Onderwerpen masterproeven 2019-2021 aan de onderzoeksgroep "Operations Research and Scheduling"

- <u>Mario Vanhoucke</u> (ZAP)
- Louis-Philippe Kerkhove (PostDoc)
- Annelies Martens (PostDoc)
- Jeroen Burgelman (WP)
- Tom Servranckx (WP)
- Rob Van Eynde (WP)
- Jakob Snauwaert (WP)
- Wout Vandoorne (WP)
- Dries Bredael (WP)

Aantal beschikbare onderwerpen: **36**
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 25 oktober 2019
- Indienen summary sheet: uiterlijk 17 februari 2020 (richtlijnen beschikbaar bij de begeleider)
- Indienen tussentijds rapport: uiterlijk 8 mei 2020
- Indienen executive summary: uiterlijk 1 oktober 2020 (richtlijnen beschikbaar bij de begeleider)
- Indienen thesis: uiterlijk 8 juni 2021

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

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 (<u>handleiding</u> 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 <u>tussentijds verslag</u> en lees deze aandachtig. Om deze richtlijnen wat concreet te maken, hebben we via onderstaande links drie voorbeeldverslagen beschikbaar gesteld:

- Verslag 1. <u>Zwak verslag</u>, 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. <u>Matig verslag</u>. 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. <u>Excellent verslag</u>. 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 Minerva vinden. De inhoudelijke richtlijnen die wij als OR&S onderzoeksgroep nastreven vind je via de volgende link: <u>finale thesis</u>.

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: A case study on project management (planning, risk or control): Empirical data and solutions

Abstract: The purpose of this thesis is to collect data for projects using a standardized methodology of the OR&S research group. The students has to visit companies and collect the data, and afterwards analyse the data to apply some existing methodologies. The focus can lie on one of the following three themes (or a combination) as described below: - Project planning: Resource-constrained project schedule is a topic that is investigated widely in the literature, and the OR&S group has done a lot of research for this challenging domain. While the majority has been done on artificial data, the master thesis should now extend the existing knowledge to empirical data. - 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. Currently, it is suggested that theoretical simulations should be extended to an approach known as "lognormal core", but no empirical validation has been made so far. 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. However, in the recent years, it has been 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. Techniques such as reference class forecasting help in improving these extensions, and should be validated on empirical data. 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
- 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: Applications of combinatorial auctions in project planning

In the operations research literature, combinatorial auctions are frequently employed to model bidding processes and design fair allocation mechanisms of sets of goods to bidders. Combinatorial auctions have a

wide range of applications. The goal of this master thesis is twofold. On the one hand, a literature overview is expected of applications of combinatorial auctions in the different OR subfields. On the other hand, the student is expected to investigate whether combinatorial auctions are applicable within a project scheduling context and illustrate this applicability. An academic publication is available as starting point of the analysis.

- Advisor: Mario Vanhoucke
- Contact person: Jeroen Burgelman (jeroen.burgelman@ugent.be)
- Required skills: Project Management, Project Scheduling, optimisation, Combinatorial Auctions
- 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: RanGen, C++, optionally Gurobi
  - Modeling and analysis: Main goal of the thesis

Topic: Planning of modular projects: heuristic solution methods

In the literature on Research and Development project scheduling "modular projects" are frequently used to incorporate possible activity failures during the project planning phase. The goal of the thesis is to develop multiple metaeuristic solution approaches to schedule modular projects. As a basis for the analysis the student can use the academic publication: "a fast greedy heuristic for scheduling modular projects". The student is expected to compare the performance of the presented algorithms and provide managerial recommendations.

- Advisor: Mario Vanhoucke
- Contact person: Jeroen Burgelman (jeroen.burgelman@ugent.be)
- Required skills: Project Planning, metaheuristics
- 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: RanGen, C++
  - Modeling and analysis: Main goal of the thesis

Topic: Planning of multi skilled projects: a matheuristic approach

In the project scheduling literature the multi-skilled nature of resources is often ignored. Recently however, this assumption has been relaxed and the explicit modelling of multi-skilled resources is incorporated in the project planning phase. The goal of this master thesis is to develop a diverse dataset that complements the existing datasets in the multi-skilled project scheduling literature. The student will develop a matheuristic to solve the created problem instances. The academic publication: "Priority-Based Heuristics for the Multi-Skill Resource Constrained Project Scheduling Problem" can be used as a starting point for the analysis.

