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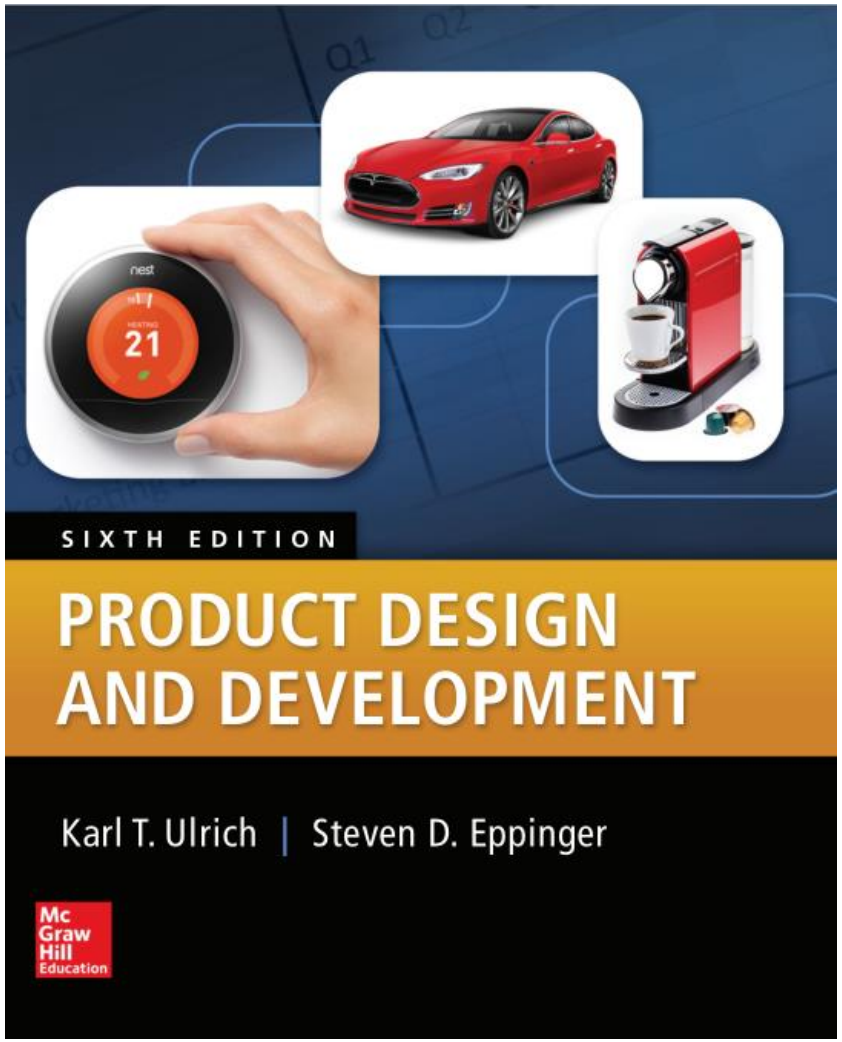
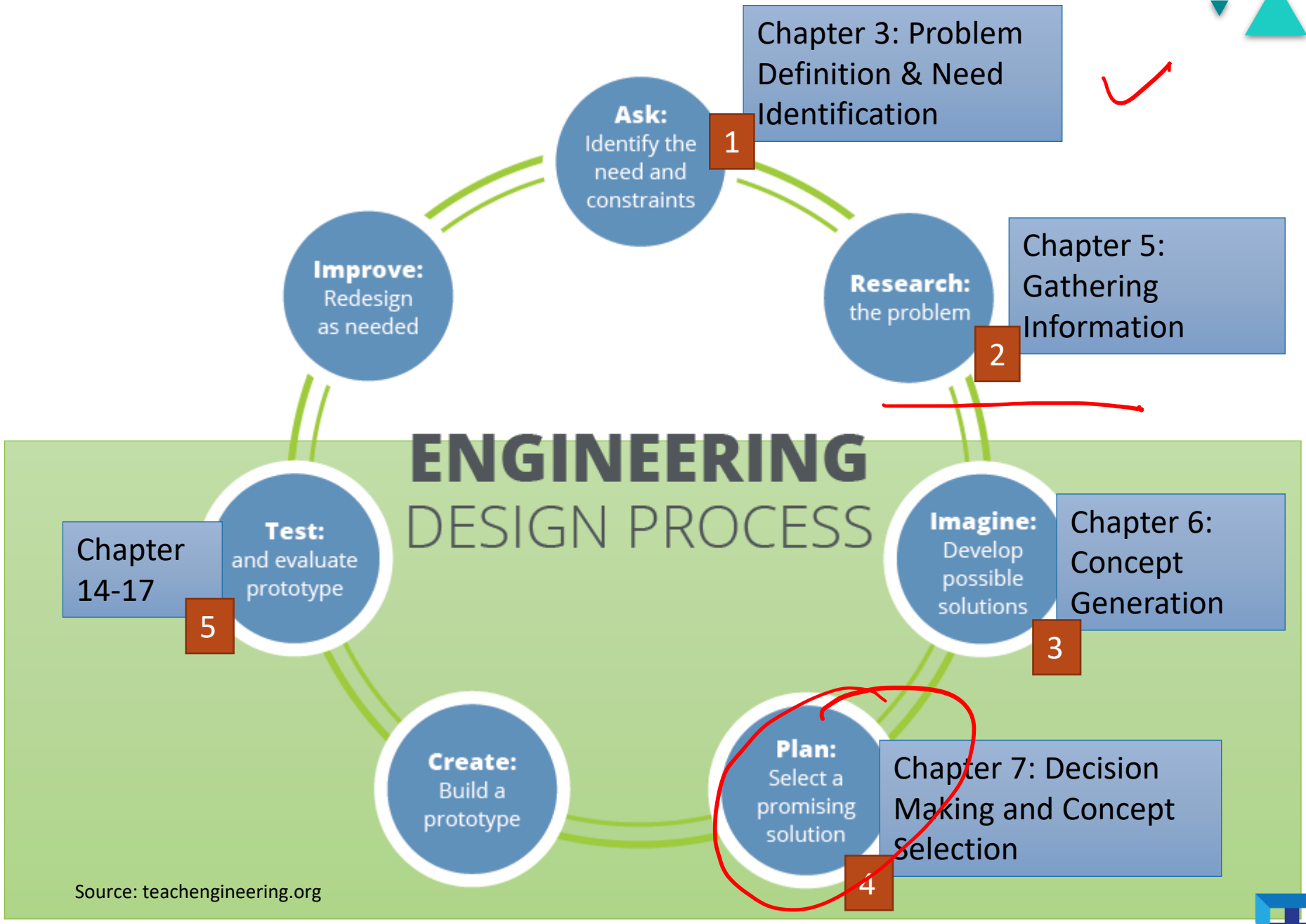
Teknik Elektro - STEI ITB

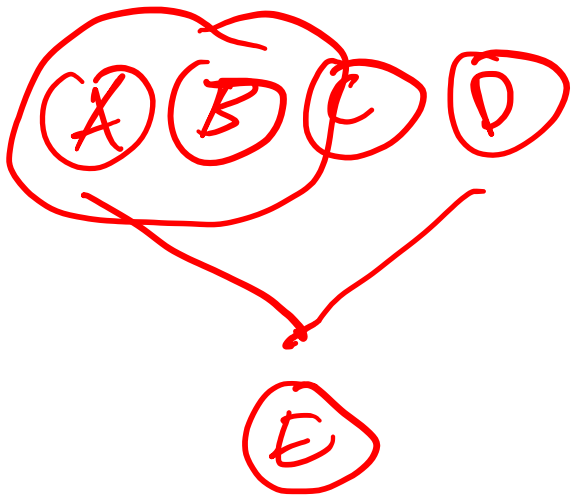
# Engineering Design Process
## Concept Generation, Concept Selection, Prototyping & Testing

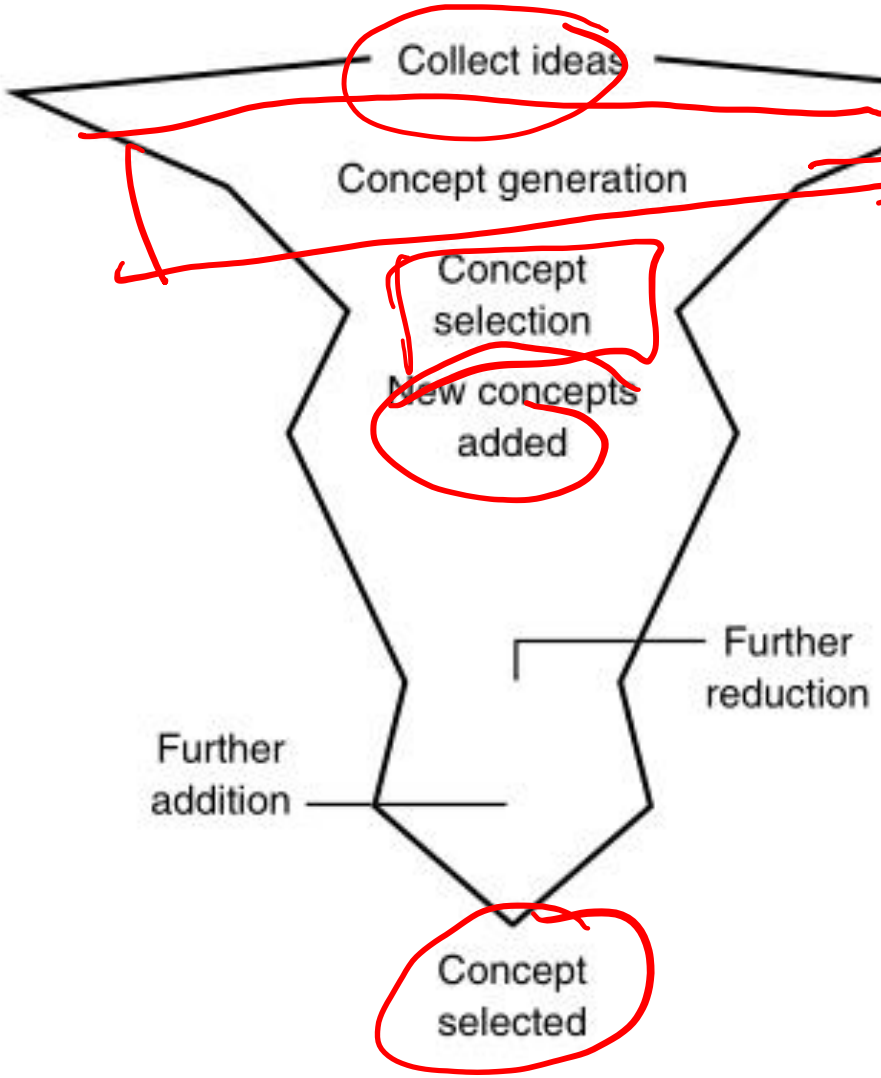
KU1202 – Pengantar Rekayasa dan Desain

# Referensi


SIXTH EDITION
PRODUCT DESIGN
AND DEVELOPMENT
Karl T. Ulrich | Steven D. Eppinger
Mc Graw Hill Education


ENGINEERING
DESIGN PROCESS
Ask: Identify the need and constraints
1
Research: the problem
2
Imagine: Develop possible solutions
3
Plan: Select a promising solution
4
Create: Build a prototype
Test: and evaluate prototype
5
Improve: Redesign as needed
Chapter 3: Problem Definition & Need Identification
Chapter 5: Gathering Information
Chapter 6: Concept Generation
Chapter 7: Decision Making and Concept Selection
Chapter 14-17
Source: teachengineering.org



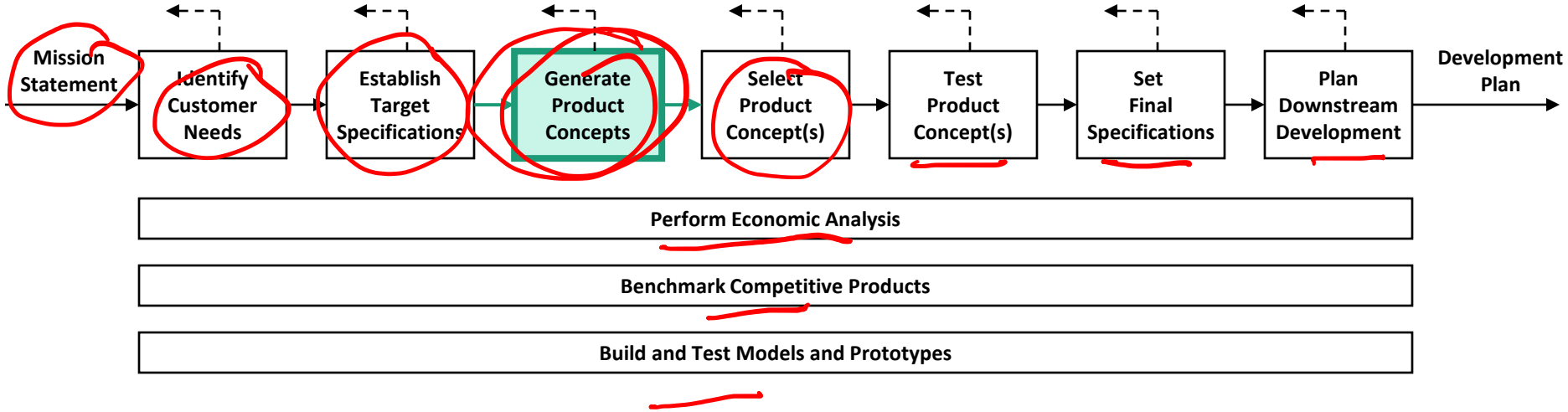




Wavelet Transform, CNN,

Concept generation and selection, viewed as alternating divergent and convergent processes.

