SEMESTER & BACHELOR PROJECTS

VIA ENGINEERING GUIDELINES

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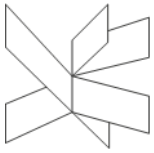
Content



1 Introduction

Project work plays a central role in all engineering fields at VIA. The students must carry out semester projects as well as a final bachelor project. If one includes the one-semester internship (which is closely related to project work), about 48 % of all the ECTS points in a degree at VIA Engineering are project related.

1.1 The system of project guidelines

This document belongs to a set of documents (see Figure 1) which describe how semester projects and bachelor projects are to be carried out in VIA Engineering. This "Semester & Bachelor Projects - VIA Engineering Guidelines" may be considered the master document and are analogous to the trunk of a Christmas tree. The document provides an overview and describes the intentions of the VIA project method.

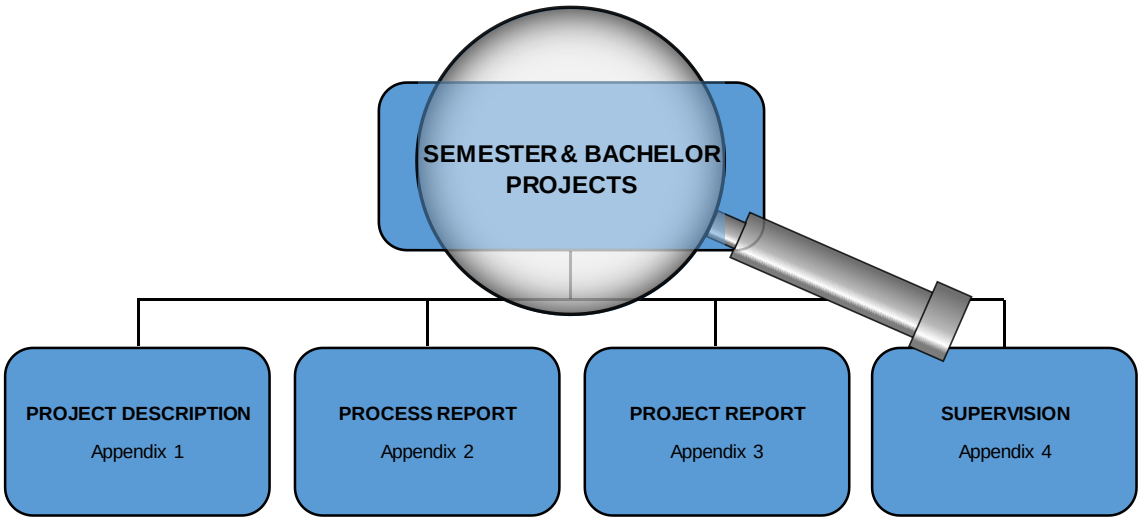
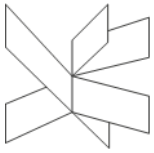


Figure 1. Structure of VIA Engineering Guidelines for semester and bachelor projects.

Details regarding requirements and recommendations for specific parts of project work (such as writing a project report) are given in Appendices and are analogous to the branches on a Christmas tree. The number of Appendices is not static, but may increase as more guidelines are produced. This set of documents is common to all VIA Engineering departments. In the analogy, VIA Engineering has one common Christmas tree.



In addition to the trunk and branches, however, there are unique requirements and recommendations for each engineering discipline. These are analogous to the decorations on a Christmas tree. All VIA Engineering project work is based on the same tree, but the decorations are unique. For example, Mechanical Engineering may require a product specification to be included in the Project Report while Global Business Engineering may require preparation of a business case.

These guidelines with appendices are introduced to the students in the common first semester course “Study Skills for Engineering Students (SSE)”. In addition, the guidelines are used continually during the subsequent semester projects and the bachelor project.

1.2 Purpose of project guidelines

These guidelines describe the framework for project work across all VIA Engineering departments by giving common, general guidelines for how projects are to be carried out. The primary target group for the guidelines is VIA Engineering students and their supervisors, thereby providing a common reference for all involved parties.

