TIL Design Project (TIL5050-12)

Instruction meeting September 2019

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1. Welcome

Good afternoon everyone!

You are about to start with, preparing or planning a TIL Design Project

Agenda of this lecture

1. Welcome

A. Theory and methods

2. Purposes of a TIL Design Project
3. Understanding design
4. Structuring a TIL Design Project
5. Current and future state
6. Tools you could use
7. Choose/evaluate the alternative designs
8. Project evaluation

B. Practice

9. Preparation and beyond
10. Working in teams
11. Examples of project reports, teams and topics, Next steps, Q & A

Closure

A. Theory & methods

2. Purposes of a TIL Design Project

A design project has 4 learning objectives:

Learning objective 1 (Analysis/Problem Definition): Is there a problem, in which context does it exist? Why does it exist? Which stakeholders are involved? What are the (hard and soft) requirements of these stakeholders? What criteria, constraints and key performance indicators can be derived from the needs of the main stakeholder(s) and used for the design?

Learning objective 2 (Design and evaluation): What is/are the goals of the design(s)? What are the capabilities of the design? Do they meet the requirements and so help to solve the earlier defined problem(s)?

Learning objective 3 (Team work and project management):
*Collaborate and cooperate so that the project goals are fulfilled.
*Learn to use/improve project management tools such as a meeting planner, communication tools, minutes, project planning scheme, logbook and a project archive.

Learning objective 4 (Reporting and presentation: Improve writing and presentation skills.

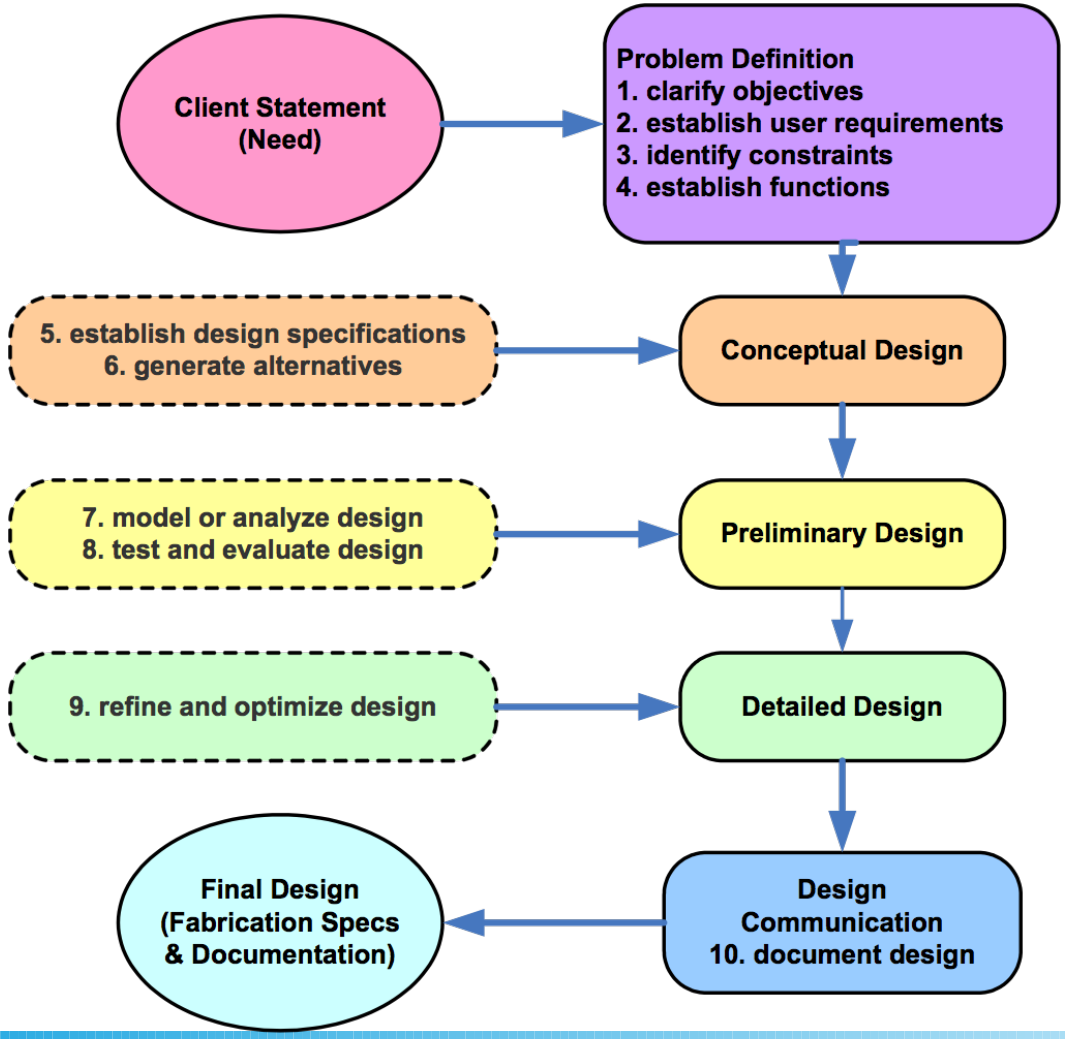
>Design project does **not** include implementation.

