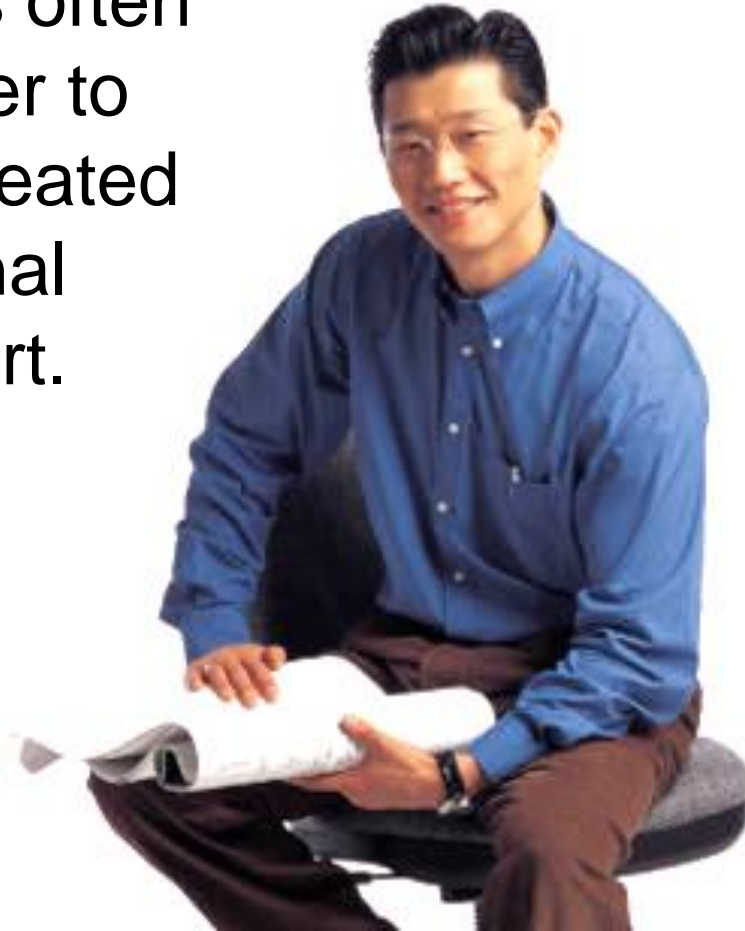# The Design Process

The Design Process

- What Is Design?

- What Is a Design Process?

- The Engineering Design Process (6-Step Version)

What Is Design?

In engineering, the word "**design**" is often used to refer to anything created by intentional human effort.

Design is also used to describe a systematic process used to creatively solve problems.

A **designer** is one who designs objects, plans or solutions.

What Is a Design Process?

Images courtesy of NASA

A **design process** is a systematic problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve or satisfy human needs or wants and to narrow down the possible solutions to one final choice.

– ITEA *Standards for Technological Literacy*

A Design Process

- A design process is an iterative, decision-making strategy to solve problems.

- Applying a single, clearly-defined design process provides a consistent basis for understanding problems and solutions.

- In this course, we will use a 6-step version of the design process.

The Engineering Design Process

1. Define the Problem

2. Generate Concepts

3. Develop a Solution

4. Construct and Test a Prototype

5. Evaluate the Solution

6. Present the Solution
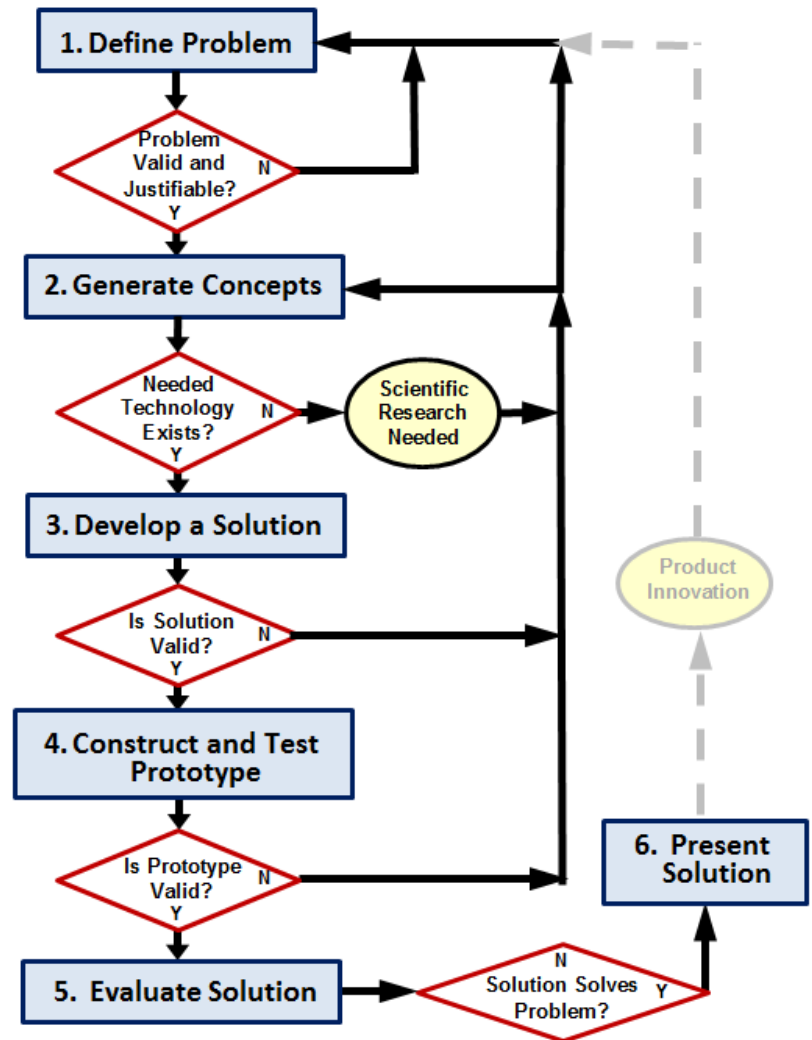
This design process was developed based on the University of Maryland - College Park - IRB Research Project

