Onderwerpen masterproeven 2020-2022 aan de onderzoeksgroep “Operations Research and Scheduling”

- Mario Vanhoucke (ZAP)
- Annelies Martens (PostDoc)
- Tom Servranckx (PostDoc)
- Louis-Philippe Kerkhove (PostDoc)
- Rob Van Eynde (WP)
- Jakob Snauwaert (WP)
- Dries Bredael (WP)

Aantal beschikbare onderwerpen: **29**
Totaal aantal studenten toegewezen aan een onderwerp: **0**

Belangrijke boodschap aan studenten: Voor sommige onderwerpen waar reeds studenten werden toegewezen laten we ook nog andere studenten toe. Indien interesse in een onderwerp dat reeds werd toegewezen, kan je alsnog een mail sturen naar de desbetreffende begeleider. De begeleider laat dan asap weten of het onderwerp nog kan gekozen worden. Uiteraard zijn alle openstaande onderwerpen nog beschikbaar.

Enkele belangrijke data:
- Indienen titel masterproef: uiterlijk 23 oktober 2020
- Indienen summary sheet: uiterlijk 15 februari 2021 (richtlijnen beschikbaar bij de begeleider)
- Indienen tussentijds rapport: uiterlijk 7 mei 2021
- Indienen executive summary: uiterlijk 4 oktober 2021 (richtlijnen beschikbaar bij de begeleider)
- Indienen thesis: Juni 2022 (datum nog nader te bepalen door FSA)

Wij zijn op zoek naar gemotiveerde studenten die zich met plezier willen inwerken in het domein van Operationeel Onderzoek & Management Science.

Wij verwachten van de studenten:

We verwachten van alle masterproefstudenten dat zij zelfstandig kunnen werken en dat zij een kwantitatieve ingesteldheid hebben. Voor sommige onderwerpen zijn we op zoek naar studenten die graag programmeren en die bereid zijn de basisprincipes van C++ onder de knie te nemen. Voor andere onderwerpen is kennis van programmeren totaal overbodig. Wat we vooral verwachten is:
- Inzet en motivatie vanaf begin oktober
- Samenkomsten op vooraf geregelde tijdstippen om de voortgang en/of resultaten gezamenlijk te bespreken
- Opmaak van de masterproef in LaTex
- Aanleren van de basisprincipes van C++ voor de start van het academiejaar (handleiding beschikbaar) (indien programmeerkennis vereist is voor de thesis)

De output bestaat uit een tussentijds thesisverslag in jaar 1 en een finale versie in jaar 2.

Jaar 1. Tussentijds verslag.

Het tussentijds verslag telt mee als deel van de finale evaluatie, en moet dus grondig worden opgemaakt. Download daarom de richtlijnen van het tussentijds verslag en lees deze aandachtig. Om deze richtlijnen wat concreet te maken, hebben we via onderstaande links drie voorbeeldverslagen beschikbaar gesteld:

- Verslag 1. Zwak verslag, Het verslag bevat geen enkele vernieuwing en is puur een samenstelling van bestaand onderzoek. De onderzoeksvraag is niet afgelijnd en het toekomstig werk werd niet perfect gedefinieerd.
- Verslag 2. Matig verslag. Het verslag bevat voldoende materiaal dat kan dienen als overzicht van de thesis, maar mist een grondig overzicht van het reeds gedane werk en bijhorende behaalde resultaten. Bovendien is het verslag niet origineel en vernieuwend.
- Verslag 3. Excellent verslag. Het verslag bevat concrete doelstellingen, voldoende vooruitgang en diepgang én een sterke kijk op het toekomstig werk. Schitterende verzorging.

Jaar 2. Finale thesis.

De praktische richtlijnen qua lettertype, vormgeving, etc. voor het finaal thesisverslag kan je op Ufora vinden. De inhoudelijke richtlijnen die wij als OR&S onderzoeksgroep nastreven vind je via de volgende link: finale thesis.

Wij bieden aan de studenten:
- Een onderwerp dat in de lijn ligt van onze huidige onderzoeksactiviteiten
- Opvolging van de ontwikkeling van het programma en de analyse van de resultaten

Bij elk onderwerp worden de contactpersoon, vereiste vaardigheden, maximaal # studenten en inhoudelijke aspecten kort vermeld. De inhoudelijke aspecten beschrijven kort waar de klemtoon van de masterproef ligt, maar dit kan uiteraard ten alle tijde, volgens de interesse van de student, aangepast worden.

