10102 Abstracts Collection
Grand Challenges for Discrete Event Logistics Systems
— Dagstuhl Seminar —

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Abstract. From 03/08/2010 to 03/12/2010, the Dagstuhl Seminar 10102 "Grand Challenges for Discrete Event Logistics Systems" was held in Schloss Dagstuhl – Leibniz Center for Informatics. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Logistics Systems, Modeling, Simulation, Coordination, Design of Decision Support Systems

10102 Executive Summary – Grand Challenges for Discrete Event Logistics Systems

In March 2010, the Dagstuhl Seminar 10102 explored the grand challenges confronting research and practice in the domain of discrete event logistics systems. The Executive Summary (see link for full paper) describes the process of the seminar and discusses the key conclusions regarding grand challenges for research and practice. Abstracts of the presentations given during the seminar are put together in this proceedings.

Keywords: Logistics Systems, Modeling, Simulation, Coordination, Design of Decision Support Systems

Joint work of: Lendermann, Peter; McGinnis, Leon F.; Mönch, Lars; Schirrmann, Arnd

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2569

Challenges on Modeling and Solving Optimization Problems in Logistics

Stéphane Dauzère-Pérès (EMSE - Saint-Étienne, FR)

There still are important scientific challenges when modeling and solving optimization problems in Discrete Event Logistics Systems. Two of them are emphasized in this abstract.

The first and broader challenge is related to 'vertical' integration and 'horizontal' integration. The main motivations behind integration are cost reduction and consistency of decisions. Vertical integration corresponds to the integration of decisions that are usually taken at different decision levels (e.g. tactical and operational), where a 'Master/slave' relationship is nearly systematic. Two illustrative examples were presented in the talk. Horizontal integration corresponds to combining decisions usually taken by different actors along the supply chain. A relevant example was also presented in the talk. A key driver behind vertical integration is consistency of decisions, i.e. decisions taken at a level should be feasible when implemented in lower levels. A key driver behind horizontal integration is cost reduction, by using the flexibility at one stage to improve decisions at another stage. Moreover, horizontal integration helps to reduce uncertainty since multiple stages are controlled simultaneously. Many research opportunities are offered by considering integration of multiple levels/stages. However, it is crucial to ensure the relevance of the resulting problems to avoid tackling fictitious issues. The extensions or re-use of existing approaches for sub-problems are not always effective, and new approaches must be proposed. One reason is that variables at different levels/stages are often of different nature, i.e. optimization problems are no longer purely continuous or integer, which make the integration particularly complex and changes the nature of the problems.

The second challenge is related to the difficulties of taking into account practical considerations in the constraints or the objective function of optimization problems, such as soft constraints that makes the solution better (or even acceptable) for the planner of Discrete Event Logistics Systems. Several illustrative examples were used from scheduling complex workshops and from maritime distribution. Novel research avenues can be explored by modeling these practical features (e.g. definition of new measures and solution robustness).

Keywords: Modeling, Optimization, Logistics, Integration

WAG Point of View

Joerg Dickersbach (Wassermann AG - München, DE)

Discrete Event Logistics Systems and especially Advanced Planning Systems have evolved significantly in the last one or two decades. There are hardly any business processes - actually in use or required by companies - which can not be modelled, scheduled or optimised in one way or another. However, most users are neither computer experts nor scientists and expect fast and easily comprehensible results for their planning problems. This requires the presentation and explanation of complex circumstances in an easy and comprehensable way and offering easily usable tools for suitable intervention. The common approach, bypassing the user's brain applying sophisticated algorithms is a tempting but two-edged approach since these algorithms prove to provide rather often questionable results in practice, e. g. due to incomplete modelling of the planning problem or faulty master data. Therefore there is a significant need as well as a void in research especially regarding the presentation and explanation of complex circumstances in an easy and comprehensable way. The Grand Challenge to Software Systems is Ease of Use.

Keywords: Usability, Ease of Use, Explanation

Challenges for Discrete Event Logistic Systems

Horst Zisgen (IBM, DE)

From my point of view major challenges of modeling large scale Discrete Event Logistic Systems (DELS) are: Granularity Large scale logistic systems are defined by thousands of parameters due their order of magnitude. But in order to achieve a manageable model one might be neither able to take every of these parameters into account nor to model every detail or discrete event of the DELS. This requires methods which help to distinguish or to categorize the parameters in essential, important, helpful, and irrelevant ones. My experience is that putting more data into a model not necessarily yields to better or more accurate results. The opposite might be the case, a vast number of parameters will detract the practitioner from staying focused on the crucial ones.

