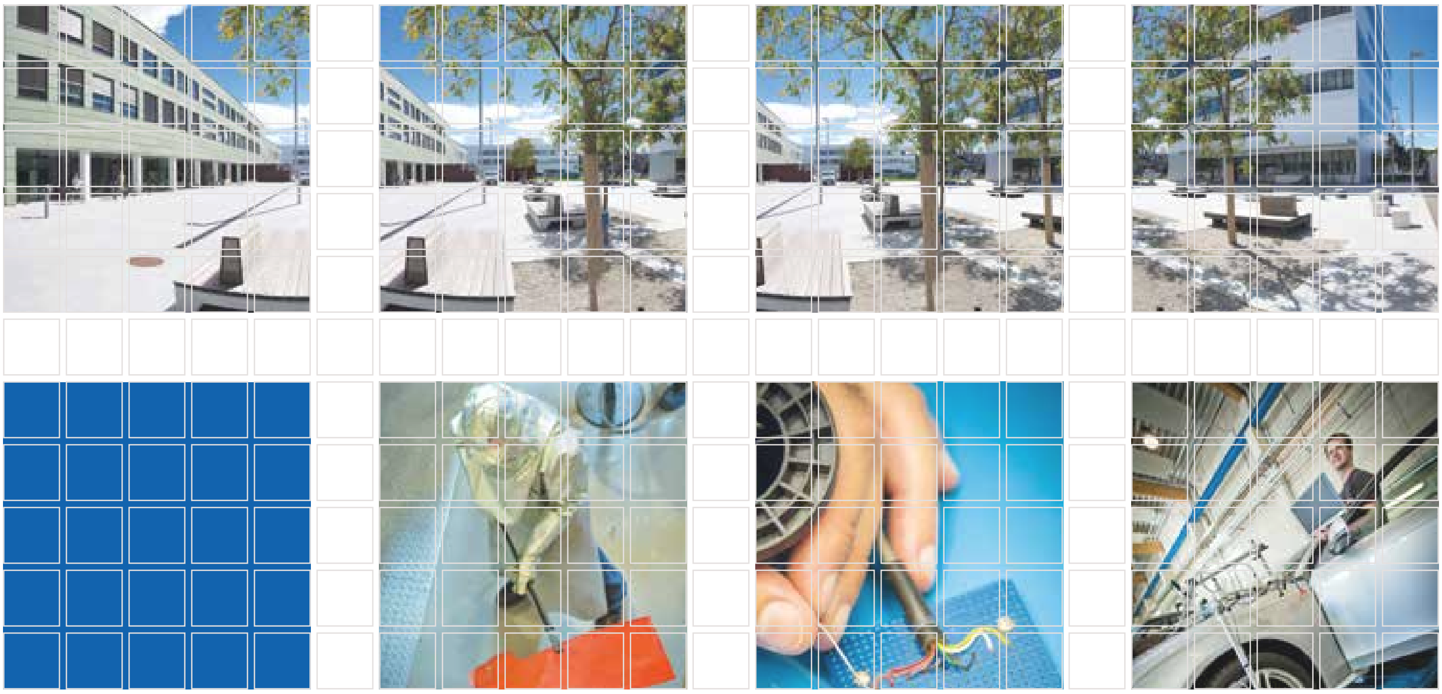
[FSI]



Annual Report 2017
Activity Report

Table of Contents

PREFACE

Andrea Hoffmann
Vice Rector Finance and Human Resources

Horst Bischof
Vice Rector Research

This FSI Activity Report 2017 once again presents the results and activities of the FSI, the successful cooperation between Magna and TU Graz.

The year 2017 was all about extension: In July the expansion of the FSI building started and we are looking forward to open the new floor in summer/autumn 2018, when the FabLab will find enough room – about 800 m^2 – and the biggest Makerspace in Austria will be able to move into its new premises.

Throughout the year the Coordination FSI organized several events – also looking beyond our immediate field of research. In a **guest lecture** on participatory design and diversity perspectives **Corinna Bath** gave an enlightening insight into her research field „Gender and Technology".

The **Annual Project Meeting**, where not only the three FSI Institutes were invited to present their research projects, results and outlooks but also the Science Park, the Institute of Automation Control and the Institute of Production Engineering.

The **FSI Recruiting Day**, which helps TU Graz students and companies to get in contact. As well as being keen to educate our students for being well-trained specialists, we also want to play an active part in their recruiting.

