

MASTER OF SCIENCE IN ENGINEERING
2019/20 YEARBOOK





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Foreword

Liebe Leserin, lieber Leser

Im Rahmen Ihres Masterstudiums MSc in Engineering an der Hochschule Luzern haben Sie die im Bachelorstudium erworbenen Kompetenzen, um zusätzliche Fach-, Methoden- und Sozialkompetenzen erweitert. Die vielen Wahlmöglichkeiten, die unser innovatives Masterstudium bietet, haben Sie gezielt und erfolgreich genutzt. Einige von Ihnen haben wichtige Erfahrungen in einer internationalen Woche oder einem Auslandssemester gesammelt. Nun sind Sie am Ziel angekommen und erhalten das Master-Diplom. Im Namen aller Dozierenden und Mitarbeitenden gratuliere ich Ihnen ganz herzlich zum erfolgreichen Masterabschluss. Für Ihre berufliche und persönliche Zukunft wünschen wir Ihnen alles Gute.

Allen beteiligten Personen danke ich für ihren grossen Einsatz im Studienjahr 2019/20 im MSE. Ein ganz besonderer Dank gilt Herrn Prof. Dr. Jörg Worlitschek, der in den letzten Jahren mit einem enormen persönlichen Einsatz und viel Leidenschaft den MSE zu einem national und international anerkannten Masterstudiengang gemacht hat. Einen wichtigen Beitrag dazu haben zudem Stephanie Snoek und Daniela Bucheli geleistet. Auch Ihnen möchte ich herzlich danken.

Zum Schluss noch eine Bitte: Bleiben Sie mit uns in Kontakt. Gerne arbeiten wir auch in Zukunft mit Ihnen zusammen, im Rahmen von Forschungsprojekten und als Auftraggeber von einem Vertiefungsprojekt oder einer Master Thesis.

Dear reader

In your MSc in Engineering studies at the Lucerne University of Applied Sciences and Arts you have been able to expand the skills acquired in your BSc program by adding a range of specialist, methodological and social competencies. You have used the selection options offered by our innovative MSc program purposefully and to your advantage. Some of you have also gained valuable experience during an international week or a semester abroad. Now, you have crossed the finishing line: you will receive your Master's certificate. On behalf of the School's faculty and employees, I would like to convey our heartiest congratulations on your graduation. We wish you all the best for your professional and personal future.

I would like to thank everybody involved for their great work during the study year 19/20. Special thanks go to Professor Dr Jörg Worlitschek, who, through exemplary personal commitment and with great passion, has made the MSE a nationally and internationally renowned Master's program. The contributions of Stephanie Snoek and Daniela Bucheli were also instrumental. Thank you very much for your strong support.

Last, but not least: Please stay in touch with us. We would very much like to continue to work with you in the future, be it in the framework of a research project or as a client for a specialization project or a Master's thesis.



Prof. Dr. Sascha Götte

Head of Studies

Master of Science in Engineering

Accompanying Word

Liebe MSE Absolventen, Studierende und Interessenten

Gratulation an unsere Absolventen! Wenn man selbst die eigene Masterarbeit betrachtet, wirkt sie plötzlich so normal und selbstverständlich. Ganz anders für Aussenstehende - und auch selbst, wäre man wohl erstaunt gewesen, hätte man die eigenen Resultate vor dem Studium bereits betrachten können! Diese wunderbare Entwicklung in Tiefe, Stil und analytischem Denken geschieht flussend und wir nehmen sie selbst daher oft fast nicht wahr. Mit dem Abschluss des Studiums und mit dem Blick zurück wird die Entwicklung plötzlich sichtbar. In diesem Jahrbuch präsentieren wir daher stolz all die Masterarbeiten und weiteren Aktivitäten, die das Resultat eines langen Weges wunderbar repräsentieren.

Der Studiengang Master of Science in Engineering (MSE) tritt mit dem Studienjahr 2020/2021 in eine neue Phase ein. Über den Zeitraum der letzten drei Jahre wurde mit mehr als 500 involvierten Mitarbeitenden, Dozenten und Professoren schweizweit an neuen Ausrichtungen und Modulen gearbeitet. Entstanden sind insgesamt 13 zukunftsweisende Ausrichtungen (Profile) des MSE, über 50 Module wurden neu entwickelt oder deutlich überarbeitet. Wir bedanken uns bei allen Mitwirkenden für dieses Engagement, das auch unseren zukünftigen Studierenden eine wesentliche Entwicklung innerhalb ihres Studiums garantiert.

Viel Erfolg und Engagement im Wirken für das Gute.

Dear MSE graduates, students and interested parties,

Congratulations to our graduates! Looking at one's own Master's thesis, its completion suddenly seems so normal and self-evident. Of course, this does not apply to outsiders and even the authors themselves would likely have been surprised about the scope and quality of their own work had they seen it before starting their degree programs. This wondrous journey toward depth, style and analytical thinking happens in incremental steps, which is why we are often unaware of it even happening. However, to those graduating and looking back, it suddenly becomes evident. In this yearbook, we proudly present this year's Master's theses and additional activities that beautifully illustrate the results of this long journey.

The Master of Science in Engineering (MSE) program will open a new chapter in the 2020/2021 academic year. Over the course of three years, more than 500 employees, lecturers and professors involved across the country worked toward the creation of new orientations and modules. Their work yielded a total of 13 future-oriented MSE profiles and more than 50 modules, both new and reworked. We would like to thank all contributors for their commitment, which opens the path toward new developments within the curriculum for our students.

I wish you much success in your work for the greater good.



Prof. Dr. Jörg Worlitschek

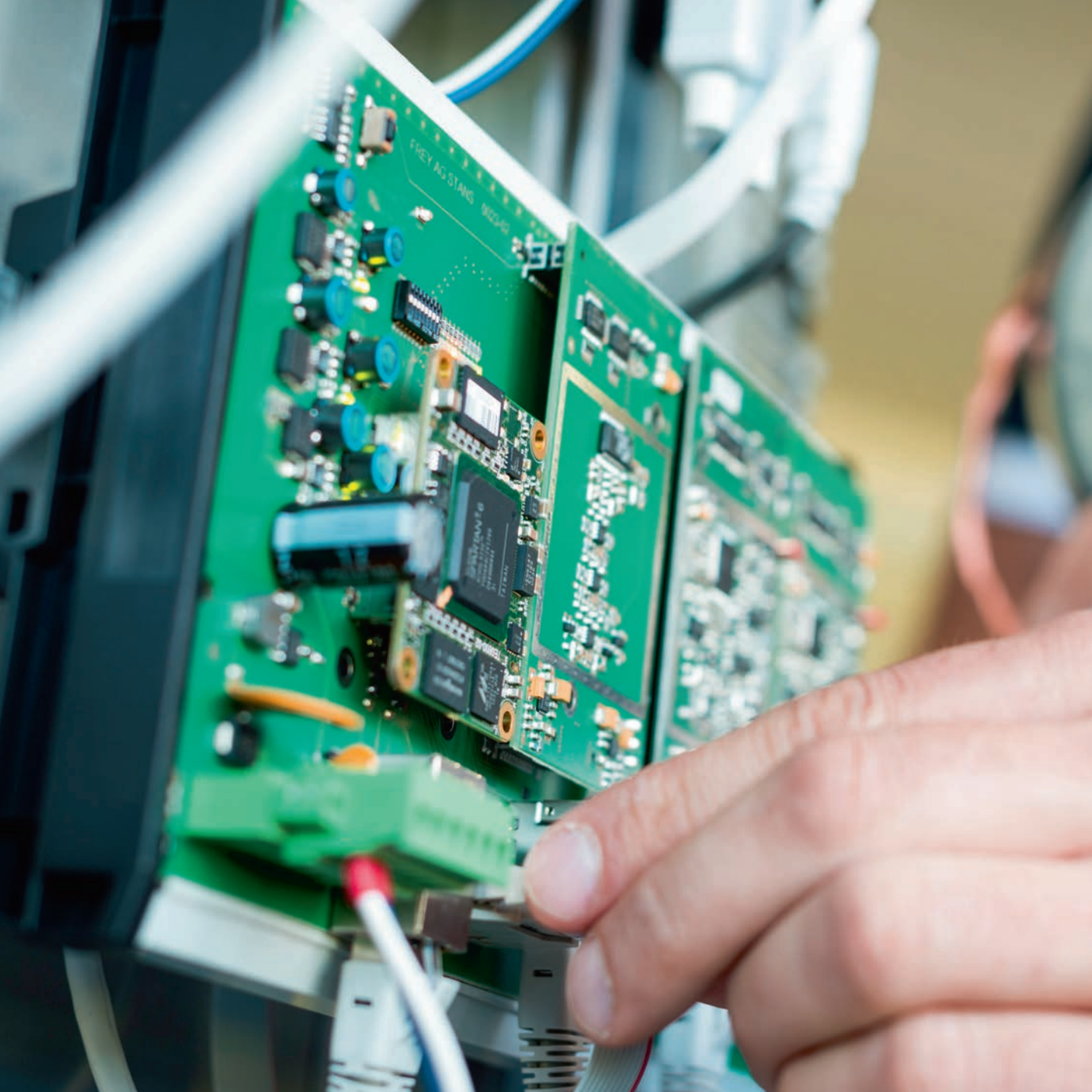
Co-Head of the CC for Thermal Energy

Storage

A word of advice for new MSE students?

Conducting the study in the part-time mode allows you to apply the newly acquired knowledge directly in your everyday work.

*Simon René Burri
Business Engineering and Production*



The new MSE

The success story of the MSE will see a new chapter in the fall of 2020. The Lucerne School of Engineering and Architecture will reshape its previous five disciplines into eleven new profiles. It allows us to include new and future-oriented topics and to offer our students a greater range of modules to choose from. The appeal of the Master's program continues to grow.

The eleven profiles

Building Technologies: equips students with the skills to combine sustainable construction and cutting-edge technologies.

Business Engineering: combines knowledge of engineering, business and user-centered design.

Civil Engineering: combines sciences and engineering. Focal points include bridge and structural engineering, tunnel, dam, road, railway, sustainable and energy-efficient construction.

Computer Science: a unique opportunity to combine research-related and economic fields of interest.

Data Science: equips students with expert skills and knowledge of data capture, storage and processing.

Electrical Engineering: problem analysis and specification of electrical and electronic solutions.

Energy and Environment: becoming an expert in energy technology with a focus on renewable energies. Developing effective and resource-efficient processes.

Mechanical Engineering: enhancement of technical skills through participation in challenging projects in applied research and development.

Mechatronics and Automation: combines autonomous mobile systems, industrial automation and mechatronic systems such as grippers, drones and mobile robots.

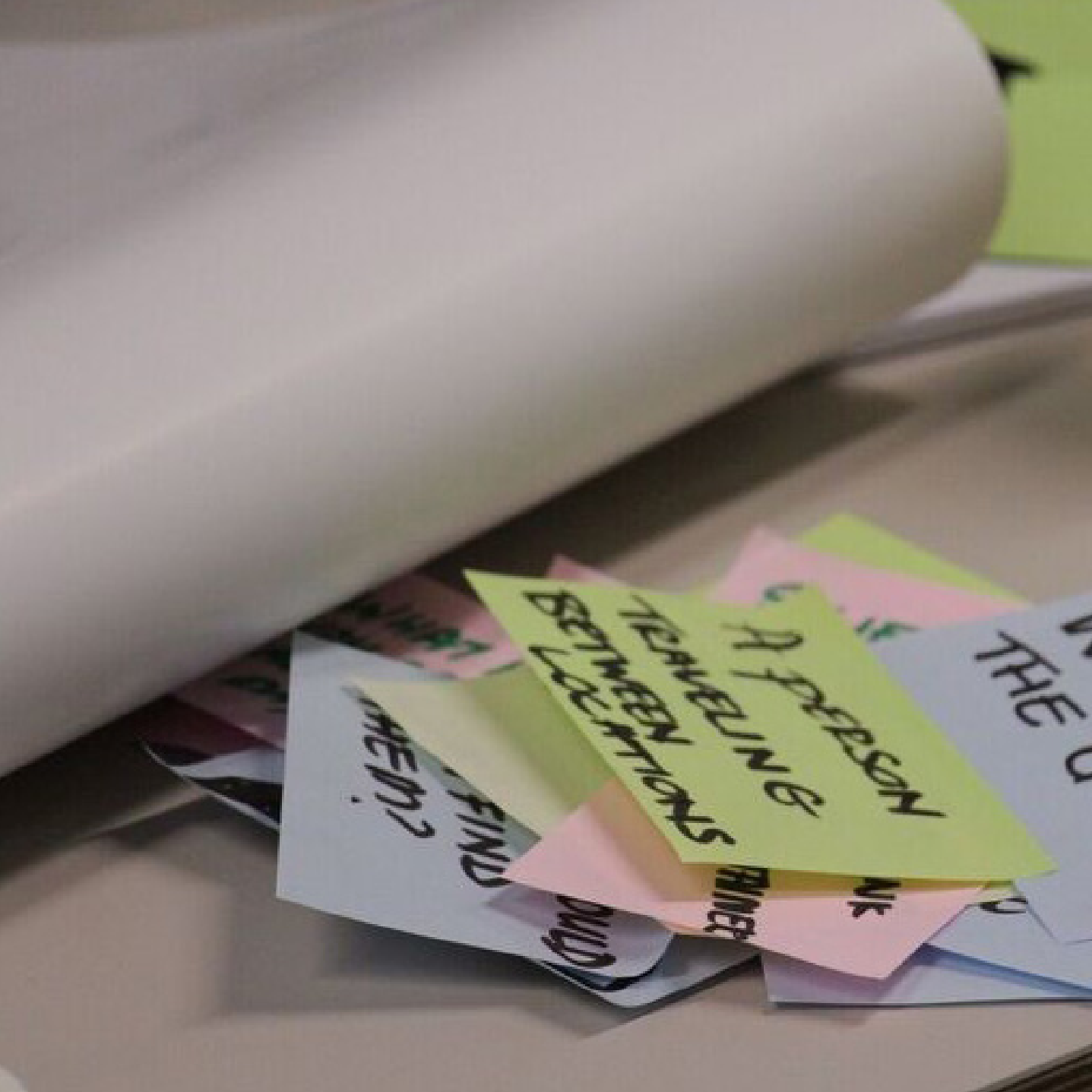
Medical Engineering: conducting analyses across the breadth of a tightly regulated market. Focal points include biomedical engineering and digital health as well as medical diagnostics and devices.

Photonics: an interdisciplinary science concerned with the generation, control, detection and interaction of light.