Define the Problem

1. Define Problem

- Write a Design Brief

    Design Brief: A written plan that identifies the problem to be solved, and the **criteria** and **constraints** of the solution.

    Criteria: Standards by which the solution is to be judged. What the solution must do.
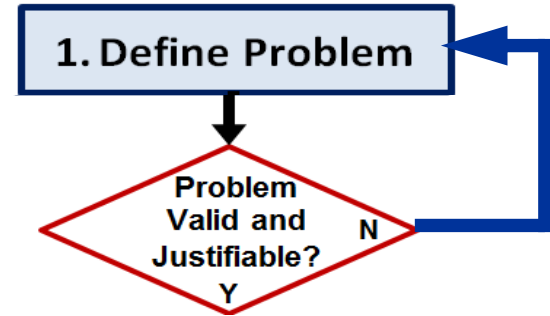
    Constraint: A limitation (e.g. size, cost, time).

    – *The Design Brief serves as the written agreement between the **client** and designer.*

- Start Keeping an **Engineer's Notebook**.

    – *Record all your research, ideas, sketches, data, etc. You'll want to refer to this later.*

Define the Problem

- Ask if the Problem is Valid.

  Valid: Well-founded on evidence and corresponds accurately to the real world.

  - *Check sources for accuracy.*
 - *Identify the adequacy of any prior solutions.*

- Ask if the Problem is Justifiable.

  Justifiable: Capable of being shown as reasonable or merited according to accepted standards.

  - *Is a solution possible? Is the scope too large?*
 - *Is the problem worth solving? Cost vs. benefit.*

Generate Concepts

- Research
  - *Past solutions and patents*
- **Brainstorm** Possible Solutions
- Refine the Best Few Ideas
- Make a **Decision Matrix**
  - *A table used to quantitatively compare design solutions with one another using specific criteria.*
- Select the Most Promising Solution
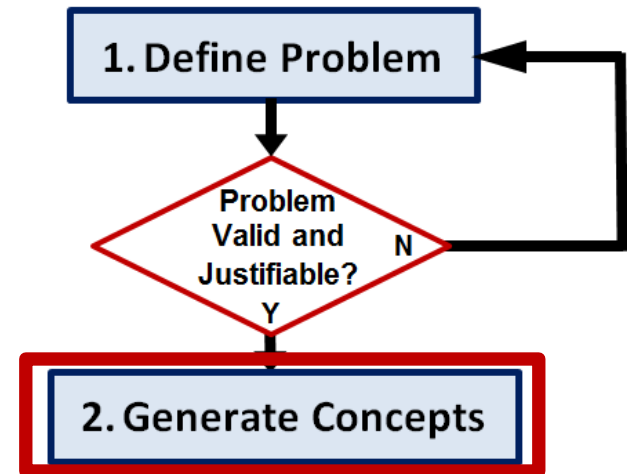
Generate Concepts

- Consider whether the Needed Technology Exists

    - *If not, scientific research may be necessary to pursue that solution. Alternatively, the technology may exist but be too expensive or unavailable where it is needed. A different solution may need to be chosen that does use available technology.*

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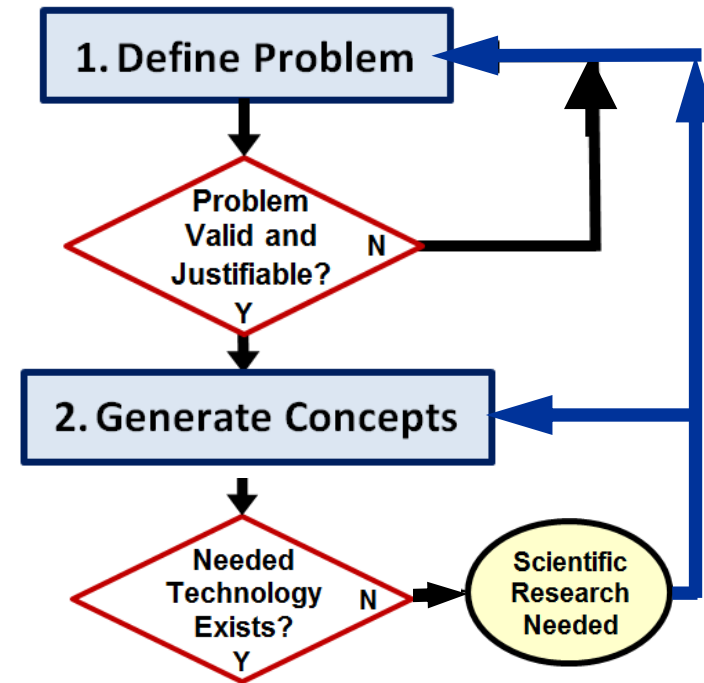
Develop a Solution

