How the reverse supply chain impacts the financial performance of original equipment manufacturers

This thesis examines the financial impact of a firm’s reverse supply chain (RSC). Specifically, the thesis examines the two questions of how the RSC can contribute to the financial performance of the firm and which factors are decisive for the RSC’s financial contribution. The thesis focuses on original equipment manufacturers. The thesis results show that the RSC can contribute to the financial performance of the firm in more than 20 different ways, which the thesis defines as functions of the RSC. Examples of RSC-functions are 1) resale of recovered end-products to price-focused market segments in the firm’s primary markets, 2) resale to customers in new markets (in e.g. emerging economies), and 3) sale of used materials back the firm’s original material suppliers. The firm’s RSC can conduct several RSC-functions simultaneously and the financial benefits from operating these RSC-functions differ widely among functions. The factors that are decisive for the RSC’s financial contribution depend on the type of RSC-function. For a RSC-function that recovers and resells end-products examples of factors decisive the function’s financial contribution are 1) the market’s willingness to pay for recovered products, 2) the firm’s profits from servicing recovered products once sold, and 3) the added probability of selling additional products to customers of recovered products. The thesis demonstrates that manufacturers can achieve considerable financial contributions from the RSC, which contracts the traditional perception of the RSC in academic literature as well as with logistics practitioners.

Improving Healthcare Logistics Processes

Healthcare costs are increasing due to an ageing population and more sophisticated technologies and treatments. At the same time, patients expect high quality care at an affordable cost. The healthcare industry has therefore experienced increasing pressures to reduce the cost of healthcare provision whilst providing high quality care. Logistics activities in hospitals provide a significant opportunity for cost containment in healthcare through the implementation of best practices.

Literature provides little guidance on how to improve healthcare logistics processes. This study investigates logistics processes in hospitals and aims to provide theoretically and empirically based evidence for improving these processes to both expand the knowledge base of healthcare logistics and provide a decision tool for hospital logistics managers to improve their processes.
Integrated Rolling Stock Planning for Suburban Passenger Railways

One of the core issues for operators of passenger railways is providing sufficient number of seats for passengers while keeping operating costs at a minimum. The process a railway operator undertakes in order to achieve this is called rolling stock planning. Rolling stock planning deals with deciding how to utilise the fleet of available train units in space and time. In this thesis, rolling stock planning has been studied, using as case study DSB S-tog, the suburban passenger railway operator of the City of Copenhagen. At DSB S-tog, the rolling stock planning process is subdivided according to time horizon into two subprocesses. Firstly, there is the long-term circulation planning process, in which planning is conducted for anonymous, virtual train units months in advance. Secondly, there is the short-term train unit dispatching process, which covers the execution of the long term circulation plan. In the train unit dispatching process, the anonymous, virtual train units from the circulation planning process will have real, physical train units assigned to them. The train unit dispatching process has a short-term time horizon of days, hours and minutes and makes sure the actual, real-world train services are performed. Disruptions are also handled in this process. In the long term circulation planning phase of rolling stock planning, a large number of railway-specific requirements must be taken into account: The physical railway infrastructure must be adhered to, e.g., platform and depot track capacities, the rules of the train control system and the order in which train units may be parked so as not to obstruct each other’s movements; All trains services of the timetable must have a least one train unit assigned; Only the available rolling stock can be used in the plan; The plan should provide seating capacity according to the passenger demand and provide an even distribution of flexible space for bicycles etc.; Planned shunting operations in the depot should have sufficient personnel on duty; Train units must undergo interior and exterior cleaning, surface foil application and winter preparedness treatment at regular time intervals; At regular service distance intervals, train units must undergo scheduled maintenance etc., and consumables must be refilled; Certain train services must have train units with additional train control system equipment installed, special passenger counting equipment installed and/or perform predefined exposure of commercials.

In the short-term train unit dispatching phase of rolling stock planning, additional railwayspecific requirements include: Exterior graffiti removal and unscheduled maintenance on demand and sometimes within a given time frame; Make available train units to meet surveillance video recording requests from the police within a given time frame. Due to the large number of railway-specific requirements and their nature, rolling stock planning is traditionally conducted in a step-by-step manner, in which the individual planning processes are not integrated with each other. Needless to say, this yields rolling stock plans that are either suboptimal or infeasible with regard to the requirements. In this thesis it is shown that it is possible to design and implement a rolling stock planning model integrating into one planning process all the railway-specific requirements of DSB S-tog, all at the same time. This integrated rolling stock planning model is implemented using a greedy heuristic and makes use of the novel (train) unit order conservation principle, implemented as special side constraints to a resource constrained shortest path algorithm. The integrated rolling stock planning model is tested extensively on 15 real-world, manually constructed rolling stock plan data instances. When run on these instances, the greedy heuristic can achieve an average economic gain of approx. 2% with processing times in all cases less than 1 hour 20 minutes. In addition to this, the greedy heuristic can make typically infeasible rolling stock plans feasible within just a few minutes of processing time. Moreover, in this thesis a number of different economic net value upper bound calculation models are designed, implemented and tested. The net value upper bound calculation models implement the railway-

Case studies were conducted at hospitals in Denmark and the US investigating three different types of processes: bed logistics, hospital cleaning, and pharmaceutical distribution. Based on an analysis and comparison of the case studies, a set of factors were identified influencing the decision on how to improve healthcare logistics processes. Furthermore, a method for benchmarking healthcare logistics processes was developed. Finally, a theoretically and empirically founded framework was developed to support managers in making an informed decision on how to improve healthcare logistics processes.

This study contributes to the limited literature concerned with the improvement of logistics processes in hospitals. Furthermore, the developed framework provides guidance for logistics managers in hospitals on how to improve their processes given the circumstances in which they operate.

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specific requirements to a varying degree and consequently expose different properties with regard to tightness of bounds and processing times. The net value upper bound model having the highest degree of requirements integration adheres to 47% of the requirements by count. Using this tightest net value upper bound calculation model, it is shown that the greedy heuristic mentioned before is able to gain approx. 1/3 of the relative gap between the net value of the original, manual plans and the net value upper bound. Moreover, it is shown that in most cases, the net value of the original, manual plans already lie close to the upper bound.

Furthermore, a branch-and-price based matheuristic integrated rolling stock planning model is designed, implemented and tested. It is shown that this type of matheuristic model is able to adhere fully to all railway-specific requirements, and that the vast majority of requirements can be integrated into the optimisation steps of the matheuristic algorithm. The branch-and-price matheuristic model can solve small instances (e.g., in the form of matheuristic iterations) to optimality. Used in conjunction with the greedy heuristic, the two methods combined can achieve an additional small gain in objective value not achievable using each method by itself. With a yearly cost of the rolling stock operation in the hundreds of million DKK, the potential benefit of a real-world application of the models to DSB S-tog is in the order of several million DKK per year. In addition to this, a substantial benefit can be gained by the way the models can automate the current, manual planning procedures. This will enable planners to invest more creativity and meticulousness into the planning process as a result of being liberated from manual planning procedures. For these reasons, DSB S-tog is eager to proceed with the real-world application of the models developed in this thesis.

Managing cyber-risk and security in the global supply chain: a systems analysis approach to risk, structure and behaviour