A project finishes with a report for the commissioner (company, government, TUD internal).

3. Understanding design:
Differences with an average TIL Project

Average TIL project	A TIL Design Project
Narrow focus	Full circle: Research, Design, Evaluation
Problem, data, tools, solutions, answers are more or less predefined	You develop your own project with systems engineering as base layer
Abstract agents and issues, focus on quantitative data	Real problems, real people, mix of qualitative and quantitative data
1-2 supervisors, irregular meetings	3-5 supervisors, frequent meetings
Freedom: Limited Challenges & risks: Limited	Freedom: A lot Challenges & risks: Many

4. Structuring a design project (Dym&Little)



Client statement and real problems

Client says: We want you to solve problem X or we think that machine Y or department Z causes the problem

Is this the goal of the project? Not necessarily

Advice 1: Always start with the why questions

Current state: Why does the company operate as it does now? Why and what does it want to change? What data does it collect, process and analyse and why?

1. Describe current processes and their performance;
2. Clarify the objectives (needs statement) of the client;
3. Establish detailed user requirements, constraints and key performance indicators (kpi) for the design.

Scoping

Scoping your project and impacts

Projects by inexperienced people may start too wide and are gradually reduced in scope

Projects by experienced people may develop in the opposite way

If you make your scope too narrow, then you may loose the big picture, you may optimise department A or function A and victimise B

If you make it too wide, then you may address a higher level (system) problem, which may be too complicated to solve by your team

How? First choices in your PVS, then kick-off and ..

Scoping is learning by doing, mistakes are normal, hence re-scoping happens during a project; supervisors assist you in this

Choice of design method

Choose a suitable Design method

- to structure your work steps and hence work in a systematic way
- to use other tools in the right stage of your project
- to define internal deadlines in your projects
- to divide the work
- to help in finding a balance between ratio and creativity

Options: One of the methods mentioned in Sage, Dym&Little, Young, Ekels etc.

Be careful with the V-shape (IT world), because of time needed for feedback loops

Design tool: DMADE (lean six sigma)

DMAIC is for implementation, in a design project you replace I by D(esign) and C by E(valuate)

Requirements analysis

“Determine the needs or conditions to meet for a new or altered product, taking into account possibly conflicting requirements of the various stakeholders, such as beneficiaries or users.

The requirements should be documented, actionable, measurable, testable, traceable, related to identified business needs or opportunities and defined to a level of detail sufficient for systems design.” (Wikipedia).

Between abstract and very concrete

When you start your project, there are many questions and uncertainties; this is part of your understanding process

Your commissioner may also express him- or herself in vague terms; we want to improve our (business) process, our product etc.

A commissioner may not have the time or the skills to study the issue

As a result, not all requirements will be concrete/hard, some are soft

Try to be as concrete as possible

You could start in a qualitative way and gradually move to quantification

It is common to add, change or remove requirements during the problem definition/analysis phase

Requirements

- are the target for the capabilities of your design / solutions / product

- are a quality factor (benchmark) of your design

If you fail to recognise key requirements, then you may develop the wrong design, or have to repair it, which costs time and money. You may also create damage to the company (lost production, sales, ..)

