

# INTRODUCTION TO ENGINEERING

- Joint Bachelor Degree of OSU-SWJTU

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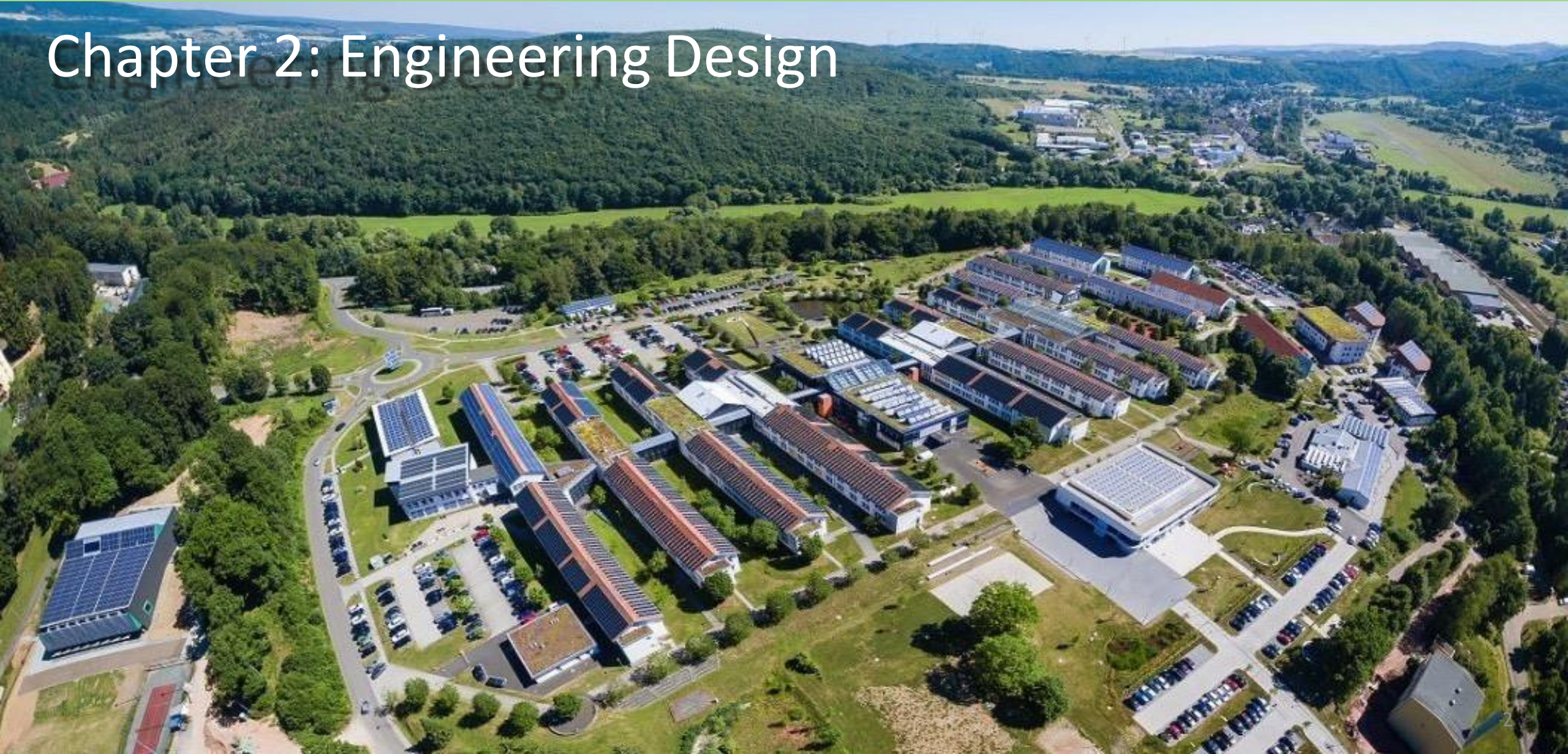


# INTRODUCTION TO ENGINEERING 1



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## Chapter 2: Engineering Design







# Engineering Design

## Objectives

- Students will learn about what engineers do and how they work.
- Students will examine and use the nine steps in the engineering design process.
- Students will understand sustainability in design, teamwork and conflict resolution.



