Newsletter

Content

Dear readers,

a new year has started under difficult auguries – populism, nationalism and protectionism proliferate. These developments will most likely negatively affect the global economies, and surely they will have negative impact on science, which since ancient times has flowered when facing internationalisation. ITPL is cultivating manifold international cooperation activeties, and we will intensely struggle to keep them active and even widen our collaboration with excellent research teams abroad.

The year 2016, just passed, gave us several chances to do so. The U-TURN project, a collaboration with Greek, British, Luxembourg, and Italian partners, delivered first promising results at half-time last November. Precious contributions from our British partners show the importance of the United Kingdom for the European research scene. We severely hope that the EU and the UK will come to agreements analogue to Switzerland, with the UK being a fully associated partner of the European Research Program after H2020. Also, as key note speaker at the 3rd International Conference on Green Supply Chain in London last July, I could win highly interesting contacts that we are eager to exploit and expand.

Taking up my activities as a visiting professor at the Interdisciplinary Internet Institute (IN3) of the Universitat Oberta de Catalunya (UOC, Barcelona) in 2015, we could acquire a Gambrinus Fellowship for Prof. Angel A. Juan from UOC, who stayed with us for two weeks in June. Luckily, we have again been successful for 2017, and Prof. Dave Goldsman (GeorgiaTech) will accompany our research and teaching work for two weeks next

May. Together with him, I am also shaping the track on “Logistics, SCM, and Transportation” at the Winter Simulation Conference. Last December in Arlington we could establish a full 3-day track, and we look forward to December 2017 in Las Vegas. In the year 2018, this high-reputation event will be in Europe for the second time, visiting Gothenburg – a valid signal for the research scene to seek trans-ocean cooperation.

With respect to our own research activities, two PhD candidates have started their work last year with funds from our Graduate School of Logistics as well as from the University of Jordan (they introduce themselves later in this newsletter). Several scientific papers could be published. As a guest editor and advisory board member of the Journal of Simulation (JOS), I could finalize a special issue on Simulation in Production and Logistics early 2016, and the next issue is already in print to be published as 1/2017.

For now, we hope that you enjoy reading this little newsletter and wish you success in the new year, especially for all your international activities!

Markus Rabe

Update on the U-TURN Project: New Model for Urban Food Transportation

Urban food logistics is facing major challenges: population growth, congestion, environmental damage along with the increased use of convenience stores and home delivery of goods purchased online. The European project "Reducing impacts and costs of freight and service trips in urban areas" (U-TURN) aims to identify new models for urban food transportation through three pilots in Athens, Milan, and London.

The project has now been running for 18 months and is half way through. Over the last six months there has been significant progress made towards the overall objectives.

TU Dortmund University, represented by the ITPL and the Institute of Transport Logistics (ITL), is responsible for the work package "Simulation Modelling and Experimentation". Simulation modelling will be used in order to provide a way to calculate the key indicators used by decisions makers. This will allow for forecasting the effects of potential future developments in the urban supply as well as for assessing the suitability of different variants of supply chain implementation. For this purpose, the design and implementation of a simulation tool to quantify the impact of alternative logistics sharing choices from efficiency (cost), effectiveness (service level) and environmental perspective has been completed in close cooperation with the project partner SimPlan AG in Hanau (Germany).

The applied tool SimChain is a discrete event supply chain simulation tool, which has been developed as a class library for the underlying simulation tool Plant Simulation. While the toolset has already offered numerous features for supply chain simulation, it has lacked specific details in the consideration of city logistics and food transportation. Therefore, the tool has been extended to model operations in city logistics. By doing so, SimChain offers the opportunity for the integrated consideration of Supply Chain networks and city logistics simulation. This helps to analyse different urban freight concepts before their implementation. Quantitative assessment of supply chain efficiency metrics will be considered as a main focus and will form the basis for objective comparison of different scenarios. The simulation will specifically address the objectives and processes of supply chains and urban freight as well as the analyses of practical solutions for collaborative business behaviour, taking into account the specific requirements of food logistics.

Currently, ITPL and SimPlan are working with the Greek partner to increase the transport efficiency in Athens. The partners in Greece have been working with 3PL businesses involved in the transportation of food as well as some grocery suppliers and retailers, to identify transport-sharing opportunities for customer deliveries to businesses in Athens. Using the above-mentioned simulation tool being developed, early simulation results suggest that collaboration would result in an increase in transport loading efficiency and a reduction in the number of trucks or the distances needed to make deliveries.

