

LAPPEENRANNAN TEKNILLINEN YLIOPISTO  
LAPPEENRANTA UNIVERSITY OF TECHNOLOGY

LUT Doctoral School

LUT Scientific and Expertise Publications  
Raportit ja selvitykset – Reports 58

# **Abstracts of LUT Doctoral School conference presentations**

**10 December 2015**

Sari Kotivirta, Terhi Virkki-Hatakka (Editors)

ISBN 978-952-265-909-5  
ISBN 978-952-265-910-1 (PDF)  
ISSN-L 2243-3384  
ISSN 2243-3384

## Table of contents

PREFACE.....	1
ABSTRACTS.....	2
POSTERS.....	3
PRACTICAL SESSION .....	16
SCIENCE SLAM.....	20
SCIENTIFIC SESSION .....	24

## PREFACE

The LUT Doctoral School Conference in December 2015 follows the first ever-organized conference a year ago. The conference offers research staff from all parts of the university an opportunity to work together, learn from each other's work and to create new contacts.

This book of abstracts introduces conference presentations given mostly by doctoral students at LUT. This year we have three types of presentations, i.e. scientific, practical and science-slam presentations, as well as posters. This has also been educational process to support writing of the abstracts and to review them by other doctoral students with more experienced faculties.

Almost everything has changed in one year. The graduate school was named to the Doctoral School to follow more popular terminology in European organizations. This also gives the new name of this conference. LUT's academic staff was re-organized into three schools: Energy systems, Engineering science, and Business and management. The year has also been economically challenging in Finnish higher education, not only at LUT. Regardless of the changes, science is done by competent researchers as earlier. Also, by sharing results with colleagues and other peers gives the real value for the work you are doing. The LUT Doctoral School conference stays to continue sharing results and opinions as well as to discuss scientific problems to be solved together with colleagues.

I warmly thank all of you, our doctoral students and others contributing to the Doctoral School Conference 2015!

**Jari Hämäläinen**

Vice president for research, Chairman of the LUT Doctoral School  
Lappeenranta University of Technology

## **ABSTRACTS**

### **Nanofiltration and reverse osmosis as a platform for production of natural extracts, the case study of carob residues**

**Almanasrah Mohammad<sup>1</sup>, Kallioinen Mari<sup>1</sup>, Duarte Luís C.<sup>2</sup>, Roseiro Luísa B.<sup>2</sup>, Brazinha Carla<sup>3</sup>, Crespo João<sup>3</sup>, Mänttari Mika<sup>1</sup>**

<sup>1</sup>Lappeenranta University of Technology, LUT School of Engineering Science, Laboratory of Membrane Technology and Technical Polymer Chemistry, Finland

<sup>2</sup>Unidade de Bioenergia, Laboratório Nacional de Energia e Geologia, I.P. (LNEG), Lisbon, Portugal

<sup>3</sup> Universidade Nova de Lisboa, Faculty of Science and Technology (FCT), Lisbon, Portugal

Carob residues represent a low-cost renewable source of phenolic compounds (high value catechin) and saccharides. As they can be isolated by water extraction, their fractionation and recovery from the aqueous extract for commercial use were rarely studied. This study aims at producing two distinct natural extracts from carob kibbles, one extract enriched in catechin and its derivatives for the nutraceuticals market and an extract enriched in sugars for the food industry. This valorisation strategy involves an integrated process based on membrane technology that fulfils the zero discharge principle and may be applied to other agro-industrial by-products. Different aqueous extraction schemes were considered (a one-step process and a two-steps approach). The aqueous extracts obtained were fractionated by nanofiltration and the fractions obtained were evaluated in terms of their content in target products. An integrated scheme for production of fractionated extracts is proposed based on the experimental work developed assuring, simultaneously, a minimal use of resources and emission of waste.

### **Life cycle assessment of thermal residues utilization possibilities in the context of South-East Finland**

**Deviatkin Ivan, Horttanainen Mika**

Lappeenranta University of Technology, LUT School of Energy Systems

The world energy consumption is constantly increasing following population growth and industrial production expansion. Even though alternative energy sources attract increasing attention, energy generation from conventional fuels remain stable. Solid fuels like coal, biomass, and waste are used widely with lowering use of coal and growing demand on biomass and waste. However, incineration of solid fuels leads to generation of thermal residues, like fly ash, bottom ash, boiler slag. The residues should be effectively recycled to reduce negative impact on the environment. Technical applicability of such residues have been widely studied. Moreover, few environmental assessments were performed. Nevertheless, little attention was drawn to the systematic assessment of residues utilization on a regional level when multiple residues could be utilized by several methods. In the study, life cycle assessment was applied to evaluate the recycling methods which exert least negative effect on the environment. The results of the study indicated that all utilization possibilities have lower non-toxic impact compared to residues landfilling with average reduction of 10-30% when residues were used for forest fertilization, road construction and road stabilization. The reduction of 3-12% could be achieved when applying residues for the landfill construction. In the future, the results could be aggregated using weighting factors and compared against economic analysis results to find the most sustainable utilization possibility in a chosen region.

## **Gold leaching in batch stirred tank**

**Gradov Dmitry**

Lappeenranta University of Technology, LUT School of Engineering Science

A typical hydrometallurgical unit operation in leaching of metals is a stirred tank reactor equipped with a rotating agitator. Stirred tank reactor is a complicated system that includes mixing and multiphase mass transfer. Thus, reliable simulation and prediction methods are required to be able to design such reactors and to optimize the reaction conditions. Design and scale-up techniques are extremely important for keeping efficiency of stirred reactors in industry at high level.

Mixed suspensions in hydrometallurgical leaching processes are normally three-phase systems consisting of solid, liquid and gas phases. The design and scale-up of multiphase stirred tank reactors require reliable predictions of the flow fields, phase volume fractions and turbulence properties. Local flow fields and volume fractions in the reactor are needed for calculation of residence time of phases to obtain homogeneous mixing and prevent flow short-circuiting, and bypassing or accumulation of phases in certain regions in the reactor. Evaluation of multiphase mass transfer is another important issue. There are numerous cases in the chemical and metallurgical industries where the production rate is driven by gas-liquid or solid-liquid mass transfer. In these cases, evaluation of multiphase mass transfer is a crucial part of reactor design. Turbulence in the reactor affects the flow fields of the phases through turbulent viscosity. In addition, turbulence intensity influences multiphase mass transfer by affecting bubble breakage and coalescence, bubble size distribution and mass transfer between bubbles or particles and the liquid phase. Turbulence models should therefore be able to predict the turbulence properties, kinetic turbulent energy and turbulent energy dissipation rate accurately in order to facilitate accurate flow distribution and mass transfer simulation.

Thus, the objective of the current research is to develop a CFD model describing hydrodynamics in multiphase mixing tank. This work clearly shows the potential of CFD for gas-liquid hydrodynamics prediction in industrial stirred tanks environment. One of the corner stone of fluid dynamics modelling is turbulence, models of which are numerous. In the current paper, performance of three vastly employed turbulence models was evaluated against experimental data for single phase. Moreover, contrary to the previous studies, the multiphase model assessment is also based on experimentally measured gas velocity profiles. From practical point of view, finite elements methods are highly demanded since they help saving resources when designing or optimizing operational units.

## **Pathways towards a low cost fully sustainable energy supply for the SAARC region with a special focus on India**

**Gulagi Ashish**

Lappeenranta University of Technology, LUT School of Energy Systems

Providing affordable, sustainable and zero carbon electricity to the people of developing countries and alleviating the poor far above the poverty line would be the focus of electricity generation in the second half of 21st century. South Asia which is also known as SAARC (South Asian Association for Regional Cooperation) is home to 23% of the world population and a large number of people are living below the poverty line. Modelling an energy system based on 100% renewables would help achieve the objectives of climate change mitigation and achieving zero GHG emissions. The SAARC region has a vast potential for various RE resources such as solar, wind, hydro, biomass and geothermal which enables a formation of a super grid connecting different sub-regions via HVDC lines to form a least cost 100% renewable energy based system. For every sub-region an optimally structured energy system based on 100% renewable energy is defined as an optimal set of RE technologies, capacity mix of these technologies and storages best suited for each sub-region. The cost of an optimized system and levelized cost of electricity (LCOE) for each sub-region are calculated. The results obtained show that 100% RE based system is a reality and lower in cost than nuclear and fossil carbon capture and storage (CCS) alternatives.

## **CFD simulation of airlift bioreactor**

**Han Mei, Laari Arto, Koiranen Tuomas**

Lappeenranta University of Technology, LUT School of Engineering Science

Airlift loop reactors (ALRs) are becoming more and more attractive in chemical, petrochemical and biochemical industries, such as cellulase enzymes fermentation, waste water purification, hydrogenation, exhaust-gas treatment and so on. The performance of ALRs depends to large extent on the hydrodynamics and mass transfer characteristics which are crucial factors for ALRs design and optimization. Computational Fluid Dynamics (CFD) has been a popular tool to investigate and predict hydrodynamics for multiphase reactors, which could offer important info difficult to obtain from experimental studies. In this research work, 3D steady state CFD simulations of airlift bioreactors were performed with the developed model for different gas flow rates. The performance of airlift bioreactors were validated and predicted in terms of gas holdup, velocity and shear fields, mass transfer rate between phases as well. The effects of the gas flow rate and the gas sparged modes, which are related to the yield of desired production in ALRs, were presented.

## **Outlier robust geodesic K-means algorithm for high dimensional data**

**Hassanzadeh Aidin, Tuomo Kauranne, Kaarna Arto**

Lappeenranta University of Technology, MVPR Laboratory

The density sensitive geodesic K-means algorithm is an extension of the standard K-means algorithm aiming at addressing the issues of non-spherical shape data clusters and the presence of outliers. Although the density sensitive geodesic K-means is efficient at dealing with low dimensional data, it is hampered by the so-called curse of dimensionality and the fluctuation of local density patterns. As an attempt to address these shortcomings, this paper proposes a geodesic distance based K-means algorithm that not only can be applied to high dimensional data but is also more robust to changes in data cluster densities. The proposed algorithm features three novel contributions. First, it employs a shared nearest neighbour (SNN) based distance metric to construct the nearest neighbour data model. Second, it combines the notion of geodesic distance to the well-known local outlier factor (LOF) model to distinguish outliers from inlier data. Third, it introduces a new strategy to integrate outlier scores into geodesic distances that facilitates the task of parameter tuning. Numerical experiment with synthetic and real world high dimensional remote sensing spectral data confirm the efficiency of the proposed clustering algorithm.

## **Innovation by User Experience Design**

**Karaseva Victoria, Prof. Seffah Ahmed**

Lappeenranta University of Technology, LUT School of Business and Management

User Experience (UX) and user involvement in product development are extremely important factors that determine the success of software product. The participation of an end user in a design process guarantees to other stakeholders the long lasting, precise and innovative design of a system. Understanding the end user's needs is key to achieving design innovation, and the process to get there is design thinking. As Tim Brown stated, the innovation design model (IDEM) proposes that where you innovate, how you innovate, and what you innovate are design problems.

The goal of our research is to find out how an innovation can be driven by design. The following are the empirical research investigations that will be conducted during this research: a systematic literature review of design methods, analysis of industry design and innovation practices via a large diary study on UX and user engagement in the innovation process; action design research in LUT living Lab facility to study of the development and usages of various types of prototype that can lead to innovation; controlled experiments to test formally the two mentioned above key research questions and hypothesis behind the innovation design model as well as to validate the innovation design model.

Thus, the outcome of this research is the elicited and validated IDEM, as well as identified factors that motivate or influence the user engagement into innovation by design process.

## **The Future Scenarios and Coping Strategies of Accounting Business Case Finnish SMEs' Accounting Firms**

**Kemppainen Liisa**

Lappeenranta University of Technology, LUT School of Business and Management

Expert advice services of SMEs include many broad and specific aspects of business. These services include, among others, financial planning, management accounting and information systems, forensic accounting, cost reduction, succession planning and pricing decisions. In the existing literature there is a scarcity of studies estimating future business models and revenue logics of accounting firms. There has been very little explicit theoretical and empirical research on the concept of accounting firms.

The aim of the study was to explore what factors contribute to the claim that an accounting firm is a genuine business partner for an entrepreneur. The qualitative data for inductive analysis data was collected by the 21 semi-structured face-to-face interviews in Finland. According to results the accounting organizations have faced a rapid change in their ways of operating.

This research contributes to the literature on Management Accounting by theorizing scenarios and coping strategies of accounting firms. As the managerial implication the new market areas were identified in the field of accounting in form of business analytics by data utilization. Cloud services combined with business analytics might give a change to solve global business problems in the future.

## **Utilization of recycled materials as a part of wood-plastic composites**

**Keskisaari Anna**

Lappeenranta University of Technology, LUT School of Energy Systems

People produce globally enormous amounts of different kind of waste materials. Although some of them are recycled, still large part of them ends up in landfill. In the future, for example, tightening legislation in some areas forces to more efficient recycling. Wood-plastic composite (WPC) is one of the places that wastes can be utilized. WPC consists of a different materials: reinforcing fibers, plastics as a matrix, fillers and additives. Almost all of those materials can be replaced by recycled one.

Research about the waste materials as a part of the WPC has been made, but there are still many waste production sectors, that haven't taken into account. For example industry, construction site and municipalities produces waste fractions that could be utilized as a part of WPC. While WPC consist of several different kinds of materials, there are wide range of materials that could be suitable. Different materials provide various properties to the product. One of the challenges is that part of the exploitable wastes are in a form that has to be processed before use.