# Concept Generation

# Concept Development Process

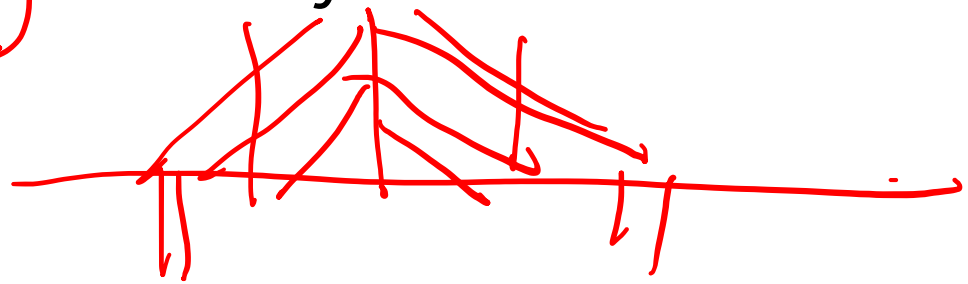


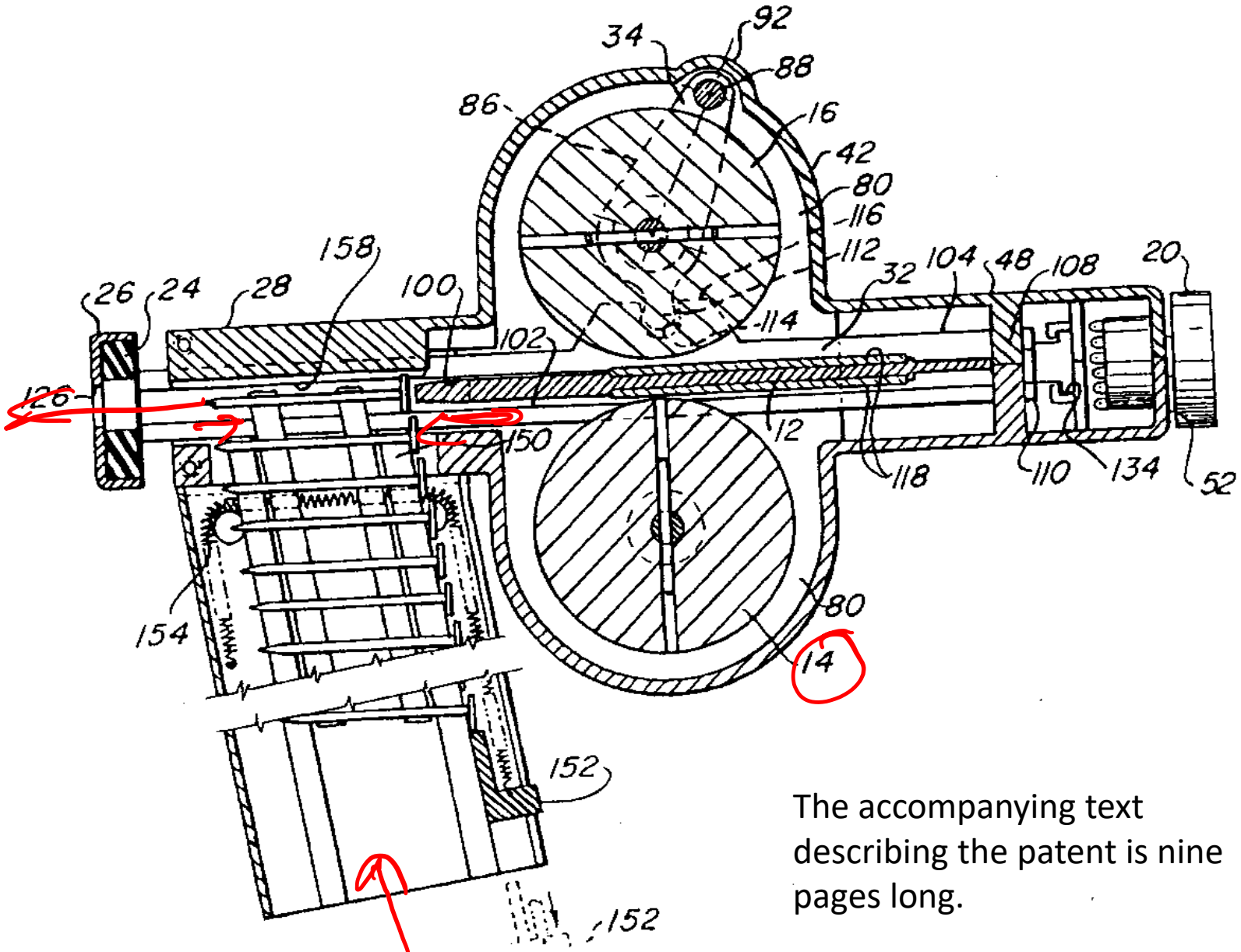
# Outline

1. Product concept, definition
2. Commonly dysfunctions in product development
3. Five steps in the product concept generation process

# Product Concept

- A technical description of how the product will satisfy the customer's needs
- An approximate description of
  - the technology,
  - working principles, and
  - form of the product
- Often expressed with a sketch or 3D model, accompanied with a brief textual description.






The accompanying text describing the patent is nine pages long.

Concept from motor-driven double-flywheel nailer patent (U.S. Patent 4,042,036).

# Common dysfunctions during concept generation

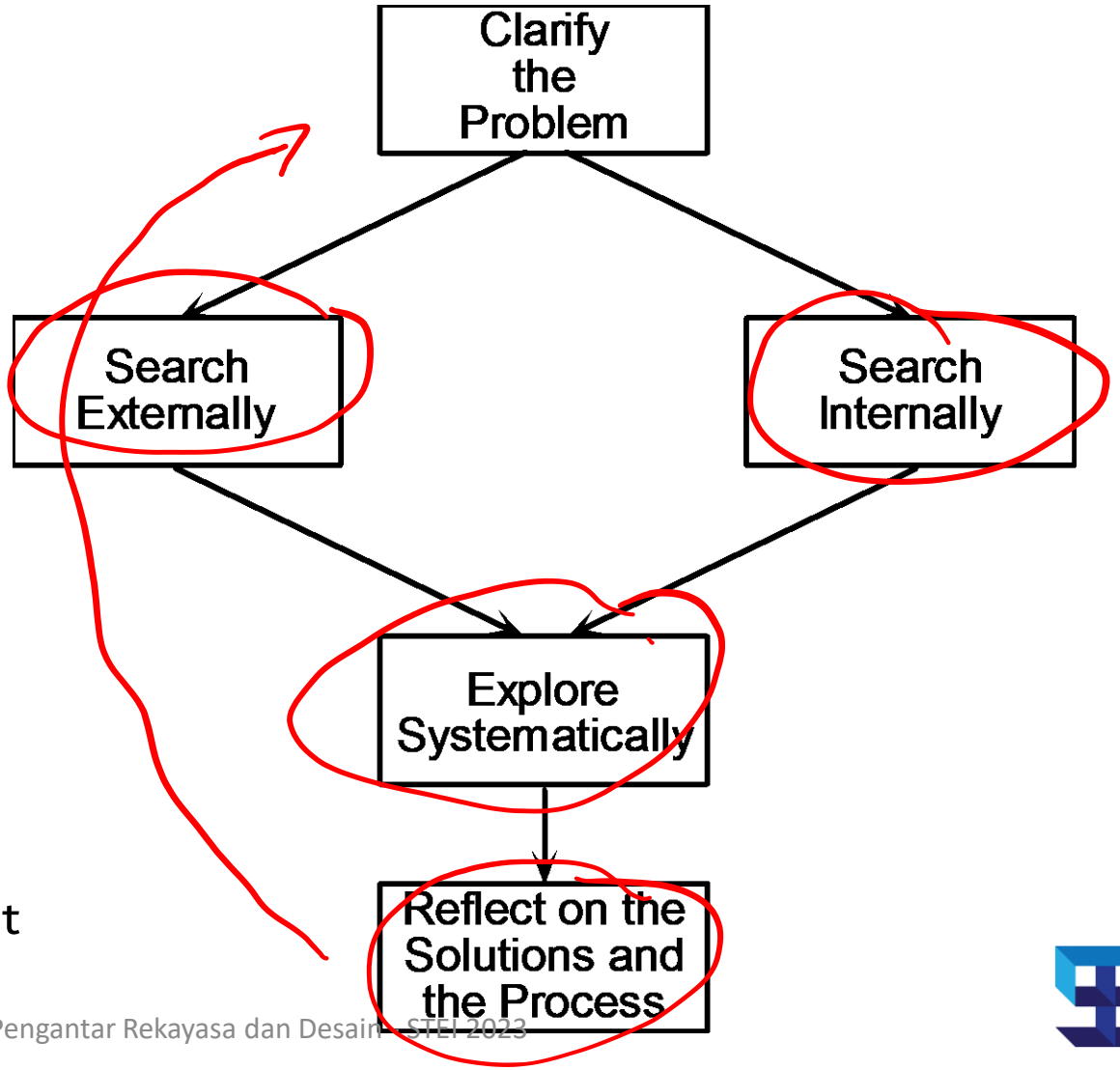
- Consider only one or two alternatives
- Fail to consider the usefulness of the concepts
- Involve only one or two people in the process
- Ineffectively integrate promising partial solutions
- Fail to consider entire categories of solutions

# Product Concept Generation Process (5 steps)

1. Clarify the problem
2. Search externally
3. Search internally
4. Explore systematically
5. Reflect on the solutions and the process.

# Concept Generation Process

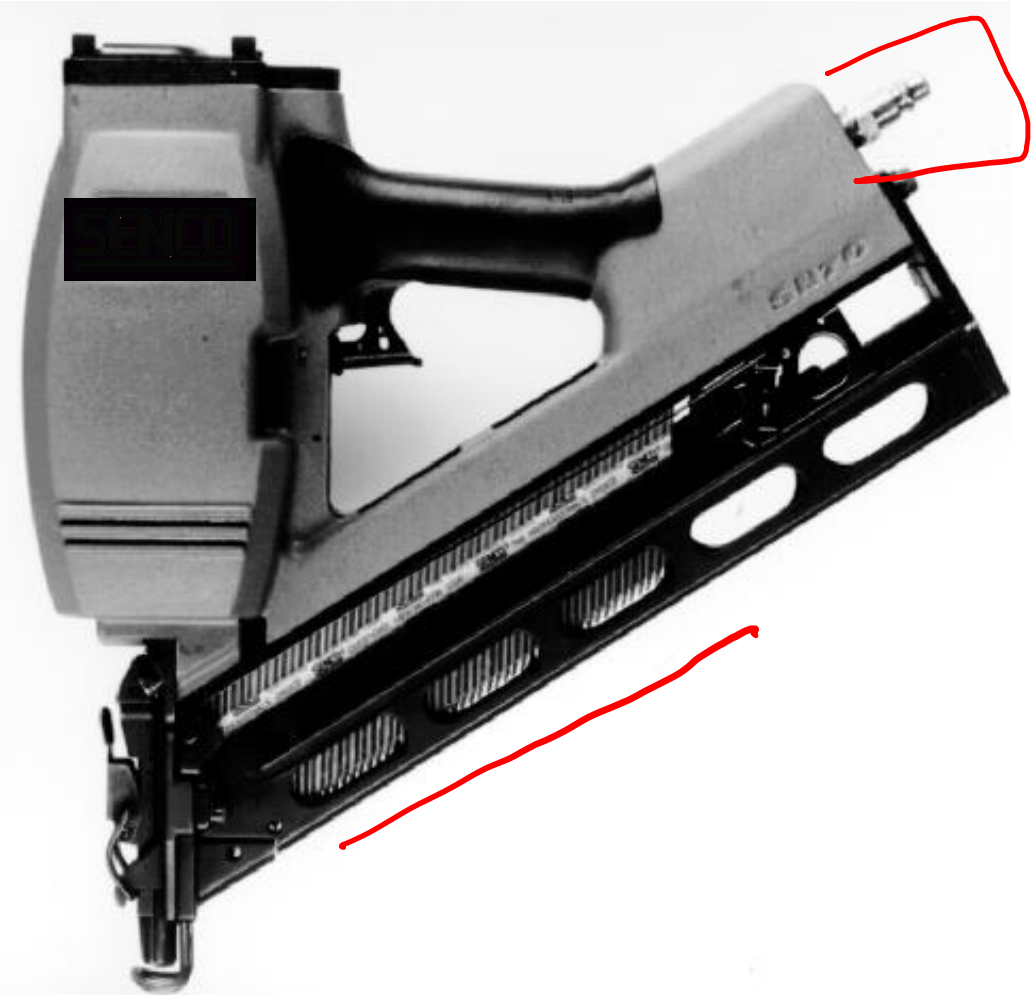
- Clarify the Problem
  - Problem Decomposition
- External Search
  - Lead Users
  - Experts
  - Patents
  - Literature
  - Benchmarking
- Internal Search
  - Individual Methods
  - Group Methods
- Systematic Exploration
  - Classification Tree
  - Combination Table
- Reflect on the Process
  - Continuous Improvement



# Product Concept

- Understand the problem
  - From the team's (product) mission statement
  - From the customers needs
  - From the product specifications
- Decompose the problem into simpler sub-problems
  - Divide and conquer
  - Using function diagrams
    - Decompose by sequence of user actions
    - Decompose by key customer's need
- Focus initial efforts on the critical sub-problems
  - Focus on critical sub-problems
  - Defer solutions to other sub-problems

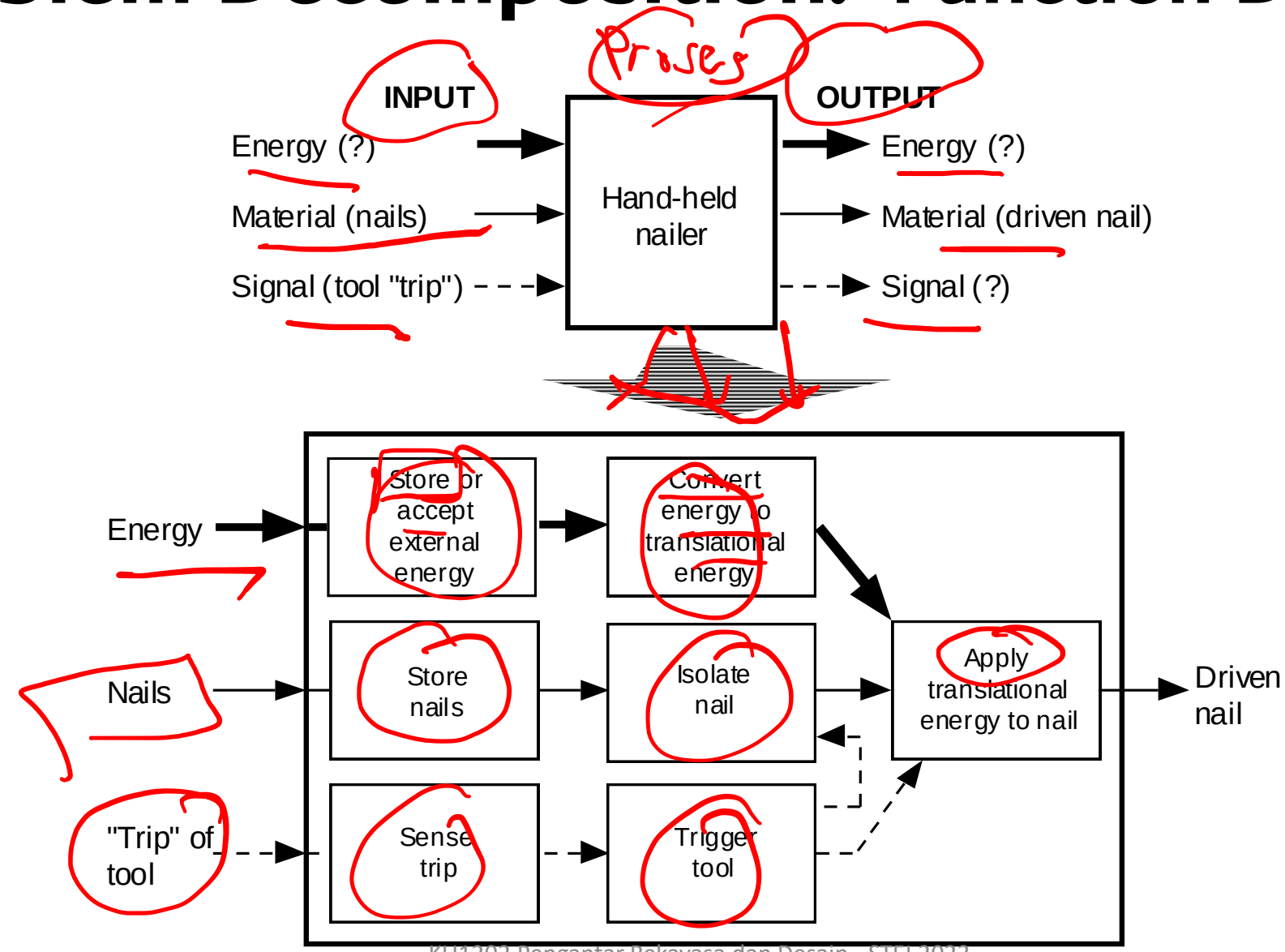
# Concept Generation Example: Power Nailer



# Understand the Problem

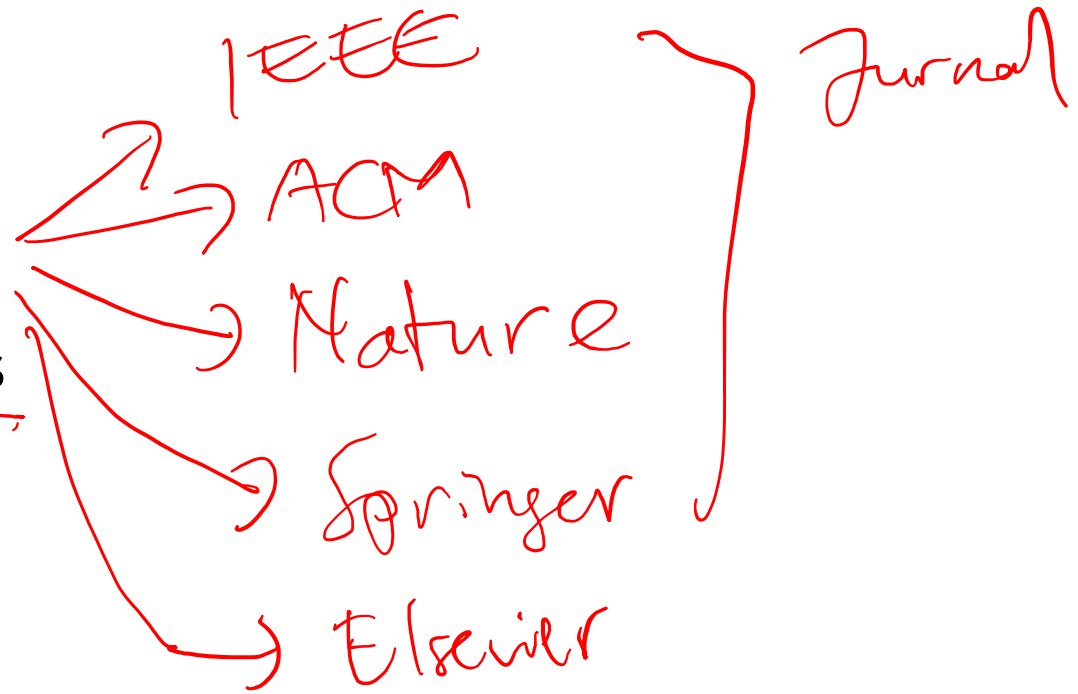
- From mission statement
  - It will use nails
  - It will be compatible with nail magazines
  - It will nail through roofing singles into wood
  - It will be hand held
- Based on assumptions
  - It inserts nails in rapid succession
  - It is light weight.
  - It has no nailing delays (from the user's view)
- From specifications
  - Nail length ranges from 25-28 mm
  - Nailing rate is 1 nail per second.
  - Tool mass is less than 4 KG.