The main purposes of these guidelines are:

1. To promote high quality learning experiences for the student that are relevant for the workplace through focussing on central aspects of project work.
2. To harmonize the approach to projects, to increase transparency, to pave the way for the formation of interdisciplinary project groups, and to promote mutual inspiration between supervisors across the VIA Engineering departments.

These guidelines are broad in order to accommodate the diversity of topics and process methods that are utilized in the different VIA Engineering departments. The guidelines attempt to provide inspiration and understanding by striking a balance between being too restrictive (resulting in inhibiting creative expression of the student and supervisor alike) and being too loose (resulting in academic rhetoric that provides no helpful structure at all).

1.3 Project phases

In practice, the course of a project can be divided into four phases: 1) Project Initiation, 2) Project Definition, 3) Project Execution and 4) Project Evaluation. Each phase can be subdivided into activities that often must be carried out in a specific order. During the course of the project, the student must have approval of the supervisor at certain crossroads to continue work. Figure 2 shows a flow diagram of the phases of a VIA Engineering project, including the necessary approvals. Further details about these phases and the activities they contain are given in Chapter 2 to Chapter 5.

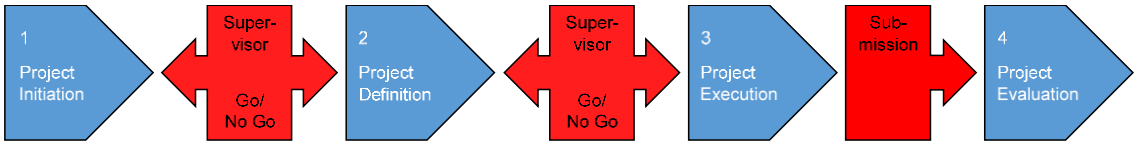


Figure 2 Flow diagram of the phases and approvals of a VIA Engineering project.

1.4 Important characteristics of VIA Engineering projects

This section identifies and describes some important characteristics of VIA Engineering projects that are common to all the Engineering disciplines at VIA.

1.4.1 The dual purpose of VIA Engineering projects

VIA Engineering emphasizes a dual purpose of project work, see Figure 3. Here, the two purposes are labelled “the product” and “the process” and may be considered distinct from one another (Dahl, et al., 2012). In VIA Engineering, a balance between these purposes is intended, indicating that the product and the process have equal importance.

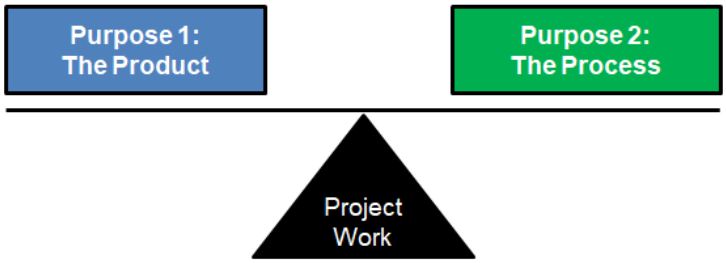


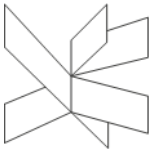
Figure 3 The two purposes of projects in VIA Engineering have equal importance.

The product: One purpose of project work at VIA Engineering is to bring about some sort of "product". This product may take on many forms, such as a tangible device, a piece of software, a method, a strategy, or an optimization. To make a product, the student must become proficient at carrying out technical, engineering work. The knowledge, skills and competences that are relevant in this work depend highly on the engineering discipline being pursued. Details related to the technical side of the product are documented in the so-called "Project Report" (see Appendix 3).

The process: This second purpose of project work at VIA Engineering is to ensure that the student becomes proficient at work processes in a group setting. This is a competence which is highly valued in the work place. In general, the desired process competencies are common for all fields of engineering. Subjects include problem analysis, time planning, group dynamics, communication between supervisor and student and many more. Different tools to support the process may be used depending on the field in question. This second purpose is documented in the so-called "Process Report" (see Appendix 2).