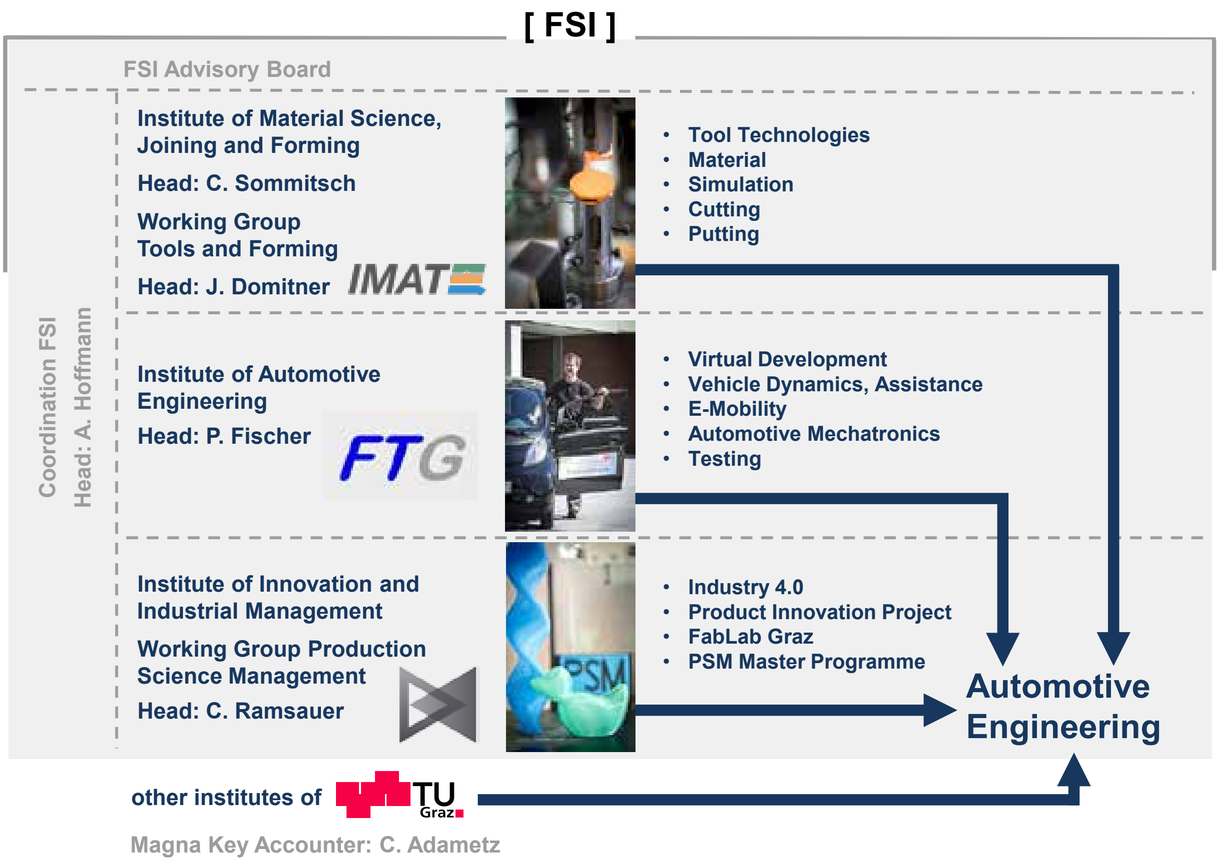
We also started a cooperation with the WKO, the Austrian Economic Chamber, to encourage the knowledge transfer between educational institutions.

In the following, the report shows a summary of activities and events at FSI in 2017. Since the beginning of the cooperation **teaching activities and research projects** have been the main pillars of the cooperation and remain the core business at FSI.

On behalf of TU Graz, we want to thank all our members and partners for the constructive collaboration througout the year.

Photos: © Schuller / FSI – TU Graz

FSI ORGANIZATION



FSI Organization Chart 2017

The FSI is an independent academic institution integrated into the Faculty of Mechanical Engineering and Economic Sciences at TU Graz. Its three institutes – FTG, IMAT, and IIM – pursue their own special research and teaching interests. They are guided by the FSI Advisory Board and supported by the Coordination FSI whose head is the Vice Rector for Finance and Human Resources.

The Coordination FSI is a one-stop service centre for FSI partners, FSI employees and FSI students, supporting communication between partners, Magna and TU Graz as well as between the FSI institutes.

The Coordination FSI

- prepares the Advisory Board meetings
- supervises the FSI Scholarships,
- organizes guest lectures and visits at FSI
- organizes events as the Recruiting Day and the Annual Project Meeting

The main tasks of the Coordination FSI are:

- reporting
- budgeting
- budgetary control of the FSI budget
- the ongoing administration of the FSI website www.fsi.tugraz.at

FSI Advisory Board Members

The FSI Advisory Board is composed of three representatives of Magna and TU Graz respectively.

At the end of 2017 Shadi d'Amelj is appointed as member of the FSI Advisory Board instead of Gabriele Ferrufino Vidal. In 2017 three regular meetings took place at the FSI in February, May and October. In these meetings the Advisory Board performed their main duties and responsibilities including:

- the definition and monitoring of common research areas
- reporting and evaluation of scientific results
- budgeting and budgetary control of the FSI budget
- defining the selection criteria as well as selecting the students for the hearing and awarding of the FSI Scholarships for qualified students

Photo: © Bergmann – TU Graz

FSI RECRUITING DAY 2017

On 26 January, 2017 the FSI Coordination organized the Recruiting Day. It was the third Recruiting event in series, where representatives of partner companies such as AVL, Mahle, Miba, Ventrex and Magna – represented by Magna International, Magna Powertrain, Magna Steyr Fahrzeugtechnik – met well-prepared students of TU Graz. The Career Info-Service of TU Graz and the IAESTE, an international student organization, were also part of the event.

After the opening of the event by Werner Raith, Head of CoC Recruiting / Human Resources Magna Steyr and Horst Bischof, VR for research at Graz University of Technology, company presentations were held in a well-filled lecture hall. The IAESTE Graz (International Association for the Exchange of Students for Technical Experience) and the Office of International Relations of Graz University of Technology presented „internships abroad". Under moderation of Christoph Adametz (Career Info-Service, Magna Key Account Manager), Sigrid Koller (AVL), Bernhard Reisner (MIBA) and Christopher Opetnik (Mahle) discussed intensively the topic „Industry 4.0 – Changes in the Working World". The opportunity to continue networking at the lunch buffet was used by numerous participants.

In cooperation with a local newspaper The FSI offered a free application photo shooting as well as a free CV check (in German or English) performed by experts of a personnel consulting company of Graz. These additional offers generated particularly strong interest from the students and were fully booked.

Top: Panel discussion on „Industry 4.0 – Changes in the Working World"
Middle: Magna presentation in the lecture hall
Bottom: Students at the Magna company booth
Photos: © FSI – TU Graz

ANNUAL PROJECT MEETING 2017

Top left: Werner Raith (Magna Steyr), Christian Ramsauer (IIM) and Andrea Hoffmann (VR TU Graz) at the poster session

Top right: FabLab Tour

Middle left: Talks of Dave Pascoe (Magna Int.) and Horst Bischof (VR TU Graz)

Middle right: Discussions at the poster session

Left: The audience in the lecture hall

Photos: © FSI – TU Graz

On 15 May, 2017 the Annual Project Meeting took place in the FSI building. After the opening of Andrea Hoffmann (TU Graz) and Shadi d'Amelj (Magna International) several interesting lectures were given.