# Problem Decomposition: Function Diagram



# Search Externally

1. Interview lead users
2. Consult experts
3. Search patents
4. Search published literature
5. Benchmark related products



# External Search: Hints for Finding Related Solutions

- Lead Users
  - benefit from improvement
  - innovation source
- Benchmarking
  - competitive products
- Experts
  - technical experts
  - experienced customers
- Patents
  - search related inventions
- Literature
  - technical journals
  - trade literature

# Search Internally (both group and individually)

- **Guide for the search**
  - Suspend judgment
  - Generate a lot of ideas
  - Welcome ideas that seem infeasible
  - Use graphic and physical media

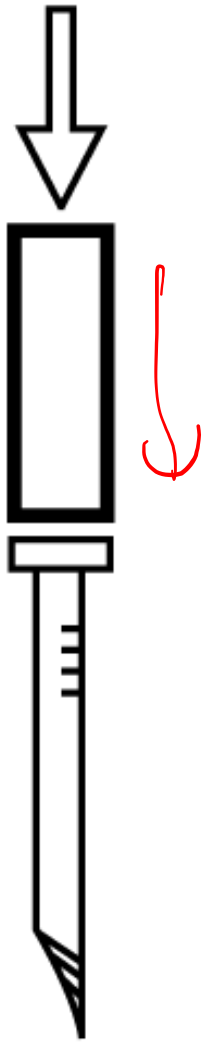
- **Hints for generating concepts**
  - Make analogies
  - Wish and wonder
  - Distort ideas → **SCRAMPER** (Substitute, Combine, Adapt, Modify/Magnify/Minimize, Put to other uses, Eliminate, and Reverse/Rearrange)
  - User related stimuli
  - Use unrelated stimuli →**synectics:** Occasionally, random or unrelated stimuli can be effective in encouraging new ideas.
  - Set quantitative goals → 10 to 20 concepts
  - Post ideas on the wall

# Internal Search: Hints for Generating Many Concepts

- Suspend judgment
- Generate a lot of ideas
- Infeasible ideas are welcome
- Use graphical and physical media
- Make analogies
- Wish and wonder
- Solve the conflict
- Use related stimuli
- Use unrelated stimuli
- Set quantitative goals
- Use the gallery method
- Trade ideas in a group

# Explore Systematically

- Concept combination tree
  - Page 132
  - Prune less promising branches
  - Identify independent approaches to the problem
  - Expose inappropriate emphasis on certain branches
  - Refine the problem decomposition for a particular branch.
- Concept combination table
  - Page 113



From *Product Design and Development*
by Karl Ulrich and Steven Eppinger
(McGraw-Hill/Irwin)

## Solutions to Subproblem of Storing or Accepting Energy

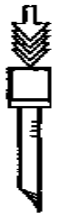
- Self-regulating chemical reaction emitting high-pressure gas
- Carbide (as for lanterns)
- Combusting sawdust from job site
- Gun powder
- Sodium azide (air bag explosive)
- Fuel-air combustion (butane, propane, acetylene, etc.)
- Compressed air (in tank or from compressor)
- Carbon dioxide in tank
- Electric wall outlet and cord
- High-pressure oil line (hydraulics)
- Flywheel with charging (spin-up)
- Battery pack on tool, belt, or floor
- Fuel cell
- Human power: arms or legs
- Methane from decomposing organic materials
- "Burning" like that of chemical hand warmers
- Nuclear reactions
- Cold fusion
- Solar electric cells
- Solar-steam conversion
- Steam supply line
- Wind
- Geothermal

## Solutions to Subproblem of Applying Translational Energy to Nail

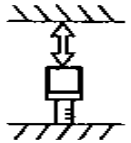
Single impact

Multiple impacts (tens or hundreds)

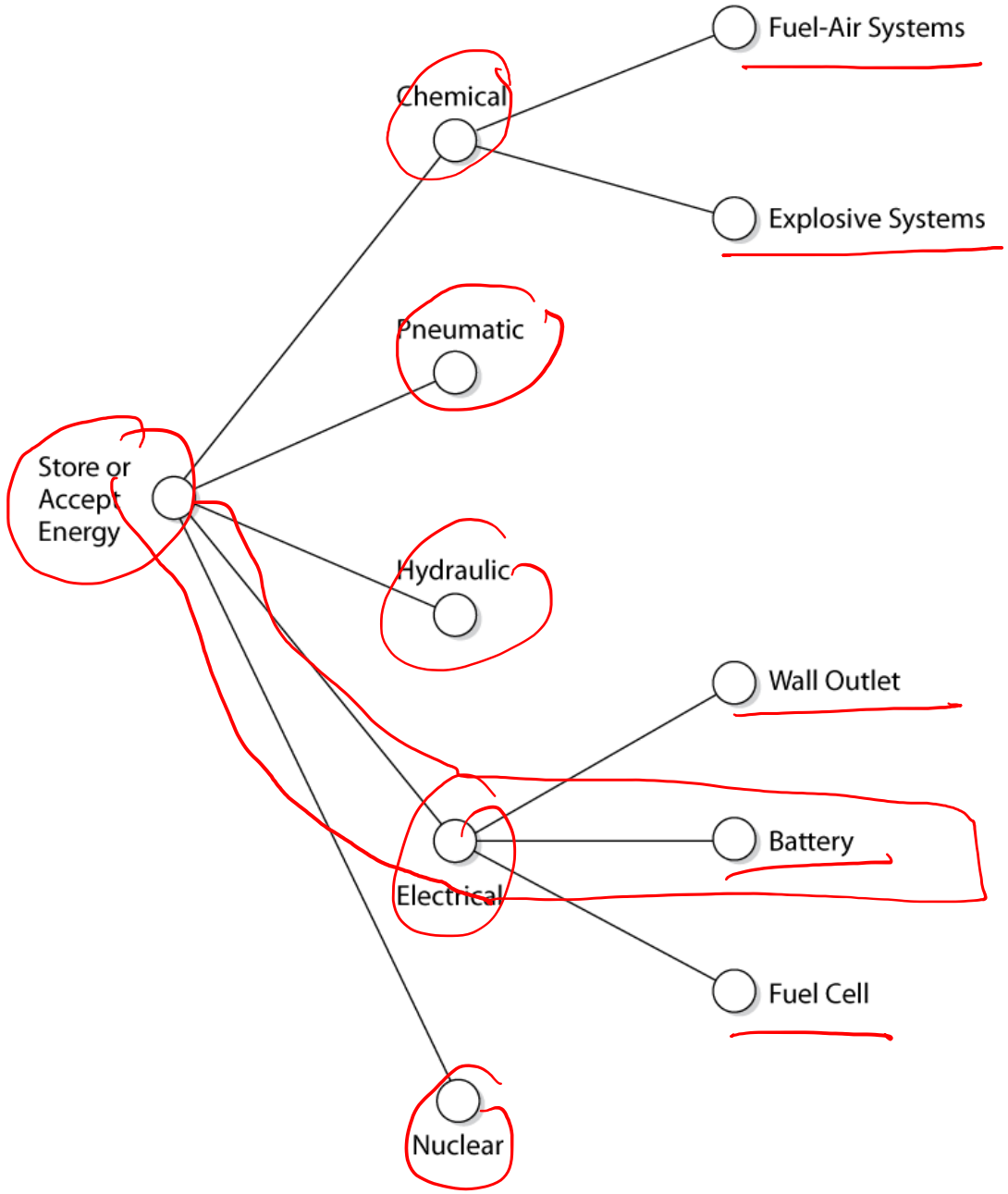
Multiple impacts (hundreds or thousands)