Requirements could be coming from

- this, another department or a CEO, CTO or CFO
- a government agency
- suppliers
- buyers
- employees
- shareholders
- third parties, e.g., citizens, surrounding companies

Stakeholder analysis:

*Awareness of their different powers, interests, relationships

* Impact on your design

Requirements could be (combinations of)

- technical
- non-technical
- financial
- social
- hard or soft
- very clear and detailed or very vague, blurred

Role of an **advisor**: while using mainly company resources, stay independent from the company

Listen to the customer, other stakeholders and supervisors, but make your own decisions!

A requirements analysis is

- a communication tool (usually a problem among engineers)
- a description that can be understood by others
- a decision making tool
- a definition of a product architecture
- a check on completion of your design
- a verification of completion of the project

- **Functional** Requirements:
  • These are the things that a system has to do, like record a fact, do a calculation, make a decision, move between locations.
  • “The airport system should (FR) record the landing time of a flight.
- **Non-functional** (Performance) Requirements:
  • What quality or attribute the system have to have: performance, security usability, maintainability..

- **Interface** Requirements:
- • Conditions of interaction between items
  • ... could be functional, physical, logical,...

Examples of **requirements**:

- cost-related e.g. reduce cost by 20%
- time-related e.g. reduce process or turnaround time by 25%
- technology related e.g. improve information system

- **Constraints**:
- • Specified influences that affects the way the requirements are met.
- Examples of constraints:

- Turn-around time should be not more than 30 minutes
- Number of defects should be less than 1/1000
- Budget is limited to 1 mln euros
- No plastics.

Requirements and constraints are related and can be mixed

Examples of **kpi's**:

- Express how the company has performed (lagging indicators)

e.g. a company produces 1000 pieces of product C per month

- Express how the company will or should perform in future (leading indicators)

Challenge: How to find a proper balance between different fields and objectives e.g. technical and financial, time and quality

What targets does the company have: Under- or overperformance?

Management and operators may understand kpi's differently

Functions of a design

Cluster requirements into logical functions for the design

Function A = throughput, capacity

Function B = safe to operate

Function C = customer should be satisfied

Function D = solution should be maintainable

Function E = solution should be affordable

Clustering also helps in the evaluation phase

Results of Requirements Analysis

- Functions:
  - ***What the system has to do?***
- Performance:
  - ***How well the functions have to be performed?***
- Interfaces:
  - ***What environments the system will perform?***
- Other requirements and constraints.

5. Current and future state

Advice 2: After the why/what? Ask the where/how?

- Current -> future state:
- What is the ideal state?
- Where and how can or should the commissioner change things internally or externally in order to meet this ideal state (remove problem A, develop a new market, produce more etc.)?
- A design is one of the possible alternatives to reach this state, but not the final answer

6. Tools you could use

Problem -> tool -> application -> design -> solution

Not: tool -> application -> design -> solution -> problem??

Why? You need a non-biased view and you should not define a problem based on the capabilities of your tool

Explain the logic of your choices and document it in your report

Choose a tool that suits the phase of the project and the available data

Qualitative tools: rich pictures, literature analysis, interviews, brainstorm, questionnaire, organo grams, stakeholder analysis, schemes, tabl,e IDEFx (level of detail), DMADE, Izikawa, swimlanes etc.

