Sequential Engineering Vs Quality by Design

Sequential Engineering

Traditional engineering, also known as sequential engineering, is the process of marketing, engineering design, manufacturing, testing and production where each stage of the development process is carried out separately, and the next stage cannot start until the previous stage is finished.

Sequential Engineering Stages

1. Research
2. Design
3. Manufacture
4. Quality Control
5. Distribution
6. Sales

Advantages of Sequential Engineering

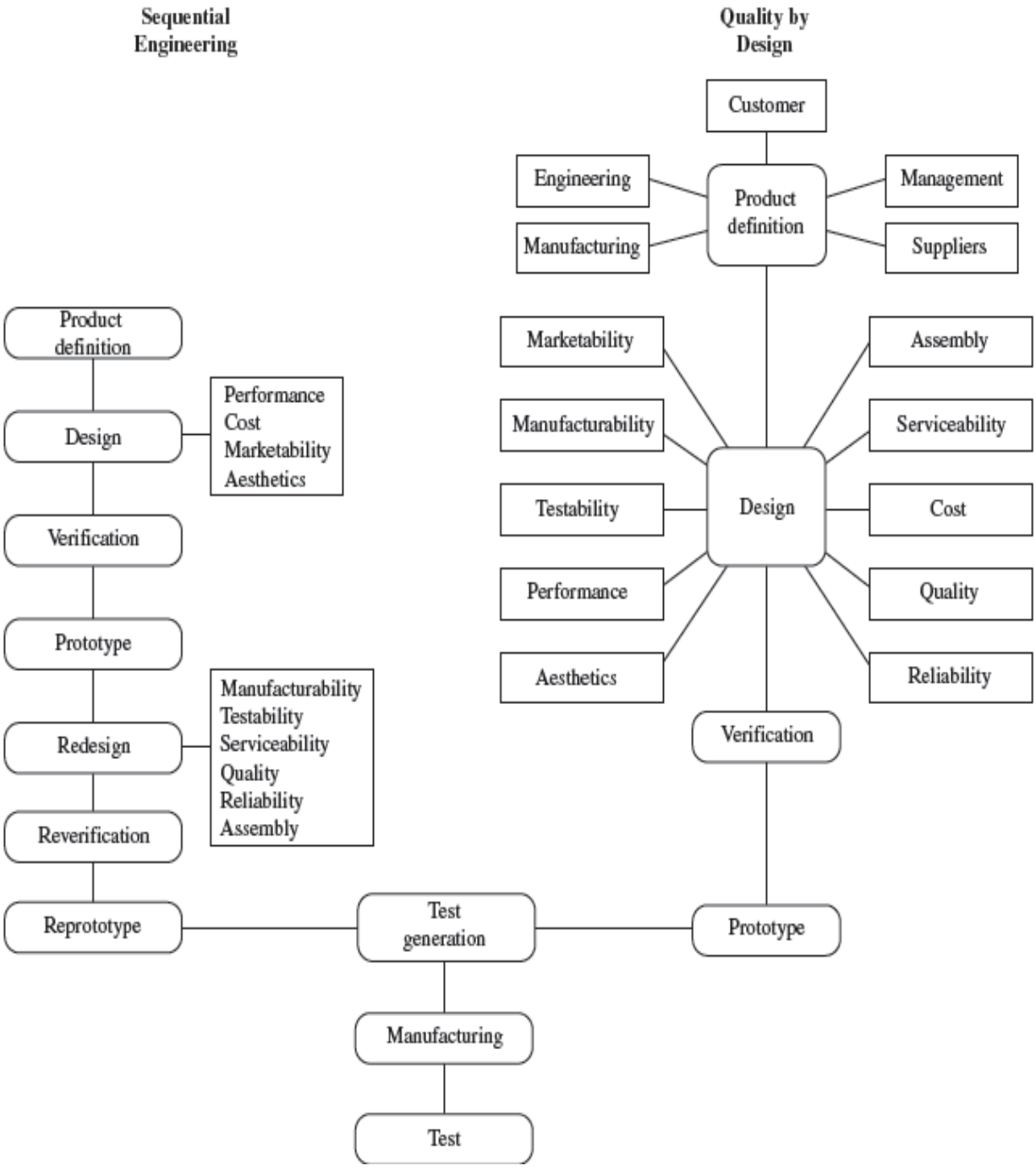
- It is simple and well-defined method of engineering production.
- It allows one to follow step one by one in easy manner.
- Enhances managerial control