# Work of the Engineers

- Engineers have existed for centuries in many cultures and designed all the products around you.
- Engineers use creativity, as well as their knowledge of math and science, to invent products that help people fill a need.
- Engineers work with businesspeople, mathematicians, scientists, and others to achieve their goals.

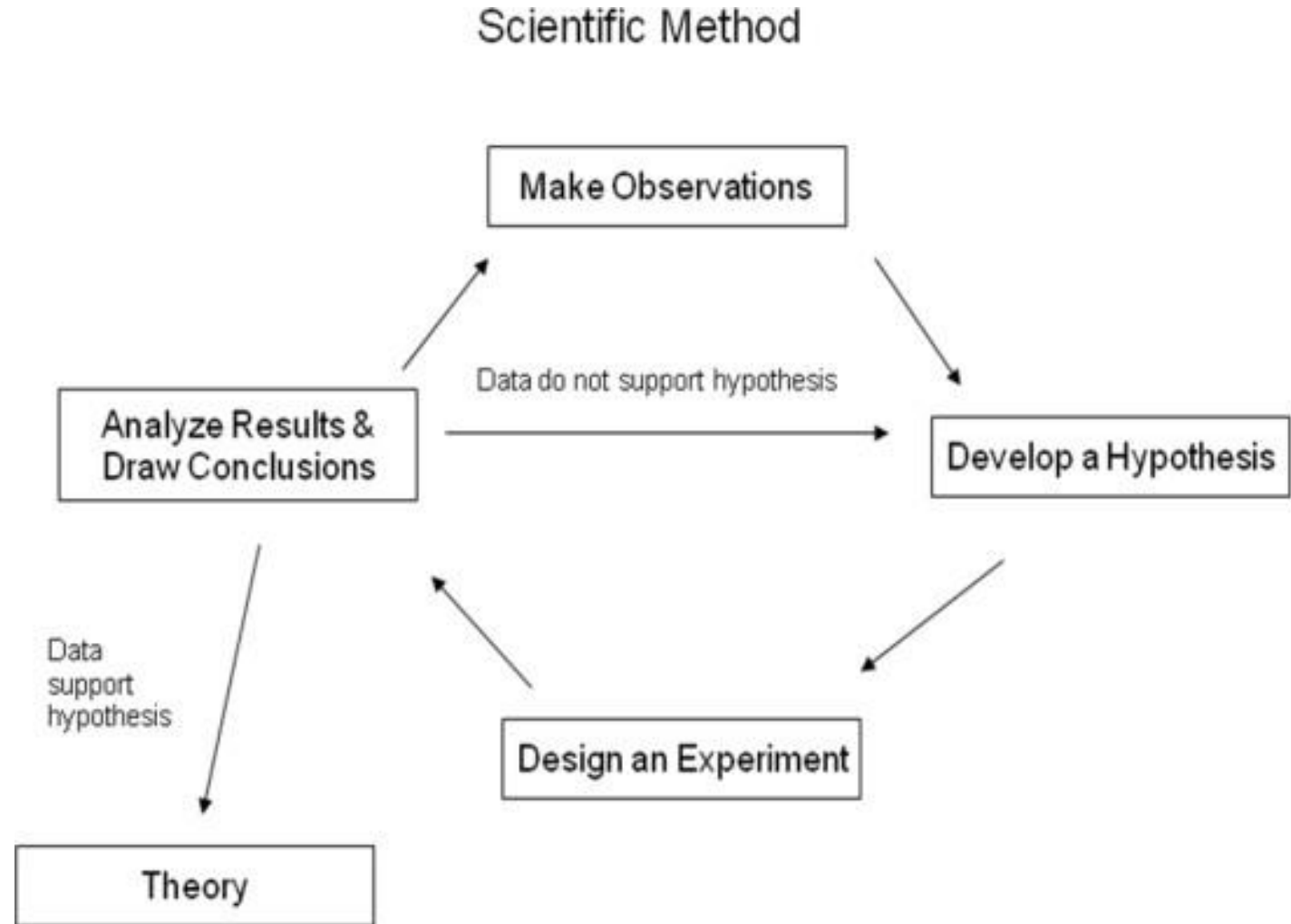


# Work of the Engineers

- Scientist (A practitioner of Science)
- Engineer (A practitioner of Engineering)
- Scientists use the **scientific method** to discover new facts about how the natural world works. These facts are helpful to engineers.