For further information please visit the projects' official website http://u-turn-project.eu.

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635773.

Visiting Professors at ITPL

Prof. *Angel A. Juan* from Open University of Catalonia (UOC, Barcelona, Spain) stayed at ITPL, partially funded by a Gambrinus fellowship grant, from Thursday June 16th until Thursday June 30th, 2016.

Prof. Juan held a public speech on the topic "From Metaheuristics to Simheuristics and Learnheuristics: Applications to Logistics, Transportation, and Production". The speech had nice attendance, and members of the audience have asked for detailed discussions in relation with their personal research, with Prof. Juan following these demands in the consecutive days. Furthermore, he held a Research Colloquium with our PhD candidates and guests. With respect to teaching, Prof. Juan held a lecture in "Simulation and Optimization" in the master course "Materialflusssimulation".

The stay of Prof. Juan was used for intense research discussions. All members of ITPL and some of the Institut für Transportlogistik (ITL) have used the chance to discuss their research in detail. In the follow-up, Prof. Juan has agreed to act as the second supervisor and reviewer for one of the PhD candidates of ITPL, Felix Dross. Also, a very interesting research topic, currently under elaboration by Aljoscha Gruler in Prof. Juan's research group, was discussed where Prof. Rabe will personally act as second supervisor. There is another journal paper that has been initiated during the stay, authored by Prof. Juan, Prof. Rabe, Aljoscha Gruler (Barcelona) and Astrid Klüter (Dortmund) in the field of city logistics.

We are very glad about this opportunity for intense scientific exchange and thank Gambrinus for the fruitful opportunity facilitating this great cooperation.

We can happily report that we could win again a Gambrinus Fellowship for 2017. *Prof. David Goldsman* (GeorgiaTech, Atlanta) will visit us in May for teaching, a public talk and intense research discussions.

KPMG Study „Survival of the Smartest 2016"

A new study on digital transformation has been published by KPMG end of last year, putting light on specific aspects such as strategy, customers, technology management, and organization and control. The discussion includes the implementation of strategies for digital transformation as well as the consideration of cyber security. ITPL has specifically contributed to this study with respect to

new challenges for data management and the chances of cooperation, and we have really enjoyed the close cooperation with the managers and experts from KPMG. The study shows results from investigations with enterprises and results in several sets of specific action guidelines. Highlighting just one important aspect, the localization of information and knowledge (in contrast to central data silos, which are still usual) will gain vigorous importance. Why do we still centralize data, when the top management is simultaneously promoting autarky and decentralization, under the fashion term "Industry 4.0"?

The full study is available in German by KPMG and can be asked for at https://klardenker.kpmg.de/.

Continuous Verification and Validation in the field of Knowledge Discovery – a new Process Model

Anne Antonia Scheidler (Dipl.-Inf.) was research assistant at ITPL from 2012 to 2016 and is currently finishing her PhD thesis as external PhD student.

In times of growing data streams, information extraction and its analysis are becoming more and more important. A huge amount of data is created within supply chain nodes. Well hidden in the huge amounts of data, there are structurally anchored principals of cause and effect, which can be modelled and understood using adequate techniques. Such an adequate technique is knowledge discovery in databases (KDD) and a lot of process models coexist. The most important step in the KDD process is called data mining, which is defined as the extraction of implicit, previously unknown and potentially useful information from data. But, which of the process models is most suitable for the extraction of supply chain knowledge? And, how can continuous verification and validation be integrated in the knowledge discovery process? This research addresses the mentioned questions. For this purpose, a new process model is developed that deals with the special needs of supply chain data. Additionally, the model constitutes a solution for combining simulation and Knowledge Discovery techniques in the field of supply chain support and demonstrates relationships among them. The research discusses how simulation is used to support the verification of the KDD output. Additionally, concepts for continuous verification and validation (V&V) are assimilated and have been included in the developed process model. This was very challenging because continuous V&V has not been part of the KDD world until now. As a consequence, a lot of work and adaption was needed, but in the end the concept for the process model which integrates the V&V in the KDD is finished.

Fascinating New Approaches in Creating Dynamics Data Mining Models: A New Hype?

Reza Jalali Sousanabady (Dipl.-Inf.) is external PhD student at ITPL and currently working as a business IT consultant for Senacor Technologies.