- Refine the Solution in Detail
  - *Consider variations in size, shape, materials*
- Make Technical Drawings
  - *Provide all the information needed to make the product (size, shape, etc.)*
  - *Use CAD (Computer-Aided Design) software to make the drawings: easy to modify and share*
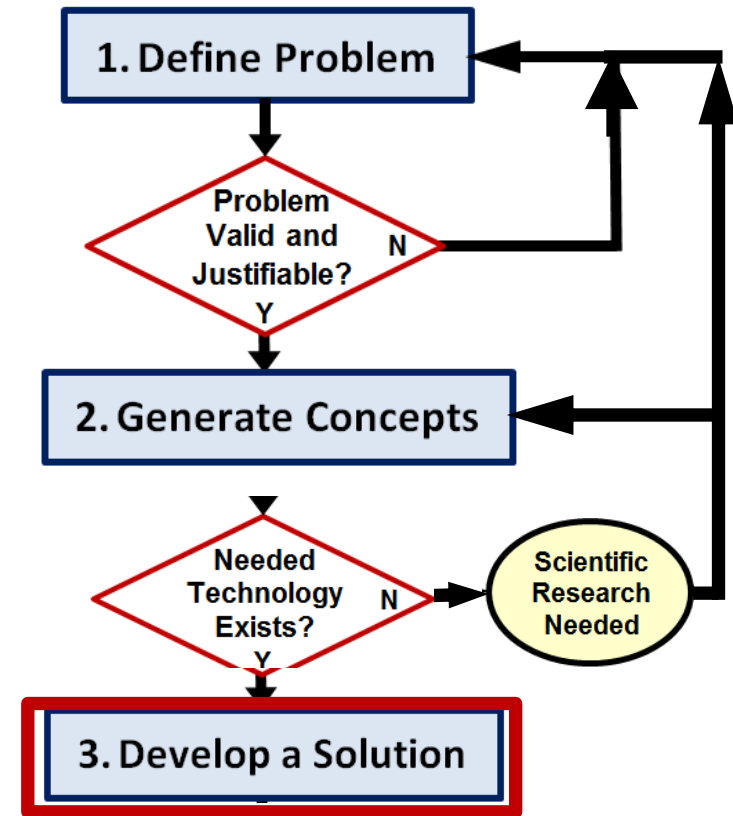
Develop a Solution

