The Engineering Design Cycle

Test & Evaluate

Subsystem, System

Testing, Evaluation, Redesign

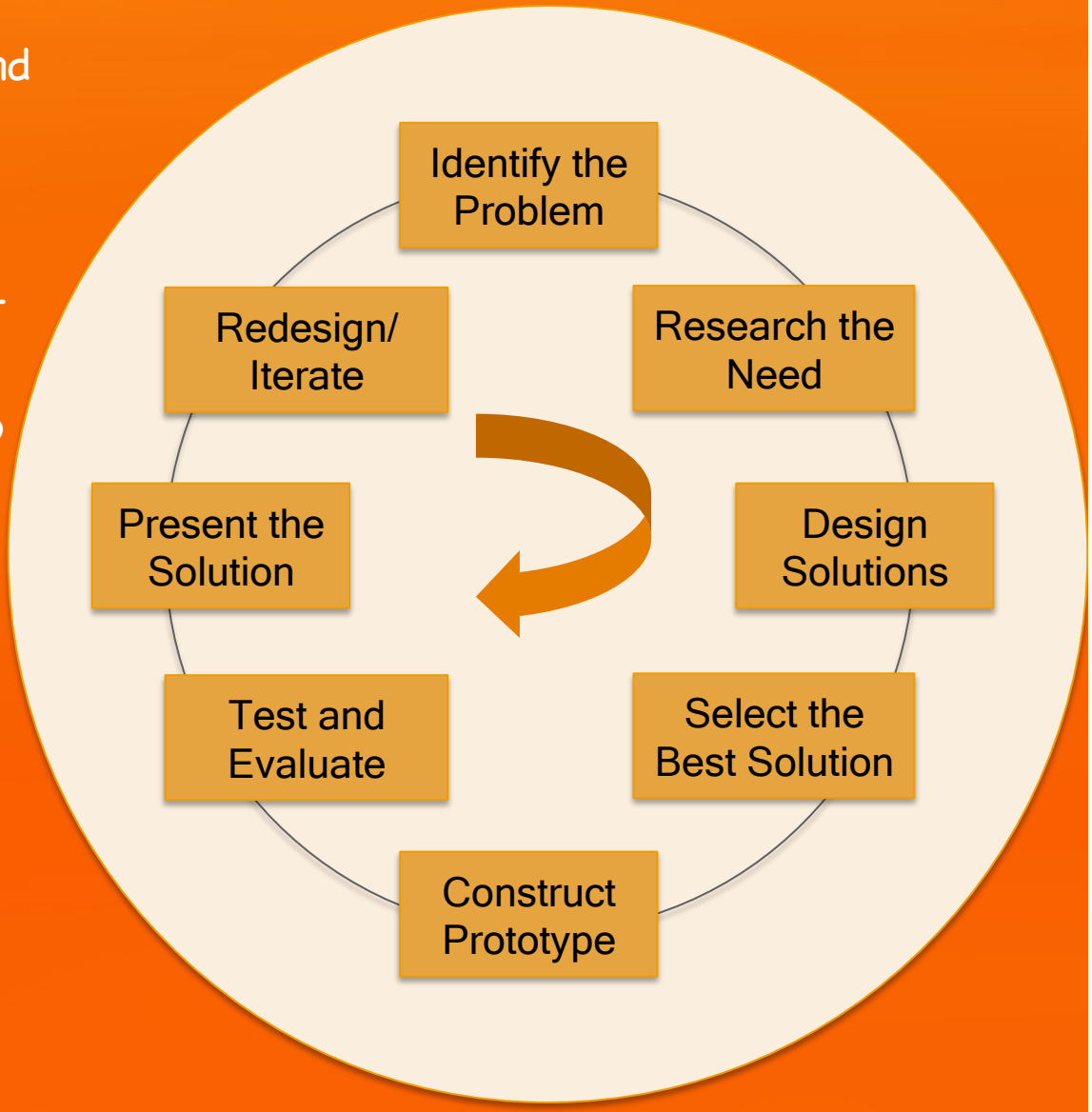
This is the part of the Engineering Design Cycle that tends to repeat the most (until the desired functionality of the whole design - the system) is achieved & verified.