Scientists investigate that which already is; Engineers create that which has never been.

— Albert Einstein —



# Role of Engineers

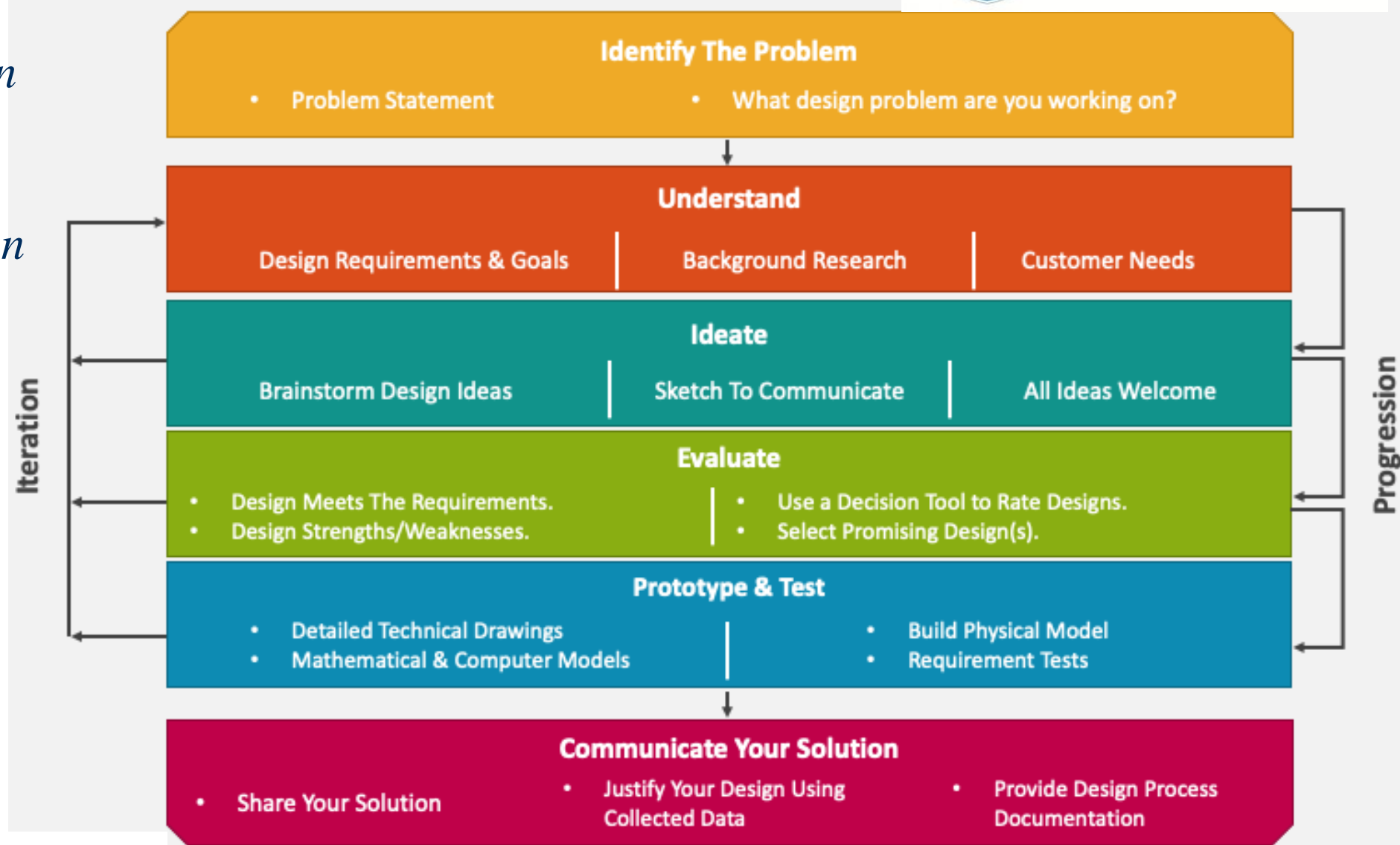
- Engineers design new products to solve some problem or to meet some human need.
- Like scientists, engineers follow a series of steps to design products.
- There are several steps in the engineering design process.



