



Dr. Eng. Infall Syafalni, S.T., M.Sc.

Teknik Elektro - STEI ITB

Engineering Design Process

Problem Definition & Gathering Information

KU1202 – Pengantar Rekayasa dan Desain

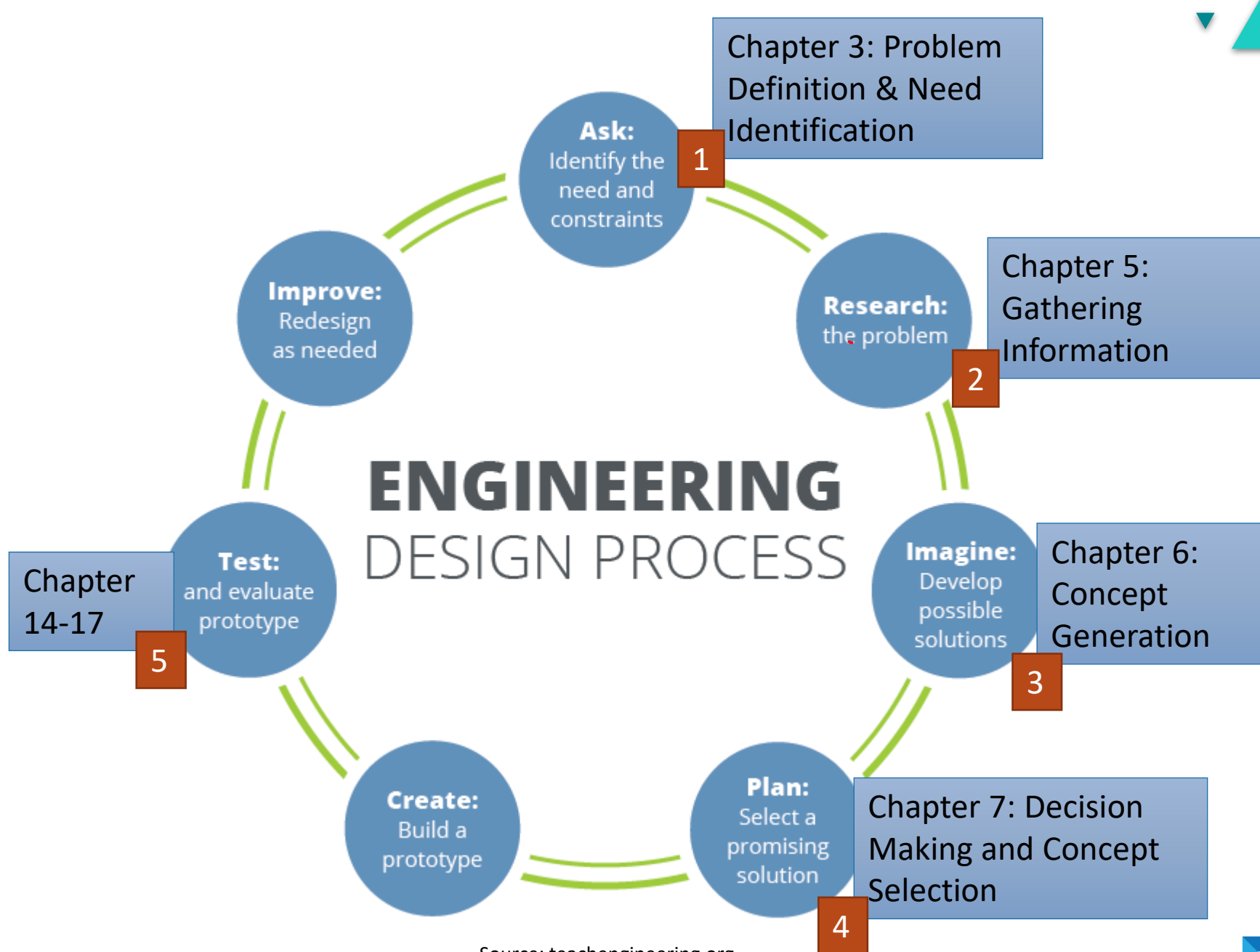


Engineering Design Process

The **engineering design process** is a series of steps that guides engineering teams as we solve problems.