- Advisor: Mario Vanhoucke
- Contact person: Jeroen Burgelman (jeroen.burgelman@ugent.be)
- Required skills: Project 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 possible
  - Software use: RanGen, C++
  - Modeling and analysis: Main goal of the thesis

Topic: Project Planning with flexible resource profiles: A Case Study

In the vast majority of the project scheduling literature resource requirements of activities are assumed to be fixed during the processing of activities. In reality, this requirement usually does not hold. The student is expected to collect company data on projects with flexible resource profiles (at least 5 projects). The Flexible Resource Constrained Project Scheduling Problem (F-RCPSP) will be studied using this real-life data and its practical applications will be tested. The focus is on the project planning phase. The collected data will be analysed by using and comparing existing state-of-art techniques. The academic publication: "MIP models for resource-constrained project scheduling with flexible resource profiles" can be used as a starting point for the analysis.

- Advisor: Mario Vanhoucke
- Contact person: Jeroen Burgelman (jeroen.burgelman@ugent.be)

- Required skills: Project 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: C++, optionally RanGen
    - Modeling and analysis: Main goal of the thesis

Topic: A comparative study between different network analysis methods

The traditional approach of network analysis through activity-on-the-node networks has led to the development of several network generators in the project scheduling literature. The network generator RanGen was developed at our research group and exhibits strong similarities with the "Design Structure Matrix" (DSM) methodology. Moreover, a recent publication "The concept of DSM and ADT integration in the product design process" confirmed these similarities. The goal of this thesis is to analyse the different approaches and to come up with a new and improved RanGen approach that combines the concepts and insights of the different network analysis techniques.

- Advisor: Mario Vanhoucke
- Contact person: Jeroen Burgelman (jeroen.burgelman@ugent.be)
- Required skills: Project Management, 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++, RanGen
    - Modeling and analysis: Main goal of the thesis

Topic: Project scheduling with hazardous materials

In project planning studies the impact of hazardous material removal on the project plan and performance is frequently ignored. In the construction industry, where the use of hazardous materials in projects is ubiquitous (e.g. asbestos removal), this approach is not viable. The student collects data from companies that deal with projects involving hazardous waste (at least 5 projects). The focus is on the planning phase of these projects. The student analyses the collected data and compares this data with project plans in which the uncertainty involved with hazardous materials removal is incorporated by means of several scheduling policies. A simulation experiment has to be conducted to indicate in which situations the different scheduling policies have a favourable effect on the project plan and its execution.

- Advisor: Mario Vanhoucke
- Contact person: Jeroen Burgelman (jeroen.burgelman@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 required
    - Software use: RanGen, 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: Reactive strategies for the project scheduling problem with flexible project structures

In the traditional project scheduling problem, most researchers explicitly assume that the project structure is fixed and known in advance. Due to the rapidly changing business environment, this is neither possible nor desirable in most practical situations. Therefore, project managers consider different alternative ways to execute subparts of the project and construct so-called flexible project structures. Consequently, the resulting scheduling problem consists of two subproblems: an alternative execution mode should be selected for each work package and the resulting project with a fixed structure should be scheduled. However, the initial schedule might become suboptimal and the decisions made in the past could turn out impossible or impractical in case that disruptions occur in the project environment. Therefore, the student will develop reactive strategies that limit the impact of disruptions on the project schedule and compare them for different degrees of allowable decision-making instability.

- 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: Contract design for projects with different execution alternatives

In most practical situations, project are executed by in-house (i.e. core teams) or outhouse (i.e. consultants) experts in order to deliver a pre-determined outcome given time and budget constraints. Therefore, there is a clear knowledge gap between the project contractor and owner against which the project owner will protect himself through well-considered contract design. Within the scope of the contract, however, the project contractor will have a certain degree of freedom to execute parts of the project in one of multiple alternative ways. The question remains which types of contracts should be designed by project contractors/owners in this situation. In this thesis, the student will design contract strategies from the perspective of the project contractor/owner and monitor the impact on the performance of the project for different project settings.

- 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: RanGen , C++
  - Modeling and analysis: Main goal of the thesis

Topic: Robust project scheduling using fuzzy set theory: alternative project parameters

The fuzzy set theory is used in a wide range of research domains to consistently collect and model inaccurate and/or unknown information, also in project scheduling and control where the values of different project parameters are seldom exactly known beforehand. The fuzzy numbers allow project managers to use assessments of experts (e.g. with respect to the activity durations) in a systematic manner to prepare (robust) project schedules. The goal of this thesis is to investigate whether the application of fuzzy set theory within robust project scheduling can be extended to alternative (rather than the traditional) project parameters. The student is expected to illustrate and test these extensions based on a case study or artificial project 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 possible
  - Software use: C++, optionally RanGen
  - Modeling and analysis: Main goal of the thesis

Topic: A case study on the impact of corrective actions on the time, cost and quality of projects

When the observed progress during project execution is insufficient to achieve project success, warning signals are generated that act as triggers for corrective actions. Corrective actions are taken on one or more of the project activities, and require a certain amount of effort (in terms of time and/or money) to be implemented. The impact of taking corrective actions on three important aspects of the project (time, cost and quality) depends on the direct and indirect effect of the corrective actions. The purpose of this case study is to review which corrective actions are taken during project execution, what the direct and indirect effects of these actions are and how these actions affect the project outcome, using both qualitative (i.e. interview with project managers) and quantitative (i.e. evaluation of data and outcomes) research.