The threat of cyber-attacks continues to grow and disrupt global supply chains, exposing companies to disruptions that severely affect or completely halt normal operations. This impacts business performance negatively through the company’s bottom line and reputation, even resulting in long-term legal ramifications. As a result, little information about attacks and their consequences is published. Supply chains continue to prepare for cyber-attacks through a mix of traditional risk and resilience frameworks, protecting their networks through patches, firewalls and antiviruses, or financially through insurance. Yet these approaches are not giving the expected results, as reflected by the steady increase in disruptions from cyber-attacks. This thesis investigates and proposes tools for managing cyber-risks in the supply chain, derived from an analysis that follows three main steps. In step one, existing knowledge about supply chain cyber-resilience is analysed through a systematic literature review, and gaps are identified. Two of the identified gaps are detailed in address, 1) insufficient understanding of the particular characteristics cyber-risks and how these compare to other supply chain risks for effective risk management, and 2) insufficient address by current methods to aspects of compartmentalization, static focus and history-dependence in the management of supply chain cyber-risk and cyber-resilience. Step two of this thesis explores the first gap by identifying the particular characteristics of cyber-risks from cyber-attack report data. Finally in step three methods based on systems thinking are applied to case studies to evaluate the degree to which these methods address compartmentalization, dynamics and history dependency in their application to the management of cyber-risk and cyber-resilience. The findings of the research are in three main domains. First, the research reveals relevant gaps in the traditional methods available for the management of cyber risks, in areas such as their consideration of dynamic behaviour, inadequate or difficult reporting of events, their dependence on historical data to manage unknown or new attacks, and a silo-approach for managing a problem that is cross-disciplinary. Second, relevant differences between cyber-risks and other supply chain risks are identified, in areas such as the capacity of disruptions from cyber risks to go undetected, the high reproduction fidelity of cyber-risks, the capacity of cyber risks to affect different geographical locations simultaneously, and the complexity of cyber-attacks. Finally, the research reveals that the novel use of methods based in systems thinking for managing cyber-risks at the same time address gaps found in traditional methods, and provide a foundation for thinking about cyber-risks not as an outside threat, but rather as the result of incomplete requirements to the supply chain design. This change in focus could allow supply chains to minimize losses by preparing the system for reaction to whatever cyber-risk leads to an operational disruption. The findings of the research have both industrial implications. The industrial implications suggest supply chains can benefit from designing the behaviours they require through cross-disciplinary, simulation-based techniques. The academic implications suggest that researchers will benefit from 1) adjusting reporting times to match the quick development cycle of cyber-attacks, 2) consolidating a cross-disciplinary cyber-risk and resilience research community, and 3) expanding existing research.
methods by integrating dynamic systems thinking into data gathering and analysis.

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**Mathematical Programming Models and Algorithms for Oshore Wind Park Design**
Designing an offshore wind park is a complex process, involving several different expertises, and multiple tasks. In this thesis we developed Mathematical Programming models and algorithms to help the wind park designers. In particular, we focused on two optimization problems arising at the design phase of offshore wind parks, namely the optimal allocation of turbines in a given site and the connection of turbines through cables. We briefly touched upon the optimization of offshore jacket foundations as well.

This thesis was motivated and supervised by Vattenfall, a leading company in wind park development and operation. Thanks to our close collaboration, the optimization problems have been described and modelled as they arise in practical applications and they have been tested on real data. Our work proved to have a huge impact in practice, being able to increase park production and reduce costs. Having a sound optimization tool to help the designers allows also for different what-if analyses and scenario evaluations. This is of key value for Vattenfall, especially when looking at new technologies on the market.

The mathematical optimization models and algorithms developed have been considered of great interest also by the Operational Research (OR) community, and resulted in six journal papers. This thesis wants to follow the two-fold nature of our project, offering interesting material both to wind energy experts and practitioners, and to OR experts. Therefore we alternate OR journal papers, with practical examples and impact evaluations.

Finally, we proposed an application of integrating Machine Learning and OR, where we investigate if a machine, trained on a large number of optimized solutions, can estimate the value of the optimized solution for new instances.

This research question is of interest for all kinds of optimization problems, and is here studied on our specific wind farm application.

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Using OR + AI to predict the optimal production of offshore wind parks: a preliminary study

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Complexity Management - A multiple case study analysis on control and reduction of complexity costs
Complexity tends to be arguably the biggest challenge of manufacturing companies. The motivation of further studying complexity is a combination between the existing literature and the practical experiences from the industry. Based on the latest trend companies are trying to supply a growing mix of products, with features more custom-made to cover individual needs, both regarding characteristics of products and support services. This necessity leads to a considerable increase of the complexity in the company, which affects the product portfolio, production and supply chain, market segments, IT systems, and business processes. In order to identify and eliminate complexity, several approaches are used, both by researchers and practitioners. The purpose of this thesis is to contribute to the existing knowledge of complexity management theory. This research focuses on the relationship between product and process complexity. The possible factors for describing this correlation are identified and defined as complexity cost factors (CCFs). By identifying the CCFs this research intends to analyze the most relevant processes where the complexity and cost are directly related to the complexity of products. In this way, it will be possible to quantify the exact cost impact on those processes for each product variant. Furthermore, initiatives regarding complexity reduction are investigated. Standardization in product design, increased reusability of components, postponement of the customer order decoupling point (CODP) and utilization of configuration systems are further examined in terms of their complexity reduction effects. The research is supplemented with empirical evidence from several manufacturing companies. Finally, the evaluation of the obtained results indicates a strong managerial and theoretical potential for the control and reduction of complexity in manufacturing industries and pinpoints areas for further investigation.

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Exact and Heuristic Methods for Integrated Container Terminal Problems

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An applied optimization based method for line planning to minimize travel time

The line planning problem in rail is to select a number of lines from a potential pool which provides sufficient passenger capacity and meets operational requirements, with some objective measure of solution line quality. We model the problem of minimizing the average passenger system time, including frequency-dependent estimates for switching between lines, working with the Danish rail operator DSB and data for Copenhagen commuters. We present a multi-commodity flow formulation for the problem of freely routing passengers, coupled to discrete line-frequency decisions selecting lines from a predefined pool. We show results directly applying this model to a Copenhagen commuter rail problem.

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Efficiency and Robustness in Railway Operations

Passenger railway transport is an effective means of providing high capacity transport that is energy efficient and has low emissions. As the population of Denmark grows and there is an increased request for mobility, there is a need for railway services offering greater capacity and more reliability. Offering these services presents a challenging sequence of planning problems for operators. These range from problems considered on a daily basis to planning for years in the future, with different problems interacting and influencing each other.

Operations research methods can be used to effectively model, investigate, and solve railway planning problems. Despite advances in computational power these large problems are still challenging to solve, especially as more modelling detail is sought. Within a Danish context this thesis seeks to apply operations research methods to different planning problems beyond past approaches, and where applicable, investigate solution methods that place more focus on the passenger and passenger experience. To cater to the growing demand for rail transport, and compete with different modes of transport, Danish railway operators must offer a consistent, reliable service, that is well planned from both a passenger and operator perspective. This thesis therefore considers different planning problems within passenger railway considering robustness of the system, and efficiency and optimality from the point of view of the passenger or operator.

The contributions of the thesis are in the investigation of robustness in railway, the application of optimization to a number of railway planning problems, and a detailed consideration of the specific concerns of Danish railway services. These contributions are summarised in the introductory chapter, and in the latter part of the thesis are given in each chapter.

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Integrating robust timetabling in line plan optimization for railway systems

The line planning problem in rail is to select a number of lines from a potential pool which provides sufficient passenger capacity and meets operational requirements, with some objective measure of solution line quality. We model the problem of minimizing the average passenger system time, including frequency-dependent estimates for switching between lines, working with the Danish rail operator DSB and data for Copenhagen commuters. We present a multi-commodity flow formulation for the problem of freely routing passengers, coupled to discrete line-frequency decisions selecting lines from a predefined pool. We show results directly applying this model to a Copenhagen commuter rail problem.

Management of business process design in global implementation of enterprise resource planning systems

Investments in global enterprise resource planning (ERP) systems are typically carried out as a part of the globalization process in multinational corporations (MNCs). Global ERP systems support integration and control in MNCs in an important way by establishing a common language across an MNC. As process and data standardization are among the primary drivers of ERP consolidation efforts, business process design is an important concern when implementing global ERP systems. This PhD study addresses three research questions that develop understanding, support, and improvement of the practice of business process design in the course of a global ERP implementation in MNCs. In light of existing theoretical and practical challenges, the research questions focus on three business process management (BPM) capabilities: alignment, governance, and method. Drawing on extensive literature reviews and findings from case studies in nine organizations, the study addresses the three prescriptive research questions through five descriptive studies.

First, by deploying alternative theories, this study explores the strategic, institutional, organizational, and relational factors that influence business process design, and particularly process standardization, in an MNC. Second, the study investigates implications of process standardization for the choice of ERP architecture in MNCs. The findings indicate the moderating impact of process standardization on a global ERP system's total cost of ownership and its support for control and coordination. Third, having identified the factors that influence process standardization in MNCs, the study investigates the alignment between process standardization and an MNC's international management strategy and indicates that process standardization as a centralizing coordination mechanism better fits MNCs structured for global integration compared to those seeking local responsiveness. The study develops conditions of fit between structural elements characterizing an MNC's international management strategy and process standardization.

Fourth, seeking governance mechanisms enabling business process design, the study explores collaborations between BPM and IT management functions and suggests the need for horizontal integration between the two functions in support of business–IT alignment. In addition, the study associates the direction of integration with the role of IT. Fifth, in search of a method enabling integrated business process design, the study investigates diverse views on enterprise architecture (EA) and various applications of enterprise architecture management (EAM) in organizations. The findings are classified as a taxonomy of EAM applications in organizations based on EA scope.