The design process is **iterative**, meaning that we repeat the steps as many times as needed, making improvements along the way as we **learn from failure** and uncover new design possibilities to arrive at great solution





Source: teachengineering.org



Ask: Identify the Need & Constraints (Identifikasi Kebutuhan dan Kendala/Masalah)

Questions include:

- What is the problem to solve? (Masalah apa yang ingin dipecahkan?)
- What do we want to design? (Apa yang ingin didesain?)
- Who is it for? (Target pemakainya siapa?)
- What do we want to accomplish? (Apa yang ingin dicapai?)
- What are the project requirements? (Apa persyaratan project?)
- What are the limitations? (Keterbatasannya apa?)
- What is our goal? (Gol/tujuannya apa?)



Research the Problem

This includes talking to people from many different backgrounds and specialties to assist with researching what products or solutions already exist, or what technologies might be adaptable to your needs.

Imagine: Develop Possible Solutions

- You work with a team to brainstorm ideas and develop as many solutions as possible. This is the time to encourage wild ideas and defer judgment!
- Build on the ideas of others!
- Stay focused on topic, and have one conversation at a time!
- Remember: **good design is all about teamwork!**



Plan: Select a Promising Solution

For many teams this is the hardest step!

- Revisit the needs, constraints and research from the earlier steps,
- Compare your best ideas,
- Select one solution and
- Make a plan to move forward with it.



Create: Build a Prototype

- **Building a prototype** makes your ideas real! These early versions of the design solution
- Help your team **verify** whether the design meets the original challenge objectives.
- Push yourself for **creativity, imagination and excellence** in design.

Test and Evaluate Prototype

- Does it work?
- Does it solve the need?
- Analyze and talk about what works, what doesn't, and
- What could be improved.

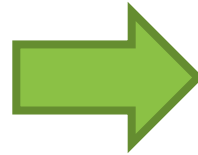
Improve: Redesign as Needed

- Discuss how you could improve your solution.
- Make revisions.
- Draw new designs.
- Iterate your design to make your product the best it can be.
- And now, REPEAT!