## **Analyzing of fleet life-cycle data as the support of asset management**

**Kinnunen Sini-Kaisu**

Lappeenranta University of Technology, LUT School of Business and Management

Data is increasingly gathered in business environment as new technologies and possibilities to utilize data have increased due to e.g. Internet of Things, cloud computing and advanced analytics, which all have got a lot of attention in literature and business context. Different kind of sensors and information systems facilitate data acquisition and the full potential of enormously gathered data has not been exploited. The purpose of research is to consider what business knowledge can be derived from data relating to a group of similar kind of assets. This group of similar kind of assets is called as a fleet. Data related to fleet is often generated by different parties in industrial network and therefore fleet data is fragmented and not always easily available. Thus, the research aims to understand and describe what needs, possibilities and applying potential there are when managing fleet data. In other words, what are the possibilities to refine fleet data into usable business knowledge in asset management? The research also considers what are the motives and expected benefits of fleet data analysis. In order to answer these question, qualitative interview data is gathered from companies and results indicate that there is a potential to analyze fleet data more carefully in order to gain business knowledge to support asset management.

## **Power-to-Hydrogen Research at LUT (Poster)**

**Koponen Joonas**

Lappeenranta University of Technology, LUT School of Energy Systems

*Keywords: Renewable energy systems, energy storage, water electrolysis, hydrogen*

In order to reach the target of 2050 in the EU to cut carbon emissions to 80% below 1990 levels, the whole energy system should be decarbonized. This requires 100% renewable energy production which is mainly based on solar and wind power. In addition, electricity and other energy sectors will have to be interconnected through hydrocarbons.

The basic idea of the Power-to-Gas concept is the linking of the existing electricity and gas grids in order to allow power generation and load to be decoupled and consequently high proportion of variable renewable electrical power to be included into the energy mix. Hydrogen's potential lies in its ability to store chemical energy, to serve as an energy carrier, and as feedstock for various industries. One method to produce hydrogen is water electrolysis, where DC power is applied to decompose water.

The first research objective is to integrate a Power-to-Hydrogen system into the LUT Green Campus environment. This will form a practical environment to demonstrate and study the integration of chemical energy storages into renewable power generating systems. The Power-to-Hydrogen system will be virtually connected to the LUT solar power plant, which enables the research of both on- and off-grid hydrogen production. The aim is to study the efficient production of hydrogen with suitable technologies, the control of the water electrolysis process, and the effect of dynamic operation.

## **Customer perceived risks in complex industrial solutions**

**Kuitunen Aino**

Lappeenranta University of Technology, LUT School of Business and Management

Integrated solutions and product service systems (PSS) have a potential to provide sustainability benefits if implemented correctly. However, purchase of a PSS is a complex decision making moment that includes various risks for the provider and the customer. The language the seller uses can contribute to the perceived risk and thus affect the decision. The aim of my research is to understand how these different aspects of risk are manifested in P2P solution purchases and perceived by the customer. Broadly speaking, risk can be simplified into two dimensions: exogenous and endogenous (Hanley et al. 2007). Exogenous refers to risk caused by external hazards that an actor can't prevent – they can only manage the severity of consequences by estimating the probabilities. Endogenous risk on the other hand refers to acknowledging agency of different players that interact with each other in, for example, the financial markets (Systemic Risk Centre, 2015). The latter contributes to systemic risk that is realized when actions of some players cause reactions, activate feedback loops and can amplify cumulative actions into crisis, at its extreme. My claim is that sustainable solutions require wider perception to risk and hence it is crucial to understand how risks are communicated. This knowledge can be used to improve models and practices that are used to manage systemic risks and to improve the communication between solution provider and customer.

## **Measuring fast heat transients: Experiments with Gradient Heat Flux Sensor**

**Levikari Saku**

Lappeenranta University of Technology, LUT School of Energy Systems, Laboratory of Applied Electronics

Direct heat flux measurement is an important task in various industrial applications. Traditional heat flux sensors are based on thermoelectric effects, mainly Seebeck effect. Because the voltage generated in Seebeck effect is parallel to the heat flux, heat flux sensors usually consist of stacked thermopiles. Stacking multiple thermopiles yields more voltage output, but also hampers the sensor's response time and may affect the system being measured.

A new type of heat flux sensor based on transverse Seebeck effect has recently been developed. This sensor is called the gradient heat flux sensor (GHFS). Generated in anisotropic thermoelements, the thermal emf of the GHFS is perpendicular to the heat flux. This structure facilitates very thin sensors, solving many problems of the older designs.

The aim of this study was to compare the response speed and characteristics of GHFS to those of traditional thermopiles and thermistors. The sensors were heated using a pulsed diode laser, and their response characteristics were analyzed. It was discovered that the GHFS is capable of detecting laser pulses which have temporal duration in range of tens of nanoseconds. The heating-up of the sensors also had little effect in the output of the sensor, compared to traditional thermal sensors.

This new type of heat flux sensor can be used in applications which require fast, small, high-sensitivity sensor for detecting instantaneous changes in heat flux. Examples of potential new applications are medical instrumentation, environmental sciences and power electronics.

## **Critical parameters in the LCA modelling of two municipal solid waste management systems**

**Liikanen Miia**

Lappeenranta University of Technology, LUT School of Energy Systems

Life cycle assessment (LCA) enables analysing the sustainability of municipal solid waste (MSW) management systems quantitatively. However, the complexity of MSW management systems limits the usability of LCA. In order to extend the use of LCA in the waste sector, it is crucial to identify the critical and also the irrelevant parameters in LCA modelling.

Uncertainties related to LCA modelling of MSW management systems have been identified rather comprehensively in previous studies. In general, technology choices, system boundaries and energy substitution have been identified to have significant influence on results. Even though the uncertainties related to modelling have been identified, the LCA of waste management systems is still typically very intricate.

The aim of the study is to identify the critical parameters and factors in the LCA modelling of two distinct MSW management systems by using the GaBi life cycle modelling software as a tool. The study has not been completed yet but the expected results are that the collection and transportation processes are not critical relative to results of the LCA models whereas the MSW treatment processes (i.a. landfilling and combustion) are. The outcome and results of the study will facilitate the LCA modelling of MSW management systems.

## **Development of WPC post-processing line**

**Matthews Sami**

Lappeenranta University of Technology, LUT School of Energy Systems

My research is about finding production parameters that allow dual process Wood Plastic Composite post-production line work in an optimal way mass production in mind. The research work has special attention on cutting and forming of a WPC material. In addition temperature control, tolerances of tools and assembly play major role in this research. The research also involves experimenting with a prototype WPC line and refinement of measured data into generalizable results for similar process lines in industry. In addition material formability and cutting tests are conducted. This research can have effect on amount of construction material ending to landfills as it is possible to utilize this waste in WPC. This process can be made more economical with correct process parameters.

## **CFD modelling of direct contact condensation of steam in Boiling Water Reactors pressure suppression pool systems**

**Patel Giteshkumar**

Lappeenranta University of Technology, LUT School of Energy Systems, Laboratory of Nuclear Engineering

In a BWR, the suppression pool is one of the key systems during a loss of coolant accident (LOCA) or safety valve actuation, which provides a large pressure and heat sink by condensing vapour into liquid and absorbing the energy discharged from a reactor vessel. Injected steam interacts with pool water by heat transfer, rapid condensation and momentum exchange which induces hydrodynamic loads to the pool structures. Therefore, detailed analysis of steam blowdown phenomena either by experiments or with numerical simulations has a great importance from the nuclear reactor safety point of view. CFD has become an increasingly applicable tool for thermal-hydraulic investigations in the field of nuclear safety analysis. In this work the CFD approach is used to model steam condensation phenomena occurs in the suppression pool. For this purpose the OpenFOAM CFD code is used. The direct contact condensation phenomenon is modeled by using the Eulerian two-fluid approach. The CFD results of this study have been validated against the test results of the POOLEX/PPOOLEX facilities of Lappeenranta University of Technology.

## **Modelling informal institutions in economic research: the case of values and sustainable consumption**

**Pekkanen Tiia-Lotta**

Lappeenranta University of Technology, LUT School of Business and Management

Modelling informal institutions, such as values and attitudes, has traditionally been difficult in economic research. Yet the cultural context appears relevant in many economic phenomena – sustainable consumption being inevitably one of them. The study at hand sheds light on how values are (and can be) incorporated in economic research on sustainable consumption, drawing conceptually and methodologically also on consumer research based on other fields of social sciences. Sustainable consumption, in more detail the consumption of responsibly produced and more conventional tissue paper, is approached under the ultimate research question: to what extent consumers can freely make choices; to what extent their behaviour is embedded in social context. The research question is modelled under different paradigms. The different angles from institutional macro-econometric research design to micro-level, survey and experiment based, research on consumer preferences provide a basis for methodological reflection on the relevance and limits of modelling values and attitudes in economic research on consumption. The study contributes to existing literature on two levels: it provides information about the actual and realised consumer preferences with regard to wood-derived products, and it sheds light on the methodological dilemma of modelling informal institutions in economics.

## **International trade of biomass and biofuels products**

**Proskurina Svetlana**

Lappeenranta University of Technology, LUT School of Energy Systems

Research focuses the international trade of biomass and bioenergy products, which will continue to have a significant impact on the bioenergy development in the world. The main research question is “How the future of solid biomass trade will look like?” Sub questions of the research are: a) What the role of Russia on the biomass markets? What the future of Russian and Finnish wood pellets? b) Solid biomass in the European context to achieving the EU renewables targets? c) What are the new trends for solid biomass on the global bioenergy market? Perspective of new solid biomass, such as torrefied biomass, its possible application and possible markets? I am interested in a wood pellets and other biofuels, which are made through gasification, torrefaction and pyrolysis, its markets and applications.

## **Open Science and Research Process**

**Tahvanainen Iris**

Lappeenranta Academic Library

Open science can significantly improve the quality and competitiveness of research in today's society and create new collaboration and innovations. Openness increases the visibility of a researcher's work, offers new possibilities for networking, and increases the number of citations. In the university strategy LUT commits to open science. National open science infrastructure strategy and roadmap 2014-2020 describes the national goals of open science in Finland.

Open science means openness of research data, methods, results and publications within the limits of research agreements. Open science encompasses the entire life cycle of research. The most important public research funders demand open access publishing of research results. There are also initiatives to open research data by public funders. Openness will be an increasing subject in commercial research in the cases of joint innovations and open developing.

The principles and practices of opening the research process must be agreed by all participants. Data collection, usage, ownership and rights as well as long term preservation, re-use, publishing and systematic destruction must be documented in the Data Management Plan (DMP). This can be a challenge in international co-operative projects.

For LUT researchers there are many national and international research infrastructures available in addition to LUT researcher services. LUT researchers have access to the EDuuni e-working environment and to the CSC-IT Center for Science open data services for depositing, opening and finding data and also Orcid researcher identifier. Also EUDAT, Zenodo and OpenAIRE data services can be used. Data and publishing services in LUT are continuously developed. The Open Science and Research initiative funded by Ministry of Culture and Education fosters the actions and infrastructure developing on national level.

## **Flexibility through financial working capital management**

**Talonpoika Anna-Maria**

Lappeenranta University of Technology, LUT School of Business and Management

**Problem:** Financial flexibility is needed in companies to survive unexpected changes in cash flow. The changes require flexible asset management.

**Literature review:** Flexible asset management aims at perceiving the best value of assets, which can be tangible or intangible. Financial working capital is one of these assets but is included only in one model. **Research question:** This thesis aims at presenting financial working capital management as a possibility to gain financial flexibility.

**Research design:** Archival research and design science has been used in this thesis. Qualitative comparative analysis and model building are used to formulate tools and strategies for financial working capital management, which are tested with simulations, case studies and statistical analysis.

**Findings:** The results indicate that there are several possible financial working capital management strategies and profitability can be increased by reducing financial working capital. Financial flow cycle is developed to measure financial working capital management and FOCAL matrix is created to assist in the strategy selection.

**Contribution:** This thesis advances knowledge of financial flexibility and introduces a management view to financial working capital management. Financial working capital management strategies are presented to managers and practical tools are provided for decision-making.

## **The droplet size and diffusion path length estimation for solvent extraction**

**Tamminen Jussi**

Lappeenranta University of Technology, LUT School of Engineering Science

Solvent extraction is a hydrometallurgical separation process, where metal is concentrated and separated from aqueous feed solution. Metal extraction is an interfacial complexation reaction. As a result, metal transfers from aqueous to organic phase. The rate of extraction depends on available mass transfer area and diffusion path length. These parameters depend on droplet size, which depend on mixing power and mixing tank geometry. Droplet sizes are widely studied in conventional stirred tanks, but rotor-stator mixers are less studied. Droplet sizes and diffusion path lengths for copper solvent extraction in rotor-stator mixers have been studied even less. Copper extraction with hydroxyoxime type reagent is intensified here using high impeller speeds in small in-line reactor equipped with rotor-stator mixer. Reference experiments were made in batch reactor equipped with pitched-bladed impeller. Droplet sizes in form of chord lengths were measured for copper extraction at outlet of in-line reactor and from batch reactor. The average diffusion path length was estimated using known correlation for rotating diffusion cell. High impeller speed and increased mixing power in in-line mixer were found to lead to smaller droplet size and diffusion path length, which are here used to explain intensified copper extraction rate in in-line mixer.

## **Establishing Key tooling Parameters for generating products based on post extrusion technologies in Wood Plastic Composites**

**Toghyani Amir**

Lappeenranta University of Technology, LUT School of Energy Systems

Establishing Key tooling Parameters for generating wood plastic composite (WPC) products based on the requirements of production process, material properties and final product demands will be focusing criteria for my research. This procedure permits use of a wide range of materials and mixtures of materials. The flexibility of the production line makes it possible to produce a variety of consumer products using diverse sequences of processes such as cutting, pressing and bending. This procedure starts from the extrusion process which is carried out with an extrusion tool that is linked with the extrusion device. Modification of the thickness or shape may be performed by various methods such as pressing, or additive manufacturing methods. The method and the device may use to fabricate products of any kind and any shape. The aim of this study is to find and develop new procedure of producing sustainable fiber composite products from the perspective of DFMA (Design for Manufacturing and Assembly). In this procedure Product and production tools design will affect by changing the material properties and applications which needs to focus on as an undeniable segments of the research.