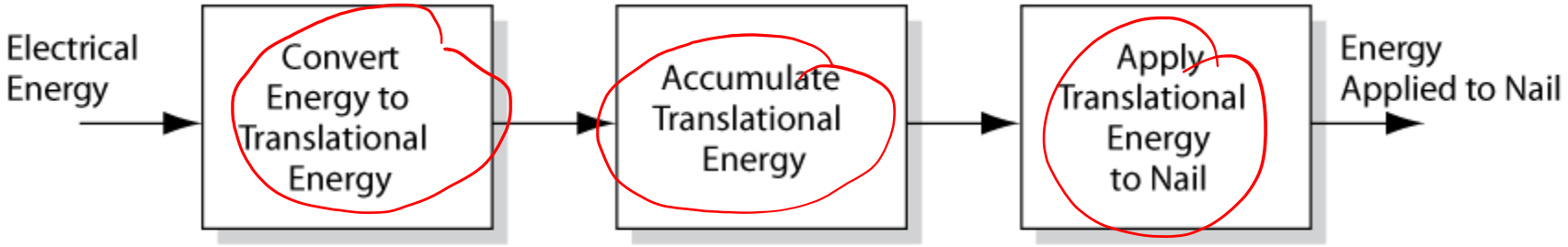
Push



Twist-push

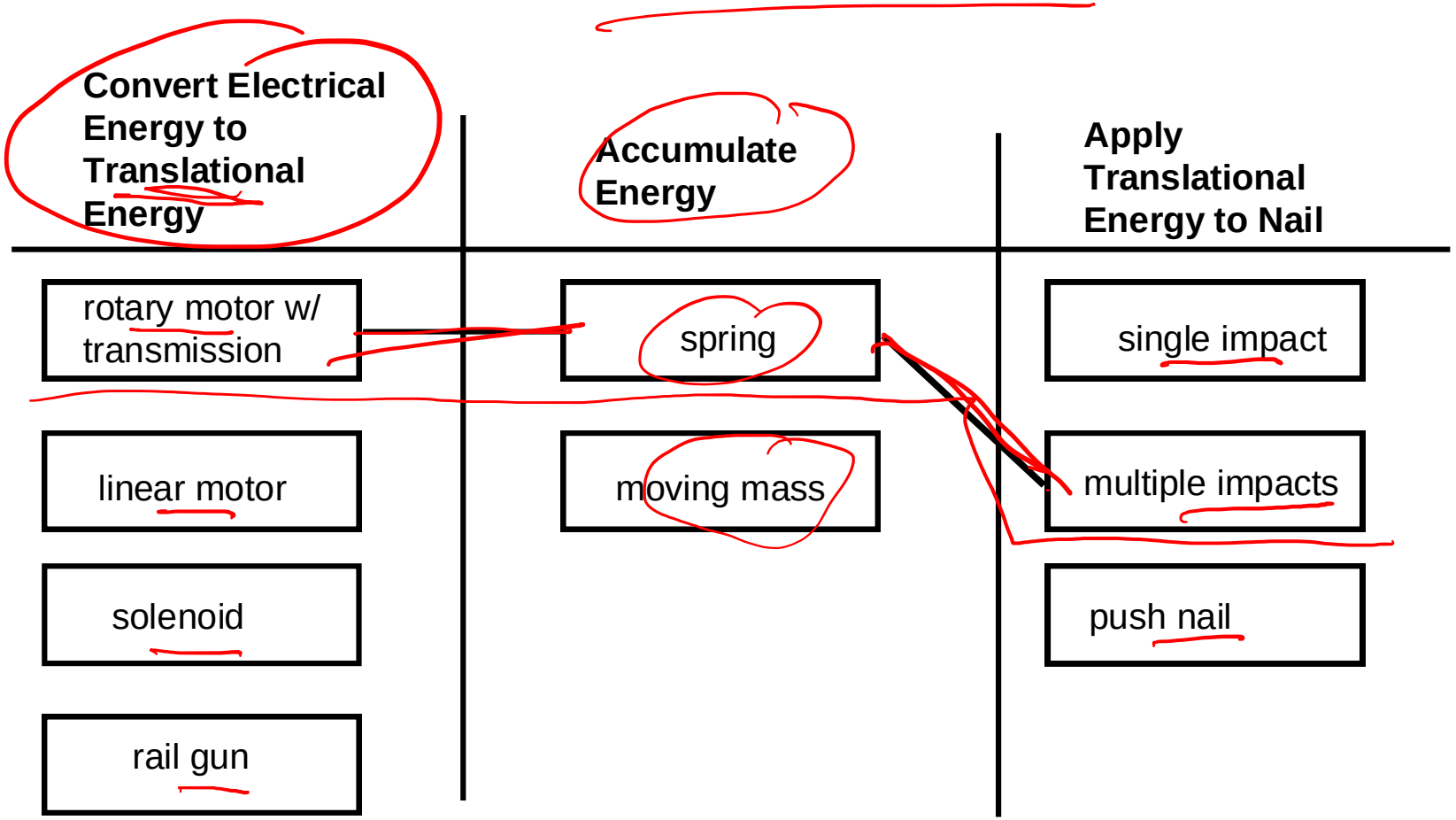


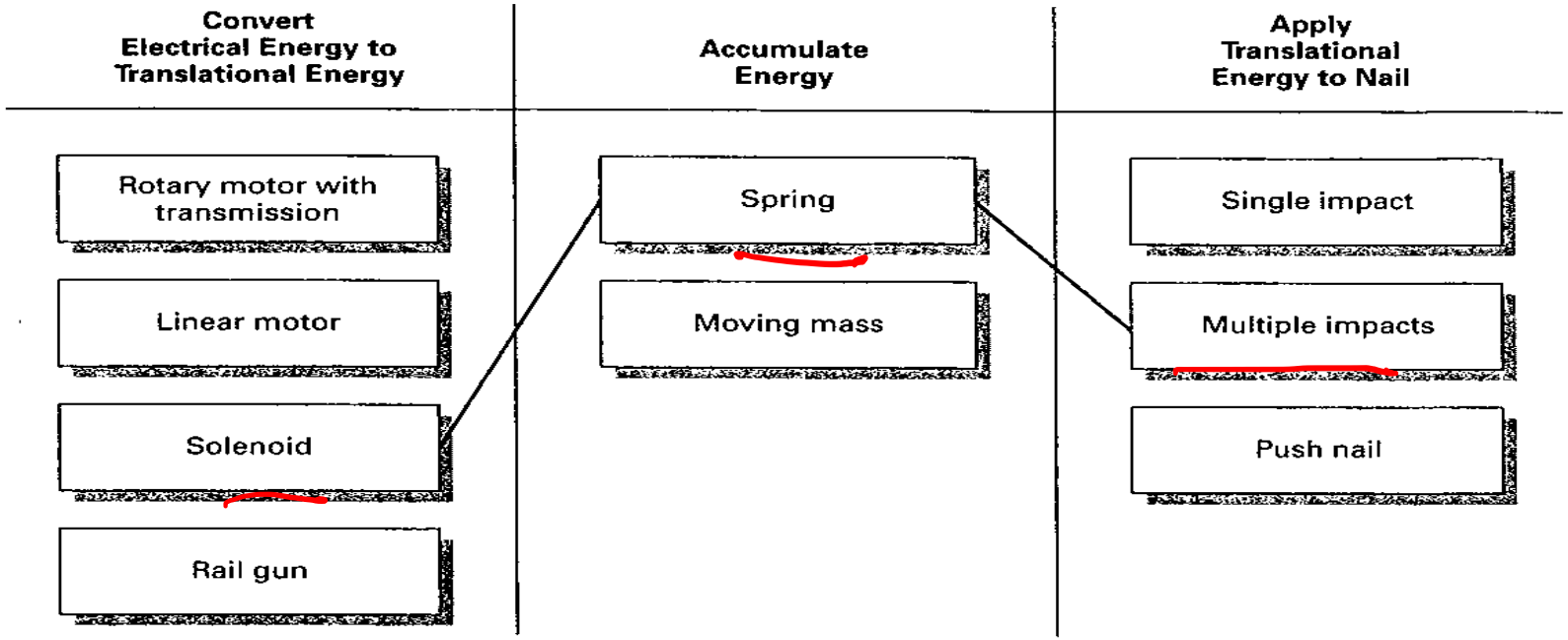

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

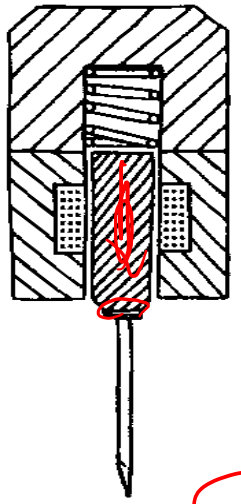



From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

# Systematic Exploration: Concept Combination Table

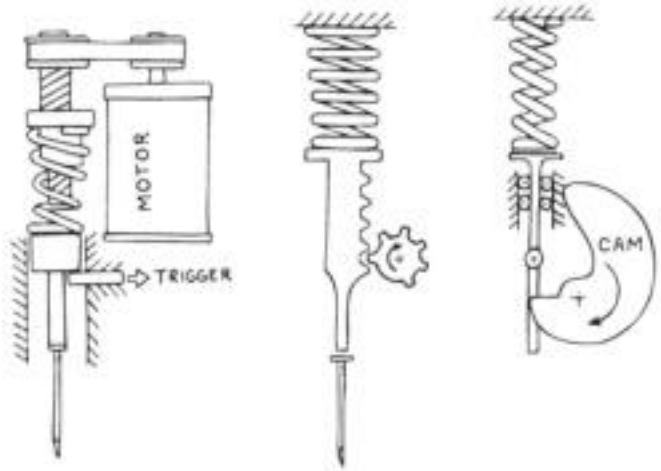




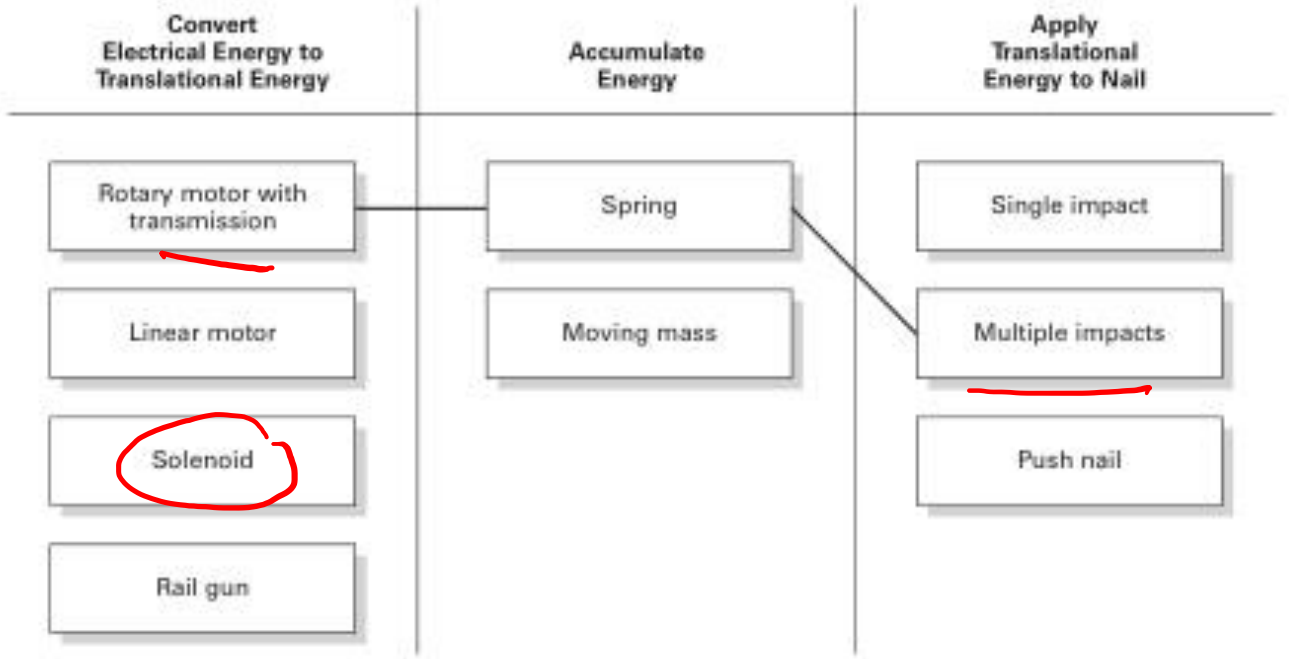



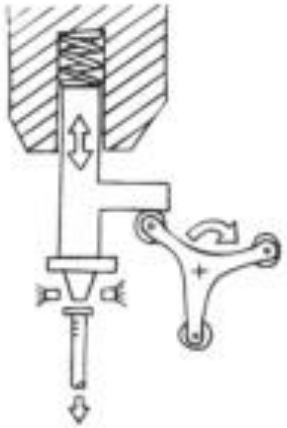
In this solution concept, a solenoid compresses a spring and then releases it repeatedly to drive the nail with multiple impacts.

| Convert Electrical Energy to Translational Energy | Accumulate Energy | Apply Translational Energy to Nail |
|---|---|---|
| Rotary motor with transmission | Spring | Single impact |
| Linear motor | Moving mass | Multiple impacts |
| Solenoid | | Push nail |
| Rail gun | | |

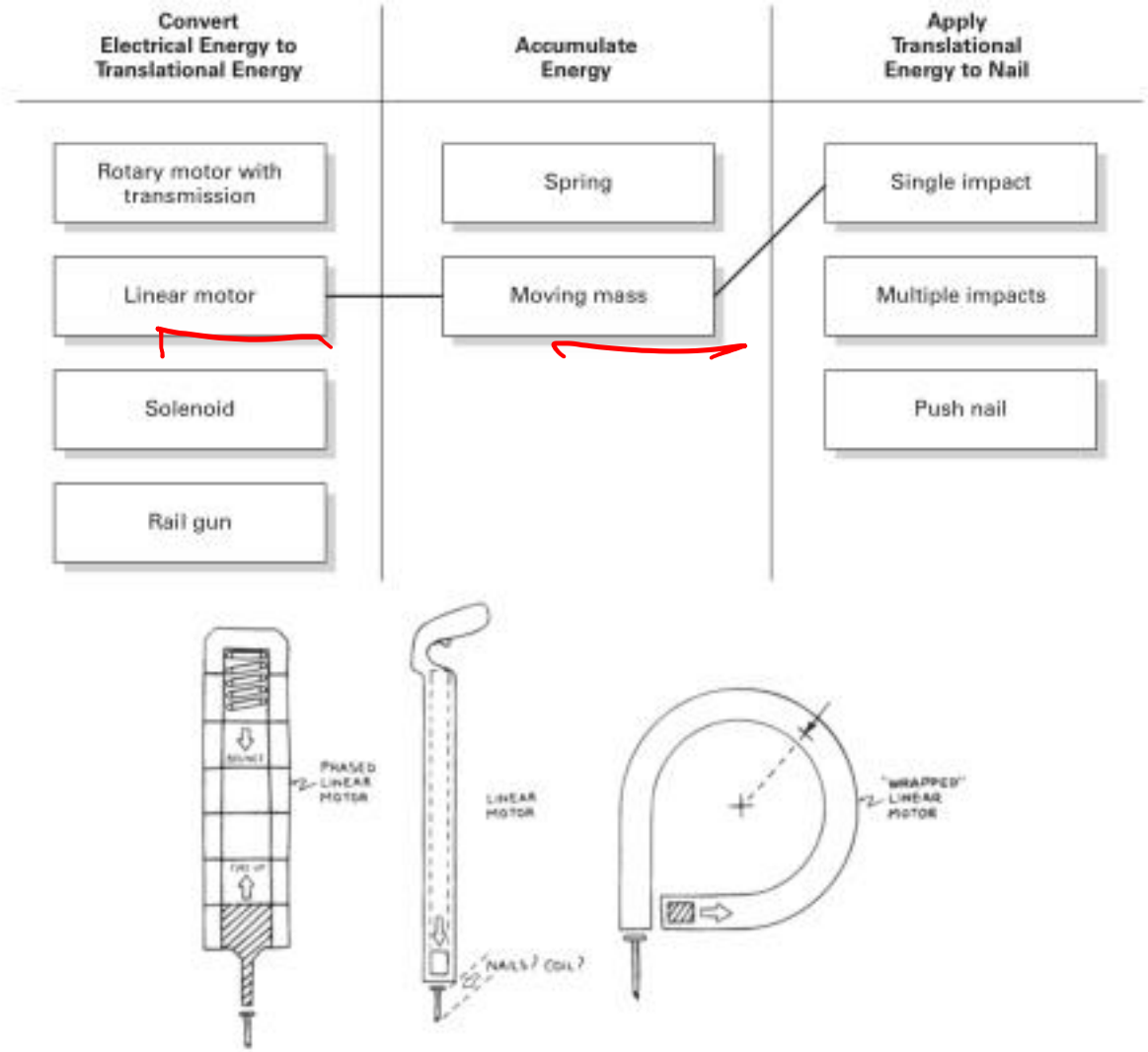



Multiple solutions arising from the combination of a motor with transmission, a spring, and single impact. The motor winds a spring, accumulating potential energy that is then delivered to the nail in a single blow.

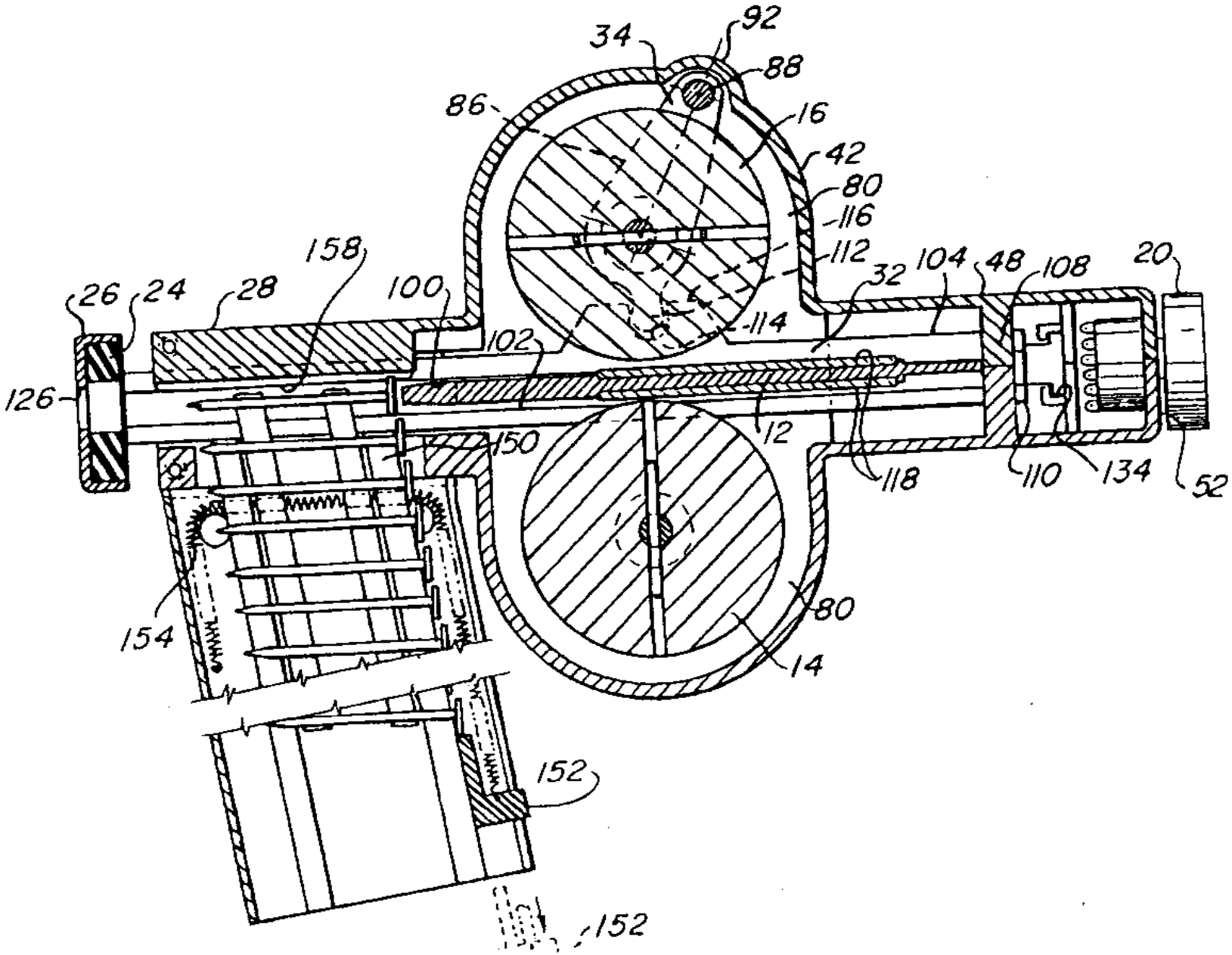


Solution from the combination of a motor with transmission, a spring, and multiple impacts. The motor repeatedly winds and releases the spring, storing and delivering energy over several blows.




Solutions from the combination of a linear motor, a moving mass, and single impact. A linear motor accelerates a massive hammer, accumulating kinetic energy that is delivered to the nail in a single blow.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# Concept Generation Example: Power Nailer

# Reflect on the Results

- The solution space?
- Alternative function diagrams?
- Alternative ways to decompose the problem?
- Additional external resources?
- All ideas generated and integrated?

# Concept Generation Exercise: Vegetable Peelers

# Vegetable Peeler Exercise: Voice of the Customer

- "Carrots and potatoes are very different."
- "I cut myself with this one."
- "I just leave the skin on."
- "I'm left-handed.  I use a knife."
- "This one is fast, but it takes a lot off."
- "How do you peel a squash?"
- "Here's a rusty one."
- "This looked OK in the store."

