur initially wants to overthrow or challenge an existing brand, perhaps in the hope that eventually the start-up may be bought by a well-established brand (which it will then help to sustain). That is to say that the idea of sustainability is compromised and made subservient to the values of business and profit making.

IES ENGINEERING AND THE SHRINKING WORLD

Our contemporary, ever more interdependent world, can be viewed in two contrasting ways: either under the category of globalization that connotes a world where economic boundaries have been nearly eliminated and implying standardization and uniformity or as a collection of global villages: local societies situated in a world-wide network each with its own identity. These identities generally represent complex value sets that include aesthetics, economics, ethics, lifestyles and politics. Consequently global villages will resist the forces of globalization. Where does engineering stand? With historical roots in the military, long standing connections with industry, and now its emphasis on innovation and entrepreneurship, engineering, especially as it has become an agent of modern technology, is generally one of the forces of globalization.

This creates an unfortunate circumstance. On the one hand, as an instrumentality of globalization, engineering may well abandon its social responsibilities. On the other, unless engineering is localized, global villages would have to survive without the benefits and amenities afforded by good engineering practice. This would constitute a serious loss -- in the extreme extending to such matters as clean air and pure water. How might this paradox be resolved?

One might note that some of the problems that would result from the absence of global engineering are the consequence of activities with which global engineering is already complicit. Air and water pollution, for example, often result from the work of industry or from military actions. To resolve the paradox careful distinctions need to be made between those activities for which global standardization and a united effort is imperative. The many problems associated with climate change provide an obvious example where global standards are necessary. But there are many problems for which local solutions are appropriate.

Engineers should be trained to assess and when desirable employ and adapt indigenous techniques and traditional technologies. Sometimes the better solution may be based upon traditional knowledge, require a lower level of technology, and consequently be less costly and generally more sustainable.

Otherwise it is important for engineers not to participate actively in the distribution of new products that may have little or no positive value in a given context. Many innovations emerge from the circumstances of advanced, postindustrial societies. While they may be enticing and
marketable they may damage a society by displacing its other needs.

**THE USEFUL ARTS**

Engineering is one of the useful arts. As such its purpose is clear. However, as technology has ascended and engineering has become more closely associated with business activity the values of engineering are tending to reflect a different notion of useful. Technology can be both demanding and seductive. One often desires and sometimes even feels compelled to acquire a new technological device on the ostensible grounds that it’s useful even though its actual utility is far fetched. Consider the multitude of “apps” available for so-called smart phones. Many promise great utility and efficiency but actually offer no advance over what pencil and paper could do just as well. There are those who feel compelled to have “apps” for every simple task – and to have apps that actually create new tasks or provide one with superfluous information or excessive amounts of data. There are also individuals who find such technology intimidating or objectionable in general. In either case one risks being tyrannized by technology. Technology in this way does not qualify as one of the useful arts. The future of engineering is largely tethered to that of technology. But perhaps engineers, more than anyone, need to attain what the philosopher Martin Heidegger called a free relation to technology, one whereby human choice determines its purpose.

**CONCLUSION**

When IES is the driving force of engineering there are conflicts with the CDIO paradigm. The combined influence of economic factors and the attractions of technology have had a profound impact upon how the purposes of engineering are understood. Rather than being one of the useful arts as defined by CDIO the IES approach sees the central task of engineering as the development of new devices that have market value from which the engineer, as owner of the IP, can derive reward in business ventures.

In addition to its deviation from the CDIO schema IES contains its own inner tension. Innovation, generally not based upon pure discovery, refers to change that may be an improvement, a repurposing, or in some other way useful to society. But when linked to entrepreneurship the purpose of innovation is set by commercial opportunity. Marketing strategies that create desire for items that may or may not be beneficial or even needed, in turn, create opportunities. Thus entrepreneurship narrows the scope of innovation. The costs of entrepreneurship, largely front loaded start-up expenses, require both a fairly quick return on investment and a minimum longevity of the product. In the context of IES this becomes the core meaning of sustainability: the long-term survival and marketability of the device. IES presents a vicious circle with the objectives of sustainability challenging the value of innovation.

When IES is played on the global stage these tensions are amplified. Global marketing often is oblivious to local values and actual needs. Particularly in the so-called developing world, needs -- including basic infrastructure improvements, do not correspond to their analogies in the West. Innovations that are developed in advanced and modern societies, even when the design offers an explicit improvement upon existing choices, may be several generations ahead of what is actually needed or would be beneficial. More than that, there is not a single path to development and what is genuinely valuable in one situation may be worthless in another. The tendency of globalization is to level or flatten cultural, social and economic differences for the sake of expanding markets and little else.

While it is the case that local communities under stress may benefit greatly from technical and social innovations, such benefits should be de-linked from entrepreneurial values and certainly from the imposition of external market strategies.

Engineering needs to preserve its status as a useful art and to fulfill its social responsibilities and concerns for the public good through this role. This means that engineering needs to resist many of the overtures proffered by economies overdriven by the desire to expand.