Data acquisition

These days a variety of IT systems (MES and ERP) and sensors (like RFID, GPS) are installed to monitor logistic systems and a lot of data is collected. Thus the pure data collection is, from my perspective, not an issue for modeling DELS. The challenge is more about gathering the right data. My experience in many modeling projects was that the common approach is the following: Data collection systems are already in place when the modeling project starts. Thus one is supposed to use data which is already available or parameters which are measured anyhow for modeling purpose. In other words Modeling usually follows data acquisition. But ideally it should be vice versa: data acquisition should follow modeling, or at least the modeling should have an impact of what data and how it is collected. Because the needed parameters are known and well defined after the model is completed. But in practice it is often difficult or even impossible to change (or exchange) existing systems, like MES, to meet the additional requirements as an outcome of the modeling process.

Data analysis

The capabilities of modern simulation tools e.g. induce modelers in practice to incorporate more and more details in the model without considering whether a corresponding statistical model is available to evaluate the experiments appropriately. For instance it is often not tested whether variables are independent. Furthermore, in case of a simulation result comparison it is often not systematically tested whether the mean of one sample is really better than the mean of the other sample taking their statistical distribution into account. Incase of large scale DELS it becomes even more difficult to ensure statistical significance of simulation results since the increasing amount of parameters to be considered make this process more complex and time consuming.

Transformation/Implementation to practice

The aim to cover broad systems implies that a lot of stakeholders have to be involved in the implementation process. Thus a successful transformation in daily operation requires the support of all these stakeholders. This required support might be only achievable if the benefit for each stakeholder is clearly transparent which should be taken into account while modeling.

Modeling Approaches

The large scale of the DELS to be evaluated might not allow developing one comprehensive model rather than requires a hierarchical modeling or decomposition approach, figuratively a kind of a Modeling 2.0. Meant is an approach which divides the problem space and models the components individually. Thereby each sub-model may be self-contained as well as be linked to others.

Modeling of random system interference

The stochastic nature of most of the problems in DELS needs more focus. E.g. common ERP systems, which - as a matter of fact - influence most of the decisions be made in the daily operation of enterprises, are not capable to consider randomness taking place in the systems they models at all.

Interdisciplinary methodologies

Traditionally research work is applying a specific methodology, like mathematical optimization or simulation, to a closely defined problem. I think in order to reach another level of usability a more interdisciplinary or multidisciplinary research work is needed, like developing optimization routines embedded in simulation or vice versa. Furthermore the interdisciplinary between analytical and experimental approaches might be desirable. Both have there advantages and drawbacks. But a combination might involve the chance to use the best of both.

The order of the listed challenges does not reflect any assessment of the importance of these challenges nor I claim the list as complete. It should be rather understood as a starting point for discussion on the workshop and are subject to be discussed.

How I may contribute...

My 10 years experience in developing and implementing decision support systems for complex and large scale manufacturing systems might be helpful. During that period of time I have developed and implemented a system which combines queueing network models and mathematical optimization routines. Furthermore I gained experience in applying analytical continuous fluid models to simulate large scale discrete manufacturing systems. The system I have developed for IBMŠs semiconductor manufacturing has become the central planning tool for capacity and lead time which is used for all capital investment planning. It is linked to other systems such as MES, for which it sets targets for real time scheduling on the shop floor or to the ERP system for which it defines the lead time and capacity constraints for the used MRP. By this we realized a modular planning environment whereby each component is selfcontained but also providing input to the others. The system has triggered the development of new MES functions to get better input data. Furthermore, it has initiated the development of additional data analysis tools and six sigma projects to get the right input data to make the right decisions.

Additionally we have developed derivatives of the central planning tool using only subsets of parameters to allow industrial engineers to perform specific evaluations of their own area to be more flexible and responsive with their analysis. This flexible way to use the planning system helped significantly to gain the support of all stakeholders and improved the data basis of the system since everybody feeding the system is able to use the system for his own needs.

Position Statement

Peter Lendermann (D-SIMLAB, Singapore)

With the experience of dealing with systems as complex as wafer fabrication plants as well as aerospace spare parts logistics networks, I would consider the following four factors as the greatest contemporary challenges for Discrete Event Logistics Systems:

1. Domain-specific characteristics of Discrete Event Logistic Systems,
2. Cycle time for model generation and model maintenance,
3. Involvement of humans in operating such systems,
4. The difficulty of quantifying the value generated by decision-support software for managing and optimising such systems.

Keywords: Logistics, Simulation, Automation, Business Application

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2010/2568

Towards a Physical Internet: A Grand Challenge

Benoit Montreuil (Université Laval - Québec, CA)

We start this talk by stating and documenting a bold claim: the way we transport, handle, store, source, realize and use physical objects around the world is not globally sustainable anymore. We then propose and document a breakthrough vision aiming to concurrently increase by an order of magnitude the environmental, economic and societal performance of these activities. This vision proposes to engineer and gradually implement a Physical Internet across the world, which would revolutionize fields such as transportation, logistics, material handling, supply chain and manufacturing. We conclude by emphasizing the challenges associated with implementing this vision and by describing an open initiative aiming to tackle these challenges.