- 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 required
  - Software use: ProTrack, optionally P2 Engine / C++
  - Modeling and analysis: Main goal of the thesis
  -

Topic: A simulation study on the impact of different corrective action types under resource constraints

During project execution, uncertainty and variability often cause delays. Therefore, corrective actions should be taken by the project manager to get the project back on track. Different corrective action types have been defined in literature, for instance fast tracking (i.e., overruling the original project network by executing precedence related activities partially in parallel) and activity crashing (i.e., using more resources to reduce the activity duration). Since the resource availability to execute projects is often limited, the project manager should consider these resource constraints when deciding which corrective actions to apply. In this thesis, a simulation study should be conducted to compare the corrective action types defined in literature, both in terms of time and cost effectiveness, given a limited availability of renewable resources to execute a project. Based on this analysis, strategies for effective corrective action taking should be proposed.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control, 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 required
  - Software use: P2 Engine, R, optionally C++
  - Modeling and analysis: Main goal of the thesis

Topic: A simulation study to review the optimal timing of corrective actions

The goal of project control is monitoring the project performance in order to detect deviations from the plan and, when necessary, take corrective actions to get the project back on track. More specifically, the progress of the project is monitored during execution and warning signals are generated when the progress is insufficient. These warning signals act as a trigger for action to the project manager. In order to get the project back on track, he or she should determine which actions should be taken on which activities, given a limited availability of time and/or money. This thesis focuses on determining the optimal timing to take corrective actions. While corrective actions should be taken when warning signals are generated, the project manager can decide to invest more effort in the early, middle or late project phases. While early corrective

actions are likely to be more effective than late corrective actions, it is more likely that the former are a reaction to false warning signals, and thus redundant. A simulation study should be conducted to assess this trade-off in order to provide useful guidelines to monitor and control real-life projects.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control, 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 required
  - Software use: P2 Engine, R, optionally C++
  - Modeling and analysis: Main goal of the thesis

Topic: A simulation study on the relation between the cost and impact of corrective actions

During project execution, uncertainty and variability often cause delays. Therefore, corrective actions should be taken by the project manager to get the project back on track. Different corrective action types have been defined in literature, for instance fast tracking (i.e., overruling the original project network by executing precedence related activities partially in parallel) and activity crashing (i.e., using more resources to reduce the activity duration). Each type of corrective action to get a project back on track results in an additional cost, for instance due to increased project risk or due to the use of additional resources. Different types of relations between the cost of a corrective action and its impact have been defined in literature. In this thesis, a simulation study should be conducted to analyse the impact of the different impact-cost trade-offs on the project outcome for the different types of corrective actions defined in literature.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control, 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 required
  - Software use: P2 Engine, R, optionally C++
  - Modeling and analysis: Main goal of the thesis

Topic: A simulation study on activity selection methods to improve the effectiveness of corrective actions

The goal of project control is monitoring the project performance in order to detect deviations from the plan and, when necessary, take corrective actions to get the project back on track. More specifically, the progress of the project is monitored during execution and warning signals are generated when the progress is insufficient. These warning signals act as a trigger for action to the project manager. In order to get the project back on track, he or she should determine which actions should be taken on which activities, given a limited availability of time and/or money. The focus of this thesis is on the selection process of the activities to take corrective actions on, in order to implement the most effective corrective actions. Using a simulation study, existing methods to rank activities according to the expected effectiveness of corrective actions should be reviewed, and adaptations to improve these methods should be proposed.