Overarching themes of the engineering design process

Overarching themes of the engineering design process

- **teamwork** and
- **design**

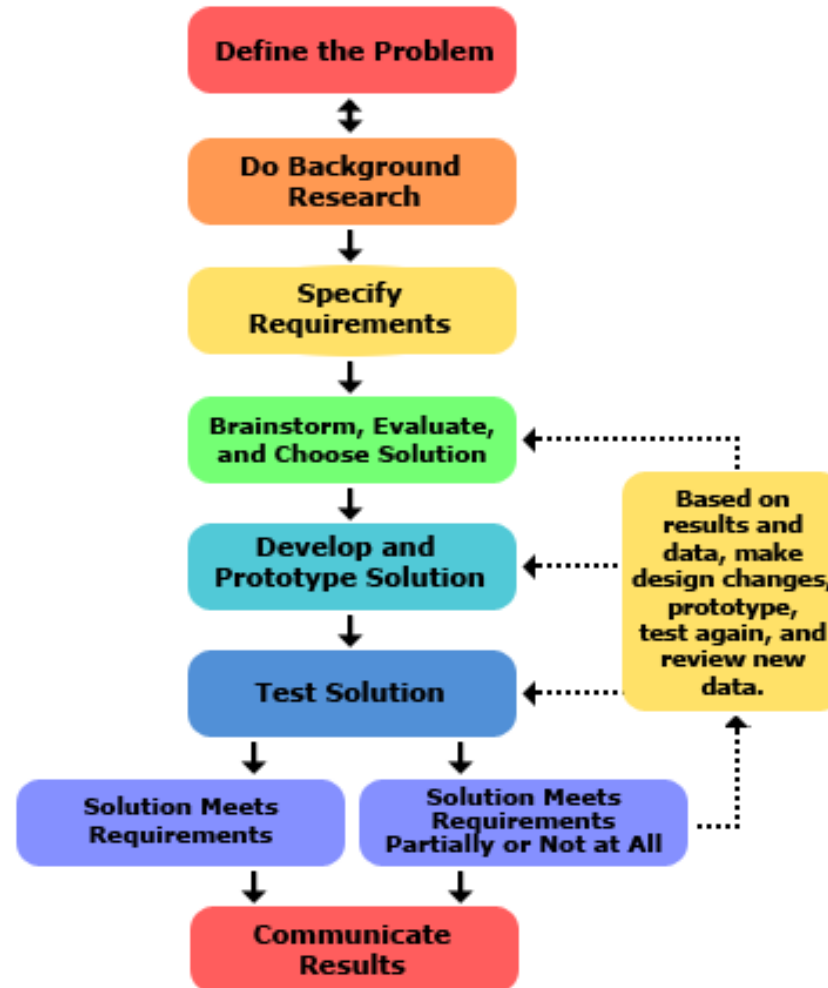


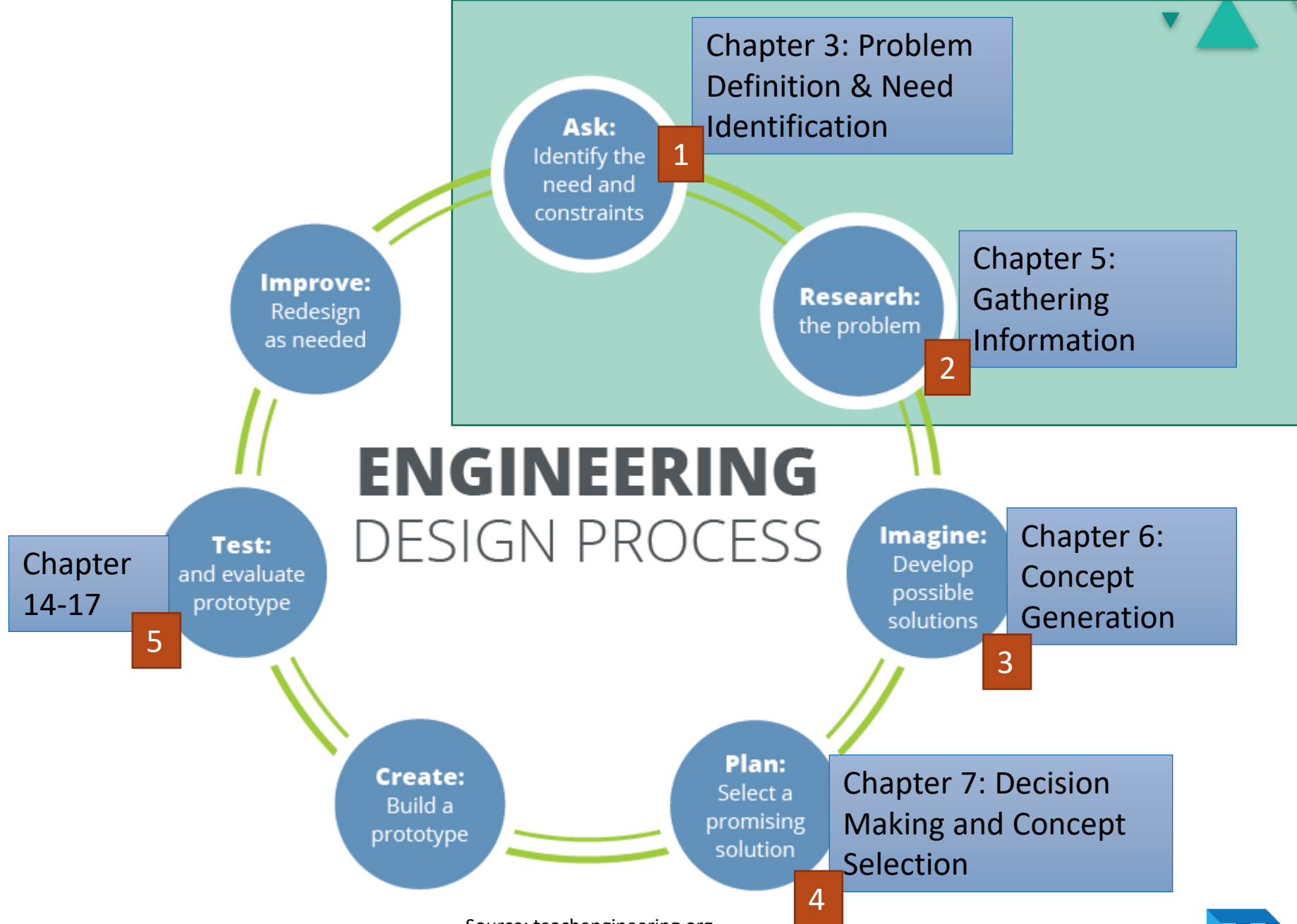
brainstorm
open-ended design



Apply science and math concepts, test
prototypes and analyze data—and aim for
creativity and practicality

Engineering Design Process





Source: teachengineering.org



Identify The Need and Constraints

- The engineering design process has been depicted as a stream of potential designs for a new product that will fit the needs of a targeted group of consumers.
- A need has been described as a gap between “what is” and “what should be”.