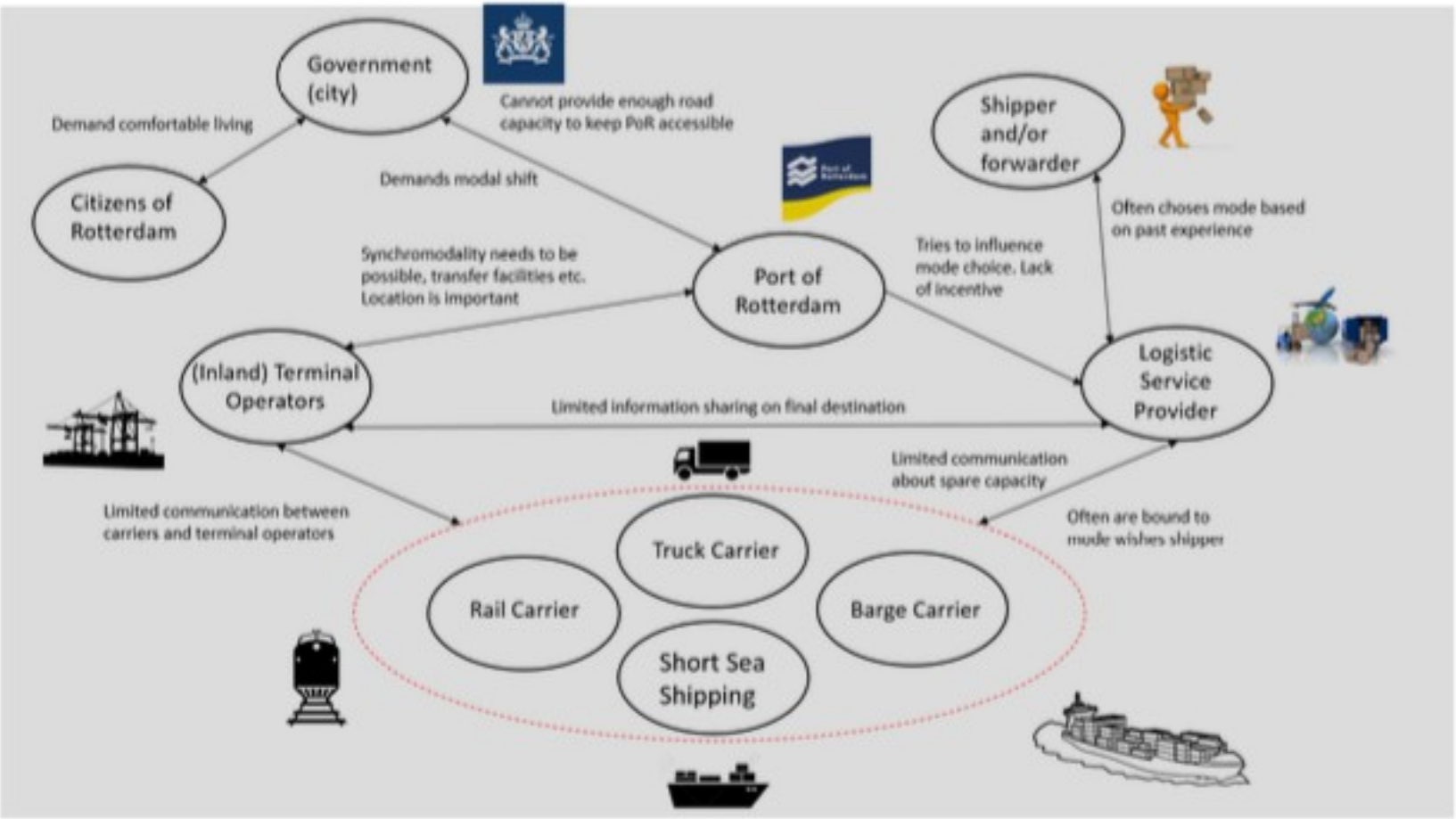
Quantitative tools
> Start with problem analysis, not by choosing or building a model
> If needed at all, use simulation only to estimate results, run scenarios etc., but not to better understand the problem(s)

Evaluation tools:

Qualitative (e.g. MCA) or quantitative e.g. a model in excel or python

> Simple tools are preferred over complex tools in most cases

Example of a rich picture (stakeholders/functions/interests identification)



Literature analysis: Purpose

- To prevent that you benchmark the company with itself
- To learn from similar cases
- To prevent re-inventing the wheel; win time and save cost by not repeating earlier work
- To disclose new information, methods and tools to the company (state-of-the-art knowledge)
- To find a potential research gap
- To give your project a sufficient scientific basis

Conceptual design: relationships

Ideal state versus realistic to achieve

*People, buildings, infrastructure etc.
*Systems, subsystems, interfaces
*Time, cost
*Performance-related: throughput, frequency, efficiency