The Engineering Design Cycle

A problem has been identified and researched. The need to solve it has been proven with credible sources. A range of solutions have been identified and the best of the bunch has been selected and prototyped. Now it's time to test & evaluate the prototype!

Basic Testing & Evaluation:

- Almost always includes some redesign and reconstructing!
- Involves multiple steps from component level to system level and relies on the block diagram to be logical and convincing.



Test & Evaluate:

Basic Level: Verifying Functionality from Component to System Level

in the Engineering Design Cycle

Basic Testing & Evaluation
Verifying Functionality

Testing a design can be done in many different ways and the exact testing strategy, amount of data, and analysis of that data required to verify the goodness and functionality of the design varies widely with the type and application of the design.

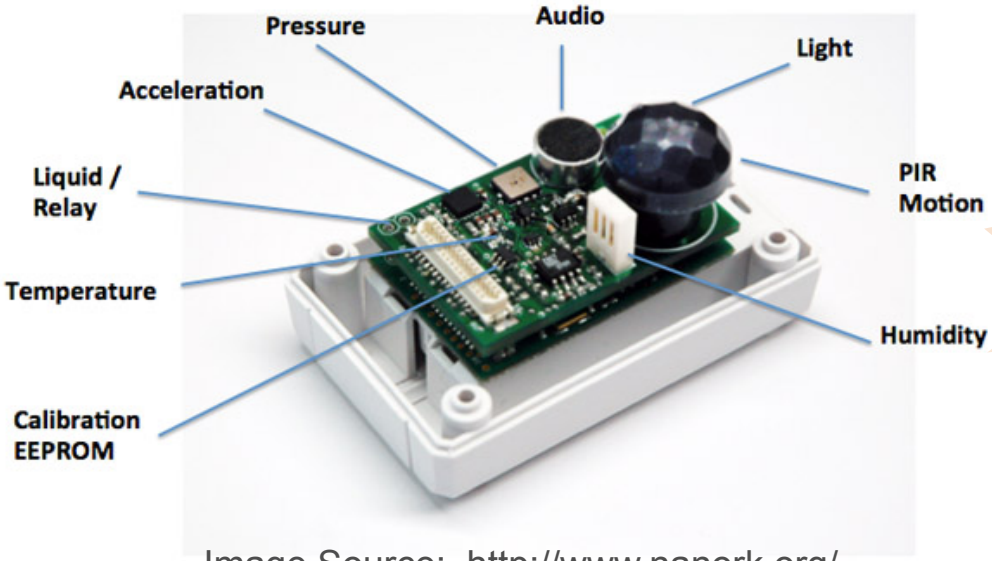


Image Source: http://www.nanork.org/

Where does testing end?

Test & Evaluate:

Basic Level: Verifying Functionality from Component to System Level

in the Engineering Design Cycle

Verifying Functionality
Testing of Subsystems & Systems

Once the main components are tested at a component-by-component level, it is time to move on to main subsystem testing (multiple main components) that operate together to deliver system functionality.

For example:

- Identification of quality of beer in a major manufacturing facility using multiple vapor (gas) sensors – the objective here is for multiple sensors to collectively differentiate "good" beer from "bad" beer.
- Risk assessment for carpal tunnel syndrome – the objective here may be to identify one or both wrists at risk for carpal tunnel syndrome and thus recommend posture/behavior changes based on whether one or both wrists are improperly positioned.
- Multiple axis outputs on accelerometer may be needed to identify both the orientation and the speed of an object.

Verifying Functionality

Testing of Main Subsystems

Have main component measurements been collected and verified in isolated and controlled environments?

Yes

Have subsystem measurements been collected and verified against expected sensor behavior?

Yes

Has a "Typical, Representative, and Realistic" Environment for System operation been defined in the design?