1.4.2 Student-centered learning

Student-centered learning is a method of learning that shifts focus from the teacher to the student (Weimer, 2002). It encourages active learning by placing the responsibility for selecting what to learn and how to learn in the student's own hands. This develops independent problem solving, an important skill in the workplace. Student-centered learning is largely based on the constructivism learning theory (Cooper, 1993). This theory states that students construct their own understanding through a process of



discovery in which they reflect on personal experiences and relate new knowledge with what they already know.

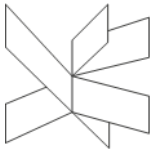
In general, projects are well-suited to student-centered learning because the majority of the work is actively carried out by the student rather than being served in the form of lectures by a teacher and being received passively by the student. VIA Engineering utilizes student-centered learning for all of its student projects. This is especially apparent in projects in which the student chooses the topic (see section 2.2) and composes the problem statement (see section 3.3). VIA Engineering departments may, however, utilize a progression approach, such that greater structure is provided by the supervisor in the early semesters while greater responsibility is placed on the students in the later semesters.

Student-centered learning also means that the supervisor has the role of a facilitator/mentor, who monitors the project and suggests tools and challenges rather than the role of a traditional teacher, who provides solutions (see chapter 0). Detailed information about the supervisor's role in VIA Engineering projects is found in Appendix 4.

1.4.3 Problem-oriented projects

Problem-oriented projects are projects in which the direction of the project work is guided by the unfolding demands of the problem rather than by a pre-determined curriculum prepared by the supervisor. Problem-oriented projects are carried out in small groups of students who make inquiries into real-world problems (Pecore, 2015). The purpose of problem-oriented projects is to achieve learning not only about the technical subject, but also about the process of solving challenges. Both of these skills are important for the workplace.

VIA Engineering endeavours to provide problem-oriented project learning experiences for the students. The issue that needs addressing is raised by the students in a problem statement. The students also plan how to approach the solution. In effect, this means that the students are responsible for developing their own curriculum.



Challenges with problem-oriented projects include that the teacher must relinquish control, that the solution to the problem is not known ahead of time and that problem-oriented projects run the risk of failing. To meet these challenges, some projects may be partially curriculum-based, meaning that certain standard elements are required to be included. The amount ratio between activities stemming from the real-world problem and those stemming from a pre-determined curriculum may increase from semester to semester in an intentional progression.

1.4.4 CDIO awareness

VIA Engineering is presently implementing the CDIO initiative, a model for engineering education that is now in use in over 100 universities throughout the world. The initiative arose at Massachusetts Institute of Technology (MIT) in the 1990's. This institution felt there was poor agreement between what the students learned during the education, and what the employers expected from graduates in the work place. CDIO stands for Conceive, Design, Implement and Operate. The vision is to give the students an education that focusses on basic engineering while learning in a CDIO context.

CDIO is not simply a principle, but comprises a detailed curriculum of engineering subjects and 12 standards on everything from active learning to enhancement of faculty teaching competence. By following the curriculum and standards, the culture of an educational institution can be reformed. To become accredited, the institution must carry out a self-evaluation and demonstrate an acceptable attainment of the 12 standards. Therefore, CDIO can be seen as a quality assurance system (www.CDIO.org).

CDIO is connected to project work at VIA Engineering. At the basic level, project work must be aware of which of the subjects Conceive, Design, Implement and Operate are included in the specific project. In addition, it is endeavoured to touch on all four subjects at some point during the student's education.

2 Project Initiation

A project is initiated by forming a group and by selecting a topic. The order of group formation and topic selection may vary: A group may be formed and then the topic decided upon or vice-versa. Or, the two may take place more or less simultaneously.

Once the group is formed and the topic selected, the group must prepare a statement to this effect (see the Group Formation and Topic Selection Template) and it must be turned in to the supervisor for approval. The supervisor must decide if the group and the topic are acceptable for continued work or whether modifications are in order (see Figure 2).