Inhoudelijke aspecten zijn:
- Literatuurstudie: ondersteunend, eventueel uitgebreid, uitgebreid of hoofddoel van de masterproef
- Case study/oefening: neen, optioneel of hoofddoel van de masterproef
- Software gebruik: neen, optioneel of ja
- C++: neen, optioneel of ja (of eventueel een andere taal, bv. Java, VBA in excel, etc.)

Research topics

Students are free to propose any other topic related to project management or operations research. Alternatively, they can select one of the challenging topics from the list below.

Topic: An analysis of empirical and case study data in project management: planning, risk or control.

A crucial part of project management research is the validation and extension of research ideas and methodologies proposed in the literature using empirical data. The difference between the controlled, artificial setting and the real, practical environment implies that certain techniques will need to be adjusted in order to better fit with the needs of project managers. Also, theoretical results might deviate from practical and empirical experience resulting in relevant managerial insights. Finally, empirical research might show that certain techniques perform better for certain types of projects or industries. The focus can lie on one of the following three themes (or a combination) as described below:

- Project planning: Resource-constrained project scheduling and its extensions are topics that are investigated widely in the literature, and the OR&S group has done a lot of research for these challenging domains. There is a increasing interest to collect and analyse data about project schedules with flexibility, multi-skilled workforces, project portfolios, etc.
- Project risk: Schedule risk analysis requires detailed risk information on the activity level as well as data about external risk factors. The more accurate the data, the more reliable the results of a traditional simulation study. Further, (external) risks at the activity level affect the final project duration and cost. Techniques such as reference class forecasting help in assessing the impact of these risks on the project outcome. This thesis focuses on data collection and empirical validation of this challenging domain.
- Project control: Project control is traditionally done using Earned Value Management (EVM) methodologies. Studies have shown that (1) numerous extensions are available that extend the EVM methods to more realistic methodologies and (2) theoretical results often deviate from practical and empirical experience. In recent years, techniques such as tolerance limits for project control and corrective actions (activity crashing, fast tracking and variability reduction) received increased attention. Since most studies have used artificial data, these techniques should be validated on empirical data.

Empirical research can be conducted in one of the following ways (or a combination) as described below: (1) Analysis of existing data, (2) Collection (and analysis) of new data and (3) Generation of case study data. First of all, the OR&S research group has collected a large dataset of real project data over the past years that can be used by the student(s) to test hypotheses and investigate existing methodologies. Secondly, the student(s) can contact companies to collect new project data, using a standardised methodology of the OR&S research group, and afterwards analyse this data. Thirdly, the student(s) can develop complex case studies based on an extensive literature review or web-based methods. Based on a good knowledge of the project management problem, these case studies can be used to obtain novel insights and/or test existing hypotheses using a controlled, yet pragmatic approach. More information about the existing data, as well as the tool to analyse new results, can be found at www.projectmanagement.ugent.be/research/data.

- Advisor: Mario Vanhoucke

- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project Management, Scheduling, Risk analysis, Earned Value Management
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use is optional (MS Excel, ProTrack, …)
  - Modeling and analysis: Main goal of the thesis

Topic: Hospital surgery room planning has a major influence on daily operations

The planning aims at maximum usage of hospital capacity decreasing surgery waiting lists. Increasing utilisation of capacity may increase spreading of patients admission, decreasing seasonality and weekly fluctuations and financially benefits physicians/hospital. The aim of the topic is to find an optimal/heuristic planning method and is performed with data from AZ Sint Jan hospital at the Bruges campus.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be); Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Hospital Planning, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: Optimal assignment of bed capacity to treatment specialisms in a hospital to manage weekly and seasonal variances in bed occupation

The aim of the topic is to evaluate bed capacity assignment strategies, performed with data from AZ Sint Jan hospital at the Bruges-Ostend campus. Admissions in a hospital are planned months ahead, without any knowledge of future care needs and unplanned admissions. How many beds may a physician schedule, In what time horizon In order to optimally use total bed capacity while minimising rescheduling and long waiting times.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be); Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Hospital Planning, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: Modeling and simulating uncertainty in corrective actions to improve the project control decision making process