Need: Identification and Analysis

- Types of needs
- Need Identification
- Principles of Need Analysis
- Example

Types of needs

- Direct Needs
- Latent Needs
- Constant Needs
- Variable Needs

Direct Needs

- Needs are expressed by the customers to the designer during various processes of need identification.
- The direct needs are those needs of the consumer which are apparent and evident from the very purpose for which the artifact is to be produced.

Latent Needs

- While preparing a list of needs in consultation with the customers during need identification there are various hidden needs which may arise in future as soon as the customer starts using the product.
- During need identification process the customer may not be able to express the hidden needs due to inexperience or short term thought process.
- Therefore, it is the duty of the designer to identify the hidden / latent needs of the customer and incorporate the same in the design.

Constant Needs

- The basic purpose for which the product is to be designed can never change although there may be modifications to the design arising out of various factors.
- For example, the basic purpose of a chair is to let the people sit in it, a customer may demand a cushioning or wheeling feature into the existing design but the basic purpose of the chair remains the same.
- Such needs which do not change with the time are termed as constant needs.

Variable Needs

- The variable needs keep on changing with the time due to various factors which may compel the user to demand for the varying features to be incorporated into the product from time to time.

Need Identification

- Customer Needs Identification is the process of determining what and how a customer wants a product to perform.
- Customer needs are non-technical, and they reflect the customer's perception of the product, not the actual design specifications, although frequently they are closely related.

Needs Identification Goals

- To keep the product focused on customer needs.
- To identify not just the explicit needs of the customer, but also the latent needs. The latent needs are the hidden needs.

Four-step method for identifying customer needs

- Gather raw data from customers
- Interpret the data in terms of customer needs
- Organize the needs
- Reflect on the Process

Need Identification

- Need identification is the most important step in the design process, because it is directly related with the satisfaction of the customer.

“The greatest defect a product can have is not satisfying the customer”

Need Analysis

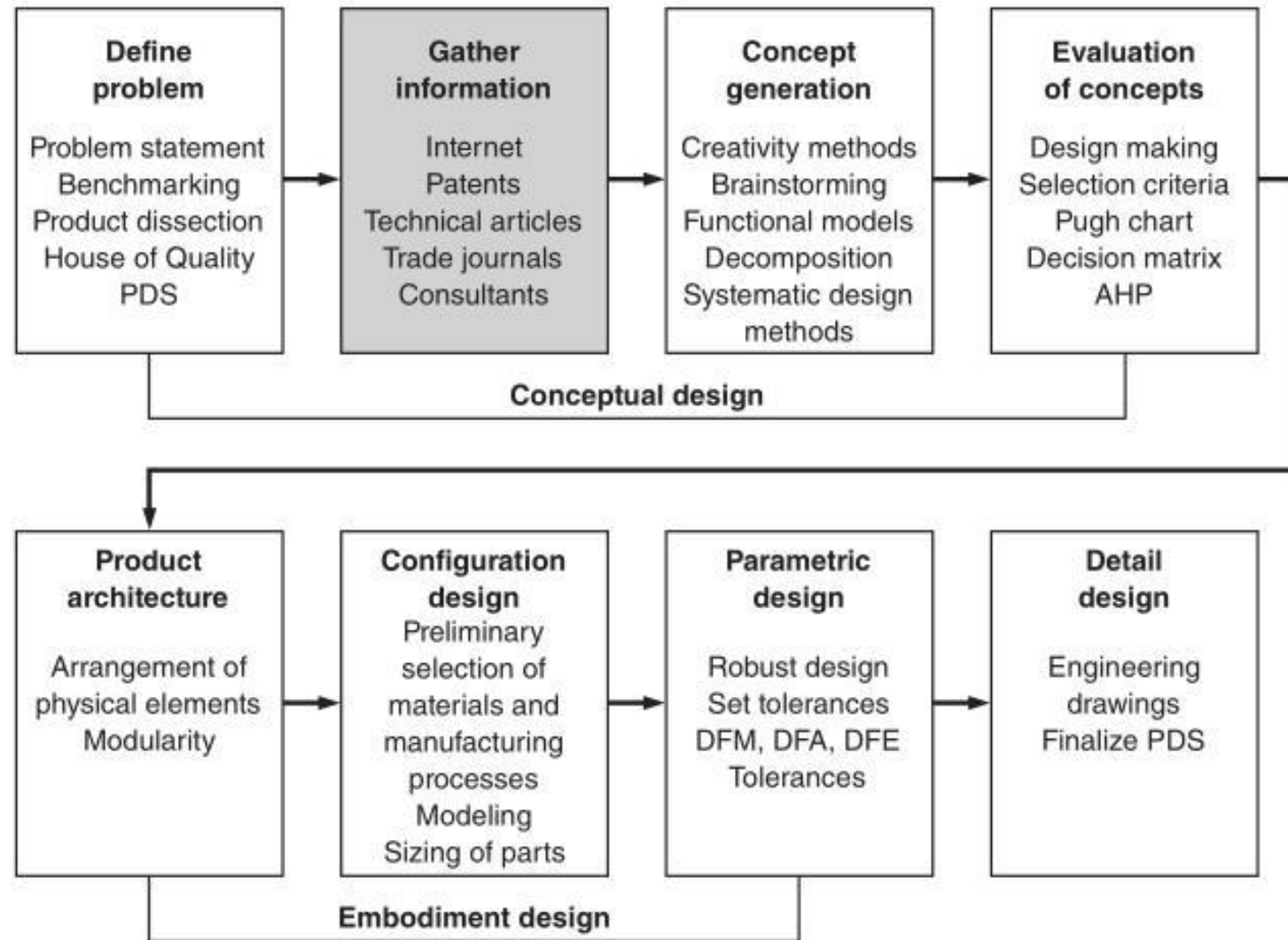
- Needs analysis is defined as a formal process focus on how a product addresses the needs of a human.
- It is often used across many industries, such as software development, automobiles, consumer products and banking services.