Insights from a student from abroad

My name is Carlos Cuadros, I am 29 years old and come from Arequipa, Peru. Having finished my degree in Industrial Engineering, my half Swiss and half Peruvian fiancée and I decided to come to Switzerland to find a better life opportunity. After finding interesting master programs I decided to choose the Lucerne University of Applied Sciences and Arts because of the attractive program they offered. Having a personal advisor and being able to choose the modules I was interested in and the large international network really made it quite easy. Now, after finishing the master program I think I made a great decision not only because of the studies but also because of the high level of professionalism from the staff of the HSLU. Special thanks to Sascha Götte and Clemente Minonne, I had a great time and now I am looking forward to applying it in the real world.





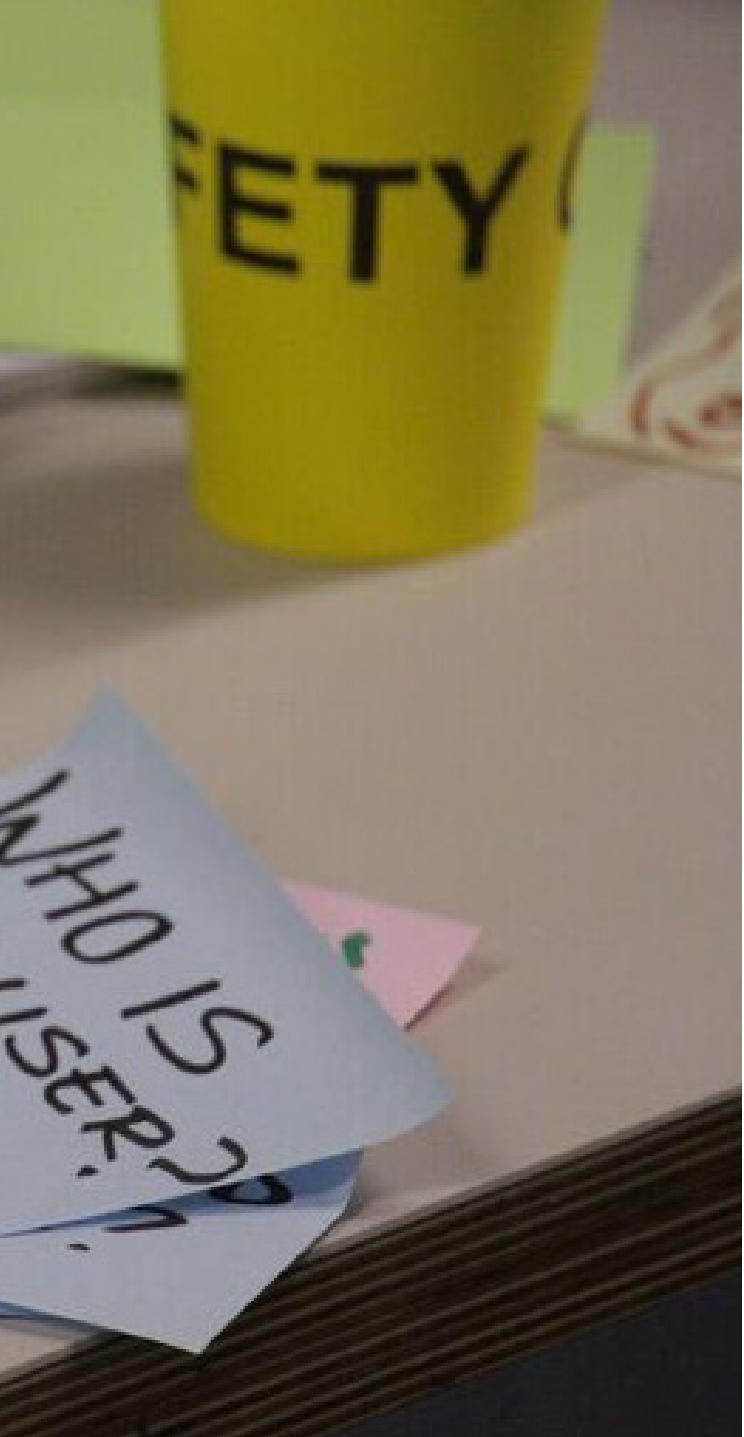
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Business Engineering and Production



Foreword

Liebe Leserin, lieber Leser

Das MSE-Fachgebiet Business Engineering and Production (BEP) entwickelt sich weiterhin sehr erfreulich. Neben den sehr guten Absolventinnen und Absolventen des Bachelorstudiums an der Hochschule Luzern – Technik & Architektur treten zunehmend auch Studierende von anderen Hochschulen aus der Schweiz und aus dem Ausland in unser MSE-Fachgebiet ein.

Auf den folgenden Seiten geben wir Ihnen einen Überblick über die im Wirtschaftsingenieurwesen engagierten MSE-Advisoren. Die vorgestellten Masterthesen unserer Absolventinnen und Absolventen zeigen die grosse Bandbreite der bearbeiteten Forschungsthemen auf. Den auftraggebenden Unternehmen, die in den verschiedensten Branchen tätig sind, sowie unseren externen Expertinnen und Experten möchten wir vielmals für die sehr gute Zusammenarbeit und Unterstützung danken.

Einige unserer Industriepartner sind im Rahmen von Exkursionen von den Studierenden besucht worden, z.B. das SBB-Werk in Olten und ABB Turbosystems in Baden im Oktober 2019. Die im Frühlingsemester 2020 geplanten Firmenbesuche konnten wegen der Coronapandemie leider nicht stattfinden und mussten verschoben werden. Unseren Absolventinnen und Absolventen wünschen wir für die berufliche und private Zukunft alles Gute.

Dear reader

MSE specialisation Business Engineering and Production is performing very well in terms of quality and quantity, and demand for the program is continuously growing. In addition to the very good graduates of the Bachelor's program at the Lucerne University of Applied Sciences and Arts - Technology & Architecture, students from other universities in Switzerland and abroad are increasingly enrolling in our Master's program. This diversity is inspiring and promotes creativity.

On the following pages we will give you an overview of the advisors engaged in the field of Business Engineering and Production. The master theses presented by our graduates show the wide range of research topics in our field. We would like to take the opportunity to thank our external partners, which are active in very different industries, for the excellent cooperation and support.

Some of our industrial partners have been visited by our students during excursions, e.g. the SBB-facilities at Olten or ABB Turbosystems at Baden in October 2019. Unfortunately, the planned excursions for the spring semester 2020 had to be cancelled due to the corona pandemic and might take place in the following semesters.

We wish our graduates all the best for their professional and personal future.



Prof. Dr. Sascha Götte

Business Engineering and Production

BEP Advisors



Prof. Dr. Ulrich Dersch

Focus: Aircraft data and sensor networks, smart grid data networks, power line communication, computer networks and protocols, product innovation, business planning & development



Dr. Silvio Di Nardo

Focus: Product development, user needs, design thinking, regulatory affairs, product risk management, usability



Prof. Dr. Sascha Götte

Focus: Marketing management, strategic management, international management



Prof. Dr. Christoph Imboden

Focus: Technology management, innovation management, product management, market analysis, business model development



Prof. Dr. Björn Jensen

Focus: Embedded systems, distributed embedded systems, robotics, 3D laser measurement, autonomous systems



Prof. Dr. Michael Kellerhals

Focus: Open innovation, alliance management, corporate venturing, cross-industry collaboration, product development



Prof. Dr. Patrick Link

Focus: Entrepreneurship, lean start-up, design thinking, agile methods, product and service management, collaboration management



Fabio Mercandetti

Focus: Operations management, corporate development, collaborations, start-ups

BEP Advisors



Dr. Clemente Minonne

Focus: Digital business transformation, knowledge management, business process innovation, analysis of complex business processes



Prof. Dr. Andrew Paice

Focus: Smart homes, automation systems, control engineering, system theory, modelling and simulation, product development



Prof. Dr. Sabine Sulzer Worlitschek

Focus: Business model innovation in the energy industry, holistic assessments of energy systems, innovation management, B2B marketing, energy efficiency measures in industry



Prof. Dr. Claas Wagner

Focus: System dynamics, life cycle (cost) analysis, energy efficiency measures, emission accounting, CSR strategies, process analytical technologies



Prof. Dr. Shaun West

Focus: Service design, industry 4.0 for services, customer experience, service and product innovation, B2B marketing, service operations

Fall 19 - Specialisation Projects 1 & 2

Service-dominant design thinking

Linus Bächler

Prof. Dr. Shaun West.

„Memories“ Smart Jewelry, development of a business model and associated product attributes

Manuel Umberto Battistessa

Dr. Clemente Minonne

Creation of a new warehouse type supermarket for an assembly line: a case study at Pietro Fiorentini S.p.A.

Matteo Bettiga

Dr. Clemente Minonne

Kollaborative Industrieplattformen: Eine Fallstudie im Schweizer Industriekontext

Marcel Bütikofer

Dr. Clemente Minonne

Development of a model to define the digital maturity level of a machine

Carlos A. C. Camacho

Dr. Clemente Minonne

Medela Enteral Feeding - Potential Analysis for Market Expansion Outside US

Rachel Cummings

Prof. Dr. Sascha Götte

Potenzial von technologischen Funktionalitäten für Sales-Prozesse bei myclimate: eine Fallstudienanalyse

Luca Grossmann

Prof. Dr. Patrick Link

Fall 19 - Specialisation Projects 1 & 2

**Vom Handelskonzern zum Entwicklungskonzern:
Produkteportfolio während strukturellem Wandel**

Manuel Güdel

Prof. Dr. Patrick Link

Optimierung von Planungsprozessen und Know-how sichern

Oliver Dennis Hausherr

Peter Radcliffe-Lunn

Prof. Dr. Sascha Götte

**Order picking in e-commerce – optimization of the flow
of goods by using a dashboard**

Marcel Leuthold

Fabio Mercandetti

**Evaluation der Wirtschaftlichkeit und Machbarkeit der
Einbindung möglicher Partnerwerke in das Stromnetz der SBB**

Adrian Pasquinelli

Prof. Dr. Christoph Imboden

Marktanalyse einer Peer-to-Peer Micro-Job Plattform

Goran Pavlovic

Fabio Mercandetti

Integration of SME truck carriers into a blockchain network

Raphael Tholl

Prof. Dr. Björn Jensen

Spring 20 - Specialisation Projects 1 & 2

Servitization in der Schweiz: Eine empirische Untersuchung

Marcel Bütikofer
Dr. Clemente Minonne

Improvement of Schindler's Product Change Management

Sebastian Egger
Prof. Dr. Shaun West

Plastic Packaging Industry and Circular Economy: Transition, measures and consequences.

Stephanie Gallegos
Prof. Dr. Christine Grimm

Transformation im Entwicklungsprozess: von einer kundenspezifischen zu einer marktspezifischen Ausrichtung

Manuel Güdel
Prof. Dr. Patrick Link

Optimierung der Lagerhaltung und Arbeitsplatzgestaltung

Oliver Dennis Hausherr
Peter Radcliffe-Lunn
Prof. Dr. Sascha Götte

Market Research: Security Robotics for a medical device manufacturer

Christophe Kurkdjian
Prof. Dr. Björn Jensen

The Minimum Viable Corporate Identity Guide for Startups

Simon Lieberherr
Prof. Dr. Patrick Link

How logistics service providers can develop value added services for firms

Shreya Mehta
Prof. Dr. Shaun West

Spring 20 - Specialisation Projects 1 & 2

Development of an agile technology management
framework for Roche Diagnostics

Florian Merk
Prof. Dr. Patrick Link

Analysis of Circular Economy Business Case

Maria-Eleni Papaefthymiou
Prof. Dr. Claas Wagner

Untersuchung möglicher Einsatzgebiete mobiler
Anlagenteile zur Energiebereitstellung am Beispiel der SBB

Adrian Pasquinelli
Prof. Dr. Christoph Imboden

Peer-to-Peer Micro-Job Plattform

Goran Pavlovic
Fabio Mercandetti

IIT Virtual Smart Lab Ideen, Möglichkeiten, Wege

Nicolas Rüegg
Dr. Clemente Minonne

Transformation zu kundenzentriertem Businessmodell in
traditionellem Unternehmen am Beispiel des
Geschäftsfeldes Elektromobilität

Markus-Antonio Sager
Prof. Dr. Patrick Link

Transformation method to Business Services Model in
manufacturing companies

Luis Ernesto Sanchez Perez
Dr. Clemente Minonne

XR technology – Evolvement for Enterprises and Business Models

Theodora Ingrid Simeonidis
Prof. Dr. Sascha Götte

A word of advice for new MSE students?

**Choose your advisor with care because you will
spend a lot of time with him.**

*David Huwyler
Industrial Technologies*

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Fall 19 / Spring 20 - Master Thesis

Management tools for effective innovation planning



Patrick Bauen

Advisor: Dr. Silvio Di Nardo

In an increasingly complex environment, a company is particularly challenged to establish tools for effective innovation planning. The derivation of such management tools is described in the present master thesis. The concept follows a systemic approach and combines information from different business areas in a context-rich view. As a result of the master thesis, an extended management tool set was created, consisting of the development matrix, business-process-stakeholder-pyramid and portfolio map. The matrix summarizes the relevant information on the five planning levels: market, product, function, technology, and knowledge. The pyramid shows the connection across different business processes using the same planning levels as the matrix. The portfolio map is used to ensure a balance between short-term and long-term goals and to depict current and future business. In combination these tools create a holistic picture of R&D and increase the effectivity of innovation planning.

Development of a service concept for large projects based on the example of Munich Airport

In this master thesis a service concept was developed for large-scale projects. The starting point of the thesis was a missing standard of the client for the handling of major projects. The developed concept is modular and allows a global approach with the consideration of local needs. In addition, a continuous improvement process is used to constantly improve the quality. After the concept was developed, the system was tested and verified at Munich Airport.



Markus Besendorfer

Advisor: Prof. Dr. Sascha Götte

Management of ammonia emissions as a strategic success position for a supplier of animal housing technology in Switzerland



Michael Birrer

Advisor: Dr. Silvio Di Nardo

Agriculture is the main source of ammonia emissions in Switzerland. Ammonia damages sensitive ecosystems, forms particulate matter and has an influence on the emission of greenhouse gases. The Federal Council has set the goal of reducing ammonia emissions from agricultural units in Switzerland by 40 % compared to 2005. Ammonia emissions from farms can be influenced by measures in animal husbandry, feeding and fertiliser application and use.

It was investigated how a supplier of animal housing technology can open up new business opportunities through new regulations for ammonia emissions. Therefore, company's environment and ecosystem, its conditions and its customers' needs were investigated. Based on these findings, requirements for a solution concept were determined. A concept for the company was developed in an agile process. The concept is based on the elements consulting, training, portfolio, business model and culture. Additionally developed documents help the company to use and share its knowledge in ammonia management. The concept opens up new business opportunities and allows the company to be a competent partner in ammonia management.