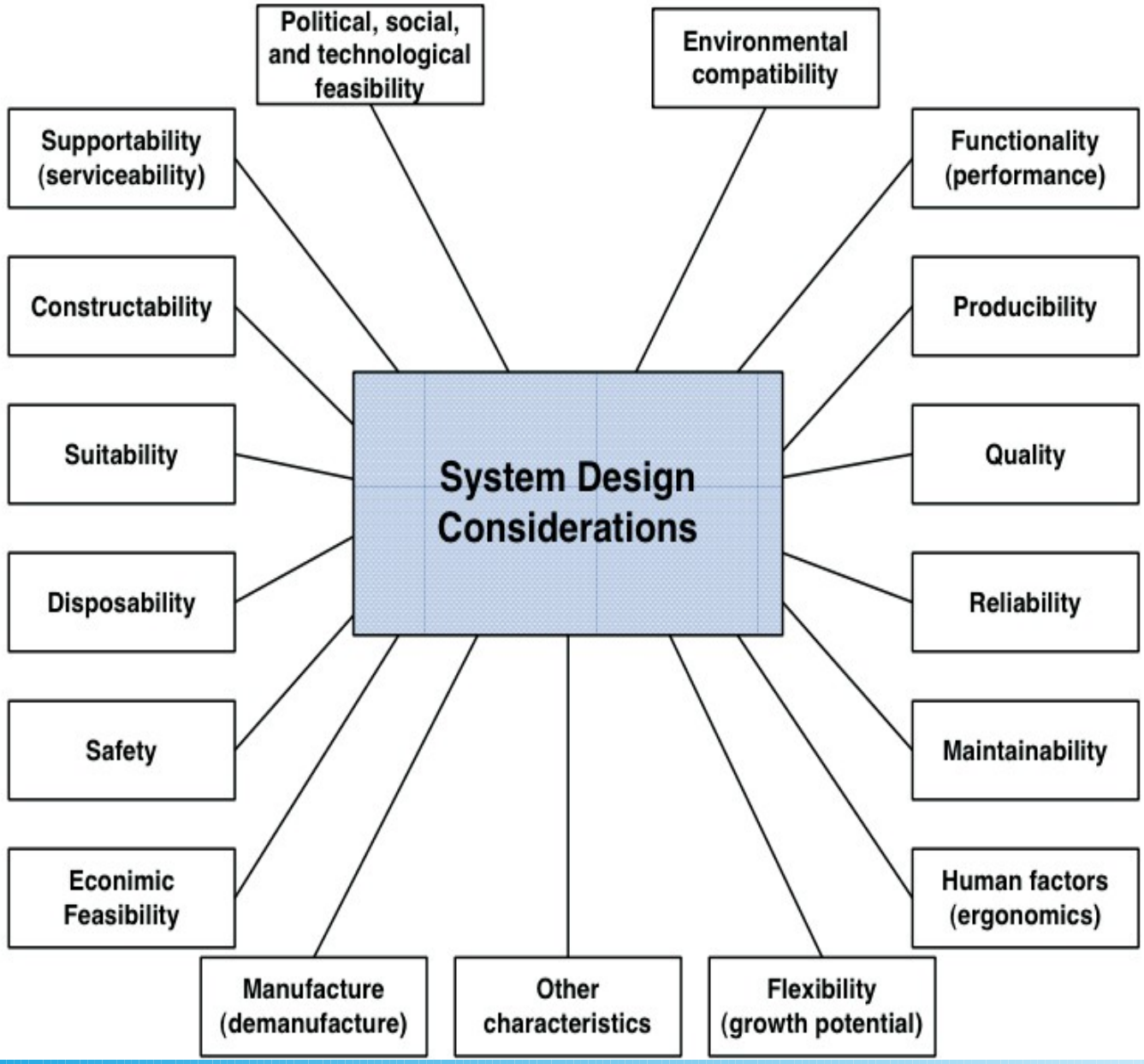
- Min, max; hard, soft
- Quantitative, measurable, collectible
- Verify these with the stakeholders; agreement

Design principles and criteria

Guiding principles for your design, e.g.,

- Simple, easy to implement
- Independent (submodules)
- Modular (strong/weak cohesion)
- Cost-effective
- Low hanging fruit or structural solutions

- Conflicts?


System Design Considerations
Political, social, and technological feasibility
Environmental compatibility
Supportability (serviceability)
Functionality (performance)
Constructability
Producibility
Suitability
Quality
Disposability
Reliability
Safety
Maintainability
Econimic Feasibility
Human factors (ergonomics)
Manufacture (demanufacture)
Other characteristics
Flexibility (growth potential)

Design space: All potential solutions you may generate (from a Design project for Vanderlande)

Figure 15. Last-Mile delivery methods DHL (DHL, 2016)

Preliminary design

Model and analyse the potential designs;

- Sketches, drawings, y/n filters, morph charts (function/feature-means), UML, IDEF, formulas, etc.