Principles of Need Analysis

- The opinion of end users is essential to unify a diverse, opinionated design team, and their opinion should transcend the desires of your design team.
- Appeal to the lowest common denominator in end user needs. Marketing to the lowest skill levels results in the largest potential market.
- Do comprehensive beta tests of your products over a long period of time to allow adequate adjustments before "freezing" your product for the final manufacturing stage.
- Continue to monitor user feedback after the product launch, and address defects quickly and keep an accurate record to apply to future releases, if they cannot be addressed immediately in the current product.
- Elegant designs are the end product of successful needs analysis, and will put your product head and shoulders above industry peers.



Research the problem-Gather Information



Data, Information, and Knowledge

- Data is a set of discrete, objective facts about events.
- Information is data that has been treated in some way that it conveys a message.
- Knowledge is broader, deeper, and richer than data or information.

Types of Design Information

Customer

- Surveys and feedback
- Marketing data

Related designs

- Specs and drawings for previous versions of the product
- Similar designs of competitors (reverse engineering)

Analysis methods

- Technical reports
- Specialized computer programs, for example, finite element analysis

Materials

- Performance in past designs (failure analysis)
- Properties

Manufacturing

- Capability of processes
- Capacity analysis
- Manufacturing sources
- Assembly methods

Cost

- Cost history
- Current material and manufacturing costs

Standard components

- Availability and quality of vendors
- Size and technical data

Technical standards

- ISO
- ASTM
- Company specific

Governmental regulations

- Performance based
- Safety

Life cycle issues

- Maintenance/service feedback
- Reliability/quality data
- Warranty data



Sources of Information Pertinent to Engineering Design

Libraries

- Dictionaries and encyclopedias
- Engineering handbooks
- Texts and monographs
- Periodicals (technical journals and magazines, and newspapers)

Internet

A massive depository of information. See Sec. 5.6 for more detail.

Government

- Technical reports
- Databases
- Search engines
- Laws and regulations

Engineering professional societies and trade associations

- Technical journals and news magazines
- Technical conference proceedings
- Codes and standards, in some cases

Intellectual property

- Patents, both national and international
- Copyrights
- Trademarks

Personal activities

- Buildup of knowledge through work experience and study
- Contacts with colleagues
- Personal network of professionals
- Contacts with suppliers and vendors
- Contacts with consultants
- Attendance at conferences, trade shows, exhibitions
- Visits to other companies

Customers

- Direct involvement
- Surveys
- Feedback from warranty payments and returned products