Dave Pascoe (Magna International) spoke on „Innovationg for Future Mobility", Horst Bischof (TU Graz) gave an update on the R&D topics at TU Graz. Not only the three FSI institutes but also the Institute of Automation and Control (Martin Horn), the Institute of Production Engineering (Franz Haas) and the Science Park Graz (Martin Mössler) were invited to give an overview of their structures, focuses and projects. Gerhard Krachler and Horst Bischof gave an outlook on further possibilites for a collaboration of Magna and TU Graz, based on the successful cooperation of the last years.

During the poster sessions about 20 posters of researchers and students of the participating institutes were presented. Additonally there was a FabLab Tour and the Networking buffet at end of the meeting provided another opportunity for individual talks and further discussions.

GUEST LECTURE CORINNA BATH

Barbara Herz (Office for Gender Equality and Equal Opportunity, TU Graz), Corinna Bath (University of Braunschweig and the Ostfalia University of Applied Sciences), Harald Kainz (Rector, TU Graz), Armanda Pilinger (Office for Gender Equality and Equal Opportunity)

Photos: © fotogenia – TU Graz

„Innovation in Vehicle Development: Participatory Design and Diversity Perspectives“

Technical studies and professions are still strongly male-dominated. Many scientific studies show that this has effects on the products that emerge in such homogeneous development teams.

Often – without reflecting on this – a „first-person methodology“ is applied. With that a resarcher or developer imaginge themselves as typical representatives of the target group. Or, technical and social standards are not checked for appropriateness and possible social exclusions. However, with the help of participatory development methods and a broad integration of gender and diversity perspectives, these problems can be overcome.

Such exclusion problems were explained and illustrated in the lecture with a focus on automotive engineering, as well as case studies how to avoid these mistakes in planning were presented. In addition, Corinna Bath demonstrated how innovative product developments can be created by means of participatory approaches combined with gender research perspectives. Rector Kainz opened the event and moderated the lively discussion afterwards. The buffet was used for further discussions and networking.

With the lecture at the FSI Prof. Dr.-Ing. Corinna Bath concluded the interfaculty international guest professorship „Gender & Technology“ at TU Graz, which she held from October to December, 2016.
Since December 2012 Corinna Bath has held the Maria Goeppert Mayer Professorship „Gender, Technology and Mobility“ at the Technical University of Braunschweig and the Ostfalia University of Applied Sciences.

Further Informationen on Corinna Bath:
https://www.tu-braunschweig.de/gtm

FSI OTHER ACTIVITIES 2017

Master pupils an their lecturers of the WIFI (Institute for Professional Advancement) course of Automotive Technology at the FSI
Bottom: Mario Hirz of the Insitute of Automotive Engineering in the lecture hall

Photos: © WIFI / FSI –TU Graz

WIFI master schools cooperate closely with TU Graz

30 prospective automotive technicians and their WIFI trainers learned about the latest research trends at TU Graz in their field. This acitivity organized by the Coordination FSI is a pilot trial which is planned to be continued and extended to other technical fields.

In four lectures by researchers from several institutes of TU Graz - Mario Hirz (Automotive Engineering), Manfred Klell (HyCenta), Wolfgang Sinz (VSI) and Peter Grabner (IVT) gave with their lectures an comprehensive picture of the mobile future - from alternative drives to the latest developments in vehicle safety. The technical implementation was shown during lab tours. An essential part of the event was also the active exchange and discussion between the teaching staff, the researchers and the students. This event demonstrates the importance of exchange between the WKO [Austrian Economic Chambers] educational institutions and universities.

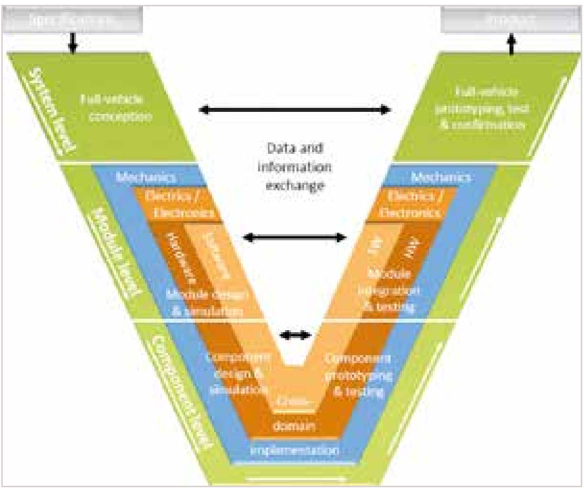
WKO President Josef Herk also pointed out that the future masters will benefit from this exchange of knowledge as well as TU Graz. Rector Harald Kainz and vice rector Andrea Hoffmann added that it is not only important to establish valuable contacts with numerous companies and budding young entrepreneurs but also to demonstrate researchers how their developments could be put into practice.

TEACHING AT FSI

MECHATRONICS ACADEMY

Mechatronics systems have an increasingly share in automotive applications, e.g. in infotainment and driver assistance functions, comfort and safety, and of course in propulsion technology.

The development and production of mechatronics systems requires deep knowledge and understanding of the wide ranging integration of mechanical, electrics/electronics and software domains. A key factor for success is the knowledge of staff involved into the entire product development and production chain. In a close co-operation with MAGNA Powertrain, FTG developed and conducted a 7-week-training programme for more than 150 employees at international locations. The courses include an introduction of structures and functions of automotive mechatronics systems and focus on the integration of the domains mechanics, electrics and electronics including software. In addition development processes are introduced and discussed in terms of their application and optimization for Magna products. A specific focus is put on electric motors for auxiliary devices in internal combustion engines, and their integration into formerly mechanical systems. The course gives also insights into simulation methods and software development, as well as different automotive standards and product verification and quality procedures.



TOOLS AND FORMING

The teaching focus is on providing a basic knowledge of forming technology and non-cutting manufacturing. A variety of technical services and consulting are also offered to industry.