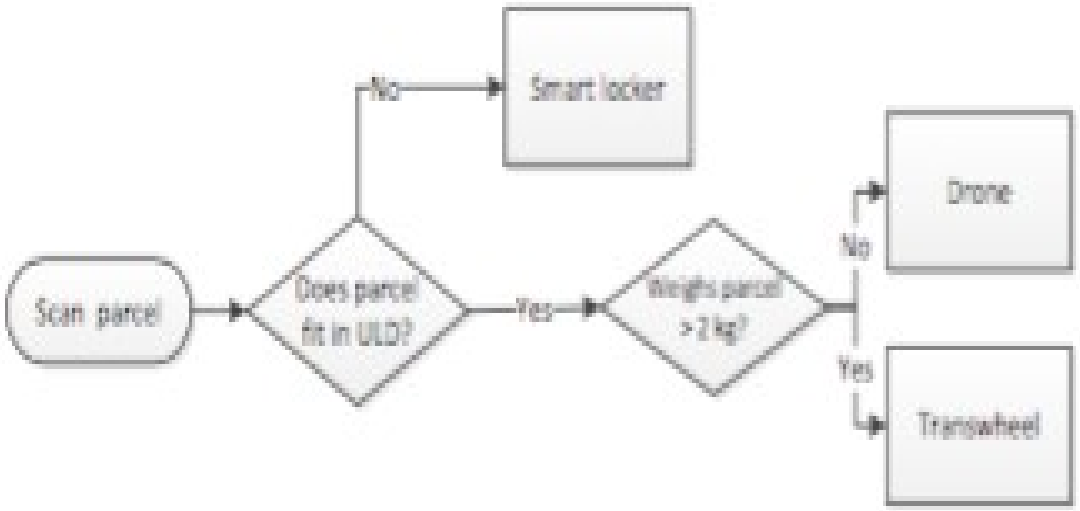


Figure 24. Decisions made by sorter

How detailed should the final design(s) be?

Choice:

- Take the alternative designs and develop <u>all</u> of them into rough (non-technical) designs, then stop

or

- Use a tool like MCA or a quantitative model to filter the <u>best</u> alternatives and develop these into detailed (non-technical) designs

7. Choose/evaluate the potential designs

Tools: quanti- and/or qualitative: swot, mca, cba, model, sensitivity analysis, simulation etc. Not your own weights..

Table 12. Throughput times for Drone and Transwheel interface

Process / mode	Drone	Transwheel
Sorting on dimensions	2 m	2 m
Loading ULD	30 s	30 s
Sorting on weight	5 s	5 s
Moving/buffering	4 m	2 m
Loading	30 s	30 s
Total	About 7 minutes	About 5 minutes

Loading time of the Smart locker is given in the Flexible scenario: 15 minutes

Detailed design

1. Choose one or a few “best” designs;
2. Decide on the level of detail;
3. Refine and optimise these designs;
   check the tool as well (e.g. model validation and verification)’.

- Verification = Are the outcomes plausible? Does the tool work?
- Validation = Quality of the outcomes? Is it the right tool (model)?
- Report about the design and the design process.

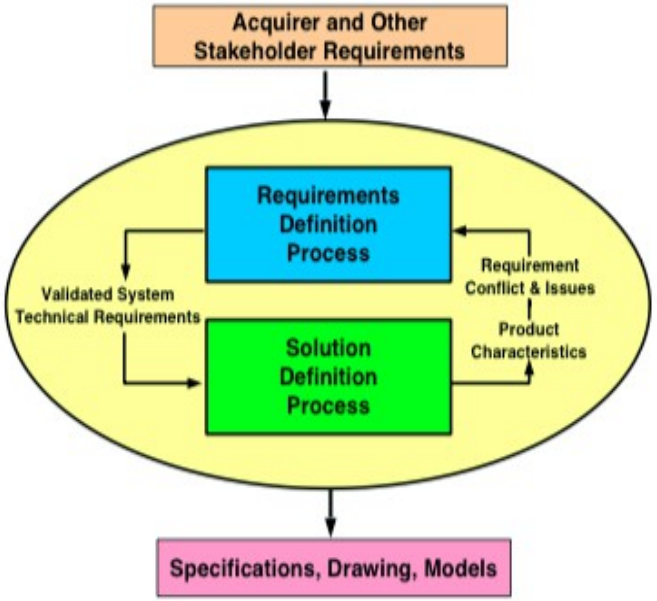
Implementation: prototyping etc.