## **Relationship of increasing the executive ability and welding quality by new management system in china**

**Yang Xiaochen**

Lappeenranta University of Technology, LUT School of Energy Systems

Nowadays executive ability improvement research is fundamental in the Chinese welding industry for large-scale, state-owned, and joint-venture companies. It is important that the quality, cost, and productivity of their products are tightly linked with executive ability. The lack of executive ability in large-scale factories or a welding quality management system in middle and small-scale factories is a widely existing problem. The lack of powerful and appropriate executive ability means not only no increases in the quality and productivity, but also no decreases in the manufacturing cost. On the other hand, for small and middle-scale factories, a welding quality management system is important. These two topics, executive ability and the quality management system, are the most significant and urgent issues to the Chinese welding industry. The slides present the current situation of the relationship of the quality management system and executive ability of companies and factories in the Chinese welding industry in different geographical areas, analyze the existing research circumstance and finally provides countermeasures and suggestions to the Chinese welding companies, and proposal to increase the executive ability and also a way to build a welding quality management system.

## **Finnish 'state of mind' on inter-organizational integration: a cost accounting and management perspective**

**Ylä-Kujala Antti**

Lappeenranta University of Technology, LUT School of Business and Management

Competitive advantages are increasingly based on the unique skillsets of value networks rather than isolated companies, even though some organizations have not yet quite internalized the importance of supplier and customer relationships from a value creation perspective. The blurring of organizational boundaries is also a serious managerial challenge, especially in the area of cost management (i.e. management accounting). Companies, together with their most essential partners, will need network-level cost accounting infrastructure, e.g. tools, methods and/or even information systems, to be able to cope with the arising, complex interdependencies. Apart from numerous case studies in the field, very little is known about neither companies' willingness and trust towards increasing inter-organizational integration nor the infrastructure already implemented.

In order to shed light on the above-mentioned aspects, an extensive survey was conducted, and aimed at senior managers of Finnish companies ranging from small to large and across the industries. More than 1500 responses were eventually received and the data was analyzed with factor and cluster analyses accompanied by certain qualitative elements (i.e. mixed methods approach). According to the data, Finnish organizations belong to five distinctive clusters; 'the cost experts', 'the trustful', 'the holdouts', 'the trailblazers' and 'the uncertain' based on their factor-specific characteristics. The interest towards increasing inter-organizational integration seems to be high in general as the two networking-oriented clusters, 'the trustful' and 'the trailblazers', account for approximately 40 percent of the companies. On the other hand, only around 7 percent of the companies have actually implemented some kind of an infrastructure. All things considered, there is clear disparity between the rhetoric of senior management and the present state of affairs. Despite high interest, the potential of inter-organizational integration remains partly untapped.

## **Kinetic modeling of high pressure pyrite oxidation with parameter estimation and reliability analysis using the Markov chain Monte Carlo method**

**Zhukov Vladimir V., Laari Arto, Koironen Tuomas**

Lappeenranta University of Technology, LUT School of Engineering Science

The aim of this work was to develop a comprehensive kinetic model for aqueous phase oxidation of pyrite that can explain all the relevant phenomena that govern pyrite oxidation, including the effects of temperature, oxygen partial pressure, particle size, and multiple surface and bulk phase reactions at different slurry concentrations. The developed model is based on experimental data presented in literature. For the current case the reaction process formulation of the shrinking particle model in the usual integrated form is challenging and the model is therefore given as differential equations that are solved numerically. A surface passivation model was implemented to explain experimentally observed surface passivation. The kinetic model includes multiple experimental parameters, which were estimated by comparison with experimental data. The reliability of the estimated parameters and model predictions was studied using novel Markov chain Monte Carlo (MCMC) methods. The MCMC analysis indicated that all the model parameters were well identified without any cross correlation. The results also show that pyrite surface reactions with both molecular oxygen and ferric iron are important at the studied experimental conditions and their relative importance depends on the pyrite slurry concentration.

### **Applications of multivariate analysis in treatment of process analytical data**

**Filianin Kirill**

Lappeenranta University of Technology, LUT School of Engineering Science, Laboratory of Separation Technology

Industrial X-ray fluorescence analyzers equipped with automated samplers are used in hydrometallurgy in order to continuously monitor the process behavior and provide fast response to possible changes. The present study is aimed to develop robust calibration procedure for accurate prediction of metal concentrations in order to effectively monitor copper solvent extraction on-line.

The solution is focused on the utilization of the complete spectral data range. Incoming spectra is processed on-line with a few milliseconds of computational time to predict metal content in a process stream. The principal advantage of multivariate methods is that it is robust to peak mergence and overlapping. The models were validated by laboratory samples and assessed with a residual mean square error of calibration. Calibration improvement is suggested in order to deal with the matrix effect due to high iron content, i.e. non-linearity in a calibration model due to characteristic radiation of copper being partly absorbed by iron atoms. Review of research articles reveals that the problem is addressed to artificial neural networks that tend to solve problem particularly for a specific training set, thus are difficult to validate. The proposed approach has potential in on-line instrumentation providing fast, robust and cheap application with automation abilities.

### **Network Analysis Interface for Literature Studies: Tools for Performing Statistical and Social Network Analysis (SNA) on Citation Data**

**Hajikhani Arash, Knutas Antti, Salminen Juho**

Lappeenranta University of Technology, LUT School of Business and Management

As the amount of publications grows on any given field, methods for analyzing, organizing and accessing information from large databases are becoming increasingly important. The objective is to save a prospective reader time and effort in finding useful information in a given topic prior to starting research on new fields.

Network Analysis Interface for Literature Studies “NAILS” is our tool for performing statistical and Social Network Analysis (SNA) on citation data. SNA is a new way for researchers to map large datasets and get insights from new angles by analyzing connections between articles. NAILS conducts data analytics on scientific literature material and provides useful information which elaborates the most influential and impactful materials in the concerned field.

The working data is from Web of Science (WOS), an academic citation indexing and searching service with wide coverage of scientific fields. After collecting the bibliometric data (title, abstract and citation) from WOS and inserting it to NAILS, a tailor made report will be illustrated with analysis of the records. The analysis identifies the important authors, journals, and keywords in the dataset based on the number of occurrences and citation counts. A citation network of the provided records is created and used to identify the important papers according to their in-degree, total citation count and PageRank scores. The analysis finds also often-cited references that were not included in the original dataset downloaded from the Web of Science.

Useful web-links can be found below:

The project page: <http://nailsproject.net/>

Github page: <https://github.com/aknutas/nails>

Here is the tool: <http://hammer.nailsproject.net/>

In this [YouTube channel](#) we made video instructions for using the tool. They come in 4 parts: [Basics of Scientific Literature Analysis, Part 1: Introduction](#)[Basics of Scientific Literature Analysis, Part 2: How to Analyse](#)[Basics of Scientific Literature Analysis, Part 3: A Case Study "Entrepreneurship"](#)[Basics of Scientific Literature Analysis, Part 4: Network analysis/visualization with Gephi](#)  
If you are more interested, please see the following article for further details: [Knutas, A., Hajikhani, A., Salminen, J., Ikonen, J., Porras, J., 2015. Cloud-Based Bibliometric Analysis Service for Systematic Mapping Studies. CompSysTech 2015.](#)

## **Context matters: Channels and mechanisms of knowledge transfer in regional entrepreneurial ecosystems**

**Lahikainen Katja**

Lappeenranta University of Technology, LUT School of Business and Management

This study examines the functioning and development of regional entrepreneurial ecosystem.

Entrepreneurial ecosystems have emerged as a concept to describe entrepreneurship within regions. The literature on entrepreneurial ecosystems agrees that ecosystems consists of combinations of cultural, financial, human, institutional and political factors. However, the research has focused on describing and classifying the different elements that make up the entrepreneurial ecosystem, while ignored the interdependencies between the elements, importance of individual elements as well as emergence and development of the ecosystems over a time.

The main goal of the study is to find out which specific conditions foster value-creating entrepreneurial activities in the entrepreneurial ecosystem. Moreover, the study aims at studying formal and informal interaction mechanisms within the ecosystem and examining the multiple role of the university in the ecosystem. The data that will be collected by conducting 15-20 conversational interviews among representatives of key stakeholders.

As a result, the study reveals the underlying mechanisms that influence the functioning of ecosystems. The study contributes to the existing literature on entrepreneurial ecosystems by addressing the research gap in investigating interdependencies of different elements of entrepreneurial ecosystems and influence of individuals' perceptions and behavior on the functioning and development of the ecosystems.

## **Towards cyanide-free gold production – technical, economic and social aspects**

**Lampinen Matti**

Lappeenranta University of Technology, LUT School of Engineering Science

Cyanide leaching has been the prevailing practice in gold production during 20<sup>th</sup> century. However, there is a constantly growing interest to replace cyanide. The social concern to the use of cyanide methods for the dissolution of gold arises from concerns regarding the toxicity of cyanide. Numerous cyanide accidents has led to international debate over the use of cyanide in mining and prompting the Czech Republic to ban cyanide in 2000. European parliament has also presented that the use cyanide in mines operating in the EU should be banned. The inability of cyanide solution to effectively leach carbonaceous or complex ores has raised the interest towards non-cyanide practices from the economical point of view, since many interesting gold deposits are these kind of ores. Many alternatives for cyanide have been presented including thiosulfate, halides, thiourea and thiocyanate. Amongst these thiosulfate has been presented to be most promising and already has an industrial applications. Recently, chloride leaching has been presented to be one possible alternative to cyanide. Chloride methods were used in 19<sup>th</sup> century. This work presents technical, economic and social aspects which pave the way towards cyanide-free gold production.

## **Investigation on the influence of various welding parameters on the arc thermal efficiency of the GTAW process by calorimetric method**

**Latifi Hamidreza**

Lappeenranta University of Technology, LUT School of Energy Systems, Laboratory of Welding Technology

Arc efficiency of Gas Tungsten Arc Welding (GTAW) was determined by calorimetric method. A water-cooled anode calorimeter was designed and manufactured to measure the arc thermal efficiency, which was determined as a function of current, arc length, polarity and gas flow rate for GTAW of mild steel. With Direct Current Electrode Negative (DCEN) polarity and 5 mm arc length, a thermal efficiency of  $67\pm 4\%$  was obtained, which was independent of the welding current. With Direct Current Electrode Positive (DCEP) polarity and 5 mm arc length, arc thermal efficiency was determined as  $52\pm 4\%$ . The experimental data show that the arc efficiency decreases from 67% to 58% and 51% as the arc length increases from 5 mm to 11 and 17.5 mm, respectively. The experimental results also show that the arc efficiency is not significantly affected by the shielding gas flow rate.

## **Welding high-strength steels for shipbuilding applications**

**Layus Pavel**

Lappeenranta University of Technology, LUT School of Energy Systems

The amount of high strength steels (HSS) used in shipbuilding industry increases yearly, due to its low weight and superb structural performance. Welding processes parameters and costs have a major influence on the reliability, quality and competitiveness of shipbuilding products. My research focuses on various ways to improve, optimize and develop welding processes for several shipbuilding steel grades (E500, F500W and other). The research focuses on acquiring a better understating of welding parameters inter-dependencies and to develop efficient and consistent welding methods and recommendations. Significant part of my work is a study on high-deposition submerged arc welding modifications for shipbuilding, which was done as a joint work with Russian colleagues from CRISM Prometey (St.Petersburg). During my research a series of experiments were conducted to test welds by methods described in Western European and Russian standards; namely, static tension test, Charpy impact test with V-notch, null-ductility (NDT) test, Tkb test (three-point bending) and crack tip opening displacement (CTOD) test.

## **Mergers, acquisitions and firm valuation**

**Nylund Iiro**

Lappeenranta University of Technology, LUT School of Business and Management

**Problem:** How is evaluation process of unlisted target companies carried out in mergers and acquisitions and what methods and techniques will be implemented in particular acquisitions situations.

**Literature review:** On the basis of searches (scholar.google.fi, dissexpress.umi.com) found no Finnish doctoral research related to acquisitions and firm valuation of unlisted companies (only one dissertation concerning essays on technology investments and valuation of public companies by Laamanen T.) Instead international (in particular USA) research on the subject has been made a certain extent (five dissertations: Anadol, B., Yu, J., Bangsund, L., Greene, D., Chen, W.).

**Research questions:**

- 1) Is there correlation between contract price and certain key figures conducted from target company's financial statement and what is the level of correlation and which factors are major dominant in nature?
- 2) How are good will, future views and synergy balanced in price determination?
- 3) How are M&A's financed in particular implementation?
- 4) Which matters motivate and tends to lead to M&A's, can there be found special owner strategy ?
- 5) What effect has the business cycle to the frequency of M&A's?

**Research design:** Research will be conducted as a crossover study, whereupon by cross section of research material will be tried to find causal connections and to explain the contract price. The research data is formed by combining the available data (e.g. Talouselämä) by the results of the enterprise inquiry. The research method for analyzing the collected data is intended to be used multivariable linear regression method and reliability of the results obtained will be statistically tested.

**Findings:** Explanatory elements for price determination for target company. Financing methods for particular implementations. Existence and content of owner strategy.

**Contribution:** Better understanding of acquisitions mechanism and valuation.

### **Integration Obstacles during ERP Development**

**Banaeianjahromi Negin**

Lappeenranta University of Technology, LUT School of Business and Management

ERP (Enterprise Resource Planning) systems have increasingly been developed and integrated with other internal and external systems. This paper contributes to the field of enterprise systems integration by clarifying the concept of integration in the context of ERP systems. We investigated integration obstacles during ERP development in 5 large organizations through theme-based interviews. Besides considering integration as purely technical challenge, our findings reveal the other perspectives of integration. In total 31 environmental, technical, managerial, and organizational integration obstacles were identified from empirical data and further mapped with 13 ERP challenge categories derived from the literature. Our findings reveal that integration barriers are related to all 13 categories of ERP challenges. This indicates that integration should not be a separate project from ERP development. Identifying the integration obstacles is necessary for practitioners to develop counteractions to enterprise integration problems.