Today, the world stands on the brink of a technological revolution that will fundamentally alter every aspect of people and companies' existence. The scale, scope, and complexity of the transformation in the ways these entities live, work, and inter-relate to one another will be unlike anything humankind has ever experienced before. Manufacturing and logistics companies will not be exceptions. Various aspects including increased competition, demand for reduced time to market as well as higher complexity of products and processes will be treated using new tools and methodologies. One such tool is data mining, through which critical knowledge can be obtained. This goal is achieved by extracting and accumulating critical data, detecting patterns and extracting highly sought new knowledge. But, methodological issues, in research design, sampling methods, data collection and data analysis techniques would arise. Another drawback lies in time-consuming procedures of data preparation and model development. Realization timespans, reusability of the developed models as well as high amount of required resources for modification of the existing models are other important key factors which need to be addressed. Dynamic data mining models can be used for a specific application domain to create instances for a variety of problems. Using them, reutilization of models increases and hence, the aforementioned obstacles can be circumvented. Two major tasks exist: creating a generalized meta-model for a sub-domain of problems and customizing it to generate an appropriate solution instance for a given problem. In the present research, ITPL focuses on proposing a novel hyper-heuristic approach to tackle these challenges in the domain of supply chains. The proposed methodology would introduce a new approach for domain-based generalization of data mining models to develop meta-models and utilize hyper-heuristic to create problem-specific solutions derived from meta-models. Ultimately, this approach is expected to exhibit a more robust ability for dynamic adaptation to complex variations of data subsets in supply chains.

A Decision Support System for Logistics Networks combining Discrete-event Simulation with Deep Reinforcement Learning

Felix Dross (M.Sc. Software Engineering) is member of the Graduate School of Logistics in Dortmund. In cooperation with ThyssenKrupp he is doing his PhD at the ITPL.

Large logistics networks are very complex systems. Even nowadays, with analytical insights into supply chain situations with the help of data warehouse technology, the management of logistics networks remains a challenge. In order to cope with the complexity, companies have built specific logistics departments, dedicated to provide their managers with accurate business reports and the

background information they need to decide about the right adjustments in their network.

Specific performance measurement systems with key performance indicators (KPIs) as well as catalogues with possible actions for certain network situations have been developed in the past. Examples for such actions could be the relocation of stock from one site to another or the adjustment of transport relations within the network.

Unfortunately though, the effects of all the actions in the catalogues and their interdependencies are very hard to predict for the managers. In many situations, they are uncertain about the right actions to take. The task becomes even harder if the managers try to predict the consequences of all the possible actions regarding multiple KPIs at once, including the temporal development of the network. Therefore, especially trading businesses are demanding for better solutions to plan their actions in the logistics network.

ITPL is facing this challenge by developing a decision support system which uses a discrete-event simulation model to predict the consequences of possible actions in the logistics network. For this, methods to automatically apply possible actions to the simulation model and to measure real world data warehouse KPIs on the simulation data have been developed.

Furthermore, the DES model of the logistics network is tied to a deep reinforcement learning agent, which teaches itself the best combinations of actions. The agent can automatically apply actions to the simulation model and then learn from these interactions. A convolutional neural network is trained and finally the system is able to recommend the best combinations of actions for many different logistics network situations.

A solid architecture and a corresponding prototype have been developed in the last year. First experiments have been conducted with a small simulation model of a segment of a larger logistics network. It is now researched whether the agent can learn in extended systems and generate useful recommendations from there. Furthermore, it is investigated how the system would scale when used for larger logistics networks.

Looking ahead: Simulating Dynamic Changes in Production Systems

Maik Deininger (Dipl.-Geoinf.) is research assistant at ITPL since 2011 and investigates the applicability of modular simulation models for simulating and optimizing production systems.

In the industrialized countries, production environments become more and more dynamic. Customers expect individual products, high quality and short delivery times. As a result, the product variety has exploded and manufacturers are faced with high numbers of individual orders. In order to determine whether an order can be fulfilled and whether the production will be economically beneficial, a system is necessary that is able to schedule every order with respect to existing and future resources and constraints. Such a system requires a proper model of the considered production system. In order to represent a transformable system, the model needs to be transformable, too. Such a model would allow for analysing the future behaviour of a system, including changes that are applied to comply with upcoming requests. This research task is faced at ITPL using Timed Hierarchical Object-related Nets (THORNs). The production system is considered as a combination of modules. Each module is represented through a small THORN model that may be connected to other modules. This way, an existing production system can be modelled and single modules may be removed, added or exchanged at any point of time. The variation of the model will be controlled through a heuristic optimisation that dynamically creates different scenarios which are evaluated against existing and expected orders. Each evaluation run will be based on a discrete event simulation that is built up on THORNs. For reducing the number of simulation runs, a deterministic version of the system will be used for estimating the outcome of the stochastic version and thus deciding on conducting the expensive stochastic experiment or not. Furthermore, the number of replications will be computed dynamically to run only as many replications as necessary. As a result, combing optimisation, simulation, and transformable models, a simheuristic methodology will be created that supports a planner with his or her decision whether an order should be accepted or not. The planner will be provided with a schedule for the orders and a list of timed changes that would have to be applied to the production system.