Project control is the process of monitoring the project progress during execution and taking corrective actions when necessary. In the project management literature, different corrective actions types are discussed (i.e. activity crashing, fast tracking and variability reduction). While actual activity durations and costs are regarded to be uncertain, the impact of corrective actions is often assumed to be fixed and known in advance. In this thesis, the uncertain impact of actions should be modeled for each type of corrective actions, and a simulation study should be conducted to compare the different corrective actions types, given their uncertain outcome.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: P2 Engine / Python / C++

- Modeling and analysis: Main goal of the thesis

Topic: Modeling and simulating the impact of activity duration dependencies and side-effects of corrective actions during the project control process

Project control is the process of monitoring the project progress during execution and taking corrective actions when necessary. Several types of corrective actions have been proposed to get the project back on track and ensure timely project completion (i.e. activity crashing, fast tracking and variability reduction). However, corrective actions on an activity might cause side-effects on other activities, such as quality losses and an increased probability that rework might be required. Further, activity durations are not necessarily independent, since they can be correlated with other activities or might suffer from a project-wide estimation bias. The goal of this thesis is to model these side-effects and activity dependencies and to conduct a simulation study in which the impact of these elements on the project outcome is examined.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: P2 Engine / Python / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Comparing a resource level and activity level control approach: modelling and simulating corrective actions for resource uncertainty

Project control is the process of monitoring the project progress during execution and taking corrective actions when necessary. In general, project delays are considered to be caused by variability in the actual activity durations and corrective actions are focused on the activity level (i.e. activity crashing, fast tracking and variability reduction). Besides activity duration variability, uncertainty regarding the project resources is a common cause of project delays. Therefore, this thesis aims at modelling resource uncertainty (variability in availability and potential breakdowns) and proposing corrective actions at the resource level (i.e., increasing, the availability, reducing the variability and reducing the probability of failure). A simulation experiment should be conducted to compare the effectiveness of activity level and resource level corrective actions

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: P2 Engine / Python / C++
  - Modeling and analysis: Main goal of the thesis

Topic: Simulation study on strategies for the corrective action taking process to improve the project control decision making process

Project control is the process of monitoring the project progress during execution and taking corrective actions when necessary. The corrective action taking process comprises several decisions that should be made simultaneously, i.e. how much and which activities should be taken corrective actions on, which type of actions should be taken and how large should the action be in order to achieve timely project completion without incurring excessive costs. The aim of this study is to identify different strategies for the corrective action taking process and conduct a simulation experiment to review the effectiveness of these strategies.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible.
  - Software use: P2 Engine / Python / C++
  - Modeling and analysis: Main goal of the thesis

Topic: A heuristic approach for the project scheduling problem with flexible project structures: hybrid priority rules

The traditional project scheduling problem explicitly assumes that the project structure is uniquely defined and known in advance. In many practical situations, however, there exist multiple alternative ways to execute subparts of the project. The resulting problem is called project scheduling with flexible project structures and consists of two subproblems: a choice must be made amongst the different alternative execution modes of the project and the resulting deterministic project structure should be scheduled. Due to the complexity of the problem, most research papers propose a solution procedure that is based on a two-stage approach. However, such an approach will not yield a global optimisation as both subproblems are solved independently. In this thesis, the student will develop a hybrid priority-rule based heuristic procedure for the proposed scheduling problem. The aim of this thesis is to compare and validate the new hybrid priority rules with best-known priority rules in literature on artificial data.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project scheduling, optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: Multi-attribute decision-making to select alternatives in the project structure

The project management process consists of scheduling the project activities, analysing the project risk and monitoring the project progress. However, these steps assume that the scope of the project is determined by the project manager (i.e. the required activities are determined, the skilled resources are identified and the complex relations between activities are analysed). In other words, the project manager will have to choose between different alternative ways to execute work packages in the project or even select appropriate subcontractors to execute the work packages, prior to project scheduling. This is a complex decision-making problem since the alternatives/subcontractors will be scored on different attributes that all contribute to the project objective. In general, information is collected about the expected or past performance of alternatives for high-level attributes such as financial metrics or production output. In project management, lower-level attributes that are related to the project scheduling process could be used. In this thesis, the student will identify relevant attributes for selecting alternatives in the project scheduling process and develop a framework for multi-attribute decision-making.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project scheduling, optimisation, simulation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: The impact of alternative options on hierarchical objectives: a quantitative and qualitative evaluation.