- Check if the Solution is Valid

  – Compare the developed solution against the **Design Brief**. If the solution is found to be invalid (does not solve the problem or satisfy the criteria or constraints), the designer must return to a previous step in the design process.
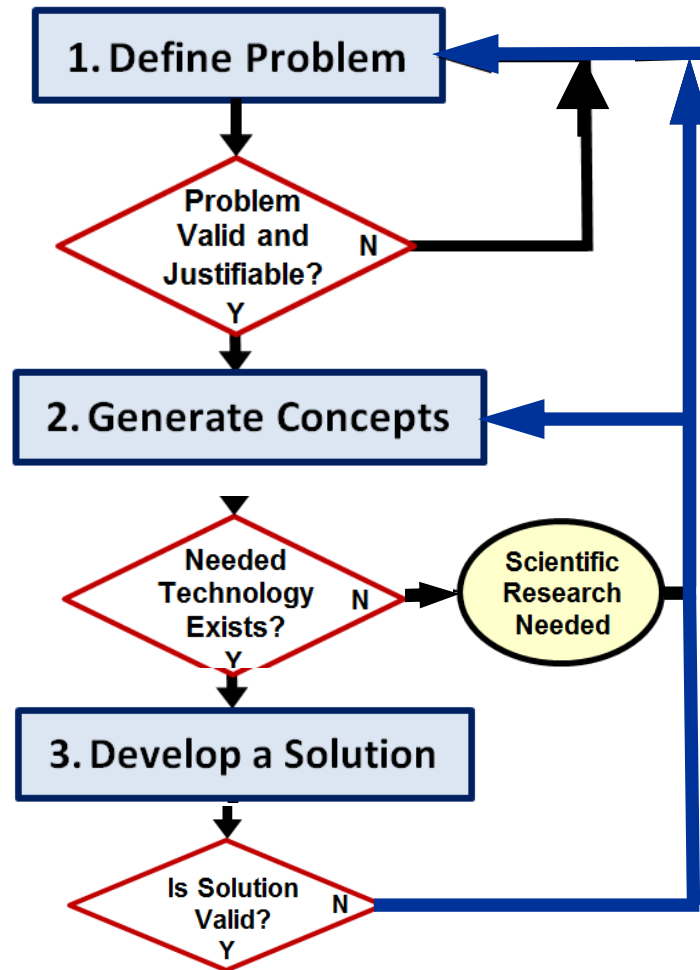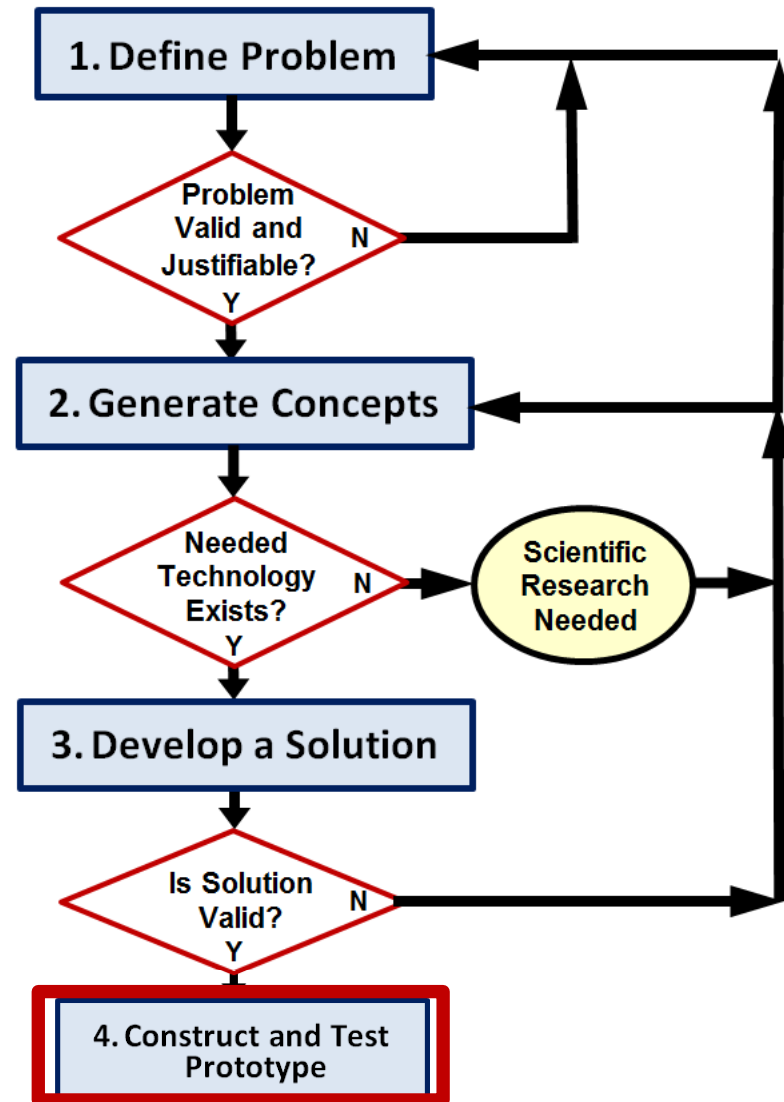
Construct and Test a Prototype

- Construct a **Prototype** based on the *Technical Drawings*

  Prototype: A full-scale working model for testing

- Plan the Types of Tests to be Conducted

- Test the Prototype
  - Collect test data

- Write a *Test Report*

1. Define Problem

Problem Valid and Justifiable? N

2. Generate Concepts

Needed Technology Exists? N → Scientific Research Needed

3. Develop a Solution

Is Solution Valid? N
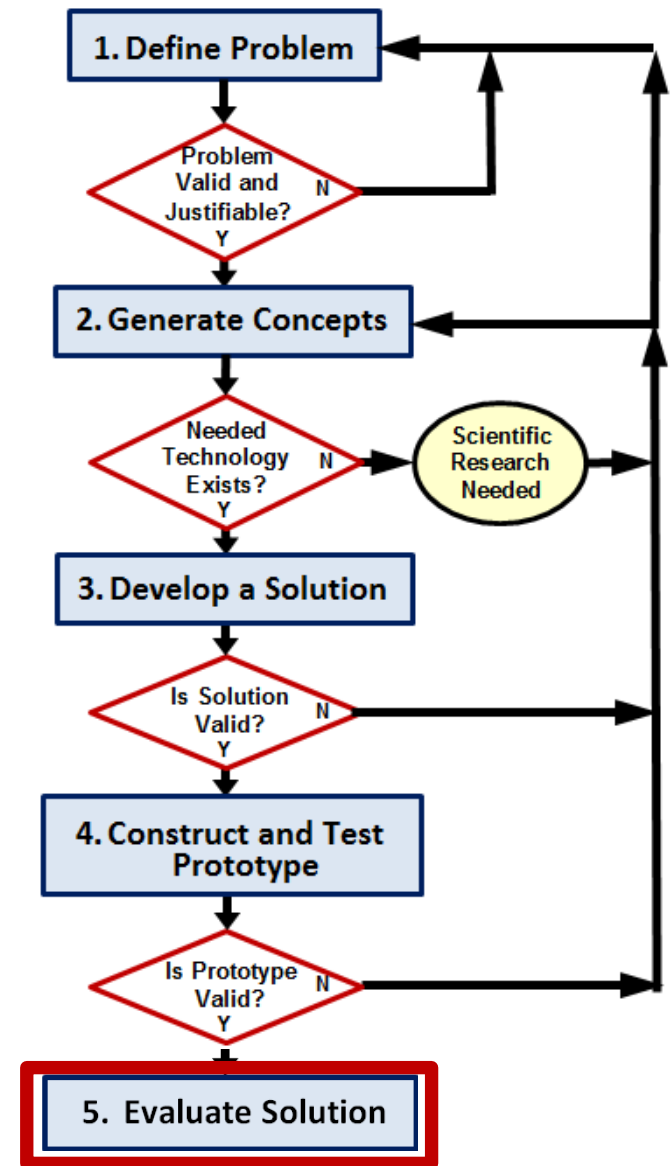
4. Construct and Test Prototype