How to achieve transparency and optimization potentials via supply chain simulation

Astrid Klüter (M.Sc.) joined the Department IT in Production and Logistics in 2014 as a student assistant. She studied Logistics at TU Dortmund University and graduated with a thesis on modeling collaborative route planning in supply chain simulation under the supervision of Professor Rabe. Since March 2016 she is a research member of the Horizon 2020 project U-TURN (see above). Her research interests include discrete event simulation and its application to real-life problem settings related to Supply Chain Management and city logistics.

The creation of data evaluations, the further development of reporting systems and the preparation of analysis results is a basis for decision-making processes in Supply Chain Management. But, the structures of supply chain data sets can become very complex due to the diversity of variants or the variability of processes. Because of the large number of variables, analytical methods can only depict this complexity very simply. Usually, logistical supply chain questions cannot be adequately answered using an optimization model. As an example, optimization is typical for location decisions, neglecting the specific transport, pro-

duction and storage processes. With the help of a simulation model, results of various scenarios can be investigated. This allows us for assessing which approaches promise a positive balance and keep losses low. In this context, at the moment Astrid focuses on transaction data at several aggregation levels from different types of supply chains.

Creating customized actions to change the simulation model of logistic networks

Dominik Schmitt (Dipl.-Inf.) is member of the Graduate School of Logistics in Dortmund. In cooperation with thyssenkrupp he is doing his PhD at the ITPL.

Today's logistics networks are very complex systems, which are influenced by many external and internal factors. To adjust the system in order to regard these effects and to guarantee an almost perfect performance of the network's continuous changes in its structure and configuration are needed. This kind of changes depends upon multiple objectives such as increasing the profit, changing the range of goods or adding new suppliers.

Optimizing such complex systems can become a huge challenge for managers. Facing this problem, ITPL developed a decision support system (DSS) that supports the user by suggesting promising actions for the given logistics network. This DSS addresses different logistic areas of the network and chooses the best integrated action sets from a given catalogue of actions to be applied while respecting their interdependencies.

Unfortunately, these suggested changes are typically predefined within the simulation program. To increase the flexibility and usability of the DSS, a concept of deriving specific actions from generic action types will be created. To realize the concept, a method to generate, integrate and execute user-generated generic action types is needed.

ITPL is addressing this challenge by creating a formal description of changes in DES models for large logistics networks. Based on the formal description of actions it is possible to transform the changes from a very technical-level into an intuitively accessible way, e.g. in a graphical editor. On this abstraction level, it is possible for the user to modify or create new actions and apply these to the simulation model.

Meta- heuristic techniques for the optimization of multi-echelon distribution networks

Majsa Ammourivoa (M. Sc.) is founded by the German-Jordanian University and currently does her PhD in the field of decision support systems for multi-echelon distribution networks at ITPL.

Nowadays, increased competitiveness introduced by globalization raised the importance of the supply chain manager's decisions, such as the management of a supply chain distribution network. In many situations, the decision depends upon multiple objectives; reducing cost, maintaining a profit margin or customer service level. Accordingly, optimizing a distribution network becomes important for suggesting the most promising one.

Currently, research in ITPL has been conducted on developing a Decision Support System (DSS) for multi-echelon distribution network. The DSS was designed to analyze possible actions to improve the network performance. As multi performance indicators are used to measure the network's performance, the analysis process of possible actions becomes a multi-objective optimization problem. The developed DSS is based on a simheuristic approach in the analysis of these actions. Further work is needed to investigate various optimization techniques and learning algorithms to improve the performance of the system.