# Vegetable Peeler Exercise: Key Customer Needs

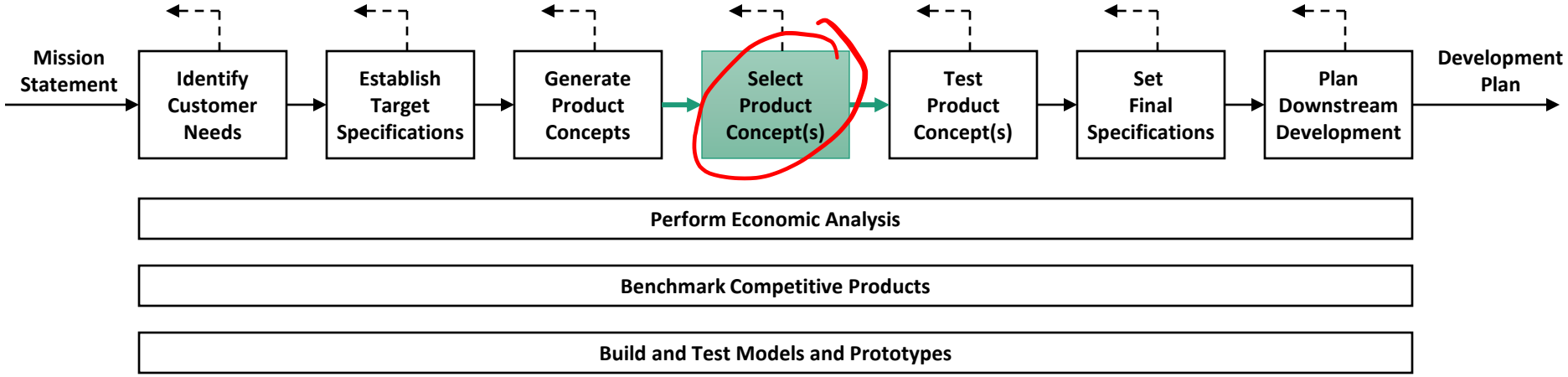
1. The peeler peels a variety of produce.
2. The peeler can be used ambidextrously.
3. The peeler creates minimal waste.
4. The peeler saves time.
5. The peeler is durable.
6. The peeler is easy to clean.
7. The peeler is safe to use and store.
8. The peeler is comfortable to use.
9. The peeler stays sharp or can be easily sharpened.

# Exercise:

- Could you apply the five-step method to an everyday problem like choosing the food for a picnic?
  - Five step method:
    1. **Clarify the problem.** Understand the problem and decompose it into simpler sub-problems.
    2. **Search externally.** Gather information from lead users, experts, patents, published literature, and related products.
    3. **Search internally**. Use individual and group methods to retrieve and adapt the knowledge of the team.
    4. **Explore systematically**. Use classification trees and combination tables to organize the thinking of the team and to synthesize solution fragments.
    5. **Reflect on the solutions and the process**. Identify opportunities for improvement in subsequent iterations or future projects.

# Concept Selection

# Concept Development Process



# Outline

- Introduction to product concept selection
- Commonly dysfunctions in product development
- Product concept selection process

# Definition

- Product concept selection is a decision process, in which the design team selects one or a few product concept for further development

# Challenges

- How to choose the best concept of abstraction?
- How to embrace all inputs (likings and concerns) from the whole team in the decision process?
- How to make use of good attributes of otherwise weak concept designs?
- How to document the decision process?

# Concept Selection Approaches

- External decision
  - By use of an external group of customers, clients, etc.
- Product champion & intuition
  - By an influential member of the development team
- Multi-voting
  - Asking each member to pick a number of concepts and pick the one with most votes.

- Pros and cons
  - The team list the strengths and weakness of each concept.
- Prototype and test
  - Build and test prototype for each concept and select based on the test data.
- Decision metrics
  - The team rates each concept against selection criteria with varying importance/weights.

# Two stages of concept selection

- Concept screening (the Pugh concept selection method)
  - To quickly narrow the number of concepts and to improve the concepts
- Concept scoring
  - weighs the relative importance of the selection criteria
  - focus on more refined comparisons with respect to each criteria

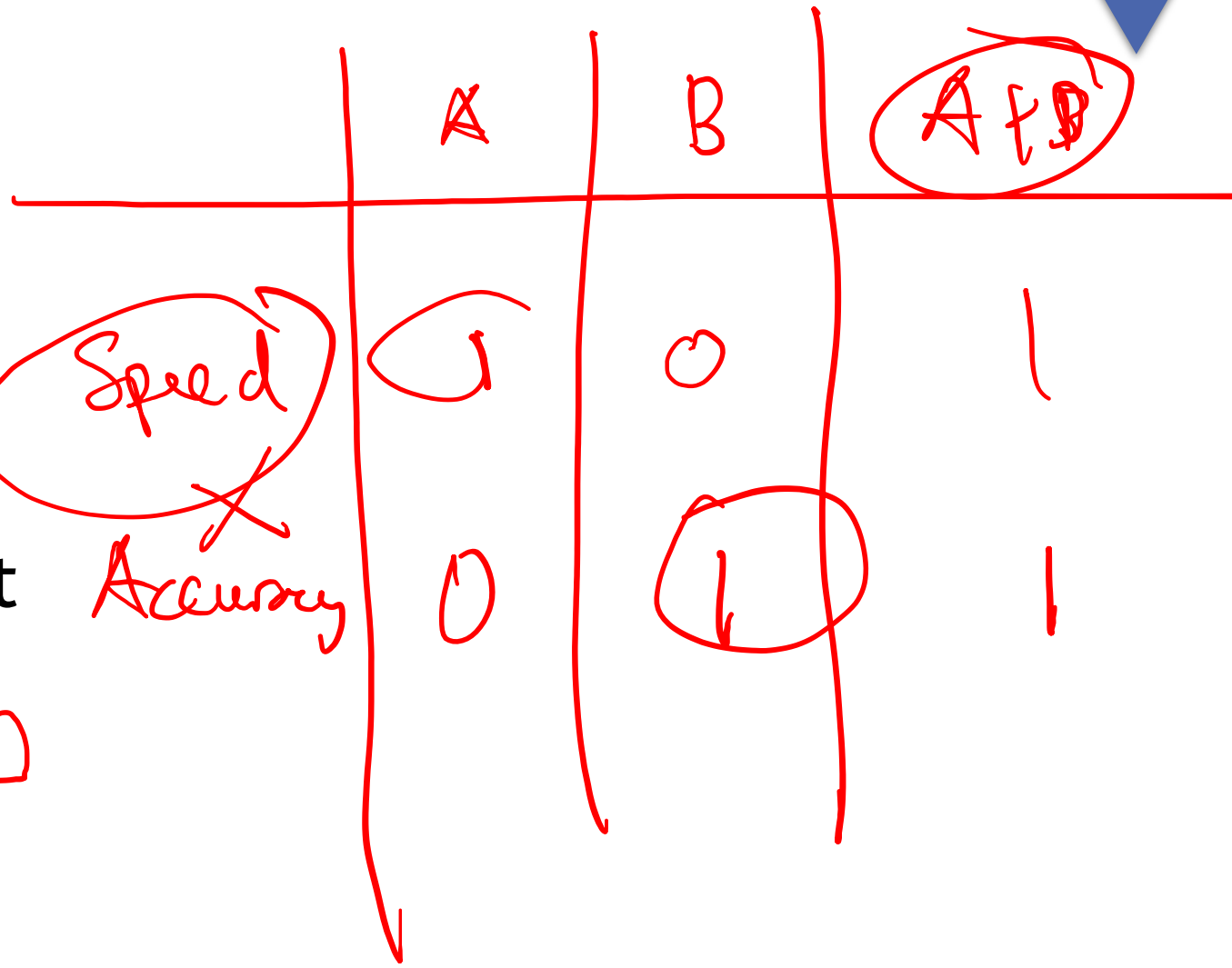
# Concept Selection Process

1. Prepare the Matrix
   - Criteria
   - Reference Concept
   - Weightings
2. Rate Concepts
   - Scale (– 0 +) or (1–5)
   - Compare to Reference Concept or Values
3. Rank Concepts
   - Sum Weighted Scores

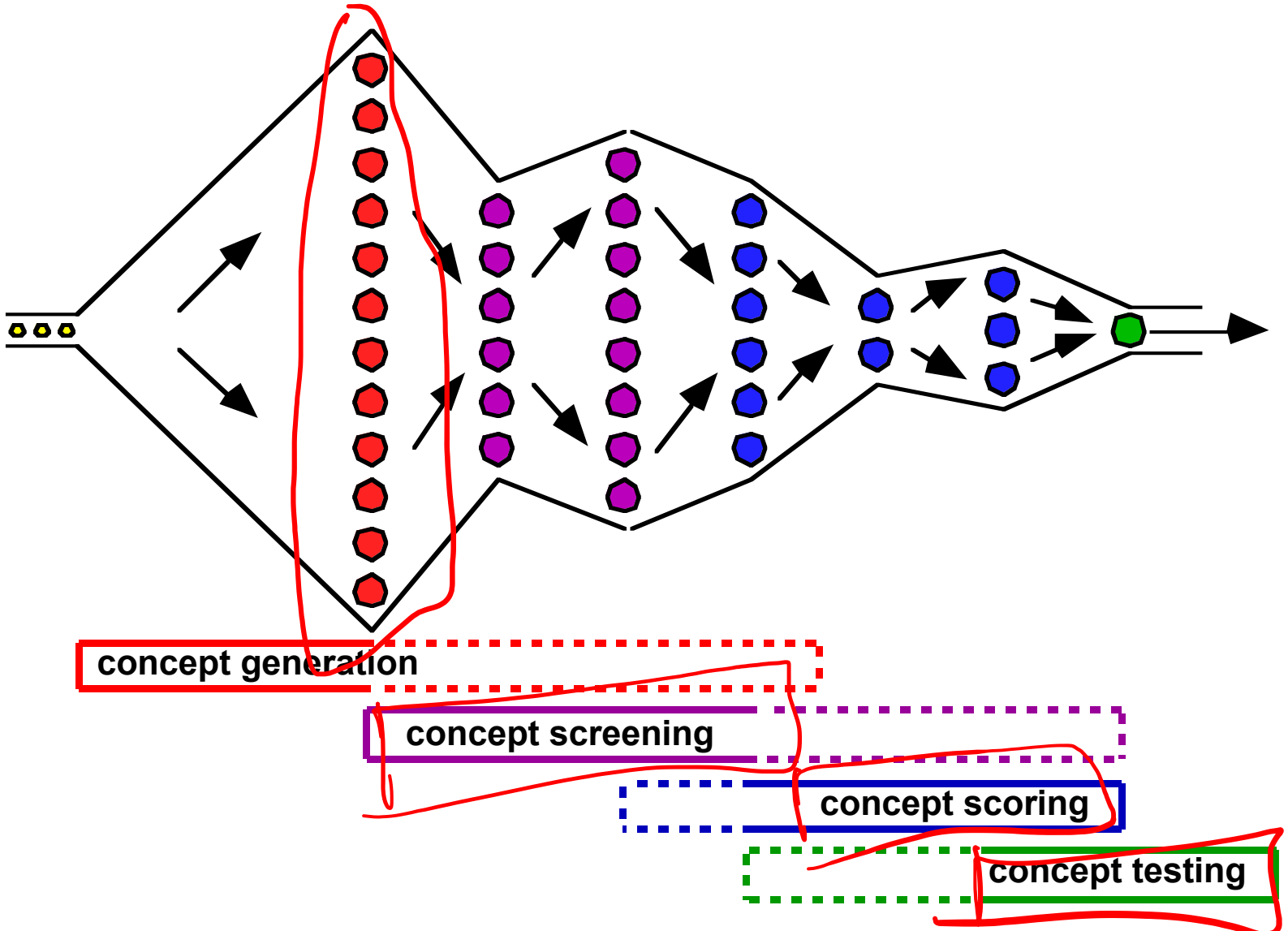
| | Criteria | A | D | C |
|---|---|---|---|---|
| $q_0$ | CPU (0.5) | 1 | | |
| $q_1$ | Memory (0,2) | 1 | | |
| $q_2$ | Package (0,1) | 1 | | |
| $q_3$ | Apps (0,1) | 1 | | |
| | | 1 | 0,5 | 0,5 |

$$\sum_{i=0}^{n} q_i \times w_i$$

4. Combine and Improve
   - Remove Bad Features
   - Combine Good Qualities
5. Select the Best Concept
   - May Be More than One
   - Beware of Average Concepts
6. Reflect on the Process
   - Continuous Improvement



# Concept Development Funnel



# Remember...

The goal of concept selection is not to

- Select the best concept.

The goal of concept selection is to

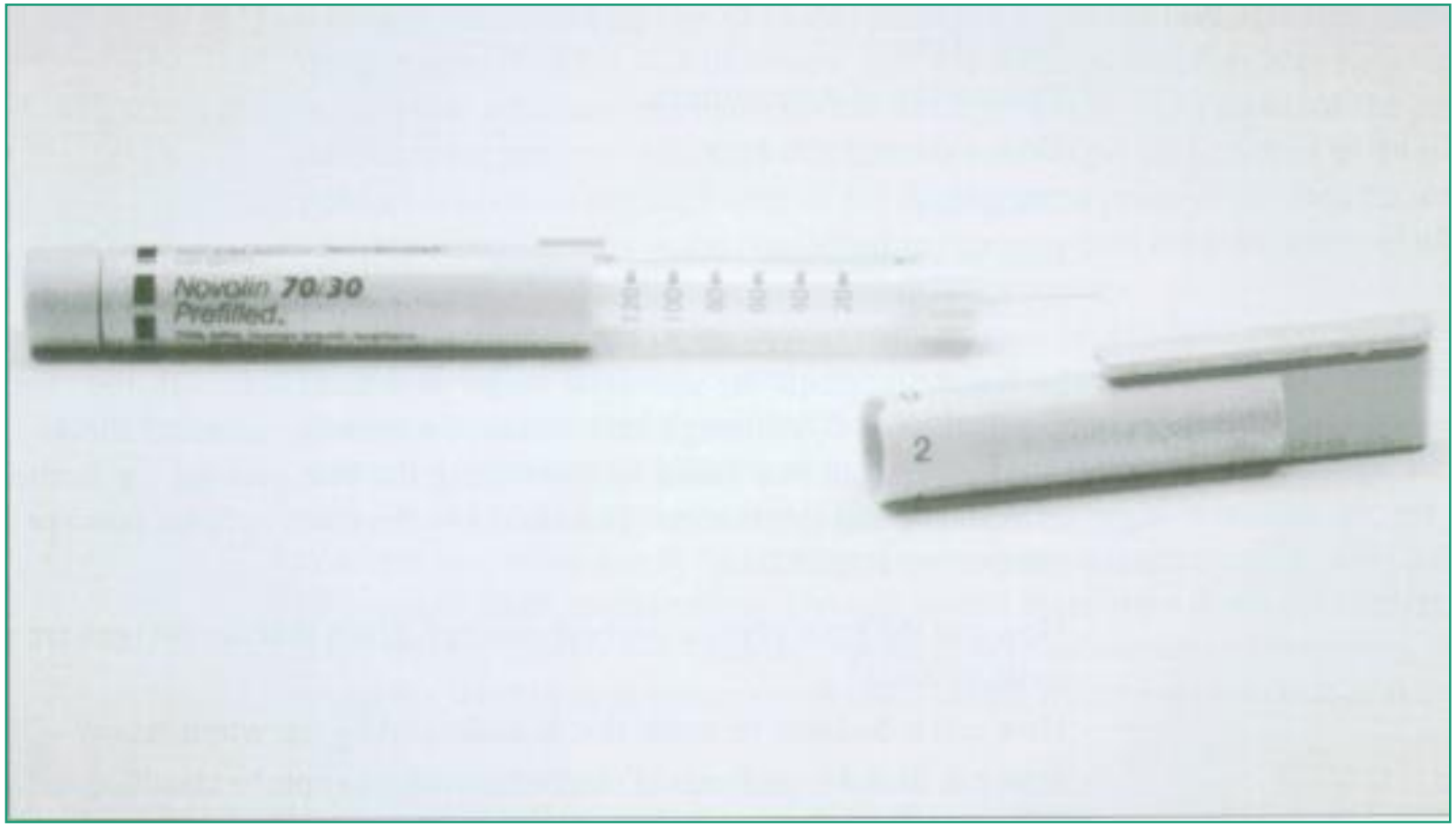
- Develop the best concept.