Research focuses include tool technology, materials, simulation, cutting and joining. Among other things, the (former) Institute of Tools and Forming developed and built the prototype of an induction furnace for the automobile industry. The induction furnace was meant to speed up the production of component parts with ultra-high strength properties and considerably reduce energy expenditure.

TEACHING AT FSI

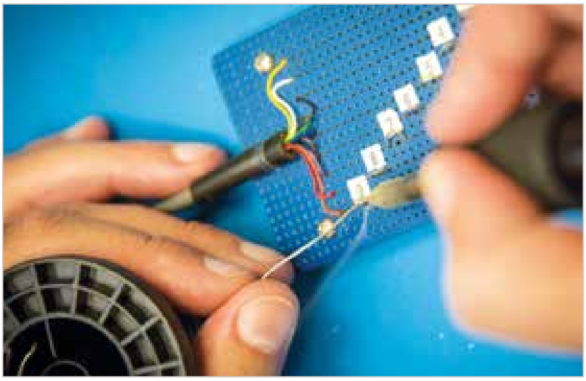
PRODUCTION SCIENCE AND MANAGEMENT

Since many years, the topic of production has gained a higher importance in Europe and North America. Industrial companies have to compete with low-cost countries around the globe. To keep production and therefore jobs in Europe and North America, companies have to increase efficiency and have to deal with new production technologies on a regular basis.

The master's program Production Science and Management is reacting to this trend. It deals with the topics of production management, production technology, and social economics. Additionally, experts from industry are employed as lecturers to discuss real life challenges and new trends in production.

The master´s program Production Science and Management has been offered since 2007 at TU Graz. All courses are held in English language to prepare students for international careers. In the winter semester 2016/17, 131 students were registered for the program and the number of students is raising every year.

The master´s program is supported by the Working Group (former Institute) of Production Science and Management, which is now part of the Institute of Innovation and Industrial Management, led by Prof. Dr. Christian Ramsauer. The idea for the master´s program Production Science and Management is to prepare students for the challenges of industrial companies.



Master's program Production Science and Management

Duration of study: 4 semesters
ECTS credit points: 120
Academic degree: „Diplom-Ingenieurin“ or “Diplom-Ingenieur (Dipl.Ing. oder DI)“, equivalent to the Master of Science (MSc)

Content

- Deepen fundamental knowledge in production science and the economic sciences
- Understand current theories, principles and methods of production science and apply these in practice
- Combine technical knowledge with economic capabilities and social as well as international competence skills
- Gain knowledge about building up industrial production: product development, planning, procurement, production, sales and marketing
- Conduct independent research and application-oriented projects
- Prepare and present results of work effectively by using modern tools
- Write scientific reports
- Develop and hone social skills such as teamwork, team leadership and negotiation strategies
- Improve English terminology and gain international experience through subsidized stays abroad

Specialization Subjects

- Advanced Technologies or
- Management and Social Economics.

For more information please visit:
fsi.tugraz.at/studying

IIM – INSTITUTE OF INNOVATION AND INDUSTRIAL MANAGEMENT

The IIM LEAD Factory

The IIM LEAD Factory is a miniature industrial manufacturing site situated on 55 square meters at Graz University of Technology containing an assembly line of a real-life product.

Efficient work involves applying the right methods – either on a small or large scale. Therefore the Institute of Innovation and Industrial Management established the real-world learning factory for the assembly of on the market available scooters with TU Graz design. Lectures and Workshops at the IIM LEAD Factory provide knowledge concerning sustainable improvements on lean management, energy efficiency, agile operations and digitalization (LEAD).

Gaining a hands-on experience is the central focus behind a learning factory and for this reason “learning by doing” has become our slogan. Not only students but also companies of every size and industry can learn hands-on to turn an inefficient production process into a “leaner”, more energy efficient and agile process during our LEAD Factory workshops. Furthermore, as Industry 4.0 and digitalization are getting more interesting in industry, the LEAD Factory is enhanced by up-to-date digital production technologies.

Besides practice-oriented trainings, the IIM LEAD Factory also serves as a research platform for advanced manufacturing technologies and processes. As it is a realistic mockup of an assembly area as it is set up in every manufacturing company, it is predestined to serve as a test-bed for state of the art technologies. The direct impact of such technologies can be experienced in LEAD Factory workshops and companies can then discuss the implications and transferability of these technologies to their own facilities. Active experience of modern technologies and methods in a real life manufacturing environment coupled with discussions and an exchange of perceptions and examples among different companies and industries with academia are the aim of the IIM LEAD Factory.

FABLAB GRAZ

FabLab Graz will transform to a product development hub for students, startups and industrial partners

The new FabLab Graz will not only offer state of the art digital production equipment for prototyping and small batch size production, but also infrastructure for co-working, product testing and demonstration. The new mandate is to assist all users – students, startups and industrial partners – with support and solutions along the product development process from idea generation to market launch.

FabLab Graz was launched as the first Austrian university based FabLab in 2014. Neil Gershenfeld from the Massachusetts Institute of Technology (MIT) set up the first FabLab (Fabrication Laboratory) worldwide in 2002. The basic idea of this global network is to offer possibilities for every individual to invent and build hardware products themselves by having easy access to capabilities for designing, manufacturing, distributing and knowledge. At the current FabLab Graz you can find machines like a laser cutter, CNC milling machine and various 3D printers. Moreover, tools for traditional manufacturing activities such as metalworking, woodworking and electronics prototyping are provided. In 2017 the construction of the new FabLab started. To become the biggest FabLab in Austria 800 m² will be created.

Opening in November 2018, the Institute of Innovation and Industrial Management will offer state-of-the-art production machines, a multifunctional room with high end multimedia equipment, co-working areas, brand-new creative areas and collaborative meeting rooms. With this new space and equipment, it will be possible - for companies, entrepreneurs and students - to come up with successful products out of their ideas. Prof. Christian Ramsauer, Head of the Institute of Innovation and Industrial Management, has a strong focus on teaching practical skills and applying them creatively. Therefore, he heavily encourages students to invent and prototype in lectures like the “Product Innovation Project” and in research done in cooperation with leading industrial partners. Open to inventors, entrepreneurs and creatives, FabLab Graz is a place for learning, prototyping and idea exchange to foster product innovation. For more information, visit fablab.tugraz.at.