A project is successfully managed when it is completed within time and budget…and within the project scope that has been promised to the client. The scope objective is often overlooked during project management since it is assumed that the project scope is fixed and pre-determined. However, the project manager can identify and investigate alternative ways to execute subparts of the project, called work packages, in order to improve the time or budget performance of these work packages, without considering the impact on the overall project scope (i.e. the alternative options might change the scope of the project). Therefore, the positive or negative impact of each alternative option on the low-level objectives (i.e. at the work package level) should be assessed, but this impact should be propagated bottom-up in the hierarchy of objectives towards the high-level objectives (i.e. at the project level). The student(s) should investigate whether the techniques from Requirement Engineering can be applied to project scheduling with alternative options. In

this thesis, a hierarchy of objectives for project scheduling should be investigated and both quantitative and qualitative evaluation techniques should be compared.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project scheduling, optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: Measuring project manager's effort in the presence of flexibility: decision difficulty and alternative search.

In traditional project management, the project structure (i.e. the number of and type of activities, the project network, etc.) is assumed to be completely known and pre-defined. In today's fast-changing project environment, however, the project managers are confronted with much more options to complete subparts of the project, so-called work packages, and they use these options or alternatives to quickly adjust to changes needed in the project. As a result, the project management process is becoming an even more complex decision-making problem as project managers need to choose between different attractive alternatives to complete the project. Although this increased flexibility has a positive impact on the project performance, it also increases the complexity of the project management process and requires an increased effort of the project manager. In current research, the project complexity in the presence of alternatives in the project structure is expressed at the project level. In this thesis, different measures of complexity at the work package level will be investigated, such as decision difficulty and alternative search. The decision difficulty is determined by how closely related the different alternatives are, while the alternative search is determined by the number of alternatives for a work package. The aim is to shed a new light on the relation between complexity and flexibility in decision-making from a project management point-of-view.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project scheduling, optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: A quantitative approach to measure and evaluate the cost of flexibility: can flexibility be considered a free lunch?

Due to the ever-increasing complexity of the rapidly changing business environment, organisations are showing a growing interest to include more flexibility in their projects in order to deal with the resulting uncertainty in the project and rapidly react to changes in the environment. For example, project schedules are constructed that incorporate different alternatives in order to tackle the uncertainty in the project environment in a proactive way. However, most studies implicitly assume that the inclusion of more flexibility in the project can be obtained at no additional cost although this is seldom the case in practical situations. Effort should be invested by the project manager to generate these alternatives or new ideas, collect information about the alternatives and contact different subcontractors to potentially execute these alternatives. The time and resources (i.e. effort) that should be invested in the project scheduling process is equal to the cost of increased flexibility. In this thesis, the student(s) should collect important drivers of the cost of flexibility through empirical or web-based research and quantify their (combined) impact on the project scheduling objective. These drivers should be analysed per industry or project type in order to obtain important managerial insights.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project scheduling, optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis

- Case study is possible
- Software use: C++, optionally RanGen
- Modeling and analysis: Main goal of the thesis

Topic: Partitioning strategies in project networks

In different areas of project management, a project network is decomposed in chains. For instance, in Critical Chain/Buffer management, the critical chain is identified and the remaining activities are divided over feeding chains to determine buffers. There are multiple ways to create these feeding chains, but no research exists that investigates the impact of how these chains are created. This thesis has three objectives: provide a literature overview on chain partitioning strategies in networks, implement different of these partitioning strategies and analyse their impact on the robustness of the schedules of Critical Chain/Buffer management.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be)
- Required skills: Project scheduling, optimisation
- Extra information:
  - This thesis is bot suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: C++, CPLEX
  - Modeling and analysis: Main goal of the thesis