# Engineering Design Process



*The engineering design process is a series of steps that engineers follow to find a solution to a problem.*



# Engineering Design Process



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## Step 1: Recognizing the Need for a Product or a Service

The need may be identified by an engineer, the company you may work for, or by a client who needs a solution to a problem or a new product to simplify and improve efficiency.





# Engineering Design Process

## Step 2: Identify/understand a problem

- An engineer has to identify the exact problem or objective in order to develop a useful product.
- A problem can be formulated to clarify the answers to “5W” questions:

## Questions to Answer...

- Who ? - would need it
- What ? - is needed
- When ? - is it needed
- Where ? - is it needed
- Why ? - is it needed
- How Many ? - are needed



# Engineering Design Process

## Step 3: Background Research and preparation

- For an engineering design project, engineers do background research in two major areas:

### i) Users or customers

- Engineers may describe the target user in any number of ways.
  - Age (old, young, infant)
  - Gender
  - Occupation
  - Hobby interests
  - Amateur or professional
  - Whether users have disabilities and require accommodations
  - Size
  - First-time user or experienced user

### ii) Existing solutions

- Research if the product already exists
- Research how your product will work and how to make it.
- Collected information must then be reviewed and organized.





# Engineering Design Process

## 头脑风暴

### Step 4: Conceptualizing ideas (Brainstorm Solutions)

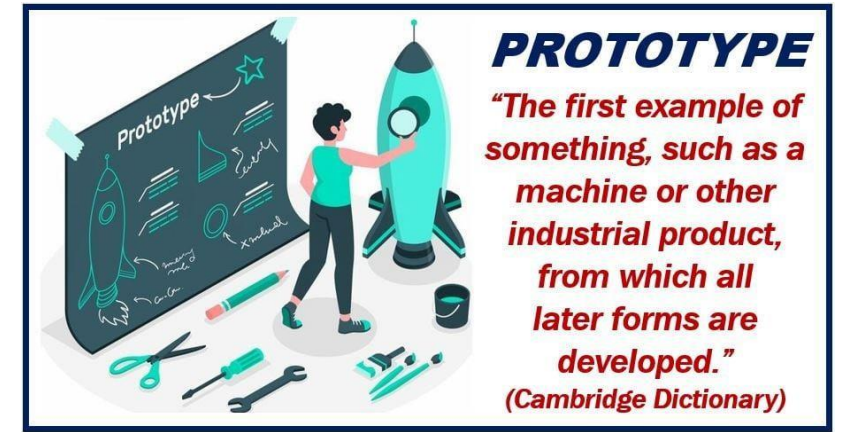
- In this step, an engineer generates as many ideas as possible to solve the design problem.
- Choose the Best Solution
- Reject solutions that do not meet the requirements
- Engineers from own engineering discipline or from other disciplines might be involved to expand the possibilities.



# Engineering Design Process

## Step 5: Synthesizing and evaluating the findings

- During this stage of design, you begin to consider details.
  - perform calculations,
  - run computer models,
  - narrow down the type of materials to be used,
  - size the components of the system, and
  - answer questions about how the product is going to be invented.
- At evaluation stage, you need to make sure that all calculations are performed correctly.
- Working models must be created and tested.