Below, group formation and topic selection are described in more detail.

2.1 Group formation

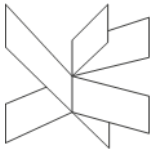
Group collaboration is a valuable competence for any person. It is an advantage to consciously train this competence rather than just trying to adsorb it though practice. The engineering student needs to become proficient in group collaboration for a number of reasons including:

- Group collaboration is an important element at most work places.
- Authentic work place problems today are often too complex to be solved alone.
- The social life of a student requires these competencies.

Obviously, a prerequisite for group collaboration is the formation of a group. This formation, however, is an activity that can be problematic. There is a risk that this process will be unpleasant or that some students will feel excluded. Therefore, the group formation process should be carefully prepared and carefully executed.

A number of guiding principles may be articulated by the project supervisor before the group formation activity begins. These may include:

- The students have a collective responsibility for ensuring that each student ends up being satisfied with his/her group placement.



- No student may be excluded from a group and group formation is not finalized until all students are placed.
- If the group formation activity becomes deadlocked, it is the supervisor's responsibility to step in.
- As a final resort, groups may be disbanded and reorganized during a trial period ending on week 8 of the semester.

On the practical side, there are different methods available for group formation. The supervisor may solicit input from the students but ultimately has the authority and responsibility to determine which method will be used.

1. **Student controlled:** Group formation may be left up to the students themselves to figure out. This is often based on the students' desire to be with certain friends or to work on a specific topic.
2. **Supervisor controlled:** The supervisor may autonomously form the groups. Criteria for forming the group may include: 1) random assignment, 2) assignment that ensures a mix of strengths and weaknesses, 3) assignment to ensure that students work with classmates that did not work together in previous semesters, and 4) assignment that ensures diversity in personality types based on a personality test.
3. **Combined:** A combination of group formation methods may be used in which students form the groups themselves while adhering to a quota system. Quotas may be set up to ensure diversity in the students' mother tongue, similarity in grade ambition, similarity in topic interests, etc.

Progression from semester to semester may be practiced in group formation, such that supervisor controlled formation is used the first semester and student controlled or combined formation is used in later semesters.

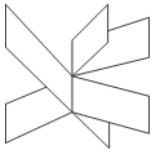
The required size of project groups in VIA Engineering is 3-8. Individual Engineering departments may declare more restrictive limits (such as 3-6) and dispensation from the general rule may be granted by the supervisor in exceptional cases. If it makes sense for the project and the supervisor is in agreement, it is possible to compose a group with members from different VIA Engineering departments.

2.2 Topic selection

As with the group formation activity described above, the topic selection activity can exhibit a progression from semester to semester, starting with supervisor controlled (to ensure that important subjects are covered during the engineering degree programme or that the supervisor is competent in the topic) and ending with completely free student controlled selection for the bachelor project.

Not all topics are suited for project work. Criteria for good topics for a VIA Engineering project include the following:

- **Student interest:** Since interest is a powerful motivator, it is important that the student is interested in the topic.
- **Relevant for the semester:** Topics which are closely related to other semester courses are to be preferred.
- **Engineering depth:** The topic should be sufficiently complex and interdisciplinary as well as being accessible to investigation.
- **Authentic:** The topic should be relevant for society outside of the engineering school and therefore be a real-world topic.
- **Exemplary:** Project work should be transferable to other areas.
- **Realistic:** Considering time and financial constraints, the topic must be realistic.



3 Project Definition

After the project is initiated through the formation of a group and selection of topic, the newly-formed project group must define the project. This phase of the work includes the following steps:

1. Group Contract
2. Problem Analysis
3. Project Description

These steps are essential for the subsequent execution of the project and are described in the following sections. In addition, the guidelines for preparing the Project Description (see Appendix 1) must be followed.