Lectures given by Department IT in Production and Logistics

Bachelor

- Informatics for Mechanical Engineers
- IT-Systems in Industrial Production
- Foundations of simulation in production and logistics

Master

- Information Exchange of Producing Companies
- IT Design in Production and Logistics
- IT Technologies for Engineering and Logistics
- Material Flow Simulation
- Lab IT for Plant automation
- Lab Business Process Modelling

Contributions to Bodies

Association of German Engineers (VDI)

- VDI GPL Fachausschuss 204 Modellierung und Simulation; Member Markus Rabe
- VDI International Gremium Digital Information (IGDT), Member Markus Rabe
- VDI Richtlinienausschuss (Guideline Committee) 3633.10 „Geschäftsprozessmodellierung“ (Business Process Modelling); Chairman Markus Rabe
- VDI Richtlinienausschuss (Guideline Committee) 3633.13 „Verifikation und Validierung“ (Verification and Validation); Chairman Markus Rabe; Member Maik Deininger
- VDI-Richtlinienausschuss (Guideline Committee) 3633.3 „Experimentplanung“ (Experiment Planning); Member Markus Rabe and Anne Antonia Scheidler
- VDI Richtlinienausschuss (Guideline Committee) 4465.1 „Modellbildungsprozesse“ (Model Building Processes); Member Markus Rabe

German Simulation Society (ASIM)

- Working Group „Simulation in Production und Logistics" (SPL); Deputy Chairman Markus Rabe
- Expert Group “Dedicated Conferences”; Chairman Markus Rabe
- Expert Group „Consideration of Energetic Impact Factors in SPL“; Member Markus Rabe

Conference Organization

- ASIM Dedicated Conference „Simulation in Produktion und Logistik“; Chairman Markus Rabe 1998, 2000, 2004, 2008, 2015
- ASIM Dedicated Conference „Simulation in Produktion und Logistik“; Program Committee Markus Rabe 1993-2017
- Winter Simulation Conference; Local Chair Markus Rabe 2012 (Berlin)
- Winter Simulation Conference; Lead Proceedings Chair Markus Rabe 2018
- Winter Simulation Conference; Track Chair Markus Rabe 2012, 2013, 2014, 2016, 2017, 2018

Board memberships

- Graduate School of Logistics; Board Member Markus Rabe

Journals

- Advisory Board Journal of Simulation (Palgrave); Member Markus Rabe
- Journal of Simulation 10 (2016) 2, Special Issue Simulation in Production and Logistics; Guest Editor Markus Rabe

Publications 2016

Wenzel, S.; Rabe, M.; Laroque, C.: Guest Editorial – Special Issue Simulation in Production and Logistics. Journal of Simulation 10 (2016) 2, S. 79.

Klüter, A.; Rabe, M.: How to Implement Collaborative Tour Planning in a Data-driven Simulation Model. The OR Society Annual Conference OR58, University of Portsmouth, 6.-8. September 2016, S. 145-146.

Rabe, M.; Dross, F.: Intelligente Entscheidungsunterstützung für Logistiknetzwerke des Werkstoffhandels. Werkstoffe in der Fertigung 5/2016, S. 24-25.

Rabe, M.: Myths and Mysteries of Green Supply Chain Simulation. Keynote, 3rd International Conference on Green Supply Chain, London Campus, Loughborough University, 11 July 2016.

Rabe, M.; Klüter, A.; Clausen, U.; Pöting, M.: An Approach for Modeling Collaborative Route Planning in Supply Chain Simulation. In: Roeder, T. M. K. ; Frazier, P. I. ; Szechtman, R. ; Zhou, E. ; Huschka, T.; Chick, S. E.: Proceedings of the 2016 Winter Simulation Conference. Piscataway: IEEE 2016, S. 2228-2238.

Cheng, R.; Macal, C.; Nelson, B.; Rabe, M.; Currie, C.; Fowler, J.; Lee, L.H.: Simulation: The Past 10 Years and the Next 10 Years. In: Roeder, T. M. K. ; Frazier, P. I. ; Szechtman, R. ; Zhou, E. ; Huschka, T.; Chick, S. E.: Proceedings of the 2016 Winter Simulation Conference. Piscataway: IEEE 2016, S. 2180-2192.

Uhrmacher, A.; Brailsford, S.; Liu, J.; Rabe, M.; Tolk, A.: Panel – Reproducible Research in Discrete Event Simulation – A Must or Rather a Maybe? In: Roeder, T. M. K. ; Frazier, P. I. ; Szechtman, R. ; Zhou, E. ; Huschka, T.; Chick, S. E.: Proceedings of the 2016 Winter Simulation Conference. Piscataway: IEEE 2016, S. 1301-1315.

Theses and Scientific Project Works 2016

Baller, N.; Nerke, C.: Untersuchung von AutoMod und Plant Simulation zur Abbildung und Analyse von Logistiksystemen. Scientific project work, 2016.