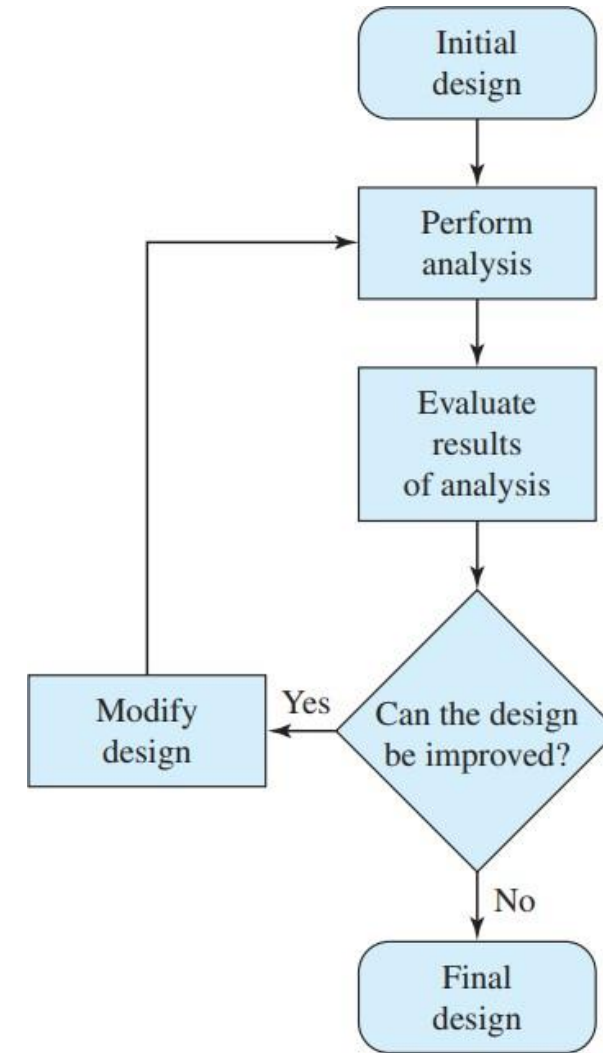




# Engineering Design Process

## Step 6: Optimization

- The design process involves multiple iterations and redesigns of your final solution.
- Any problems found in this stage will go through their own version of the engineering design process.
- Design optimization is always based on some particular criterion, such as cost, strength, size, weight, reliability, noise, or performance.



An optimization procedure

# Engineering Design Process

## Step 7: Communicate the solution/results

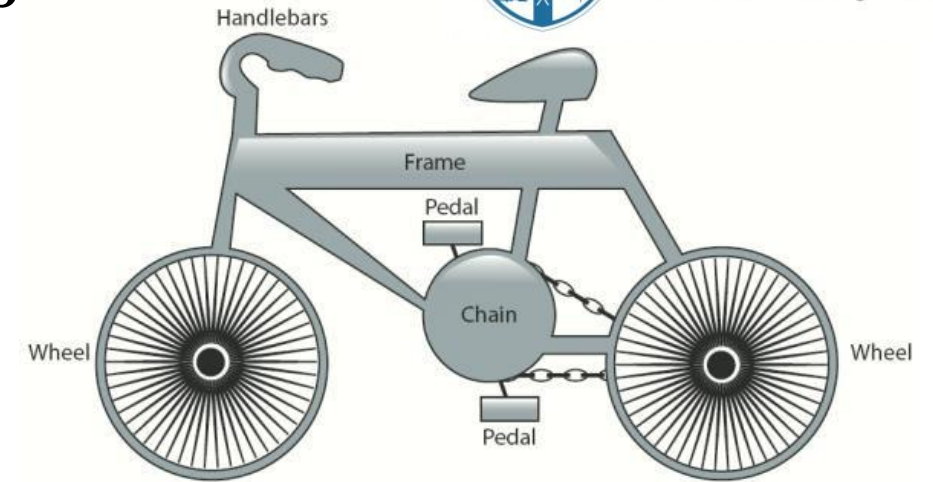
- Communicate the solution to the client (boss, customer etc)
- Presentation of a design includes both oral and written reports.