RESEARCH HIGHLIGHTS 2017

INSTITUTE OF AUTOMOTIVE ENGINEERING, DEP. OF AUTOMATED DRIVING, DRIVER ASSISTANCE SYSTEMS

Figure 1: HMI for different automation levels: a) manual, b) semi-automated and c) automated

Application of a Driving Simulator for Human-in-the-Loop Testing of Automated Driving Functions

Currently a great barrier for market introduction of automated driving functions of SAE level 3 and higher, is still an unsolved problem of safety proof and/or guarantee of a fail-safe operation. On the other hand, drivers' acceptance and trust in automated driving function is crucial for their use and market success.

The dissertation project IAFA on the Institute of Automotive Engineering, in cooperation with Magna, deals with this problem. The project goal is to investigate the potentials for applying virtual tools in the development process of automated driving systems.

For this purpose, during the summer 2017 a driver simulator study with multiple participants was conducted as a part of a novel approach that integrates a driving simulator in a virtual development process aiming to reduce the effort for system development. The approach is demonstrated on a specific automated lane change assist (LCA) system. Therefore, the LCA function and the corresponding human machine interface (HMI) are developed and implemented in the driving simulator. In this study with 20 volunteer drivers, the LCA system is evaluated with respect to driver acceptance and user friendliness. The method proposes a novel two stage testing concept in order to provide better insight into the overall system performance and detect potentials for improvements separately on both – the function and the HMI of the system. The results of the study are used for the parametrization and fine tuning of the LCA function as well as for the HMI improvement.

The first objective of this study was the investigation of drivers' performance on the one hand, and drivers' acceptance of the automated driving function on the other. Thus, LC initialization timing and LC duration, as the two main comfort criteria by overtaking, were evaluated in the driving simulator using some standard scenarios with overtaking manoeuvres on highway.

Along with the LCA function, a corresponding human machine interface (HMI) is developed as well. The HMI is realized using two tablet computers. The main one is positioned behind the steering wheel as a dashboard and represents the core of the HMI (Figure 1). Its graphical design is principally dedicated for the LCA support.

Since drivers will still need to monitor and inspect the

Figure 2: Driving simulator showing a lane change manoeuver

actions of the next generation automated ADASs, drivers' acceptance of these systems will depend at great extent from usability and user friendliness of a HMI. Therefore the second objective of the study was to test and evaluate the quality of the developed HMI system. The aims and aspects of the two stages can be summarized as following:

- The first stage investigates drivers' preferred LC initiation timing and LC duration using four basic LC traffic scenarios. The kinematic constellation of each scenario is fixed and therefore same for every participant. The advantage of scenario repeatability with driving simulator is utilized here. The findings from this test stage can be used later to define rules and parameters for the control strategy of the LCA function.

- In the second test stage the LCA system is tested on a highway scenario with the microscopic traffic flow simulation. In this stage, the overall acceptance of an automated LCA system is evaluated in a "naturalistic" traffic scenario on highway. The traffic flow test concept provides information about the overall drivers' impression regarding usability of the LCA system in three automation levels: manual, semi-automated and automated. Hereby the focus is on the HMI concept, with its logic, design and related drivers' subjective workload, comfort and safety.

The study was conducted using the fixed base full vehicle driving simulator of the Graz University of Technology. The simulation of the microscopic traffic flow is carried out by PTV Vissim software (Leyn & Vortisch 2015) in co-simulation with the ego-vehicle dynamics. This is essential since the dynamic interaction between the ego-vehicle and the traffic is a key element for test and validation of the LCA system in the second testing stage. Figure 2 shows the view out of the driving simulator during one LC manoeuvre.

A total of 20 drivers, 10 males and 10 females, participated in the study. Age range of all but two participants was from 20 to 61 years. Beside gender and age distribution criteria by the participants selection, another criteria of minimum annually mileage of 10,000 km, predominantly on highways, was set in order to target the end-user group of skilled drivers. The main goal of this study was to demonstrate the potentials of the novel method and the application of a driving simulator for a development of ADAS. However, the results of will be used for the parametrization and fine tuning of the LCA function as well as for the HMI improvement. In this way the LCA system is being prepared for its potential implementation in a real vehicle and reduces the amount of the costly on road tests.

RESEARCH HIGHLIGHTS 2017

INSTITUTE OF AUTOMOTIVE ENGINEERING, DEP. OF VEHICLE DYNAMICS AND TYRES

Photo: © Magna Powertrain

Vehicle Dynamics Observer

Within a cooperative project between Magna Powertrain and the Institute of Automotive Engineering, a real-time capable vehicle dynamics observer was developed. As a highlight, a novel algorithm to estimate the road condition during driving was developed.

The road condition is one of the most important inputs to safety relevant control systems like ESP, respectively for advanced torque vectoring strategies. The latter shall improve driving performance, especially when operating the vehicle close to the physical limits. In this way, agility of the vehicle during cornering can be improved. Since this application is highly safety critical, a methodology to detect the current road condition has to be robust and deliver reproducible results for all conditions (lighting, different temperatures, different driving styles etc.) that may occur during vehicle operation.

A control strategy was developed for robust estimation of the road condition in certain driving scenarios. The aim of the developed control strategy during this project was to deliver estimates with high accuracy rather than to detect very fast changes of the road condition. In addition, vehicle states like the yaw rate or the wheel speeds can be estimated by the vehicle dynamics observer in real-time and used within advanced vehicle dynamics control strategies. For this purpose the observer includes a model (16 DOF, springs, dampers, simple tyre model) of the vehicle that is more complex than the normally used approaches via one-track model.

As a next step, vehicle tests are planned to validate and improve the developed algorithms. Optimization of the algorithms to different driving scenarios will be the topic of possible further cooperation. The project was carried out by Christian Prettenthaler (MPT), Liang Shao and Cornelia Lex (both Institute of Automotive Engineering).

