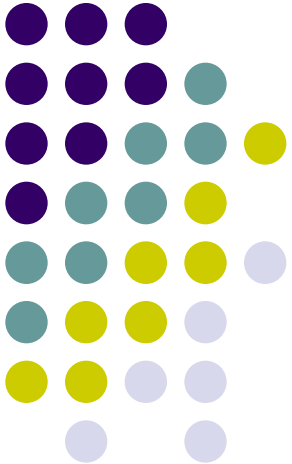
ME 482 – Rapid Product Development and Manufacturing

Chapter 3

New Product Development Techniques



Mechanical Engineering
University of Gaziantep

Dr. Sadık Olguner

Feasibility Studies

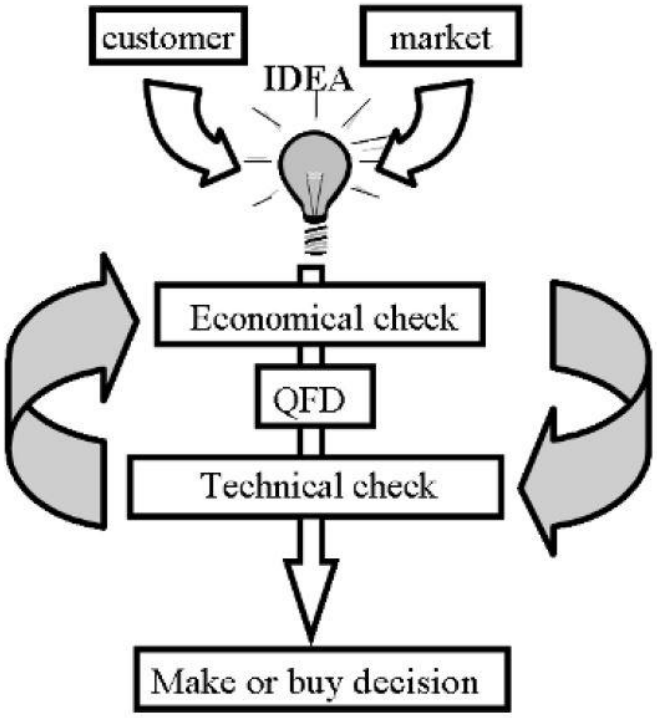
- **Feasibility** is the assessment of the possibility that a design, process, or material for production fulfils all the engineering requirements with the minimum capacity required at the specified volumes.
- Feasibility assessments are required for new products, changes to products and processes, or important changes in volume.
- For these evaluations, planning tools such as Failure Mode and Effect Analysis *(FMEA)*, control plans, process capability analysis and design of experiments processes are used.
- Manufacturing feasibility should be established before taking on any commitment with regard to tooling or manufacturing resources.
- There are three concepts that should be taken into account when talking about feasibility:
  - Technical requirements (product or process)
  - Production volume
  - Profitability

Feasibility Studies

- One important concept in the feasibility studies is that of **bottlenecks**. A bottleneck is faced when any of the current processes is incapable of accomplishing the objectives established in terms of cost, quality, manufacturing volumes, or any other requirements.
- The detection of these bottlenecks in the design phases constitutes one of the most evident advantages of working on **Concurrent Engineering**.
- The possible solution channels will basically emerge from the utilization of some or all the following techniques.
  - Make or buy analysis
  - Functional analysis
  - Quality Function Deployment (QFD)
  - Innovation
  - Investments analysis
  - Ongoing improvement
  - Computer simulation
  - Benchmarking

Make or Buy

- Deciding whether a new product is to be introduced into the current portfolio is possibly one the most important decisions to be made.
- The analysis should be made for each of the elements of the product family tree. Obviously, the decision is based on the estimate of whether we can make a given component at a cost that renders it possible to obtain profits for the given selling price.
- Make or buy analysis is an iterative process. From the "idea" coming from individual customers, the market, or both, economical *(pay-off)* and technical *(feasibility and capability)* checks have to be done. **QFD methodology** lies in the middle of the iterative circle as a methodology that can push overpassing current limitations beyond the current status by incorporating innovation.