Topic: Disruption management in production planning: a case study

The objective of this thesis is to study how a production company should adapt its production planning when machine failures or other disruptions occur. At the core of the problem lies the trade off between (a) satisfying customers by meeting deadlines and (b) keeping production efficiency high enough by reducing setup times, product switches et cetera. The study is set up for a production company in the chemical sector (the first contacts have been made). The thesis will consist of several steps. In the first steps the students focus on understanding of the problem under study: visiting the company to understand their production environment, formulating research questions that are relevant for the company, gathering and analyzing the relevant data. Then, the students will develop solution strategies to address the identified problems, followed by an analysis and evaluation of their different strategies.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be)
- Required skills: Scheduling, Data analysis
- Extra information:
  - This thesis is recommended for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: Depends on how the research will be approached
  - Modeling and analysis: Main goal of the thesis

Topic: A comparison between artificial and real project data

Project scheduling has been widely studied for several decades. Most of the researchers evaluate their algorithms by testing them on standardized libraries of project instances. These projects were artificially generated while trying to cover a wide range of different project types. There also exist databases of real projects, that were constructed by interviewing practitioners etc. In this research, the student will compare real and artificial data and analyse the differences between these two types of data and provide insights in how these differences could be interesting for new solution approaches.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be)
- Required skills: Networks, programming
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: C++, Java or Python
  - Modeling and analysis: Main goal of the thesis

Topic: Series parallel networks and complexity

Many problems in (project) scheduling are difficult to solve to optimality. However, for certain special cases of the underlying network structure, some of these problems become easy to solve. One of these special structures is the class of series parallel networks. The goal of this thesis is twofold. First, the scheduling literature will be reviewed regarding the state of the art of solution procedures for problems on series parallel networks. Second, based on the insights from the literature, the student will develop a new solution procedure for one of the open problems that were discovered in the literature review.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be)
- Required skills: Scheduling, networks
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: C++, CPLEX
  - Modeling and analysis: Main goal of the thesis

Topic: Information asymmetries in project management

Most of the research on project scheduling focuses on the scheduling process from the viewpoint of the project manager. He or she is responsible for achieving the objectives (time, cost and quality). This manager is evaluated by a controlling agent: a boss or a client. However, there is a fundamental information asymmetry: even if the manager acts in the best interest of the controlling agent, the agent may not be able to evaluate the actions of the manager correctly because he does not have the necessary information. The goal of this master thesis is to twofold. First, the student will study what types of information asymmetries may occur in a project management setting. Second, the student will study which approaches can be used to moderate or resolve the information asymmetries.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be)
- Required skills: Project Management
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review: yes
  - Case study is possible
  - Software use: C++, CPLEX
  - Modeling and analysis: Main goal of the thesis

Topic: Robust workforce composition under unknown resource requirements

Organisations are always striving for a diversified workforce. A good balance of older, more experienced, employees and younger, more dynamic and creative, employees is paramount in today's organisational structure. Equally important is the inclusion of a set of specialist workers that counterbalance the large group of regular workers. Clearly, differences in skill-level and heterogeneous efficiencies will characterise these workforces. The focus of this thesis will be on analysing the characteristics of a robust multi-skilled workforce that is composed before the details of the final project are available. More specifically, the goal is to find the features of a robust workforce that can deal with unknown resource requirements. The student starts by incorporating this into a project scheduling problem and analyses the existing literature. Additionally, the student collects or generates data and uses it to test their heuristic approach to this problem.

- Advisor: Mario Vanhoucke
- Contact person: Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Project Scheduling, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is possible
  - Software use: C++
  - Modeling and analysis: Main goal of the thesis

Topic: An analysis of the existing datasets for multi-skilled projects

In recent years, service organisations as well as manufacturing organisations have been downsizing their resource pool. This is induced by the recent increasing need in flexibility and versatility of workers, which also had an impact on the recent research in project scheduling. To reduce the gap between the industry and the literature, a multi-skilled extension on the traditional RCPSP was introduced. The goal of this master's

thesis is to analyse and compare the different existing datasets on the MSRCPSP and to develop a new dataset that deals with the flaws of the others as well as incorporates new characteristics. These newly developed instances will bring research and the theory behind the multi-skilled resource-constrained project scheduling problem closer to real-life projects.

- Advisor: Mario Vanhoucke
- Contact person: Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Project Scheduling, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is not possible
  - Software use: C++
  - Modeling and analysis: Main goal of the thesis

Topic: Resource Renting Problem with heterogeneous efficiencies

The Resource Renting Problem (RRP) is a subproblem in project scheduling that intends to minimise resource availability costs under temporal constraints. The RRP looks for the optimal moments to hire and fire workers. This results in a trade-off between keeping idle resources, which will increase the renting costs, and firing them, which brings along procurement and removal costs. In this case, there is the extension of heterogeneous efficiencies, which means that the resource costs will vary among the different workers. The student is expected to collect empirical data and find additional practical applications of this case. This data and its characteristics will be compared to the literature. Afterwards the student analyses the empirical data thoroughly and develops a solution approach for the problem.