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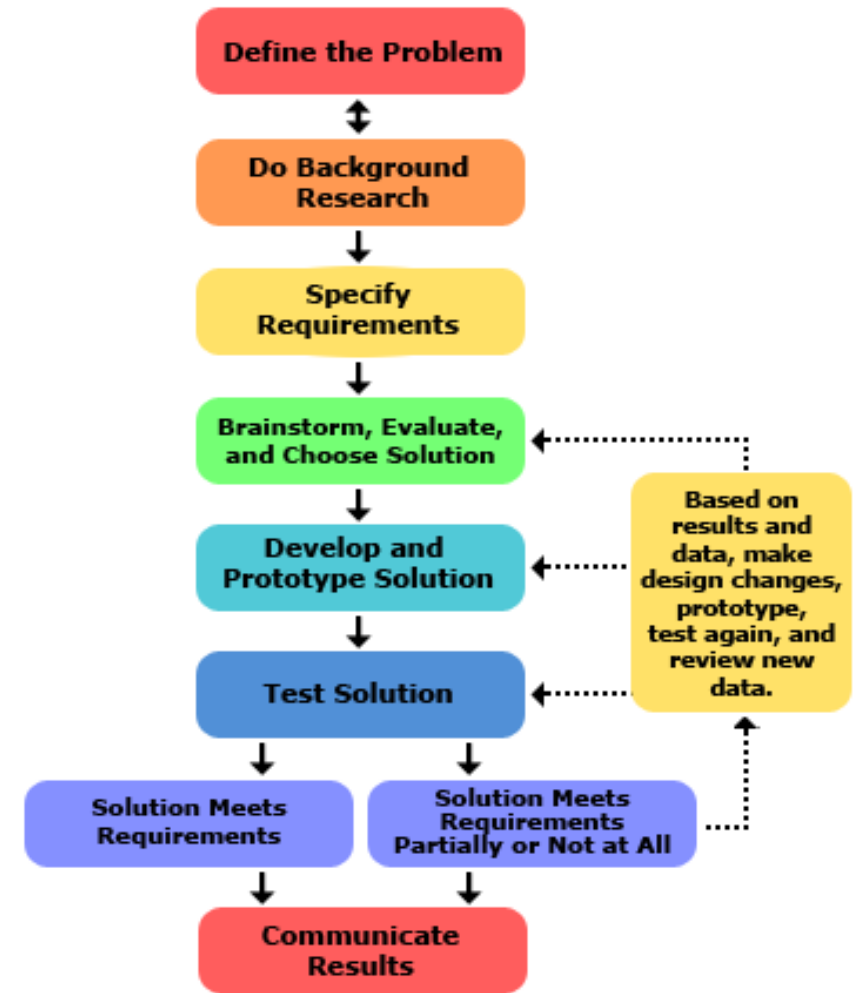
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Quiz Pekan 3

1. **Engineering Design Process** adalah tahapan dari seorang *engineer* dalam mencari solusi dari sebuah masalah. Solusi dapat berupa sebuah desain produk dalam bentuk komponen, sistem, ataupun proses (seperti mesin, komputer program, sistem ataupun subsistem elektronik) yang sesuai dengan kriteria untuk menyelesaikan sebuah tugas. Diagram di bawah ini menunjukkan langkah dari *Engineering Design Process*. **Pilihlah sebuah masalah *Engineering* dan jelaskan secara singkat dari *Engineering Design Process* untuk memecahkan masalah tersebut.**



Tugas Pekan 4

- Sebuah pelat baja memiliki tebal 2,00 mm, panjang 169,0 mm dan lebar 19,8 mm, massa jenis : 7800,0 kg/m³. Berapa luas permukaannya? Berapa massanya dalam gram?
- Sebuah pompa hidrolik dengan luas permukaan tekan 10,00 cm² mendapat tekanan dengan gaya 20,00 kgf. Berapa psi tekanan yang dihasilkan?

Dimensi	SI	MKS	US
Panjang	m	M	1 ft = 12 in = 0,3048 m
Massa	kg	Kgm	1 lbm = 0,4536 kg
Percepatan Gravitasi	9,81 m/s ²	9,81 m/s ²	32,174 ft/s ²
Gaya	N = kg m/s ²	1 kgf = 9,81 N	1 lbf = 4,448 N
Tekanan	Pa = N/m ²	1 kgf/cm ² = 98,0665 kPa	1 psi = 1 lbf/in ² = 6,895 kPa

