Doing Projects – Manual (v2024.1)

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Monday 1st July, 2024

Contents

1 Introduction

1.1 Context

Doing Projects is about running an academic project, especially in the context of a degree programme, so students at work doing an academic project. Also tips on coaching / supervising are presented. However, *Doing Projects* can be used by anyone who has to run an academic or a (complex) engineering project.

This approach and guidelines has grown from years of experience in supervising thesis-project students in engineering degree programmes mixed with suitable approaches used in systems engineering and academic-skills techniques. On the latter two topics, material from Bonnema, Veenvliet and Broenink (2016) and Tulder (2018) is used.

The workflow of *Doing Projects* work is presented in Chapter 2 and tips on techniques and tools is in Chapter 3. The rest of this chapter deals with the nature of research projects, in the context of a degree programme.

In MSc Robotics the *Doing Projects* approach is adopted for their MSc-Thesis project (graduation project) and the global workflow of it is consolidated in their EER, Education and Examination Regulations. Besides the start date and end date, also the other two milestones (Project Plan and Demo), must be specified in the registration & planning form and registered in the Student Information System (Osiris).

1.2 Students doing research / design work as a project

Doing research / design or contributing to it in the form of an academic project is not a straightforward process. Quite often questions pop up like "how deep to go into literature search?", "How many alternatives should be digged into, and how deep?", "Are the proposed solution directions doable and feasible?".

This generates a lot of uncertainty, in how to proceed, and how much time it takes. So doing academic projects causes a tension between the research / design work and the project-like (time-boundedness) context. In combination with the university setting, this tension is on two levels:

- Nice, complete results versus finishing in time.
- Student versus supervisor / research employee.

The context of an academic degree programme gives two more issues to take into account:

- The knowledge and skills students have concerning the topics needed for the research / design work.
- The experience and skills students have with respect to doing projects and doing the scientific work.

Figure 1.1 and Figure 1.2 illustrate these tensions and context.

To deal with these tensions, it is benificial and thus relevant to see the difference between:

- Doing the project in a structured way, using an well laid-out workflow, as presented in Chapter 2.
- Doing creative research / design work, stimulated / coached by the supervisors.

This calls for forcing a structured way of working from the students and also from the supervisors, and leaving the content / creativity open. This to let the project run in an effective way, while letting the content be developed as best as possible.

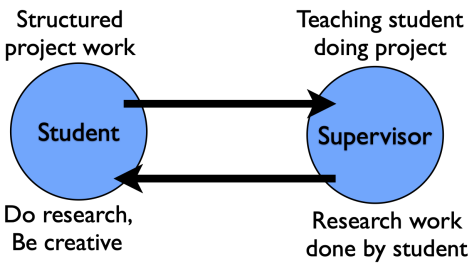

Figure 1.1: Tension while doing an academic project.

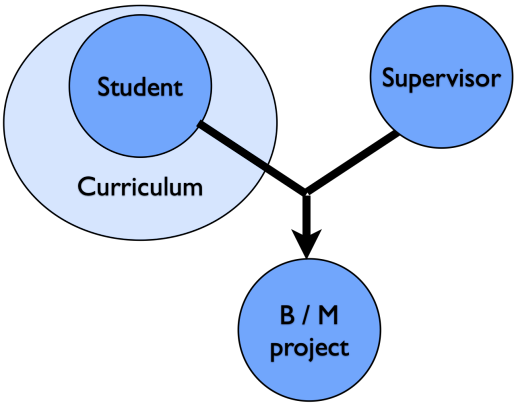

Figure 1.2: Context of a thesis project in a degree programme.

Given this flavour of academic projects, flexibility and adaptability is necessary, and must be supported by the workflow and tools. This is achieved by:

- Allow updating the planning during the course of the project.
- Allow updating the priorities of tasks and tasks themselves during the project.

To facilitate this flexibility, a project is divided into phases, and the planning is a so-called *rolling forecast*:

- Three phases: Exploration, Production, Finalisation.
- Good view / plan of current phase and a global view of upcoming phase(s).

The three phases, that is the work flow, are explained in the next chapter, Chapter 2. Besides explanation, also check lists are provided, both for the student and supervisor.

Tips and techniques on *doing projects* are in Chapter 3.

1.3 Document Structure

There are basically *three levels of information* in dealing with Doing Projects:

- *Generic*, doing academic projects in general.
- *Specific to the curriculum*, context, content, and regulations.
- *Specific to the research chair*, specific lab rules, ways of working, habits of their research field.

This text obviously deals with the first two levels. However, sometimes info on the third topic is indicated, or pointed at.

1.4 Document History

The *Doing Projects* approach is grown from quite some years of experience in supervising MSc students at RaM. Contributions to shaping of this approach are from many staff members, and especially from Job van Amerongen, Theo de Vries, Douwe Dresscher, and Momen Abayazid.

As we also continuously improve this document, newer versions appear regularly, see its date and version number. Changes are summarized in the Changelog, in Appendix A.

The latest version is on Canvas, because this document is not yet complete. Be sure to always use the latest version of this guide.

2 Workflow of Doing Projects

2.1 Introduction and overview

In this chapter, the three-phase workflow is explained. Techniques and tips to execute the workflow (e.g. planning, risk analysis) are explained in Chapter 3.

Next to the three project phases (*Exploration Phase*, *Production Phase*, and *Finalisation Phase*), also the *Preparation Phase* (for setting up a project) and the *Resit Phase* (in case the result is not good enough) are discussed.

The general time line of a project, including the preparation phase and possible resit phase is shown in Figure 2.1. It is laid out for a MSc-Thesis project of 40EC including 4 extra weeks as slack time, so 32 weeks (full time) in total. For the Academic-Skills Project (ASP) of 10 EC or a BSc-Thesis Project, the duration must be scaled accordingly. However, the three phases of equal size is the same for all projects.

The project activities of the project itself are shown in Figure 2.2.

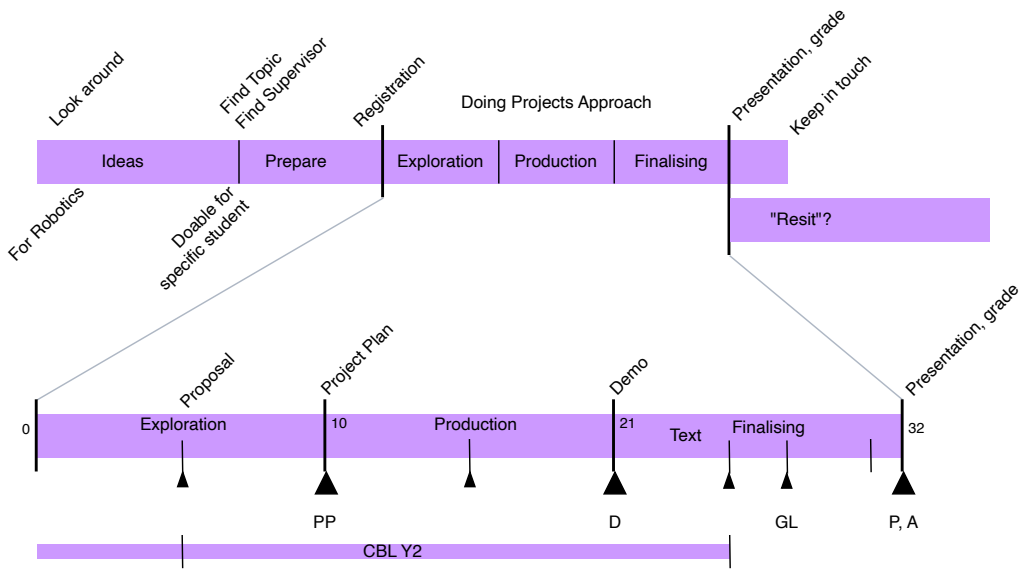

Figure 2.1: Time line of a project. Top bar: text above towards students; text below towards supervisors. Duration in weeks is for a MSc-Thesis Project. The bottom small bar labeled “CBL-Y2” is specific for MTP of MSc Robotics.