- Advisor: Mario Vanhoucke
- Contact person: Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Project Scheduling, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: Multi-skilled resource investment problem

The resource investment problem deals with the research question: “What is the cheapest workforce pool for a given schedule?”. The goal is to minimise the resource availability costs and to schedule activities subject to precedence constraints and a project deadline. A key characteristic of this problem is that the costs of making the resources available are independent of time. As a result, the amount of times the resources are deployed in the project does not affect their cost. In this case, the resource availability costs depend on the skillset of the multi-skilled resource. The student will look for companies that work in a project environment and deal with this problem. Next he or she will develop a solution approach to this problem and test it on the empirical data from these companies.

- Advisor: Mario Vanhoucke
- Contact person: Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Project Scheduling, Optimisation
- Extra information:
  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: A case study on skills in project management: Empirical data collection and solutions

The goal of this thesis is to collect empirical data of projects that incorporate skills. In the well-known RCPSP every activity has a demand for resources, or more specifically resource types. In this case, we are looking for projects that have a demand for skills, to which these resources can be assigned to. The student will visit companies and gather real-life data which he will analyse thoroughly. Additionally, the student will develop a

procedure that assists in dealing with the data. From this procedure and its outcome the student will gain new knowledge and give managerial insights.

- Advisor: Mario Vanhoucke
- Contact person: Jakob Snauwaert (jakob.snauwaert@ugent.be)
- Required skills: Project Management, Project Scheduling, Optimisation
- Extra information:
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  - Literature review is supportive but not the main theme of the thesis
  - Case study is required
  - Software use: optionally
  - Modeling and analysis: Main goal of the thesis

Topic: Diversified workforces and their impact on quality

On the one hand, manufacturing companies need experienced workers in their workforce to keep the continuity and make sure that the quality of their products does not diminish over time. On the other hand, younger, more creative and technologically-savvy workers are required to keep up with the current state of affairs and to be able to stay ahead of competitors. The focus of this thesis will be on the impact that skill-levels and experience will have on the quality of the individual activities and on the project as a whole. In general, workers with lower skill-proficiencies will most likely deliver a worse product than their more highly skilled colleagues. The student starts by incorporating this into a project scheduling problem and analyses the existing literature. Additionally, the student collects data and uses it to test their heuristic approach to this problem.

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Topic: Optimising multi-mode, multi-project portfolio scheduling of competing projects

Competing projects in a multi-project portfolio are projects, which if successfully completed, cannibalise the completion reward of other competing projects. This is not uncommon in Research and Development (R&D) project scheduling literature. A topical example is the race to create a vaccine for a newly emerged disease. The vaccine is required as soon as possible and a number of alternative R&D projects are available. The successful completion of only one of the projects is necessary. However a lot of uncertainty is involved in deciding on how to schedule these projects. The manager could decide to rush certain critical activities or maybe even to skip other not strictly necessary activities. However, this would increase the risk of project delay in the later phases or even result in overall project failure. The goal of this thesis is to develop a model that analyses this problem statement. A simulation study is required to study the effects of these uncertainties on the optimal portfolio schedule and the resulting makespan under limited resources.

- Advisor: Mario Vanhoucke
- Contact person: Dries Bredael (dries.bredael@ugent.be)
- Required skills: Project scheduling, optimisation, simulation
- Extra information:
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  - Case study is possible
  - Software use: C++, CPLEX or Gurobi
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Topic: The impact of sharing and trading behaviours in decentralised project portfolio management under uncertainty

An organisation running a portfolio of projects is often managed by different project managers. These managers are responsible for the performance of their assigned projects. They can either be evaluated on

the performance of the project portfolio as a whole which would encourage them to help out other PM's by sharing their own assigned resources if needed. Alternatively, they can be evaluated based solely on the performance of their own projects. In this situation, the managers will only cooperate if it improve their own performance. They would only trade resources if the trade is beneficial to both parties. The goal of this thesis is to quantify the impact of these two kinds of behaviours on the performance of a multi-project portfolio. The project activities are characterised by uncertainty in their resource requirements and/or durations. To this end, one or more trading mechanisms will have to be constructed and the performance of both behaviours needs to be analysed through a simulation study.