Automation strategy for SMEs

The KNF Flodos AG, a manufacturer of liquid diaphragm pumps, is increasingly exposed to competition. Buyers of large quantities are questioning the currently pursued pricing strategy. Measures are therefore being taken to ensure that the company can continue to defend its market position effectively. The products are characterized by a high degree of specialization and configurations tailored precisely to customer requirements. A new product will combine these unique selling points with a cost-efficient pump design. In addition, the two best-selling products are to be assembled automatically in a cost-efficient manner in the future.

The goal of the master thesis was to define an automation strategy, which addresses the current challenges of the company. This included not only the demonstration of the feasibility of different assembly, logistics and personnel concepts, but the resulting maintenance issues and the definition of the requirement specifications for implementation. The approach required the use of simulation software (Siemens Tecnomatix Plant Simulation), intensive study of technical literature and carrying out expert surveys.



Simon René Burri

Advisor: Fabio Mercandetti

A Service Business Model Design for the Smart-locks market based on market analysis



**Carlos Andres
Cuadros Camacho**

Advisor: Dr. Clemente Minonne

In the present research, Good Dominant Logic (GDL) and Service Dominant Logic (SDL) concepts are analysed. Then, a more detailed analysis is applied based on the Customer Domain Logic (CDL), a framework with a much more customer-oriented approach and putting the customer at the centre for the business model design. In parallel, an interview session is held with partners and customers of the company.

Two relevant service focused tools are applied, the Services Business Model Canvas (SBMC) and the Services Dominant Logic Business Model Radar (SDBM/R). At the end of this research, both are delivered to the partner to be applied in real life and thus propose a significant improvement in the re-engineering process and development of a new business model following service-oriented standards.

Ecosystem of the Swiss medical orthopaedic devices market

Use of 3D printing has been gaining momentum in the medical device industry, especially in orthopaedics. A Swiss startup company is planning to enter this market to provide patient-specific solutions for orthopaedics. This research aids them to enter the Swiss market smoothly, identify the relevant decision-making players in the ecosystem and recommend reimbursement strategies. Methodologies such as ecosystem mapping were used to explore Swiss medical device ecosystem. Further, customer journey mapping was used to identify market needs. They were identified to be - facilitation of surgeons' tasks in performing complex surgeries, saving surgical cost, improving surgical safety and patient outcomes. Competitor's business was also studied to recommend partnership strategies and market positioning. Business models for market entry were subsequently developed to fulfil the research goals.



Shreya Dey

Advisor: Dr. Silvio di Nardo

Data centric approach to implement PLM in the medical device industry



Claude Flury

Advisor: Dr. Silvio Di Nardo

This thesis describes the creation and application of a data-centric meta-model for the uniform structuring and systematic collection of processes and data. Today, digital transformation offers companies a lot of potential for increasing their agility, efficiency and effectiveness, but also for designing new business models. However, to cope with the rapid changes in technology, economy and society as a company is sometimes not an easy task, as data and processes often take place in clearly dedicated departments and locations that do not communicate with each other. This creates walls in companies that hinder transparency and the ability to communicate. These walls must be removed in a targeted and gradual manner in order to unfold the benefits of digital transformation. The developed meta model represents this guideline and is presented together with a modern process and organizational structure for an agile company to prepare itself sustainably for the digital future.

Performance Analysis of a Swiss Service Provider

This research investigates the challenges of a large Swiss transport service provider. The intention is to provide an external view on the existing practices of this large firm which is facing new challenges in a rapidly changing environment.

A five-step methodology was applied as an overarching framework for this research. This ensured the development of a holistic overview, the assessment of the investigated firm and the further development of solutions to improve the performance and quality of its services.

Based on this assessment, eight fields of action were identified, supported by propositions, and then evaluated with selected managers. This report documented a relevant case for future research by assessing one of the largest service providers in Switzerland. The application of the structured framework according to the EFQM-model allowed the identification of eight fields of action for the development of practical solutions and recommendations to improve the performance and quality of services. This thesis concludes to further validate the applied framework through case studies and provide further research on the field of managing complex systems.



Michael Huonder

Advisor: Prof. Dr. Shaun West

Order picking in e-commerce – optimization of the flow of goods by using a dashboard



Marcel Leuthold

Advisor: Fabio Mercandetti

Initial Situation: Competec Logistik AG is expanding its warehouse to reach the necessary capacity. The existing infrastructure is at its limit. It is challenging to maintain the customer promise „ordered today, delivered tomorrow“. Appropriate instruments for monitoring and steering the picking-process are not available at the company until today.

Goals: The purpose of the thesis is to develop a dashboard that helps to control the overall system. The thesis defines the right KPIs which should be integrated in the dashboard and its visualisation by creating a mockup.

Procedure: In the first part a status quo analysis of the company was carried out. In addition, a benchmark analysis was carried out with other e-commerce logistics providers. Afterwards, the concept was developed with the information out of the status quo analysis and the benchmark analysis.

Conclusion: The analysis showed that fluctuations of the order backlog within the system exist. To steer the system more efficiently a dashboard is recommended. The dashboard mockup was created with grafana. The dashboard shows the order backlog, the current picking performance, the stock level in the buffer, customer frequency and further KPIs. The KPIs are updated every five minutes. With this information it is possible to react faster and more accurately to changes and enables the identification of bottlenecks at an early stage

Situation analysis and strategic realignment of a logistics network in the construction industry

The Master's thesis contains the situation analysis and strategic reorientation of the logistics network of Implen AG in the construction industry. The focus of this investigation is to gain a deep understanding of the internal logistics and the associated effects. Based on the internal and external analysis, a final logistic concept is formulated and rated which the board of directors can use for the future strategic direction. Based on theoretical fundamentals and scientifically evaluated tools, such as logistics analysis, benchmarking, PESTEL, SWOT-analysis and balanced scorecard, the analysis and elaboration of the results is accomplished. Initially, the internal logistics activities are analysed. In addition to that, the external environment is analysed and used as a benchmark for comparison with domestic companies and as analysis of the relevant trends. The results are shown in the conclusion. It came out, that Implen AG should implement the logistic concept with the highest added value. The corresponding implementation planning for the logistics concept is also stated in the results. Due to the facts the most important recommendations are to implement the logistic concept under consideration of the implementation planning to ensure a long-term growth of the company and to consider the future impacts of the external environment.



Patrick Markovic

Advisor: Fabio Mercandetti

Development of Strategies for the Digital Transformation of Mid-Sized Airlines based on the example of Lufthansa CityLine



Anet Mathews

Advisor: Prof. Dr. Sascha Götte

This thesis aims to develop strategies for a digital transformation within mid-sized companies, based on the example of Lufthansa CityLine (CLH). It focuses on process mining for operational excellence, a digitalization project within CLH. The results comprise of common topics that impact a digital transformation which are consolidated into categories. Strategies were developed within each category for a successful digital transformation.

Digital transformation requires well-planned strategies, especially within a historically grown industry that is highly regulated and uses legacy technologies and systems. The strategies should address the reasons for a transformation, change management concepts, the team leading the transformation, etc. Research indicates that digital transformation requires high investments of resources, time and budget. Thus, the strategies should be defined by a combined top-down and bottom-up approach. Moreover, the payback time for the digital transformation is long and its benefits only visible with a time delay after its implementation. Hence, the right expectation should be set from the beginning with the top management who approve the investments, and the employees who make the effort to execute the transformation.

A systems thinking view on circular economy in water

This study provides a systemic view on circular economy in water by asking: What are the economic and operational system effects of a circular economy on water utilities? A literature-based economic view of the urban water system is qualitatively modelled, overlaid with a modelled circular water economy system supplemented with input from expert interviews and case studies. Digitalisation, water reuse and resource recovery were found to be the key tools underpinning circularity in water, providing compelling operational benefits through efficiencies and a boost in revenue generating potential. However, issues of investment, non-cost reflective water pricing and a missing enabling legal framework are slowing their rate of uptake. Therefore, circular economy is seen to be both a challenge and an opportunity for the water industry. Given that circular solutions are context-specific, further research is needed to better understand context-specific quantitative system behavior.



Tanaka Mandy Mbavarira
Advisor: Prof. Dr. Christoph Imboden

Fostering Open Innovation at Roche Diagnostics International: A Framework of Academia-Industry Collaboration



Lauren Elizabeth McMillan

Advisor: Prof. Dr. Michele Kellerhals

Previous work showed a large gap between the desired level of interaction between academia and industry, particularly in the realm of project work. Social and geographic proximity were shown to be key proximity metrics for Roche Diagnostics International (RDI), when collaborating with academia. Therefore, this thesis considers the development of an academia-industry relationship framework, focused on the case of RDI and Hochschule Luzern (HSLU). Following open innovation and design thinking protocols, the problem space was explored with interviews and defining the team point of view. Key frustrations in existing relationships were a lack of structure, mismatched expectations and the difficulty to find a relevant contact. Moving into the solution space, Ideation and Prototyping workshops were held virtually with participants from both RDI and HSLU. Iterating on the outcomes of the workshop resulted in the following six prototypes: Platform, Governance Term Sheet, Project Pipeline, Project Proposal Form, Master@RDI program and Lunch & Learn events. The main benefits of collaborating are the exposure to new perspectives and talent acquisition. The main recommendations of this work are to implement a governance structure between RDI and HSLU, focus on student-workers and improve accessibility and visibility within the organizations. These learnings should then be applied to academia-industry relationships with other organizations.

Digital Transformation of Operations Planning Processes at ABB Switzerland

With the fast-paced technology development on today's market, more organizations are realizing benefits from applying it to improve their business processes. Tools for initializing digital transformation within organizations are available and the cost of ownership is low, thus the interest is high while the technical know-how is still missing.

The focus of the thesis was adaptation of Lean Six Sigma improvement cycle model, known as DMAIC (Define, Measure, Analyze, Improve, Control), for further use in business process digitalization projects.

The thesis presents the findings of actions, tools as well as critical success factors that support DMAIC model in business process digitalization projects. As an outcome, the adapted DMAIC model is delivered and shall support similar projects at ABB Switzerland.



Filip Mestrovic

Advisor: Prof. Dr. Patrick Link

Process and Governance Mechanism for Cost-Benefit Evaluation of Digitisation Projects



Yves Müller

Advisor: Prof. Dr. Christoph Imboden

The present master thesis examines a variety of combinations of practices, techniques, and methods of portfolio management to measure and to demonstrate the total value of individual and aggregated digitization projects as well as to reduce the inherent risk. The goal of this master thesis is to develop a process and governance mechanism for the cost / benefit evaluation of Pilatus Aircraft Limited digitization projects. The procedure will allow Pilatus Aircraft Limited to support their decision-making process for a systematic prioritization and governance of projects as well as optimization of resource planning. The assessment procedure is linked to the corporate strategy, the total benefit of the project portfolio is maximized, and the achievement of a balanced portfolio and the right constellation of projects are considered.

Digital Transformation of Operations Planning Processes at ABB Switzerland

The goal of this master's thesis is to provide IT executives with knowledge about open source that is tailored to the application in an enterprise environment.

The results comprise historical background on the emergence of open source, different software business models and open source licenses. On basis of past cases, possible intents behind opening or closing access to the source code are derived. Potential signals that could lead to such strategic moves are analyzed. Security and the quality of code are compared between open source and proprietary software. Common reasons for failure of open source projects are identified. Migration best practices are given that can be applied to move from proprietary to open source software. Then a comparison of benefits and challenges that arise with the adoption of open source software is done. After this theoretical chapter, a market overview of open source software is given with both a global and Swiss scope. Enterprise requirements for open source software are discussed. Also, potential barriers that prevent businesses from using open source software are analyzed. Finally, the bill of materials tool for software is introduced to cope with the increased complexity of an open source software portfolio.



Raphael Tholl

Advisor: Prof. Dr. Björn Jensen

Development and Application of a Framework for Shift Planning Solutions in the Manufacturing Industry regarding Industry 4.0



Marius Vogel

Advisor: Prof. Dr. Claas Wagner

In this thesis, a framework regarding the selection of an ideal shift planning solution is developed and applied at the premises of a multi-national manufacturing company. The proposed framework of this thesis is divided into seven phases, each with its distinct goals and deliverables. The preparation and gap analysis phase provide insight into the issues of the current shift planning system in use and lays the basis for the requirement analysis.

In the solution comparison phase, a total of 29 distinct shift planning solutions are reviewed. Following a prioritization of the requirements and their alignment with the shift planning solution, a final decision towards a shift planning solution is simplified. The framework thus provides a proven guideline in selecting a shift planning solution in the manufacturing industry by making the decision and selection process more accessible and transparent.

Smart journey of the Future: improving mobility experience

This Master thesis focuses on the innovation of mobility with the help of service design and foresight methods, explains the actionable transformation process and shows how the company can achieve success in the future. Global trends and new technologies affect the lives of people, they change people's the expectations and influence the way people interact with the smart world. Future mobility solves the weaknesses and problem points in the journey and good moments are improved increasing the total experience satisfaction. Future smart mobility is a radical transformation for the product-centred company, it will change the customer segments, have a great impact on the business model and the company's selling approach. The vision and roadmap were created to provide the actionable path towards innovation.



Victoria Zulauf

Advisor: Prof. Dr. Shaun West



CEBT

Civil Engineering and Building Technology



Foreword

Liebe Leserin, lieber Leser

Vier Personen dürfen wir diesen Sommer das Diplom des MSE mit Fachrichtung Civil Engineering and Building Technology überreichen. Dies freut uns und fordert uns, weiterhin ein attraktives Angebot zu bieten.

Auch in Zukunft möchten wir in die Ausbildung von Bau- und Gebäudetechnikern investieren und zukunftsorientierte Module anbieten, um den MSE in Horw weiterhin attraktiv zu gestalten und mit den diversen Prüfständen und Möglichkeiten der angewandten Forschung zu fördern. Mit einer Anstellung an einem der Kompetenzzentren können die MSE-Studierenden zudem vom Wissen erfahrener Mitarbeitenden profitieren. Im Rahmen des Re-Designs des MSE wurde das Profil «Civil Engineering» geschärft und inhaltlich überarbeitet sowie das neue Profil «Building Technologies» geschaffen. Den diesjährigen Absolventinnen und Absolventen wünsche ich einen gelungenen Start in einen neuen Abschnitt ihrer beruflichen Laufbahn.