The action list (tasks time line) for students is in Section B.1.

The list of actions for the supervisor, especially the senior examiner, is in Section B.2.

2.2 Preparation, so before the project

Student

As a student, you must find an MSc-Thesis Project yourself.

Most robotic research groups advertise student projects on their website, and often there is one contact person for further information. Furthermore, checking research projects of the research groups gives an indication what kind of student projects can be available.

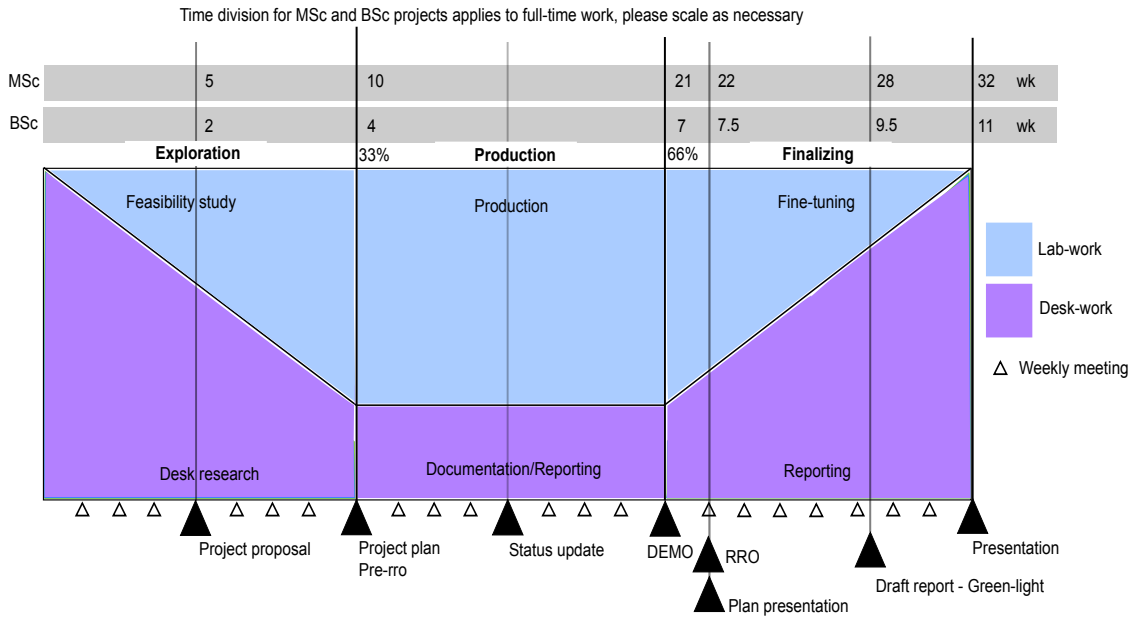

Figure 2.2: Phases and milestones of a project.

[todo] Check terms and milestone places in Phases and milestones Figure: ASP!!

Sometimes, you can influence the topic of your MSc-Thesis Project. However, the research group where to do the project is in the lead of drawing up the topic and the envisaged supervisor has to approve the project explicitly.

Supervisor(s)

As a supervisor, your ideas for an MSc-Thesis project must *not* to be detailed out in full: during the exploration phase, the student writes the project proposal and the project plan.

It is important, though, to check that this project idea

- fits in the planning of your research (project(s)).
- is on academic level.
- is doable by a student with respect to time budget (40 EC), and expected skills.

Match and final check (supervisor)

Once a student takes the MSc-Thesis project, the supervisor explicitly checks that

- the project is doable by the specific student with respect to their expertise (gained during courses) and time budget.
- the topic of the project is in a scientific field on which the student's *Specialisation* is grounded.
- aspects being taught in the student's *Profile* can be addressed in the project.

Registration and Administration (student *and* supervisor)

Both student and supervisors / chairperson of the Supervision Committee have a role in this:

- As student you have to be sure that you meet the entry requirements before you start the project. A maximum of 10 EC next to the MSc-Thesis project may be unfinished, whereby the compulsory courses of your specialisation must have been completed. For MSc Robotics, this embraces the six compulsory courses of your Specialisation and CBL Year 1 (202200115). Check your Study Progress Overview (Osiris) and when in doubt check at the Educational-Affairs Office yourself.

- As student produce an initial project description, and discuss this with your supervisors. It is really an initial project description, as during the first part of the Exploration phase, this description is further detailed out. You can use / base it on the project proposal as written by the supervisors to advertise for the project.
- As student, make an intial planning, using the MSc-Thesis Registration / Planning Form, and discuss this with your supervisors. Here you lay out the MSc-Thesis-Project work-days on your schedule / calendar. The milestones, being start date, project-plan date, demo date, and final-presentation date must be put on that form. It is advised to spend *at least* 60% of full time to your MSc-Thesis Project to keep the project going and not to lose too much time to get started again and again. A more comfortable minimum is 80%. For tips and hints on planning, see Section 3.7.
- As supervisors, determine the *Supervision Committee*. The external examiner does *not* need to be known at this moment. see the EER on rules for composition.
  Note that the external examiner must *not* be involved in the supervision.
- After agreement on global planning (milestone dates) and initial project description, the chairperson of the supervision committee signs the forms, and the student sends these to the Educational-Affairs Office respectively uploads into Mobility Online.
- As a student, check whether the research group has some centralised student-project registration (like info on website), and provide the information for that.

Note that the planning of the milestones before the start of the project is the initial plan and thus provisional. These may be updated during the course of the project. See Section 3.8 for hints and tips on this.

Relevant articles in the EER are: A3.7, A3.8, B3.12, and B4.7.

The regulations to which the MSc-Thesis project must comply are in the Education and Examination Regulations (EER), linked to on the programme's website. The text here is based on those regulations. In case of discrepancy between this document and the EER, the EER is leading.

2.3 Upon Project Start – Organisational Arrangements

At the beginning of the project, make agreements concerning:

- Practical issues
  Like workplace, access to Lab (if applicable), where to go for support, use of tools and servers etc. This is of course specific to the research group where the work is conducted.
- Weekly PIP meetings
  On Progress, Issues, Plans: once per week with the student and at least the day-to-day supervisor.
- Monthy PIPPF meetings
  On Progress, Issues, Plans / Planning on project level: once per month with Supervision Committee (or a relevant representation of it) and student.
  Furthermore, the Supervision Committee gives formative feedback to the student.
- Ad-hoc meetings
  For getting questions answered in between the scheduled meetings.

More on PIP and PIPPF meetings in the next Section (2.4), and for practical tips see Section 3.2.

When the work is done part-time, the PIP and PIPPF rhythm can be scaled accordingly.

2.4 Weekly PIP and monthly PIPPF meetings during the *whole* project

During the *whole* project, so during *all* three phases, weekly and montly progress meetings must be held. This to keep the project on track, both contentwise and timewise.

2.4.1 PIP meetings – weekly

The PIP meeting is a weekly meeting with the student and at least the day-to-day supervisor on Progress, Issues, and Plans:

- *Progress*
  On the progress since the previous PIP, to align your supervisor(s). It can be as simple as a bulleted list, with explanations if needed.
- *Issues*
  Topics to be discussed, or need for explanation, clarification, help. Add details if useful.
- *Plans*
  Tasks, actions envisaged to be done until the next PIP. This might get updated as a result of the PIP meeting.

The PIP meetings can be more on specific and/or operational issues, whereas the PIPPF meetings focus on the project level, so overviewing the whole project. Tips on PIP meeting are Chapter "Tools and Techniques", Section 3.2.