### **Residential customer in a Smart Grid Environment**

**Belonogova Nadezda**

Lappeenranta University of Technology, LUT School of Energy Systems

The research work focuses on the roles and activities of a single residential consumer of electricity in the emerging smart grid environment. Global challenges such as climate change, environmental pollution, natural resource depletion, growth of population, and on the other hand, the tightening society requirements towards a reliable supply of energy raise many questions. One of them is what a single residential customer's activities should be that contribute to a sustainable future for the next generations.

The focus of the study is on customers with electric heating loads because of load control flexibility and the fact that they constitute the largest proportion of residential electricity consumption. The customers are equipped with solar PV or solar PV battery systems. The main aim of the study is to optimize the PV-battery-controllable loads system both from the economic and technical perspectives so that the customer's, retailer's, and DSO's interests are met.

The first part concentrates on forecasting a single customer's consumption in the present operating environment, in other words, without load control actions and local energy resources. The result is a total electricity consumption profile with an extracted controllable part. An important part of the forecasting model is the control responses of electrical heating loads, in other words, a payback model. The second part focuses on the mathematical optimization of the electrical load control under the impact of price signals from different electricity markets such as spot-, balancing-, and frequency control markets.

The main contribution of the study is establishing a concept of an active customer (consumer and prosumer) and demonstrating the benefits and challenges it can deliver to all smart grid environment parties (retailer, DSO, TSO). This will spread awareness and help set up business models of an active customer and a full participant in the electricity markets in the smart grid environment.

## **Integration of power-to-gas –process to wastewater treatment plant with biogas production**

**Inkeri Eero**

Lappeenranta University of Technology, LUT School of Energy Systems

To avoid carbon dioxide emissions and restrain global warming, much trust is given for renewable energy sources, such as wind and solar. If these energy sources are used to provide the largest share for the energy demand, energy storages are required to balance the intermittent nature of wind and solar. PtG (power-to-gas) is one solution for long-term energy storage, and biogas production by anaerobic digestion is one possible biogenic source for carbon dioxide used in a PtG process. In this study PtG process integration to a biogas production at wastewater treatment plant is modeled at a yearly time scale with hourly time steps. Traditional biogas plant produces gas with CH<sub>4</sub> (methane) content of 60-70 % and 30-40 % of CO<sub>2</sub> (carbon dioxide). With PtG integration it is possible to increase biogas production during electricity surplus by converting the CO<sub>2</sub> in biogas to CH<sub>4</sub> with hydrogen from electrolysis. Produced biomethane can be stored for later power production or sold as transportation fuel. Further benefits are provided by oxygen from electrolysis and heat from both electrolysis and methanation, which can be used in aeration of wastewater sludge and biogas production, respectively. Main modeling issues are mass and energy balances, design sizes of the components, corresponding buffer storages and operation dynamics including costs and incomes.

## **Structural Changes of the Global Power Generation Capacity Towards Sustainability**

**Orozco Francisco Javier Farfan**

Lappeenranta University of Technology, LUT School of Energy Systems

Global energy systems have evolved over time, going through different phases. Nevertheless renewable energy sources have always played a very important role in the global energy system, historically in the form of hydropower and geothermal energy. However, the increasing concern on problems related to climate change together with the constant development of new alternative renewable energy sources like solar photovoltaic and wind is progressively changing the composition of the global energy systems. Strict policies on reduction of greenhouse gas emissions and for development of renewable energy sources by countries and international organizations is having a clear impact in the transformation of the energy system towards sustainability, a tendency clearly visible in the past couple of decades. Are we going to burn everything? The global answer is no... but we still have to work on it.

## **Energy efficiency indicators in Finnish Pulp and Paper Industry**

**Slobodenyuk Anna**

Lappeenranta University of Technology, LUT School of Energy Systems

Papermaking is a widespread traditional industry in Finland. This important production sector is one of the greatest national energy consumers. Out of some 521 PJ used in manufacturing industry in 2014, about 270.5 PJ used in pulp and papermaking industries. The aim of research is to analyze energy efficiency improvement in Finnish pulp and paper sector over almost 20-year period. During this time, the industry has undergone many critical changes: some paper mills were closed, another were modernized. Improvement of existing production lines results not only energy costs reduction, but also saves water, raw materials, improves mill profitability. Together with that, energy savings influence achievement of national and international environmental commitments positively.

Variety of complex technologies, products and capacities result poor understanding of possibilities for energy use reduction. This paper clarifies benchmarking for modern pulp and paper operations, processes and products. Evaluation of saving potential based on specific electricity and heat consumption values. Individual approach to each mill enables to predict future energy demand in whole pulp and paper sector with high accuracy. Additionally list of possibilities for electricity and heat demand minimization was developed.

## **Design of the High-Speed Rotating Electrical Machines**

**Uzhegov Nikita**

Lappeenranta University of Technology, LUT School of Energy Systems

High-speed electrical machines are nowadays used in a number of industrial applications. The key benefits of these machines are high power density, small footprint as well as high system overall efficiency. These factors are attracting the manufacturers producing, for instance, gas compression applications, air blowers, vacuum pumps, turbines, machine tools, and machine tool spindle drives.

My research is concentrated mostly on the electromagnetic design of the HS Induction Motors and Permanent Magnet Synchronous Machines as these two machine types are widely used in the industrial applications. My field of expertise lays in the electromagnetics, nevertheless, the basic knowledge of the mechanics and thermal engineering are required.

To sum up, my research is concentrated on the multi-faceted studying of the high-speed electrical machines. It includes the analytical and numerical design, the topology selection based on the customer requirements, the material properties investigation, a development of the calculation tools, the prototypes measurements and the research results publishing.

The research helps to improve the existing drive train systems, increase their efficiency and reduce the amount of wasted energy.

## Dissolution of magnetite and hematite in sulfuric and nitric acid using oxalic acid as a boosting agent

**Vehmaanperä Paula**

Lappeenranta University of Technology, LUT School of Engineering Science

Dissolution of iron oxides with mixtures of acids has not been extensively studied. Also, kinetics and thermodynamics of dissolution of iron oxides are in general not agreed on. The objective here is to investigate the dissolution mechanisms of magnetite and hematite in acidic environments by adding oxalic acid in sulfuric or nitric acid. This can contribute to more efficient and environmentally friendly processes. The work is based on performing thermodynamic and kinetic experiments at different temperatures and acid ratios. So far the results have shown that the solubility of magnetite and hematite improves and reaction rate increases by adding oxalic acid in sulfuric acid. The temperature has an effect on the equilibrium kinetics, but higher temperatures do not automatically result in higher solubility. The Kabai model has been found most suitable in describing the dissolution kinetics of magnetite and hematite in mixtures of oxalic and sulfuric acid. A solid specific constant  $a$  of the Kabai model has been found to vary for the different acid ratios for magnetite and hematite dissolution, which has not been reported by Kabai and has been relatively little discussed by other authors observing the same change in  $a$ . Observed changes in the solid phase during the dissolution is suggested cause the differences in  $a$ .

### **From entrepreneurial academics to entrepreneurial universities: comparison between Finland and UK**

**Albats Ekaterina**

Lappeenranta University of Technology, LUT School of Business and Management

This study is at the stage of the literature review and research design. So, there is no yet actual results collected. However, the author would appreciate comments on this research proposal.

#### Problem

Entrepreneurial intention rate in Finland remains moderate (Global Entrepreneurship monitor, 2015). At the same time both public and private investments in R&D are among the highest globally. Hence, one of the source of entrepreneurship in Finland should be universities, which achieve leadership in exploiting the results of public R&D investments. Historically low intention of highly educated Finnish people to set up an own business (Aaltonen, 2014) leads to the global issue: how to deal with those, who do not see themselves as entrepreneurs, but actually are carriers of high tacit commercial value (coming out of their knowledge)? In addition to a practical need the literature review found a lack of the research on Finnish case in that context. UK is not only in top 3 of publishing on this topic but is also a pioneer in practicing it ((Global Entrepreneurship monitor, 2015). The UK case *will be studied* as a benchmark for comparing it to Finland and transferring the best practices of entrepreneurial university creation.

#### Literature review

The phenomenon of *entrepreneurial university* is widely discussed in the literature for at least the last decade. The authors consider governmental regulations effect in this area (Bayh-Dole Act in US, Law on University patenting in Denmark, Universities Act in Finland, and others) and carefully study the issue of the new entrepreneurial mission and its effect on the main education and research activities (Hakala, 2009; Duberley et al., 2007). However, when it comes to exploring the individuals' intentions, the authors are mainly focusing on researching the purely profit-oriented activities (as patents sales, licensing, and academic spin-offs). Presence and volume of these activities are considered among the key indicators of university-industry collaboration success (see Albats & Fiegenbaum, 2015; Rossi & Rosli, 2013). Much fewer authors consider a less tangible phenomenon of *entrepreneurial academics* (Kalar & Antoncic 2015; Alexander 2015) and its affect on entrepreneurial culture. Only one of all these Scopus indexed studies (by Tahvanainen, 2004) is found considering the case of Finland in particular in biotech context. Tahvanainen (2004) highlights importance of further deeper research in this field on the national level to expand the role and task of academia to turn universities from 'ivory towers' to entrepreneurial organizations. Thus, in addition to a practical need in exploring entrepreneurial academics and necessity to develop an entrepreneurial university in conditions of lack of entrepreneurial intention there is a deficiency of the research on Finnish case in that context. In particular case of Finland it would be interesting also to analyse the effect of the recently happened cuts of the governmental funding of academia on the academics entrepreneurial intention.

Discussing entrepreneurship in the literature, the authors highlight a distinction between academic entrepreneurs and entrepreneurial academics (Kalar & Antoncic 2015; Alexander 2015). The concept of academic entrepreneur refers to an individual holding a teaching and research function at the higher educational institution, but focusing on formal commercialisation activities as patents creation, selling licences or the creation of new ventures and spin out firms (Franklin et al., 2001; Shane, 2004; Alexander, 2015). Entrepreneurial academics are not necessarily so growth and profit oriented as academic entrepreneurs and participates in a wider range of engagement, collaboration and knowledge transfer activities building a network with other organisations, including industry (Meyer, 2003; Perkmann et al., 2013; Alexander, 2015). In this research I aim to understand how to stimulate nurturing of entrepreneurial academics. Thus, the research questions are: RQ1: *What aspects of academics' human*

*capital define their willingness to engage with non-university parties? RQ2: What particular aspects of entrepreneurial academics' behaviour affect university entrepreneurial culture?*

#### Research design

The research strategy includes a series of in-depth interviews with university researchers from UK and Finland, interviews with universities' decision makers. The aim is to conduct 40 interviews in UK and 40 interviews in Finland. The interviews will be conducted by phone and face-to-face. The data will be transcribed verbatim and analysed using NVivo software.

#### Results and contribution

In terms of scientific contribution, this study will shed a light on the phenomena of entrepreneurial academics and their human capital by identifying the factors influencing their willingness to interact with external actors. Moreover, this study is devoted to identifying the links between individual academics entrepreneurial intentions, their interaction with external parties with entire university entrepreneurial culture.

The best practices and tacit mechanisms of forming an entrepreneurial university collected during my research will serve as a knowledge base for further development of institutional measures. Moreover, the findings on entrepreneurial academics will interest academics being one of the key research objects. It will also serve Finnish and UK economies and business as a whole by shedding the light on how to boost entrepreneurship through stimulating academics involvement into real business and economic processes.

#### REFERENCES

- Aaltonen, 2014. 'Entrepreneurs, academia in Finland' - Speech given for LSE alumni and offer holders. LSE Alumni Association Finland event at the British Embassy in Helsinki. August 20th, 2014. Available online: [www.aleksi.info](http://www.aleksi.info)
- Albats E. & Fiengenbaum I. (2014). Evaluating University-Industry Collaboration Projects: Performance Indicators. Presented on The 2014 ISPIIM Asia-Pacific Innovation Forum, 7-10, December 2014.
- Alexander, A. T., Miller, K., & Fielding, S. (2015) Open for Business: Universities, Entrepreneurial Academics and Open Innovation. The XXVI ISPIIM Conference – Shaping the Frontiers of Innovation Management, Budapest, Hungary on 14-17 June 2015.
- Duberley, J., Cohen, L., & Leeson, E. (2007). Entrepreneurial academics: developing scientific careers in changing university settings. *Higher Education Quarterly*, 61(4), 479-497.
- Franklin, S. J., Wright, M., & Lockett, A. (2001). Academic and surrogate entrepreneurs in university spin-out companies. *The Journal of Technology Transfer*, 26(1-2), 127-141.
- Global Entrepreneurship monitor, 2015. Country profiles: Finland and UK. Available online: [www.gemconsortium.org/country-profiles](http://www.gemconsortium.org/country-profiles)
- Hakala, J. (2009). The future of the academic calling? Junior researchers in the entrepreneurial university. *Higher Education*, 57(2), 173-190.
- Kalar, B., & Antoncic, B. (2015). The entrepreneurial university, academic activities and technology and knowledge transfer in four European countries. *Technovation*, 36, 1-11.
- Meyer, M. (2003). Academic entrepreneurs or entrepreneurial academics? Research-based ventures and public support mechanisms. *R&D Management*, 33(2), 107-115.
- Perkmann, M., Tartari V., Mckelvey M., Autio E., Brostrom, A., D'este, P., Fini, R., Geuna, A.; Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F. Salter, A. & Sobrero, M. 2013. Academic engagement and commercialisation: A review of the literature on university -industry relations. *Research Policy*, 42 (2), 423–442.
- Rossi, F., & Rosli, A. (2013). Indicators of university-industry knowledge transfer performance and their implications for universities: Evidence from the UK's HE-BCI survey. CIMR Research Working Paper Series. Working Paper No. 13. 19 July 2013.
- Shane, S. A. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*. Edward Elgar Publishing.
- Tahvanainen, A. J. (2004). Growth inhibitors of entrepreneurial academic spin-offs: The case of Finnish biotechnology. *International Journal of Innovation and Technology Management*, 1(04), 455-475.