Quality Function Deployment (QFD)

- **Quality Function Deployment (QFD)** is a methodology that started in Japan by the end of the 1960's, jumped to USA in the 1980's and expanded from there to many other countries in the world.
- **QFD** systematically translates customers' requirements *(voice of the customer)* into design requirements *(voice of the engineer)*. QFD is a proven approach to improving customer satisfaction, reducing product development cycle times, integrating internal and external suppliers, lowering start-up problems, and developing a customer-driven knowledge base.
- **QFD** may be defined as a "Structured process aiming to gather the voice of the customer, translate and integrate it into life cycle product/process design requirements **with contribution of all actors** in the development process".

Quality Function Deployment (QFD)

- QFD “forces” to follow strictly a series of systematized stages, in which all functions will participate. In this way, the following goals are reached:
  - Nothing is “missed.”
  - All information is channelled toward the customer.
  - The creativeness of team members is enhanced.
  - A series of tools are applied in a joint and systematized manner.
- The most significant advantage of QFD is its high competitive character. The correct use of QFD methodology will allow the company to reach a privileged position among the competitors. This fact emerges from aspects such as:
  - Differential performances.
  - Reduction of development time.
  - Reduction of engineering changes.
  - Cost reduction.

Theory for Inventive Problem Solving (TRIZ)

- The work on the Russian Theory for **Inventive Problem Solving** was begun by Genrich Altshuller in 1946, and was continued since then by his students and followers.
- TRIZ is based on some fundamental premises that can be enunciated as:

  - ***Systematization:*** The "inventor" follows a method but it is intuitive. However TRIZ systematizes it.
  - ***Solutions:*** The solutions are given but must be found which can actually be done.
  - ***Patterns of evolution:*** Technological systems do not evolve randomly but following some evolution patterns or guidelines.
  - ***Ideality:*** All technological systems move toward ideality. Maximum ideality level is reached when a system performs its functions without actually existing.
  - ***Contradictions:*** Any inventive problem contains a contradiction. If this contradiction can be solved, innovation appears.
  - ***Systems approach:*** A system is not isolated but formed by sub-systems and integrated in a super-system. In many cases the real problem is not where it seems to be but in any of the other levels. The solution in another level may be easier to find and less costly to implement.

Theory for Inventive Problem Solving (TRIZ)

- **TRIZ** has been used successfully for the development of new products, for the forecast of future product developments or evolution of technologies, for building patent "fences" for uncovering the causes of past failures, as well as identifying and eliminating potential causes for failure prior to their appearance.

Identify Problem	Formulate Problem	Find Solutions	Asses Solutions	Implement Solution
Reliability FMEA	QFD Market Research	Trial and error Brainstorming	Robust Design Reliability	On purpose means

Failure Mode and Effect Analysis (FMEA)

- **Failure Mode and Effect Analysis (FMEA)** is a method which, by means of a systematic analysis, contributes to the efforts of identification and prevention of failure modes of a product or a process, evaluating their seriousness, occurrence, and detection, to prioritize the causes on which action must be taken for preventing occurrence of these failure modes.
- FMEA makes it possible to identify the significant variables of a process/product that allows us to determine and establish the corrective actions needed to prevent the failure, or the detection thereof, if it occurs, ensuring that faulty or unsuitable products do not reach the customer.
- The people that perform FMEA on a system should be familiar with the failure modes and possible causes of each failure mode of each part.

Value Analysis (VA)

- **Value Analysis (VA)** is a system of techniques and procedures geared towards identifying superfluous costs.
- It analyzes the balance between the function performance quality and the function cost seeking to achieve the highest performance (value) at a cost as close as possible to the value they provide.
- The importance that each of the functions has for the user is called value and is evaluated based on information collected from real consumers. At the end of the analysis, each function has got a relative percentage weight in the global (100%) customer satisfaction.
- **In an ideal situation,** the percentage of cost should be equal to the percentage of value to customer for each function. Therefore big imbalances *(high costs vs. low satisfaction level)* are the objectives for cost reduction.