2.4.2 PIPPF meetings – monthly

The PIPPF[1] meeting is a montly meeting with the student and the *whole* Supervision Committee. Depending on the experience of the supervisors / habits of the research group, not all committee members need to be present at every PIPPF meeting. However, the supervisors present must be able to provide the formal formative feedback (mandatory for MSc Robotics).

A PIPPF is PIP – Progress, Issues, Plans – on project level, Planning (whole project), and formal formative Feedback:

- *Progress*
  Since the last PIPPF.
- *Issues*
  To discuss about with the *whole* Supervision Committee.
- *Plans*
  Until the next PIPPF.
- *Planning*
  The planning of the project as a *whole* and indicate / discuss whether the project is on track or not, see Section 2.6.1, on *risk analysis*.
  If the project would need extra time, discuss possible mitigation approaches, i.e. *Repair procedure*, see Section 2.8.1.
- *Formal formative feedback*
  The Supervision Committee gives formal formative feedback to indicate whether the project is on track with respect to the quality and amount of work the student has delivered sofar.
  In case of an MSc-Thesis Project of MSc Robotics, this formative feedback is compulsory, otherwise voluntary. If the Supervision Committee expects no pass to be achieved at the planned end date, the *Resit procedure* can be investigated, and started, if necessary, see Section 2.8.2. This resit procedure is specific for MSc Robotics.

Note that when the work is done part-time, the PIPPF rhythm can be scaled accordingly.

For MSc Robotics, the supervisor sends the dates of the PIPPF meetings marking the end of the Exploration Phase and Production Phase (milestones PP and D) to the Educational-Affairs Office, see the sections on wrapping up these phases: Section 2.5.3 resp. Section 2.6.3.

[1] PIPPF was previously called MPIP, Monthly PIP, but PIPPF beter reflects the topics to be treated.

2.5 Exploration Phase

The Exploration Phase is on looking around, investigating what the project idea implies, and what directions the project can go to. So, indeed exploring possibilities in the project.

2.5.1 Activities during Exploration Phase

Progress of this phase so keeping on track, both timewise and contentwise, must regularly be discussed with the supervisors using the PIP and PIPPF meetings, see Section 2.4.

The following activities need to be done, albeit not neceresarily in the given order.

Write the Project Proposal

This consist of the context of the project (one paragraph), and the goal / approach (one paragraph). It is actually a next version of the description of the project that was produced and registered before the project, during the preparation (Section 2.2). You can further specify the work by producing a bulleted list of tasks to be done in the project.

In case the research group publishes the ongoing graduation projects on their website, the first two paragraphs of the Project Proposal can be used for this.

Goals and approach need a context, such that the reader understands in which direction the project develops.

Formulate the goal and objectives of the project

The goal and objectives of the project indicate what you want to achieve with the project. These are the mission / business needs of the project, to formulate it in terms of Systems Engineering (Faulconbridge and Ryan, 2020). So, a concise and complete statement of what the project is about.

Stating the objectives, so what to achieve while doing the academic project, is important to do in the beginning of the project, because the objectives are used to give direction to the project. Later in the project, choices are made such that the resulting work contributes to the goal and needs of the project. Especialy, in the latter half of the project, life becomes easier when the goal and objectives are clearly set.

Goals and objectives can be formulated as research questions or as (design) objectives. What form is best to use, depends on the nature of the project.

Section 3.3 provides tips on producing the goals and objectives.

Generate ideas

Exploring (this phase *is* the Exploration Phase) implies generate ideas, formulate possible (top-level) descriptions of solutions that might be feasible. Structuring ideas, possibilities, detailing out ideas, can best be after that.

In Section 3.4 tips on creativity in research are presented.

Search & Read Literature

To study the scientific area of the project, literature search is needed: to indentify other work to get inspiration from, to build your own work on (like previous projects), to detail out your own ideas.

Section 3.5 and also (Tulder, 2018, Skill Sheets A20 - A22) provide tips and techniques on searching literature.

Perform Feasibility Tests

Feasibility is on finding out whether alternatives / research directions are practicable, workable, achievable, realisable. This can often be achieved by performing some tests: small experiments to find out whether alternatives deliver what they 'promise'. Tests can be indeed experiments in the Lab, but also calculations, simulations, technical drawings, etc.

Note that doing these tests / experiments can also serve as mastering tools and techniques you need in the project.

See Section 3.6 for tips. Unfortunately (Tulder, 2018, Skills Sheets part A and especially Sheet A11) is on research in the social-sciences domain, so in general not so applicable for engineering research / design.

Setup and start the CBL work

As an MSc-Robotics student, you must write on Challenge-Based Learning experiences / activities done during your Master-Thesis Project, and add that to the CBL portfolio of the course CBL in MSc Robotics 2 (202200121). See that Canvas course site for more details. Have your CBL activities to be done during the MTP formulated after *one* month, so together with your Project Proposal.

Plan this Exploration Phase

Planning is producing a list of tasks to be done, in which order, when to start, and when to be ready. A plan serves to do the work in an effecive way.

For this Exploration Phase, all work / tasks mentioned in this section need to be put in the plan.

A plan can be written down as a list of tasks including end dates (to-be-ready date, or deadline), or shown in a Gantt chart. See Section 3.7 for tips.

Starting with an initial set of tasks, the planning can grow during the course of the Exploration Phase. Major milestones later in the project are indicated from the beginning. This is a so-called *rolling forecast*. Such a early planning can be very well presented using a Gantt chart.

A plan is a useful tool to keep on track, that is, to get the work done within the indicated time frame. For this, prioritising tasks may help. Checking whether tasks still contribute to the goals and objectives is a way to determine the priority of these tasks and whether these tasks still must be executed.

Section 3.7 and Section 3.8 and also (Tulder, 2018, Skill Sheets A20-A22) provide tips and techniques on planning and keeping on track.

Produce the Project Plan

The Project Plan reports on the results of the Exploration Phase. It furthermore contains the initial planning of the Production Phase and the initial structure of the final report. The latter two items serve to do the work in the Production Phase effectively.

A global setup of the project plan is as follows:

1. Introduction
   Context, problem statement, goals and objectives, approach.
   Depending on the nature of the work, the objectives can be formulated as design objectives or as research questions.
2. Background / Literature Survey
   What others have done / made.
3. Analysis and (Design) Choices
   Report on feasibility and motivated choices on what to do next. You can use trade-off tables / decision matrices to show how each alternative scores on each requirement /

criterion. This should result in a proposed solution / direction, including requirments (if applicable).

4. What to show at the Demo Meeting
   So, at the end of the Production Phase, to show the *essential results* of the project. Describe the testing (verification / validation), what to show as result of tests, to support the scientific reasoning. This forms the basis for the results part of the final thesis.
5. Initial structure of the final report
   This gives a target to work towards, and pinpoints to what items must be delivered.
6. Initial plan of the Production Phase
   List of tasks, including priorities, a *Plan of Attack*. Can be presented as a Gantt chart or a list of tasks.

The first three parts can be seen as a early version of the beginning of the final report. Having crisp and clear what the goals and objectives are, including what to deliver at the end, gives focus to the work in the Production Phase. This gives also focus for the Finalisation Phase, albeit growing insight during the Production Phase, obviously causes the details for the Finalisation Phase to get adapted.

Examples of project plans are available on the Canvas site of MSc Robotics.

2.5.2 Deliverables of the Exploration Phase

From a *Doing Projects* point of view, these items must be produced in this Exploration Phase.

- Project Proposal
- Planning of the Exporation Phase
  This plan may grow during the Exploration Phase.
- Project Plan

2.5.3 Wrapping up the Exploration Phase

The end of the Exploration Phase is the Project-Plan meeting and thus the milestone PP.