INSTITUTE OF AUTOMOTIVE ENGINEERING, DEP. OF VIRTUAL PRODUCT DEVELOPMENT

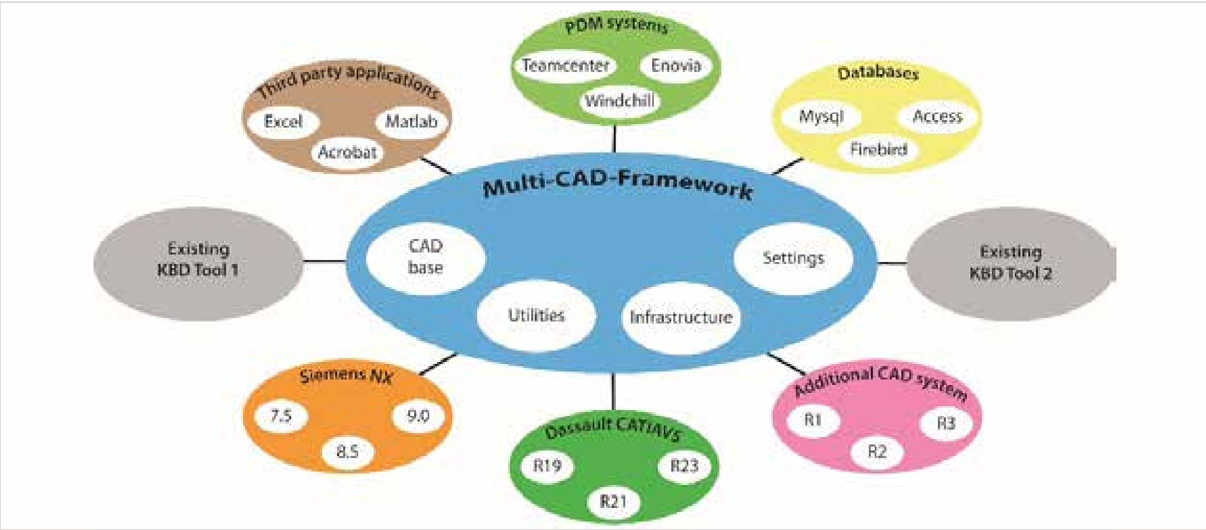


Figure: SDK layout for a Multi-CAx environment

Knowledge-based Design Methods in Multi-CAD Environment

Today, the virtual development in automotive design is characterized by a huge variety of different CAx systems, applied methods and strategies. In order to reduce the required development time and to increase the product quality at the same time, CAx based applications are used to support engineers during the design process.

Those applications enable the automation of existing functionalities of the originating CAx application, the development of new functionalities and the storage of engineering knowledge in the corresponding object model and require therefore the exposure of commands and functionalities of the CAx application to the API (Automation Program Interface). This leads to a high programming effort, since automotive supplier companies like MAGNA, have to use multiple software vendors for a CAx application due to customer requirements and due to specific strengths and weaknesses of specific systems, e.g. different releases of CATIA V5 and V6 and of NX in terms of CAD. Since a CATIA based application works differently from an NX based application, due to different API and design strategies, today typically separate applications will be programmed for each CAD system.

Therefore, the PhD project has focused on the development of a knowledge based engineering (KBE) automation strategy, enabling the development of CAx applications capable of supporting multiple CAx programs, as well as the definition of program interfaces, enabling the consistent connection of different CAx tools at MAGNA. The output is a software development kit (SDK), which includes methods, strategies and instructions for the creation of multi-CAx applications along specific guidelines for the deployment of developed applications at MAGNA.
During the project, various applications have been developed using the SDK which are currently used at MAGNA worldwide. The presented approach allows a high efficiency in the creation of new CAx based applications and ensures the preservation and consistent deployment of engineering knowledge throughout the whole company.

RESEARCH HIGHLIGHTS 2017

IMAT – INSTITUTE OF MATERIALS SCIENCE, JOINING AND FORMING, RESEARCH GROUP TOOLS AND FORMING

Numerical simulation and experimental validation of self-piercing riveting joints

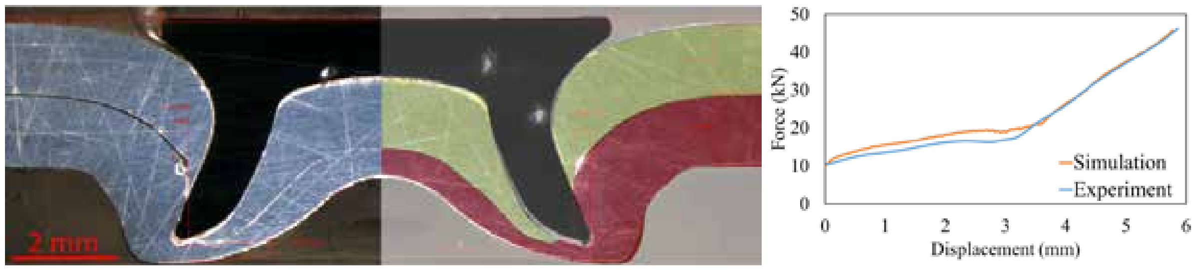


Figure: Comparison between experiment and simulation: SPR joint cross-section (left) and punch force-displacement curves (right)

To fulfill the requirements in terms of emissions, fuel consumption and performance for modern vehicles, lightweight design is one of the key topics in car body evolution. The increasing variety of materials used for the body-in-white causes new challenges for joining processes, since thermal joining is often difficult or even impossible.

Mechanical joining processes such as self-piercing riveting (SPR) are therefore increasingly used for multi material joints. Due to the huge number of rivets and dies on the market, a reliable simulation model is required to predict the rivetability of the blank stack with the chosen configuration of rivet and die.

In the presented study a 2D axisymmetric model of the SPR process for joining aluminium alloy 6xxx blanks was built and validated with experimental data. In order to get optimum simulation results, the material behavior of blanks and rivets was investigated using uniaxial tensile tests and compression tests. The geometrical data of the rivets and dies were determined using an optical measurement system.