Baydar, E.: Data Farming Konzept in Tecnomatix Plant Simulation. Bachelor thesis, 2016.

Eskuchen, A.; van der Valk, H.: Simulation einer Modell-Fabrik. Scientific project work, 2016.

Hahn, M.: Durchführung einer Machbarkeitsstudie zur Implementierung von AutoID-Technologien in der Intralogistik eines Sondermaschinenbauunternehmens. Master thesis, 2016.

Heßmann, F.: Entwicklung eines ereignisdiskreten Simulationsmodells zur Planung und Optimierung eines Hochregallagers einer Modell-Fabrikanlage unter besonderer Berücksichtigung von verschiedenen Lagerstrategien. Scientific project work, 2016.

Hnida, I.: Untersuchung zentraler Begriffe im Zusammenhang mit der Kollaboration von Supply-Chain-Partnern. Projektarbeit 2016.

Hoffmann, R.: Systematische Untersuchung von simulationsbasierten Optimierungsverfahren für ein ereignisdiskretes Simulationsmodell eines Werkstoffhandelsnetzwerkes. Master thesis, 2016.

Janßen, A.: Struktureller Vergleich branchenspezifischer Supply Chains. Scientific project work, 2016.

Klüter, A.: Ein Konzept zur Umsetzung eines kollaborativen Tourenplanungsansatzes in einem datengetriebenen Supply-Chain-Simulationsmodell. Master thesis, 2016.

Knoblauch, D.: Untersuchung von Ausgestaltungsmöglichkeiten zukünftiger Daten-Organisationsmodelle. Master thesis, 2016.

Lei, W.: Entscheidungsbäume zur Prüfung der Simulationswürdigkeit von Produktionssystemen. Master thesis, 2016.

Lichtlein, D.: Analyse der Funktionalitäten von Warehouse Managementsystemen in Bezug auf die zukünftigen Anforderungen der Industrie 4.0 am Beispiel SAP EWM. Master thesis, 2016.

Lobeck, D.: Entwicklung von Lern- und Prüfungskonzepten für die EPK-Modellierung in der universitären Lehre. Projektarbeit 2016.

Mühlenbrock, M.: Spezifikation und Klassifizierung von Objekten in Produktionssystemen zur Simulation mittels Petri-Netzen. Scientific project work, 2016.

Ruprich, V.: Untersuchung von Ausgestaltungsmöglichkeiten zukünftiger Kooperationsmodelle von Unternehmen im Zeitalter der digitalen Transformation. Master thesis, 2016.

Schaffran, F.: Konzeptentwicklung für den urbanen Lebensmitteltransport in Deutschland. Bachelor thesis, 2016.

Schmidt, A.: Optimierung des Entscheidungsprozesses zur Einlagerung von Produkten in einem teilautomatisierten Logistikzentrum unter Anwendung von Data Mining. Master thesis, 2016.

Schomberg, L.: Anwendungskonzept für ein logistisches Assistenzsystem im Werkstoffhandel. Bachelor thesis, 2016.

Srednicki, D.; Srednicki, D.: Entwicklung eines Tools zur Visualisierung von Simulationsabläufen mittels

Petrinetzen. Scientific project work, 2016.

Su, W.: Knowledge Discovery in Suppy Chain Transaction Data by Applying Data Farming. Master thesis, 2016.

Tietze, S.: Entwicklung eines Softwarearchitektur-Konzeptes zur Steuerung einer Modell-Fabrikanlage unter besonderer Berücksichtigung von Automatisierungskonzepten für das Internet der Dinge. Scientific project work, 2016.

Tietze, S.: Konzept zur Integration von Verkehrsinformationen für ein Supply-Chain-Simulationsmodell. Master thesis, 2016.

Welschoff, D.: Simulationsstudie zur Prozessoptimierung im Rahmen der Einführung von Lean-Production-Konzepten. Bachelor thesis, 2016.

Zimmermann, R.: Statistische Versuchsplanung für Data Farming-Konzepte in Tecnomatix Plant Simulation. Bachelor thesis, 2016.

All our theses and project works can be downloaded from our homepage.

Contact

Univ.-Prof. Dr.-Ing. Markus Rabe

Tel.: +49 231 755 8020
Fax: +49 231 755 8022
Mail: markus.rabe@tu-dortmund.de
Web: www.itpl.mb.tu-dortmund.de

Technische Universität Dortmund
Fakultät Maschinenbau
FG IT in Produktion und Logistik
Leonhard-Euler-Str. 5
44227 Dortmund