So remember to combine and refine the concepts to develop better ones!

# Caveats

- Beware of the best "average" product.
- Perform concept selection for each different customer group and compare results.
- Check sensitivity of selection to the importance weightings and ratings.
- May want to use all of detailed requirements in final stages of selection.
- Note features which can be applied to other concepts.

# Concept Selection Example: Reusable Syringe



# Mission Statement

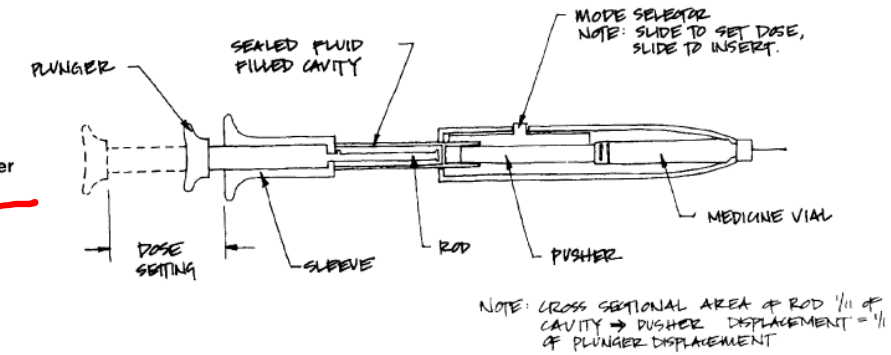
- Product description:
  - Reusable syringe with precision dosage control for outpatient use.
- Primary market
  - Elderly
- Major features:
  - Accuracy of dose metering
  - Inexpensive

# Need analysis

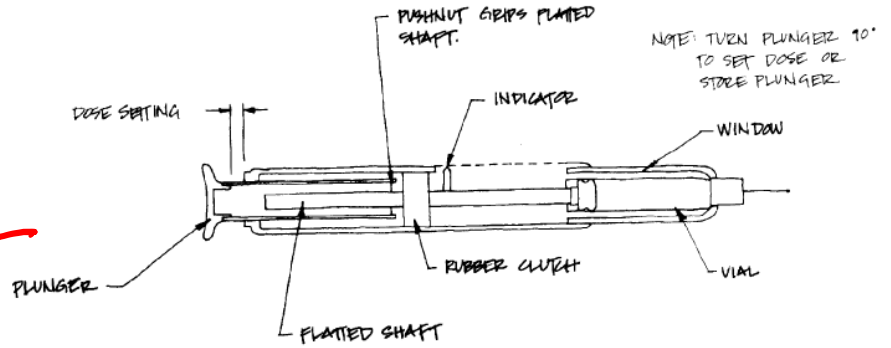
- Ease of handling
- Ease of use
- Readability of dose settings
- Accuracy of dose metering
- Durability
- Ease of manufacture
- Portability

# Seven concepts for the outpatient syringe

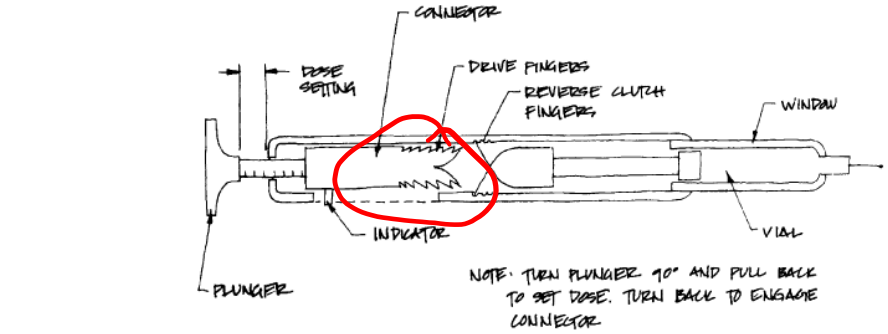
Concept A: Master Cylinder



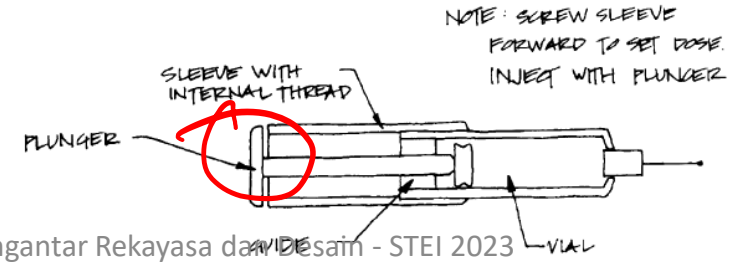

Concept B: Rubber Brake




Concept C: Ratchet

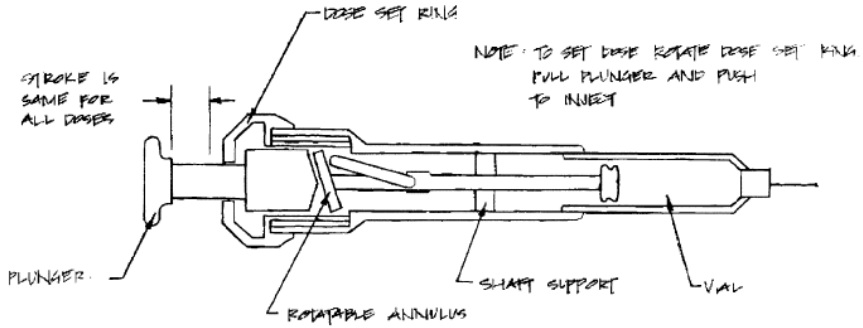



Concept D: Plunge Stop

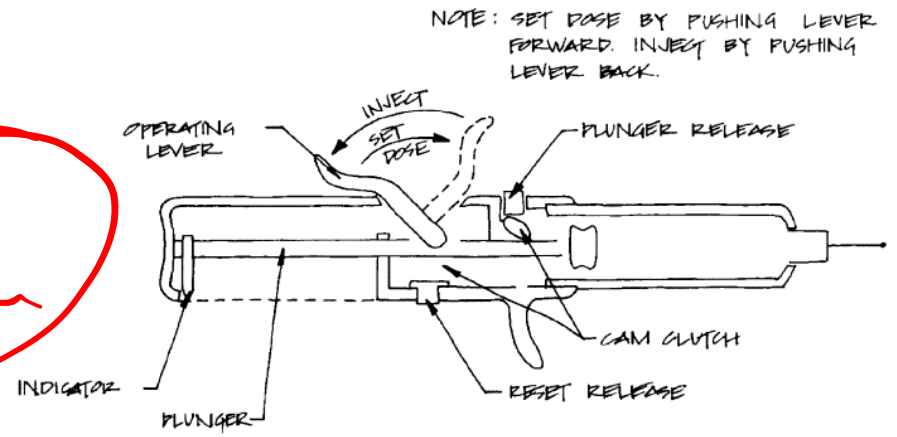



From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

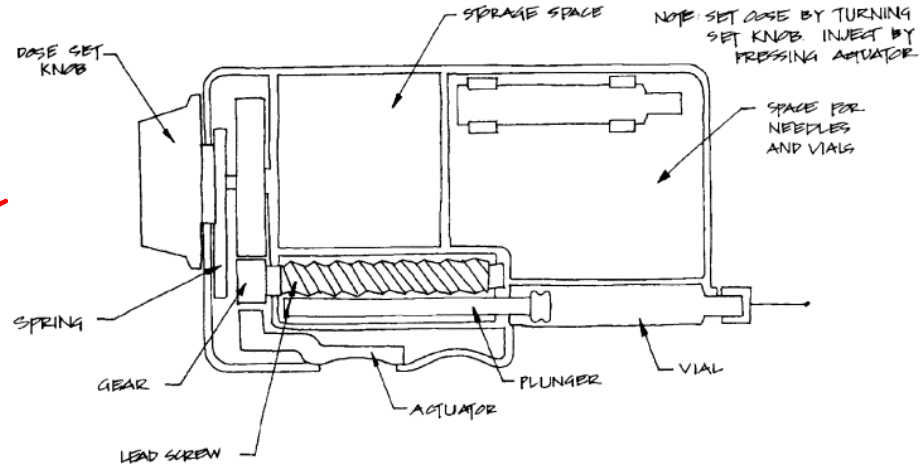
**Concept E: Swash Ring**




**Concept F: Lever Set**




**Concept G: Dial Screw**




From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

# Concept screening steps

1. Prepare a selection matrix based on the selection criteria
2. Rate the concepts
3. Rank the concepts
4. Combine and improve concepts
5. Select one or more concepts
6. Reflect on the results and the process

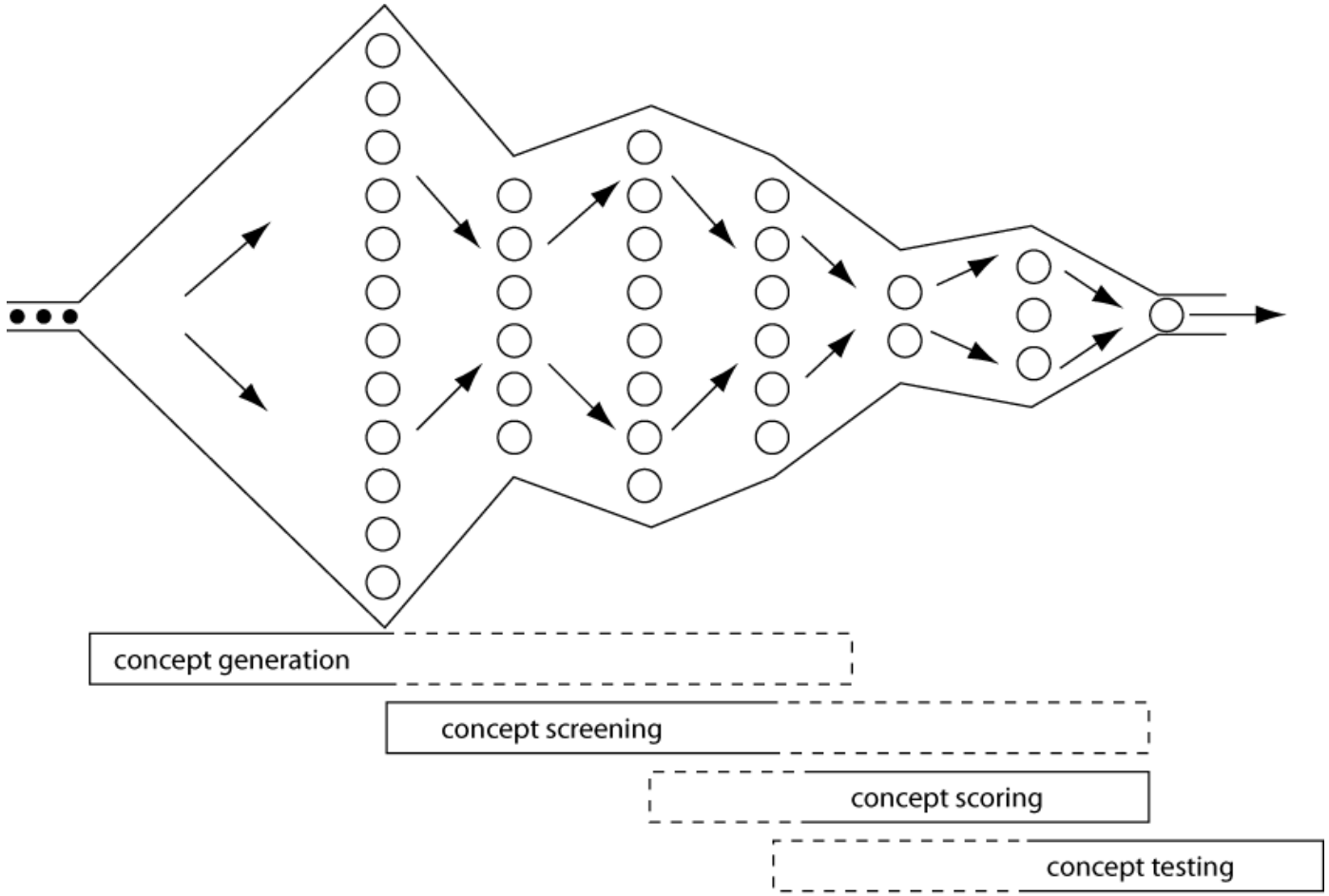
# Concept screening principles

- Be focused on customer needs
- Match or exceed competitors' performance along key dimensions
- Improve the product's manufacturability
- Reduce lead time
- Encourage more and effective participation from the design team members
- Have better documentation of the decision process.

# Example: Concept Screening

| | Concepts | | | | | | |
|---|---|---|---|---|---|---|---|
| Selection Criteria | A Master Cylinder | B Rubber Brake | C Ratchet | D (Reference) Plunge Stop | E Swash Ring | F Lever Set | G Dial Screw |
| Ease of handling | 0 | 0 | – | 0 | 0 | – | – |
| Ease of use | 0 | + | – | 0 | 0 | + | 0 |
| Readability of settings | 0 | 0 | + | 0 | + | 0 | + |
| Dose metering accuracy | 0 | 0 | 0 | 0 | – | 0 | 0 |
| Durability | 0 | 0 | 0 | 0 | 0 | + | 0 |
| Ease of manufacture | + | – | – | 0 | 0 | – | 0 |
| Portability | + | + | 0 | 0 | + | 0 | 0 |
| Sum +'s | 2 | 1 | 1 | 0 | 2 | 2 | 1 |
| Sum 0's | 5 | 4 | 3 | 7 | 4 | 3 | 5 |
| Sum –'s | 0 | 2 | 3 | 0 | 1 | 2 | 1 |
| Net Score | 2 | –1 | –2 | 0 | 1 | 0 | 0 |
| Rank | 1 | 4 | 7 | 3 | 2 | 3 | 3 |
| Continue? | Yes | No | No | Combine | Yes | Combine | Revise |

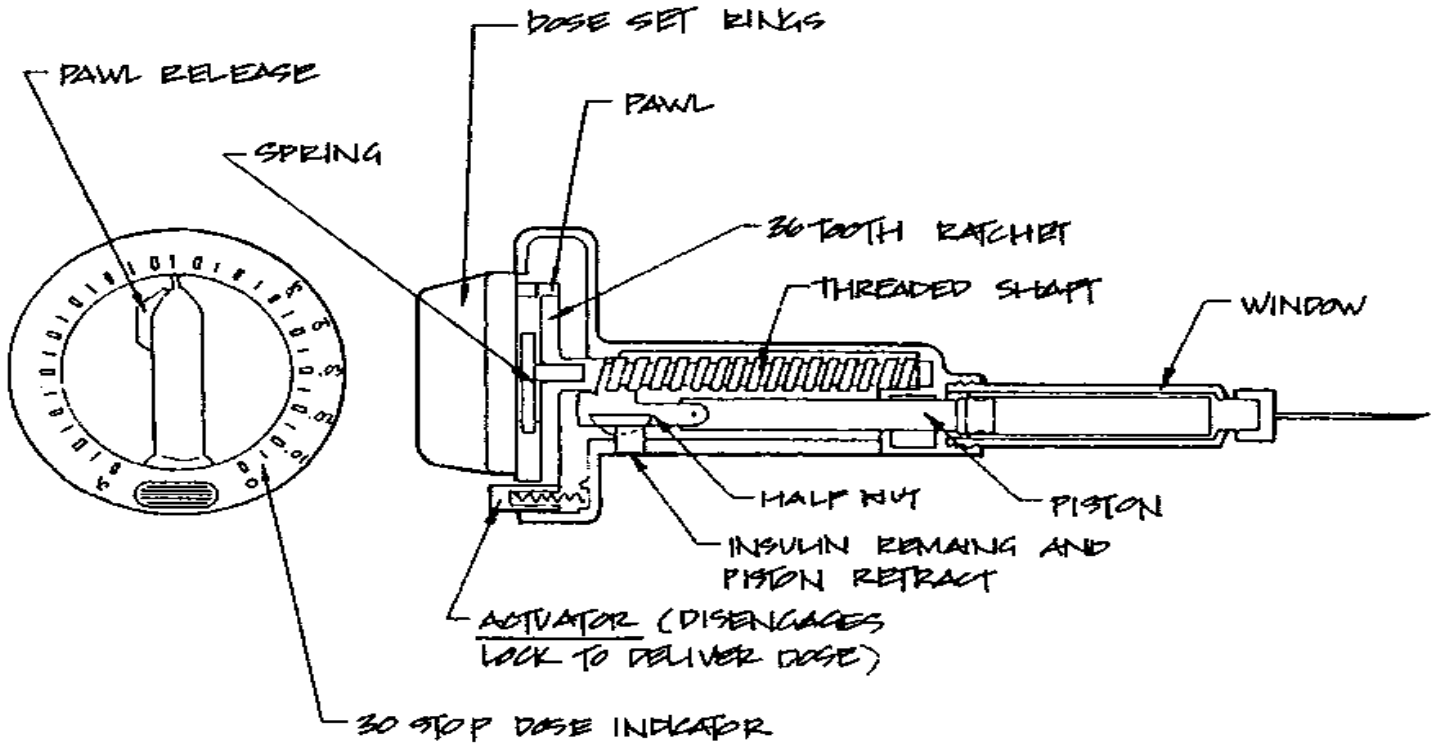
The concept-screening matrix. For the syringe example, the team rated the concepts against the reference concept using a simple code (1 for "better than," 0 for "same as," 2 for "worse than") to identify some concepts for further consideration. Note that the three concepts ranked "3" all received the same net score.