Construct and Test a Prototype

- Check if the Prototype is Valid
  - If the analysis of the test data indicate a flawed design, or if a working prototype cannot even be built, the designer must return to a previous step of the design process.
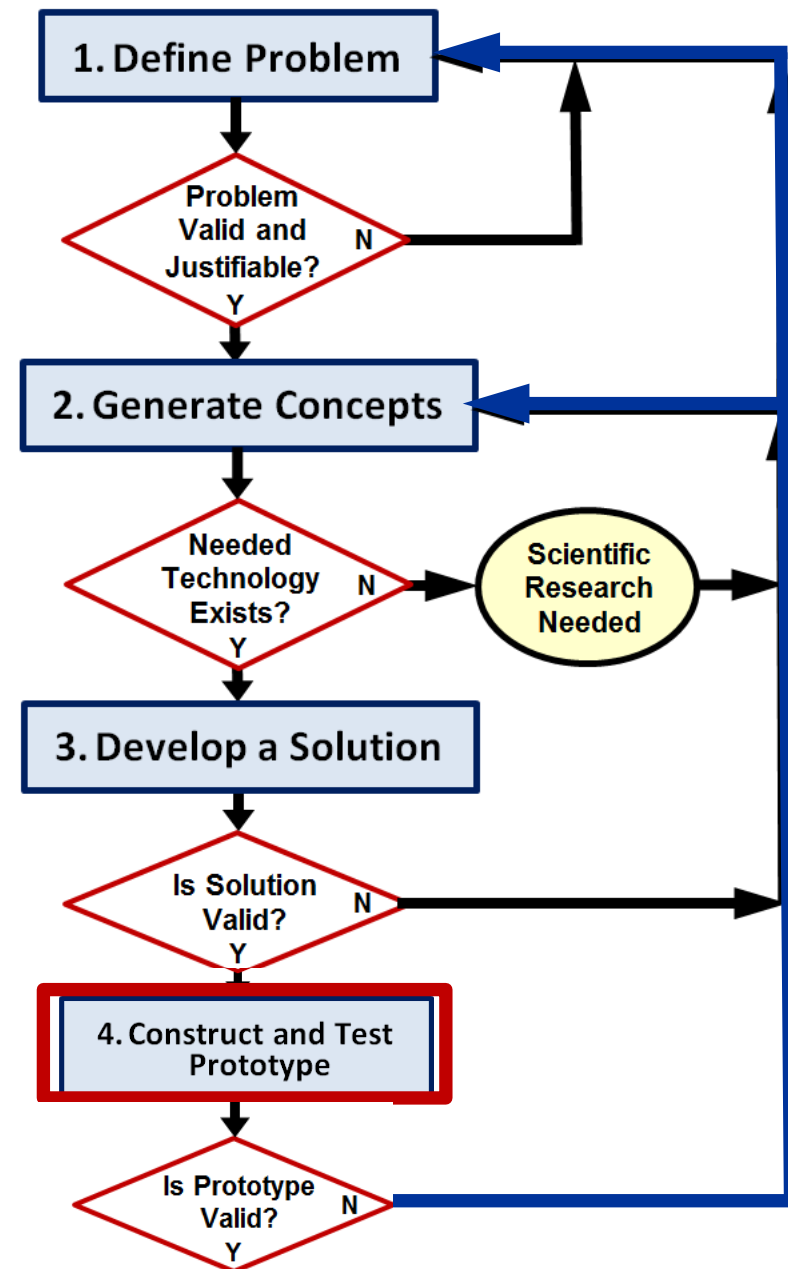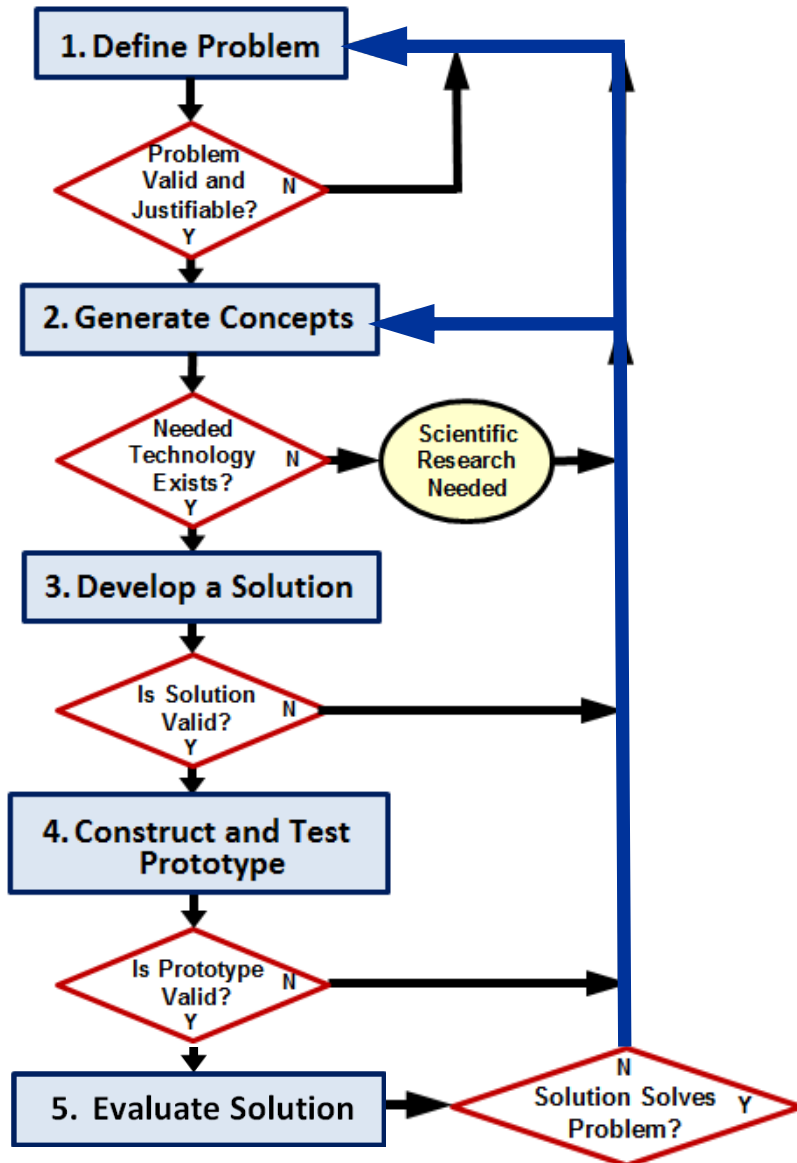
Evaluate the Solution