In this meeting the project plan is discussed. It is a specific PIPPF meeting, shown as a solid triangle tagged PP in Figure 2.2. The result of this meeting is to consolidate this project plan, and thus the work to be done in the Production Phase. Changes to the plan can be proposed, and that part of the project plan might need to be updated before it can be consolidated, and be used as a starting point for the next phase.

In case of an MSc-Thesis project of MSc Robotics, the supervisors give formal formative feedback about the performance of the student, as part of this PIPPF meeting. The supervisor sends the date of this meeting to the Educational-Affairs Office to record in a minimalistic way the status of the student's MSc-Thesis Project.

Next to this, in case of work rated below-par, repair actions are formulated (see Section 2.8.1), such that the project can get on par at the next PIPPF. If at that next PIPPF meeting the work is still below par, the resit procedure can be started, see Section 2.8.2.

2.6 Production Phase

Essentially, the Production Phase is on executing the project plan, in such a way that the next major milestone (Demo) is reached with a sophisticated quality and amount of work, without or with minimal delay.

2.6.1 Activities during the Production Phase

Progress of this phase so keeping on track, both timewise and contentwise, must regularly be discussed with the supervisors using the PIP and PIPPF meetings, see Section 2.4.

The following activities need to be done; the first two concurrently and the last one at the end, obviously.

Execute the Plan

So, do the operational work.

Carefully document the work, by keeping a logbook / journal. This is useful to:

- Record (partial) results to be used for the final report, and reporting during PIP / PIPPF meetings.
- Record the actions you did, allowing repeating the “experiment” / work. Useful for documentation or trouble shooting / debugging.
- Record where you got material / information from, for proper referencing.

So this is on doing the tasks right. On doing the right tasks and spending the right amount of time on tasks, is ”Keep on Track”, which is discussed below.

Keep on Track / Risk Analysis

In MSc-Thesis projects (or any scientific project), work mostly appears to be different than originally planned. This is due to growing insight, growing experience, growing (detailed) knowledge, unforeseen issues popping up, etc. To keep on track and to keep focus on the whole project and results, tasks, priorities of tasks, and as a result of this the planning need to be reconsidered and updated.

Do a *risk analysis* at each PIPPF: reconsider tasks, priorities, and planning. Doing this once per PIPPF gives a right balance between the work itself and overseeing the whole project. For this, investigate whether tasks might take more time than originally planned, see Section 3.8 about techniques for this.

If rearranging of tasks and/or replanning is necessary, produce a motivated proposal to be discussed in the upcoming PIPPF. Best is to do this risk analysis as part of the preparation of each PIPPF (Planning, so third P).

Demo

The *Demo* marks the end of the Production Phase, and shows the essential results of the work. Its goals are:

- Show that results have been achieved.
- Discuss results and gather feedback from the supervisors.
- Conclude whether the work is good enough to enter the Finalisation Phase.

In terms of Systems Engineering (Faulconbridge and Ryan, 2020), this demo can be seen as a *design review*.

So, this *Demo* must be prepared carefully. In that, it is beneficial to check the goals and objectives of the project (as written in the Project Plan), as the work shown here must contribute to these goals and objectives.

Note that *Results* and *Demo* is not only result of some design or experiment. It can also be the outcome of theoretical work, calculations, or simulations, so any work as part of an MSc-Thesis Project.

2.6.2 Deliverables of the Production-Phase

From a *Doing Projects* point of view, these items must be produced in this Production Phase.

- Demo
- Planning of the Finalisation Phase

2.6.3 Wrapping up the Production Phase

The end of the Production Phase is the Demo meeting and thus the milestone D.

In this meeting the results as shown during the demo are discussed. It is a special PIPPF meeting, shown as a solid triangle tagged D in Figure 2.2. The result of this meeting is to consolidate the essential results, and allow to enter the Finalisation Phase.

However, the work to be done by the student in the Finalisation Phase, next to report writing, must be carefully decided upon and planned. This because as usually many new ideas arise during the demo, so the left-over work and those new things must be carefully prioritised to avoid overloading of the Finalisation Phase, and thus unnecessary extending this last phase.

In case of an MSc-Thesis project of MSc Robotics, the supervisors give formal formative feedback about the performance of the student, as part of this PIPPF meeting. The supervisor sends the date of this Demo / PIPPF meeting to the Educational-Affairs Office to record in a minimalistic way the status of the student's MSc-Thesis Project.

Next to this, in case of work rated below-par, repair actions can be formulated, see Section 2.8.1, or in case the results being below par are due to quality and amount of the work student has deliverd, the resit procedure can best be started, see Section 2.8.2.

2.7 Finalisation Phase

This Finalisation Phase is the *end game* of the project. It is about doing the last bits and pieces of the work, and write the final report, prepare and hold the presentation.

2.7.1 Activities during the Finalisation Phase

Also in this phase, progress, so keeping on track, both timewise and contentwise, must regularly be discussed with the supervisors using the PIP and PIPPF meetings, see Section 2.4.

The following activities must be done, in a concurrent way, where in the end the focus is on report writing and presentation preparation, with the assessment and formal summative feedback as the last action, obviously.

Update the planning

Update the planning of the Finalisation Phase, as was presented during the Demo meeting, by incorporating the left-over work as agreed upon at the demo meeting.

Plan the report writing, taking into account feedback moments and reading time for reviewing by the supervisors. For instance, the final draft report to be discussed at the *Green-Light* meeting, must be ready for review about one week earlier.

Note, that as a result of report writing, new insight can come up, demanding finetuning some operational work (design most notably) or redoing some tests / experiments. That is why report writing should start at the very beginning of this phase.

Take into account the two intermediate, formal milestones in this phase, namely the *Green-Light* meeting and the Final-Report submission deadline, at least four weeks respectively one week before the presentation day.

Finalise the operational work

Simply do the work.

Documenting it is as important as before, but might be more obvious as final report writing is another task of this phase.

As indicated above, due to growing insight, some finetuning, redesign, redoing tests / experiments might pop up. This might cause more work than foreseen at the beginning of this phase,

so careful risk analysis and replanning might be needed. However, as the end of the project is approaching, the available slack time might be minimal, or already being consumed.

Write the Report

First produce an articulated outline (*Rich Report Outline – RRO*). This RRO is the global line of thought / reasoning of the report, so more then only chapter and section headings. After that, produce the text, by detailing out the RRO lines. This way, the storyline of the report is separated from the actual writing of the text, resulting in an elegant two-step process, thus optimising writing and reviewing time.

Each type of project can a specific skeleton of chapters and topics, most notably research-focussed versus design-oriented projects, see Section 3.3 on research versus design and Section 3.9 on details of report writing, including support for LaTeX.

For the review process, check first what is common at the research group / preference of the supervisors. Often only the day-to-day supervisor reviews the report on a chapter-by-chapter basis, such that feedback to the first-reviewed chapters can be used while writing the later chapters. Sometimes, the RRO can be discussed with a supervisor before you start writing the texts.

Obviously, use earlier-made documentation, most notably the project plan.

The draft report must be reviewed at the *Green-Light* meeting, see below. It must be ready in time, such that the Supervision Committee has time to read it before the meeting.

Use the green-light review comments to finalise the report.

This final version must be send to the *whole* Assessment Committee (that is the Supervision Committee plus the external examiner) one week before the date of presentation and assessment. Depending on the process at the research group, the report might also be sent to others.

This final version must also be uploaded to the essay server of the UT (`https://essay.utwente.nl`). Check on beforehand with the supervisors whether the report is considered confidential, such that you can indicate that on the essay website.