Dear reader

This summer we have the privilege of presenting the MSE Civil Engineering and Building Technology certificate to four graduates. We are pleased about this and committed to maintaining our attractive range of programs.

We will continue to invest in the education of civil and building technology engineers and to offer future-oriented modules to maintain the high quality of the MSE in Horw and to promote applied research with our various test stations. What is more, by working for one of the competence centers, MSE students have the opportunity to benefit from the expertise of experienced employees. The MSE's redesign encompassed the sharpening of the "Civil Engineering" profile including the reworking of its content as well as the launch of the "Building Technologies" profile.

I wish this year's graduates a great start to a new phase in their professional careers.



Prof. Dr. Albin Kenel

Civil Engineering and Building Technology

CEBT Advisors - Civil Engineering



Dr. André Arnold

Focus: Foundation, theoretical and experimental soil mechanics, soil-structure interactions



Prof. Dr. Michael Baur

Focus: Earthquake engineering with a focus on conservation, steel and steel-concrete composite construction, finite element calculations, probabilistic detection methods in construction



Prof. Dr. Daniel Heinzmann

Focus: Structural behavior and modeling of reinforced concrete and solid construction structures



Prof. Dr. Albin Kenel

Focus: Punching and punching reinforcements, load bearing and deformation behaviour of reinforced concrete



Prof. Dr. Klaus Kreher

Focus: Structural behavior of composite components, application of adhesive technologies, development of construction products



Prof. Dr. Andreas Luible

Focus: Building envelope, structural glass, steel, metal, light-weight, membrane construction, anchoring technology, wind engineering, adaptive building envelopes



Prof. Dr. Hartwig Stempfle

Focus: Load-bearing behaviour of prestressed, ultra-high-strength fibre reinforced concrete structures and masonry structures, textile concrete, non-linear finite element methods



Prof. Dr. Karel Thoma

Focus: Load-bearing behaviour of prestressed load-bearing structures and components made of ultra-high-strength fibre-reinforced concrete, fatigue behaviour of roadbeds

CEBT Advisors - Building Technology



Prof. Dr. Heinrich Manz

Focus: Building physics, energy, comfort and building, modelling and simulation (thermal, energetic component simulation, building simulation, CFD flow simulation), glass construction, passive cooling



Prof. Dr. Olivier Steiger

Focus: Building automation, building informatics, building monitoring, smart building technologies



Prof. Dr. Andrew Paice

Focus: Smart homes, automation systems, control engineering, system theory, modelling and simulation, product development



Prof. Dr. Axel Seerig

Focus: Building climate, energy efficiency, building and plant simulation, demand-side management, forecasting

Fall 19 - Specialisation Projects 1 & 2

A parametric energy building simulation case study on the potential and limitations of passive design strategies in modular volumetric construction suited to the Mediterranean climate

Dynamisches Verhalten von Gebäuden in moderner Holzbauweise, Untertitel Thermische Behaglichkeit und Betriebsenergiebedarf im Quervergleich

Low-Tech and Low-Energy Building - a case study by means of building energy simulation

Bewertungsverfahren für den Vergleich von Energiemanagementsystemen – Systemverständnis als Grundlage

Modellbildung einer schief gelagerten Hohlkastenbrücke

Durchstanzversuch mit schiefwinkliger Biegebewehrung

Ahmed Daralnakhla
Prof. Dr. Heinrich Manz

Stefan Felder
Prof. Dr. Heinrich Manz

George Walter Fewkes
Prof. Dr. Heinrich Manz

Carina Gubler
Prof. Dr. Olivier Steiger

René Hungerbühler
Prof. Dr. Thoma Karel

Andreas Jäger
Prof. Dr. Daniel Heinzmann

Spring 2020 - Specialisation Projects 1 & 2

Prefabricated modular structures – life-cycle energy and embodied environmental impact analysis

Ahmed Daralnakhla
Prof. Dr. Heinrich Manz

Optimierung von Entwurf und Konstruktion mithilfe der Gebäudesimulation, Untertitel: Wohnüberbauung Bizun in Ennetbürgen

Stefan Felder
Prof. Dr. Heinrich Manz

Operational and Embodied Environmental Impact of a Low-Tech Building - a Life Cycle Assessment Comparison of Alternative Constructions

George Walter Fewkes
Prof. Dr. Heinrich Manz

Bewertungsverfahren für den Vergleich von Energiemanagementsystemen – Erarbeitung des Bewertungsverfahrens

Carina Gubler
Prof. Dr. Olivier Steiger

Tragfähigkeit einer einzelligen Hohlkastenbrücke unter kombinierter Beanspruchung

René Hungerbühler
Prof. Dr. Thoma Karel

What are you taking away with you from the studies?

The independent development of complex problems.

*Livio Brunner
ICT - Embedded Systems*

Fall 19 / Spring 20 - Master Thesis

Statische Überprüfung einer schief gelagerten Überführung



Andreas Jäger

Advisor: Prof. Dr. Daniel Heinzmann

Das Thema dieser Masterarbeit ist die statische Überprüfung einer Autobahnüberführung. Mit den vorhandenen Schalungs- und Armierungsplänen kann das statische System sowie die konstruktive Durchbildung erfasst werden. Das Ziel der Arbeit ist es, die Überführung korrekt nach zu modellieren und das Tragverhalten zu verstehen.

Die Schnittkräfte infolge der Einwirkungen werden mit drei verschiedenen Modellen berechnet. Der Momenten- und Querkraftverlauf wird mit einer Plattenmodellierung ermittelt. Die Normalkraft resultiert einerseits aus der Rahmentragwirkung und zum anderen infolge des Erddruckes, welche mit einem zweidimensionalen Rahmensystem und einem Scheibenmodell untersucht werden.

Der Durchstanznachweis wird zum einen mit verschiedenen Laststellungen und zum anderen mit verschiedenen Berechnungsarten des Beiwertes k_e nachgewiesen. Der Biegenachweis wird mit zwei unterschiedlichen Fließbedingungen geführt; zum einen mit der Normalmomenten-Fließbedingung, welche auf dem oberen Grenzwertsatz basiert, und mit dem Sandwichmodell, welches auf dem unteren Grenzwertsatz basiert. Im Auflagerbereich wird der Querkraftnachweis nach SIA 262 und nach dem Model Code geführt.

Direct and Indirect Ecological Expenditure of a Building over its Lifetime

The master thesis consists of a life cycle assessment of a typical existing apartment building in the Swiss midlands. A life cycle analysis is used to quantify the indirect ecological expenditure of the building over its lifetime. By means of a software simulation the energy demand to operate the house is determined. Four different heating systems are used in the calculations to cover this demand and their influence on the direct ecological expenditure is examined. In conclusion it is shown whether from an ecological point of view a new replacement building or a renovation of the existing building should be favoured, and with which measures the total ecological expenditure of a building can be minimised. In the results, the refurbishment case is compared with new, modern buildings in timber and solid construction. The ecological expenditure is represented by the environmental indicators primary energy (non-renewable), greenhouse gas potential and environmental impact points.



Rebekka Merz

Advisor: Prof. Dr. Heinrich Manz

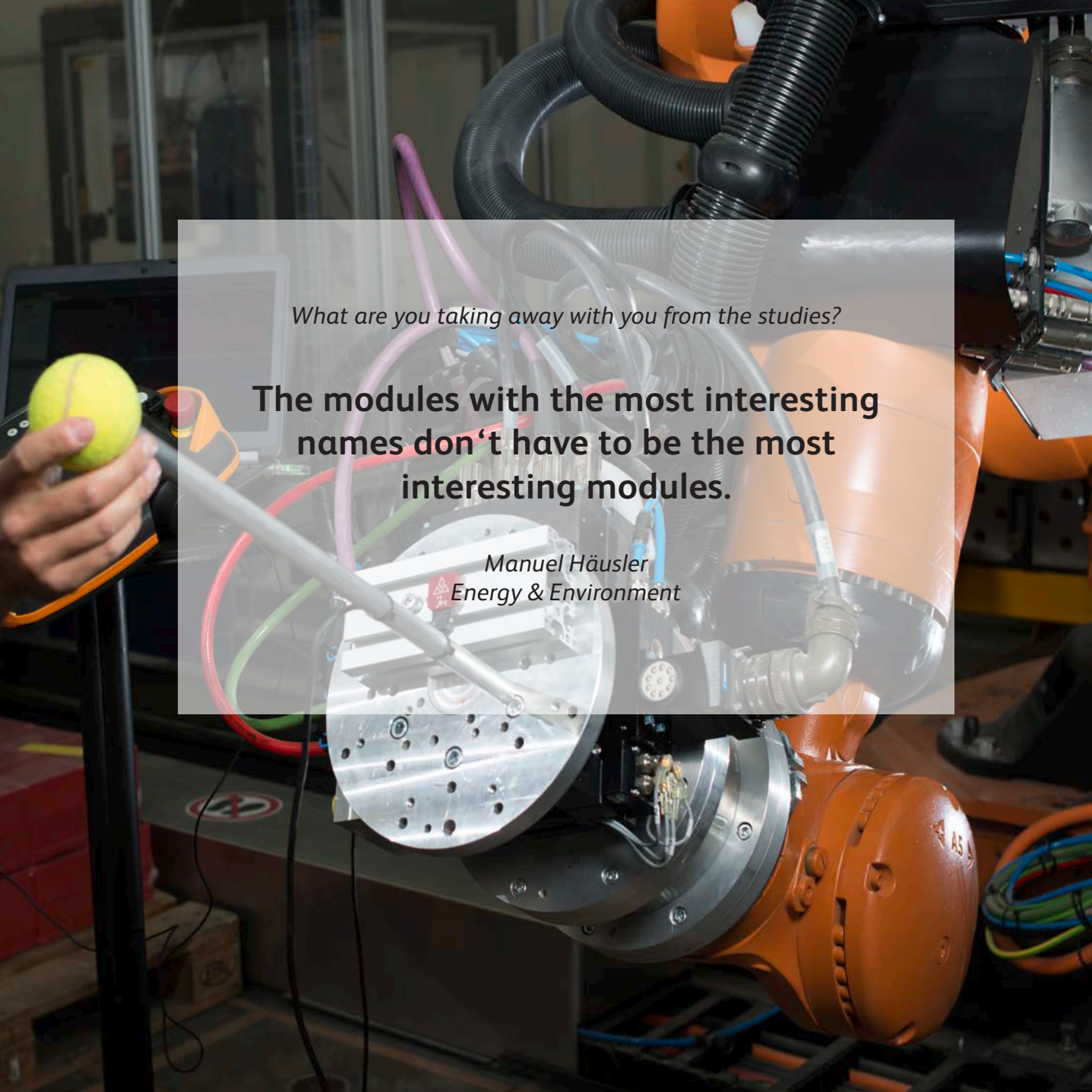
Modelling and simulation of a test cell for hygrothermal durability testing of thermal insulation composite systems (ETICS)



Michael Näf

Advisor: Prof. Dr. Heinrich Mainz

Swisspor is one of the leading manufacturers of insulation and seals for the building envelope. As a company, Swisspor has a special interest in planning a test cell according to the current normative specifications (FprEN16383) in order to be able to test and develop its products. During the test, three different load phases will act on the thermal insulation composite systems (ETICS). The test object is exposed to heat, frost and water. These load phases represent a large challenge when planning the test facility. In the context of this work a tool was developed which shows the hygrothermal behaviour of the test facility. The tool is based on the object-oriented „Modelica-Approach“. In this thesis it turned out that the coupled unsteady heat and moisture transport can be described with the „Modelica-Approach“ with good correlation to other programs. Based on this, the hygrothermal behaviour and the determination of the heating and cooling power requirements for the test cell could be determined.

A photograph of a laboratory or industrial setting. On the left, a person's hand holds a bright yellow tennis ball. To the right, an orange industrial robot arm is visible, with various cables and hoses connected to it. The background shows a metal frame and other equipment. A semi-transparent white box is overlaid in the center, containing text.

What are you taking away with you from the studies?

The modules with the most interesting names don't have to be the most interesting modules.

Manuel Häusler
Energy & Environment



E&E

Energy and Environment



Foreword

Liebe Leserin, lieber Leser

Das Thema «Energy & Environment» ist seit langer Zeit im öffentlichen Diskurs präsent und wird in den letzten Jahren stark von jungen Menschen vorangetrieben. Je deutlicher der Klimawandel in Erscheinung tritt, desto dringlicher werden Massnahmen für eine Energietransformation hin zu einer nachhaltigen Energieversorgung empfunden. Das gleichnamige Fachgebiet bzw. ab dem Herbstsemester 2020 gleichnamige Profil des MSE setzt genau dort an. Es bildet Studierende im Bereich der Energieversorgung und Energietechnik aus. Der Fokus liegt dabei auf Energieeffizienzen und der Einbindung erneuerbarer Energien. Ab dem Herbst 2020 wird Aspekten der Umwelttechnik wie Boden-, Wasser- und Luft-Reinhaltung grössere Aufmerksamkeit zuteil. Für das kommende Studienjahr kann «Energy & Environment» an der HSLU erfreulicherweise Rekordanmeldezahlen verzeichnen. Dies lässt darauf schliessen, dass mit dem überarbeiteten Angebot den Bedürfnissen der Studierenden entsprochen wird.

Wir wünschen den Absolvierenden für die Zukunft alles Beste und hoffen, dass sie dazu beitragen werden, die Zukunft ein wenig grüner zu gestalten.

Dear reader

The topic „Energy & Environment“ has been present in public discourse for a long time now and has been strongly promoted by young people in recent years. The more climate change becomes apparent, the more urgent measures for energy transformation towards a sustainable energy supply are perceived. This MSE's subject area or, beginning in autumn of 2020, its profile of the same name, starts precisely there. It educates students in the field of energy supply and energy technology, with a focus on energy efficiency and the integration of renewable energies. From autumn 2020, greater attention will be devoted to aspects of environmental technology such as soil, water and air quality control. For the coming academic year, the profile „Energy & Environment“ at the HSLU is pleased to report record enrolment figures, which suggests that the revised program meets the students' needs.

We wish the graduates all the best for the future and hope that they will help to make the future a little bit brighter and greener.