- Reflect on the Design
  - *Consider improvements*
- Optimize or Redesign the Solution
  - *Return to a prior step, if necessary*
- Write a *Project Recommendation*
  - *Failure is an opportunity for discovery*

1. Define Problem

Problem Valid and Justifiable? N Y

2. Generate Concepts

Needed Technology Exists? N Y → Scientific Research Needed

3. Develop a Solution

Is Solution Valid? N Y

4. Construct and Test Prototype

Is Prototype Valid? N Y

5. Evaluate Solution

Evaluate the Solution

- Evaluate whether the Solution Solves the Problem
  - Compare the solution with the Design Brief.
  - If the criteria or constraints are not met, the designer must return to a previous step in the design process.

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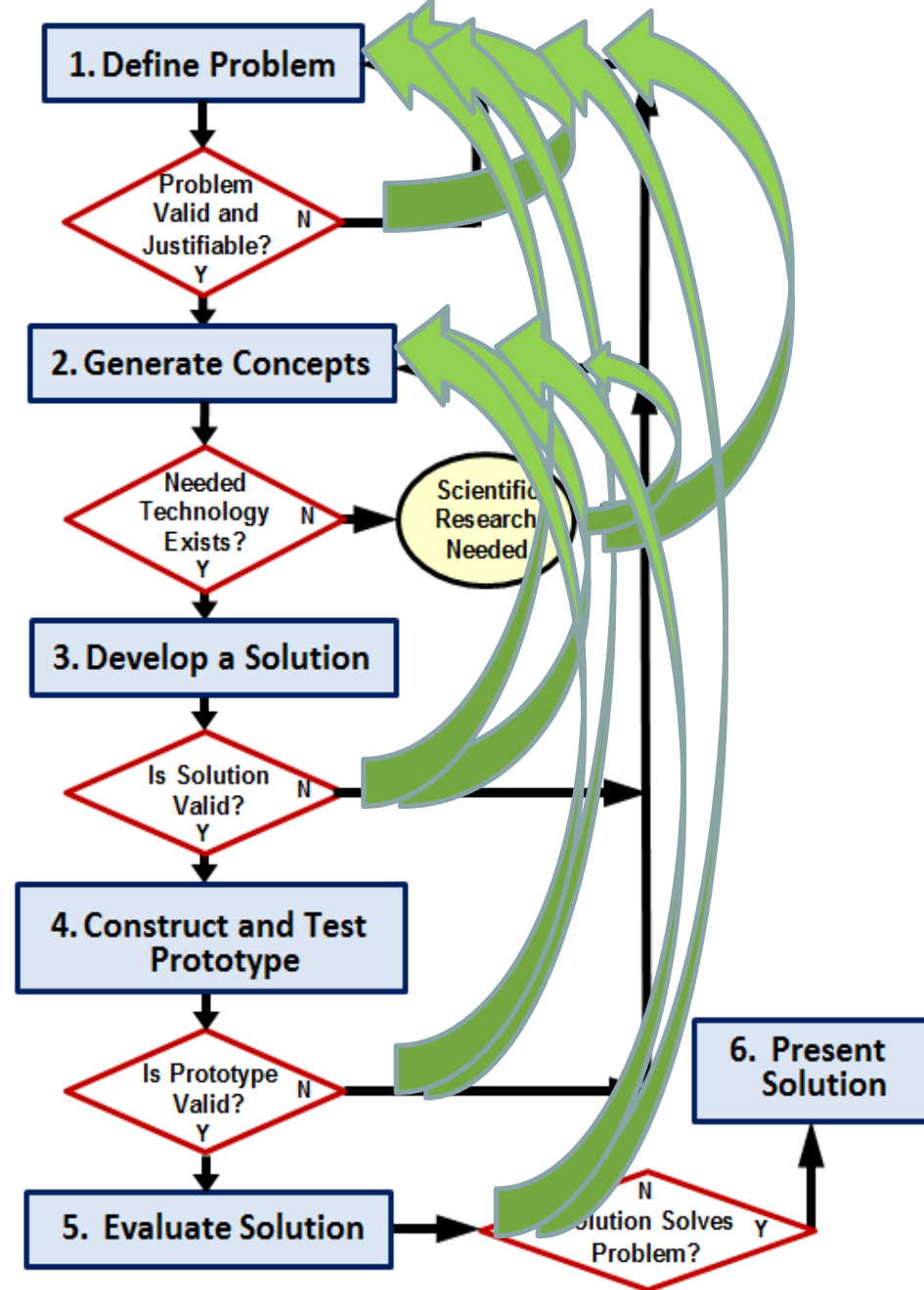
Present the Solution