Finalise CBL work

As an MSc-Robotics student, you must write and submit on Challenge-Based Learning experiences / activities done during your Master-Thesis Project, via your CBL portfolio of the course CBL in MSc Robotics 2 (202200121). Submit the intermediate portfolio on learning goals one month after the start of the MTP (coincides with the PIPPF on Project Proposal) and the final portfolio one month after the Demo meeting, to *not* dealing with too much work / deadlines / stress in the last few weeks of the MTP. See that Canvas course site for more details.

As usual for CBL work, this CBL contribution to the portfolio is assessed separately from the MSc-Thesis Project by the CBL teacher.

Green-Light Meeting and Master-Examination Registration

The *Green-Light* meeting is a special PIPPF, in which the draft report is *scrutinised* by the Supervision committee. For this, the draft report must be submitted in time (normally one week before) to allow the supervisors to carefully read the draft report.

After discussing the report, the Supervision Committee decides on *green light*, that is, the work and draft report are good enough to give a final presentation and the whole project can be assessed after the presentation, provided the work to be done is of same quality as shown before.

As a student, you have to pre-fill in the Master-Examination Registration Form, available at `https://www.utwente.nl/en/rob/forms_and-procedures/#MTP`. The senior examiner (chairperson of the Supervision Committee) co-signs this form, and the student

sends it to the Educational-Affairs Office. This form must be at the Educational-Affairs Office *at least* four weeks ahead of the presentation day. This because they need some time to process all checks. Furthermore, the Examination Board checks to, in order to formally issue the diploma in case the MTP is the last unit to be graded (next to CBL Year 2).

The green-light meeting can best be planned at the Demo PIPPF meeting. Also, the presentation day and time can be decided upon. The Supervision Committee can start looking for the external examiner. However, the Supervision Committee can wait for the green-light decision to decide upon presentation date and/or external examiner.

Prepare and hold the Presentation

The presentation takes exactly 30 minutes, and after that, a Q&A session of about 20-30 minutes, chaired by one of the supervisors. The target audience are the student's peers: MSc students eager to start an MSc-Thesis project in the research group where the current MSc-Thesis project takes place. Next to that, the Assessment Committee is important here, as they base their assessment partly on the presentation and the Q&A session.

Assessment

The MSc-Thesis Project is assessed by the Assessment Committee after presentation and Q&A session, and based on the work and report. The specific assessment form to record and file formal summative feedback and thus the assessment must be used. A copy of the completely filled-in assessement form can be handed to the student.

At this moment, the resit procedure can be applied if needed, that is, the result is below par. However, try to avoid applying the resit procedure so late in the process, as there have been ample opportunities to do this earlier.

Aftermath

This is on consolidating the work of the MSc-Thesis Project.

All data must be gathered, for both later use by the research group, and to record what the student has produced as evidence of the thesis work.

If applicable, decide on reuse versus disassemble the set up that has been used, and further clear the lab space used.

2.7.2 Deliverables of the Finalisation Phase

The following items must be produced and submitted in this Finalisation Phase:

- the final report
- the presentation
- all other artifacts, like source files of the report and presentation, measurement results files, design documents, software, constructed set up.

2.7.3 Wrapping up the Finalisation Phase

The end of the Finalisation Phase is the presentation and assessment and thus the milestone P in Figure 2.2. It is also the end of the MSc-Thesis Project. And in case the normal flow of the MSc programme is taken, it is also the last exam, thus graduation, if this last exam results in a pass.

Depending on the procedure of the research group, the assessment form is send either directly or via the research group's secretariat to Educational-Affairs Office for formal registration, after all obligations have been done, most notably, submitting all artifacts and clearing work space (if applicable). The Educational-Affairs Office must recieve this assessment form within a week after the assessment.

2.8 Repair and Resit Procedures

The *Repair procedure* is used when a delay is expected (thus a deviation from original plan) due to reasons beyond control of the student.

The *Resit procedure* is used when the quality of results and amount of work produced sofar by the student are below par, that is, the supervision committee expects *no* pass to be achieved at the planned end of the project without any measures taken.

For MSc Robotics, see EER, Article B4.7 for the formal basis of the Repair and Resit procedures.

2.8.1 Repair Procedure

The *repair procedure* is activated when during the project, it appears that the original project gets delayed beyond the control of the student. Reasons can be:

- The work appears to be too much to finish within the normal time period of the project.
- The work appears to be too complex to finish within the normal time period of the project.
- Malfunctioning of the setup /equipment / tools to be used causes serious delays.
- Lead time of ordered parts / components are significant larger than expected on beforehand.
- or other reasons beyond the control of the student, like illness.

In this, the capabilities, knowledge, end experience of the student are taken into account.

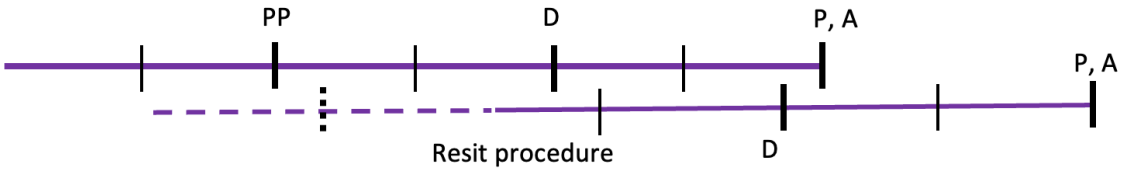

Figure 2.3: Project time line including the Repair Procedure. At any PIPPF meeting the Repair Procedure can be started.

After identifing the delay, and checking whether the work can be reordered as possible mitigation, the planning needs to be updated.

The *repair procedure* is

1. Identify the amount of extra / different work, and extra time caused by this.
2. Check whether the work / supervision strategy / support can be adapted / replanned to minimise the delay, via *Risk Analysis*, see Section 3.8.
   If no delay appears, just continue with the updated planning, while still keeping the same end date.
3. If a delay is inevitable:
   (a) Update the planning and agree about it by the student and the supervision committee.
   (b) In case the total project gets delayed, the student updates the Registration form (duration of delay, updates of intermediate milestone date(s), end date), one of the supervisors co-signs this update, and the student sends it to the Educational-Affairs Office.
4. In case no agreement on the rescheduled plan is reached, the EB (Examination Board) must be requested to mediate.

2.8.2 Resit procedure

The *resit procedure* is activated when it appears at formative feedback moments that the student's work is below par, that is, the Supervision Committee expects no pass to be achieved at the planned end date assuming the quality and quantity of work delivered by the student stays the same as before.

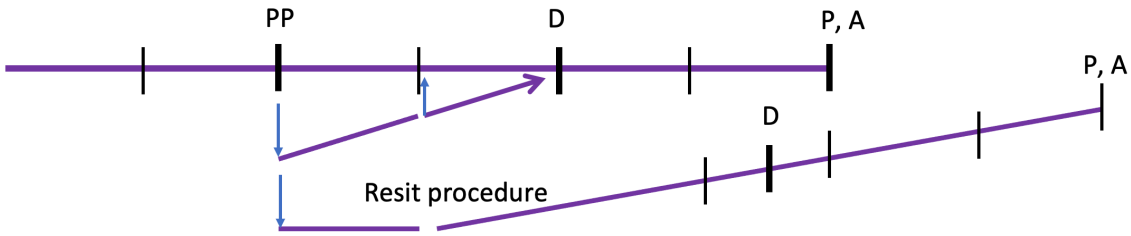

Figure 2.4: Example of a project time line including the results of a Resit Procedure.

The *resit procedure* is (Figure 2.4)

1. As supervisor committee, give formative feedback at an PIPPF meeting announcing the work is below par.
2. Check whether the supervision strategy / support and/or work needs to be adapted. Adapt if needed.
3. Check at the next PIPPF whether student's performance is now sufficient or still below par.
   If the work is of sufficient quality and quantity, continue the project according to the current plan.
4. In case the student's performance is still below par:
   (a) Extend the project with 2 months, and adapt the planning accordingly.
   (b) The final grade can be either a Pass with a 6 or a Fail.
   (c) The Registration form is updated accordingly, and the chair of the Supervision committee co-signs this update, and the student sends it to the Educational-Affairs Office.
5. In case the student disagrees with this measure, the student can request the EB (Examination Board) to mediate.