Keywords: Physical Internet, Sustainability, Logistics, Transportation, Materials Handling, Supply Chains

Grand Challenges in Discrete Event Logistics Systems

Scott J. Mason (University of Arkansas - Fayetteville, US)

My experience with discrete event logistics systems (DELS) is based on both inside and outside of factory walls. First, I previously worked full-time (and continue to consult) in the semiconductor industry, focusing on facility logistics related to production planning, scheduling, dispatching, and capacity analysis. The primary goal is to develop support systems for wafer fabs and their operators to make effective lot movement decisions at a local (tool) level that benefit the global (fab-level) performance. This has been accomplished by optimizing wafer starts into the fab, subject to capacity (bottleneck) tool constraints and by the development of custom heuristic rules for product movement. At a higher, supply chain level, my DELS experience relates to my industry-sponsored research projects with such companies as Wal-Mart, Sam's Club Stores, Tyson Foods, and Arkansas Best Freight Corporation, in addition to projects funded by the US government in military and healthcare logistics.

Throughout my career, my colleagues and I have developed a variety of operations research-based models and solution approaches to help companies answer a variety of DELS-related questions. While we always hoped to not develop "a huge variety of specific modeling tools [..] that generally require application by tool experts to answer narrowly defined logistics questions," I'm quite sure that a number of our solutions indeed fall into that category. As we continue to analyze larger and larger problems for companies, they are interested in both global- and locally-effective solutions. For example, while supply chain optimization is needed to strategically assign suppliers to distribution centers (DCs) with minimum transportation and total delivery cost, focused research efforts are required to effectively operate the distribution center and its associated resources and personnel in order to insure all inbound goods are shipped out of the DC within a company-desired 48 hour time limit.

Additional computation resources have provided researchers with a large variety of parallel computing clusters/servers/processors that have helped to somewhat ease the computational burden of solving large scale DELS problems. While one primary challenge in operations research is to develop solution methodologies that can most effectively take advantage of parallel computing opportunities, rather than simply employ current solution procedures over a group of parallel computing resources, I believe a grand challenge for DELS researchers is to effectively decouple/decompose our domain's problems of interest into appropriate subproblems or stages such that we can effectively benefit from the ever-increasingly available parallel computing resources to solve larger, more realistic, more impactful problems for our research clients as a whole.

Often, we require both static and dynamic analyses of our systems depending on the level of abstraction to be employed (i.e., strategic vs. tactical vs. operational). Embracing the computational platforms available to develop effective optimization-, heuristic-, and simulation-based solution approaches and modeling tools that are effectively integrated for large-scale problem analysis will be key as the research community continues to address larger and larger scale problems of interest. In this way, typically static cost, location, capacity, and allocation decisions can be viewed in terms of their impact on dynamic performance measures such as inventory, cycle time, network congestion, and market dynamics.

Further, some of our current research initiatives involve understanding and quantifying supply chain risk. Modern supply chains have evolved into complex systems due to globalization and decentralization. As with many complex systems, there are risks involved in supply chains. Of primary concern are the risks associated with large-scale disruptions due to natural disasters, terrorist attacks, political instability, and transportation/network failures. These important risks can have both direct and indirect impacts on supply chain continuity- they can dramatically reduce the effectiveness of the supply chain, result in significant economic loss, and result in the loss of human life. Therefore, it is essential for organizations to assess these risks and develop strategies to mitigate them.

The risk profile of a supply chain depends on the configuration of its primary components-suppliers, warehouses, service centers, staging areas, ports of debarkation, and transportation modes. The location, transportation mode selection, and supply chain partner identification constituting these components are strategic decisions with which substantial costs are associated. These strategic decisions should make a supply chains robust, reliable, and resilient, while at the same time not compromise an organization's ability to meet its mission requirements. Poor decisions with regard to any of these components can make a supply chain vulnerable to disruptions. Unfortunately, many organizations make these strategic decisions without considering the risk of disruption.

The second grand challenge I believe that is facing DELS researchers today is to develop models for resilient, reliable, and sustainable supply chain network design using both reliability- and optimization-based tools and techniques. My colleagues at Arkansas and I are conducting research to develop a fundamental understanding of the inter-dependence within and between critical supply chain infrastructure systems. The goal is to quantify the impact of this inter-dependence on both the resiliency and sustainability of supply chain systems, both individually and collectively. Although relatively early in the project, we have focused initial efforts in understanding the inter-dependence within and between critical supply chain infrastructure systems and how to develop mathematical models of resiliency and sustainability that are capable of supporting analysis and decision making in complex, multi-echelon supply chain environments.