To consider the complex friction behavior a combined friction model of Coulomb's friction and shear friction was applied and the friction coefficients were calibrated iteratively using inverse modelling. The validation of the numerical results was conducted using cross-sections of SPR joints and force-displacement curves measured during the riveting process. The comparison between experiments and simulations revealed that the numerical model represents the SPR process quite well and that the model is able to predict the riveting results very accurately.

Simulation of springback occurring in deep-drawing of advanced high-strength steel sheets

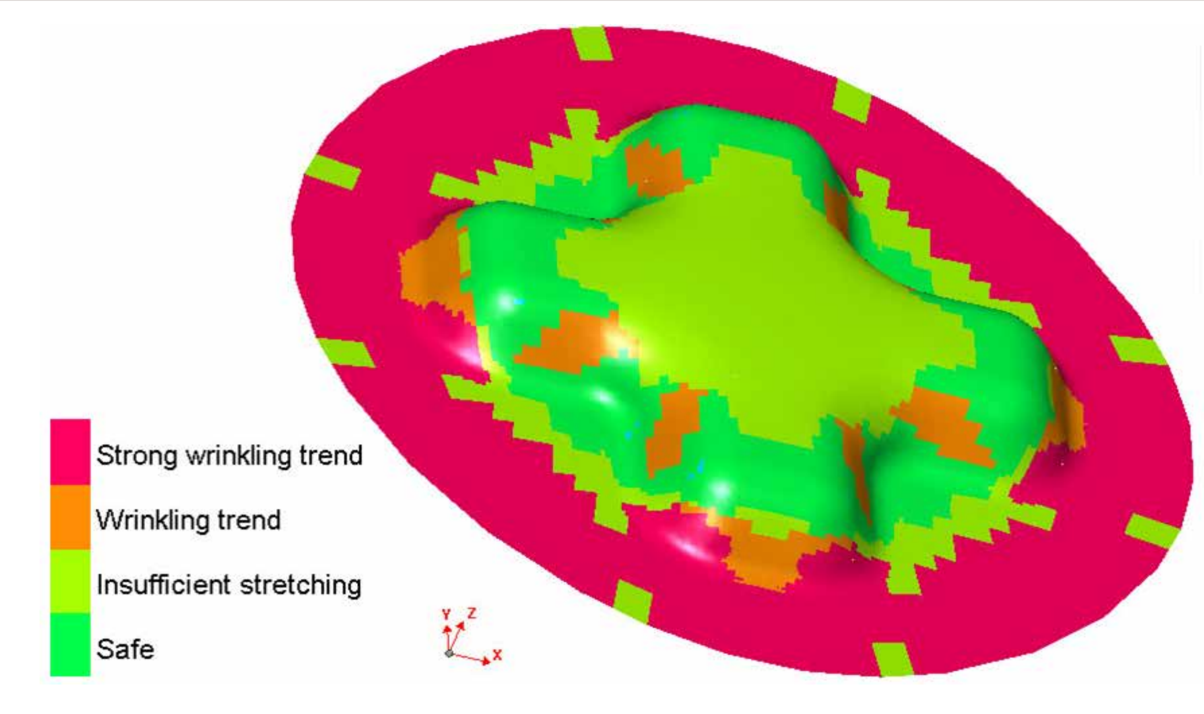


Figure: Virtual component (cross-tool geometry) with critical zones obtained from simulation

The use of advanced high-strength steels (AHSS) increases continuously in the automotive industry, since the production of lightweight car structures with improved crash performance becomes increasingly important. However, using AHSS in deep-drawing of automotive components causes some serious challenges regarding the fulfillment of dimensional specifications.

In particular, springback occurring when releasing the forming tools from the components is considered as one of the major problems in deep-drawing of AHSS. The higher strain hardening of AHSS compared to mild steel results in a significant increase in elastic springback. In order to avoid expensive experimental tryout loops numerical simulation of springback becomes increasingly important. Therefore, six different commercial finite element (FE) software packages for springback simulation in deep-drawing processes were evaluated in this project.

Additionally, a literature study about the main parameters influencing springback was conducted in order to gain deeper understanding about the springback phenomenon. Numerical simulation of a deep-drawing process with focus on springback formation was performed using the best-rated software package. The effect of different drawing process parameters as identified in the literature study (e.g. drawing speed, blank holder force) on the springback tendency was investigated for a standardized cross-tool geometry. Finally, the results of the deep-drawing simulations (virtual components) were validated with deep-drawing experiments (real components) to check the precision of the software and its suitability for springback prediction.

FSI SCHOLARSHIPS 2017

Top: Dave Pascoe, Martin Kremsmayr, Stefan Puschnigg, Horst Bischof, Alexander Pointner, Andrea Hoffmann, Christoph Sommitsch, Florian Pichler, Karl-Friedrich Stracke, Stefan Heldmann, Shadi d'Amelj, Franz Heitmeir (February 2017)

Bottom: Andrea Hoffmann, Dave Pascoe, Martin Dohr, Bernhard Walzel, Thomas Böhm, Gerhard Krachler, Shadi d'Amelj, René Nagl, Peter Fischer (May 2017)

Photos: © FSI – TU Graz

FSI SCHOLARSHIPS 2017

Horst Bischof, Gerhard Krachler, Shadi d'Amelj, Philipp Schuster, Maximilian Wilfinger, Andrea Hoffmann, Dave Pascoe, René Nagl. (October 2017)

Photo: © FSI – TU Graz

Magna and TU Graz have the intention of supporting excellent performances of diploma and doctoral students at FSI within the framework of the cooperation. Therefore, a FSI-grant has been set up which is regularly granted to especially qualified students of the TU Graz. Talented students who write their final papers at the FSI (diploma, master's or doctoral thesis) are eligible for the merit-based scholarship awarded by Magna. Requirements and application modalities for students can be found under: www.tugraz.at/kooperationen/fsi/about-fsi/scholarships/

