



# Semester Task

## Systematic Product Development

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April 26, 2021

# **Contents**

<b>1 About this document</b>	<b>3</b>
<b>2 Grading</b>	<b>3</b>
2.1 Exam Components . . . . .	3
2.1.1 Project Report . . . . .	3
2.1.2 Presentation of Project Results . . . . .	3
2.1.3 Digital examination . . . . .	4
2.2 Grading Scale . . . . .	4
<b>3 The Truly Cordless Drill</b>	<b>5</b>
3.1 Tasks for the Project Report . . . . .	7
3.1.1 1 <sup>st</sup> submission . . . . .	7
3.1.2 2 <sup>nd</sup> submission . . . . .	8
3.2 Evaluation Criteria . . . . .	8

# 1 About this document

This document serves as a consolidated description of the things in the course “Systematic Product Development” (SPD) that are relevant to grading. It contains information on how grades are calculated as well as the official documentation of the group task. While we aim to keep the definition of the task consistent throughout the semester, this is a “living document” into which the clarifications made in response to your questions will be incorporated. Its version history is maintained on GitHub<sup>1</sup>.

## 2 Grading

### 2.1 Exam Components

The exam is composed of four different components. Three of these (presentation, 1<sup>st</sup> and 2<sup>nd</sup> project report) are conducted in groups, the final exam is conducted individually. The weighing of these components is shown in table 1.

#### 2.1.1 Project Report

The task for the project report is explained in detail in section 3.

#### 2.1.2 Presentation of Project Results

While the project reports are aimed at the description of the applied methods, the presentation is focused mainly on the developed product. What does that mean?

You will have 10 minutes to present your product idea with all relevant information to the customer. We, the instructors of the course, represent the customer who has to be convinced to either buy the product itself or buy the product idea to produce and sell it. This means that for this presentation you have the choice of using different presentation

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<sup>1</sup><https://github.com/mpm-tu-berlin/lehre-spd>

Table 1: Point Distribution

Component	Points
1 <sup>st</sup> submission of project report	10
2 <sup>nd</sup> submission of project report	25
Presentation of project results	15
Digital examination	50
<b>Sum</b>	<b>100</b>

techniques and tools such as the product pitch or the promotional video. You can also present a mock panel discussion with yourself as the expert. But we are also open to any other creative presentation formats you can think of, as long as the time limit is not exceeded. Of course you are allowed to choose both recorded videos and live formats in zoom. To be brief, here are the main constraints for the presentation:

- Presentation theme: product idea/prototype presentation to possible customers
- 10 minutes per group, up to 15 minutes discussion afterwards
- min. 80% presentation of your product and its features
- max. 20% description of your development/ decision making process
- All formats allowed (video, ppt, live role play) as long as they serve the purpose of “selling” your product idea

### **2.1.3 Digital examination**

The final exam will be conducted online on ISIS as an individual task. It will consist both of multiple choice questions and free form questions testing both straight-up reproduction of the course knowledge (for example “fill in the blanks”) as well as application (for example “identify problems and recommend solutions for a given analysis”). It will be designed as an open-book exam, with any supporting documents allowed, as long as you conduct the exam on your own!

## **2.2 Grading Scale**

The final grade is calculated as follows:

1. The component percentages are rounded to full points. Example: Getting 84% in a 10-point component leads to 8 points for this component.
2. The points for each component are summed up.
3. The final grade is calculated according to table 2

Please note that if any part of the exam is failed due to scientific fraud (e.g. plagiarism), the whole module will be graded as “failed” and will need to be repeated.

Table 2: Grading Scale

Points	Grade
$\geq 95$	1,0
$\geq 90$	1,3
$\geq 85$	1,7
$\geq 80$	2,0
$\geq 75$	2,3
$\geq 70$	2,7
$\geq 65$	3,0
$\geq 60$	3,3
$\geq 55$	3,7
$\geq 50$	4,0
$< 50$	5,0

### 3 The Truly Cordless Drill



Figure 1: Not an acceptable solution: Manual operation without energy storage. Image: “Saint Joseph charpentier” by Georges de La Tour (1593–1652).

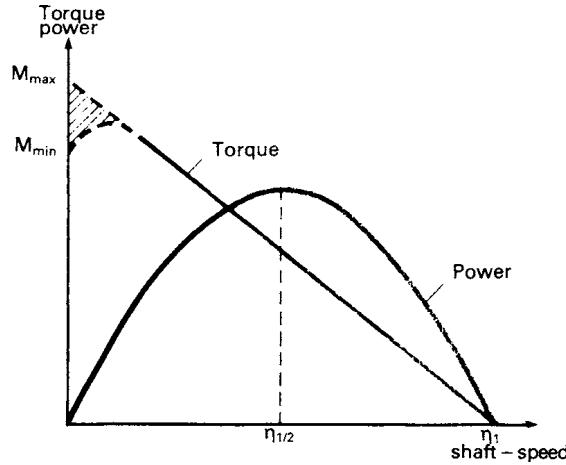


Figure 2: Exemplary speed-torque curve. Yours may differ! Source: [1]

Your task for this semester will be to design a cordless drill. There is a twist though: It should work without utilizing any electricity. By this we mean that it should still work if all physical laws governing the flow of electricity in (semi)conductors were not to exist. Electrical motors, batteries and capacitors are out, as are electric switches and silicon-based control systems.