Note that items 4c and 5 as descibed here, are specific for MSc Robotics. Other degree programmes mostly have a resit procedure for final projects.

3 Tools and Techniques

3.1 Introduction

In this chapter, a number of practical tools and techniques are introduced, including tips on use, of course focusing on the *Doing Projects* context. The workflow of *Doing Projects* is explained in Chapter 2.

Some tools and techniques are suitable at specific points in the workflow, while others are more suitable to dealing with issues when they occur.

3.2 PIP and PIPPF meetings

The goal of the PIP and PIPPF meetings is to keep the project on track, both contentwise and timewise.

PIP meetings

The PIP meeting is a weekly meeting with the student and at least the day-to-day supervisor on Progress, Issues, and Plans.

Both overview and content are important here. So, use a structured bulleted list, with explanations.

- *Progress*
  On the progress since the previous PIP, to align your supervisor(s).
  In case the explanation gets lengthy, you can put that below the PIP bulleted list. You can even mix these forms when in one meeting you have items with both long and short explanation.
- *Issues*
  Topics to be discussed, or need for explanation, clarification, help.
  In case the description needs quite some space, it is better to place these below the PIP buleted list.
- *Plans*
  Tasks, actions envisaged to be done until the next PIP.
  Have clear what you want to focus on / actually do in the period to the next PIP meeting.
  As a result of the meeting, these tasks might get updated.
- *Next meeting*
  In case the meeting schedule is ad hoc / irregular, check / propose a date for the next meeting.

Tips for PIP meeting documents

- The PIP document contains bascially three bulleted lists, one for each topic. Add (short) explanations if necessary. In case these become lengthy (for instance including diagrams) consider putting the three bulleted lists at the top of the document to keep the overview and focus on the essence, and put explanations thereafter.
- Number the PIP meetings, and use that number in the document file name / message subject.
- Use Plans of the previous PIP as starting point for Progress of the current PIP.
- For focussing the meeting, present Progress and Plans as FYI (for you information), so no discussion on it. The Issues part should take most of the time of the meeting. Plans might need updated as a meeting result, so that might need some discussion time.
- Only mentioning the topics at the subbullets is *not* enough (in general). So, add some explanation.

- On stimulating creativity and student guidance, see Section 3.10 on "Supervision / Coaching".

[rro] examples? template!, or is this too simple?

PIPPF meetings

The PIPPF meeting is a montly meeting with the student and the *whole* Supervision Committee. Although having the whole committee present is strongly adviced, it is *not* an obligation. Of course, enough *experienced* supervisors must be available, most notably for the Formal Feedback.

The PIPPF is PIP – Progress, Issues, Plans – on project level, and Planning (whole project) and formative Feedback (the latter is compulsory in case of an MSc-Thesis Project of MSc Robotics).

Overview and content are important here, so use a structured bulleted list with explanations. Note that the overview and discussions of the PIPPF deal with a larger part of the project (in general one month: since the previous PIPPF meeting) than at the PIP meeting, so less detailed (in general). Furthermore, for the Planning, the *whole* project needs to be overseen.

- *Progress*
  On the progress since the last PIPPF.
  Keep in mind that not all committee members know about the weekly PIP meetings, so summarizing what has been topics of the in-between PIP meetings needs to be part of this progress.
- *Issues*
  To discuss about with the *whole* Supervision Committee. Take advantage of having the whole Supervision Committee at the table, i.e., 'use' their expertise while selecting topics to discuss.
- *Plans*
  Until the next PIPPF. These plans should have a more overview character (so, can be less detailed) than the plans at the weekly PIPs.
- *Planning*
  The planning of the project as a *whole*. Clearly indicate deviations since last PIPPF and whether this has consequences for the upcoming milestones (PP, D, P+A), that is, should these milestones be postponed or would finishing the work in time for these milestones get difficult? Do a *Risk Analysis* to prepare, see Section 3.8.
  The goal is to discuss whether the project is on track or not and decide in the latter case on possible measures to keep the project finish on time, or get a carefully taken decison on delaying the project. This means, checking the *Repair Procedure*, Section 2.8.1, which includes a *Risk Analysis*, Section 3.8. Note, extra project time due to the performance of the student is subject of the next bullet.
- *Formative Feedback and possible Resit Procedure*
  The Supervision Committee gives formative feedback to indicate whether the project is on track with respect to the quality and amount of work the student has delivered sofar. This includes also the PIP and PIPPF meetings themselves.
  In case of an MSc-Thesis Project of MSc Robotics, this formative feedback is compulsory, otherwise voluntary.
  If the Supervision Committee expects no pass to be achieved at the planned end date, the *Resit Procedure* can be investigated, and started, if necessary, see Section 2.8.2. Note that not all MSc programmes allow applying a Resit Procedure early in the project.
- *Next meeting*
  If a next meeting is not yet planned, propose a date for the next meeting.

Tips for PIPPF meeting documents

- The PIPPF document contains basically five bulleted lists, one for each topic (F is normally only the title).
- Add concise explanations for each part / bullet point. In case the explanation needs some space (diagrams etc), use the five topics and bullet points to structure the report in chapters and sections.
- Number the PIPPF meetings, and use that number in the document file name / message subject.
- Use the Plans of the previous PIPPF meeting as starting point for Progress of the current PIPPF.
- For focussing the meeting, present Progress and Plans as FYI (for you information), so no discussion on it, hwever, as some committee members only attend PIPPF meetings, explaining / summarising what has been done since the previous PIPPF might be useful. The Issues part should take most of the time of the meeting. Plans and Planning might need updated as a meeting result, so that might need some discussion time.
- On Planning: clearly indicate the updates of the planning as shown in the Gantt chart. This includes possible extension of the project duration and delaying milestones. If applicable, indicate (give underpinning) why the project gets delayed. Obviously, deciding on a possible delay is a result of the meeting.
- Reserve some time for the Formal Feedback at the end of the meeting.
- Presenting the Planning in a Gantt chart gives a good overview, and showing progress of each task (bar) can be insightful, see Section 3.7.
- On stimulating creativity and student guidance, see Section 3.10 on "Supervision / Coaching".

[rro] examples? template!, or is this too simple / obvious?

3.3 Goals and RQ / DO

[rro] mision as goal in 1 sentence / ultimate goal

[rro] RQ or DO: a few main Q/O and subs, see also vT A15 and SysEng: F&R

3.4 On Creativity

[rro] What is good research. sl 2-5 DoingResearch

- So vT part A; slides 3, 4; for Chap 4?
- types of student / academic projects, slide 5; needed at all?
- refer to techniques on creativity, ideas generation

[rro] see notes on doingResearch topics

3.5 Literature Search

[rro] can we add something? should be available in vT etc?

[rro] tools to record, keep track where you found stuff, to avoid plagiarism, of course

3.6 Feasibility Tests

[rro] OOPS vT is too much towards social sciences

[rro] OOPS, vT, A11, A9, A12 on social sciences. A11, Feasi, is for planning purposes useful to look at: In Chap 3?

3.7 Planning

The goal of the planning is to know what to do in what time period, and keep focus on the things that need to be done. Furthermore, it helpt to keep the project on track, both contentwise and timewise.

Due to the nature of an academic project, (quite some uncertainty, see Section 1.2), a planning can best be made in a coarse way first, and detail out only for the upcoming short term.