A Brief Glance at Current Work

Sven Spieckermann (SimPlan AG - Maintal, DE)

More efficient and effective simulation modeling is one of the great challenges in the business of a DES service provider. In this respect, procedure models are very helpful. Those models do provide the basic steps to be followed throughout a simulation project. However, they do only give very few hints and typically do not set any standards on how to execute each step. Here is a great chance for meta-modeling research, in particular with regard to steps such as conceptual or formal modeling. The presentation is pointing these and other challenges on the background of the project scope and company set-up of a simulation consulting company.

Keywords: Procedure Models, Meta-Modeling, Model Engineering

Grand Challenges for DELS - Position Statement

Arnd Schirrmann (EADS, DE)

Using DELS technologies in the perimeter of an aerospace related research project for production & supply chain problems (e.g. ramp-up optimal supply chain design) and for downstream logistic problems (e.g. performance based spares logistics / services).

These logistic systems to be modeled, analyzed and/or optimized by the use of DELS technologies can be characterized as for instance spare logistic systems:

- Complex logistic networks (e.g. world-wide, multi airlines flight & logistics network, high number of bases, local stocks and central warehouses) with huge numbers of stakeholders (airlines, MRO, OEM) and logistic objects (hundreds of aircrafts, compiled by thousands of components to be covered by spares logistics, up to ten or more movements per aircraft per day within the network)

- Complex interrelationships/contracts & services dependencies between network stakeholders (e.g. OEM contracts with airlines, MRO contracts with airlines, OEM performance based contracts) with local decision making and optimization of sub networks. Data availability (aircraft / component health status, aircraft utilization, etc.) is limited and dependents on the contract situation.
- Decision making within the network is decentralized and locally optimized by specific stakeholders. The system strongly dependents on human behavior, decision making and stakeholder specific, decentralize Decision-Support-Systems (e.g. operational flight planning by OCC, maintenance planning by MCC; logistics planning by OEM).

From an 'end user' point of view the following challenges for DELS technologies have to be discussed more detailed:

- 'Real' system-of-system modeling and simulation has to cover decentralized decision making and 'non-perfect' / locally optimized behavior of stakeholders (e.g. in-corporating principal-agent-theory / games theory). As the real world behaves not perfectly (or global optimal), the modeling of human behavior within 'real' networks (e.g. decision makers in command & control centers or maintenance staff behavior) has to cope with uncertainties in 'real' decision making. Beside that the extension of typical DELS problems (resource allocation for logistics movements, etc.) to contract related issues (availability, service level, penalty) is required.
- Single events relevance & stochastic modeling within DELS. In 'real' logistic systems a single event can change the whole future of a network (e.g. preventive component replacement vs. lose of aircraft). Complex logistic networks contain many local 'intelligence'/ autonomous & self-interested decision making instances. Consequences of decisions taken by single instances within complex networks are difficult to model (and later on to understand from a user perspective). Modeling of future behavior will differ from todayŠs stochastic approaches (e.g. health managed, single aircrafts vs. MTBUR modeled fleet behavior) and will lead to multiple future scenarios with different probabilities of occurrence (risk approach in evaluation of DELS).
- Data availability / Integration into control systems for productive use of DELS applications. The availability and quality of real world data for DELS is a major risk. Stochastic modeling approaches require historical data sets (for MTBUR estimation) which are difficult to provide for new products or for a 'real' world environment (contract issues, etc.). The new 'intelligent' logistic objects (e.g. health monitored components) as part of DELS will add more complex behavior models (e.g. physical degradation models) and additional control mechanisms (decision making instances creating the logistics demand signals). The productive use of DELS within command & control functions requires a further effort in standardization and extension of architectural frameworks (e.g. MIMOSA) to be undertaken. DELS has to become a regular space within the decision support layers in that kind of frameworks.

- Verification of complex DELS applications. Different from an academics approach a comparison of sophisticated DELS application with existing solutions (human decision makers / unsophisticated tools) and verification of cost savings / profit generation coming from DELS application is rather difficult. The generation of 'real' test cases (e.g. optimized logistics system for 12 month airline fleet operations) for model validation is required to get reliable solutions for end-users who are not experts in fancy DELS technologies. Implementation costs for full fledged experiments are inappropriately high but the verification of the technology often requires that big effort in order to start the project.

Innovative Aisle Configurations for Unit-Load Warehouses

Russell D. Meller (University of Arkansas - Fayetteville, US)

Unit-load warehouses are used to store items—typically pallets—that can be stowed or retrieved in a single trip. In the traditional, ubiquitous design, storage racks are arranged to create parallel picking aisles, which force workers to travel rectilinear distances to picking locations. We consider the problem of arranging aisles in new ways to reduce the cost of travel for a single-command cycle within these warehouses. Our models produce alternative designs with piecewise diagonal cross aisles, and with picking aisles that are not parallel. One of the designs promises to reduce the expected distance that workers travel by more than 20 percent for warehouses of reasonable size. We report on the expected performance of these designs under various warehouse configurations and operating policies, as well as relate experiences from the implementation of these designs.