- Document the solution
- Communicate the solution to client
  - *Ask if this is what the client wants*
- **Patent** your product
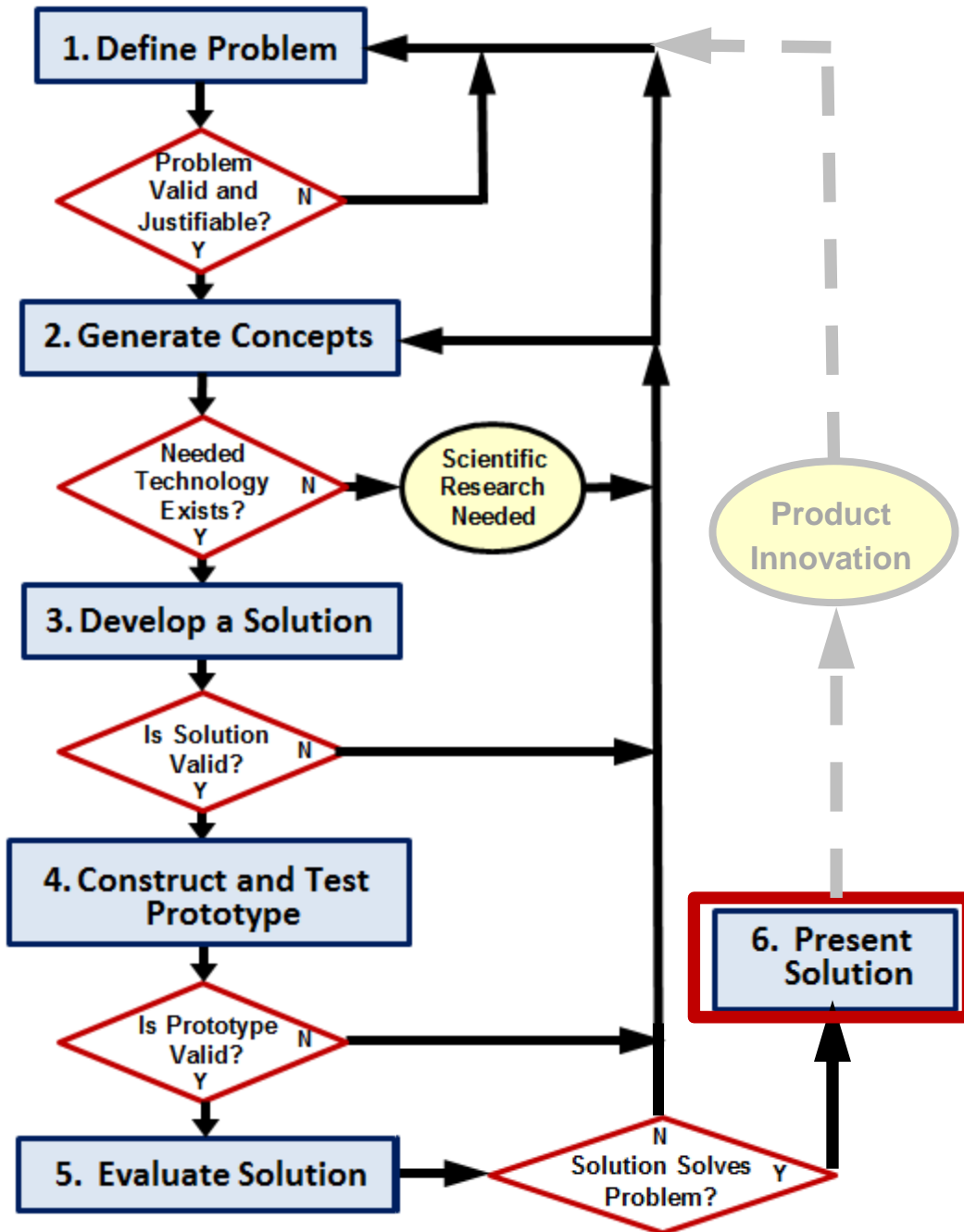 - *Submit a detailed Engineers Notebook*
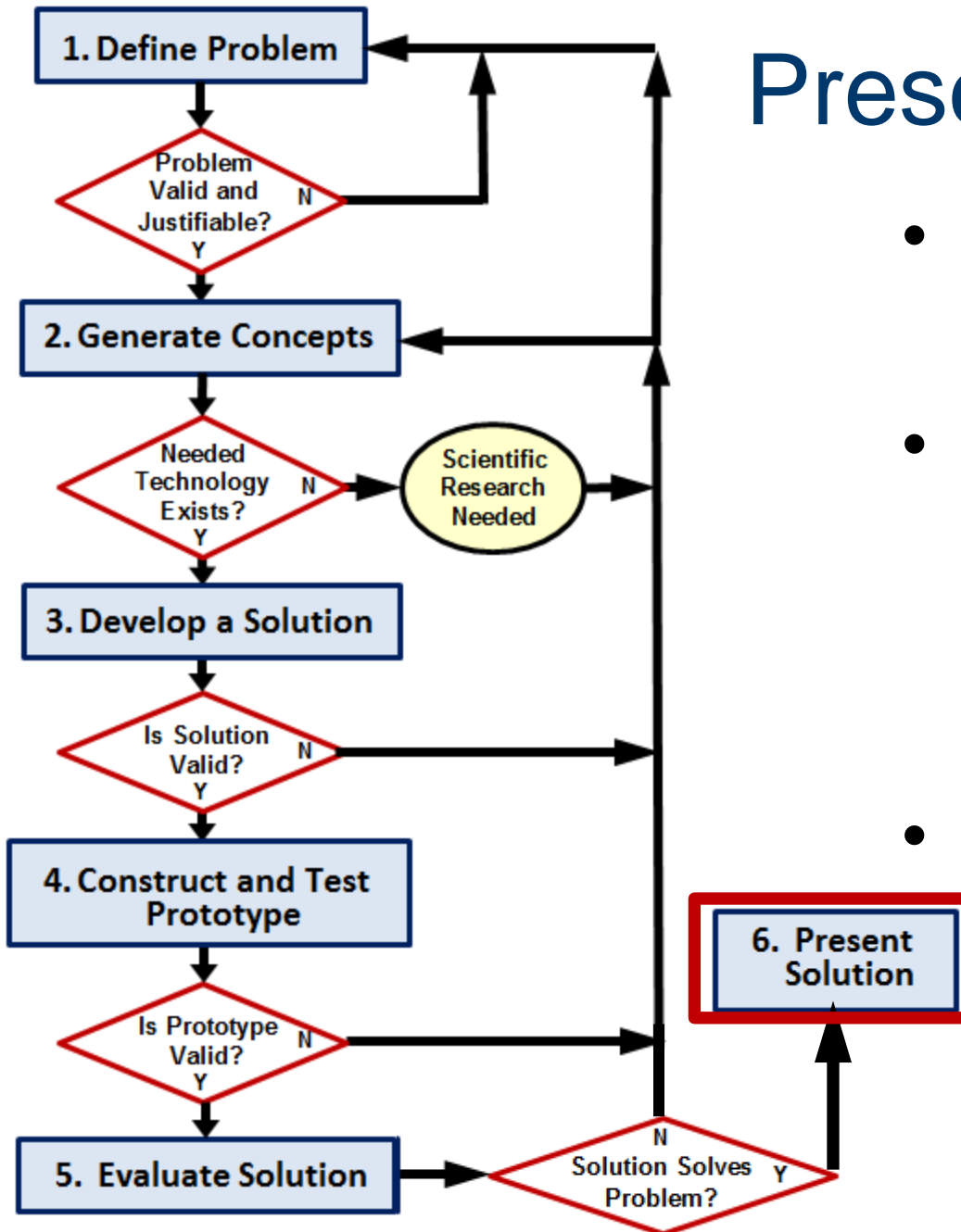
Iterations

The Design Process is **Iterative**

a process that repeats a series of steps over and over until the desired outcome is obtained

Innovations

A request for a product **innovation** or redesign will require the designer to repeat the design process.

Invention: a new product

Innovation: a new feature on an existing product

Image Resources

National Aeronautics and Space Administration (NASA). (n.d.). *NASA image exchange.* Retrieved from http://nix.nasa.gov/.