- Advisor: Mario Vanhoucke
- Contact person: Annelies Martens (annelies.martens@ugent.be)
- Required skills: Project management, project control, 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 required
  - Software use: P2 Engine, R, optionally C++
  - 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 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: Generation procedures for artificial data

Due to the lack of reliable real life data in project scheduling literature, researchers often generate artificial data to benchmark their algorithms. Many generation algorithms and data sets have been proposed. However, none of these generators is proven to be uniform, i.e. that each possible instance has an equal probability of being generated. The goal of this thesis is twofold. First, the student will examine existing generators and propose a methodology to evaluate how 'close' they are to a uniform generation scheme. Second, the student will propose a new generation scheme that approximates uniform generation as good as possible. Some insights and ideas are available as starting point.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@ugent.be)
- Required skills: Data generation
- 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: Heuristics for multiproject scheduling with external resources

When a company operates in a multi-project environment, it has to coordinate several projects in parallel and results in additional decisions that need to be made. The portfolio management consists of 3 phases: the strategic, tactical and operational phase. This thesis is situated in the tactical phase, where two main decisions are taken. The first decision is project selection, the company decides which of the eligible projects it will add to its portfolio. The second decision considers non regular capacity: will the company use overtime, subcontracting outsourcing to process a part of the projects in its portfolio? This decision process is repeated in a rolling horizon fashion, because new opportunities may arrive in later periods. The focus of this thesis is twofold: implementing a model that simulates the random arrival of new projects and implementing heuristics to solve this problem.

- Advisor: Mario Vanhoucke
- Contact person: Rob Van Eynde (rob.vaneynde@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++, CPLEX
    - 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: 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
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- 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.

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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.

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Topic: On the human aspect of Project Management

To have great project success managing human resources is not an option, it is a necessity. There have been several studies on the use and impact of human resources in the project scheduling environment and they put values on certain characteristics, such as productivity, effectiveness, learning, skills levels, etc. But there are also less-quantifiable aspects of human resources that the current literature has not taken into account yet. In this thesis, the student will look at the less- (or non-) quantifiable aspects of human resources in projects and analyse the possible impact on project performance. Examples of these less-quantifiable aspects are communication, competencies and team coordination. Additionally, the student will study feedback techniques and other techniques and their effect on the project.

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  - Literature review is the main goal of the thesis
  - Case study is possible

- Software use: optionally ProTrack, CPLEX or C++
- Modeling and analysis: Supportive

Topic: Reference Class Forecasting: a framework to classify drivers of similarity

Nowadays, project managers are frequently and to a serious extent overwhelmed by modern day challenges and obstacles. In the field of project management, more specifically the domain of project control, a great amount of forecasting and controlling methods have been developed in order to successfully execute complex projects. However, interference of human bias, i.e. the underestimation of risk that is related to projects, has often resulted in weakened predictions and corresponding cost overruns. Reference Class Forecasting (RCF) is a method that was originally developed to compensate for this so-called cognitive bias in human forecasting by taking an outside view. RCF does not try to forecast specific uncertain events that will affect a particular project, but instead places the project in a statistical distribution of outcomes of a class of similar, historical projects. Nonetheless, the question remains: what are the drivers that determine similarity between projects? And more importantly, how can we achieve a classification of these drivers? To answer both questions the student will have to conduct a research that is threefold. First and foremost, an elaborate literature overview is necessary to discover possible patterns for future classification. Secondly, the previously gained knowledge has to be further supplemented by data that is collected from project managers. Finally, a quantitative analysis is to be conducted in order to both validate and compare the classification of drivers that were collected empirically and from literature.

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Topic: An application of cluster analysis on project properties

In general, projects are often classified according to industrial background or the type of delivery. However, insufficient research has been performed in order to classify projects according to a more extended spectrum of criteria. These new drivers can be quantitative in nature such as the network topology or schedule risk. Even more interesting may be the qualitative specifications. Examples are the background of the project team, specific technologies used, governmental restrictions, etc. Once the student has obtained a number of promising criteria through literature review and empirical research, a method to evaluate the data is cluster analysis. The formation of clusters may vary according to the algorithm used, the drivers included and number of clusters specified. Eventually, the student is expected to conduct cluster validation. This can be done internal (how coherent are the clusters?) or external (to which extent do the industry labels match with the clusters?).

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Topic: Reference Class Forecasting: design of an adjusted method

Projects are often characterised by and subject to great amounts of risk. The consequences of these risks, however, are frequently underestimated. It is undisputable that the underestimation of risk eventually results in immense cost overruns. The possible explanations, or root causes, of the actual risk underestimation can be grouped into two categories: deliberate and undeliberate underestimation. In case of undeliberate underestimation, it is recommended to use a method called Reference Class Forecasting (RCF). RCF does not try to forecast specific uncertain events that will affect a particular project, but instead places the project in a statistical distribution of outcomes of a class of similar, historical projects. However, since RCF is a relatively recent method, it still contains some shortcomings. The student is expected to discover and analyse some of these deficiencies. This initial research will further on be used to propose an adjusted and

hopefully improved methodology of RCF. Finally, a quantitative comparison and benchmark against the classic method of RCF is required.