Prof. Dr. Mirko Kleingries

Energy and Environment

E&E Advisors - Electrical Engineering



Prof. Dr. Adrian Omlin

Focus: Power electronics and electrical drives, power engineering



Dr. Antonios Papaemmanouil

Focus: Smart Grids / decentralized power systems, data-driven power systems, digital infrastructure management, digitale power markets / ancillary services, e-Mobility / V2G



Prof. Dr. Thierry Prud'homme

Focus: Automation: buildings, machinery, robotics, control engineering (medical technology, buildings, machines), industrial software (process visualization and control)

E&E Advisors - Mechanical Engineering and Energy Technology



Prof. Dr. Ernesto Casartelli

Focus: Fluid mechanics, hydraulic and thermal turbomachinery, fluid dynamics (CFD), multiphysics



Prof. Dr. Ludger J. Fischer

Focus: Thermal storage, building adaptive facades, process integration of high temperature heat pumps, phase change dispersions, mixing and dispersing technology



Prof. Dr. Carsten Haack

Focus: Computer aided engineering (CAE), thermo-mechanical analysis, modelling of dynamic systems, device development, fluid systems



Prof. Dr. Mirko Kleingries

Focus: Technical sorption processes (adsorption, absorption, desorption), heat and mass transfer, evaporative cooling, solar dehumidification and cooling

E&E Advisors - Mechanical Engineering and Energy Technology



Prof. Dr. Christoph Imboden

Focus: Technology management, innovation management, product management, market analysis, business model development



Prof. Dr. Luca Mangani

Focus: OpenFOAM™ framework, compressible flows, heat transfer applications, numerical discretization, CFD solver, RANS turbulence modelling, LES turbulence modelling



Prof. Dr. Ulf Christian Müller

Focus: Dynamic simulation of energy systems, organic rankine cycle (ORC), thermal machines, fluid dynamics (CFD), multiphysics



Prof. Dr. Thomas Nussbaumer

Focus: Fluid dynamics optimization of wood combustion, design of electrical cutters, planning of district heating networks, techno-economic evaluation of energy systems



Prof. Dr. Philipp Schütz

Focus: Computer tomography methods, the simulation-based optimization of measurement methods and the analysis of large image data volumes.



Prof. Dr. Claas Wagner

Focus: System dynamics, life cycle (cost) analysis, energy efficiency measures, emission accounting, CSR strategies, process analytical technologies



Prof. Dr. Beat Wellig

Focus: Heat pumps and refrigeration systems, material and energy regeneration, process integration and pinch analysis, thermal separation processes and environmental technology



Prof. Dr. Jörg Worlitschek

Focus: Thermal energy storage, design of latent heat storage, new storage materials and phase change materials, energy storage in the building

Fall 19 - Specialisation Projects 1 & 2

Optimisation approaches for the computational and experimental investigation on the drying process of aqueous polyacrylate dispersions

Roman Blätter
Prof. Dr. Mirko Kleingries

Development of an innovative atmospheric water generator

Marc Fill
Prof. Dr. Mirko Kleingries

Digitaler Zwilling des Pumpenprüfstandes

Manuel Häusler
Prof. Dr. Ulf Christian Müller

Simulationsmodell für Halbleiterverluste eines Mittelspannungsantriebs

Yannick Inderbitzin
Prof. Dr. Adrian Omlin

Implementation of higher order triangular and tetrahedral element in the CVFEM

Raphael Lindegger
Prof. Dr. Luca Mangani

Absorption Refrigeration in Industrial Processes - Integration, Simulation and Implementation

Michael Schubaschitz
Prof. Dr. Beat Wellig

Spring 20 - Specialisation Projects 1 & 2

Development of a Design Tool for an Optimal Building Energy System

Marc Fill

Prof. Dr. Mirko Kleingries

Development of a Design Tool for an Optimal Building Energy System

Manuel Häusler

Prof. Dr. Ulf Christian Müller

Cooling concept for Hyperloop pod prototypes

Yannick Inderbitzin

Prof. Dr. Adrian Omlin

Verifikation des Simulationsmodells für Halbleiterverluste eines Mittelspannungsantriebs

Simon Joss

Prof Dr. Ernesto Casartelli

Separation von Mikroplastikpartikeln und Wasser

Angelika Schmid

Prof. Dr. Ulf Christian Müller

**Absorption Refrigeration in Industrial Processes –
Development of a Process Integration Methodology
based on Case Studies**

Michael Schubaschitz

Prof. Dr. Beat Wellig

A word of advice for new MSE students??

The combination of work and studies is very well possible. So, do not hesitate to think about a part-time model but be prepared to be flexible where you invest your time.

*Rebekka Merz
Civil Engineering and Building Technology*



Fall 19 / Spring 20 - Master Thesis

Geschäftsmodell-Innovation bei Energieverbänden



Lukas Achtnich

Advisor: Prof. Dr. Sabine Sulzer

Worlitschek

In der Arbeit wurde eine Methodik zur Geschäftsmodell-Innovation bei Energieverbänden entwickelt. An Hand dieser Methodik wurde das in der Schweiz gängige Geschäftsmodell «Energieverbände im Contracting» analysiert und weiterentwickelt. Es entstand die Idee den Kunden, beim Anschluss an einen Energieverbund, die Auswahl zwischen verschiedenen Finanzierungsmodellen und der Länge der Vertragslaufzeit zu geben. Zur Umsetzung dieser Idee wurde ein neues Preismodell entwickelt und an Hand von einem echten Verbundprojekt des Industriepartners durchgerechnet und verifiziert. Erste Kundenfeedbacks zeigten zudem, dass mit dem neuen Wertversprechen - der Flexibilität beim Preismodell - ein wichtiges Kundenbedürfnis abgedeckt wird. Das neue Geschäftsmodell führt zu einer höheren Attraktivität von Energieverbänden und leistet so einen Beitrag zur Erreichung der Energiestrategie der Schweiz.

Multivariable Control of Heat Pumps Coupled to Thermal Energy Storage Systems for Heat Integration in Non-Continuous Processes

More than half of the end-energy consumption in the Swiss industrial sector is related to process heat. Furthermore, many industrial processes are not operated continuously. To exploit heat recovery potential in such processes, heat pumps coupled to thermal energy storage systems can be integrated. This integration, however, introduces new interconnections of process streams, leading to new challenges regarding the control of the system. Aiming to enable the reduction of energy consumption in the industry, these new challenges are investigated in this work.

To overcome the aforementioned challenges, the overall control task is separated into a real-time and an energy management task. With model predictive control, an advanced control method is proposed for the energy management task of the system. This control method allows for a minimization of the energy consumption while ensuring operability.

A simulation study performed with a test case demonstrates the operability of the combined control strategy. It is shown that the model predictive controller can reject unknown disturbances through the planning of the optimal inputs necessary to maintain the system operationally.



Raphael Agner

Advisor: Prof. Dr. Beat Wellig

Creation of a Modelica library for vacuum transportation applications and the design of a cooling system for the AlphaTube



Manuel Häusler

Advisor: Prof. Dr. Ulf Christian Müller

Vacuum transportation is a concept for a new mode of transport where vehicles are levitating in a partial vacuum tube traveling at almost the speed of sound. EuroTube Foundation was founded with the purpose to accelerate the development of vacuum transportation technologies and is going to build the very first European vacuum tube test track called AlphaTube in Switzerland.

In this thesis a basis is laid for an extensive modeling library containing different models for vacuum transportation applications and linear drives. The library is created using the modeling language Modelica. First models added to the library are created with the focus on the thermal domain to design an optimised cooling system for AlphaTube. With the help of parameter variations on an AlphaTube system model a cooling concept was developed. The most efficient cooling is achieved if water from the nearby river as cold and as close as possible is available at the heat sources leading to large temperature gradients between source and refrigerant.

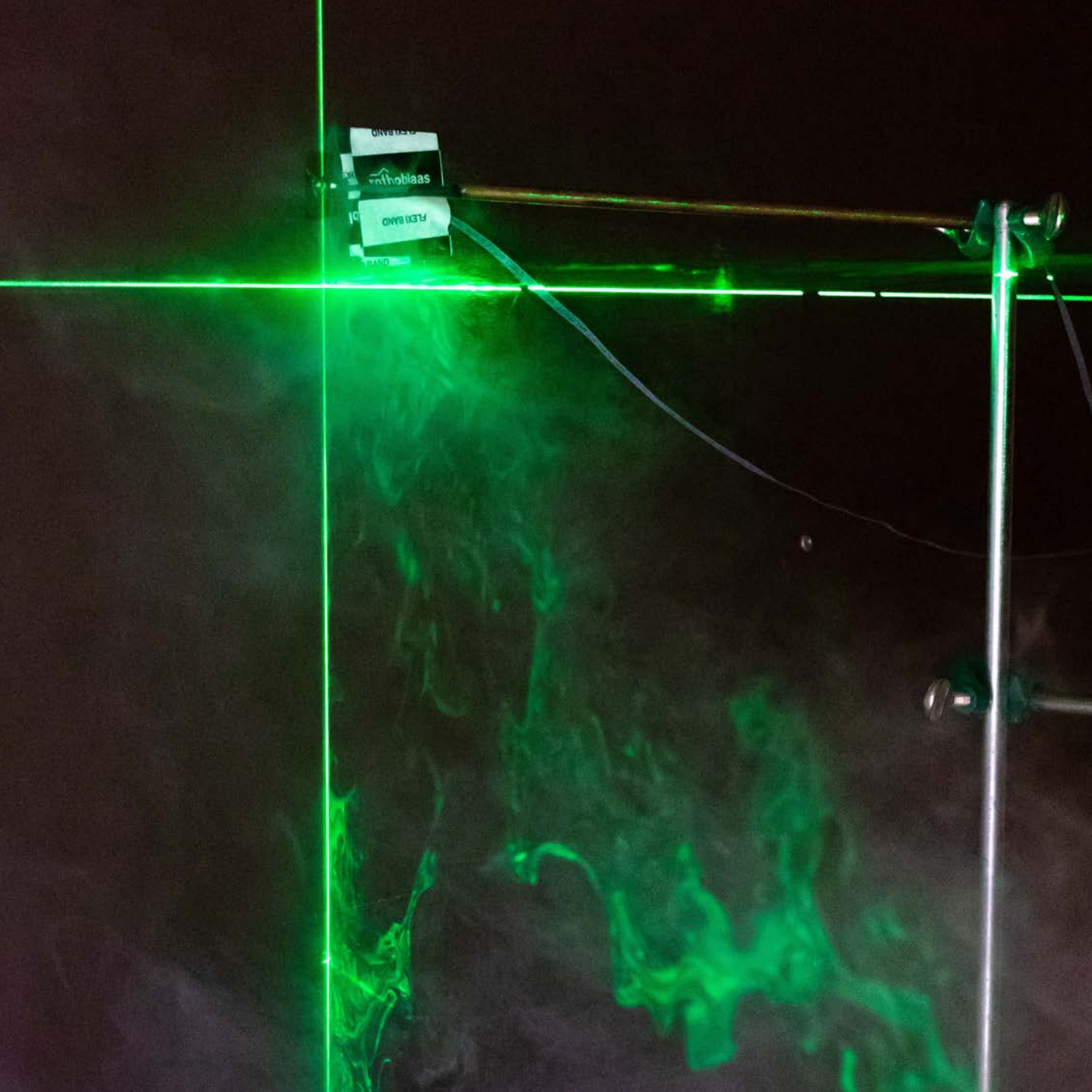
Solving the Navier-Stokes Equations Using the Control Volume Finite Element Method

A wide variety of computational fluid dynamics (CFD) tools based on solving the Navier-Stokes equations are used in various industrial fields. The majority uses the cell centred finite volume method (FVM) for the equation discretization. The purpose of this work is to solve the Navier-Stokes equations using the lesser known vertex centred discretization scheme control volume finite element method (CVFEM). Due to the lack of detailed information available, numerical experiments had to be carried out in order to find a robust discretization. Therefore, a new software framework in C++ with a segregated and fully coupled solution procedure was developed. It was then used to simulate various cases in order to prove its capabilities. The discretization did work as expected. In order to be competitive, the implementation of the linear solver has to be improved. Based on the results the CVFEM is considered a method with potential to improve the current state of the art in CFD.



Raphael Lindegger

Advisor: Prof. Dr. Luca Mangani



A song that best describes my studies is...

**Welcome to the Jungle
by Guns N' Roses**

Pascal Jund
ICT - Embedded Systems



IndT

Industrial Technologies



Foreword

Liebe Leserin, lieber Leser

Masterstudierende, die im Fachgebiet Industrial Technologies abschliessen, haben ihre Kenntnisse in der Analyse, Entwicklung, Optimierung, Herstellung und Nutzung von Maschinen, Anlagen und Produkten im industriellen Umfeld vertieft.

Die fachliche Breite und die Vielzahl von Anwendungsfeldern dieses Fachgebiets ist sehr gross und zeigt sich in der Unterschiedlichkeit der Masterarbeiten. Auch dieses Jahr sind bei den Masterarbeiten viele verschiedene Themengebiete enthalten, was das Lesen der kurzen Zusammenfassungen spannend und lehrreich gestaltet.

Ab dem Herbstsemester 2020 wird das Fachgebiet in fünf neue Profile aufgeteilt: Electrical Engineering, Mechanical Engineering, Mechatronics & Automation, Medical Engineering und Photonics. Für die Studierenden und die potenziellen Arbeitgeber ergibt sich eine verständlichere Aufteilung und Zuordnung.

Das MSE Studium bleibt ein individuelles praxisorientiertes Vertiefungsstudium und entspricht den Bedürfnissen der Studierenden und ihren neuen Betätigungsfeldern. Die Befähigung aus dem MSE Studium erlaubt es fachlich attraktive Stellen zu finden und führende Rollen in der beruflichen Praxis zu übernehmen. So werden sie gestaltend in Forschung und Entwicklung, in der Produktion und im Management von Betrieben im industriellen Umfeld wirken.

Dazu wünschen wir Ihnen viel Erfolg und hoffen auf eine lange Verbundenheit mit unserer Institution.

Dear reader

Industrial Technologies graduates have deepened their skills in and knowledge of the analysis, development, optimization, production and use of machinery, plants and products in the industrial sector.

The subject's disciplinary range and its many fields of application is evident in the great variety of topics covered in the Master's theses. Accordingly, this year's Master's theses also discussed various subject areas, making the short summaries an exciting and instructive read.

Starting in the 2020 fall semester, the discipline will be divided into five new profiles: Electrical Engineering, Mechanical Engineering, Mechatronics and Automation, Medical Engineering, and Photonics. This helps to create a clearer delineation and allocation within the discipline for students and future employers alike.

The MSE degree program remains a specialization with a practical focus, which is attuned to the needs of the students and their new fields of activity. The qualification of MSE graduates allows them to find and assume attractive specialist positions in professional practice. They have the skills to work in and shape the research and development, production and management departments of companies in the industry sector.

We wish them great success for their professional endeavors and hope for their long-term affiliation with our institution.