Not part of your project

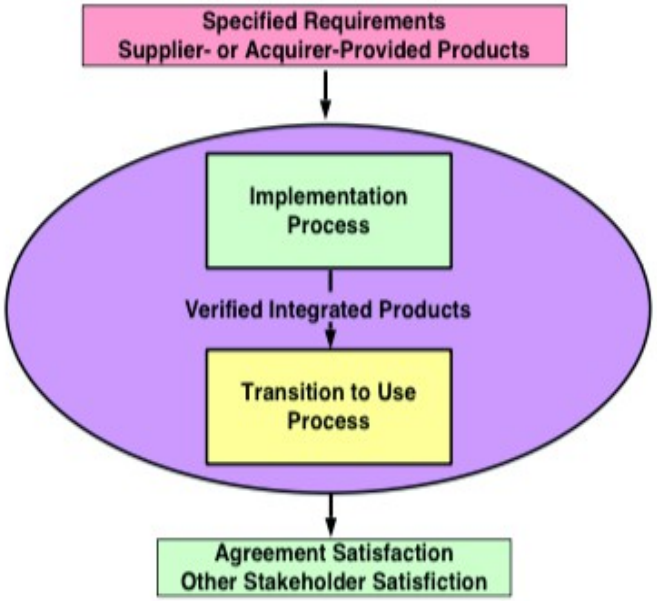
But, you may provide an advice on how your design could be implemented, how (procedures and persons), how to maximise performance, additional research needed, investments, required tests, or a manual on how to use a developed tool.

From Design towards Realisation

System Design Process



Product/System Realization Process



Verification & Validation

8. Project evaluation

An appendix in your report about

1) Your findings
2) Process
3) Team work
4) Supervision
5) Personal lessons learned
6) Improvement of the course
7) Anything else

References – assumed knowledge!

Vleugel, J., 2019, **Course manual** on Brightspace and TIL website;

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Ludema, M., **SPM4611** sheets on Brightspace;

Dym, C.L. & P. Little, 2004, **Engineering design, A project-based introduction**, second edition, In particular chapters 2, 3, 5, 6 and 7 (TUD lib);

Sage, A.P. & J.E. Armstrong: http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0471027669.html

Young, R.R., 2004, **The requirements engineering handbook**, in particular chapters 1, 4, 5, 7 (TUD lib);

Veeke, H., Ottjes, J. & G. Lodewijks, 2008, **The Delft Systems Approach**, Springer (TUD lib online), part of TIL4030-14.

Q + A = :) ?

B. Practice

9. Preparation and beyond

Individuals and team	Coordinator
1. Enroll on Brightspace	Accept enrollments
2. Find team mates, think about potential topics, contact companies	Help with 2: Announce on Brightspace, meetings, emails
3. Fill in enrollment form and email to coordinator or ask for a meeting with him	Process forms, accept students, arrange a start-up meeting / check if team composition is ok
4. Start-up meeting: prepare questions for meeting, start with PVS, do Belbin test	Have the start-up meeting Discuss potential companies, topics, helps to choose Read and comment on draft PVS's
5. Continue with PVS, contact experts, company (if available)	If customer and topic are acceptable, then I arrange a coaching team
6. Kick-off meeting: plan a date with all coaches and coordinator, invite all of them and arrange a meeting room via secretariat(s)	Chair, discuss, advise

How to get a project?

– Choose a particular field or topic that you would like to explore
– Develop ideas about topics
– Use the DP company list
– Contact companies, governments, lecturers if they have a project or an idea fitting with what you would like or something else they need help with
– Ask around: other students, family contacts etc.
– Contact the course coordinator

– First phone, then email commissioners
– Use the flyer, refer to the website portal, to the coordinator

PVS = (nearly) ready before the kick-off

What you know about the customer and the problem already, what you expect, what you want to achieve, how, when, supervisors, planning, team information -> see template

=> Expectations, no blueprint

When do you start? One quarter before you want to do the project, PVS takes a few days to collect information and write