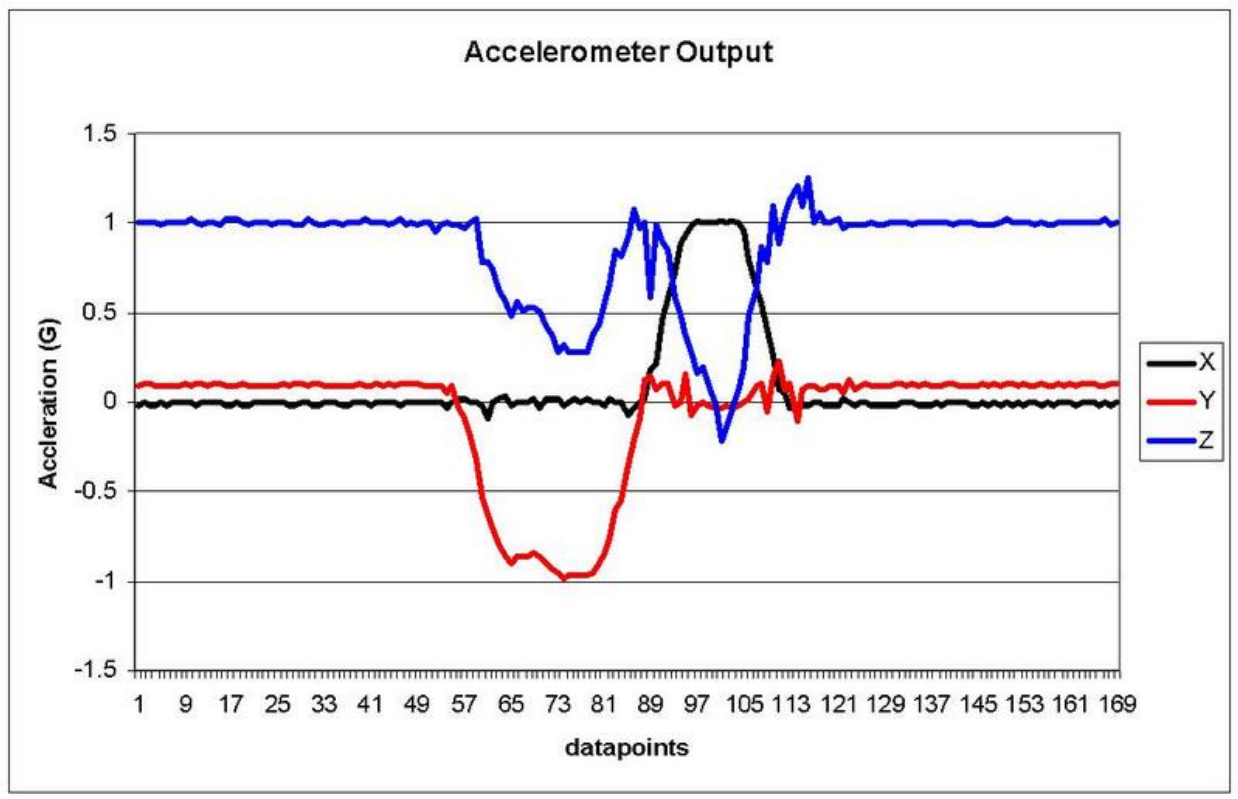
Yes

Test System under "Typical, Representative, and Realistic" conditions

Is System Functional?