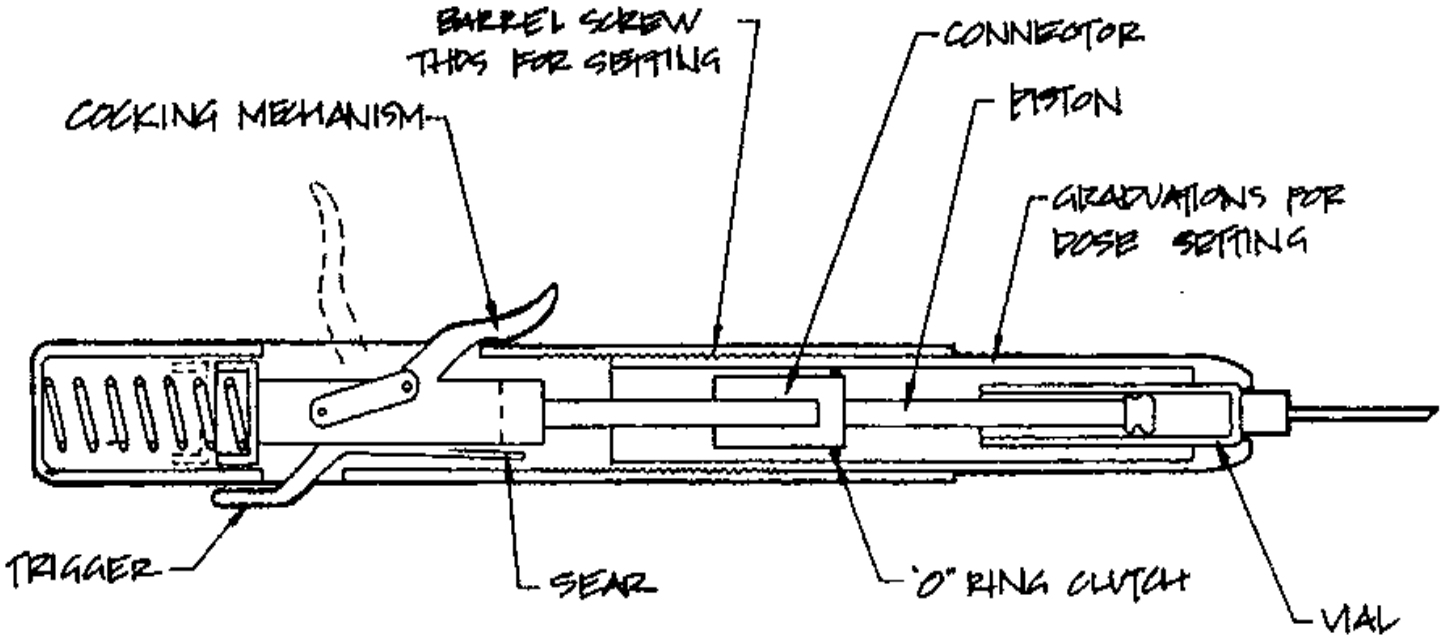

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Concept selection is an iterative process closely related to concept generation and testing. The concept screening and scoring methods help the team refine and improve the concepts, leading to one or more promising concepts upon which further testing and development activities will be focused.

**Concept G+:**
**Dial Screw+**



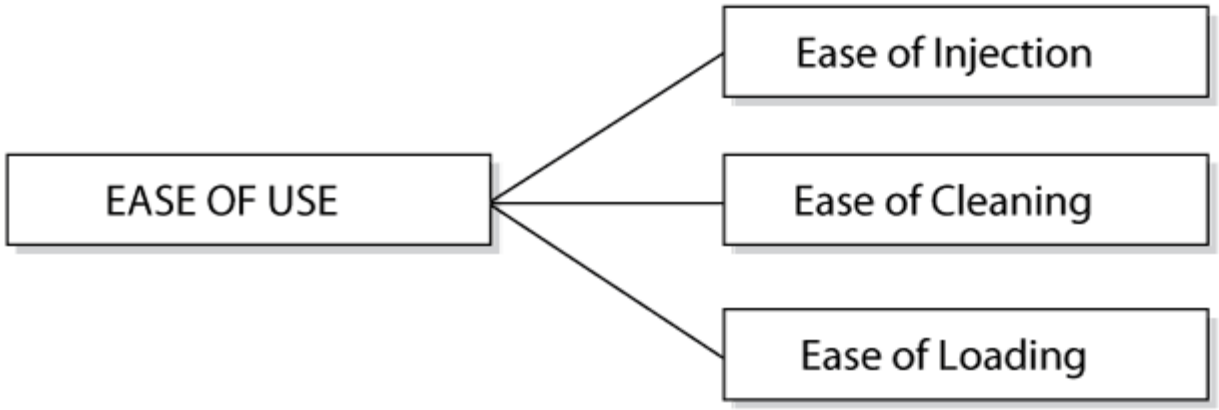
Concept DF:
Lever Stop




New and revised concepts for the syringe. During the selection process, the syringe team revised concept G and generated a new concept, DF, arising from the combination of concepts D and F.

# Concept scoring steps

1. Prepare a selection matrix, based on the selection criteria
2. Rate the concepts
3. Rank the concepts
4. Combine and improve concepts
5. Select one or more concepts
6. Reflect on the results and the process




From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Hierarchical decomposition of selection criteria. In conjunction with more detailed concepts, the team may choose to break down criteria to the level of detail necessary for meaningful comparison.

# Concept Scoring Method

$$S_j = \sum_{i=1}^{n} r_{ij} w_i$$

- where
  - $w_i$ = the weight for the $i$th criterion
  - $r_{ij}$ = raw rating of concept $j$ for the $i$th criterion
  - $n$ = number of criteria
  - $Sj$ = total score for concept $j$

# Scale for Rating the Concepts (relative performance)

1: much worse than the reference

2: worse than the reference

3: same as the reference

4: better than the reference

5: much better than the reference

# Example: Concept Scoring

| | | Concept | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A (Reference) Master Cylinder | | DF Lever Stop | | E Swash Ring | | G+ Dial Screw+ | |
| Selection Criteria | Weight | Rating | Weighted Score | Rating | Weighted Score | Rating | Weighted Score | Rating | Weighted Score |
| Ease of handling | 5% | **3** | 0.15 | 3 | 0.15 | 4 | 0.2 | 4 | 0.2 |
| Ease of use | 15% | **3** | 0.45 | 4 | 0.6 | 4 | 0.6 | 3 | 0.45 |
| Readability of settings | 10% | 2 | 0.2 | **3** | 0.3 | 5 | 0.5 | 5 | 0.5 |
| Dose metering accuracy | 25% | **3** | 0.75 | 3 | 0.75 | 2 | 0.5 | 3 | 0.75 |
| Durability | 15% | 2 | 0.3 | 5 | 0.75 | 4 | 0.6 | **3** | 0.45 |
| Ease of manufacture | 20% | **3** | 0.6 | 3 | 0.6 | 2 | 0.4 | 2 | 0.4 |
| Portability | 10% | **3** | 0.3 | 3 | 0.3 | 3 | 0.3 | 3 | 0.3 |
| | Total Score | | 2.75 | | 3.45 | | 3.10 | | 3.05 |
| | Rank | | 4 | | 1 | | 2 | | 3 |
| | Continue? | | No | | Develop | | No | | No |

The concept-scoring matrix. This method uses a weighted sum of the ratings to determine concept ranking. While concept A serves as the overall reference concept, the separate reference points for each criterion are signified by **bold** rating values.

# Issues in the decision process

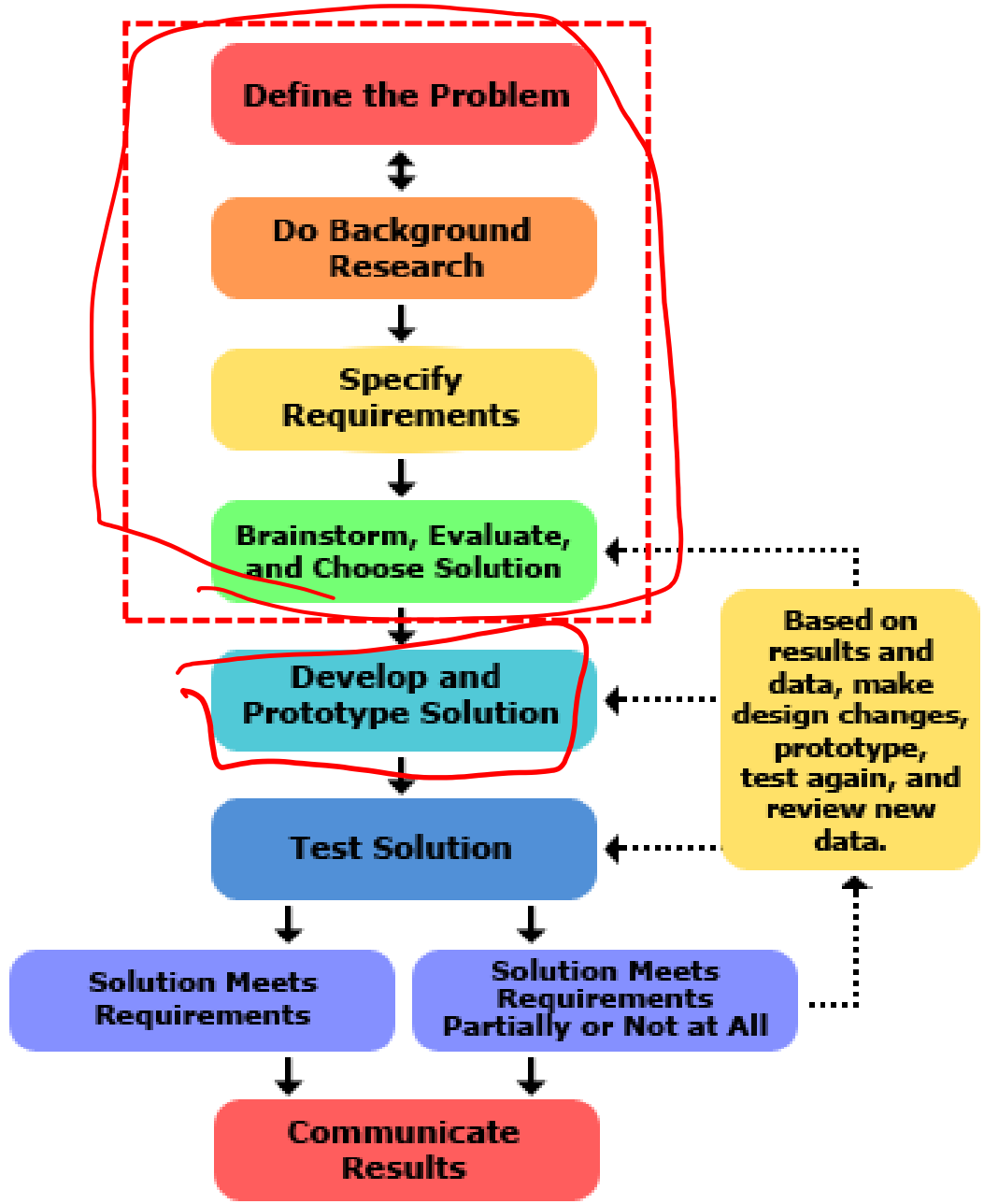
- It assumes that the selection criteria reflect customer's needs
- It assumes that the selection criteria are independent
- Manufacturing costs and manufacturability are not included in the decision
- It is better to directly evaluate those independent, simpler concepts underpinning the design concepts, if they constitute all the product concepts.
- The process of concept selection can be applied to throughout the development process.

NEED

KNOW

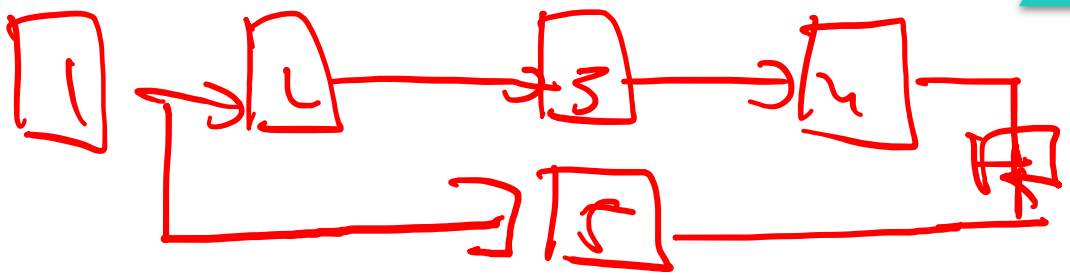
HOW

SOLVE



# Develop the Solution

- Development involves the refinement and improvement of a solution, and it continues throughout the design process, often even after a product ships to customers.



