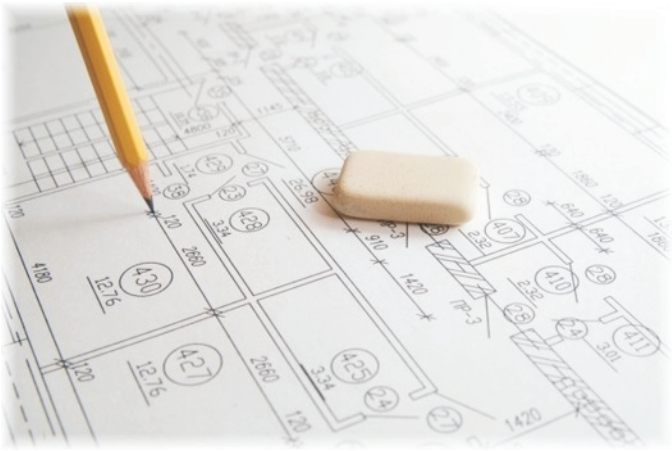
Understanding the Reverse-Engineering Process

REVERSE ENGINEERING has become a vital approach to product development and technology advancement. It can be used to reuse a system that works, improve on an existing system, or understand and improve on a competitor's product. A general series of steps is taken in the reverse-engineering process. The steps are performed to allow for a complete study of a product or process. With this study, information can be generated to understand a complete design.



Objectives:

1. Describe reverse engineering.
2. Identify the steps in the reverse-engineering process.
3. List the reasons for reverse engineering a product.

Key Terms:

design
durability
forward engineering
functionality
product definition statement
reverse engineering
subsystems

The Process of Reverse Engineering

In general, there are basically two different types of approaches in engineering: forward and reverse. The difference is essentially the manner in which several steps are taken or rearranged.

FORWARD ENGINEERING

Forward engineering is the traditional process of moving through a problem. Initially, the approach or solution is abstract. Then, through a series of logical designs, a final physical product or system is implemented. A problem needs to be solved or a product needs to be created. Its requirements are explored, and any specific needs or constraints are noted. Concepts are created, and designs are explored, which eventually lead to a final result.

REVERSE ENGINEERING

Reverse engineering is the process of taking something that already exists apart to analyze its workings in detail. Some examples are electrical devices or components to software and programs. The intent is to reconstruct the device or program in a new manner that does the same thing but with more efficient and exact functions.

Improvements

One objective of the reverse-engineering process is to capitalize on successes and to learn from the shortcomings of existing designs. Reverse engineering begins with the product and works backwards through the design process to arrive at a **product definition statement** (PDS), which describes the product for testing and improvement purposes. In doing so, a lot of information about the design can be uncovered. Questions are answered (e.g., What decisions were successful? Why were certain parts used? How can this be improved?). Typically, reverse engineering is only cost-effective if the item to be studied has a high investment turn around. This may be true for products that will be reproduced in large qualities or can be made much more efficient with less cost overhead.

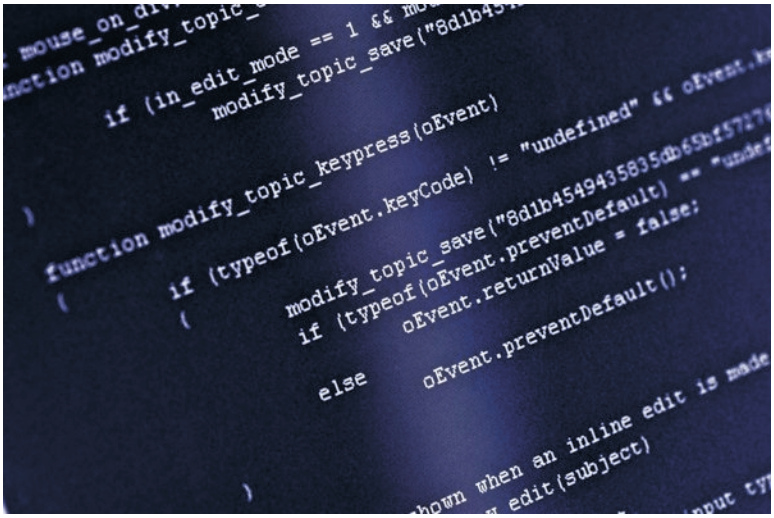


FIGURE 1. Software engineers will often decode programs to learn how to make them process information more efficiently.