## Towards collaborative value assessment in industrial maintenance services

Ali-Marttila Maaren

Lappeenranta University of Technology, LUT School of Business and Management

This study examines the key processes of service value assessment done in cooperation by the customer and service provider. The research of maintenance service value has mainly focused on the technical and financial value. However, there are elements of soft and intangible elements that are as important. The value of services consists comprehensively of both financial and non-financial (e.g. reputation, trust, trained labor, willingness to cooperate) elements and they are often case specific. If the customer and service provider cannot clearly assess the value creating elements, it is often the financial element price that is eventually the deciding factor and this can result in transaction based and short-term relationships. Therefore new methods are needed to improve the communication between the customer and the service provider to understand comprehensively the value assessed. The aim of this paper is to present how the value of industrial services can be collaboratively identified and communicated to each party. To understand the phenomena a case study with semi-structured interviews has been conducted. Data has been collected from seven firms (from two different maintenance service networks with main customers operating in energy and mining industries), and a total of 9 interviews have been undertaken. As a main result a managerially grounded process model for collaborative value assessment is presented. Key processes identified include mutual identification of the value creating elements, visualization, mutual goal setting and active feedback and evaluation. This study contributes to the literature of industrial services and value creation by presenting a novel approach for collaborative value assessment. In addition it provides managers a systematic process model for communicating the service value within the service relationship. The present study is limited to maintenance services and therefore future research should be conducted in broadening the scope to other industrial services as well.

### References

- Aarikka-Stenroos, L. and Jaakkola, E. (2012) 'Value co-creation in knowledge intensive business services: A dyadic perspective on the joint problem solving process', *Industrial Marketing Management*, Vol. 41, No. 1, pp. 15-26.
- Corsaro, D. (2014) 'The emergent role of value representation in managing business relationships', *Industrial Marketing Management*, Vol. 43, No. 6, pp. 985-995.
- Grönroos, C. and Helle, P. (2010) 'Adopting a service logic in manufacturing: Conceptual foundation and metrics for mutual value creation', *Journal of Service Management*, Vol. 21, No. 5, pp.564-590
- Keränen, J. and Jalkala, A. (2013) 'Towards a framework of customer value assessment in B2B markets: An exploratory study', *Industrial Marketing Management*, Vol. 42, No. 8, pp. 1307-1317.
- Lindgreen, A. and Wynstra, F. (2005) 'Value in business markets: What do we know? Where are we going?', *Industrial Marketing Management*, Vol. 34, No. 7, pp. 732-748.
- Liyana, J.P. and Kumar, U. (2003) 'Towards a value-based view on operations and maintenance performance management', *Journal of Quality in Maintenance Engineering*, Vol. 9, No. 4, pp. 333-350.
- Nätti, S., Pekkarinen, S., Hartikka, A. and Holappa, T. (2014) 'The mediator role in value co-creation within a triadic business service relationship', *Industrial Marketing Management*, Vol. 43, No. 6, pp. 977-984.
- Rosqvist, T., Laakso, K. and Reunanen, M. (2009) 'Value-driven maintenance planning for a production plant', *Reliability Engineering and System Safety*, Vol. 94, No. 1, pp. 97-110.
- Toossi, A., Lockett, H.L, Raja, J.Z. and Martinez, V. (2013) 'Assessing the value dimensions of outsourced maintenance services', *Journal of Quality in Maintenance Engineering*, Vol. 19, No. 4, pp. 348-363.
- Ulaga, W (2003) 'Capturing value creation in business relationships: A customer perspective', *Industrial Marketing Management*, Vol. 32, No. 8, pp. 677-693.

# Investigation of the Flow Behavior inside a Supercritical CO<sub>2</sub> Centrifugal Compressor

**Ameli Alireza**

Lappeenranta University of Technology, LUT School of Energy Systems, Laboratory of Fluid Dynamics

One of the most important ways of managing the growth in energy consumption is energy efficiency. Energy conversion cycles are the major part of the electricity production in the world. Brayton and Rankine cycles are the most common energy conversion processes. A small increase in these cycle efficiencies would achieve a significant gain in electricity production and would save more primarily energy sources. Depending on the working fluid, supercritical organic Brayton cycles (SCOBC) have a higher cycle efficiency with the relatively low maximum temperature and the efficiency is closer to the Carnot efficiency [1].

The investigated compressor is a centrifugal compressor tested in the Sandia supercritical CO<sub>2</sub> compression loop [2]. Commercial flow solver ANSYS CFX was used for all simulations in this study. In order to take account for nonlinear variation of the properties near the critical point, the flow solver is coupled with an extensive Look up Table of properties of fluid. Behavior of real gas near its critical point and effect of that on the compressor performance are studied. Results are compared to the experimental data performed at Sandia facility [3] and good agreement was achieved.

## References

- [1] V. Dostal, M. Driscoll and P. Hejzlar, A Supercritical Carbon Dioxide Cycle for Next Generation Nuclear Reactors, The MIT Center for Advanced Nuclear Energy Systems . (MIT-ANP-TR-100), March 10, 2004.
- [2] S. A. Wright, R. F. Radel, M. E. Vernon, G. E. Rochau and P. S. Pickard, "Operation and Analysis of a Supercritical CO<sub>2</sub> Brayton Cycle," Sandia National Laboratories - Sandia report 2010-0171, 2010.
- [3] S. A. Wright, M. Conboy Tom, J. Parma Edward, G. Lewis Tom and A. Rochau Gary, "Summary of the Sandia Supercritical CO<sub>2</sub> Development Program," in SCO<sub>2</sub> Power Cycle Symposium, Boulder, Colorado, May 24-25, 2011.

## **Eurasian Super Grid for 100% Renewable Energy power supply: Generation and storage technologies in the cost optimal mix**

**Bogdanov Dmitrii, Breyer Christian**  
Lappeenranta University of Technology

Increasing ecological problems provoked by human activities, including the fossil fuel based energy sector, emerge the development of a renewable energy (RE) based system as the way to stop pollution and global warming but also to reduce total energy system cost. Small population density and availability of various types of RE resources in Eurasian regions including solar, wind, hydro, biomass and geothermal energy resources enables the very promising project of building a Super Grid connecting different Eurasian regions' energy resources to reach synergy effects and make a 100% RE supply possible. For every sub-region it is defined a cost-optimal distributed and centralized mix of energy technologies and storage options, optimal capacities and hourly generation. Charge and discharge profiles of storages are computed for regions interconnected by high-voltage direct current (HVDC) power lines. System cost and levelized cost of electricity (LCOE) for each sub-region are computed. The results show that a 100% RE-based system is lower in cost than nuclear and fossil carbon capture and storage (CCS) alternatives.

## **Design of an intelligent fuzzy expert system (FES) to mimic the decision-making behavior of humans on CO<sub>2</sub> capture and storage (CCS)**

**Buah Eric**

Lappeenranta University of Technology, LUT School of Energy Systems

Carbon capture and storage technology (CCS) has emerged as part of the mitigation solution to mitigate the problem of climate change. Despite the vast potential of CCS in the low-carbon energy transition, international research evidence indicates that on a global scale, uncertainties currently prevail on its social acceptance. However, predicting human thinking and value-based decision in the domain of CCS presents a tremendous challenge. This is because human cognitive judgment towards CCS development and implementation (especially the view of the lay public) is based on mental images and patterns instead of numerical quantities (i.e. probability terms used by the expert). This makes human decision-making complex to model.

Traditionally, CCS acceptance domain experts employed different statistical methods to model this complex human behavior. This mainstream statistical approach has however been limited in dealing with the intrinsic imprecisions in human reasoning due to its mathematical inflexibility.

To overcome these limitations, an artificial intelligent expert system is one powerful tool. Fuzzy logic, when applied to the system modeling of this intelligent expert system, helps address the approximate nature of human reasoning. In this paper, the applicability of fuzzy logic in CCS acceptance context has been explored. The main objective is to design a simulation-based fuzzy expert system for predicting lay people's attitude towards acceptance of CCS technology using human factors. The proposed system is a Multi-inputs Single-output (MISO) fuzzy expert system. It uses four human factors as its input parameters: trust, risk perception, benefit perception and affect. This intelligent system has capability of mimicking the decision-making behavior of human using these input parameters to predict degree of acceptability. The proposed system could be used in parallel with other technological acceptance models as a decision aided expert system to assist CCS actors (both proponents and opponents) in environmental decision-making and risk communication aimed at exploring pro-CCS and anti-CCS behaviors. In this paper, an experimental and simulation results are shown to demonstrate the feasibility of the proposed system when the system was tested with a secondary experimental data and compared to the desired result that measured Chinese universities students' attitude towards CCS implementation in China.

## IC enhancing product and managerial innovation in high versus low-tech companies

**Buenechea Marta Elberdin**

Lappeenranta University of Technology, Finland and University of Deusto, Spain

**Kianto Aino**

Lappeenranta University of Technology, Finland

**Sáenz Josune**

University of Deusto, Spain

Knowledge has increasingly become the central element for gaining competitive advantages. Nevertheless, there is unawareness on how intellectual capital (hereinafter referred to as IC) promotes different kinds of innovations, under particular organizational contingencies. Therefore, this study examines how IC affects the development of new products/services and new management practices in high- and low-technology companies.

In comparison to product/service innovation, innovations in management practices depend more on the idiosyncrasy of each corporation. However, the extant literature addresses innovation either as a general capacity to produce renewals, or in terms of product innovation. Apart from few studies comparing IC in incremental or radical innovation, there is little understanding on how IC differs in supporting different types of innovations.

Typically, IC research has been performed for high-technology companies, while it is likely that IC elements are important for boosting innovations of various kinds also to the low-technology firms. Therefore the question of how the relationships between IC elements and innovation might vary in high- and low-technology firms is also addressed.

Structural equation modelling based on partial least squares is applied using data from 180 Spanish firms from different industries. The preliminary findings demonstrate that product/service and managerial innovations depend on different IC elements, and that these patterns vary between high and low-tech firms. Our findings provide guidelines for managers about how high- and low-technology companies could enhance product/service and management innovations by means of IC.

### References

- Alpkan, L., Bulut, C., Gunday, G., Ulusoy, G. & Kilic, K. (2010). Organizational support for intrapreneurship and its interaction with human capital to enhance innovative performance. *Management Decision*, 48(5), 732 - 755.
- Carmona-Lavado, A., Cuevas-Rodríguez, G. & Cabello-Medina, C. (2013) Service Innovativeness and Innovation Success in Technology-based Knowledge-Intensive Business Services: An Intellectual Capital Approach. *Industry and Innovation*, 20(2), 133 - 156
- Delgado-Verde, M., Cooper, S., Castro, G.M.-D. (2015). The moderating role of social networks within the radical innovation process: A multidimensionality of human capital-based analysis. *International Journal of Technology Management*, 62(2), 117 - 138.
- Delgado-Verde, M., Martín De Castro, G., Navas-López, J.E., Amores-Salvador, J. (2014) Vertical relationships, complementarity and product innovation: An intellectual capital-based view. *Knowledge Management Research & Practice*, 12, 226 – 235.
- Drucker, P. F. (1993). The rise of the knowledge society. *The Wilson Quarterly*, 17(2), 52.
- Grant, R. M. (2002). *Contemporary strategy analysis*. (4th Ed.) Massachusetts, USA: Blackwell Publishers Inc.
- Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, 17(Winter special Issue), 45 - 62.
- Subramaniam, M. & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal*, 48(3), 450 - 463.
- Wang, D. & Chen, S. (2013). Does intellectual capital matter? High-performance work systems and bilateral innovative capabilities. *International Journal of Manpower*, 34(8), 861 – 879.
- Wu, W.-Y., Chang, M.-L. & Chen, C.-W. (2008). Promoting innovation through the accumulation of intellectual capital, social capital, and entrepreneurial orientation. *R&D Management*, 38(3), 265 - 277.
- Wu, S.H., Lin, L.Y. & Hsu, M.Y. (2007). Intellectual Capital, Dynamic Capabilities and Innovative Performance of Organizations. *International Journal of Technology Management*, 39(3-4), 279 - 296.

# Vision and Initial Feasibility Analysis of a Recarbonised Finnish Energy System

Child Michael

Lappeenranta University of Technology, LUT School of Energy Systems

The Finnish energy system is at a crossroads due to an aging system of power generation, opinions about different modes of low-carbon energy generation, responsibilities to mitigate climate change, and worries of fluctuating energy prices. At the same time, Finnish society has goals regarding national energy security and a wish to both retain a competitive industrial sector and meet the needs of a future society. This work seeks to envision and analyse a future, recarbonized energy system for Finland in 2050 whereby current sources of carbon in the energy system based on fossil fuels are replaced by those that are derived sustainably. This includes an examination of the components of a fully-integrated energy system, the roles of energy storage technologies and the effects of varied levels of nuclear power and forest-based biomass in the system. Findings suggest that such a recarbonised energy system is possible for Finland in 2050 based on the assumptions in this study. High shares of variable renewable energy were deemed feasible when supported by flexibility harnessed from other aspects of the energy system. A 100% RE system corresponds to a highly competitive cost solution for Finland, as total system costs decrease through interaction between the power, heating/cooling and mobility sectors. These sectors are incorporated on an hourly resolution using historical data and the EnergyPLAN modelling tool. In 2050, a 100% renewable energy scenario has the lowest overall annual cost, at 24.1 b€/a. This is followed by several scenarios that feature increasing levels of nuclear power, which range in annual costs to 26.4 b€/a. Scenarios were also modelled with varying levels of forest-based biomass. Results suggest that annual costs do not increase dramatically with reduced levels of forest-based biomass fuel use.