Prof. Othmar Schälli

Industrial Technologies

IndT Advisors - Electrical Engineering



Prof. Dr. Marc Achermann

Focus: Modelling of physical effects; Terahertz, IR, optical and UV systems; optical sensors, receivers, LEDs and lasers



Prof. Dr. Ulrich Dersch

Focus: Aircraft data and sensor networks, smart grid data networks, power line communication, computer networks and protocols



Prof. Dr. Christoph Eck

Focus: Navigation algorithms: Data fusion, Kalman filter, integrated navigation, systems theory and applied control engineering, aerial robots, system integration for robotics



Prof. Dr. Thomas Graf

Focus: Modelling of physical effects; Phenomena of acoustics, AC/DC and RF



Prof. Dr. Björn Jensen

Focus: Mobile robotics, localization, navigation, data fusion



Prof. Marcel Joss

Focus: Conductor-bound and wireless communication systems,
electromagnetic modelling and simulation, microwave,
compact antennas engineering



Prof. Dr. Adrian Omlin

Focus: Power electronics and electrical drives, power engineering



Prof. Dr. Andrew Paice

Focus: Smart homes, automation systems, control engineering,
system theory, modelling and simulation, product development

IndT Advisors - Electrical Engineering



Prof. Dr. Thierry Prud'homme

Focus: Automation: buildings, machinery, robotics, control engineering (medical technology, buildings, machines), industrial software (process visualization and control)



Prof. Othmar Schälli

Focus: Circuit technology, high frequency circuitry, electroacoustics, communications engineering



Prof. Peter Sollberger

Focus: Wireless sensor networks, communication infrastructures, sensors, sensor data processing and conditioning



Prof. Erich Styger

Focus: Embedded Systems, microcontrollers, internet of things (IoT), digital forensics, wireless communications, robotics, eclipse, ARM



Prof. Dr. Markus Thalmann

Focus: Microcontroller, FPGA and SOC programming, time of flight distance and occupancy measurement (TOF), system and processor architecture, HW/SW codesign, VHDL, IoT



Prof. Dr. Jürgen Wassner

Focus: HW/SW Codesign for Embedded Systems, Realtime Digital Signal Processing, Model based Design



Prof. Dr. Klaus Zahn

Focus: Video content analysis and vision sensors, image processing, intelligent, cameras, sensor networks

IndT Advisors - Mechanical Engineering and Energy Technology



Prof. Ralf Baumann

Focus: Numerical simulation, finite element method, computer mechanics, lightweight structures



Prof. Dr. Ernesto Casartelli

Focus: Fluid mechanics, hydraulic and thermal turbomachinery, fluid dynamics (CFD), multiphysics



Prof. Dr. Ludger J. Fischer

Focus: Thermal storage, building adaptive facades, process integration of high temperature heat pumps, phase change dispersions, mixing and dispersing technology



Prof. Dr. Carsten Haack

Focus: Computer aided engineering (CAE), thermo-mechanical analysis, modelling of dynamic systems, device development, fluid systems



Dr. Rolf Kamps

Focus: Product development, design of synthetic components, systematic design tasks, solution finding with innovation tools such as TRIZ, WOIS, SIT



Prof. Dr. Mirko Kleingries

Focus: Technical sorption processes (adsorption, absorption, desorption), heat and mass transfer, evaporative cooling, solar dehumidification and cooling



Prof. Ralf Legrand

Focus: Production and automation technology, machining technology, measurement technology, articulated robotics, quality management



Prof. Dr. Luca Mangani

Focus: OpenFOAM™ framework, Compressible flows, Heat transfer applications, Numerical discretization, CFD solver, RANS Turbulence Modelling, LES Turbulence Modelling

IndT Advisors - Mechanical Engineering and Energy Technology



Prof. Dr. Ulf Christian Müller

Focus: Dynamic simulation of energy systems, organic rankine cycle (ORC), thermal machines, fluid dynamics (CFD), multiphysics



Prof. Dr. Thomas Nussbaumer

Focus: Fluid dynamics optimization of wood combustion, design of electrical cutters, planning of district heating networks, techno-economic evaluation of energy systems



Prof. Dr. Gerhard S. Székely

Focus: Aerospace systems, mechanics and structural dynamics, product development (from idea to tested product), systems engineering



Prof. Dr. Beat Wellig

Focus: Heat pumps and refrigeration systems, material and energy regeneration, process integration and pinch analysis, thermal separation processes and environmental technology



Prof. Dr. Jörg Worlitschek

Focus: Thermal energy storage, design of latent heat storage, new storage materials and phase change materials, energy storage in the building

IndT Advisors - Medical Engineering



Prof. Dr. Roger Abächerli

Focus: Biosignal processing and biomechanics, medical technology



Prof. Dr. Marcel Egli

Focus: Neurobiology, neuro-endocrinology, space biology



Dr. Fabian Ille

Focus: Personalized medicine, human cartilage regeneration, mathematical models in fertility medicine, software as a medical device, clinical decision support systems



Prof. Dr. Philipp Schütz

Focus: computer tomography methods, the simulation-based optimization of measurement methods and the analysis of large image data volumes.

What I will always remember about my time spent studying my MSE is...?

I missed the daily reminder from mechanical engineering students that business engineers are no real engineers.

*Raphael Tholl
Business Engineering and Production*

Fall 19 - Specialisation Projects 1 & 2

Entwicklung eines autonomen smarten Greifers zur
Übertragung von Bahnpunkten im Offlinebetrieb mittels
integrierter IMU

Inchworm-inspired propulsion system based on a
stacked silicone dielectric actuator

Classification of Acoustic Room Properties from
Speech Samples

Modellbasierte Regelung eines thermischen Speichers

Verschleissbeständigkeit von Messerstählen

Implementation and Validation of the P1 Thermal
Radiation Model for a Coupled CFD Solver

Nicht-Invasive Stromsensoren

Grundlagen über die Dynamik des Golfschlägers

Noah Dossenbach
Prof. Dr. Ralf Legrand

Michael Durrer
Prof. Dr. Carsten Haack

Silvio Emmenegger
Prof. Dr. Jürgen Wassner

Cyrill Hächler
Prof. Dr. Thierry Prud'homme

Samuel Heinzer
Prof. Dr. Ralf Legrand

Anna Kiener
Prof. Dr. Luca Mangani

Ehu Li
Prof. Dr. Andrew Paice

Floris Johannes Piso
Dr. Rolf Kamps

Fall 19 - Specialisation Projects 1 & 2

Griff in die Kiste (Bin Picking) mit modernen 3D-Vision-Systemen

Daniel Rohrer

Prof. Dr. Carsten Haack

**Analysis and Definition of Data Formats and Materials
for color-coded Components for patient-specific Applications
in Medical Technologies**

Tobias Walker

Prof. Dr. Thierry Prud'homme

Spring 20 - Specialisation Projects 1 & 2

A telemetry Antenna Design for the ARIS Space Project

Frederik Imhof

Prof. Marcel Joss

**Numerical Computation and Validation of the Stress
Field in an Overhead Line Conductor by Means of Sub-modelling**

Sascha Jabornegg

Prof. Ralf Baumann

**Localization and Navigation for Autonomous Shuttling
of a Mobile Robot**

Martins Ladzdins

Prof. Dr. Markus Thalmann

**Grundlagen zur Optimierung von Kranunterbauten mit
bionischen Algorithmen**

Floris Johannes Piso

Dr. Rolf Kamps

Fall 19 / Spring 20 - Master Thesis

Position Tracking of a Wireless Robotic Gripper with integrated IMU



Pascal Bozzini

Advisor: Prof. Dr. Ralf Legrand

The automation industry is one of the quickest developing branches of engineering that propose technological innovative solutions. In practice there is a growing need for implants to work faster, more reliable and to reduce the time for programming machines, such as robot arms.

This project comes from a vision: a gripper detached from the robot that could be handled by the movement of a human hand. This method tears down the programming's difficulty of the robot, because the only knowledge required is something as natural as a hand movement, while drastically reducing the programming time.

This project consists of a feasibility analysis of such a system through the use of an Inertial Measurement Unit (IMU) mounted on the gripper.

The results have shown that a standalone IMU system for position tracking cannot be used to track precisely enough of hand movements due to the drift coming from the double integration of the acceleration data. Therefore the system was enhanced by adding a camera and an Apriltags detection system as an external referencing system. The precision of the system created lies in the millimeter range.

Verbindung von Drahtlitzen mit Hilfe des Hot-Stacking Prozess

Die vorliegende Arbeit befasst sich mit dem Hot-Stacking Prozess im Bereich der Wicklungsfertigung bei der Firma maxon. Mit Hilfe der Erarbeitung der technischen Grundlagen im Bereich der Umform- und Fügetechnik wurden die Vorgänge in Bezug auf Temperatur, Kraft und Weg während dem Prozessvorgang aufgezeigt.

Dabei konnte ein qualitativer Prozessablauf, aufgeschlüsselt in die wichtigsten Prozessphasen dargestellt und damit der Zusammenhang der Parameter in Bezug auf die Prozesszeit analysiert werden. Welche Prozessparameter als Stellgrösse definiert werden können und welche Auswirkungen diese auf weitere prozessrelevante Grössen haben, wurde in Bezug auf Produktmerkmale schematisch dargestellt.

Mit Hilfe von einer Umformsimulation wurde die theoretisch auftretenden Umformkräfte ermittelt und durch praktische Untersuchungen verifiziert. Zudem sind Umformgrade im Werkstoff dargestellt und analysiert. Weiter wurde mithilfe eines thermischen Netzwerks und dessen Simulation die Prozess Temperatur aufgrund definierten Prozessparameter im Verlauf der Zeit dargestellt. Anhand der Analyse von geometrischen, elektrischen und mechanischen Produktmerkmale von Versuchsmuster wurden die Prozessparameter verifiziert.



Michael Durrer

Advisor: Prof. Dr. Carsten Haack

Acoustic Scene and Room Classification for Real-Time Applications



Silvio Emmenegger

Advisor: Prof. Dr. Jürgen Wassner

Acoustic signal processing is often accompanied by adaptive filtering in order to achieve optimal audio quality. In terms of hearing aids, the intention is an optimal speech intelligibility and environmental audio perception. We introduced a system which continuously recognizes acoustic environments using Artificial Intelligence (AI) in the form of a Deep Convolutional Neural Network (CNN) with focus on real-time implementation for adjusting hearing aids parameters. For training a custom dataset was acquired consisting of 23.8h of high-quality binaural audio data including five classes per label. Using a manual Grid Search method, three models with respect to different complexity metrics were optimized for a trade-off between accuracy and throughput. CNNs were then post-quantized to 8-bit which achieved an overall accuracy of 99.07%. After reducing the number of Multiply-Accumulates (MAC) by factor 154x and parameters by 18x, the classifier was still able to detect scenes and soundscapes with an acceptable accuracy of 94.82% which allows real-time inference at the edge on discrete low-cost hardware with a clock speed of 10 MHz and one inference per second.

Model-Based Predictive Control of Room Temperature

In today's buildings often only rudimentary room temperature controls are used. With such simple controllers, it can happen that heating is still running in the morning, even though the room is heated beyond the desired temperature in the afternoon due to sunny weather.

By using a model-based predictive control, external weather influences can be taken into account, comfort can be increased and also the heating energy demand can be reduced.

In the context of this thesis, the algorithms for the implementation of such model-based predictive control were combined in a software framework, which also allows integration into home automation. Several of those controllers can be instantiated in the software framework, which makes it simple to control several rooms.



Cyrill Hächler

Advisor: Prof. Dr. Thierry Prud'homme

Experimental and Numerical Investigation of Powder Material inside Additive Manufactured Particle Dampers



Gian Hauenstein

Advisor: Prof. Dr. Ralf Baumann

Particle dampers are a promising approach for passive reduction of vibrations. With additive manufacturing, it is possible to manufacture parts with embedded powder cavities.

The goal of this thesis is to determine the dynamic behavior of the internal powder in an additive manufactured particle damper. The research questions are:

- How can the energy dissipation of powder be characterized?
- In addition, what are the main dependencies for the product development of additive manufactured particle dampers?

In this thesis, the dynamic behavior of the stainless steel CL 20ES powder is modelled with the Discrete Element Method, which is a numerical method for simulation of particle motions and particle interactions. Due to the powder material used, which has particle sizes in the micrometer range and a high number of particles per volume, it is only possible to perform this investigation on scaled cavities in the millimeter range. The dynamic behavior of the powder is determined under harmonic base excitation of the cavity. This work examines the influence of different cavity sizes, cavity shapes, excitation amplitudes and frequencies on the energy dissipation.

F&E-Plattform Advanced

This thesis works on a Grid-Living and Mobility Platform on the HSLU, also called the F&E-Plattform. This platform was maintained and the data from the photovoltaic station was collected. The collected data is used for visualization. Further an important point of this thesis is to establish an advanced algorithm to control the energy flow of this platform. This algorithm not just includes the management of loads, it also maximizes the autarky and that should be complied with a Grid-beneficial behaviour. The work relied on previous studies, imbedded into the actual environment and elaborated for future development of the platform. The development is fast, the stressed fields are large and numerous technologies, components and interests are coming together. It is further a central building block in the change, pushed by society and now forced by the politics.



Raphael Hugi

Advisor: Prof. Dr. Jörg Worlitschek

OpenMV with i.MX RT



David Huwyler

Advisor: Prof. Erich Styger

Image processing applications with machine learning and neural networks are very computationally intensive and consume a lot of energy. New ARM Cortex M7 microcontrollers are capable of running these demanding applications.

The new microcontroller family i.MX RT by NXP with ARM Cortex M7 Core allows clock frequencies up to 1GHz. To evaluate the i.MX RT controllers, the open source image processing framework OpenMV was ported. Performance and power measurements were performed, the complex memory architecture was analyzed and comparisons were made to OpenMV on the STM32H7. Since OpenMV is based on MicroPython, it was ported to the i.MX RT family using the NXP SDK. For the development platform (Seeed-Arch-Mix Board with i.MX RT1052) a PCB was designed to connect various hardware extensions.

A complete OpenMV port for the i.MX RT1052 was created. Different cameras are supported, even thermal images can be evaluated. OpenMV on the i.MX RT1052 consumes 0.5W and has a performance comparable to the STM32H7. The developed hardware and software enable a comprehensive OpenMV platform based on the i.MX RT1052.

Electric Truck Energy Consumption Prediction: A Comparison of Models based on Physics, Linear Regression, and Artificial Neural Networks

E-Force One AG is an electric truck company based in central Switzerland. Predicting the energy consumption on a given trip is one of the challenges they face. This report shows a method based on the sub-systems: route predictor, speed profile predictor, and truck energy model.