Fields

Reverse engineering is common in many fields: software

engineering, civil engineering, the automotive industry, electronics, and the chemical industry. When a new product comes out on the market, competing manufacturers may buy it. They will disassemble it to learn how it was built and how it operates. In civil engineering, new buildings or bridges may copy the successes of existing designs to decrease the likelihood of catastrophic failure. In software engineering, a good source code or program line is often a variation of an already existing code or line. A chemical company may use reverse engineering to get past a patent on a competitor's manufacturing process. By working backwards from a solution that works, they may be able to find a totally new way to achieve the same results.

Steps in the Reverse-Engineering Process

There are basically six general steps in the reverse-engineering process. Each one involves a series of questions and analysis. Following are identifications and descriptions of the steps.

PREDICTION

In this step, a list is created of some of the design objectives for the product. The engineers also look at some of the constraints that may have influenced the product. Basic questions are asked: *For what market was the product created? How does the product work? What is the purpose of this product?*

OBSERVATION

Here, the product is studied and information about its form and function are noted. Again, questions are asked: *How do we think it works? How does it meet the overall design objective? Why exactly is it designed the way that it is?*

DISASSEMBLE

In this step, the product is taken apart and examined. The engineers and designers want to find out how it works and how it is made. They also want to find out how many parts there are and which ones move. They can also check their predictions to make sure that what they assumed was correct.

FIGURE 2. By dissembling an existing product, you can learn about all the subsystems used to make it function.

ANALYZE

The design is carefully examined. All the systems and **subsystems** (secondary or subordinate sets of parts forming a complex whole) are analyzed, such as internal processes, structural details, and the makeup of electrical components. These are all the smaller pieces within each separate part of the design that make it all work. In this step, the design may need to be redrawn and laid out. Measurements will be taken and notes created on all the system's designs, components, safety issues, and controls.

TEST

The product is carefully reassembled in this step. The device will then be operated, and observations will be recorded. Its performance is studied in terms of its **functionality**—how well it operates. Its ergonomics are also studied, in terms of how well its form relates to its function. In addition, the **durability** (ability to exist without deterioration) of the design is studied to find out how long the product is expected to last and how well it will resist stress and force.

DOCUMENTATION

In this step, all the gathered information is organized and noted, including the inferred design goals and constraints. Schematic ideas and diagrams are created explaining various design parts. The entire **design** (sketch or outline showing the main features) is documented. This includes all of its materials, form or geometry, and functionality. Lists are created that note and describe all the components, including flaws and successes. Any refinements that may enhance the product's use and function are identified. All the required upgrades and needed changes are noted and explained.

Reasons for Reverse Engineering

There are several reasons why a product may be reverse engineered. In some cases, this may be required because all that exists of the design is the actual product itself. For instance, the original manufacturer of the product may no longer produce it. The original manufacturer may no longer exist, but a need for the product may remain. The original documentation cannot be found or never existed. The original supplier cannot or will not provide additional parts or replacement parts. In many cases, reverse engineering is required to update obsolete materials and manufacturing processes with more current and less expensive ones.

Other reasons may include the need to remove bad features on a product. This might relate to unknown excessive wear on a product. There may be a need to strengthen good product features based on long-term use. It may also be done to explore new ways of improving prod-

uct performance. Some reasons may also relate directly to the competition. This might include analyzing the good and bad qualities of a competitor's product. In addition, it may be required to learn the methods of a competitor's product development to make improvements.

Summary:

Reverse engineering can be a very helpful and necessary approach. By taking something that already exists apart to analyze it, much information can be found. In some cases, this is required to improve an existing product or to improve on a competitor's product.

There are six basic steps in reverse engineering. First, the product is studied. Predictions are made, and the product is observed, disassembled, and analyzed. The product is then tested and fully documented. With this knowledge, a product can be reproduced. If it is unavailable, it can be developed, and it can be improved if necessary.

Checking Your Knowledge:

1. What is reverse engineering?
2. Name one field that uses reverse engineering.
3. Name three steps in the reverse-engineering process.
4. What is documented during the final stage of the reverse-engineering process?
5. What are two reasons for reverse engineering?

Expanding Your Knowledge:

A lot can be learned when the reverse-engineering process is used. Its concept can be applied to almost anything. Go to a secondhand shop and purchase some products that are of interest to you in terms of how they work. Apply the steps in the reverse-engineering process to this product and learn as much as you can about how it works.

Web Links:

Frequently Asked Questions About Reverse Engineering
http://www.chillingeffects.org/reverse/faq.cgi

Reverse Engineering
http://www.americanscientist.org/issues/pub/reverse-engineering