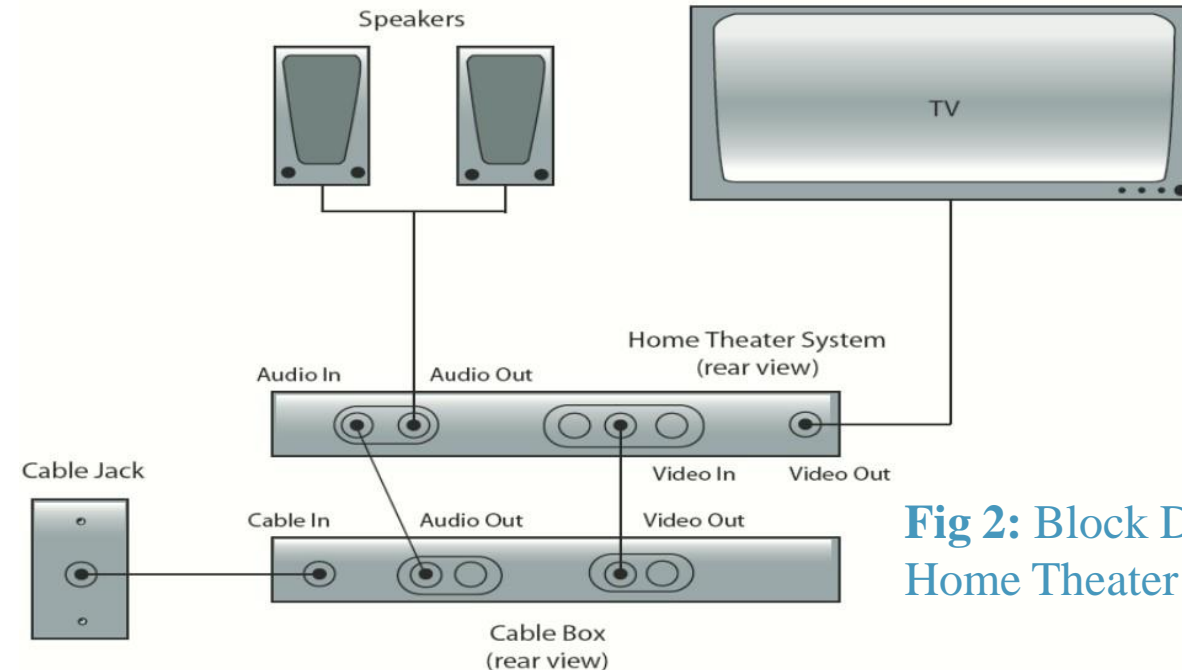


# Block Diagrams in Engineering Designs

- Most products have many interconnected parts. Engineers use block diagrams to show these connections.
- Block diagrams show pictures of the parts in a product and how the parts work together.
- A block diagram can be simple or complex.



**Fig 1: Block Diagram of a bicycle**



**Fig 2: Block Diagram of a Home Theater System**

# Civil Engineering Design Process



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- Civil engineering design process is slightly different from other disciplines

## Design process for buildings (i.e. schools, offices, shopping malls, hospitals)

1. Recognizing the need for a building (*Step 1: recognizing the need for a product or a service*)
2. Define the usage of the building (*Step 2: problem definition and understanding*)
3. Project planning (*Step 3: research and preparation*)
4. Schematic design phase (*Steps 4 & 7: conceptualization and presentation*)
5. Design development phase (*Steps 5, 6, & 7: synthesis, evaluation, and presentation*)
6. Construction documentation phase (*Steps 5 & 6: synthesis and optimization*)
7. Construction administration phase



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# Sustainability in Design

**Sustainability or Sustainable engineering:** *“design and development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”* (IEEE)

- When designing, engineers must consider earth’s resources, environmental, socio-economic, ethical, & technical factors.
- All engineering organizations support adding sustainability education to engineering curricula.
- Civil engineers are crucial in addressing climate change and sustainability issues.



# Teamwork

- A *design team* is a group of skilled individuals working together to solve problems or achieve a common goal."
- The goal could be to provide a service, design and make a product, or improve an existing service or product.
- A good team helps each other to perform at their best.
- A good team knows when to compromise for the common goal.
- Communication is an essential part of successful teamwork.
- The team members must understand each other's roles and tasks.





# Common Traits of Good Teamwork

1. The team must clearly understand the project's clear goals.
2. The team should be comprised of people with relevant skills, problem-solving abilities, backgrounds, and talents.
3. The team must have a good leader.
4. The team leadership and the environment in which discussions take place should promote openness, respect, and honesty.
5. Team needs and goals should come before individual needs and goals.