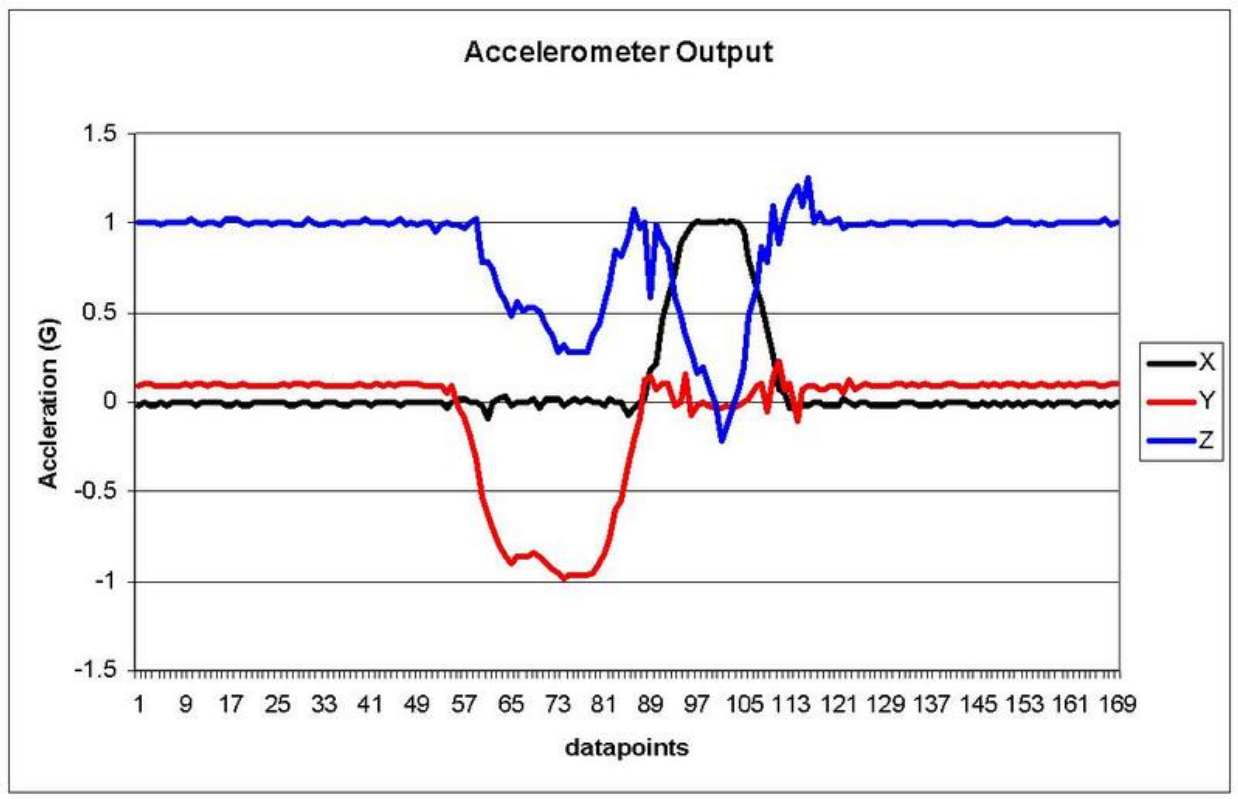
A functional system either predicts the output of interest within specified accuracy OR it can discern patterns of output with a specified rate of successful identification of those patterns.

Verifying Functionality
Testing of Main Subsystems



The three axes of an accelerometer may be used to detect the orientation of a tennis racquet (to which they are attached) within a certain # of degrees of accuracy.

Verifying Functionality
Testing of Main Subsystems



Alternatively, the three axes of an accelerometer may be used to detect whether or not the tennis racquet is in the proper posture for a successful swing.

Verifying Functionality
Testing of Main Subsystems

	Positive HIV infection	No HIV infection	
Positive results	495 A	995 B	1,490
Negative results	5 C	98,505 D	98,510
	500	99,500	100,000

Sensitivity: A/A+C = 495/500 = 99%
Specificity: D/B+D = 98,505/99,500 = 99%
Predictive value of a positive test: A/A+B = 495/1,490 = 33%

This graph shows comprehensively how many inputs were detected correctly (upper left and lower right quadrants) and how many were detected incorrectly (upper right and lower left quadrants) for a wide range of people.

Basic Testing & Evaluation

A Prototype must be tested:

Second, at a subsystem and system level, at two levels

- Within typical or representative operating conditions
- At extreme operating conditions that are still part of the design specification but are most likely to cause disruption or failure in the design performance
- Verification of functionality (answering -- does it work?) can involve absolute quantities or patterns of behavior