## References

- [1] B. V. Mathiesen, H. Lund and K. Karlsson, "100% Renewable energy systems, climate mitigation and economic growth," *Appl. Energy*, vol. 88, pp. 488-501, 2, 2011.
- [2] J. Kiviluoma and P. Meibom, "Influence of wind power, plug-in electric vehicles, and heat storages on power system investments," *Energy*, vol. 35, pp. 1244-1255, 3, 2010.
- [3] A. Lehtilä, T. Koljonen, M. Airaksinen, P. Tuominen, T. Järvi, J. Laurikko, L. Similä and L. Grandell, "Low carbon finland 2050-platform. energijärjestelmien kehityspolut kohti vähähiilistä yhteiskuntaa." VTT Technology, Espoo, Tech. Rep. 165, 2014.
- [4] Finnish Energy Industries, "Turning challenges into opportunities - a carbon neutral vision of electricity and district heat for 2050." Finnish Energy Industries, Helsinki, 2009. [Online]. Available: [http://energia.fi/sites/default/files/turning\\_challenges\\_into\\_opportunities\\_-\\_a\\_carbon\\_neutral\\_vision\\_for\\_electricity\\_and\\_district\\_heat\\_for\\_2050.pdf](http://energia.fi/sites/default/files/turning_challenges_into_opportunities_-_a_carbon_neutral_vision_for_electricity_and_district_heat_for_2050.pdf) [Accessed: January 4, 2015]
- [5] Finnish Ministry of Employment and the Economy, "Energy and climate roadmap 2050. Report of the parliamentary committee on energy and climate issues." Ministry of Employment and the Economy, Tech. Rep. 50/2014, 2014. [Online]. Available: [https://www.tem.fi/files/41483/Energy\\_and\\_Climate\\_Roadmap\\_2050.pdf](https://www.tem.fi/files/41483/Energy_and_Climate_Roadmap_2050.pdf) [Accessed: January 8, 2015]
- [6] Agora Energiewende, "Comparing the cost of low-carbon technologies: What is the cheapest option?" Prognos AG, Berlin, 2014. [Online]. Available: [http://www.prognos.com/fileadmin/pdf/publikationsdatenbank/140417\\_Prognos\\_Agora\\_Analysis\\_Decarbonisationstechnologies\\_EN.pdf](http://www.prognos.com/fileadmin/pdf/publikationsdatenbank/140417_Prognos_Agora_Analysis_Decarbonisationstechnologies_EN.pdf) [Accessed April 24, 2015]
- [7] H. Lund. EnergyPLAN. *Advanced energy system analysis computer model*. [Online]. Available: <http://www.energyplan.eu/> [Accessed: November 15, 2014]
- [8] S. Rinne and S. Syri, "The possibilities of combined heat and power production balancing large amounts of wind power in Finland," *Energy*, vol. 82, pp. 1034-1046, 3/15, 2015.
- [9] R. Sikkema, A. Faaij, T. Ranta, J. Heinimö, Y. Gerasimov, T. Karjalainen and G. Nabuurs, "Mobilization of biomass for energy from boreal forests in Finland & Russia under present sustainable forest management certification and new sustainability requirements for solid biofuels," *Biomass Bioenergy*, vol. 71, pp. 23-36, 2014.
- [10] P. D. Lund, J. Lindgren, J. Mikkola and J. Salpakari, "Review of energy system flexibility measures to enable high levels of variable renewable electricity," *Renewable and Sustainable Energy Reviews*, vol. 45, pp. 785-807, 5, 2015.

## **Off-terrain Hybrid Heavy-Duty Vehicle Driveline Design**

**Gerami Tehrani M., Sopenen J.T.**

Lappeenranta University of Technology, LUT School of Energy Systems

The architecture of conventional heavy off-road vehicle drive line is based on diesel engines and hydraulic pump/motor as power transmission. In order to replace the engine with an electric motor, a relatively big diameter electric motor is needed in order to produce high level of torque in agricultural application at low speed. In order to overcome this problem a downsized electric motor integrated with a reduction gearset is designed to increase the torque on wheels at low rpms. A generic model that gives the possibility of modifying all parameters of tractor and electric motor simultaneously is built by co-simulation of software that in this study are Matlab Simulink and Mevea. In order to validate the applicability of the proposed driveline in different vehicle architectures e.g. electric drivelines as well as hybrid or all electric, a generic model is needed to be developed. Hybridization of off-terrain vehicles is introduced in this paper. Hub-wheel electric motor is proposed for electric powertrain and the benefits of subsiding of local emission and noise disturbance are explained.

## Adjusting the properties of nanowires for next-generation Solar cells

Geydt Pavel

Lappeenranta University of Technology, LUT School of Engineering Science, Laboratory of Physics

Nanowires (NWs), and particularly semiconductor NWs, e.g. GaAs or InP, are extensively used inside modern devices for various applications [1]. One of the key implementations for them is in design and fabrication of next generation Solar panels [2]. Firstly, surface-to-volume ratio of Solar cells with NWs is much higher than for flat panels – they collect more photons from sunlight, due to high pn-junction area and architecture, where photons become entangled and absorbed in the organized array [1, 3]. Secondly, utilization of NWs for Solar cells can lead to significant decrease of semiconductor material spent during fabrication and considerably high efficiency [3]; reached/published by other groups already. Thus, materials economy and clean energy principles can become satisfied with NW-based arrays on Solar cells.

Electric parameters of NWs arrays are usually tested with massive contact, which can give averaged electric data of specified area. Idea of our work is to investigate the electrical properties of individual nanowires, which will give photoconductivity, self-resistivity and crystal structure data about single free-standing semiconductor nanowires with help of Atomic Force Microscope, which is fast and tremendously informative [4]. After collecting such detailed data, information is used for adjusting of the properties of large-scale devices on basis of fundamental physical laws. The best is yet to come, since theoretical limit of efficiency was declared overcome [5].

One of the main problems is in high resistivity of the NWs, caused by so-called Schottky barrier on the border between NWs golden hats and semiconductor material [6]. Recently, we have found that electrical Schottky junction on top parts of the NWs is diminished, when Schottky barrier height becomes lowered by surface states of NW's interfacial natural oxide layer. According to our new results, Schottky barrier is reduced by charge accumulation on surface states. Moreover, charge accumulation can be regulated by doping level, passivation and electrical bias potential applied to the NW leading to elimination of Schottky barrier input. We expect that determination of all electrical parameters together will help to increase the efficiency of Solar cells.

### References:

- [1] R.R. LaPierre, *Phys.Stat.Sol. RRL* 7(10) (2013).
- [2] Y.-H. Lee, *Nanotechnol. Spie* (2013).
- [3] J. Wallentin, *Science* 339 (2013).
- [4] R. Timm, *Nano Lett.* 13(11) (2013).
- [5] P. Krogstrup, *Nature Photonics* 7 (2013).
- [6] D.B. Suyatin, *Nature Comm.* 5 (2014).

## A method for supporting complex long-term decision-making

Hanski Jyri

VTT Technical Research Centre of Finland

The long-term perspective of infrastructure related strategic decisions makes it difficult for purely monetary indicators to capture all the relevant issues. Additionally, uncertainties grow as the investment period gets longer. Long-term perspective calls for the use of scenarios, and the different stakeholders and experts should be involved in the decision process. Because of the deep uncertainties involved, the strategies implemented by organisations should be robust. This means that any strategy should perform adequately irrespective of which scenario will materialise. In this presentation a method for representing and visualising the uncertainty in strategic decisions is introduced. The method is a novel combination of Multi-Criteria Decision Analysis and Robust Decision-Making. One of the key aspects of the method is the modelling of uncertainty of the quantitative indicators by minimum and maximum values which are plotted on radar plots such that each strategy option's performance, under each scenario, can be visually inspected for robustness. The method is tested with two cases related to energy systems under pressures of climate change.

### References

- Adger N, Arnell N, Tompkins E (2005) Successful adaptation to climate change across scales. *Global Environmental Change*. 15(2):77-86. ISSN 0959-3780, <http://dx.doi.org/10.1016/j.gloenvcha.2004.12.005>.  
<http://www.sciencedirect.com/science/article/pii/S0959378004000901>
- Belton V, Pictet J (1997) A Framework for Group Decision Using a MCDA Model: Sharing, Aggregating or Comparing Individual Information? *J Decision Systems* 6(3):283-303.
- Hanski J, Rosqvist T, Crawford-Brown D (2015) ToPDAd deliverable D4.3 - Demonstration description – visualisation of robust adaptation strategies. Available: <http://www.topdad.eu/publications>. [Accessed October 2015].
- Harjanne A, Nurmi V, Perrels A, Votsis A, Osborn T, Melvin T, Wallace C (2014) ToPDAd deliverable D2.1 - Climate hazard and impact scenarios. Available: <http://www.topdad.eu/publications>. [Accessed October 2015].
- Hinkel J, Bisaro A (2014) Methodological choices in solution-oriented adaptation research: a diagnostic framework. *Reg Environ Change*. doi:10.1007/s10113-014-0682-0.
- Kasprzyk JR, Nataraj S, Reed PM, Lempert RJ (2013) Many objective robust decision making for complex environmental systems undergoing change, *Environmental Modelling & Software*, Volume 42, April 2013, Pages 55-71, ISSN 1364-8152, <http://dx.doi.org/10.1016/j.envsoft.2012.12.007>. (<http://www.sciencedirect.com/science/article/pii/S1364815212003131>)
- Lempert RJ, Groves DG, Popper SW, Bankes SC (2006) A General, Analytic Method for Generating Robust Strategies and Narrative Scenarios. *Management Science* 52(4):514-528.
- Scrieciú SŞ, Belton V, Chalabi Z, Mechler R, Puig D (2014) Advancing methodological thinking and practice for development-compatible climate policy planning. *Mitigation and Adaptation Strategies for Global Change* 19(3):261-288.

## Wind turbine sound annoyance: case studies in two wind farms

Janhunen Sari

Lappeenranta University of Technology, LUT School of Business and Management

Wind turbine sound annoyance is an emerging problem. Previous studies [1, 2, 3] indicate relationships between wind turbine noise, annoyance and sleeping difficulties. Individual attitudes, economic benefits and view to wind farm also influence in human experiences [4, 5, 6]. However, effects on sleeping disorders and role of other moderating factors are still unclear.

In this paper human experience of wind turbine sounds is studied. The main focus is on association between health and welfare, and sound levels and characteristics in the vicinity of two wind farms. Human experience was studied by questionnaire, sound diaries and interviews. Additionally, acoustic measurements were carried out at five places in residential area (mean distance 850 m to nearest wind turbine) with Nor 140 sound level meter and microphone Nor 1217. Data was collected at winter time.

Most of the respondents were not disturbed by wind turbine sounds at all. However, experienced wind turbine sound annoyance was found and it was associated in sleeping problems. Experienced annoyance was not explained only by sound pressure level, but also by wind characteristics, such as wind direction influencing in the turbine rotor orientation versus the observer. Results highlight human experience in wind turbine sound research and the complex role of moderating factors.

### References

- [1] Onakpoya, I. J., O'Sullivan, J., Thompson M. J. & Heneghana, C. J. (2015) The effect of wind turbine noise on sleep and quality of life: A systematic review and meta-analysis of observational studies. *Environment International* 82, 1–9.
- [2] Hongisto, V. (2014) Tuulivoimamelun terveystvaikutukset. Työterveyslaitos.  
[http://www.ttl.fi/fi/verkkokirjat/Documents/Tuulivoimamelun\\_terveysvaikutukset.pdf](http://www.ttl.fi/fi/verkkokirjat/Documents/Tuulivoimamelun_terveysvaikutukset.pdf) (accessed 11 th November, 2015).
- [3] Bakker, R.H., Pedersen, E., van den Berg, G.P., Stewart, R.E., Lok, W. & Bouma, J. (2012) Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress. *Science of the Total Environment*, 425, 42-51.
- [4] Taylor, J., Eastwick, C., Wilson, R. and Lawrence, C. (2013) The influence of negative personality traits on the effects of wind turbine noise. *Personality and Individual Differences* 54, 338-343.
- [5] Pawlaczyk-Łuszczczyńska, M., A., Zaborowski, K., Zamojska-Daniszewska, M. & Waszkowska, M. (2014) Evaluation of annoyance from the wind turbine noise: A pilot study. *International Journal of Occupational Medicine and Environmental Health* 27 (3), 364-388.
- [6] Pedersen E., van den Berg F., Bakker R., Bouma J. (2009) Response to noise from modern wind farms in The Netherlands, *The Journal of the Acoustical Society of America* 126(2), 634-643.

# Business Relationship Quality in Russian-Finnish Context: The Meanings under the Surface

Jukka Minna

Lappeenranta University of Technology, LUT School of Business and Management

Business relationship quality (RQ) is conceptualized as a multi-dimensional higher-order construct. The discussion what these dimensions could be in the different cultural contexts is still on-going, and in the field there is a lack of cross-cultural studies. Russian-Finnish buyersupplier relationships are particularly interesting as Russian-Finnish business collaboration was recently challenged by economic and political turmoil. The aim of this study was to analyze how business partners participating in Russian–Finnish trade evaluate RQ, and what are their meanings of RQ dimensions. In this study the Personal Constructs Theory and the Repertory Grid method were used to identify the meanings of RQ dimensions of 22 Russian and Finnish managers. This research contributes to the literature on relationship marketing in the context of cross-cultural relationships. Using the assumptions of Motivation-Opportunity- Ability theory, this study introduced a novel 3C framework (Communication quality, Commitment, Competence) to capture relationship quality. In addition, the shared meanings of these three dimensions were described for Russian and Finnish managers. The shared meanings of Russians were related to their preferences for interpersonal relationships, and highly valued informal communication. The Finns appreciated more personally distant relationships with formal communication, and they comprehended business relationships more as cooperation between organizations.