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Topic: Reference Class Forecasting: the determination of a relevant uplift

Projects are often characterised by and subject to great amounts of risk. The consequences of these risks, however, are frequently underestimated. It is undisputable that the underestimation of risk eventually results in immense cost overruns. The possible explanations, or root causes, of the actual risk underestimation can be grouped into two categories: deliberate and undeliberate underestimation. In case of undeliberate underestimation, it is recommended to use a method called Reference Class Forecasting (RCF). RCF does not try to forecast specific uncertain events that will affect a particular project, but instead places the project in a statistical distribution of outcomes of a class of similar, historical projects. This distribution is then used to determine a budgetary uplift in order to lower the chance of a cost overrun. However, one should keep in mind that the company disposes over a finite budget. Next to this, an overestimation could also result in counterproductivity or the so-called financial Parkinson's Law. The student is expected to develop a method in order to determine the uplift to optimality. In a second phase the student has to test his/her findings on a data set that is ought to be collected in advance.

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  -

Topic: Hybrid strategies for product portfolio demand prediction

Traditionally companies have used time series models (ARIMA, SARIMA, Holt, Winters,...) to predict the demand for their products. However, due to ever increasing demand for customer customisation, shortening product life cycles and and the advent of online shopping these techniques are no longer able to make predictions for the majority of a product portfolio since they are mainly suited to products for which there is a reasonably high demand. The goal of this dissertation is to investigate how several different techniques can be combined to make predictions better. Specifically the use of clustering techniques to use historic information on related products for new product introductions and the use of causal models that use information on product categories, brands, online search trends,... are to be investigated. Moreover, the key goal of this research is to determine what a hybrid strategy for a complete portfolio could look like through a combination of various techniques (potentially weighted based on the sales volume of a specific product). The key goal of this dissertation is to conduct an experiment on real data from a mid-market retail company, in order to validate the conclusions of this research.

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  - This thesis is suitable for two students. Use of LaTeX is mandatory.
  - Literature review is supportive but not the main theme of the thesis
  - Experiments on real data
  - Software use: optionally C++, Python or R
  - Modeling and analysis: Main goal of the thesis

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.

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Topic: Agile team composition: a solution to maximize skills?

Nowadays companies are often working in a multi-project based environment. In order to execute these projects, teams of employees have to be composed. This thesis will focus on the idea of recomposing those teams after some projects out of the portfolio are successfully terminated. The student will have to focus on the advantages and disadvantages of forming every time new project teams. How does this have an impact on the way knowledge and skills are transferred between team members? Will this have a positive impact on the general learning rate in the company, or will particular knowledge deteriorate after some time? The ultimate goal of this thesis will be to make a comparison between fixed and agile team composition and the impact on the portfolio and the execution of it.

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Topic: Case study: an efficient and flexible approach to deal with dynamically arriving projects

Research on multi-project scheduling is nowadays mainly focusing on a fixed number of projects which are all present at the beginning of the planning period and they all have to be scheduled before their individual deadline. This approach largely deviates from how things are going in real life. While some projects are being executed and others are already scheduled in the future, companies receive requests from clients with new projects. After a positive evaluation of the project's contribution to the portfolio, these new projects should be fit into the already existing schedule. One of the goals of this thesis will be to investigate how companies are dealing with the problem in practice and inspired by this information a new methodology should be developed in order to satisfy as much requests as possible. In the meantime, resources should be efficiently used and the already scheduled and running projects have to be perfectly executed as well.

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Topic: Project portfolio management – Analysing different ways of clustering projects wherein resources can be freely shared

Companies working in a multi-project environment have a whole portfolio of projects running at the same time. They can assign resources at the beginning of the planning horizon to each project and schedule each of them as a single project without the need to take the other projects into consideration. The purpose of this thesis will be to consider different ways of forming clusters of projects wherein resources can be freely shared and used by all projects in the cluster. By gathering real-life data an analysis should be made of how the company's objective is impacted by these different ways of clustering.

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Topic: Project portfolio management – Analysing the geographical location of resources in order to optimize the company's objective(s)

A company's resources can be placed on different geographical locations. A resource placed at one particular location can be used by all the projects in the vicinity. Consequently when taking decisions about the position of resources a couple of things have to be taken into account: e.g. serve as many projects as possible, minimize the number of transfers of resources to other positions… This last one can be necessary if a company has too many projects in its portfolio for its limited capacity of a particular resource. The purpose of this thesis will be to come up with a model to optimize the geographical locations of the resources, taking the restrictions and the company's objective(s) into consideration. Testing this model on small examples should lead to some interesting conclusions and recommendations.

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