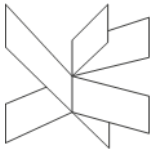
3.1 Group Contract

The Group Contract is the second document to be prepared by the newly-formed group. Preparation of a Group Contract provides an opportunity to discuss the ground rules of the coming collaboration. The purpose of the Group Contract is to accelerate and improve the group's development and function (Kaae, 2015).

Each project group must prepare and sign a Group Contract. A Group Contract Template is available for use, if desired. The Group Contract is to be included as an appendix in the Project Description, see below.

3.2 Problem Analysis

At this stage, a preliminary analysis of the problem is carried out. This analysis will vary depending on the problem. The Problem Analysis often includes a literature survey. In addition, the Problem Analysis may include an analysis of needs, stakeholders, surroundings, resources, etc. More information is found in Appendix 1.



3.3 Project Description

The Problem Description is a document which describes what is to be achieved and how it is to be achieved. The project group must turn in a draft of the Project Description to the supervisor for the purpose of receiving official written feedback. A Project Description Template is available for use, if desired. On the basis of the feedback, the draft is then revised. A minimum of one revision is required. A number of revisions may be necessary. The Project Description document must be approved by the supervisor before the project group moves on to Project Execution, see Figure 2.

The Project Description is composed of the following items:

- Background description
- Definition of purpose
- Problem Statement
- Delimitation
- Choice of models and methods
- Time schedule
- Risk assessment
- Sources of information

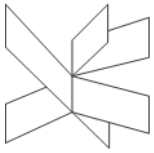
In addition, the Project Description must include the Group Contract as an appendix and may include additional appendices. Detailed requirements for the Project Description are in Appendix 1.

One of the most important parts of the Problem Description is the Problem Statement. A problem statement is a concise portion of prose that raises the issue that the project will address. A good problem statement sets the stage for and guides the subsequent investigation. It should be brief, focused, solvable within the time frame allotted and relevant for the semester topics. It is often crafted as a one main question with several supporting questions. The Problem Statement should have sufficient engineering depth and have a taxonomy suitable for the students' level of progression. The Problem Statement is NOT a topic, a solution, or a goal. A main problem statement question often has two clauses and a relation, e.g. "How does the quality of food service at

Campus Horsens (clause 1) affect (relation) the well-being of engineering students (clause 2)?" The Problem Statement may be considered the question which is answered in conclusion section of the Project Report.

The Problem Statement is the focal point for the execution of the project and therefore a very important element of project work. Einstein once wrote "The formulation of a problem is often more essential that its solution".

The supervisor must either approve the Project Description/Group Contract or request modifications for the group to continue to the next phase of the project work (Figure 2).



4 Project Execution

This phase represents the bulk of the project work. Here, data is collected, investigations are made, tangible and intangible products are developed, and documentation is carried out.

Group discussions are carried out and revisions of the Group Contract or Problem Statement are made, if necessary (all significant revisions must be cleared with the supervisor).

Project group meetings and group/supervisor meetings are held during the Project Execution phase. It is recommended that meeting roles are divided up between the group members prior to each meeting (Kaae, 2015). In this way, each group member gets to play the role of chairperson, minute taker and evaluation leader.

The project group must work together in a way so that true collaboration is used rather than individual work in separate silos. Any conflicts that arise in the project group must receive attention and be addressed.

The Project Execution phase is complete when the Project Report and the Process Report are complete. If desired, drafts of these reports may be discussed at meetings with the supervisor prior to the deadline. However, the supervisor is not responsible for reading and commenting full drafts and the responsibility for these reports rests solely on the project group.

5 Project Evaluation

Following Project Execution, the project enters the Project Evaluation phase (Figure 2) in which oral presentation, written reports and the question and answer session of the examination are evaluated.

5.1 Dual purpose of examinations

In VIA Engineering, project examinations have two purposes: evaluation and learning (Skov, 2013).