## Bibliography

- Andreeva, T. (2014). Russian culture in the eye of the beholder. In B. Gehrke & M-T. Claes (eds.) *Global leadership practices: A cross-cultural management perspective* (pp. 222–237). Hampshire: Palgrave MacMillan.
- Akrout, H. (2014). Relationship quality in cross-border exchanges: A temporal perspective. *Journal of Business-to-Business Marketing*, 21(3), 145–169.
- Athanassopoulou, P. (2009). Relationship Quality: a critical literature review and research agenda. *European Journal of Marketing*, 43, 5/6, 583–610.
- Crosby, L.A., Evans, K.R. and Cowles, D. (1990). Relationship quality in services selling: an interpersonal influence perspective. *Journal of Marketing*, 54, 2, 68–81.
- Huntley, J.K. (2006). Conceptualization and measurement of relationship quality: linking relationship quality to actual sales and recommendation intention. *Industrial Marketing Management*, 35, 6, 703–714.
- Kelly, G. (1955). *The Psychology of Personal Constructs*, New York: Norton.
- Morgan, R.M. & Hunt, S.D. (1994). The commitment-trust theory of relationship marketing. *Journal of Marketing*, 58, 20–38.
- Palmatier, R.W., Dant, R.P., Grewal, D. & Evans, K.R. (2006). Factors influencing the effectiveness of relationship marketing: a meta-analysis. *Journal of Marketing*, 70, 4, 136–153.
- Samaha, S. A., Beck, J. T. & Palmatier, R. W. (2014). The role of culture in international relationship marketing. *Journal of Marketing*, 78, 78–98.
- Segarra-Moliner, J-R., Moliner-Tena, M-A. & Sánchez-García, J. (2013). Relationship quality in business to business: a cross-cultural perspective from universities. *Marketing Intelligence & Planning*, 31, 3, 196–215.
- Turner, T. & Pennington, W.W. (2015). Organizational networks and the process of corporate entrepreneurship: how the motivation, opportunity, and ability to act affect firm knowledge, learning, and innovation. *Small Bus Econ*, 45, 447–463.
- Woo, K. & Ennew, C. T. (2004). Business-to-business relationship quality: An IMP interaction-based conceptualization and measurement. *European Journal of Marketing*, 38, 9/10, 1252–1271.

## The investigation of pattern formation in FitzHugh-Nagumo reaction-diffusion system: qualitative analysis of secondary solutions and quantitative classification of nonlinear steady states

Kazarnikov Alexey

Lappeenranta University of Technology, LUT School of Engineering Science

The main purpose of the current research is analytical and numerical investigation of pattern formation processes in reaction-diffusion systems. In nature, patterns are visible regularities of form. Reaction-diffusion systems were initially introduced by Alan Turing in 1952 for qualitative modeling of embryo growth processes and later have found a wide range of applications in many branches of science. The mechanisms of pattern formation are still not completely understood, however a lot of models have been developed for quantitative and qualitative description of pattern formation.

In our research, FitzHugh-Nagumo reaction-diffusion system is studied. It is a classical model of excitable media. When no spatial dependence is assumed, FitzHugh-Nagumo model becomes a generalized version of classical Rayleigh oscillator. For the special case of one control parameter, a qualitative analysis of bifurcations and secondary time dependent and stationary solutions is performed. Analytical approaches from bifurcation theory, asymptotic methods and functional analysis are used for studying system dynamics near the threshold of instability. For the analysis of dynamics far from threshold, numerical methods are used.

To study numerically how the pattern formation depends on the model parameters, we apply a recently developed distance concept, based on generalized correlation integral vectors. The preliminary results, obtained by now, are of both theoretical and practical interest.

### References

- [1] M. Cross, H. Greenside. Pattern formation and dynamics in nonequilibrium systems. Cambridge University Press, 2009, 553 P.
- [2] H. Haario, L. Kalachev, J. Hakkarainen. Generalized correlation integral vectors: A distance concept for chaotic dynamical systems // Chaos, 2015, 25(6).
- [3] S. V. Revina. Recurrence formulas for long wavelength asymptotics in the problem of shear flow stability // Computational mathematics and Mathematical Physics, 2013, 53(8), pp. 1387-1401.
- [4] V. I. Yudovich. Investigation of auto-oscillations of a continuous medium, occurring at loss of stability of a stationary mode // Journal of Applied Mathematics and Mechanics, 1972, 36(3), pp. 424-432.
- [5] A. M. Turing. The chemical basis of morphogenesis // Philosophical transactions of the Royal Society of London. Series B, 1952, 237(641), pp. 37-72.

## **Socially-oriented Entrepreneurial Intentions: Adapting Intention Model into Social Entrepreneurship**

**Kunttu Anna**

Lappeenranta University of Technology, LUT School of Business and Management

Entrepreneurship is a key factor in the economic and societal development. Similarly, entrepreneurship has been proposed to play a role in solving environmental and social issues, and as a response, different forms of entrepreneurship have emerged, such as social entrepreneurship. The aforementioned emergence has turned attention towards drivers of entrepreneurial intentions. Entrepreneurial intentions and opportunities both have an essential role in entrepreneurship process, but the prior literature has tended to include entrepreneurial opportunities implicitly in entrepreneurial intention models, although the need to examine entrepreneurship type -specific intentions has been raised. Moreover, there is only limited empirical evidence about intention formation in the field of social entrepreneurship. The research aims to answer the question of what are the drivers of socially-oriented entrepreneurial intentions. In particular, we aim at extending and adapting the existing intention models to include entrepreneurial opportunity and its dimensions by bringing them into the context of social entrepreneurship. Within this framework, the research focuses on the impact of work values and self-efficacy on the antecedents of entrepreneurial intentions, namely attitudes towards social entrepreneurship, perceived entrepreneurial desirability and feasibility, as well as the role of the latter three in formation of socially-oriented entrepreneurial intentions. By utilizing measurement scales from prior research and two self-developed measures, data was collected via anonymous questionnaires from 394 university students in Liechtenstein, Austria and Finland in the spring 2015.

The results show that attitude towards social entrepreneurship and perceived entrepreneurial desirability enhance socially-oriented entrepreneurial intentions. Moreover, attitudes towards social entrepreneurship are positively impacted by altruism, while extrinsic reward has negative impact on the attitudes towards social entrepreneurship. On the contrary, entrepreneurial desirability is driven by intrinsic and extrinsic reward. The results of the study imply that it could be a time to integrate entrepreneurial opportunities into intention models, and that we need to address the conflict between work values. The findings of the study have implications to entrepreneurship education.

## **Energy efficiency as a key competitive factor for Russian gold mining companies**

**Mineeva Anna**

Saint Petersburg Mining University

The research seeks to analyze the problem of energy efficiency of such energy intensive industries as mining under the context of the economic sustainable development. The United Nation Environment Programme (2015) determines sustainable resource management, cleaner production and resource efficiency as key prospects for sustainable consumption and production strategy, hence the issue of energy efficiency for mining company should be considered as a crucial strategic initiative. The academic interest to this issue is justified by the fact that mining industry can be regarded not only as a unique supplier of non-renewable natural resources but also as its significant consumer since mining industry is admitted to be one of the most energy intensive industry according to Energy Account report by Australia Bureau of Statistics (2011). Prindle (2010) revealed that energy costs within energy intensive industries have tripled since 2000. The aim of the research is to analyze whether implementing energy management system provides an opportunity for mining company to get significant competitive advantage by reducing energy costs and what barriers company can be facing on this way. The methodology is based on a single company case study of energy performance of Russian gold mining industry based on in-depth and group interviews as well as secondary data analysis. This analysis enables to understand how do energy efficiency contributes to gold mining company performance. Moreover, the awareness of existing barriers and challenges for improving energy efficiency gives an opportunity for business and academia to develop strategic approach of how to overcome it and improve competitiveness of Russian gold mining industry.

# Knowledge Management Problems in Paediatric and Paediatric Neurology Departments

## A case study based on the Grounded Theory

Nyerwanire Helvi<sup>1</sup>, Mustonen-Ollila Erja<sup>1</sup>, Valpas Antti<sup>2</sup>, Heikkonen Jukka<sup>3</sup>

<sup>1</sup>Lappeenranta University of Technology, Innovation and Software

<sup>2</sup>South Karelia Social and Health Care District, Department of Obstetrics and Gynaecology

<sup>3</sup>University of Turku, Department of Information Technology

Knowledge management means how information communication technology systems and intellectual human capital is applied to support knowledge creation, as well as in the capturing, organization, access, and use of an organization's intellectual capital. This paper investigates knowledge management problems in paediatric and paediatric neurology departments. The Grounded Theory approach is applied in data collection and analysis. The analysis revealed 8 thematic categories as follows: Patient, Physician, Patient Data, Nurse, ICT Systems, Patient Treatment, Diagnosis, and Learning and Experience. The categories are related to each other, and we found 13 higher levels of abstraction of statements. A conceptual framework of knowledge management categories, their relationships to each other, and propositions to our categories was developed by using the Grounded Theory approach. The relationships between the knowledge management categories enhance confidence in the validity of the categories and their relationships, and expand the emerging theory.

### References

- Alavi, M. and Leidner, D.E. (2001) 'Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues', *MIS Quarterly*, vol. 25, no. 1, pp. 107-136.
- Benbasat, I., Goldstein, D.K. and Mead, M. (1987) 'The Case Study Research Strategy in Studies of Information Systems', *MIS Quarterly*, vol. 11, no. 3, pp. 369-386.
- Brixey, J.J., Robinson, D.J., Turley, J.P. and Zhang, J. (2010) 'The roles of MDs and RNs as Initiators and Recipients of Interruptions in Workflow', *International Journal of Medical Informatics*, vol. 79, no. 6, pp. 109-115.
- Burgess, C., Cowie, L. and Gulliford, M. (2012) 'Patients' perceptions of error in long-term illness care: qualitative study', *Journal of Health Services Research and Policy*, vol. 17, no. 3, pp. 181-187.
- Chadi, N. (2009) 'Medical Leadership: Doctors at the Helm of Change', *McGill Journal of Medicine*, vol.12, no. 1, pp. 52-57.
- Creswell, J.W. (2007) *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, California: Sage Publications.
- Curley, S. P., Connelly, D. P. and Rich, E. C. (1990) 'Physicians' Use of Medical Knowledge Resources: Preliminary Theoretical Framework and Findings', *Medical Decision Making*, vol. 10, issue 4, pp. 231-241.
- de la Tassa, J., Martín, D., Fernández, E., Castro, M. and Sánchez, G. (2013) 'Survey on the Culture of Patient Safety Among Spanish Health Care Residents', *American Journal of Medical Quality*, pp. 1-9.
- Denzin, N.K. (Ed.). (1978) *The research act: A theoretical introduction to sociological methods*, New York: McGraw-Hill.
- Dias, L., Chabner, B. A., Lynch, T. J. and Penson, R. T. (2003) 'Breaking bad news: a patient's perspective', *The Oncologist*, vol. 8, pp. 587-596.

## **Detection of emerging technologies and scientific discoveries based on topic modeling approach: case of emerging cooling technologies in thermal management system**

**Samira Ranaei<sup>1</sup>, Mika Lohtander<sup>2</sup> and Tuomo Kässi<sup>3</sup>**

<sup>1</sup> Doctoral student, Lappeenranta University of Technology, LUT School of Business and Management

<sup>2</sup> Supervisor, Lappeenranta University of Technology, LUT School of Energy Systems

<sup>3</sup> Supervisor, Lappeenranta University of Technology, LUT School of Business and Management

Patent and publication databases as basic knowledge sources play a major role in identification of emerging technologies or new technological opportunities. However, detection of scientific discoveries or technological development from existing databases can be challenging in several respects. The document records related to emerging fields carry new terminologies and concepts that may not fit to the established categorization of existing patent or publication databases. Therefore, in this paper an automated clustering scheme has been applied on both patent and publication records. The generated clusters by Latent Dirichlet Allocation (LDA) algorithm represents the topical focus of practice and academia. Later, the cosine similarity measure has been utilized to illustrate the topical similarity between the clusters of patents and publications. The performance of applied method was evaluated by a case study in field of thermal management system and explored the emerging cooling technologies used in electronic devices. The patent data related to cooling technologies have been collected from Derwent Innovation Index (DII) and publication records from Web Of Science (WOS) between the year 1990 and 2013. The expected results would show distinct topics in industry and academia which signals the industrial or research opportunities. Or possible topical overlaps that may reflects the mutual interests between scientists and practitioners that could be developed further

## Solving technical problems in construction engineering

**Renev Ivan**

Lappeenranta University of Technology, LUT School of Business and Management

**Cechurin Leonid**

Professor, Lappeenranta University of Technology, LUT School of Business and Management

There are two possible ways to overcome ongoing issues in construction: optimization and invention. In order to obtain better solutions, construction engineers have to find unique ideas which help solving technical problems. A good invention in any technical field means solving contradiction. One of the strongest techniques helping engineers to invent is the Theory of inventive problem solving (TRIZ) which is the powerful set of tools for new ideas generation and inventive thinking. The method is quite universal and finds its application in different fields. During last decade, there were a number of attempts to apply TRIZ to even nontechnical areas such as business, service, art, etc.

However, the classic TRIZ was created to solve general technical issues and, therefore, does not provide specific solutions to specific problems. This is one of the reasons why researches work on adaptation of classic TRIZ to specific fields (such as process engineering, electrical storage systems and many others). During the literature review on application of TRIZ in construction it was found out that there are no specially adapted TRIZ tools to solve issues in construction and not every classic TRIZ tool is sufficiently applicable to civil engineering.