Drawing on findings from descriptive studies, the PhD study clarifies the criticality of business process design in the course of a global ERP implementation by explaining the impact of strategic, institutional, organizational, and relational contexts on process standardization on the one hand, and the importance of process standardization for reducing ERP total cost of ownership and its deployment as an integrative mechanism on the other. The study concludes that business process design in the course of a global ERP implementation can be supported by aligning decision making on process
standardization with corporate international management strategy and structural characteristics. Furthermore, business process design can be supported by establishing permanent central governance for BPM and horizontally integrating the BPM function with the IT function at the strategic and operational levels. Business process design in the course of a global ERP implementation can be improved by adopting EAM as a methodology that enables integrated design of business processes and IT systems in alignment with business strategy.

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Medarbejderinddragelse i produktinnovation: Hvorfor MIPI? Fordele og forudsætninger

Dette hæfte beskriver hvilke fordele der kan opnås ved at inddrage medarbejdere fra produktionen, samt hvilke forudsætninger der ligger til grund. Hæftet skaber grundlaget for at benytte hæfte 2, som giver en pejling af dit udgangspunkt for at inddrage medarbejdere og dernæst hæfte 3, som præsenterer konkrete metoder til medarbejderinddragelse. Som illustreret i figuren er hæfterne værktøjer til at afklare og afstemme hvordan medarbejderne kan inddrages i produktinnovation netop din virksomhed.

Formålet med MIPI hæfterne er at oplyse og hjælpe virksomheder med at benytte medarbejderinddragelse i produktinnovation. I hæfterne findes information og inspiration, samt konkrete arbejdsmetoder til at initiere medarbejderinddragelse. Hæfterne er rettet imod ledelsen og projektledere i danske fremstillingsvirksomheder med egen produktudvikling.

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Medarbejderinddragelse i produktinnovation: Hvad er jeres udgangspunkt? En diagnose af virksomheden


Formålet med MIPI hæfterne er at oplyse og hjælpe virksomheder med at benytte medarbejderinddragelse i produktinnovation. I hæfterne findes information og inspiration, samt konkrete arbejdsmetoder til at initiere medarbejderinddragelse. Hæfterne er rettet imod ledelsen og projektledere i danske fremstillingsvirksomheder med egen produktudvikling.
Medarbejderinddragelse i produktinnovation: Hvordan gør man? Metoder til inddragelse
Dette hæfte beskriver 9 metoder til hvordan virksomheder kan inddrage produktionsmedarbejdere i produktinnovation. Metoderne er blevet udviklet og testet i samarbejde med danske produktionsvirksomheder. Metoderne understøtter alle samarbejde og kommunikation, som et middel til at opnå produktinnovation. Metodebeskrivelserne er rettet imod projektledere i enten udvikling eller produktion, som ønsker at få input til produktinnovation.
Formålet med MIPI hæfterne er at oplyse og hjælpe virksomheder med at benytte medarbejderinddragelse i produktinnovation. I hæfterne findes information og inspiration, samt konkrete arbejdsmetoder til at initiere medarbejderinddragelse. Hæfterne er rettet imod ledelsen og projektledere i danske fremstillingsvirksomheder med egen produktudvikling.

Optimizing wind farm cable routing considering power losses
Wind energy is the fastest growing source of renewable energy, but as wind farms are getting larger and more remotely located, installation and infrastructure costs are rising. It is estimated that the expenses for electrical infrastructure account for 15-30% of the overall initial costs, hence it is important to optimize o shore inter-array cable routing. The routing should connect all turbines to one (or more) o shore sub-station(s) while respecting cable capacities, no-cross restrictions, connection-limits at the substation, and obstacles at the site. The objective is to minimize both the capital that must be spent immediately in cable and installation costs, and the future reduced revenues due to power losses. The latter goal has not been addressed in previous work. We present a Mixed-Integer Linear Programming approach to optimize the routing using both exact and math-heuristic methods. In the power losses computation, wind scenarios are handled eciently as part of the preprocessing, resulting in a MIP model of only slightly larger size. A library of real-life instances is introduced and made publicly available for benchmarking. Computational results on this testbed show the viability of our methods, proving that savings in the order of millions of Euro can be achieved.
Participatory simulation in hospital work system design

When ergonomic considerations are integrated into the design of work systems, both overall system performance and employee well-being improve. A central part of integrating ergonomics in work system design is to benefit from employees' knowledge of existing work systems. Participatory simulation (PS) is a method to access employee knowledge; namely employees are involved in the simulation and design of their own future work systems through the exploration of models representing work system designs. However, only a few studies have investigated PS and the elements of the method. Yet understanding the elements is essential when analyzing and planning PS in research and practice.

This PhD study investigates PS and the method elements in the context of the Danish hospital sector, where PS is applied in the renewal and design of public hospitals and the work systems within the hospitals. The investigation was guided by three research questions focusing on: 1) the influence of simulation media on ergonomic evaluation in PS, 2) the creation of ergonomic knowledge in PS, and 3) the transfer and integration of the ergonomic knowledge into work system design. The investigation was based on three PS cases in the Danish hospital sector. The cases were analyzed from an ergonomics system perspective combined with theories on knowledge creation, transfer, and integration. The results are presented in six scientific papers from which three core findings are extracted: 1) simulation media attributes influence the type of ergonomic conditions that can be evaluated in PS, 2) sequences and overlaps of knowledge creation activities are sources of ergonomic knowledge creation in PS, and 3) intermediaries are means of knowledge transfer, and interpretation and transformation are means of knowledge integration.

Simultaneously Exploiting Two Formulations: an Exact Benders Decomposition Approach

When modelling a given problem using linear programming techniques several possibilities often exist, and each results in a different mathematical formulation of the problem. Usually, advantages and disadvantages can be identified in any single formulation. In this paper we consider mixed integer linear programs and propose an approach based on Benders decomposition to exploit the advantages of two different formulations when solving a problem. We propose to apply Benders decomposition to a combined formulation, comprised of two separate formulations, augmented with linking constraints to ensure consistency between the decision variables of the respective formulations. We demonstrate the applicability of the proposed methodology to situations in which one of the formulations models a relaxation of the problem and to cases where one formulation is the Dantzig-Wolfe reformulation of the other. The proposed methodology guarantees a lower bound that is good as the tighter of the two formulations, and we show how branching can be performed on the decision variables of either formulation. This paper also includes a discussion on the types of problems for which the method is of particular interest. Furthermore, it proves the correctness of the procedure and considers how to include interesting extensions such as cutting planes and advanced branching strategies. Finally, we test and compare the performance of the proposed approach on publicly available instances of the Bin Packing problem. Compared to the standard branch-and-price approach from the literature, the method shows promising performance and appears to be an attractive alternative.
Aircraft Stand Allocation with Associated Resource Scheduling

An aircraft turn-round refers to the set of processes taking place from when an aircraft parks at its arrival stand until the time it departs from its departure stand. When handling a turn-round, the different processes involved (arrival, disembarkation of passengers, cleaning, etc.) require different ground handling resources (taxiways, aircraft stands, gates, etc) at different times. Each resource can be claimed by at most one turn-round at a time. The aircraft stand allocation problem with associated resource scheduling is the problem of allocating the required ground handling resources to handle a given set of aircraft turn-rounds. We develop a set packing-based model formulation of the problem which is both flexible in the sense that it can encapsulate any type of resource required during the handling of a turn-round and strong in the sense that conflicts that occur when two or more turn-rounds simultaneously claim the same resource are handled implicitly. To solve the model, a heuristic based on linear programming is developed. The heuristic iteratively solves a relaxed, restricted version of the problem, adding extra variables at each iteration if needed. The additional variables are identified by a cost-based partial enumeration of the possible variables for each turn-round and the heuristic stops when the first feasible solution is encountered. The heuristic has been tested on real data from Copenhagen Airport with a special focus on tactical day-to-day planning. The results show that the method generates high-quality feasible solutions within reasonable time for tactical planning.