3.7.1 Initial, Coarse-Grained Planning

The first planning is only about the three phases, and the tasks to be done during the first phase (Exploration Phase). The whole project is divided into three equally-sized phases: Exploration, Production, and Finalising Phases, see Figure 3.1, being a recall of Figure 2.2).

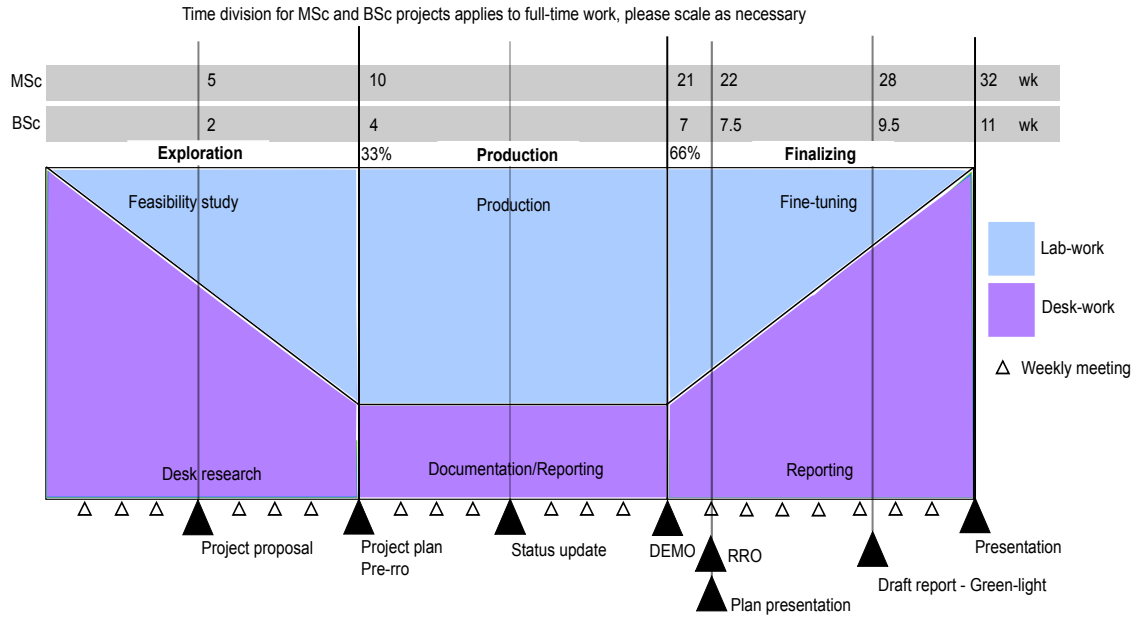

Figure 3.1: The three phases and milestones of a project (recall of Figure 2.2)

These three parts must be laid out on your Calendar, to determine on what dates the milestones and end date of the project are, provided the start date is determined.

Take into account the following:

- Lenghts of phases indicated in Figure 3.1 are weeks of full time work (*full-time weeks*), without any disturbance, so each week is 40 h of work. The full-time duration of an MTP is 32 wk (weeks). This is including 4 wk slack time, as 40 EC of 28 h equals 28 wk of 40 h. The phases are 10, 11, and 11 weeks long.
- Actual time that cannot be spent on the project, must be accounted for, and causes the milestones and/or enddate to move to later.
- Non-workable days / weeks (non-workable for the project!) that can be foreseen are:
  - Public holidays on weekdays (on which the UT is closed).
  - Other days the UT is closed, i.e. specific days.
  - Your own vacation period / days off.
  - Your other activities, like extra-curricular activities, a part-time student job, or student-assistance work.
  - Time to spend on other study units, like one or two courses that are not yet finished.
- Spending at least 60-80% of full time on the project is necessary in order to keep the project going and not to loose too much time to get started again and again.

- Unforeseen days like absence due to illness, do not *need* (uh... cannot) be put in the planning, obviously. During the project, unforeseen absence may happen, such that the planning must be updated.
- While laying out the project time on your Calendar, taking into account all the *non-workable* days, can be easier when counting in workdays. The MTP of 32 weeks is 160 days. The three phases take 10, 11, 11 weeks respectively, so 50, 55, 55 days. A course of 5 EC is 140 h, which is 17.5 day.
- Although milestone dates and enddates are determined to be on a specific date, in practice, the actual date may divert from the planned date with a few workdays (± half a week).
- Before finalising the start date, milestone dates and end date, check with your supervisors whether they are availalbe on those dates. This, because those milestones imply meetings at those days, obviously.
- Updates of this planning (especially the milestone dates) need to be agreed upon by the Supervision Committee, as an update here lengthes the total (wall-clock) time of the project (in general).

The milestone dates and the dates calculation of this planning must be put on the MSc-Thesis Project Planning form. The MSc-Robotics MTP planning form calculates the total number of actual (wall-clock) weeks the project takes.

Once you have agreement upon these dates with your supervision committee, the form can be finalised, signed, and send to the Educational-Affairs Office, either directly or via the student-project support (secretariat) of the research group.

Possible updates of the milestone dates as stated on the Planning / Registration form, need to be communicated again, by sending an updated form.

Tips for Initial Planning

- See UT's Academic Planning web page[1] for holidays and other UT closing days. Also the Academic Calendar is linked there, which you could use to layout your activities on real dates.
- Be realistic in computing the time that *cannot* be spend on the project: Underestimating this can cause needing an extension too early in the project, which might be cumbersome to get. Overestimating this can give a low-profile, low-productive impression, which is not beneficial.
- Estimate time for redoing a course *not* too optimistic, as the earlier attempt is indeed insufficient, and you can better start all over again, and thus budget the full 5 EC for this redoing.
- Gantt Chart tools often support in calculating end time of tasks that are interrupted by free time. See Section 3.7.2 for links to some tools.
- Write the milestones in your Calendar / main page of your logbook, to easily see them or refer to those important dates. This can best be discussed during the PIPPF meetings (it is the third P).
- Skill sheet *Study Planning: Semester* (Tulder, 2018, B13), might give some inspiration in planning longer periods with several activities.
- See an example in the Appendix « to be provided ».

[rro] example, using UT's academic year schedule?

3.7.2 Fine-Grained planning of a Phase

This fine-grained planning is about making the plan for a specific Phase of the project.

[1] see https://www.utwente.nl/en/ces/planning-schedules/academic-calendar/

However, making such a plan is not easy, because precisely defining tasks and estimating durartion is difficult. Especialy in the case of *Doing (academic) Projects*, as what chuncks of work to do, and how long it takes is not so known on beforehand.

Therefore, use a a *rolling forecast* also here. So, the short term is planned rather precisely, the middle term rather global, and for the longer term (whole project) only the relevant milestones are drawn up.

Furthermore, updating the planning regularly (for each PIPPF meeting, ideally every month), gives the planning enough forecast, without the need of unnecessary detailing out future work that simply cannot yet be detailed out. Such an update rhythm is inline with the PIPPF meetings, obviously (and deliberately).

This planning work is:

- Come up with a list of tasks to be done. This is a kind of WBS, Work Breakdown Structure of the project phase (cf. Systems Engineering, (Faulconbridge and Ryan, 2020)).
- Write each task as an action sentence. Also write the expected result of the task, to have a goal to work towards.
- Estimate durations of each task. Use a day granulariy.
- Only detail out (time duration, exact topic) tasks due in the upcoming Month. Use coarse estimates for further-away tasks. Preciseness comes later for these tasks.
- Put the tasks in order taking care of dependencies between them (a task needs the results of another task, or is dependent on materials / results from outside).
- Put tasks in a list or diagram (Gantt chart) for an overview.
- Assign a priority to each task. Use this for checking / updating the planning to keep your project on track. See Section 3.8.
- Update this planning every PIPPF period, ideally a month (forward the rolling forecast). You can use a *Risk Analysis* (Section 3.8) to determine the validity of the tasks, including their contribution to the goals of the project.