The authors suggest to adapt one of the most used classic TRIZ tool the Contradiction Matrix to generate new solutions in construction. The basis of the research is a search for inventive solutions in the construction field (either patented or not). Each of those solutions is a subject to be analyzed in detail regarding the used inventive principles and the technical contradictions solved. After aggregating all identified combinations into a Construction specific contradiction matrix, this matrix will be compared to the classic TRIZ contradiction matrix in order to evaluate the success rate of the given principles in these matrices for solving specific problems. The main result is a ranking of the most used inventive principles in construction engineering.

### References

- [1] Y. Salamatov, TRIZ: the right solution at the right time: a guide to innovative problem solving, 2nd ed. 2005.
- [2] G. S. Altshuller, L. Shulyak, and S. Rodman, 40 Principles: TRIZ Keys to Technical Innovation. Technical Innovation Center, INC., 1997.
- [3] Z. Ding and J. Ma, "An exploration study of construction innovation principles: Comparative analysis of construction scaffold and template patents," in Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate, 2014, pp. 843–850.
- [4] Y. Mohamed, "A Framework for systematic improvement of construction systems," University of Alberta, 2002.
- [5] S. Mohamed, Y., AbouRizk, "Triz for structuring construction innovation," in Canadian Society for Civil Engineering - 31st Annual Conference: 2003 Building our Civilization, 2003, pp. 241–249.
- [6] R. C. Shao-tsai Cheng, Wen-der Yu, Chih-ming Wu, "Analysis of construction inventive patents based on TRIZ," in Proceedings of the International Symposium on Automation and Robotics in Construction and Mining, 2009, pp. 1–6.
- [7] K. C. M. C. Altun, "Applicability of TRIZ to In-Situ Construction Techniques," in International Proceedings of Economics Development & Research, 2011, p. 17.
- [8] P. C. Lin, Y.H. Lee, "Applying TRIZ to the construction industry," in 10th International Conference on Civil, Structural and Environmental Engineering Computing, Civil-Comp 2005, 2005, p. 12.
- [9] H. Cui, "Exploring Conflict Resolution Methods for Construction Projects: A TRIZ Theory Perspective," in ICCREM 2014, 2014, pp. 791–796.
- [10] S.-M. Chang, P.-L., Yu, W.-D., Cheng, S.-T., Lee, "Exploring underlying patterns of emergent problem-solving in construction with triz," in 27th International Symposium on Automation and Robotics in Construction, ISARC 2010, 2010, pp. 607–616

## Role of business incubators on start-ups innovativeness and innovation output

Teplov Roman

Lappeenranta University of Technology, LUT School of Business and Management

*Keywords: Business Incubators; Innovation; Organizational innovativeness; Commercialization; Start-up*

Successful innovation is considered to be one of most essential sources for companies' competitiveness (Tushman and O'Reily, 1996). Start-ups are characterized by high degree of organizational innovativeness, which should have a positive relationship with innovation process output, and consequently contribute to company success (Ruvio et al., 2014). On the other hand, small enterprises are struggling from numerous limitations, which make the development of market-successful innovation increasingly important, but also a difficult task (Partanen et al., 2014).

Business incubators (BI) are aimed to provide support for high-tech start-ups (Löfsten & Lindelöf 2001). Some previous studies reported higher survival rates and better performance of firm-incubatees (Şehitoğlu and Özdemir, 2013). At the same time, common notion of many incubator residents is that they could have established a company even without incubator support (Hackett and Dills, 2004). The impact provided by BIs remains therefore controversial (Bruneel et al., 2012; Schwarz, 2013). Therefore, the main aim of the study is to examine the moderating effect of BIs services on the company's economic and innovation output.

The main data source for the study is the online survey among companies-residents of BIs in Finland and Russia. The measures applied in the questionnaire provide basis for the statistical analysis. At the same time, open questions allow us to gather additional insight on the studied problems. Additionally we imply comments and thought collected from the experts during the questionnaire building and piloting.

Our research expands works by Abduh et al., 2007, Grimaldi and Grandi, 2005 and Scillitoe and Chakrabarti, 2010 and explains how different BIs services facilitate innovation process within entrepreneurial firms. The main finding expected to be the understanding of services adding the most value to innovation process of firm-incubatees. We explore the relationship between organizational innovativeness and final product/services innovativeness. The Business Incubator services are considered as a moderator in such relationship.

### Essential references

Abduh, M., D'Souza, C., Quazi, A. and Burley, H.T. (2007) Investigating and classifying clients' satisfaction with business incubator services. *Managing Service Quality*, Vol.17, No.1, pp.74-91

Garcia, R. & Calantone, R. (2002) A critical look at technological innovation typology and innovativeness terminology: a literature review. *The Journal of Product Innovation Management*, 19, pp. 110-132

Grimaldi, R. & Grandi, A. (2005) Business incubators and new venture creation: an assessment of incubating models. *Technovation*, 25, pp. 111-121

Ruvio, A., Shoham, A., Vigoda-Gadot, E. and Schwabsky, N. (2014) Organizational Innovativeness: Construct Development and Cross-Cultural Validation. *Journal of Product Innovation Management*, Vol. 31, Issue 5, pp. 1004-1022

Scillitoe, J.L. & Chakrabarti, A.K. (2010) The role of incubator interactions in assisting new ventures. *Technovation* 30, pp. 155-167

## **Numerical Study on the Loss Generation Mechanisms in the Downscaled Centrifugal Compressors**

**Tiainen Jonna, Jaatinen-Värri Ahti, Grönman Aki, Backman Jari**

Lappeenranta University of Technology, LUT School of Energy Systems, Laboratory of Fluid Dynamics

Low Reynolds number reduces efficiency in micro-scale centrifugal compressor. In the past, the efficiency deterioration has been estimated by correction equations. All the correction equations published in the literature aim to account Reynolds number effect into compressor efficiency, but there are differences between the formulas. In this paper, the effect of the Reynolds number on the centrifugal compressor flow field and performance is studied numerically by downscaling two test compressors. The test compressors are downscaled in the scaling factor range from 0.05 to 0.9 resulting in the chord Reynolds number to vary from 80 000 to 1 700 000. The numerical simulations are performed by the commercial Computational Fluid Dynamics software and turbulence is modelled by the widely accepted SST  $k-\omega$  model. The results are validated against experimental data and the reasons for the performance deterioration are studied in detail. The results indicate that the shear stress near the shroud induced by high rotational speed is the most significant loss generation mechanism at low Reynolds numbers. However, the results also indicate that the two-equation model used in this study might fail to predict the losses in micro-scale centrifugal compressors well below the critical chord Reynolds number (200 000).

## Social mission in social enterprises' growth modes

Tykkyläinen Salla

Lappeenranta University of Technology, LUT School of Business and Management

Social enterprises are expected to solve some of the most burning issues of our time; high hopes are placed on their growth. However, the research field is fragmented and there is a lack of accumulated knowledge on the phenomenon. The purpose of this study is first, to pinpoint the distinctive characteristics of social enterprise growth, and second, to deepen our understanding on how social mission is being operationalized during the growth process. The first round of data collection resulted thematic interviews of seven, growth oriented Finnish social enterprises. The data was analyzed with the help of a tentative framework based on literature reviews of studies comparing social and commercial enterprises and social enterprise growth research. The preliminary findings suggest social enterprises pursue growth for both social and financial reasons, but at the same time, their social mission sets limits for plausible growth strategies and models. Notwithstanding their pronounced purpose to create beneficiary value and need to prove their social impact, social goals and anticipated outcomes of growth are poorly defined. As a result, it is proposed that social enterprise growth modes should be evaluated also from stakeholders' and beneficiaries' point of view to gain more comprehensive insight on the growth process and its outcomes. The main contribution of this study is the steps taken towards an analytic framework suitable for investigating growth in social enterprise context. The analytical focus should be shifted on business activities, often run in partnerships, through which the social impact is expected to be increased.

### References:

- Austin, J., Stevenson, H. & Wei-Skillern, J. (2006). *Social and commercial entrepreneurship: same, different, or both?* Entrepreneurship: theory & practice, 30 (1), 1–22
- Davidsson, P. & Wiklund, J. (2000). Conceptual and Empirical Challenges in the Study of Firm Growth. In D.L. Sexton & H. Landström (Eds.), *The Blackwell Handbook of Entrepreneurship* (pp. 26-44). Blackwell Publishing
- Lumpkin, G.T., Moss, T.W., Gras, D.M., Kato, S. & Amezcua, A.S. (2013). *Entrepreneurial processes in social contexts: how are they different, if at all?* Small Business Economics 40, 761-783.
- Lyon, F. & Fernandez, H. (2012). Strategies for scaling up social enterprise: lessons from early years providers. *Social Enterprise Journal*, 8 (1), 63-77
- Westley, F. & Antadze, N. (2009). *Making a Difference. Strategies for Scaling Social Innovation for Greater Impact*. The Innovation Journal: The Public Sector Innovation Journal, 15(2).

## Modeling of solvent extraction equilibrium using D-optimal design of experiments

Vasilyev Fedor

Lappeenranta University of Technology, LUT School of Engineering Science, Laboratory of Separation Technology

Modeling of chemical processes is a powerful tool, which allows by process simulation to gain a better understanding of a process and to choose its most profitable operating conditions. Prediction power of a model depends on quality of the collected experimental data used for model fitting and validation. A design of experiments (DoE) used for data collection has to maximize an information on the process and minimize an expenditure of time and chemicals. The common approach, to use factorial statistical DoE to choose the experimental conditions and response surface methodology (RSM) to model and analyze the collected data, functions best, when only little is known on a process under an investigation. However, for many chemical processes, an underlying mechanism can be anticipated and an appropriate mechanistic model can be suggested prior to the experimental studies. Therefore, experimental data are required to validate the model and to fit model parameters. In this case, model-based D-optimal design of experiments can be constructed to contain minimum data points, on the one hand, and to provide substantial information on process variations, on the other hand.

Within hydrometallurgical circuit of pure copper recovery, solvent extraction (SX) is responsible for purification and concentration of a pregnant leach solution to generate an electrolyte for electrowinning of high quality copper cathodes. Although, the process is stable and efficient, it is thoroughly studied only in the range of low aqueous feed concentrations. However, recent advances in leaching technology give an opportunity to feed SX with aqueous phase containing up to 43 g/L of copper. Therefore, reliable data on equilibrium of the process in industrially relevant conditions and a predictive model of the process are required.

In this study, model-based D-optimal DoE is used to choose experimental conditions for data collection, whereas nonlinear least squares regression is used to fit model parameters against experimental data. Methodology for an efficient collection of experimental data on chemical processes has been implemented and tested on the case of copper solvent extraction. The collected data and the developed model can be used for future R&D of copper solvent extraction plants.

### References

- Franceschini G, Macchietto S. Model-based design of experiments for parameter precision: State of the art. *Chemical Engineering Science* 2008 10; 63(19):4846-72.
- Ocaña N, Alguacil FJ. Solvent extraction of iron(III) by MOC-55 TD: experimental equilibrium study and demonstration of lack of influence on copper(II) extraction from sulphate solutions. *Hydrometallurgy* 1998 4; 48(2):239-49.
- Schlesinger ME, King MJ, Sole KC, Davenport WG. Chapter 15 - Hydrometallurgical Copper Extraction: Introduction and Leaching. In: Davenport, Mark E. Schlesinger Matthew J. King Kathryn C. Sole William G., editor. *Extractive Metallurgy of Copper (Fifth Edition)* Oxford: Elsevier; 2011. p. 281-322.
- Schlesinger ME, King MJ, Sole KC, Davenport WG. Chapter 16 - Solvent Extraction. In: Davenport, Mark E. Schlesinger Matthew J. King Kathryn C. Sole William G., editor. *Extractive Metallurgy of Copper (Fifth Edition)* Oxford: Elsevier; 2011. p. 323-347.
- Srivastava V, Sharma YC, Sillanpää M. Response surface methodological approach for the optimization of adsorption process in the removal of Cr(VI) ions by Cu<sub>2</sub>(OH)<sub>2</sub>CO<sub>3</sub> nanoparticles. *Appl. Surf. Sci.* 2015 1/30;326:257-70.

## Segmentation of Partially Overlapping Nanoparticles Using Concave Points

Zafari Sahar, Eerola Tuomas, Sampo Jouni, Kälviäinen Heikki, Haario Heikki  
Lappeenranta University of Technology, Mathematics and MVPR Laboratory

This paper presents a novel method for the segmentation of partially overlapping nanoparticles with a convex shape in silhouette images. The proposed method involves two main steps: contour evidence extraction and contour estimation. Contour evidence extraction starts with contour segmentation where contour segments are recovered from a binarized image by detecting concave points. After this, contour segments which belong to the same object are grouped by utilizing properties of fitted ellipses. Finally, the contour estimation is implemented through a non-linear ellipse fitting problem in which partially observed objects are modeled in the form of ellipse-shape objects. The experiments on a dataset consisting of nanoparticles demonstrate that the proposed method outperforms two current state-of-art approaches, Nanoparticles Segmentation (NPA) [1] and Concave-point Extraction and Contour Segmentation (CECS) [2], in overlapping nanoparticles segmentation with higher detection rate and segmentation accuracy. The method relies only on edge information and can be applied to any segmentation problems where the objects are partially overlapping and have an approximately elliptical shape, such as cell segmentation.

### Main References

1. Park, C., Huang, J.Z., Ji, J.X., Ding, Y.: Segmentation, inference and classification of partially overlapping nanoparticles. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 35 (2013) 669–681
2. Zhang, W.H., Jiang, X., Liu, Y.M.: A method for recognizing overlapping elliptical bubbles in bubble image. *Pattern Recognition Letters* 33 (2012) 1543 – 1548
3. Kothari, S., Chaudry, Q., Wang, M.: Automated cell counting and cluster segmentation using concavity detection and ellipse fitting techniques. In: *IEEE International Symposium on Biomedical Imaging*. (2009) 795–798
4. Bai, X., Sun, C., Zhou, F.: Splitting touching cells based on concave points and ellipse fitting. *Pattern Recognition* 42 (2009) 2434 – 2446