Knowledge- and data- driven truck energy models were developed and compared by its performance. Physical models were found to have the best generalization. Linear regression was shown to be a good tool to extract physical parameters of a truck. Additionally, certain artificial neural network models show also a promising use case, especially when its structure is based on physics and its number of parameters is in balance to the available training data. The flexible number of parameters and the capability of neural networks to learn non-linear relationships gives it an edge over other models, in the way it is able to incorporate relationships that have not previously been thought of or are hard to predict.



Reto Müller

Advisor: Prof. Dr. Thierry Prud'homme

Smart Camera for 3D Inline Inspection



Silvan Murer

Advisor: Prof. Dr. Jürgen Wassner

Heliotis develops and commercializes 3D measurement systems based on white light interferometry. Due to the high accuracy and the short cycle time these measurement systems are used in production lines for quality control. In existing machine vision systems the topology information is transferred to and evaluated on a vision computer which communicates the inspection outcome to a higher level control unit. This thesis expands the measurement system to a smart camera. A framework for integration of inspection tasks is evaluated. A script based solution is selected and realized using the HALCON image processing library. Two interfaces for communication with a higher level control unit are implemented. For simple signalling digital IOs are used whereas numerical results are transmitted over EtherCAT. A demonstrator was built and the smart camera's performance is benchmarked vs. a conventional computer based solution.

Color-coded Components for patient-specific Applications in Medical Technologies

This paper provides the overall process description from creating and reading of medical images (DICOM), the segmentation of parts of the human body based on those images, the application of color-coded information onto these models and the use of the models for multicolor (4D) printing and further use cases. All of these process steps and the information used are patient-specific or could be used for patient-specific components.



Daniel Rohrer

Advisor: Prof. Dr. Carsten Haack

Offline Optimisation of Robot Movements in Bin Picking Applications



Tobias Walker

Advisor: Prof. Dr. Thierry Prud'homme

A time-consuming configuration is necessary to find fast and feasible robot movements and prevent collisions in a bin picking unit. With the simulation software RoboDK a real bin picking unit is emulated and two approaches are tested. The first approach simulates various paths of movement for each object and chooses the best one. In the second approach an artificial neural network is used. A multilayer perceptron without shortcut connections represents the implemented structure of the network. Both approaches are implemented, tested and analyzed. The brute force approach provides for each object a robot path if one exists. The more movements are simulated the more likely the best possible path is found. A trained neural network will always provide a solution too. But in contrast to the simulation this result does not have to be a feasible robot path. Therefore, the analysis of the output from the neural network is an important part.

DC-DC Converter for a Hybrid Accumulator in the Formula Student Electric

Accumulators used in electrically powered race cars need to provide high amounts of power while maintaining as little weight as possible.

Therefore the cell selection is a compromise between a high power density and a high energy density. A hybrid accumulator combines high energy density accumulators with supercapacitors that can provide very high amounts of power for a short period of time. To connect these two energy storages to the drivetrain, a DC/DC converter is needed to adapt the voltages.

In this thesis a prototype of a dual input synchronous boost converter for use in a hybrid accumulator in a formula student electric race car is assembled and commissioned. The prototype which uses silicon-carbide semiconductors and has a maximum power of 40 kW is commissioned in a laboratory environment.

The evaluation of optimal parameters for the design of the converter is determined using a multi-objective optimization implemented in Matlab and Simulink.

For the control of the converter a state space representation is determined and compared to a circuit simulation using PLECS.



Daniel Winz

Advisor: Prof. Dr. Adrian Omlin

Microwave Imaging for Detection of Breast Cancer



Simon Zuber

Advisor: Prof. Dr. Markus Thalmann

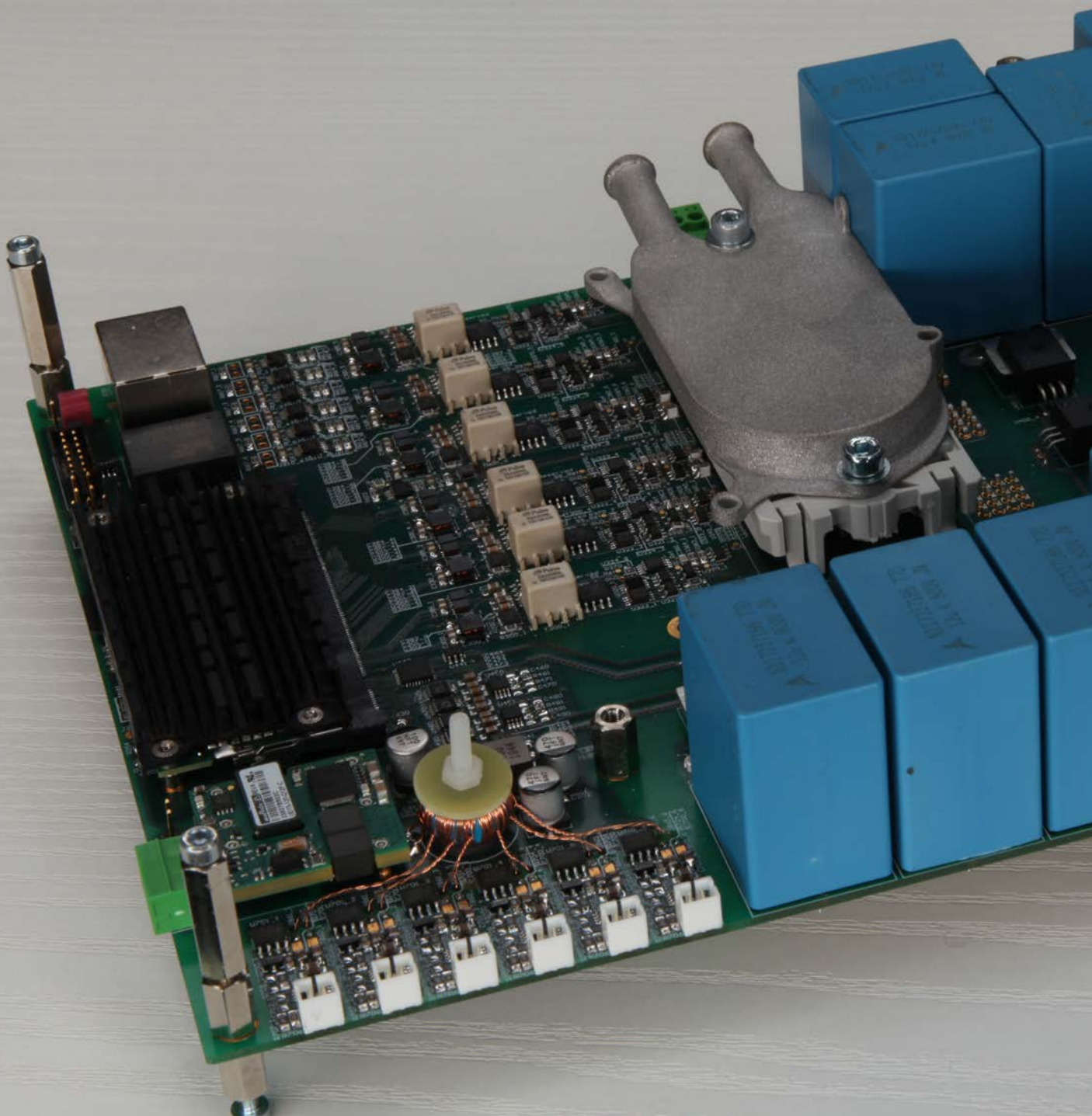
Microwave imaging is an early breast cancer detection method. In contrary to the mammography it does not have the disadvantages of X-ray stress on the breast, uncomfortable breast compression and high costs. A task that has not yet been solved satisfactorily is the design of a static microwave measuring system without moving antennas. The static design has the advantages that it is reliable, cheap and fast. The created simulation model of the static microwave measuring system shows the influence of the antenna geometry, the transmitter frequency, the tumor diameter, the tumor location, the breast size and the breast tissue on the detection accuracy. The presented prototype bases on the results of the simulations and consists of a 3D-printed measuring tank, 16 custom-made PCB patch antennas, a custom-made high frequency switch matrix PCB and a laboratory network analyzer. The produced measuring system detects the cylindrical tumor phantom with a diameter of 5mm in the measuring tank.

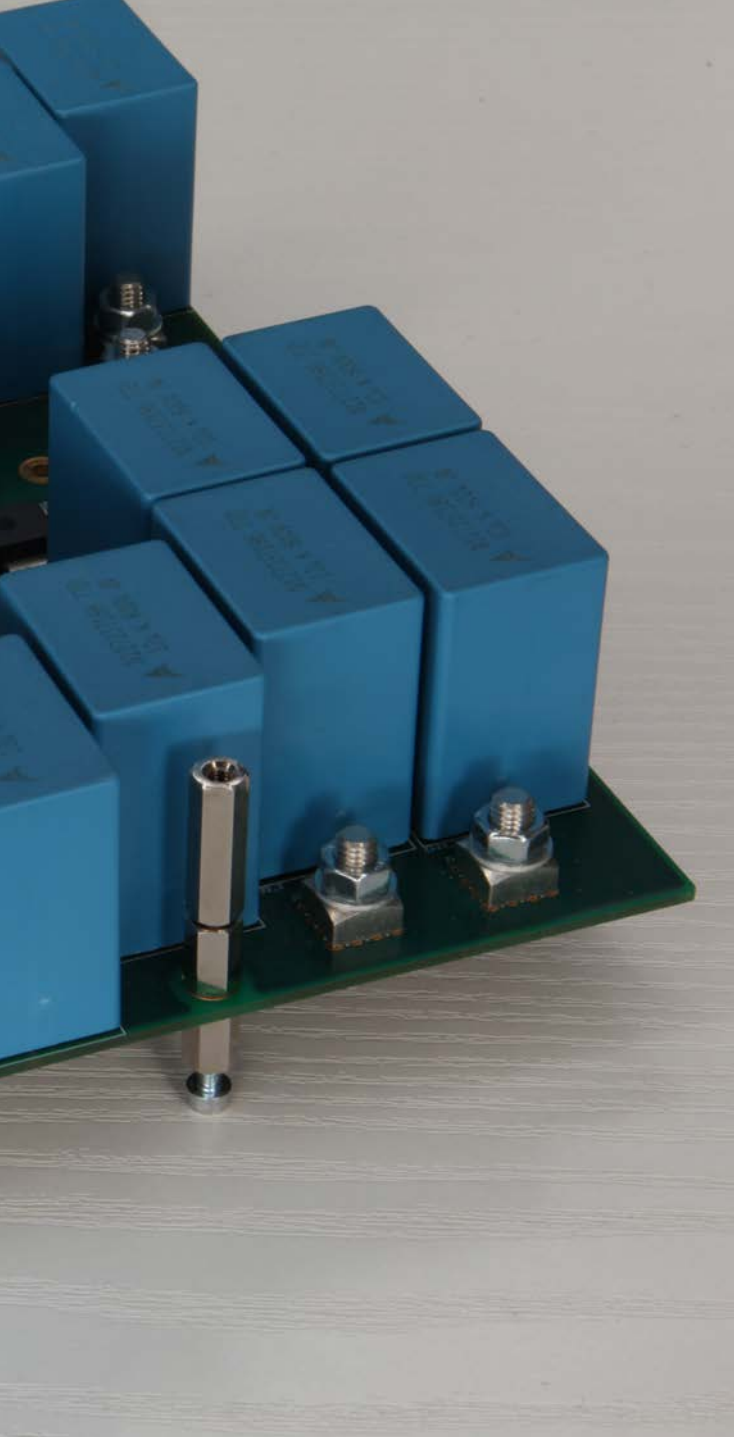
*What I will always remember about my time
spent studying my MSE is...?*

**The challenges in the first semester and
the development of efficiencies in
combining work and studies.**

*Raphael Hugi
Energy & Environment*







ICT

ICT - Embedded Systems

Foreword

Liebe Leserin, lieber Leser

Nichts ist so unsicher wie die Zukunft. Und Dinge, die unvorstellbar oder undenkbar sind, werden plötzlich Realität. Dies haben uns alle die Ereignisse im Frühling 2020 mit COVID-19 gezeigt. Es hat nicht nur die laufenden Forschungsprojekte beeinflusst und erschwert, es hat uns allen vor Augen geführt, dass vieles plötzlich möglich sein kann, im Guten wie im Schlechten.

Auf der positiven Seite hat COVID-19 eine neue und massive Digitalisierung der Gesellschaft und der Industrie angestoßen. Eine Wendung mit massivem Einsatz von Kommunikation, Informatik, Sensorik, Analysetechniken, auch unter Anwendung von Mikrocontrollern und eingebetteten Systemen. In kürzester Zeit wurden neue Technologien entwickelt, neue Ideen zu den Produkten realisiert und allgemein innovative Antworten zu komplexen Fragestellungen gesucht.

Genau in diesem Schmelzpunkt von Elektronik und Informatik zeigen unsere Master Absolventen im Gebiet ICT – Embedded Systems, dass sie ihren wichtigen Beitrag zu den Herausforderungen von heute und morgen leisten können. Damit Antworten für die Fragen gefunden werden. Auch wenn es in der Natur der Forschung liegt, dass Antworten immer neue Fragen aufwerfen.

Ich gratuliere den Absolventen herzlich zu ihren erbrachten Leistungen und wünsche ihnen viel Freude und Erfolg! Was auch immer kommen mag.

Dear reader

Nothing is more uncertain than the future. And things which are unthinkable or impossible can get real. This happened this springtime with the COVID-19 events. It not only impacted research projects, it showed us all that it can make things possible, for good or bad.

On the positive side, COVID-19 initiated a change to a digital world, both for society and industry. A shift with a massive use of communication, computer science, sensing and analysis technology, including using microcontrollers and embedded systems. In a very short time new technologies have been developed, new ideas transformed into products and innovative answers were sought for complex questions.

In this melting pot of electronics and computer science, our master graduates in ICT – Embedded Systems can make their contributions to the challenges of today and tomorrow. Ultimately to find the answers for the questions. Although it is within the nature of any research that answers will lead to even more questions.

Congratulations on your graduation and best wishes and success for your next adventure. Whatever may come!