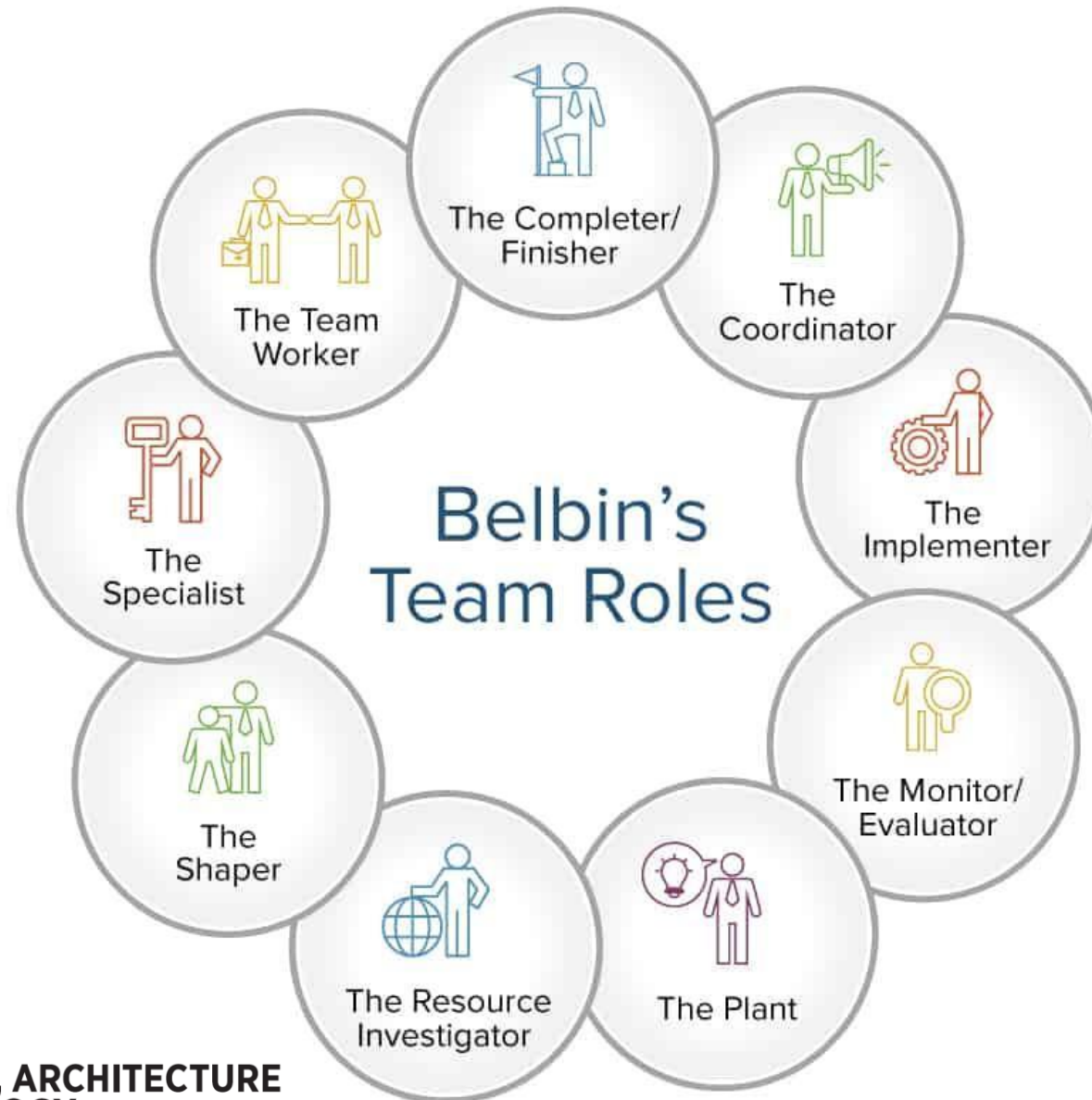


Characteristics of effective team

# Common Traits of Good Teamwork



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## Further Reading

- *Management Teams - Why They Succeed or Fail* by Dr Meredith Belbin, published by Butterworth Heinemann (2nd Edition) 2003.
- [www.belbin.com](http://www.belbin.com)