Scholarships were granted for:

Schnöll, Stefan, IIM, Master: *Technology Evaluation and Assessment of its Impact*

Pointner, Alexander, IIM, PhD: *Reinforcing Lean Production through Agility Aspects*

Kremsmayr, Martin, IIM, PhD: *Ramp-up management in process-oriented high-tech industries*

Pichler, Florian, FTG, PhD: *Multibody dynamics of jointed flexible structures*

Heldmann, Stefan, IIM, PhD: *Big data-based monitoring to increase agility of industrial companies*

Dohr, Martin, IMAT, Master: *Development of a systematic for evaluation of failures in wrought material in deep drawing processes as well as the prevention of them in final products*

Walzel, Bernhard, FTG, PhD: *Smart Parking*

Böhm, Thomas, IIM, PhD: *Corporate Makerspaces - Roles, Effects and Success Factors*

Wilfinger, Maximilian, IIM, Master: *Development Process Optimization of Mechatronic Systems in Automotive Applications*

Schuster, Philipp A., IMAT, Master: *Characterisation and comparison of process chains for the production of automotive structural parts from EN AW-7xxx aluminium sheets*

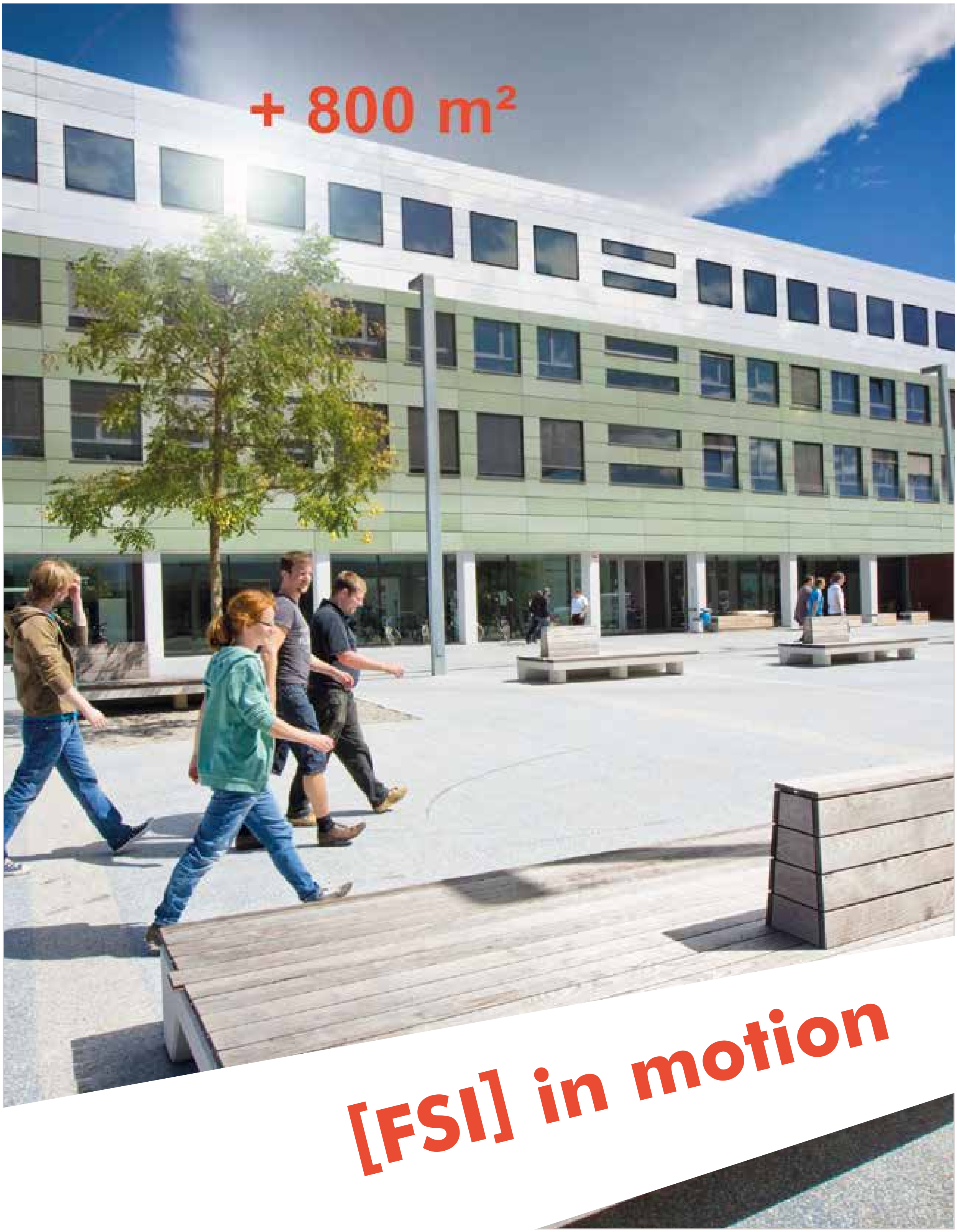


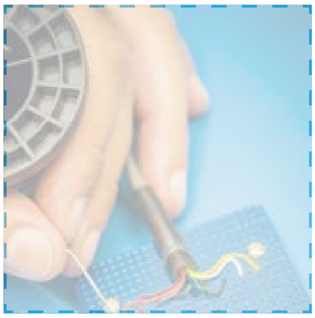
Photo: © Lunghammer – TU Graz

FSI COOPERATIONS with third-party companies

SCIENCE ▪ PASSION ▪ TECHNOLOGY






Contact:

Coordination FSI
Inffeldgasse 11/2, 8010 Graz, Austria
Phone: +43 316 873 9471
Fax: +43 316 873 9472
Email: fsi@tugraz.at

Imprint – Legal Notice:
Coordination FSI, Inffeldgasse 11/2, 8010 Graz, Austria
Concept and layout: Coordination FSI
Photo credit: Lunghammer/Schuller/Magna/ FSI
Print: TU Graz 2018
www.fsi.tugraz.at