Keywords: Warehousing, Design, Aisles, Optimization

See also: 'Aisle Configurations for Unit-Load Warehouses' *IIE Transactions on Design & Manufacturing*, **41**(3), 171–182, 2009.

Grand Challenges for Discrete Event Logistics Systems: A System-based Perspective

Lars Mönch (FernUniversität in Hagen, DE)

1. What are the Grand Challenges? A DELS in a broader sense consists of the following components:
   - base system
   - operative system
   - control system
   - planning system.

Operative system, control system, and planning system form the information system. We differentiate between application systems that correspond to automated parts of the planning and control process and human actors. Note that the base system is related to a DELS in the original sense, i.e., the base system contains resources and the material that flows. The base system is influenced by the information system. The operative system deals with the immediate control of the base system. All the relevant data of the base system are stored in data bases of the operative system. The data bases will be updated in an event driven manner based on events that happen in the base system and base process. The control system receives feedback from the operative system and sends instructions to the operative systems. Finally, the control system also provides some aggregation and disaggretation functionality that is necessary for the planning system. In contrast to the planning system with a medium or long term horizon, the horizon of a control system is usually rather short. The planning system provides instructions for the control system. The operative, control, and the planning system consist of several subsystems that have to interact in a certain way. Algorithms are the heart of the control and the planning system. Often, the different subsystems of the control and planning layer also have proprietary (sub) models of the base system for their decision-making. Appropriate software representations are necessary for the algorithms. Based on the described setting, we can identify the grand challenges:

(a) Modeling on the base system level:
The base system can be replaced in the laboratory by appropriate simulation models. Simulation can be used to assess the performance of the control and planning system and the related processes. It is still challenging to build these simulation models for a single fabrication facility and for the entire the supply chain because of the complexity of these models when a naive modeling perspective is taken. The challenge is to find models that answer our questions but at the same time the level of detail has to be as small as possible to reduce model complexity.

(b) (Data) modeling on the application system level:
Here, the necessary data for the different algorithms on the control and planning level has to be collected and appropriately represented. The challenge is to find data representations that are rather generic, but at the same time, they should contain enough details for decision-making in specific domains. Also appropriate techniques to aggregate and disaggregate data are highly desirable. The problem of treating missing data is often ignored by academics. From my point of view, the data gathering problem is one of the major obstacles for a successful automation of decision-making processes. It is a wrong assumption by academics that this problem can be solved easily.

(c) Algorithm design: Three different sub challenges are identified.
   i. One challenge is that often the decisions made by the different subsystems of the control and planning layer are independent and not integrated. This is especially true for sub systems on the same level.

For example, the manufacturing execution system makes job scheduling decisions while the transportation control system is looking for transportation task decisions. The question is whether we should strive to come up with integrated approaches which are difficult to treat because of model complexity or should we come up with heterarchical or hierarchical approaches where the decisions have to be coordinated in an appropriate way? There are numerous other examples on the supply chain level. The design of distributed hierarchical algorithms across different levels is also an interesting issue.

ii. Another research challenge is the automated situation-dependent parameterization of the different algorithms. Finding appropriate parameterizations is often not straightforward and inhibits the usage of state of the art algorithms in real-world DELS.
iii. Another open question is an appropriate consideration of uncertainty in control and planning algorithms.
iv. Software representations:
It is a fact that ERP systems, often packaged software solution, have a huge impact on the way how business is performed in enterprises. These systems are often monolithic and do not offer the appropriate support for decision-making that is beyond data collection. The research question is what are appropriate next generation application systems that are appropriate to address some of the challenges described in point 2 and 3.

2. What are approaches to address these challenges?
Theses 1 (Modeling on the base system level): More research is necessary for model reduction techniques. We have to look for simple, but meaningful models based on aggregated data. Reference models have to be developed.
Theses 2 (Modeling on the application system level): Data have to be used where they are produced. I strongly believe that here some progress can be achieved only together with the efforts in point 3 and 4.
Theses 3 (Algorithm design): Much more effort should be spent on the foundation and the design of (modern) distributed hierarchical algorithms. They are somewhere between centralized and fully heterarchial algorithms. More effort is necessary to address planning problems. When planning is done in an appropriate way than the sophisticated 'troubleshooting' on the control level is somehow obsolete. Methods from machine learning can be used to tackle the second sub challenge. Robust optimization is a possible way to deal with the third sub challenge.
Theses 4 (Software representation): Hybrids between multi-agent-systems and servicebased systems have to be designed, implemented, and assessed. A closer interaction between software vendors and universities is necessary.
3. What are your contributions?
My group has started to work on distributed hierarchical production control algorithms a couple of years ago. Our research efforts lead to the multi-agent-system FABMAS. Currently, we extend our approach to production planning problems. We also look for hybrids, i.e., multi-agent-systems that

use services. We study the interaction between demand forecasting and master planning in complex supply networks. Furthermore, the interaction between job scheduling and transportation task scheduling is studied.