A Matheuristic Approach for Solving the Railroad Hump Yard Block-to-Track Assignment

This paper presents a novel matheuristic for solving the Hump Yard Block-to-Track Assignment Problem. This is an important problem rising in the railway freight industry and involves scheduling the transitions of a set of rail cars from a set of inbound trains to a set of outbound trains over a certain planning horizon. It was also the topic of the 2014 challenge organised by the Railway Applications Section of the Institute for Operations Research and the Management Sciences for which the proposed matheuristic was awarded first prize. Our approach decomposes the problem into three highly dependent subproblems. Optimization-based strategies are adopted for two of these, while the third is solved using a greedy heuristic. We demonstrate the efficiency of the complete framework on the official datasets, where solutions within 4-14% of a known lower bound (to a relaxed problem) are found. We further show that improvements of around 8% can be achieved if outbound trains are allowed to be delayed by up to two hours in the hope of ensuring an earlier connection for some of the rail cars.
A Networked Perspective on the Engineering Design Process: At the Intersection of Process and Organisation Architectures

The design process of engineering systems frequently involves hundreds of activities and people over long periods of time and is implemented through complex networks of information exchanges. Such socio-technical complexity makes design processes hard to manage, and as a result, engineering design projects often fail to be on time, on budget, and meeting specifications. Despite the wealth of process models available, previous approaches have been insufficient to provide a networked perspective that allows the challenging combination of organisational and process complexity to unfold. The lack of a networked perspective also has limited the study of the relationships between process complexity and process performance. This thesis argues that to understand and improve design processes, we must look beyond the planned process and unfold the network structure and composition that actually implement the process. This combination of process structure—how people and activities are connected—and composition—the functional diversity of the groups participating in the process—is referred to as the actual design process architecture. This thesis reports on research undertaken to develop, apply and test a framework that characterises the actual design process architecture of engineering systems as a networked process. Research described in this thesis involved literature reviews in Engineering Design, Engineering Systems, Complexity and applied Network Science, and two case studies at engineering design companies with the objective of iteratively developing the framework and providing a proof-of-concept of its use in a large engineering design project. The developed Networked Process (NPr) Framework is composed of a conceptual model of the actual design process architecture, and an analytical method that allows the model and data-driven support to be quantified. The framework provides a networked perspective on three fundamental levels of analysis: 1) the activity-level, characterised as a network of people performing each activity, 2) the interface-level, characterised as a network of people interfacing between two interdependent activities, and 3) the whole process-level, characterised as a dynamic network of people and activities. The aim of the framework is to improve the design process of engineering systems through a more detailed overview of the actual design process, to support data-driven reflection of the relationship between process architecture and performance, and to provide the means to compare process plans against the actual process. The framework is based on a multi-domain network approach to process architecture and draws on previous research using matrix-based and graph-based process models. The results of the NPr Framework's application in two case studies showed that decision makers in engineering design projects were able to gain new insights into their complex design processes through the framework. Such insights allowed them to better support and manage design activities, process interfaces and the whole design process. The framework also was used to enrich project debriefing and lessons-learned sessions, to spot process anomalies, to improve design process planning, to examine process progress, and to identify relationships between process architecture and performance. Contributions to knowledge include: First, the development of a more complete model of the actual process architecture and concrete analytical methods to quantify the developed model. Second, the identification of key structural and compositional variables as well as tests to identify the relationship between those variables and performance metrics. Third, the creation of a platform for further research on the relationships between actual design process architecture, behaviour and performance.
A New Approach to the Container Positioning Problem
In this paper the Container Positioning Problem is revisited. This problem arises at busy container terminals and requires one to minimize the use of block cranes in handling the containers that must wait at the terminal until their next means of transportation. We propose a new Mixed Integer Programming model that not only improves on earlier attempts at this problem, but also better reflects reality. In particular, the proposed model adopts a preference to reshuffle containers in line with a just-in-time concept, as it is assumed that data is more accurate the closer to a container’s scheduled departure the time is. Other important improvements include a reduction in the model size, and the ability of the model to consider containers initially at the terminal. In addition, we describe several classes of valid inequalities for this new formulation and present a rolling horizon based heuristic for solving larger instances of the problem. We show that this new formulation drastically outperforms previous attempts at the problem through a direct comparison on instances available in the literature. Furthermore, we also show that the rolling horizon based heuristic can further reduce the solution time on the larger of these instances as well as find acceptable solutions to much bigger, artificially generated, instances.

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A central issue for operators of passenger railways is providing sufficient number of seats for passengers while at the same time minimising operating costs. This is the task of rolling stock planning. Due to the large number of practical, railway specific requirements that a rolling stock plan has to take into account, rolling stock plans are often constructed in a step-by-step manner, taking some requirements into consideration in each step. This may make it difficult in the final step to produce a plan that is feasible with regard to all of the requirements and at the same time economically attractive. This paper proposes an integrated rolling stock planning model that simultaneously takes into account all practical requirements for rolling stock planning at DSB S-tog, the suburban passenger train operator of the City of Copenhagen. The model is then used to improve existing rolling stock plans using a hill climbing heuristic. Experiments show that the heuristic used in the integrated rolling stock planning model is able to produce feasible solutions within minutes of computation time starting from infeasible rolling stock plans. Furthermore, the heuristic is able to improve the economic attractiveness of typical rolling stock plans with an average of 2%.

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Arbejdsmiljø i idé-, program- og projektfaserne: Grundlaget for sikkerhed og sundhed i udførelse gennem projektering

General information
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Organisations: Department of Management Engineering, Production and Service Management, Risk Research Group, Implementation and Performance Management
A Systemic Perspective on Innovation from Energy Efficiency Policy efforts