Specifically, what we are asking you to design is a

- Hand-holdable
- Rechargeable

device to produce

- A peak torque  $M_{max}$  of 50 Nm
- A no-load rotational speed  $\eta_1$  of 1500  $\frac{1}{min}$
- With the ability to do useful work at intermediate speeds and torques
- As selected by the user's graduated power demand
- For 1 minutes of continuous operation at the maximum power point without recharging
- applied to an industry-standard  $\frac{1}{4}$ -inch hexagonal socket according to DIN ISO 1173 form D. [3].

You are allowed to use a two-speed geared design. This device must operate and recharge without using any electricity, but it could be manufactured by processes that require electricity (so you don't need to design a mechanical lathe as well).

### **3.1 Tasks for the Project Report**

The project report shall be a report on the development of your solution to the semester task. It should be a well-written technical/scientific report that contains the sub tasks shown below. We expect these sub tasks to be linked together in a reasonable structure, as well as an introduction describing the problem and a conclusion. It should observe the rules of good scientific and engineering practice as well as the stylistic “rules” of good typography. It should not exceed 20 content pages<sup>2</sup> for the 1<sup>st</sup> submission and 25 additional content pages for the 2<sup>nd</sup> submission. That means that if your first submission was 10 pages long and we did not note any missing parts in our corrections, your second submission must be below 35 pages.

The 1<sup>st</sup> submission should be submitted as a PDF file, the 2<sup>nd</sup> submission should be submitted as a .zip archive containing the PDF report and the additional files.

#### **3.1.1 1<sup>st</sup> submission**

The 1<sup>st</sup> submission consists of the following sub tasks:

- One SWOT analysis for the team skills and one for the product idea developed in the first workshop.
- Project management - responsibility matrix and timetable are mandatory, everything else is voluntary
- A list of requirements according to Pahl/Beitz [2], using the template given on ISIS.
- A functional structure with sub-functions and the derivation of working principles for these sub functions.
- A morphological box showing all possible sub-solutions.
- The systematic derivation of at least three possible solution variants using a reduced morphological box.<sup>3</sup>
- Coherent explanation and sketches of these three solutions.
- Applying a weighing and value scales to the evaluation criteria shown in section 3.2.

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<sup>2</sup>“Content pages” refers to the page count excluding front and back matter, such as table of contents, bibliography etc.

<sup>3</sup>Completing this task requires the application of selection and evaluation methods. This has been missed by some groups in the past.

### **3.1.2 2<sup>nd</sup> submission**

The 2<sup>nd</sup> submission consists of the following sub tasks:

- All content of the first submission, with revisions as per our corrections.
- A selection of a final concept using performance calculations and coherent assumptions.
- A detailed design of the final concept:
  - A short functional description of the final concept with detailed pictures/drawings of the main functions.
  - A calculation of the primary performance characteristics, describing the relevant mathematical formulas and showing the calculation of torque, no-load speed, power and energy.
  - A risk assessment (FMEA).
  - A parts list specifying the sourcing and cost of each part.
  - A 3D CAD model in the STEP format.
  - A plot showing the main dimensions of the final product.
  - Manufacturing drawings (PDF) for the “classical” custom-made parts and STL files for the custom-made parts utilizing additive manufacturing.

## **3.2 Evaluation Criteria**

The evaluation criteria listed in Table 3 should be used by you for selecting your final concept and will guide us in which design we will (hopefully) attempt to actually build.

Table 3: Evaluation criteria

Criterion	Description	Value	Remark
Peak torque	The peak torque available at the output shaft.	50 Nm	Minimum value
Peak speed	The no-load rotational speed of the output shaft.	1500 $\frac{1}{min}$	Minimum value
Energy	The device shall operate for the given time at its maximum power.	1 minutes	Target value
Cost	The total price of the prototype not including final assembly labor.	500 €	Target value
Reliability	The number of charge and operation cycles without maintenance intervention.	10	Target value
Control	The device shall be able to drive a wood screw into a pieces of soft and hard wood without damaging the work piece or screw.	N/A	Target

## References

- [1] Antony Barber. “SECTION 5 - Applications”. In: *Pneumatic Handbook*. Ed. by Antony Barber. Eighth Edition. Oxford: Butterworth-Heinemann, 1997, pp. 297–420. ISBN: 978-1-85617-249-3. DOI: [10.1016/B978-185617249-3/50006-4](https://doi.org/10.1016/B978-185617249-3/50006-4).
- [2] Gerhard Pahl et al. “Task Clarification”. In: *Engineering Design*. Springer London, 2007, pp. 145–158. DOI: [10.1007/978-1-84628-319-2\\_5](https://doi.org/10.1007/978-1-84628-319-2_5).
- [3] *Schraubwerkzeuge – Mitnahme-Verbindungen für hand- und maschinenbetätigtes Schraubendrehereinsätze und Verbindungsteile – Maße und Drehmomentprüfung*. DIN ISO 1173:2009-06. DIN e.V., June 2009.