Keywords: Systems Theory, Modeling, Simulation, Information Systems, Distributed Hierarchical Production Control

Improvements in Modeling Technology

Oliver Rose (Dresden University of Technology - DE)

Current situation:

- Huge DELS with gigantic amounts of data which was created during design, realization and operation of these systems, and it is becoming more and more data (RFID, Internet of Things,...)
- Still no efficient way to use all this data
  - Not for the same components over their whole lifecycle
  - Not for all planning and control tasks
  - Not even for a complete analysis of these systems
- Main problem: no consistent meta models for the different lifecycle phases and the different use cases
- First approaches for model conversion and automated model generation from data sets

Challenges:

- If we cannot bridge the gap between existing industry data and new methods for planning and control, there is no real use of all the nice academic ideas
- Appropriate meta models
- Appropriate model conversion technology
- Ontologies to link meta models on a semantic level
- Model building standards or at least guidelines (which is also an issue for engineering curricula)
- Technologies to separate important data from useless data, to clean data
- Find strategies to be not overwhelmed by massive data volumes
- Create simple and robust core models for planning and control

My share:

- Modeling standardization efforts for simulation models using SysML
- Development of simple models for semiconductor fabs
- Automated model generation from semiconductor industry data sets (online simulation, optimization input)
- Simulation-based scheduling for complex assembly lines (including automated model generation and standardized system model description)

Position Statement

Cathal Heavey (University of Limerick, Ireland)

The ultimate aim for the research community in the area of discrete event logistics systems is to provide decision makers through the provision of optimization and decision support. This position statement will discuss some challenges and ideas in regard to simulation in achieving this aim. Namely, (i) we discuss the needs and challenges in the provision of decision support simulation applications; (ii) support for faster simulation model building; (iii) provision of simulation support for operations decision making.

Sub-daily Staff Scheduling in Logistics and Related Industries

Volker Nissen (TU Ilmenau, DE)

Sub-daily personnel planning, which is the focus of our work offers considerable productivity reserves for companies in certain industries, such as logistics, retail and call centers. However, it also creates complex challenges for the planning software. We compare particle swarm optimisation (PSO), the evolution strategy (ES), a constructive agent-based heuristic and manual planning on a set of staff scheduling problems derived from a practical case in logistics. All heuristics significantly outperform conventional manual full-day planning, demonstrating the value of sub-daily scheduling. PSO delivers the best overall results in terms of solution quality and is the method of choice, when CPU-time is not limited. The approach based on artificial agents is competitive with ES and delivers solutions of almost the same quality as PSO, but is vastly quicker. This suggests that agents could be an interesting method for real-time scheduling or re-scheduling tasks.

Keywords: Staff Planning, Workforce Management, Sub-daily Scheduling, Metaheuristic, Constructive Heuristic, Artificial Agents

Grand Challenges for DELS Based on the Example of Semiconductor Supply Chains

Hans Ehm (Infineon Technologies - München, DE)

The global supply chain is our new fab! This requires to master material-, value- and especially information flows on global scale in the same way or even better than it is done on fab level. Increasing demand volatility due to fast product introduc-tions requires to solve the triple AAA challenge: Adaptability and Agility for proper response to demand changes and Alignment with the partners in the supply chain.

The Grand Challenges we would like to address during the Dagstuhl Seminar are on:

- Common standards
- Supply chain simulation frameworks
- Generic simulation data sets based on real life supply chains

Joint work of: Ehm, Hans; Ponsignon, Thomas

DELS Analysis/Synthesis Methodology

John Fowler (ASU - Tempe, US)

There have been numerous efforts to use modeling and simulation tools and techniques to improve the efficiency of Discrete Event Logistics Systems (DELS) over the last four decades. While much progress has been made and more and more DELS decisions are being made based on the use of models, their use is still less than ubiquitous. We believe that there is a need for pervasive use of modeling and simulation for decision support in future DELSs. Borrowing heavily from a 2002 Dagstuhl workshop on grand challenges in modeling and simulation, we see several challenges that need to be addressed by the operations research community to realize this vision. First, we need to achieve an order of magnitude reduction in problem solving cycles. Second, we need to develop an easy to use, real-time simulation-based problem solving capability. Third, we need true plug-and-play interoperability of simulations and supporting software for DELS applications. Fourth, we need efficient hierarchical models of DELSs. Finally, we still need greater acceptance of modeling and simulation within industry.