In order to reduce climate change, resource scarcity and other global environmental issues major increases in energy efficiency are necessary throughout our energy system. Despite this daunting outlook and the fact that energy efficiency in most instances makes economic and environmental sense, these energy efficiency improvements do not occur by themselves. This challenge of low diffusion for energy-efficient solutions has been the subject of policy efforts since the oil crisis in the 1970s and they are gaining in attention. In certain sectors, however, it seems like energy efficiency is starting to make a differences and businesses appear especially innovative in this field (Borup et al., 2009). This thesis therefore investigates the dynamics of energy efficiency innovation and, in particular, their relation to public policy efforts. These innovation activities in energy efficiency have not been the subject of much research in the innovation studies field, where most attention is given towards energy supply technologies and energy end-use technologies tend to be left in the dark. This thesis applies different qualitative and quantitative research methods to analyse how actors are collaborating on innovation activities within energy efficiency. It furthermore investigates the long and complex process of innovation activities in energy efficiency with attention to the co-evolutionary dynamics of technology development, policy and market transformation. The findings cover different aspects of the research topic. At the cross-sectoral level it contributes with insights into the collaborative RD&D activities in energy efficiency and how the structure of these development activities has an impact on the innovation output of the RD&D projects. It furthermore identifies the driving forces of energy efficiency innovation activities where market demand and policy efforts appear to have the most impact. The thesis also goes in depth with a single sector to describe the complexities of innovation processes in energy efficiency and the noticeable role of policy. Overall the doctoral thesis provides an insight into the dynamics of energy efficiency innovation and the necessity of policy efforts. For innovation and market transformation to occur, strategic and integrated policies are absolutely crucial in order to overcome the barriers towards energy efficiency and thereby enabling energy efficiency innovation for the benefit of firms and the environment.
environmentally unsustainable and that the level of unsustainability may be increasing over time. A clear rationale therefore exists for developing and using absolute environmental sustainability indicators (AESI) that not only can identify the anthropogenic system with the lowest environmental interferences in a comparison of systems, but also can evaluate whether any of the compared systems can be considered environmentally sustainable, and if not, can quantify the decrease in environmental interferences required for environmental sustainability. The purpose of this PhD thesis is to improve AESI using life cycle assessment (LCA) and to deepen the understanding of drivers and obstacles for increasing the use of AESI in decision-support. The thesis summarizes in three core chapters the work of five peer reviewed scientific articles and one scientific viewpoint article. The first chapter is concerned with operationalizing the concept of carrying capacity as reference value of environmental sustainability in environmental indicators in general and in LCA indicators specifically. LCA is a tool that quantifies environmental stressors (resource use and emissions) occurring over the life cycles (“cradle to grave”) of anthropogenic systems and translates these stressors into metrics of environmental interferences for a number of mutually exclusive and collectively exhaustive “impact categories”, such as climate change, eutrophication and ecotoxicity. Carrying capacity is in this thesis defined as “the maximum sustained environmental interference a natural system can withstand without experiencing negative changes in structure or functioning that are difficult or impossible to revert.” In the design of AESI a choice needs to be made for each of 12 identified concerns. Existing AESI are found to be based on different choices for concerns, such as “threshold value”, “quantifying environmental interferences of studied system” and “modelling of carrying capacity.” This difference in choices across AESI can lead to high uncertainties in indicator scores, potentially 3 orders of magnitude, and should thus be reduced where possible. Existing AESI are also found to only partially cover all impact categories. LCA indicators can potentially contribute to increasing the coverage of impact categories in AESI and to reducing indicator uncertainties, due to the consistent choices made for LCA indicators for many of the 12 indicator concerns. LCA indicators are relative and must be modified with carrying capacity references to become AESI. This modification can either happen in the normalisation of indicator scores or by developing new characterisation factors (CFs) used to translate environmental stressors to metrics of environmental interferences in LCA. Operational global and European carrying capacity based normalisation references are developed for 11 LCA impact categories and can be used to translate indicator scores from metrics specific to each impact category (such as Global Warming Potential for the impact category climate change) to a common metric of carrying capacity occupation, expressed in person years. To improve the representation of spatial variations, a generic mathematical equation for integrating carrying capacity in CFs is developed. Such CFs express indicator scores as hectare years, i.e. occupation of carrying capacity integrated over space and time. CFs for the impact category terrestrial acidification are developed and show strong local and regional variations (e.g. ranging above a factor of 5 across contiguous United States). The high spatial variation is an argument for using carrying capacity modified CFs, as opposed to modified normalisation references, when the locations of stressors of a studied anthropogenic system are known. The second chapter is concerned with calculating carrying capacity entitlement of individual anthropogenic systems, with analysing the applicability of different valuation principles in calculating entitlements and with how sensitive calculated entitlements are to choice of valuation principle. Entitlements must be calculated to evaluate whether an anthropogenic system can be considered environmentally sustainable, which is the case when carrying capacity occupation does not exceed entitlement. Calculation of entitlement must consider the perceived value of a studied system relative to systems that compete for the same carrying capacity for their functioning. An ideal and a simplified method for identifying competing systems in a spatial assessment are outlined. A list of valuation principles is presented and includes contribution to Gross domestic product (GDP) and contribution to meeting human needs. The applicability of the valuation principles on different types of anthropogenic systems (territorial or lifecycle-based from micro-to macro scale) is analysed. Case studies are used to illustrate that the choice of valuation principle has a potentially large influence on the carrying capacity entitled to an anthropogenic system. The third chapter is concerned with characterising companies’ use of AESI in stakeholder communication and with how to increase this use. Companies have recently been encouraged by various initiatives to adopt AESI to define targets with deadlines for environmental sustainability at company level. A screening and context analysis of the largest global database of corporate responsibility reports found that only 23 out of 9,000 companies were following this advice. Explanations for the low share may be that the use of AESI is (still) not being sufficiently demanded by critical stakeholders and that operational AESI for impact categories other than climate change are either not available or not compatible with the tools with which companies express their environmental interferences. Two strategies for increasing the use of AESI by companies are proposed: 1) AESI based on LCA indicators should be further developed and made available to companies, since many companies already use LCA to reporting environmental interferences. 2) The awareness of AESI must be increased amongst critical stakeholders so that they can pressure companies to adopt AESI. Following the three core chapters, a final chapter with recommendations is provided. This chapter outlines future research needs on AESI related to indicator development and refinement, inventory data, social sustainability references and consensus needs. Practical measures for increasing the use of AESI in decision-making are also proposed.

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We present a solution method for the liner shipping network design problem which is a core strategic planning problem faced by container carriers. We propose the first practical algorithm which explicitly handles transshipment time limits for all demands. Individual sailing speeds at each service leg are used to balance sailings speed against operational costs, hence ensuring that the found network is competitive on both transit time and cost. We present a matheuristic for the problem where a MIP is used to select which ports should be inserted or removed on a route. Computational results are presented showing very promising results for realistic global liner shipping networks. Due to a number of algorithmic enhancements, the obtained solutions can be found within the same time frame as used by previous algorithms not handling time constraints. Furthermore we present a sensitivity analysis on fluctuations in bunker price which confirms the applicability of the algorithm.

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Competitive Liner Shipping Network Design
The goal of this thesis is to develop decision support tools, which can be used to optimize container shipping networks while supporting competitive transportation services. The competitiveness of container liner shipping is to a high degree determined by transportation times and number of transshipments on the most important sailing routes. The proposed methods in this thesis, aimed at liner shipping network design, integrate competitiveness such that the fuel consumption per transported container is reduced without increasing the transit times. A well-designed route net is decisive for container shipping company earnings. The operation of the route net constitute the majority of the total costs, so it is essential to achieve a good capacity utilization in a route plan with travel times that satisfy customer requirements. Most academic articles dealing with the design of container networks neither take the container transportation times that can be realized in the network nor the number of transshipments into consideration. This is mainly because the optimization problem is based on other transportation networks where these constraints are not decisive to the quality of the network. Furthermore, the problem in itself is challenging to optimize due to its size and complexity. However, the field has seen crucial progress and is mature to include handling of competitiveness in the actual design of the network. As a liner shipping network is an organic entity, which is constantly changed to reflect changes in the freight markets, it is of significant value that the changes are based on the existing network, which presumably is of high quality. At the same time, changes often affect a limited geographical area in the global shipping market. In this thesis methods to incorporate the competitiveness of the network in the form of requested transportation times and transshipments and to ensure better capacity utilization in the network are presented. The project has developed large-scale mathematical methods that leverage the existing network to optimize a specific freight market/geographic area or the entire network. The result is prototypes of decision support tools to make incremental changes to a network e.g. by adding/deleting ports from routes or change speed between two ports in order to examine how it changes the total earnings taking into account the network’s competitiveness and quality. The contributions of this thesis cover modeling, methodology, and applications. The developed methods address operational (cargo routing), tactical (speed optimization and service selection), and strategic (network design) planning problems faced by liner shipping companies. Ultimately, the proposed methods help answer questions such as: How can the capacity utilization of the network be improved while taking into account the competitiveness and quality? How should new routes be designed such that they utilize existing and new markets or possibly leave unprofitable markets? What routes are the most profitable to operate? How should changes in the fleet be integrated into the existing network? What ships will be relevant to use in the future? What transportation times and number of transshipments would be appropriate to provide for a given transport?
Eco-innovation dynamics and sustainability – new perspectives in innovation studies illuminated through the case of lighting and its energy consumption

There is an increasing consensus about the need to reduce the environmental burden of economic activities. The concept of sustainable development has led to increased efficiency of the economic process through innovation, which is now the main strategy applied both to preserve environmental capital and to achieve economic growth. Consequently, many innovations have been given the label of "eco" due to their ability to improve the efficiency of the economic process. The history of energy consumption is a paradigmatic example of diffusion of this type of eco-innovations. The efficiency of converting energy in lighting has increased a thousand times in the last century, and is expected to increase three to six times in the near future, thanks to the development and diffusion of LED technology. Consequently, many societal actors and policy-makers now rely on this promising eco-innovation to reduce the consumption of energy during the provision of light. Researchers have already investigated the dynamics of production and consumption associated with the most recent light "revolutions". Interestingly, these revolutions resulted in increased energy consumption for the provision of light, even if energy efficiency increased. The same paradox has been experienced by other sectors and has been discussed in the eco-innovation literature, with innovation being considered as both a cause of and a solution for environmental degradation. The present thesis has investigated the roots of this paradox and the implications for policies and societies, of a new conceptualization of eco-innovation that can overcome such paradox. In my view, the paradox stems from two conceptual weaknesses of the traditional eco-innovation literature. First, this literature has underestimated the debate between the advocators of weak sustainability (that is, sustainability as the sum of natural and human-made capitals) and the ones of strong sustainability (that is, sustainability as the preservation of natural capital). Second, the eco-innovation literature has not integrated the findings of the rebound effect literature, in which relations between innovation and consumption have been widely analyzed. As a result, a current popular definition of eco-innovation, implicitly based on the concept of weak sustainability, has been erroneously promoted to achieve specific environmental targets (such as a reduction of energy consumption) that represent the strong sustainable perspective. For this reason, I propose a new conceptualization of eco-innovation for strong sustainability that focuses specifically on the impacts of any innovation with respect to consumption. Based on this conceptualization, an eco-innovation is not one that increases efficiency, but one that reduces overall environmental impacts. The dualism of the eco-innovation concept has important consequences for the specificity of the case study, and for the more general discussion about innovation and sustainability. In the case of energy consumption for lighting, the thesis indicates the need to frame future innovations in a context that fosters the emergence of new practices leading to energy saving. One of the several recommendations I make in this thesis is that the future smart light system based on the LED technology should be provided by a new type of lighting service company that aims to sell light saving. In fact, LED is not only a more efficient technology; it is also superior to other technology in numerous ways. For this reason, the future smart LED light system is expected to encourage demand for lighting, as will the emergence of new lighting players that will generate new market opportunities. The actual impacts of these dynamics, in terms of energy consumption, will depend on which practices will be developed and how these new technological opportunities will be integrated. For that reason, there is a need for a better conceptualization of eco-innovation that can provide a better understanding of the potential opportunities and risks presented by the most promising innovations for sustainability. Similarly, policy makers should seek to deconstruct the current concept of the lighting sector, from being the realm of the electric bulb, to the realm of light and lighting. In fact today many actors which provide (natural) light, as for example windows producers, are not framed as part of the lighting sector. The thesis suggests to policy makers to promote a more functional definition of the boundaries of the lighting sector, including all the players that provide both natural and artificial light.
Enabling Mass Customization in Engineer-To-Order Industries: A multiple case study analysis on concepts, methods and tools