Prof. Erich Styger
ICT - Embedded Systems

ICT - Embedded Systems Advisors



Prof. Dr. Marc Achermann

Focus: Modelling of physical effects; Terahertz, IR, optical and UV systems; optical sensors, receivers, LEDs and lasers



Prof. Dr. Ulrich Dersch

Focus: Aircraft data and sensor networks, smart grid data networks, power line communication, computer networks and protocols



Prof. Dr. Thomas Graf

Focus: Modelling of physical effects; Phenomena of acoustics, AC / DC and RF



Prof. Dr. Björn Jensen

Focus: Mobile robotics, localization, navigation, data fusion



Prof. Marcel Joss

Focus: Conductor-bound and wireless communication systems,
electromagnetic modelling and simulation, microwave,
compact antennas engineering



Prof. Othmar Schälli

Focus: Circuit technology, high frequency circuitry,
electroacoustics, communications engineering



Prof. Dr. Zeno Stössel

Focus: Indoor localization & navigation, sensors,
microtechnology



Prof. Erich Styger

Focus: Embedded systems, microcontrollers, internet of things
(IoT), digital forensics, wireless communications, robotics,
eclipse, ARM

ICT - Embedded Systems Advisors



Prof. Dr. Markus Thalmann

Focus: Microcontroller, FPGA and SOC programming, time of flight distance and occupancy measurement (TOF), system and processor architecture, HW / SW codesign, VHDL, IoT



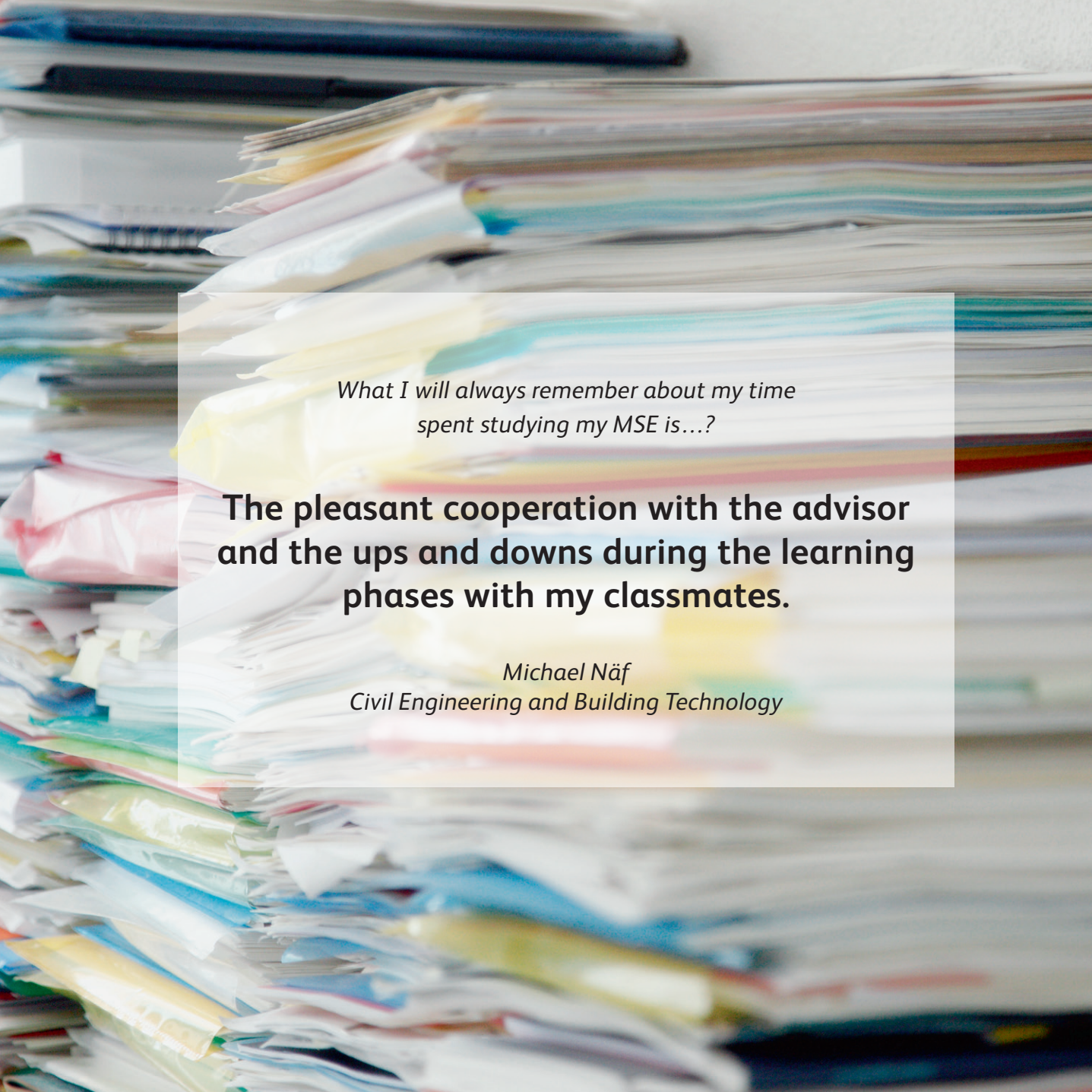
Prof. Dr. Jürgen Wassner

Focus: HW/SW codesign for embedded systems, realtime digital signal processing, model based design



Prof. Dr. Klaus Zahn

Focus: Video content analysis and vision sensors, image Processing, intelligent, cameras, sensor networks



*What I will always remember about my time
spent studying my MSE is...?*

**The pleasant cooperation with the advisor
and the ups and downs during the learning
phases with my classmates.**

*Michael Näf
Civil Engineering and Building Technology*

Fall 19 - Specialisation Projects 1 & 2

LoRa SmartSilo Satellite Gateway

Diego Bienz
Prof. Erich Styger

3D Laser Scanning for Mapping and Navigation

Livio Brunner
Prof. Dr. Markus Thalmann

Automatisierte Erkennung von Anomalien in Produktionsdaten

Daniel Klauser
Prof. Dr. Klaus Zahn

Optimization of neural networks for FPGA implementation

Michael Kurmann
Prof. Dr. Jürgen Wassner

Spring - Specialisation Projects 1 & 2

LoRaWAN mit Lacuna

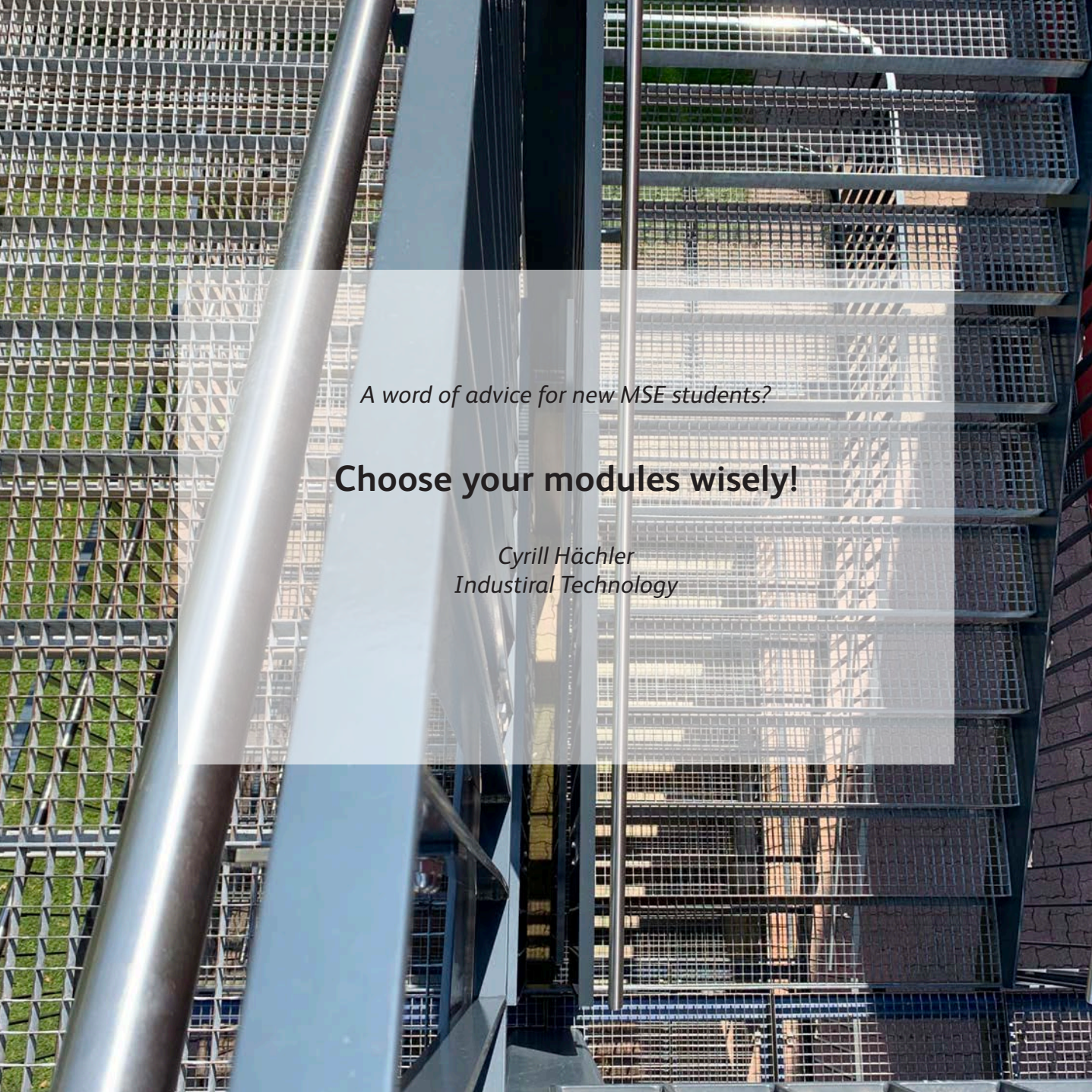
Diego Bienz
Prof. Erich Styger

Automatisierte Erkennung von Personenaktivitäten
in Videoaufnahmen

Daniel Klauser
Prof. Dr. Klaus Zahn

Secure RFID Reader

Ueli Leber
Prof. Erich Styger



A word of advice for new MSE students?

Choose your modules wisely!

*Cyrill Hächler
Industrial Technology*

Fall 19 / Spring 20 - Master Thesis

VR-Interface for Semi-Autonomous Robotic Exploration



Livio Brunner

Advisor: Prof. Dr. Markus Thalmann

In this work an interface of VR to mobile robots is developed. For this task, the VR headset HTC Vive Cosmos is used. The interface can be applied to any mobile robot based on the Robot Operating System (ROS). The virtual environment (VE) viewed by the operator with the VR headset, as well as the controlling of the robot, is realized with the game engine Unity. The VE is visualized with offline data by Swisstopo. Additionally, sensors on the robot provide information of the environment at runtime. These sensors are 360° camera, stereo vision camera, and 3D light detection and ranging laser scanner. These sensors are realized and integrated in the interface and tested separately. A system test on an actual robot is pending. In the VE, the operator can intuitively set a goal position by the controller which the robot can reach autonomously. An evaluation with several test subjects confirms the advantage of perception of the environment and the controlling of the robot while using VR.

Design & Implementation of a Scalable CNN Accelerator

Deep Convolutional Neural Networks (CNNs) have become indispensable for computer vision tasks due to their high accuracy. While large efforts are made to confine the high computational costs of CNNs, low power embedded devices struggle to achieve a real-time frame rate.

In this work, we present BinArray, a hardware accelerator for Binary Approximated Convolutional Neural Networks (BACNNs), which provide a configurable trade-off between accuracy and complexity. BinArray translates this trade-off into a task specific compromise between area, throughput and accuracy depending on the given constraints. Its Systolic Array (SA)-architecture is scalable for different sizes of BACNNs ranging from a GTSRB CNN to large MobileNets. We implemented BinArray on a Xilinx Zynq FPGA. Without losing accuracy, an accelerated BACNN achieves a throughput of up to 92.1 FPS on GTSRB compared to a CPU with only 7.9 FPS. BinArray accomplishes this while using less than 2 % of the logic available on a mid-sized FPGA.



Mario Fischer

Advisor: Prof. Dr. Jürgen Wassner

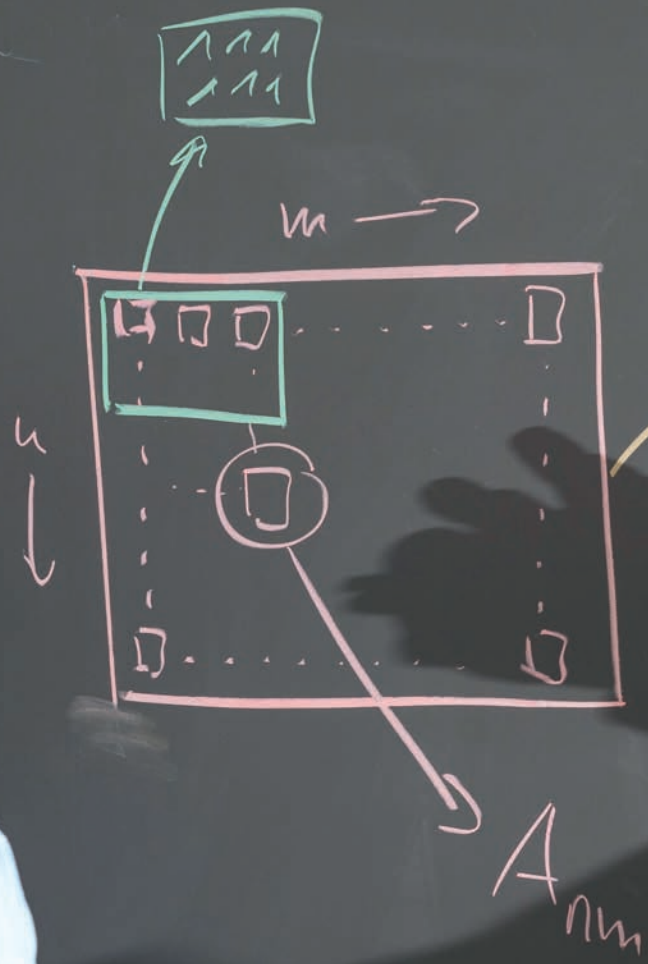
Acoustical System Identification



Pascal Jund

Advisor: Prof. Dr. Thomas Graf

This paper concerns the measurement of an acoustical impulse response of a room. To achieve this goal, a hardware platform was developed to determine the complex frequency spectrum between a sound source and a receiver. A loudspeaker serves as a sound source to expose the room to acoustical pressure waves. The loudspeaker passes stepwise through the audible spectrum. Four microphones measure the signals at different positions in the room. As soon as a steady state condition is reached, the phase and amplitude of the signal are computed. Subsequently to the spectral measurements, the impulse response can be calculated. The impulse response can be used to simulate the acoustical behavior of a room. For example, a song can be computed to sound exactly if it was played in a room where a measurement has been done.



$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$







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Hochschule Luzern – Technik & Architektur
Master of Science in Engineering

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Prof. Erich Styger – Foreword
MSE Students – Text, Master-Thesen
Elio Amato – Layout
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