Design of Experiments (DoE)

- **Design of Experiments (DoE)** is intended to find the best combination of factors that will optimize the output *(in quality and quantity)* of a manufacturing process or the performance of a system.
- In any industrial processes a distinction should be made between **variables** and **results**. Variables must be selected based on the experience of the people involved in the study, the most accurate the variables, the better will be the results of the study.
- Design of Experiments (DoE) on its way provides a means to solve both the typical errors of the experimentation and the limitations from traditional methods. As a result:
  - It is possible to study the factors with few experiments
  - We get more information (interactions)
  - It statistically discards the effects of undesired variables
  - It saves time and money

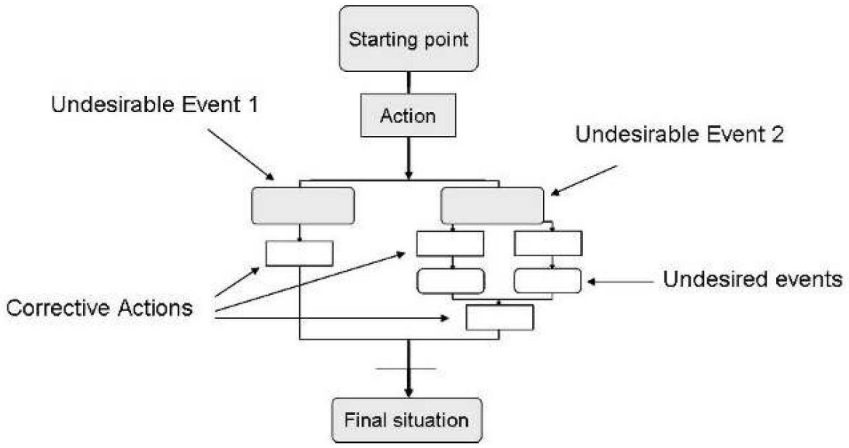
Taguchi Techniques

- Taguchi techniques may be regarded as a variant, more engineering and less mathematic, of the DoE.
- Taguchi's main contribution is the development of tables with a reduced combination of experiments claiming that the accuracy of the results is significantly similar to the one obtained by a whole DoE.
- Taguchi technique is considered as being more adequate to industrial environments where the easy and rapidity of obtaining good results in short time and less cost is more important than the achievements of sound scientific experimental results characteristic of academic and research environments.

Process Decision Program Chart (PDPC)

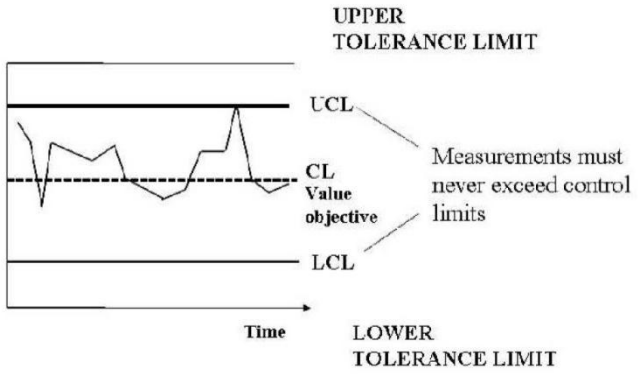
- Process Decision Program Chart (PDPC) is a flow chart collecting all possible undesired situations along the implementation of a plan with the aim of:
  - Establishing preventive actions impeding their occurrence
  - Foreseeing corrective actions or alternative ways of evolution to be used in the case of the undesired event finally appearing

- It is recommended to use PDPC in cases such as:
  - New processes with unknown results are being set up
  - The plan is complex, critical and it has high failure probabilities
  - Anticipation to difficulties is desirable



Tools for Continuous Improvement

- **Capability Studies:** Whenever a manufacturing process is being designed, set up, or has suffered important modifications, a capability study is needed in order to foresee the ability of the process to manufacture the parts it has been designed for at the required level of quality.
- **Statistical Process Control:** means using statistical techniques to control the production process with a view to limit the variability of quality characteristics and avoid deviations in them.
- **Quality Costs Control:** is one of the most precise and reliable measurements of the efficiency of the quality system of a company.



Tools for Continuous Improvement

- **Kaizen:** is an **ongoing improvement process** that involves all personnel, including executives and operators. Kaizen philosophy means *"small improvements through continuous efforts."*

  This process is based on team work establishing multi-disciplinary and multi-level teams working together on identifying the **causes and delivering solutions**.

  The feeling of being a group raises the commitment and willingness to work on the problem and contribute to its solution.

  Kaizen is a **customer-oriented improvement strategy**. The management should seek customer satisfaction and serve the customer in order to allow the company to survive in the business and be profitable.