Keywords: Modeling, Analysis

An Efficient Heuristic Approach for a Multi-period Logistics Network Redesign Problem

Stefan Nickel (KIT - Karlsruhe Institute of Technology, DE)

In this talk a multi-period logistics network redesign problem arising in the context of strategic supply chain planning is studied. Several aspects of practical relevance are captured namely, multiple echelons with different types of facilities, product flows between facilities in the same echelon, direct shipments to customers, and facility relocation. A two-phase heuristic approach is proposed to obtain high-quality feasible solutions to the problem, which is initially modeled as a large-scale mixed-integer linear program. In the first phase of the heuristic, a linear programming rounding strategy is applied to find initial values for the binary location variables. The second phase of the heuristic uses local search to correct the initial variable choices when a feasible solution is not identified or to improve the initial feasible solution when its quality does not meet given criteria.

An extensive computational study is performed on randomly generated instances for a variety of logistics networks. The performance of the new heuristic is discussed relative to the lower bound of the linear relaxation.

Keywords: Logistics Network Redesign, Heuristic, Linear Programming, Rounding, Local Search

Joint work of: Nickel, Stefan; M.T. Melo; F. Saldanha-da-Gama

Integration of Interrelated Decision Problems

Herbert Kopfer (Universität Bremen, DE)

1. Challenges
   One of the great challenges with respect to the support for complex decision making is the integration of interrelated problems which usually are modeled or solved independently out of computational reasons but which influence each other in different ways. The challenge is to conceive and to model the interrelations in such a way that the overall decision making is supported as well as the decision making for all relevant problems. In general, there are several levels of decision. Usually, the lower levels comprise several subordinate problems constituting a superordinate (i.e. overall) problem. Alternatively, several problems might be in a flat relation. Thus, the models of the interrelated problems may be in a hierarchical relation or in a heterarchical relation. Or they may be in a complex hybrid relation which includes several levels and requires a detailed analysis. The integration process should be able to connect decision models and should in particular be able to combine approaches for simulation and approaches for optimization models.
2. Frameworks for integration
   It would be helpful to develop, to provide and to evaluate frameworks for the integration of interrelated models. Probably, there will be a need for different types of frameworks being suitable to different types of integration with specific types of relationships between the problems to be integrated. Several standard types of integration should be identified and analyzed in order to develop suitable frameworks for them.
3. Application areas for integrated problems
   I would like to discuss and analyze some typical examples for integrated problems in different application areas.
   The first example refers to the combination of hoist scheduling and the determination of capacity limits for different layouts of the production line which is served by the scheduled hoists. In this example the integration of

an optimization model with a simulation model can be demonstrated and analyzed.

The second example refers to the process of distributed transportation planning performed by several interacting agents (vendors, dispatchers, drivers) of one forwarder. Moreover, this example refers to the even more complex scenario of collaborative planning performed by the agents of several co-operating forwarders.

The third example refers to the relation between the planning processes on different planning levels. This problem gets challenging when combining the operational planning and the strategic planning leads to conflicts. This might occur when the short-time restrictions (and/or goals) and the long-time restrictions (and/or goals) do not harmonize; i.e. they must be met although they are partly contradicting. Another but similar situation occurs if in a coalition of co-operating agents the planning process of each single partner has to be adjusted to the own desired effects and to the effects desired by the entire coalition. This might in some cases result in conflicts between single partners. But it might also result in conflicts between the coalition as a whole and single partners within the coalition.

An additional very interesting application area for interrelated problems and their models is given by the planning problems induced by the operation of container terminals.

On the basis of these examples I would like to identify several typical relationships between simulation models and/or optimization models. Then I would like to discuss approaches useful for integrating such models.

Decentralized Coordination Mechanisms

Andreas Fink (Helmut-Schmidt-Universität - Hamburg , DE)

We consider discrete event logistics systems (DELS) which involve autonomous and selfinterested decision making units (which manage related resources). Acting on this assumption is certainly reasonable in connection with inter- organizational coordination problems concerning transactions between different firms. Following agency theory, related coordination problems also arise within firms (intra-organizationally), as organizational sub-units and corresponding decision making units may pursue different performance criteria and information asymmetry must be taken into account. While information sharing and collaborative planning might in theory provide a mutually beneficial outcome, benevolent collaboration between selfinterested decision making units cannot be taken for granted. Therefore, adequate mechanisms for handling coordination problems should take into account decentralized decision making among autonomous decision making units, which strategically interact in an intendedly rational way (in consideration of feasible modes of cooperation at the level of operations management) with the goal to exploit win-win opportunities. The modes of cooperation are supposed to be representable within a formal model (contracts, common plans concerning inter-agent decision variables), which defines a search space so that the problem is accessible for automated computation. Taking account of opportunistic behavior and information asymmetry (i.e., incomplete information at the global level), we aim for decentralized search mechanisms (fully automated negotiation procedures), which support the generation of 'high quality' modes of cooperation that all involved decision making units agree on. These mechanisms are evaluated with regard to the requirements of feasible decision making procedures.