Choosing goods and services that satisfy individual needs has become possible in many consumer markets today. Technological advancement in sales and production enabled a variety of products, from automotive to apparel, to be mass customized in a profitable manner. Over time, these companies learned to handle the negative impact of a resulting increase in architecture complexity. In contrast, engineer-to-order firms, which core business is to create bespoke product variants engineered to specific needs, could not benefit to the same degree from the progress towards mass customization. Though customizing engineering products has a wide-ranging impact on companies' architecture. The interconnected and hardly standardized design combined with highly varying processes makes the specification and fulfillment of customization requests difficult to handle. Moreover, although likewise affected with rising complexity levels and stronger customization responsiveness, their challenges and motivations towards mass customized solutions have seldom been discussed. To address this challenge, this thesis elaborates on state-of-the art research in architecture design and specification processes development and defines general capabilities to facilitate mass customization in engineer-to-order firms. The established understanding is complemented with interviews of practitioners from 18 engineering companies to obtain further insight into essential aspects of the research field. Based on the gained experience, eleven empirical studies have been conducted to develop relevant concepts and methods aiming at enhancing the identified capabilities. This close collaboration with industries ranging from construction to process plants and machinery applications promoted the development of a practical tool, termed Integrated Design Model (IDM). The IDM tool integrates adjacency matrices, node-link diagrams and generic modelling methods, to improve the explicitness and visibility of architectures. Connected to advanced expert systems, such as product configuration systems, the tool enables a formalized procedure for managing the design of complex architectures using aspects of visual analytics and computational structural analyses. Finally, the evaluation of the obtained results indicates a strong managerial and theoretical potential for the establishment of mass customization in engineer-to-order industries and pinpoints areas for further investigation.

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Bibliographical note
Medforfatter: Lrktor Kirsten Jørgensen (kjr@dtu.dk)
Exact Methods for Solving the Train Departure Matching Problem

In this paper we consider the train departure matching problem which is an important subproblem of the Rolling Stock Unit Management on Railway Sites problem introduced in the ROADEF/EURO Challenge 2014. The subproblem entails matching arriving train units to scheduled departing trains at a railway site while respecting multiple physical and operational constraints. In this paper we formally define that subproblem, prove its NP-hardness, and present two exact method approaches for solving the problem. First, we present a compact Mixed Integer Program formulation which we solve using a MIP solver. Second, we present a formulation with an exponential number of variables which we solve using column generation. Our results show that both approaches have difficulties solving the ROADEF problem instances to optimality. The column generation approach is however able to generate good quality solutions within a few minutes in a heuristic setting.

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Firm and user community collaboration: A complex love story

The purpose of this thesis is to develop a comprehensive framework that describes the dynamic relationship between firms and user communities. To understand the implications of collaboration, from the relation between users and firms rather than from their individual properties, this thesis urges a more relational approach to collaborations between users and firms than is offered by the literature. As tensions arise from collaborations between firms and users, the argument is that their relationship (and innovation potential) can be better understood by highlighting the dynamics between their conflicting demands. This thesis investigates tensions in the idea-development phase and conceptualizes innovation performance as firms' innovation potential and ability to renew themselves and develop new products. Thus, the thesis seeks to answer the following overall research question: How do tensions arise from innovation-related firm and user community collaborations and how do these tensions affect the innovation performance?

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INFO kort om ulykkesrisici og sikkerhedsbarrierer
Denne rapport indeholder en gennemgang af de væsentligstes risici, som fører til ulykker. For hver risici er det angivet de væsentligstes generiske sikkerhedsbarrierer, både med hensyn til hvad man skal observere, hvad man skal vurdere og hvilke handlinger, der bør ske som følge heraf.

General information
Reactive Robustness and Integrated Approaches for Railway Optimization Problems

Planning railway operations is not a simple task as it entails solving multiple interdependent optimization problems. These problems have been subject to study in the literature for the last few decades, and are still profoundly researched. The robustness of a plan or schedule denotes the ability to absorb or withstand unexpected events such as delays. Making robust plans is central in order to maintain a safe and timely railway operation. This thesis focuses on reactive robustness, i.e., the ability to react once a plan is rendered infeasible in operation due to disruptions. In such time-critical situations, new plans must be found quickly. Integration of the different planning problems is also considered in this thesis as these problems are strongly interdependent in many cases. In contrast, finding feasible plans for each problem in isolation can lead to an overall infeasibility, e.g., during a disruption the updated timetable may be impossible to realize due to the lack of rolling stock units at certain positions. It is important to avoid creating problems for later or subsequent planning stages. Several railway problems are studied in this thesis. The main contributions are summarized in individual chapters, some of which are papers that have been submitted to international scientific journals in operations research. The problems have been formulated as optimization problems and solution methods have been proposed to solve them using optimization theory and various solution techniques. In collaboration with industry and academic partners real-life and realistic data has been used to benchmark and test the solution methods. A central actor and theme of the thesis is the rolling stock running on the railway networks. A public timetable is given, and in order to service the departures and passengers a rolling stock schedule (or circulation) is sought that provides the best compromise between operational cost, robustness, contract requirements and passenger satisfaction. In between train services the rolling stock units must be parked in the available depots. As trains cannot overtake each other easily, special attention must be given to avoid conflicting movements. Furthermore, rolling stock units are heavy and consume a considerable amount of energy in operation; with proper optimization tools a significant amount of the energy can be saved. A prompt optimization of individual train journeys helps the driver to drive efficiently and enhances robustness in a realistic (dynamic) environment. Four international scientific prizes have been awarded for distinct parts of the research during the course of this PhD project. The first prize was awarded for work during the ‘2014 RAS Problem Solving Competition’, where a freight yard optimization problem was considered. The second junior (PhD) prize was awarded for the work performed in the ‘ROADEF/EURO Challenge 2014: Trains don’t vanish!’, where the planning of rolling stock movements at a large station was considered. An honorable mention (and second place) was awarded in recognition for excellent work in the ‘Discrete Optimization Challenge’, where
the aim was to minimize energy consumption in timetables. Finally, a second place was awarded in the '2015 RAS Student Paper Award', where a comparison of solution methods for planning shunting yard movements was considered.

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A central issue for operators of suburban passenger train transport systems is providing sufficient number of seats for the passengers while at the same time minimising operating costs. The process of providing this is called rolling stock planning. This technical report documents the terminology, the processes, the cost structures and the requirements for rolling stock planning at DSB S-tog, the suburban passenger train operator of the City of Copenhagen. The focus of the technical report is directed at practical train operator oriented issues. The technical report is thought to serve as a basis for investigating better methods to perform the rolling stock planning (to be the topic of later papers). This technical report is produced as a part of the current industrial Ph. D. project to improve the rolling stock planning process of DSB S-tog.

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**Simultaneous Optimization of Container Ship Sailing Speed and Container Routing with Transit Time Restrictions**
We introduce a decision support tool for liner shipping companies to optimally determine the sailing speed and needed fleet for a global network. As a novelty we incorporate cargo routing decisions with tight transit time restrictions on each container such that we get a realistic picture of the utilization of the network. Furthermore, we show that it is possible to extend the model to include optimal time scheduling decisions such that the time associated with transshipments is also reflected accurately. To solve the speed optimization problem we propose an exact algorithm based on Benders decomposition and column generation that exploits the separability of the problem. Computational results show that the method is applicable to liner shipping networks of realistic size and that it is important to incorporate cargo routing decisions when optimizing speed.

