PRODUCTION SYSTEMS ENGINEERING

Project Description 2021

Contents

1. Goals of the project

The project Production Systems Engineering (PSE) aims at providing knowledge, competences, tools and practice for designing production systems. In particular, the ability to obtain and maintain overview in a complex and multi-disciplinary project will be practiced.

This results in the following educational goals:
After this project the student:

- Is able to (re)design (a part of) a production system on a basic level by applying theory/tools and solutions from the Production Management, Systems Engineering and Statistics disciplines;
- Can obtain and maintain overview over, and between the constituting parts and disciplines;
- Has practiced integrated production system development;
- Has practiced to make an academic poster.

Since this project takes place almost at the end of the Mechanical Engineering bachelor, it is encouraged (and valued) to apply prior knowledge and further deepen yourself.

2. Assignment

Subject
Morocant Drives is a specialist in driving technology for over 50 years now. They offer a wide range of components and products used in the propulsion technology used in the automotive, airplane, energy and agriculture sectors. They design, manufacture and assemble their own products, all in the same factory at Breda. Morocant has a number of high-quality machines, such as machine centers, NC lathes and NC milling machines, some equipped with loading robots. Many of their products are made to order. This reduces stock obsolescence and finished goods inventory (smaller warehouse), but unfortunately it increases waiting times for the customer.

Morocant is growing rapidly and their current building is old and becoming too small for any (future) expansion. Now Morocant was able to buy a piece of land at the Rithmeesterpark in Breda. They will build a new manufacturing facility, but the dimensions are not known yet. All the machines from the old factory will be moved to the new location. Probably some new machines need to be bought, because capacity at this moment seems not to be sufficient. The current product portfolio, available machines and the order pattern of 4 months (Aug, Sept, Oct, Nov) in 2020 are given in de excel file on Canvas (Datasheet PSE 2021.xlsx). These 4 months are representative for the whole of 2020.

Due to the type of sectors Morocant operates in, they are forced to have a good quality system. For example they use FMEA's to optimize their production, but also SPC is used to monitor and control their processes (Cpk-values > 1.5). Since January 2018 they are EN-ISO 9001:2000 en AS9100 certified.

At January 2021 a new customer showed up; Sali. They design and produce tractors. Morocant is asked to be a supplier of a part that is used in the wheel construction. The estimated amount of products they order per month is 150.

The assignment is to design a production system and its layout that will be able to produce the new product of Sali and the products mentioned in the datasheet, assuming that the order pattern of the past is a good forecast for the future.

Designing a production system is a complex task, not all data is available so assumptions need to be made. Assumptions are OK as long as the origin can be traced and they are properly documented.

Some additional aspects:
- The new production system should perform as optimal as possible.
- Available production time: 2 shifts/day, 48 weeks/year.
- The floor space necessary for the new factory will be a result of your calculations.

Execution
The assignment is executed by a number of teams in parallel, each consisting of 12-15 students. Each team has a mutual start-up phase, in which the requirements are defined, the system design concept is created and the sub-systems are determined. Then in the second project phase, the teams are subdivided into smaller groups of 2 (or at most 3) students. The subdivision is the group's own responsibility. The smaller groups work on their own sub-system. The division into sub-systems has to be done before the first deadline (see *Planning* below). Naturally, it is paramount that all sub-systems fit together into a properly functioning larger system in the end.

Areas that have to be covered are:
- Requirements and specifications based on an investigation of the problem;
- System architecture;
- Communication;
- Integration (within the sub-system, and with other sub-systems);
- Implementation (what hardware is needed and how is it organized?);
- The design of the individual elements in order to achieve optimal system performance;
- Every group (of 2-3 persons) will design at least one sub-system;
- Testing of the final integrated system.

The production system concept has to be detailed to the point that at least the following questions can be answered:
- What are the *requirements*, as seen from the producer(s) of the system, the user and other relevant stakeholders?
- What *sub-systems* are needed, what are the *interfaces*, and how are the subsystems *integrated* (the architecture of the system)?
- *How* do the system and its sub-systems *function*?
- What are the *costs* (both investment and running costs) and the *benefits*?
- How long is the *development program* and how many people are needed?
- How will the *production system look like*, in terms of layout, number of machines, quality system, logistics etc.?
- Are the *requirements met*?