- Advisor: Mario Vanhoucke
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Topic: A case study on project interdependencies in a project portfolio

In Project Portfolio Management (PPM) the existence of beneficial or disadvantageous effects between projects are recognised. Including one project can force the exclusion of another project or can mandate the inclusion of a third project. Furthermore, the early completion of one project can cannibalise the reward associated with another project, or higher resource efficiencies could be the result of running certain activities of different projects simultaneously. These kinds of effects between (the activities of) projects are often called project interdependencies. There exist some studies that analyse and classify different types of project interdependencies, but an overall unified framework or classification is missing. The goal of this thesis is to study, define and logically classify different types of project interdependencies in PPM. This classification will then be used to analyse empirical data on a project portfolio, from literature or gathered by the student, where (some of) these interdependencies can be identified. A case study on the operational effects of these project interdependencies is required.

- Advisor: Mario Vanhoucke
- Contact person: Dries Bredael (dries.bredael@ugent.be)
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Topic: A study on flexibility mechanisms on hierarchic decision making in a multi-project portfolio

In Project Portfolio Management, the decision on multi-project selection and scheduling is often done in two separate decision making phases. In the first selection phase, a decision is made on which projects to include in the portfolio to maximise the NPV value of the portfolio under a general resource constraint. This general resource constraint can be thought of as a budget to simply the analysis. In the second phase, the activities of these selected projects have to be scheduled with limited renewable resources. The first (selection) decision making phase didn't fully capture the complexity of the resource constraints, which is why suboptimal schedules can result. To alleviate this issue, project managers count upon the flexibility mechanisms they have at their disposal to counteract this potential suboptimal decision. The goal of the thesis is to analyse the benefit of different types and magnitudes of flexibility mechanisms in this situation through a simulation study. Examples are the use of overtime for some or all resources, outsourcing/ subcontracting, or others. The effects of different types of operational uncertainties can additionally be analysed as well.

- Advisor: Mario Vanhoucke
- Contact person: Dries Bredael (dries.bredael@ugent.be)
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Topic: A study on the choice of the evaluation criterion in multi-project scheduling

When scheduling the activities of different projects to optimise for a pre-specified objective function, it is unclear what the effect of the choice of this objective function is on other performance metrics. For example, minimising overall multi-project makespan could lead to certain projects not meeting their deadline (tardiness). Or, minimising the sum of project tardiness could result in long individual project makespan. Clearly, the decision on which criteria to optimise for has implications for the performance of the multi-project schedule on different evaluation criteria. The goal of this thesis is to define and categorise different types of evaluation criteria for multi-project scheduling by studying relevant academic literature. The performance of different optimisation methods (goal programming, weighting method,...) in combination with these criteria will then be analysed on all these evaluation criteria. The results of this optimisation study can be used to determine which optimisation methods and evaluation criteria achieve the best overall performance.

- Advisor: Mario Vanhoucke
- Contact person: Dries Bredael (dries.bredael@ugent.be)
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Topic: How to deal with the impact of project team composition on efficiency and flexibility in portfolio management

This thesis will focus on the formation of project teams and the consequences of it on the portfolio of projects. As we are working in a multi-project environment, multiple teams have to be composed in order to create the ability to work on different projects at the same time. This project team formation can be done in different manners. First of all, you can compose teams with more or less the same skills for all the team members present in one team. This will have a positive effect on the learning rate for those particular skills and on the efficiency in performing tasks which are asking for those skills. A downside will be that the teams will be less flexible in the kind of activities they can perform. A second way of team composition can be to create teams with a large diversity in the members' skills. Consequently, a higher flexibility is created into the portfolio because projects can more easily be switched between the teams. This advantage has to be paid with less efficiency. The goal of this thesis will be to investigate how teams have to be composed taking the specifications and the uncertainty of the projects into account.

- Advisor: Mario Vanhoucke
- Contact person: Tom Servranckx (tom.Servranckx@UGent.be)
- Required skills: Project scheduling, optimisation
- Extra information:
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