Disadvantages of Sequential Engineering

- It is time-consuming and slow process
- Remains uncertainty in the beginning of the project
- Changes to be desired on later stage of product development become difficult and expensive to bring.
- Customer is able to see the product at the end only.

Quality by Design

Quality by Design is a systematic approach to development that begins with predefined objectives and emphasizes product and process understanding and process control, based on sound science and quality risk management.


Sequential Engineering
Product definition
Design
Performance
Cost
Marketability
Aesthetics
Verification
Prototype
Redesign
Manufacturability
Testability
Serviceability
Quality
Reliability
Assembly
Reverification
Reprototype
Test generation
Manufacturing
Test
Quality by Design
Customer
Engineering
Manufacturing
Product definition
Management
Suppliers
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Reliability
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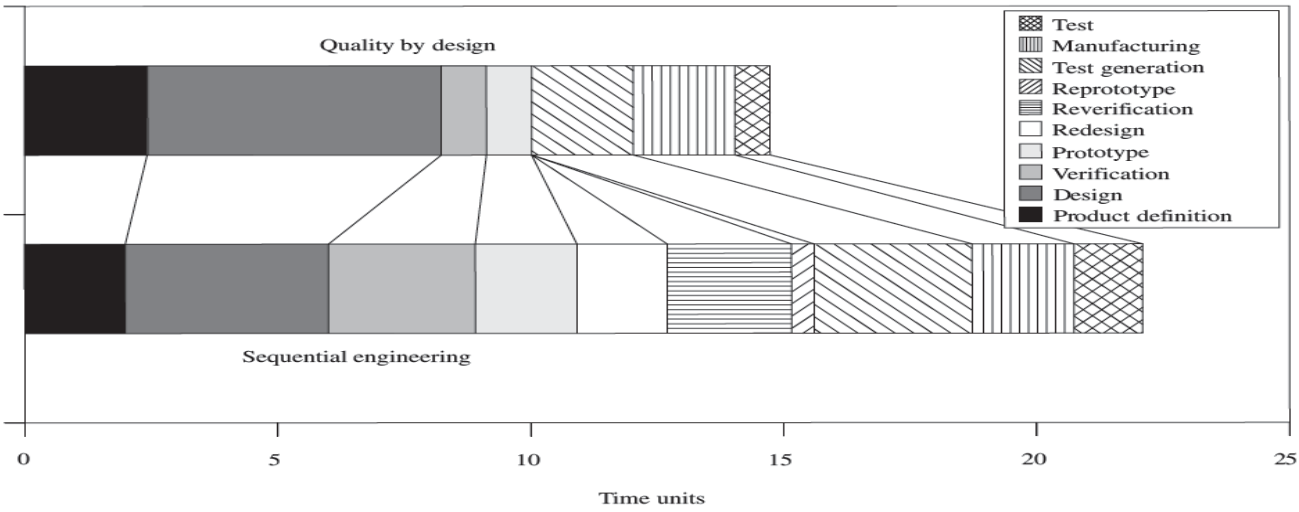
Prototype

1. Comparing Sequential Engineering and Quality by Design



Hypothetical Product Development Time Line

Design for Six Sigma (DFSS)

Six Sigma is a disciplined, statistical-based, data-driven approach and continuous improvement methodology for eliminating defects in a product, process or service. ... Six Sigma can also be thought of as a measure of process performance, with Six Sigma being the goal, based on the defects per million.

Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by American engineer Bill Smith while working at Motorola in 1980. It is explained by **DMADOV**

- **D**efine the project goals and customer deliverables.
- **M**easure and determine customer needs and specifications.
- **A**nalyze to generate innovative concepts, and evaluate and select the best concept for the design.

- **D**esign details, optimize the design, and plan for design verification and validation. This phase often requires simulations.
- **O**ptimize the design of the Product
- **V**erify and validate the design reliability and capability to meet customer requirements.

Organizational Tools

- Total Quality Management philosophies.
- Computer networks.
- ISO 9000.

ISO 9000 is defined as a set of international standards on quality management and quality assurance developed to help companies effectively document the quality system elements needed to maintain an efficient quality system. They are not specific to any one industry and can be applied to organizations of any size.

- ISO 14000

ISO 14000 is a series of environmental management standards developed and published by the International Organization for Standardization (ISO) for organizations. The ISO 14000 standards provide a guideline or framework for organizations that need to systematize and improve their environmental management efforts.

- Total productive maintenance.
- Quality function deployment.
- Information technology.
- Electronic meeting software.
- Enterprise resource planning software.

Product Development Tools

- Computer-aided drafting software.
- Solid modelling software.

- Finite element analysis software.
- Parametric analysis software.
- Rapid prototyping techniques.
- Design for manufacture and assembly (and service and environment) techniques.
- Design for reliability.
- Design for maintainability or serviceability.
- Failure mode and effect analysis.

Design for Reliability (DFR)

- Failure mode and effects analysis (FMEA).
- Stress strength analysis to minimize the chances of failure.
- Part selection, considering operating conditions and load factors.
- Derating means using the system at lower than rated load to increase reliability.
- Redundancy is a technique similar to a 'stand-by' subsystem.
- Reliability growth models to monitor whether system reliability meets the target.
- Accelerated life testing (ALT) is done at the increased stress and/or faster operation to reduce the test duration.
- Multiple Environment Overstress Tests (MEOST) is a technique of applying combined loads to simulate all failure modes in the lab tests.

Design for Maintainability or Serviceability

- Low fastener count
- Low tool count
- Predictable maintenance schedules
- One-step service functions

- Extend maintenance intervals since predictable failures are relatively less expensive when compared to random failures, for example, filter change, oil change
- Provide diagnostics and monitoring facilities

Production Tools

- Robotics.
- Computer-aided manufacturing.
- Computer numerical controlled tools.
- Continuous process improvement.
- Just-in-time production.
- Virtual manufacturing software.
- Agile (or lean) manufacturing.
- Advanced measurement and verification

Statistical Tools

- Statistical tolerance stack-up analysis.
- Reliability and life data analysis.
- Design of experiments.
- Response surface methods.
- Statistical process control.

Misconceptions

1. Quality by design is not simultaneous design and production; it encourages just the opposite. Nothing is produced until all designs are agreed upon between all the producers required to fabricate the product.
2. Quality by design is not a quick fix or magical formula for success; it is a way of thinking. The people involved in the quality by design group must be specialists before they are

incorporated in the group. If this technical expertise is not present, little will be gained with quality by design principles.

3. Quality by design does not require multiple tests of the product to be conducted until the optimum design is achieved. Quality by design applies a one-pass design, where the product passes testing the first time.

4. Quality by design is often confused with inspection techniques used in TQM. Quality by design is highly dependent upon a TQM environment, but the same inspection methods are not required. Quality by design incorporates repeatability into its products, either automatically or manually. Quality by design considers and applies what was learned about process capabilities in the TQM setting. Thus, products are stringently designed well within process capabilities to facilitate SPC.

Quality Function Deployment (QFD)

What is QFD?