This results in the following guidelines for the project deliverables (your team decides on the exact content and details):
- Requirements of the system
- Architecture of the system

- Performance and strategy of the production system
- Layout and flow of the system
- Planning and control, capacity and inventory management of the system
- Quality, maintenance and risk management of the system
- Improvement strategy for the system
- Processing of the results of the Statistics case
- Etc.

3. Planning

Large team (3 weeks)

- Investigate the problem;
- Compile the requirements (specifications and wishes);
- Investigate possible divisions into sub-systems and interfaces;
- Definition of the architecture and sub-systems, including ensuring correspondence between the sub-systems and fitness for purpose;
- Present this as a research poster in English (design review).

Small groups (5 weeks)

- (Detail) analyses;
- Define the requirements for the sub-system;
- Describe the functions and the functional behavior;
- Design (or find) the required functional components and support your choices with calculations and/or simulations;
- Define the interfaces between components;
- Create an integration plan and a test plan;
- Use the result of the Statistic case to adapt the production system caused by the influence of variability on the production system;
- Present this in a research poster in English (final review).

Man hours for the project and courses

Table 1 indicates the allocated hours for the Production Management, Systems Engineering, project assignment and Statistics. Also, the type of work is indicated; i.e. lectures, self-study and project work. Note the fact that a considerable number of the hours of the Production Management and Systems Engineering courses contribute to the project work.

Table 1: Hour-budget for the Production Systems Engineering project.

	Production Management	**Systems Engineering**	**Project Assignment**	**Statistics Case-study**	**Total**
Lecture	20	12	-	**-**	**33**
Study	20	12	-	**-**	**32**
Project work	16	18	49	7	**90**
Total	**56**	**42**	**49**	**7**	**154**

4. Project courses

Systems Engineering (1.5 EC)

- Integrated product development, including how to deal with multi-disciplinary design projects;
- Systems Thinking;
- Tools: different views on the concept, visualization of interfaces, functional block diagrams, budgets etc.
- Interface design: communication between sub-systems and externally (outside the system); Time-scales;
- Product planning: modularity, reuse;
- Design reviews.

Production Management (2.0 EC)

- Production management is the activity of managing the resources that create and deliver products by changing inputs into outputs using an "input-transformation-output" process;
- Company/manufacturing strategies;
- Designing a production system;
- Planning and control of a manufacturing system (some practicals are included);
- Maintenance;
- Relation between topics mentioned above.

5. Timetable

Date	Time	Activity	Remarks
3 February	9.00 am	Start of the project	
26 February	9.00 am	Deadline poster$_1$ submission	Hand in on Canvas
2/3 March		Design review (2 groups / 1 hour 45 min)	Review of system requirements, concept, and sub-system definition, based on the submitted poster. Schedule will be available on Canvas
9 April	9.00 am	Deadline poster$_2$ submission	Hand in on Canvas
13-15 April		Project presentations and assessment (2 groups/2 hours)	Schedule will be available on Canvas
16 April	8.00 am	Deadline essay SE	See Canvas organization SE for instruction
12 April	13.45-16.45	Exam PM	See Canvas

6. Assessment

Project PSE is assessed with one final mark. This mark is based on the results of the project courses, Production Management and Systems Engineering, and the project. The Statistics case-study has to be a pass.

Poster presentations
The project has two moments for assessments: the two poster presentations (design and final review). This includes the poster, the presentation and the discussions; also see section 7.

The first poster is made by the large team. The items to cover are listed in section 3. The mark applies to all group members. For the second presentation, each smaller group creates and presents a poster on their sub-system. In addition, a poster covering the integration and testing has to be made. The mark for the second poster only applies to the members of the small group. The protocol for the final review is presented in section 7.

All posters have to be in English and handed in through Canvas before the deadline (see section 5). On Canvas guidelines for the appropriate technical-English writing style and for making a poster are presented.

NB: A full report is **not** required for this project. Some background information to the posters may be supplemented and can be handed in together with the posters.

Production Management
Production Management will be assessed with an exam that results in a mark. See the timetable for the time and place of the exam.