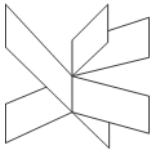
The first purpose is described in the examination regulations (Uddannelses og Forskningsministeriet, 2016). It is stated here that the purpose of an examination at universities is generally to evaluate to which degree the student fulfils the professional goals determined for the subjects in the curriculum. This traditional definition focusses on ensuring a valid evaluation that maintains the student's legal certainty. This purpose is made more difficult since learning objectives are often very complex. Learning objectives for projects often contain skills and competence goals that are more difficult to evaluate than knowledge goals. To be fair, the form of the examination should be suitable for the subjects that are taught. Multiple choice, for example, is seldom the best choice to evaluate a competence goal related to group cooperation.

A project examination includes possibilities for the second purpose that reach beyond the evaluation purpose. The examination situation can also actively support the student´s learning. In practice, this double purpose can unfold especially during the questioning period of a group examination as well as feedback and reflection in connection with the giving of grades.

In this way, students become equipped to be able to self-evaluate after the engineering school and teachers are no longer part of the graduates' lives.

5.2 Project examination procedure

Project examinations are carried out as oral examinations. In principle, they are open to the public (Uddannelses og Forskningsministeriet, 2016), making it possible for peers



to attend. One or more internal examiners from VIA will always be present. Typically, this is the project supervisor and possibly a teacher from one of the semester courses. In addition, an external examiner (may or may not be an external supervisor) may be present.

The normal procedure for a VIA project examinations is as follows:

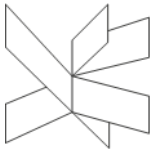
1. Group oral presentation (approximately 5 minutes times the number of students)
2. Clarifying questions from the supervisor or external examiner to the whole group
3. An optional break in which the students leave the room (about 5 min) to relax while the supervisor and external examiner discuss the oral presentation.
4. An extended “Question and answer session” in which the students are present as a group (about 20 minutes times the number of students). Questions may be directed to the entire group (hands must be raised before answering) or to a specific group member to ensure that all group members can be evaluated.
5. The students leave the room while the supervisor and external examiner decide on the individual grades for each student.
6. The students are given their grades. This is normally done with all students present, but can be individually if one or more students is uncomfortable with this method.
7. Feedback/feedforward on the project in plenum.

5.3 Grading

Individual grades are given even when group examinations are used. Grading a project is a complex activity which includes the following aspects:

- Written reports and/or other products
- Oral presentation
- Question and answer session during examination.

It should be noted that the grade depends on process aspects as well as product aspects of the project.



6 Supervision

Supervision is carried out by a supervisor with the purpose to support the group, but not to take over responsibility for the project. Supervision includes both product supervision and process supervision. Various supervision methods may be used, depending on the situation (Kolmos, 2007). More information about supervision is given in Appendix 4.

Supervision is carried out at various phases of the project work:

Project Initiation: The project supervisor is responsible for determining the rules for group formation and topic selection. Typically, the supervisor is present during the group formation process. Finally, the supervisor must approve the Group Formation and Topic Selection document or request changes.

Project Description: The supervisor must give feedback to the project group regarding the draft Project Description document (which include the Group Contract as an Appendix), with special focus on the Problem Description. The supervisor must also approve the final Project Description or give an explanation for why approval was not possible.

Project Execution: Supervision meetings are typically held once per week. This frequency may increase during critical periods of the project and decrease when needs are less pronounced. The project group is responsible for inviting the supervisor to the meetings, providing a written agenda with the invitation, and preparing written minutes after each meeting. The project group may include this information in the Process Report.

Project Evaluation: When the Process Report and the Project Report are submitted, the supervisor is responsible to read these reports in preparation for the examination. The supervisor must also prepare for the Question and Answer period for the examination. Finally, the supervisor in collaboration with the external examiner is

responsible for carrying out the examination and giving the students individual grades for the project work.

7 Deliverables, report length, deadlines and submission

This chapter defines the project's deliverables, deadlines and methods of submission. Table 1 provides an overview:

Deliverable	Deadline	Method of submission
Group Formation and Topic Selection	Semester week 3	determined by the supervisor
Project Description & Group Contract	Semester week 8	determined by the supervisor
Project Report & Process Report	Last day of the project period	WISEflow

Table 1. Overview of VIA Engineering project deliverables, deadlines and method of submission.