Tips for Fine-Grained planning

- Skill sheet *Good Time Management* (Tulder, 2018, Sheet B10, Sec. 2), presents some tips on identifying chunks of work, especially, easy plannable size of chunks (called modules).
- Skill sheet *Study Planning: Week* (Tulder, 2018, Sheet B11), presents tips on how to divide a week in plannable chunks of work, update this level of detail every 2-3 days, and plan some slack time.
- Show in the Gantt chart / list of tasks also how far each task has progressed, to indicate the progress of the work. Showing the *status line*, marking the current day, supports determining whether the project is on track assuming the Gantt chart represents the actual situation.
- Some background and critial analysis on using Gantt charts in modern project management is in Geraldi and Lechter, 2012.
- Our favourite Gantt chart tool is GanttProject[2], or Gitlab's issues, issue boards and roadmap facilities[3]. The latter, originated from software engineering, has quite some facilities for planning / tracking (team) work. However, a spreadsheet can do the essence of the job, especially when using a Gantt chart template, of which several exist[4].
- More specifically for the Production Phase, simply a list of tasks with durations, deadlines, priorities, etc in a table gives often an overview in an effective way. Such a table is often called a *Plan of Attack*.

[2] https://ganttproject.biz, single use is free, cloud / shared use has a really fair usage-based pricing.
[3] You need to connect to a Gitlab server, for instance https://gitlab.utwente.nl
[4] for instance Excel template TM16400962.

[rro] Example Gantt chart in Appendix, see sl 38 SuperviseStudents

3.8 Keep on Track

Do this *Keep on Track* activity in case an upcoming deadline / milestone might get compromised (might get delayed) or some tasks appear to be really problematic (especially timewise but also contentwise).

The importance of each task is needed, and that is expressed by its priority. Then, a *Risk Analysis* can be performed to reshuffle and / or update the tasks to get the planning adhere to the project bounds, that is get finished in time, and obtain a useful set of results. It case keeping the project planning within time bounds (ready on time) is not possible, a proposal for taking more time (dealying the end time) must be developed and discussed during the PIPPF meeting (Section 2.4).

3.8.1 Prioritise tasks using MoSCoW

MoSCoW is a task / requirements prioritisation technique used in management and agile development approaches like DSDM or Scrum. Prioritising tasks is useful when time is limited (time boxed), so focussing on the most important tasks, fullfilling most important requirments is an obvious thing to do. See for instance Wikipedia[5] for further explanation.

For *Doing Projects*, prioritising of tasks usen MoSCoW helps tuning of the planning and gives focus to the work that must be done. It also helps in preventing doing excess work.

All tasks must get one of the four priority levels of MoSCoW:

Must Task is *mandatory* to do. It is critical to the project. Missing a *must* task is a failure to the project.

Should Task is *highly desirable* to do. It is important to the project, however, failing this task is not a show stopper.

Could Task is an *interesting wish*. It is nice to have. It may improve quality, or other properties: it is not really necessary. If time permits, just do it.

Will not (or *won't*) Task is *not for now*, maybe later. It is least critical, and it might be even not feasible to get it done in the project. This way, all know that this task will not be done.

Note that at regular intervals (PIPPF meetings) priorities can be reconsidered. Especially, when from new insight it appears that a task /requirement ranked as *must* appears to be too complex, too time consuming to realise, or even not feasibile to get realised within the project.

Tips for MoSCoW Prioritisation

For tasks not easy to select the right priority (or all tasks?) use the following questions:

- Does the task contribute to the goal, subgoal of the project?
  Is it essential to reach the goal? Is this specific task needed to reach the goal (often there are several ways to reach a goal).
- Is the task easy to do / part to make, technically?
  Is it straightforward work, so low risk? Is it about new things to explore / do, so a higher risk? Relate this to the knowledge, skills, and experience of those who have to do this task.
- Is the task ready in time, that is, be sure on planning?
  Often about parts to be ordered, where lead time might be unsure.

3.8.2 Risk Analysis of near-future / current tasks

Risk Analysis is to reconsider tasks, priorities, and planning. Doing this once per PIPPF gives a right balance between the work itself and overseeing the whole project. For this, investigate

[5] https://en.wikipedia.org/wiki/MoSCoW_method

whether tasks might take more time than originally planned, provided that the content and quality levels must stay as originally planned.

The essence of Risk Analysis is:

- Check for each task whether it is still in the right MoSCoW priority level.
  Obviously, when the project goals have been tuned, priorities need to be checked.
- Shortly before an important deadline (PP, D, GL, etc milestones), priorities might shift, as focus on a good result for that deadline is really imporant.

Tips for Risk Analysis

These tips are comparable to those of MoSCoW prioritisation presented above. However, here relation to the project goal and consequences for being ready in time are more prominent.

- Does the task contribute to the result at the upcoming milestone?
- Does omitting the task negatively affect the result at the upcoming milestone?
  Simply skipping a task, or doing it later saves time for the current period...
- Are alternatives for the specific task / part possible?
  Or alternative (uh.. more efficient) way of doing this task? Can it be done in less time (less detailed, less precise?), without compromising the result?
- Can a different order of tasks be feasible, and thus saving time?
  For instance, when delivering part takes longer than expected.

More tips and some tools are in Bonnema, Veenvliet and Broenink (2016), Section 4.12, Risk Management amd Section 4.8, System Budgets.

3.9 Report Writing

[rro] overview, and refer to extensive story -> Appendix?

- mention RRO package and Latex template
- on different report structures: research vs design

3.10 Supervision / Coaching

[rro] slide 20 of SuperviseStudentsatEE18

[rro] refer to SDaE en vT

A Change Log

- **Version 2024.1, June 2024**
  Updates:
  - Timeline diagram (Ch 1) updated
  - Repair and Resit policy -> procedure, to be consistent with EER-2024
  - PIP and PIPPF text updated, extended (Ch2, CH3)
  - Planning (Ch 3) added
  - Keep on Track (CH 3) added
  - Quite some typos etc repaired
- **Version 2023.2, 16 January 2024**
  Updates:
  - Chapter 2, workflow, text completed, and exisiting text updated
  - Chapter 3, Section on PIP, PIPPF meetings added
- **Version 2023.1, 21 July 2023**
  Initial version, consisting of:
  - Chapter 1, Introduction
  - Chapter 2, workflow, partly text, partly RRO only
  - Chapter 3, Techniques, only RRO

B Check Lists

[rro] intro

B.1 Check List for Students

[rro]

B.2 Check List for Supervisors

[rro]

Bibliography

Bonnema, G. M., K. T. Veenvliet and J. F. Broenink (2016). *Systems Design and Engineering: Facilitating Multidisciplinary Development Projects*. London: CRC Press. ISBN: 978-1-4987-5126-1. URL: http://eprints.eemcs.utwente.nl/26609/.

Faulconbridge, R. Ian and Michael J. Ryan (2020). *Applied Systems Engineering*. Canberra, Australia: Argos Press. Chap. xii, 336 pages : illustrations ; 25 cm. ISBN: 978-1-921138-13-3 1-921138-13-0.

Geraldi, Joana and Thomas Lechter (Jan. 2012). 'Gantt Charts Revisited'. In: *International Journal of Managing Projects in Business* 5.4. Ed. by Jonas Söderland and Joana Geraldi, pp. 578–594. ISSN: 1753-8378. DOI: 10.1108/17538371211268889. URL: https://doi.org/10.1108/17538371211268889 (visited on 04/01/2024).

Tulder, Rob van (2018). *Skill Sheets: An Integrated Approach to Research, Study and Management*. Third. Amsterdam: Pearson. ISBN: 978-90-430-3350-3.