Grand Challenges for DELS

Dirk Mattfeld (TU Braunschweig, DE)

The workshop description refers to a misfit of discrete event models research currently proposes and decision models as implemented for instance in ERP systems. The first modelling paradigm focusses on logical or/or temporal interdependencies between events as a main driver of economic objectives. ERP/APS systems typically neglect this influence by looking at logistics systems on a higher level of aggregation. In practice, complexity of logistics systems does not allow for planning, tracking and deciding on the operational level of single events.

Recent progress in information technology allows for recording and storing of fine-grained data of logistics processes. Even more important, new business models require accurate on time production and delivery of goods. This need leads to an economic relevance of single events of logistics systems and has therefore caused demand of such decision support functionality in ERP/APS systems. However, former ways of looking at events in a static way do not cope with the requirements of practice. Complex distributed logistics processes require the consideration of stocastic variability because the processes indispensably interact with its (stochastic) environment.

Two main questions with respect to stochastics come into play. First, we consider stochastic durations of activities such that events may not be executed as planned a priori. For instance, think of a home delivery for a premium customer announced in a narrow time window. Furthermore, the occurrence of events themselves may be subject to stochastic variation. Think of a stochastic pattern of customers requesting a service. Both issues can be answered by providing a substantial amount of spare capacity, either in production or in transportation systems. Whenever this is not feasible with respect to the economic impact, discrete event logistics systems are unavoidable in IT planning and control systems.

From my point of view, among others, two common viewpoints of academic discrete event systems research hinder the integration in IT systems. First, the data of optimization problems is assumed to be given. For instance, transportation is carried out in a vital and sometimes chaotic environment. However, the academic communitiy still neglects this fact and plans based on distances. It is largely ignored that research performed in our neighboring academic community of civil engineering thinks of travel times in terms of distribution instead of distances. Machinery engineering research has created the term mean time between failures since long; however, optimization typically considers continous availability of production resources.

In a recent research of mine, I do consider daytime dependent travel times for routing decisions in urban areas. Based on car floating data provided by a fleet of taxicabs day of week and time of day dependent travel times are derived for travel links. Then, these detailed measures are clustered in order to achieve aggregates with respect of time and space in order to feed VRP heuristics. It can be shown that the consideration of even crude aggregates can significantly improve the reliabilty and performance of delivery processes. I claim for a better and deeper understanding of historic data by means of data analysis.

Another misleading viewpoint of academic research is to strive for optima. In a stochastic system, there is no optimum; even optimum strategies are of more or less theoritical use only. Thus, a common presumtion focusses on solving too simple models to optimality instead of heuristically solving better suited models. Since dynamic stochastic programming has shown to fail for many problem domains, another extreme pursues the development of good rules of guess. This indeed may not be suitable in complex situations. Thus, taking up the well defined paradigm of dynamic programming and applying such methods in a heuristic fashion may be a more promising way of supporting plannig and control in discrete event logistics systems.

Recently, my group has started working with approximate dynamic programming for servicing stochastic customer requests in a transportation domain. Results are rather promising and suggest to extend work towards more complex VRP problems.

Grand Challenges in Discrete Event Logistics Systems

Leon McGinnis (Georgia Institute of Technology, US)

Discrete event logistics systems (or DELS), as a field of research and practice, is in a period of very significant change. In practice, the impact of DELS is increasingly important to the sustainability of human welfare, and also changing in fundamental ways-new technologies (e.g., RFID), new business requirements (e.g., performance based logistics), new organizations (e.g., outsourcing, virtual enterprises), shorter product lifecycles but longer product lives, etc. Research is challenged to create, organize, disseminate, and use a very broad range of knowledge, encompassing not only the structure and behavior of physical logistics systems, but also associated business models and practices, decision theory, analysis/synthesis methods, computational processes, and the nature and capabilities of humans in collaborative and competitive decision making.

The Grand Challenges for both research and practice center on the creation, capture, use, and re-use of knowledge, particularly in the form of models. We need to recognize two related but distinct types of models: (1) those that capture what we know or think we know about the DELS enterprise; and (2) those we use to help us make decisions about predicting, controlling, and designing DELS. To make progress in this direction, we will need very expressive languages, standard semantics, common interfaces, unified open frameworks, libraries, and, most importantly, collaborative development.