7.1 Deliverables

In connection with a VIA Engineering project, a deliverable is a document or other product that is to be turned in. There are four deliverables in a VIA Engineering project; the Group Formation and Topic Selection, the Project Description including the Group Contract, the Process Report and the Project Report.

7.1.1 Group Formation and Topic Selection

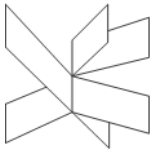
This document includes information on the group members and the selected topic. A template in Microsoft Word is available for use, if desired.

7.1.2 Project Description

The Problem Description is a document which describes what is to be achieved and how it is to be achieved. It must include the Group Contract with the ground rules of the coming collaboration as an appendix. Detailed requirements for the Project Description are found in Appendix 1. A template in Microsoft Word is available for use, if desired.

7.1.3 Process Report

At the end of the project, the project group must turn in a Process Report.



Detailed requirements for the Process Report are found in Appendix 2. A template in Microsoft Word is available for use, if desired.

7.1.4 Project Report

At the end of the project, the project group must turn in a Project Report. Before turning in, this report will have undergone many revisions. Detailed requirements for the Project Report are found in Appendix 3. A template in Microsoft Word is available for use, if desired.

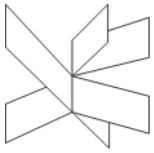
7.2 Report lengths

The length of a report is generally poorly related to the grade, since unnecessary wordiness and the absence of important information are equally undesirable. There are a number of factors, however, that can affect the length of a report, including:

- Number of group members
- Which semester the report is made
- Number of courses that the report covers
- Which engineering department the group belongs to
- Number of figures in the report.

The required length of the deliverables assuming a group of approximately four students is as follows. These lengths exclude front matter and appendices but include figures and the reference list.

Deliverable	**Pages**
Group Formation and Topic Selection	2-4
Project Description	8-12
Process Report	10-15
Project Report	20-60



Failure to comply to these limits may ultimately result in a failing grade. At the discretion of the supervisor, dispensation for these page limits may be given, providing the project group alerts the supervisor prior to the deadline.

7.3 Deadlines

In the interests of harmonizing the various fields of engineering, three project deadlines are common to all of VIA Engineering. There is an exception to these deadlines for bachelor projects in some VIA Engineering departments (here, the project description must be turned in prior to the final semester).

First deadline: The Group Formation and Topic Selection document must be turned in by the end of semester week 3.

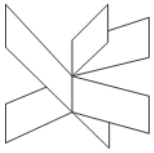
Second deadline: The final draft of the Project Description (including the Group Contract as an appendix) must be turned in by the end of week 8 of the semester. In order to allow for at least one revision of the Project Description, a draft must therefore be turned in and commented by the supervisor prior to these dates.

Third deadline: The final Process Report and final Project Report must be turned in by the end of the project period but before the beginning of the study period.

7.4 Submission of deliverables

The method for submitting the Group Formation and Topic Selection document as well as the Project Description document is determined by the supervisor. Typically, this is on StudyNet, although other methods may be used.

The Process Report and Project Reports must be uploaded on WISEflow. The Process Report is comprised of a single pdf file. The Project Report is comprised of two separate files. The first file consists of everything except the appendices and is uploaded in pdf format. The second file consists of an assembly of the appendices. In many cases, this file may be a single pdf file. In some cases, the appendices include



files in specific software. These may be assembled in zip-format. If there are questions about submission format, the project group should check with the project supervisor.

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APPENDICES

Appendix 1. VIA Engineering Guidelines - Project Description

Appendix 2. VIA Engineering Guidelines - Process Report

Appendix 3. VIA Engineering Guidelines - Project Report

Appendix 4. VIA Engineering Guidelines - Supervision

AVAILABLE TEMPLATES

Group Formation & Topic Selection Template

Group Contract Template

Project Description Template

Process Report Template

Project Report Template