Systems Engineering
Systems Engineering is assessed on the basis of an individual essay. Every student has to write a short essay (maximum 2 pages A4) on how Systems Engineering was applied in the project, what went well, and what you would have done differently. During the module one lecture is organized on how to write a good essay.

Statistics
The course Statistics itself is not assessed in the project and therefore the result of the Statistics exam does not count towards the final result of the project. The Statistics case-study on the other hand is part of the project. The knowledge gained in the Statistics course and case study should be applied in the project if applicable. The assignment is considered to be an individual assignment (made in small groups). The result will be a pass or fail. When failed: an additional assignment has to be made.

Final mark
The four marks mentioned above result in the final mark in the following manner:

$$Final\ mark = \frac{\frac{1}{4}Poster_1 + \frac{3}{4}Poster_2}{2} + \frac{Exam_{PM}}{4} + \frac{Essay_{SE}}{4}$$

Where:
$Poster_1$ and $Poster_2$: The first and second poster, including the presentation and discussion, respectively;
$Exam_{PM}$: The result of the exam for Production Management
$Essay_{SE}$: The result of the essay for Systems Engineering

Note that all items (posters, $Exam_{PM}$ and $Essay_{SE}$) have to be 5.5 or higher and the Statistics case-study has to be a pass.

In assessing the project, several facets are important, as described in this document before. The final result of project PSE includes at least (also section 2):

- Requirements and wishes and their implementation
- Concept of the system
- Sub-systems, interfaces and their integration
- Principles of operation of (sub-)system(s)
- Cost
- Length and intensity of the development program

7. Reviews

7.1 Design review

Goal of the poster is to inform your client about the design process so far and the chosen sub systems.
Important aspects:
Poster related:

- Logical order of content
- Ratio text/pictures
- Connection between information
- Redundant information
- English language

Content related

- Quality of requirements (and wishes) (see document at Canvas)
- Correct choice of system architecture/subsystems (including interfaces)

- Correct tools/techniques presented (and used)
- Discussion/defending

Procedure during the design review:

- The groups will have some time to view each other's poster
- 2 Groups present
- First group present their poster in max 15 min + discussion round
- Second group present their poster in max 15 min + discussion round

7.2 Final review

To promote interaction during the final project review and to stimulate each group member to take an active part in these reviews, the protocol is outlined below. Two groups are present in this protocol, designated as group A and group B. The posters of all subgroups have to be handed in on time and are available to the groups for the preparation of the final review.

1. Group A presents the work using the posters and if needed a PowerPoint presentation (ca. 20 min);
2. Group B presents the work using the posters and if needed a PowerPoint presentation (ca. 20 min);
3. Discussion among the smaller groups to review each other's work. A subgroup of A sits together with the corresponding subgroup of B. E.g. the system engineers of A review the work of the system engineers of B and *vice versa*. Also, the subgroups on for example assembly review each other's work, etc. The exact configuration of subgroups depends on the design choices of the groups. The result is a list of questions of each sub-discussion. This list has to be emailed to the project assessors (total ca. 20 min);
4. Open plenary discussion based on the lists of questions that have been compiled in Item 3. Mutual questioning and answering between groups A and B is foreseen. The project assessors take part in the discussion as well (ca. 30-40 min);
5. Wrap up and finish.

This means that every final review takes about two hours for two groups.
For grading we will look at all the aspects mentioned throughout this description (also see Canvas).

Due to corona it might be necessary to change this approach for the final review. There will be a peer review system before the final reviews. During these presentations each group will have 1 hour to present their results (20 minutes) and defend it (40 minutes). So one group at a time.

8. Contact information

In contrast to the preceding projects, no tutor is provided to the teams. Each team has to organize itself. The teachers involved are available for discussions if necessary. Prepare yourself for such a discussion and if possible provide the teacher with relevant information (beforehand)!

Teacher	Office	e-mail	Role
Maarten Bonnema	HR-W230	g.m.bonnema@utwente.nl	Teacher SE Examiner PSE
Wieteke de Kogel	HR-W252	w.dekogel-polak@utwente.nl	Coordinator PSE Teacher PM

			Examiner PSE
Nelly Litvak	ZI 4031	n.litvak@utwente.nl	Teacher Statistics
Marcus Pereira Pessoa	HR-W260	m.v.pereirapessoa@utwente.nl	Examiner PSE Coordinator module 11