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Survey af Danske kommuners indsats overfor MSB og analyse af samarbejdet omkring MSB i 3 udvalgte kommuner

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Tramp Ship Routing and Scheduling - Models, Methods and Opportunities
In tramp shipping, ships operate much like taxis, following the available demand. This contrasts liner shipping where vessels operate more like busses on a fixed route network according to a published timetable. Tramp operators can enter into long term contracts and thereby determine some of their demand in advance. However, the detailed requirements of these contract cargoes can be subject to ongoing changes, e.g. the destination port can be altered. For tramp operators, a main concern is therefore the efficient and continuous planning of routes and schedules for the individual ships. Due to mergers, pooling, and collaboration efforts between shipping companies, the fleet sizes have grown to a point where manual planning is no longer adequate in a market with tough competition and low freight rates. The aim of this paper is to provide a comprehensive introduction to tramp ship routing and scheduling. This includes a review on existing literature, modelling approaches, solution methods as well as an analysis of the current status and future opportunities of research within tramp ship routing and scheduling. We argue that rather than developing new solution methods for the basic routing and scheduling problem, focus should now be on extending this basic problem to include additional real-world complexities and develop suitable solution methods for those extensions. Such extensions will enable more tramp operators to benefit from the solution methods while simultaneously creating new opportunities for operators already benefitting from existing methods.

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Contributors: Vilhelmsen, C., Larsen, J., Lusby, R. M.
Window Stories: The significance of windows to Germans - a qualitative, anthropological investigation of the qualities of a window

This research project has investigated 17 households in Germany (cities and rural areas). The main aim was to learn about the significance of the window to these people: What they think of their windows, how, when and why they use them in their everyday life, if they have a favorite window and why, as well as the opposite. The report also includes a special focus on overheating and people's strategies against this. Knowing about what people appreciate in a window and their actual practices and the reasons for their behaviour may be useful in many different ways, for instance to inform public strategies for overheating or to communicate with people in a more user informed way. The people participating in the study lived in different houses and had different backgrounds. They were involved in the project over a period of 3-4 months. The prolonged participation was facilitated through a variety of ethnographic tools that required their involvement, such as making a diary of their heating experiences during a random week in the summer of 2014, taking photos of windows and sending postcards with specific tasks.

General information
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Organisations: Department of Management Engineering, Technology and Innovation Management
Contributors: Hauge, B.
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A Branch-and-Price Framework for Railway Rolling Stock Rescheduling During Disruptions

Rescheduling rolling stock during a disruption is a passenger railway optimization problem. In current practice this is typically optimized manually despite the high complexity and high runtime requirements of the task. In this paper we propose a path-based mathematical formulation that is solved using column generation in a complete Branch-and-Price framework. In contrast to flow-based approaches our formulation is more easily extended to handle certain families of constraints, such as train unit maintenance restrictions. We benchmark the framework against real-life instances provided by the suburban railway operator in Copenhagen (DSB S-tog). In combination with a lower bound method we show that near-optimal solutions can be found within a few seconds during a disruption. In addition we show that framework is also able to find solution within a few minutes for non-disturbed timetables.

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Publication status: Published
Organisations: Department of Management Engineering, Management Science
Contributors: Haahr, J. T., Lusby, R. M., Larsen, J., Pisinger, D.
Number of pages: 27
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A Math-Heuristic Framework for the ROADEF/EURO Challenge 2014

General information
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Organisations: Department of Management Engineering, Management Science
Contributors: Haahr, J. T., Bull, S. H.
Number of pages: 5
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A_Math_Heuristic_Framework.pdf

Research output: Book/Report › Report – Annual report year: 2014 › Research

Decision-support for climate change adaptation – applications for coastal regions
This Ph.D. project aims at developing a new decision-support framework for managing climate change in coastal areas. The framework is developed in order to facilitate screening of climate change impacts in all coastal areas worldwide and is designed as a complete system for combined multi-hazard-assessment and multi-hazard-management. The framework addresses the hazards of ecosystem disruption, gradual inundation, salt water intrusion, erosion and flooding and can be used for hazard management at local, regional and national level. It is developed as a simple system that can be applied in areas with limited data availability and institutional capacity and is especially targeted the needs of developing countries. In order to make the framework easily accessible to coastal managers, it is designed as a graphical tool – the Coastal Hazard Wheel – that functions as a key for determining the characteristics of a coastline, its hazard profile and possible management options, and can be used for screening purposes prior to more detailed feasibility studies. The project has applied the framework for multi-hazard-assessments for the state of Karnataka, India and for the state of Djibouti to showcase its application in two very different coastal settings. The assessments are carried out in a GIS using basic and publicly available data, and a range of thematic hazard maps and hazard management recommendations have been developed for the two areas. Along with this, the assessments include discussions of practical challenges, uncertainties and limitations. Based on the applications on Karnataka and Djibouti, feedback from coastal experts and a range of selected spot-assessments, a slightly revised version of the Coastal Hazard Wheel has been developed. This is presented in an overview paper together with general guidelines for applying the framework for coastal hazard assessment and management.

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Contributors: Appelquist, L. R.
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Decoding the productivity code: Towards an improvement theory for sustainable organizational performance
This thesis introduces a new perspective on how organizations can achieve sustainable organizational performance in a changing world. By integrating Lean, the strength-based perspective, and organizational development, the false dichotomy and struggle between rationalization and employee well being, that is, the productivity code of the 21st century, is dissolved. Today, organizations are pressured for operational efficiency, often in terms of productivity, due to increased global competition, demographical changes, and use of natural resources. Taylor’s principles for rationalization founded
This report presents approaches of selected European countries to the management of low adhesion problems. It spans approaches addressing different levels of the problem, including preventive measures focusing on the tasks aimed at removing or reducing low adhesion, mitigative technical measures aimed at improving wheel performance in low adhesion conditions, as well as mitigative measures for driving and operating trains under these conditions. The report thus spans measures that are often managed by different organisations, mainly infrastructure managers and train operators. The report focuses on management of low adhesion and will not go into detail with the characteristics and generation of the low adhesion layer but will touch on this only to the extent that this determines or is directly linked with the specific low adhesion measures taken. Neither will the report go into detail with purely technical aspects of e.g. braking and WSP systems, but focus on the implied requirements for organisations and drivers.

The report is largely based on literature describing measures taken by existing railway organisations, comprising, besides a few journal article, largely reports by railway organisations and authorities, supplemented by presentations from an International Workshop held at DTU on 16 April 2013 at which experts presented updated knowledge about measures in the UK, Germany, the Netherlands and Sweden. The background for this report was a DTU project originally focusing on a SPAD1 incident in 2011 in Denmark and the braking ability of a specific type of train (Havarkommissionen 2012), but since expanded to encompass general problems with low adhesion (Nielsen et al. 2012). This report thus addresses problems that are already well-known to Danish railway organisations, but it gathers and analyses results and experiences from neighboring
European countries that have similar climate, vegetation and rail infrastructures. This report provides information that is based on up-to-date research and experiments in countries, where this topic has been subject to systematic investigations and empirical research.

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Contributors: Thommesen, J., Duijm, N. J., Andersen, H. B.
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**Offshore Platform Hydrocarbon Risk Assessment – OPHRA: Feasibility**
This report describes the feasibility demonstration of a new method to perform risk assessments for offshore platforms. This method simulates the following phenomena as concurrent sequences of events using the Arena® Discrete Event Simulation (DES) software (version 14.50.00):
- Release, ignition and fire;
- Detection, shut down and alarm;
- Escape and evacuation;
- Exposure and impact on people and equipment
This method leads to a transparent framework for modelling, which helps to demonstrate the correctness and appropriateness of models and assumptions.
The report lists the (type of) models and data needed for the risk assessment framework, and provides specific suggestions for some of those models.
Some preliminary calculations with the DES model have been performed to illustrate type of results that can be obtained and to provide some insight in the accuracy and computational efforts.
Finally, further work is identified in order to develop an operational risk assessment tool.