When should final PVS be ready? 1 week before the kick-off date, discuss drafts with coordinator (in meetings)

10. Working in teams

Tuckman model:

-Forming (orientation)

-Storming (conflicts)

-Norming (cohesion – we)

-Performing (productive)

-Adjourning (split-up)

> Supervision needs change during the project

Positive vibrations

- Cooperation
- Different individual capabilities; complementarity
- Sharing the workload; working in parallel
- Social learning

Negative vibrations

- Individuals produce more and better ideas than teams
- Individual memory is also better
- Individual analysis and decision-making is also better
- Groupthink

Individual motivation may shrink:

- You feel being watched, that creates stress
- Individual work is not recogniszed; negative behaviour, hitchhiking

Effective teams

- Optimistic and goal oriented;
- Open atmosphere;
- Personal learning moments;
- Accept leadership;
- Accept feedback;
- Identify with and support each other;
- Self-knowledge;
- Learning skills plus self control.

Overview of a project

Phases

Problem analysis: Customer, problem, requirements, tools

Design specification (criteria, kpi, constraints)

Conceptual, preliminary, detailed design

Evaluation

Finish reporting

Presentation, defence and assessment/grading

Kick-off, First steps

Kick-off meeting with supervisors and course coordinator

Project goal(s), conceptual questions and (initial) design questions, project management, first division of team roles, planning

Apply systems analysis throughout the project

Problem -> tool -> application -> design -> solution

Not: tool -> application -> design -> solution -> problem??

<u>Start writing draft text as soon as you can</u>

Problem analysis

Define: What is the real problem?

Scoping

Choose and apply this methodology

Systems-actors-problem analysis: Describe and analyse context, organisation (subsystems, functions, components), actors, and relations(ships) in/external

Literature review (concise) - research gap

Measure: Data collection (quantitative, qualitative), and analysis

Analyse

Answer relevant questions

Finish with a requirements specification

Mid-term meeting ~ 50%

Presentation

Report: Finished problem analysis, stakeholder analysis, requirements analysis

A first sketch / rough design that reflect your teams' idea's regarding the design and its capabilities

Show that you used a system engineering approach

Quality assessment, planning update/next steps

Designing

Conceptual design: ideal state as reference

Then choice based on available information:

a. Limited data: Develop only preliminary design(s): a set of alternative designs and compare these

b. Good data: Filter the best of these and detail the remaining design(s) in all the aspects considered relevant and showing (tested) capabilities

Methods: Morphological chart, MCA, calculation or simulation

Draft solution(s)/design(s)

Design = Scenarios + Alternative solutions (designs)

Scenarios are different sets of conditions under which the **designs** should be able to operate: different context, different demand for services, different policies, etc.

They are used to test how the designs behave

Models are used to estimate/simulate the impact of the designs when fed with the scenario values

Evaluation tools are used to see if the specified targets can be met

*Green light meeting ~ 90%

Discussion of the draft report

Feedback on the results

Discussion

Quality assessment: green/yellow/red

Improve the draft report towards a final report/design

Green light ~> Final presentation

Work on remaining issues and questions from the coaches

Prepare for final presentation / defence

Final Presentation and Defence

Presentation / Defence

Quality assessment

Team work assessment

Project reflection

Grading Rubric -> mark(s) → Brightspace

Timeline

Examples of PVS and project reports

Teams and topics

Next steps

Timeline

	2019-20	**TIL 5050-12**				Kick-off/
		When to start preparations	Topic + commissioner ready	First contact with coordinator	PVS (KO-)	project start
Sep-Nov	Q1	Before July 1	On July 1/week 26	In Q3 or Q4 2018-19	Week 34/35	Week 35/36
Nov-Jan	Q2	In Q1 or earlier	In October	In Q1 or earlier	Week 43/44	Week 44/45
Feb-Apr	Q3	In Q2 or earlier	In January	In Q2 or earlier	Week 4	Week 5
May-Jul	Q4	In Q3 or earlier	In April	In Q3 or earlier	Week 17	Week 18

Q + A = :) ?

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https://www.goleansixsigma.com/wp-content/uploads/2012/02/DMAIC-The-5-Phases-of-Lean-Six-Sigma-www.GoLeanSixSigma.com_.pdf

Team work
M. Bekker, 2012, Focus op groepsdynamica, Boom/Lemma.