

Lesson 3: The Engineering Design Process

Scientific and Engineering Research Methods

Overview

- The Engineering Design Process is a systematic procedure for designing a product or service
 - Examples of products are things like tablets, ovens, cars, furniture, websites and many other things
 - Examples of services are cable or internet television (Netflix), public transportation (air travel, railroads), online shopping and delivery (Amazon.com)
- It is an iterative procedure (steps are repeated several times until the requirements are fulfilled)

Step 1: Requirements

- The design of a product or service starts with specifying the requirements. These are the set of conditions the product or service must satisfy.
- Requirements describe all aspects of the product's or service's operation
- Requirements cover size, shape, performance, reliability, what it does, what it costs, how it works, etc., as applicable

More on Requirements

- Suppose you want to design a bicycle. Examples of requirements on your design could be
 - Size of the bicycle: The bicycle must be between 65 and 80 inches long. The bicycle must use standard 26" wheels
 - Maximum weight: The bicycle must weigh no more than 16 pounds
 - Cost: The bicycle must cost no more than \$150 per unit to manufacture
 - Features: The bicycle will be a 15 speed bike
 - Performance: The bicycle must support a rider that weighs up to 250 lbs

More on Requirements (continued)

- Reliability is often an important area for requirements. Reliability requirements address areas such as
 - How long the product will last
 - Example: The iron must work for at least 5 years. This type of requirement allows the manufacturer to offer a warranty which helps convince consumers to buy the product
 - What percent of the time it functions correctly
 - Example: The computer must work correctly 99.999% of the time

Step 2: Design

- The product or service is designed in accordance with the requirements
- The design takes the form of a specification that describes what the product looks like, what parts are used, how it is put together, etc.
- If the product or service needs to do something that has never been done before, the design process could include prototyping
 - Prototyping is building some aspect of a product or service in a way to prove that it is feasible
 - A prototype is not a full scale version of the final product

Step 3: Build

- Build the product or service as it has been designed
- This is a version that is meant to perform as required

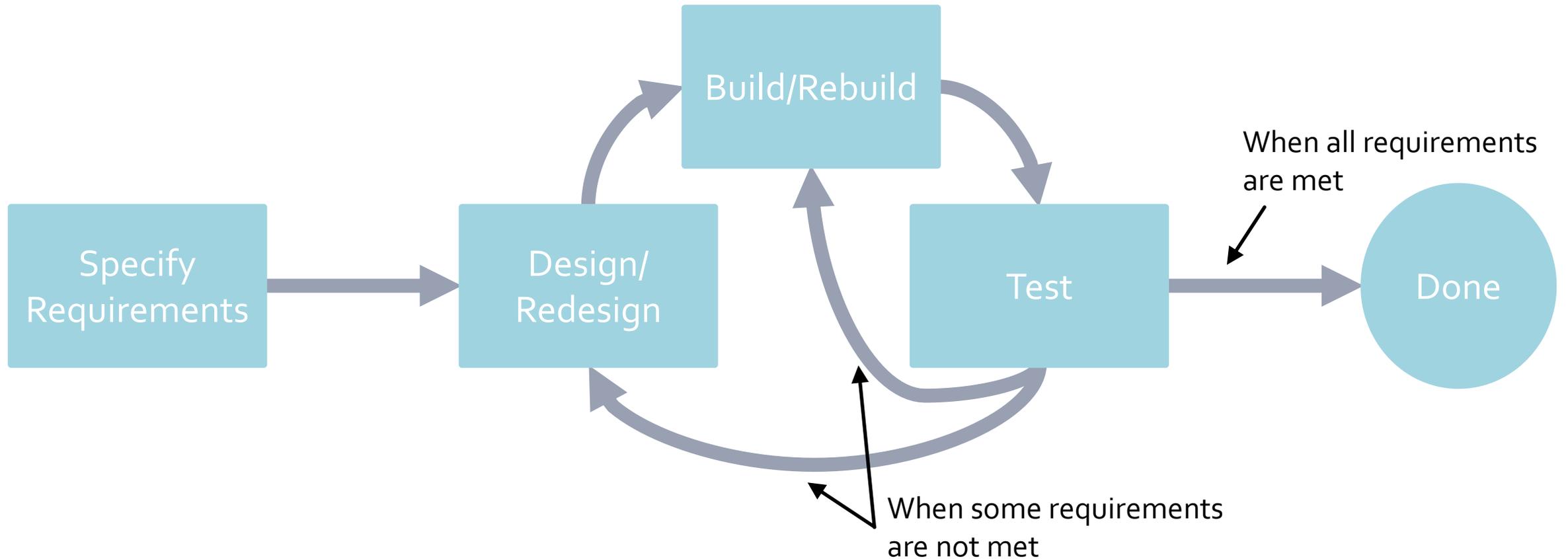
Step 4: Test

- Test the product or service against the requirements
- Make sure it meets or exceeds all requirements
 - Suppose you are designing a device to throw an egg without breaking it
 - A proper requirement for this would be something like: The device must throw an egg a distance of at least 10 feet and not break it at least 90% of the time
 - You would operate the device and measure how far it throws the egg and then check whether the egg is intact
 - In this example you must perform the test multiple times in order to verify it performs properly at least 90% of the time

Step 5: Rebuild or Redesign

- If one or more of the requirements are not met, the product must be modified
 - This may require rebuilding parts of it, or it may require a redesign
- After modifying the product, it must be retested
- If it still fails some requirements, it must be modified and retested again
- This continues until the product meets all the requirements
- This is the iterative part of the process

Iteration



Main Points

- The Engineering Design Process is an iterative procedure for developing a product or service
- It consists of these basic steps:
 - Specify requirements
 - Design the product or service to meet the requirements
 - Redesign if necessary if some requirements haven't been met according to testing
 - Build the product or service
 - Rebuild parts of the product or service if necessary if some requirements haven't been met according to testing
 - Test the product or service
 - If the tests all pass, you're done. If not, fix the problem by either redesigning and then rebuilding or just rebuilding, as appropriate. Then test again.