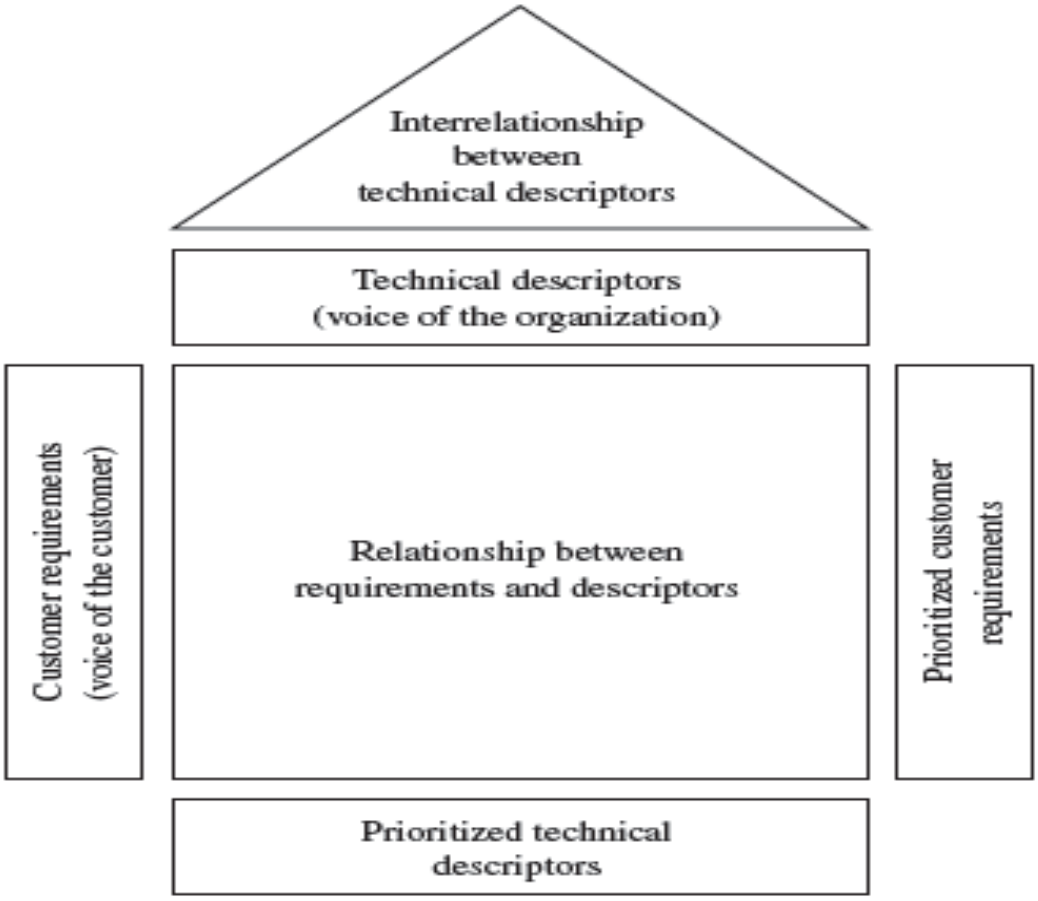
- Quality function deployment (QFD) is a team based planning tool used to fulfil customer expectations.
- It is a disciplined approach to product design, engineering, and production and provides in-depth evaluation of a product.
- It is employed to translate customer expectations, in terms of specific requirements, into directions and actions that can be deployed through:
  - Product planning
  - Part development
  - Process planning
  - Production planning
  - Service industries

Benefits of QFD

- Improves Customer Satisfaction

- Reduces Implementation Time
- Promotes Teamwork
- Provides Documentation

House of Quality



Building a House of Quality

1. Step 1—List Customer Requirements (WHATs)

2. Step 2—List Technical Descriptors (HOWs)
3. Step 3—Develop a Relationship Matrix Between WHATs and HOWs
4. Step 4—Develop an Interrelationship Matrix Between HOWs
5. Step 5—Competitive Assessments
6. Step 6—Develop Prioritized Customer Requirements
7. Step 7—Develop Prioritized Technical Descriptors