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**Sectoral Innovation System Foresight in Brazil and Korea: Competences for innovation system transformation**
For long it has been argued that foresight has a potentially important role in relation to policy making on national innovation systems (Martin & Johnston, 1999). The field of foresight has recently undergone a two-tracked transformation. Firstly, foresight is in a process of developing theoretical foundations as the field moves from being practice-oriented towards increasingly also becoming a scientific discipline. Secondly, foresight is in a process of implementing a systemic
and evolutionary understanding of innovation into its conceptual and applied methodology. Andersen and Andersen (2014) have suggested the concept of 'innovation system foresight' (ISF) as a tentative framework that can bring forward this two-tracked transformation. Here we argue that this transformation can be aided by an increased focus on sector level foresight because it facilitates taking into account necessary contextual factors and the broad participation of stakeholders essential to ISF. Both ISF in general and sector level foresight in particular are conceptually underdeveloped and empirically under-researched (see section 2). Advancing our knowledge in this area is important for better understanding the issues involved in strategic innovation system (IS) transformation. This paper seeks to address the latter research gaps by exploring sector foresight in Brazil and South Korea (henceforth Korea). Though very different, both countries face challenges of IS transformation. In both countries sector level foresight initiatives have been launched to complement and/or to address the lacking impact of national and technology oriented foresights. We analyze these sector foresights by looking at the presence of core features of ISF in foresight design and on how these influence the foresight process. The focus of the paper is thus on conceptualization and design of foresight. The key propositions of this paper are: (1) adhering to the principles of ISF will improve impact of foresight for innovation; (2) the principles of ISF are particularly relevant for sector level foresight. The paper is theoretically motivated and it is empirically explorative. Though generalization potential is limited, the case studies hold lessons for our theoretical suggestions that in turn serve for pointing towards other research challenges. The paper contributes to foresight research on two points. First, it further explores the notion of ISF and advances fruitful integration between the two academic fields of Innovation Studies and Foresight. Second, it highlights the need for, and explores the practice of, foresight at the sector level. The latter is a gain for practitioners and policy makers – especially those interested in innovation policy in emerging economies as Brazil and Korea. Chapter two will outline the basic principles of ISF that will be translated into indicators for our measuring of ISF. Also, it will illustrate why the sector-level approach is necessary. Chapter three presents sector foresight cases from Brazil and Korea. Chapter four is the conclusion.

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Organisations: Department of Management Engineering, Technology and Innovation Management, Science and Technology Policy Institute, Center for Strategic Studies and Management Science, Technology and Innovation, University of Oslo
Contributors: Dahl Andersen, A., Andersen, P. D., Park, B., Cagnin, C.
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South-South Development Cooperation and Soft Power. The case of Brazil’s foreign policy and technical cooperation
The objective of this thesis is to advance scientific knowledge on South-South Development Cooperation and on the understanding of southern countries’ ambitions in contributing to international development, taking Brazil as a case. The main research question addresses the reasons behind Brazil’s participation in development cooperation and how these international political ambitions influence the project model of its South-South Development Cooperation, called technical cooperation. This was done by investigating the manifestations of ‘soft power’ in Brazilian development cooperation activities in three articles elaborated during the research. Considering the dearth of information about South-South Cooperation, the first article critically reviews the construction and principles of South-South Cooperation and its main instrument, South-South Development Cooperation. The need for rapid solutions to the problems caused by climate change have accelerated the debate about the effectiveness of development aid and prompted the search for alternatives to the northern aid model. By drawing a distinction with the ‘traditional’ aid approach, South-South Cooperation is gaining more and more relevance in the aid debate on the model of project implementation. Several approaches and principles such as horizontality, demand-driven or mutual benefit originate from the southern countries’ claims and shape their international development narrative. The first article therefore advances the understanding of the southern countries’ narrative on international development by categorising the values and approaches put forward within South-South Cooperation and South-South Development Cooperation. This categorisation provides a framework that enables further investigation on the southern participation in development cooperation. The second and third articles apply the theory of soft power to study Brazil’s ambitions in participating in development cooperation. Elaborated by Joseph Nye, soft power theory asserts that a country can gain or maintain power by making its image attractive to other countries. To date, empirical research has focused on the results of a soft power strategy rather than on soft power creation, both at the agent’s and the subject’s end. These articles provide empirical evidence at both ends of soft power generation (the agent’s actions and the subject’s perception), enabling further development on the conceptualisation and implementation of South-South Development projects. Specifically, the second article investigates how the Brazilian government under President Lula (2003-2011), in this case the agent, conceptualised its ‘soft empowerment’ with the help of its cooperation agency by
influencing its organisation, sectors and targets and by increasing its budget with the objective of constructing positive outcomes. The findings therefore support Nye's assumptions of international relations by showcasing that Brazil (the agent) relied on the suppositions that its image has a role in the achievement of its wishes. Addressing the subject's end (in this case the 'recipients'), the third article demonstrates that the perceived manifestation of South-South Cooperation principles produced a positive image of Brazil among the 'recipients', thus offering empirical support to the idea that obtaining soft power is dependent upon image and perception. It also establishes that the 'recipients' emphasize the style rather than the content or completion of the project activities. This reveals the priority given by the 'recipients' to the respect demonstrated for the principles of South-South Cooperation in development cooperation projects. This thesis thus confirms the key element of context in soft power, i.e. that soft power was obtained not because of the resource used (development projects) but how this resource was used. Furthermore, this research underlines the importance of the subject's positive reception of the agent's attractive actions without which a country's soft power is non-existent. Therefore this thesis maintains that soft power theory should shift its current analytical focus from the agent to the subject and enhance the analysis on the role of subject's perceptions in the creation of 'soft empowerment'.

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Contributors: Bry, S.
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Textiles in the Material Practice of Architects – Opportunities, Challenges and Ways of Stimulating Use

This dissertation reports on a design research project about textiles in the material practice of architects. Targeting practicing architects, its aim is to understand how textiles are currently part of their material practice, factors influencing their use and non-use of textiles, and how awareness of their benefits may be raised. The project's three research questions are thus: 1) How are textiles currently used by architects? 2) Which challenges to the use of textiles in architecture can be found in the material practice of architects? 3) How can the use of textiles in architecture be stimulated? Based on Donald Schön’s view of design as reflective practice, material practice is defined as how architects work with, choose and apply materials. To reach the aim, the project integrates literature from material science, engineering design, textile engineering and design, as well as architecture, and conducts empirical studies using first hand face-to-face interviews with practicing architects and then workshop-based experiments with architecture students. The interviews were used to answer the first two research questions by analysing the current situation. This showed that architects, even though it is to a limited extent, use textiles in their designs in different ways and in their design process and an awareness of opportunities with their use in architecture. However, four dilemmas and the high integration of material considerations in the architectural design process make the use of textiles difficult. The influence of experience, cost and legislation are yet three factors that explain non-use of textiles. The analysis also pointed to the importance of material samples for the material choice, but also limitations concerning how they are used by, and presented to architects. Based on this analysis of the current situation five experiments were carried out to probe further into how awareness of the opportunities with the use of textiles may be raised, and into ways of stimulating the use of textiles in architecture. The first two experiments involved architects and other professional stakeholders in the design of more healing hospital environments using a textile design game and multi-material model making. Then, three experiments in workshops with architecture students explored the use of textiles in sketch model making, as a way of sketching ideas for how textiles can be used in office environments. The experiments show that by experimenting with representations of textiles, materials that exhibit and imitate properties of textiles, and physical samples of actual textiles, awareness and understanding increase, and ultimately stimulate architects' use of textiles. Core contributions include discussions of the definition of textiles in the context of architecture and of the place of textiles in material classifications as well as a number of interactive experiments that may easily be conducted by architectural firms, contributing with new knowledge on how the use of textiles may be increased among architects.

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Contributors: Wærsted, E. H.
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**A Model of Safe Subcontracting**
This report is an excerpt from Deliverable D1.4.1.3 of EU Project iNTeg-Risk. The model presented here is the result of Task 1.4.1 of the iNTeg-Risk project that addressed safety problems related to outsourcing and subcontracting of safety-critical tasks. Concerns have been raised over the effects of the fragmentation of work processes associated with subcontracting and outsourcing, where safety may be affected by heterogeneous safety cultures, distributed lines of responsibility, unclear ownership of safety responsibility, and sometimes lack of local knowledge or lack of core skills.

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A_Model_of_Safe_Subcontracting.pdf
Research output: Book/Report› Report – Annual report year: 2012 › Research

**A survey of the literature on challenges to safety posed by outsourcing or subcontracting of critical tasks**
The purpose of this document is to report on a review of the literature on the relation between safety and outsourcing or subcontracting. The review seeks to identify the problems and solutions that have been identified and described in the literature concerning outsourcing and subcontracting. The report, being the first of three reports that comprise Deliverable D1.4.1, describes results of an extensive review of the literature that has been referenced in science and engineering databases.

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