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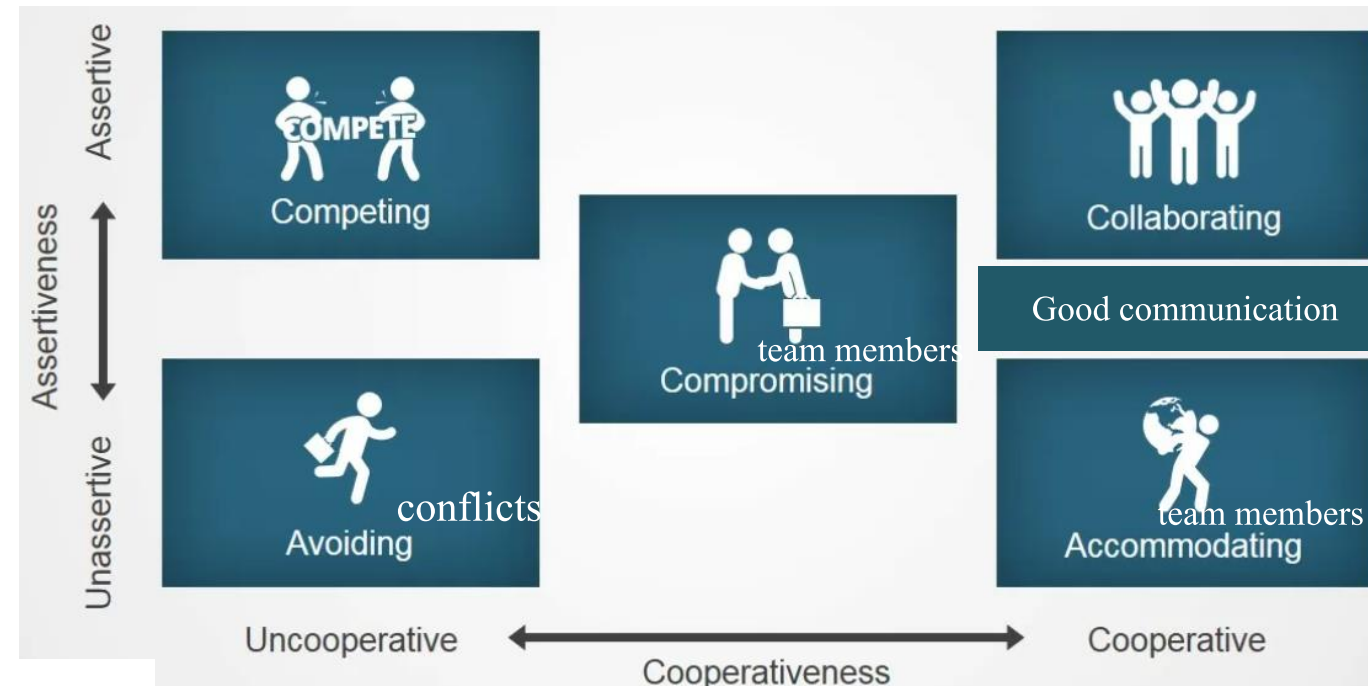
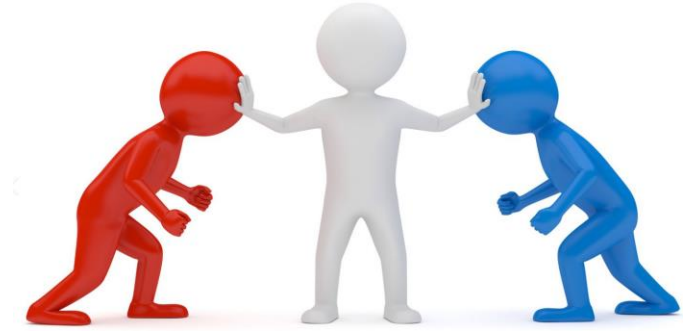
# Conflict Resolution



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- \* Conflict Resolution is a way for two or more parties to find a peaceful solution for a disagreement among them.

*Reasons:* miscommunication, personality differences, or the way events & actions are interpreted by a member of a team.







# Project Scheduling and Task Chart

- Project scheduling ensures that a project is completed on time and within budget.
- A good schedule will assign an adequate amount of time for various project activities.
- It involves planning, organizing, and controlling resources and personnel to complete the project.
- A good schedule can make work better and stop doing the same thing over and over.

TABLE 3.2 Example of a Task Chart

Task	Personnel	Week												
		1	2	3	4	5	6	7	8	9	10	11	12	13
		9/9	9/16	9/23	9/30	10/7	10/14	10/21	10/28	11/4	11/11	11/18	11/25	12/2
Research and preparation	Jim and Julie													
Progress reports	Lisa													
Concept development	Jim, Julie, and Lisa													
Synthesis and evaluation	Jim, Julie, and Lisa													
Fabrication	Mr. Machinist													
Testing	Julie and Lisa													
Optimization	Julie													
Preparing the written and oral reports	Lisa													
Final presentation	Jim, Julie, and Lisa													



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# Thank you