## Develop the Solution

- Development Work
- Drawing
- Storyboards

# Development Work

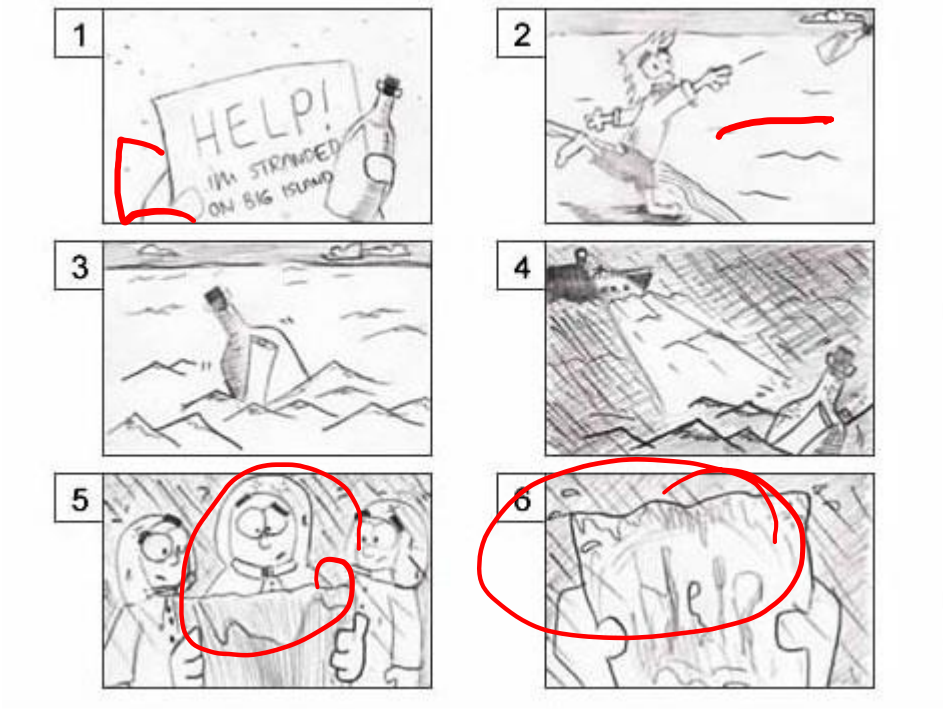
- **Development** involves the refinement and improvement of a solution.
- The goals of development work are to:
  - Make it work!
  - Reduce risk.
  - Optimize success.
- **Methods** of development work include:
  - Drawings
  - Modeling
  - Prototyping
  - Storyboards
  - Analysis

# Drawing

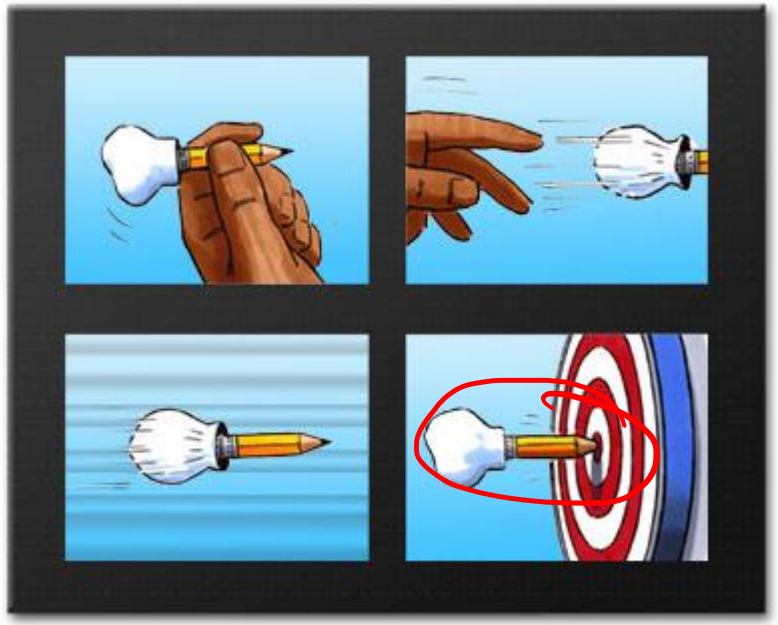
- Drawings are what allow you to show other people what's in your imagination.
- The purpose of design/engineering drawing is to **communicate your ideas** to other people in the simplest form possible.
- Your need to get your ideas across to others through **simple shapes** and **symbols**.
- Start drawing your ideas as **thumbnails**, small, doodle-like sketches of your ideas.
- Combine the thumbnails that make up your final design.
- Check out this How to Draw Guide from HowToons for more details on design drawing!

# Storyboards

- Storyboards are a great way to visually depict an experience or an interaction among people or people and objects.
- Three main points during the design process in which you may want to create a storyboard:
  1. Research-Stage Storyboard:
     - you analyze your problem to fully understand what you are trying to solve and why it needs a solution.
     - By creating this storyboard, you will be able to see the component parts of your problem and gain a greater understanding of the problem itself.
  2. Prototype-Stage Storyboard
     - A great way to compare these alternative solutions is to create storyboard prototypes
  3. Presentation-Stage Storyboard
     - To present your final solution
     - Use your storyboard to break down your final design, and show that it is successful.




Prototype-Stage Storyboard



Presentation-Stage Storyboard

# Build a Prototype

- A prototype is an operating version of a solution. Often it is made with different materials than the final version, and generally it is not as polished. Prototypes are a key step in the development of a final solution, allowing the designer to test how the solution will work.

Prototyping

- A **prototype** is an operating version of a solution. It is often made with different materials (cheaper and easier to work with) than the final version.
- Prototypes allow you to test how your solution will work and even show the solution to users for feedback.
- Creating prototypes may involve using
  - readily available materials,
  - construction kits,
  - storyboards, or other techniques that help you to create your solution quickly and with little cost.
- Keep in mind that these are mockups of your final solution, not the real thing!

# Test and Redesign

- The design process involves multiple iterations and redesigns of your final solution. You will likely test your solution, find new problems, make changes, and test new solutions before settling on a final design.

**Test and Redesign**

# Test and Redesign

- The design process involves multiple loops and circles around your final solution. You will likely test your solution—find problems and make changes—test your new solution—find new problems and make changes—and so on, before settling on a final design.
- At this point, you have created prototypes of your alternative solutions, tested those prototypes, and chosen your final design. So you're probably thinking that your project is finished! But in fact, you have yet to complete the final and most important phase of the engineering design process—test and redesign.
- Test and redesign requires you to go out and test your final design with your users. Based on their feedback and their interaction with your solution, you will redesign your solution to make it better. Repeat this process of testing, determining issues, fixing the issues, and then retesting multiple times until your solution is as successful as possible. Keep in mind that minor changes this late in the design process could make or break your solution, so be sure to be thorough in your testing!

# User Test

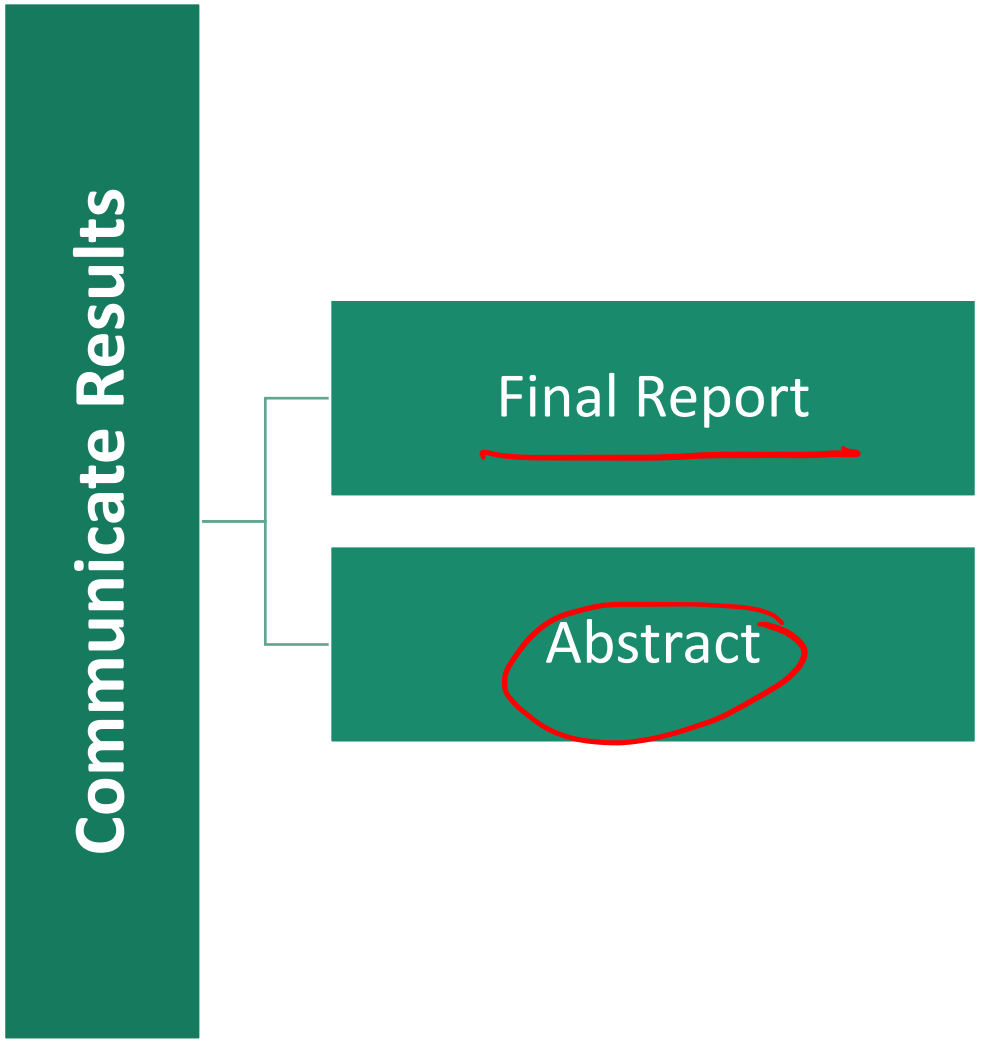
- Go back to your problem statement, and remember your potential users.
- To present your solution to these users while the users are in the **problem environment**. The problem environment is the situation or atmosphere in which the problem you are trying to solve happens.
  - If your solution is a product, give the product to the users in the environment where they would use it.
  - If your solution is a website or software product, ask users to test it on computers.
  - If your solution is an environment or experience, place your user in that environment or experience, and see how they react.
- Record your observations in your design notebook. Watch closely as people use your product, navigate your website, or go through your designed environment or experience.

# Redesign

- Use the findings from testing to:
  - Fix any problems that occurred, and
  - Further polish aspects of the design that were even more successful than you originally thought.
- To make these changes, look at the answers to the four major questions you asked during testing:
  - Is your user able to overcome the problem by using or interacting with your solution?
  - Does the user ever need to ask you any questions when using or interacting with your solution?
  - Does the user interact with your solution exactly the way that you intended for them to?
  - If you have measurable targets for your solution, did you meet them?

# Communicate Results

- To complete your project, communicate your results to others in a final report and/or a display board. Professional engineers always do the same, thoroughly documenting their solutions so that they can be manufactured and supported.


Communicate Results
Final Report
Abstract

# Communicating The Results

- At this point, you are in the home stretch. Except for writing the **abstract**, preparing your project final report will just entail pulling together the information you have already collected into one large document.

# Reports

- Your final report will include these sections:
  1. Title page.
  2. Abstract. An abstract is an abbreviated version of your final report.
  3. Table of contents.
  4. Question, variables, and hypothesis.
  5. Background research. This is the Research paper you wrote before you started your experiment.
  6. Materials list.

7. Experimental procedure.
8. Data analysis and discussion. This section is a summary of what you found out in your experiment, focusing on your observations, data table, and graph(s), which should be included at this location in the report.
9. Conclusions.
10. Ideas for future research. Some science fairs want you to discuss what additional research you might want to do based on what you learned.
11. Acknowledgments. This is your opportunity to thank anyone who helped you with your science fair project, from a single individual to a company or government agency.
12. Bibliography.

# Abstract

- An **abstract** is an abbreviated version of your science fair project final report. For most science fairs it is limited to a maximum of 250 words (check the rules for your competition). The abstract appears at the beginning of the report as well as on your display board.

→ Latar belakang / masalah

→ Solusi

→ Hasil

→ Rencana

- An abstract should have the following five pieces:
  - **Introduction**. This is where you describe the purpose for doing your project or invention.
    - Why should anyone care about the work you did? You have to tell them why.
    - Did you explain something that should cause people to change the way they go about their daily business?
    - If you made an invention or developed a new procedure how is it better, faster, or cheaper than what is already out there?
    - **Motivate** the reader to finish the abstract and read the entire paper or display board.
  - **Problem Statement**. Identify the problem you solved or the hypothesis you investigated.

- **Procedures**. What was your approach for investigating the problem? Don't go into detail about materials unless they were critical to your success. Do describe the most important variables if you have room.
- **Results**. What answer did you obtain? Be specific and use numbers to describe your results. Do not use vague terms like "most" or "some."
- **Conclusions**. State what your science fair project or invention contributes to the area you worked in. Did you meet your objectives? For an engineering project state whether you met your design criteria.

# Abstract

- **Things to Avoid**
  - Avoid jargon or any technical terms that most readers won't understand.
  - Avoid abbreviations or acronyms that are not commonly understood unless you describe what they mean.
  - Abstracts do not have a bibliography or citations.
  - Abstracts do not contain tables or graphs.
  - If you are working with a scientist or mentor, your abstract should only include procedures done by you, and you should not put acknowledgements to anyone in your abstract.

# Tugas Pekan 3 atau 4

- Tentukan satu masalah atau kebutuhan rekayasa.
- Buatlah beberapa konsep yang ingin dibandingkan sebagai solusi permasalahan rekayasa. Carilah dari referensi-referensi terpercaya.
- Bandingkan berbagai konsep tersebut dengan tabel concept selection / concept screening. Pilih satu konsep / solusi terbaik.
- Rancanglah konsep terpilih dengan tahapan-tahapan yang digambarkan dengan diagram blok.
- Rancanglah bagaimana prototipe dari konsep terpilih dapat direalisasikan.
- Rancanglah beberapa skenario dari test dari prototipe dan sebutkan langkah-langkahnya.

# Tugas Pekan 4

- Buatlah Abstrak dari sebuah konsep yang kalian rancang.

- Buatlah presentasi untuk mengkomunikasikan tahapan engineering design process dari konsep yang kalian racang.

# Materi UTS

Jadwal UTS: Selasa, 28 Februari 2023, Jam 13

- Definisi Engineering
- Etika Profesi
- Aspek-Aspek Penyelesaian Masalah
- Enginering Design Process

# Tugas Besar PRD STEI 2023

- Tujuan:
  - Melatih dan mempraktekkan *problem formulation* ataupun identifikasi kebutuhan/masalah dari *user*.
  - Melatih dan mempraktekkan *creative thinking* dalam merumuskan solusi, merancang solusi dan mengevaluasi solusi dari *engineering design*.
  - Dapat berkomunikasi dan bekerja sama dalam tim secara efektif dan efisien.

- Masalah atau kebutuhan bersifat "*Open*" dan boleh dari berbagai bidang engineering. Tiap kelompok mendapatkan dana maksimal 200 ribu yang diajukan RABnya pada asisten.

- Hasil dari tugas besar adalah:
  - Solusi rekayasa yang dapat berupa sistem, komponen, atau proses (boleh HW dan ataupun SW)
  - Laporan dokumen teknis yang terdiri atas 1) Latar belakang masalah, 2) Studi literatur, 3) Persyaratan Solusi (Target general spesifikasi), 4) Generasi konsep/solusi, 5) Pemilihan solusi, 6) Perancangan solusi, dan 7) Pengujian solusi

# Detil Batasan Dokumen Tugas Besar

1) Judul dan abstrak (1 lembar A4)
2) Latar belakang masalah (2 paragraph, max 1 lembar A4)
3) Studi literatur (max 2 lembar A4)
4) Persyaratan Solusi (Target general spesifikasi dalam table dengan minimal 3 parameter, max 1 lembar A4)
5) Generasi konsep/solusi (Minimal 3 konsep, max 3 lembar A4)
6) Pemilihan solusi (Menggunakan Concept Decision Matrix dan penjelasannya, max 2 lembar A4)
7) Perancangan solusi (Gambar desain/flowchart/dataflow dan penjelasannya, max 5-7 lembar)
8) Pengujian solusi (Analisa performansi solusi dalam grafik / table, max 2 lembar)
9) Kesimpulan (1 lembar A4)

Total maksimal halaman dokumen 20 lembar.

# Kuliah Sharing Industri KU1102 K24

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