Reverse Engineering and Functional Analysis

WHAT is Reverse Engineering?

*Reverse engineering* (RE) is the process of taking something apart and analyzing its workings in detail, usually with the intention of understanding its structure, function, and operation.

WHY is Reverse Engineering Used?

- Documentation
- Discovery
- Investigation
- Product Improvement

WHY is Reverse Engineering Used?

- Documentation
  - No existing documentation
  - Interoperability
  - Maintenance
WHY is Reverse Engineering Used?

- **Discovery**
  - Academic/research/learning
  - Curiosity

- **Military or commercial intelligence**

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WHY is Reverse Engineering Used?

- **Investigation**
  - Analysis and testing
  - Document patent infringement
  - Forensics: Design failure

- **Improve or redesign a product**
  - Increase efficiency
  - Improve reliability
  - Improve manufacturing techniques
  - Eliminate failure mode
  - Reduce cost
  - Increase ease-of-use
  - Reduce negative environmental impacts
  - Recycle parts
  - Etc.
Reverse Engineering Tools

- Micrometers
- Caliper
- Optical Probe

Medical Imaging

Interactive Visualization

Stages of Reverse Engineering

- Visual Analysis
- Functional Analysis
- Structural Analysis

Functional Analysis

After a product has been selected, a non-destructive **functional analysis** is performed.

- First, the product's **purpose** is identified.
- Next, observations are made to determine how the product **functions**. These observations are recorded in detail.
- Lastly, the system's **inputs** and **outputs** are listed.

Functional Analysis Example

**Purpose**

The **purpose** of a toothbrush is to clean teeth and gums to prevent tooth and gum decay. Water and a cleansing paste are used in conjunction with the brush.
Functional Analysis Example

**Function**
An annotated sketch, with all visible components labeled, is created. A hypothesis is devised to describe (in detail) the sequential operation or function of the device using the sketch as a reference.

Black Box Systems Model

A *black box systems model* is used to identify what goes into and out of the product in order to make it work as a system.

Black Box Systems Model

The *black box* is used to represent the product’s internal components or processes, which are deemed unknown at this point.

Functional Analysis Example

Inputs: Hand Motion, Toothpaste, Water, Energy

Output: Sound, Heat, Waste, Clean teeth and gums