Total Quality Management

Mechanical Technology Chapter 3 Notes

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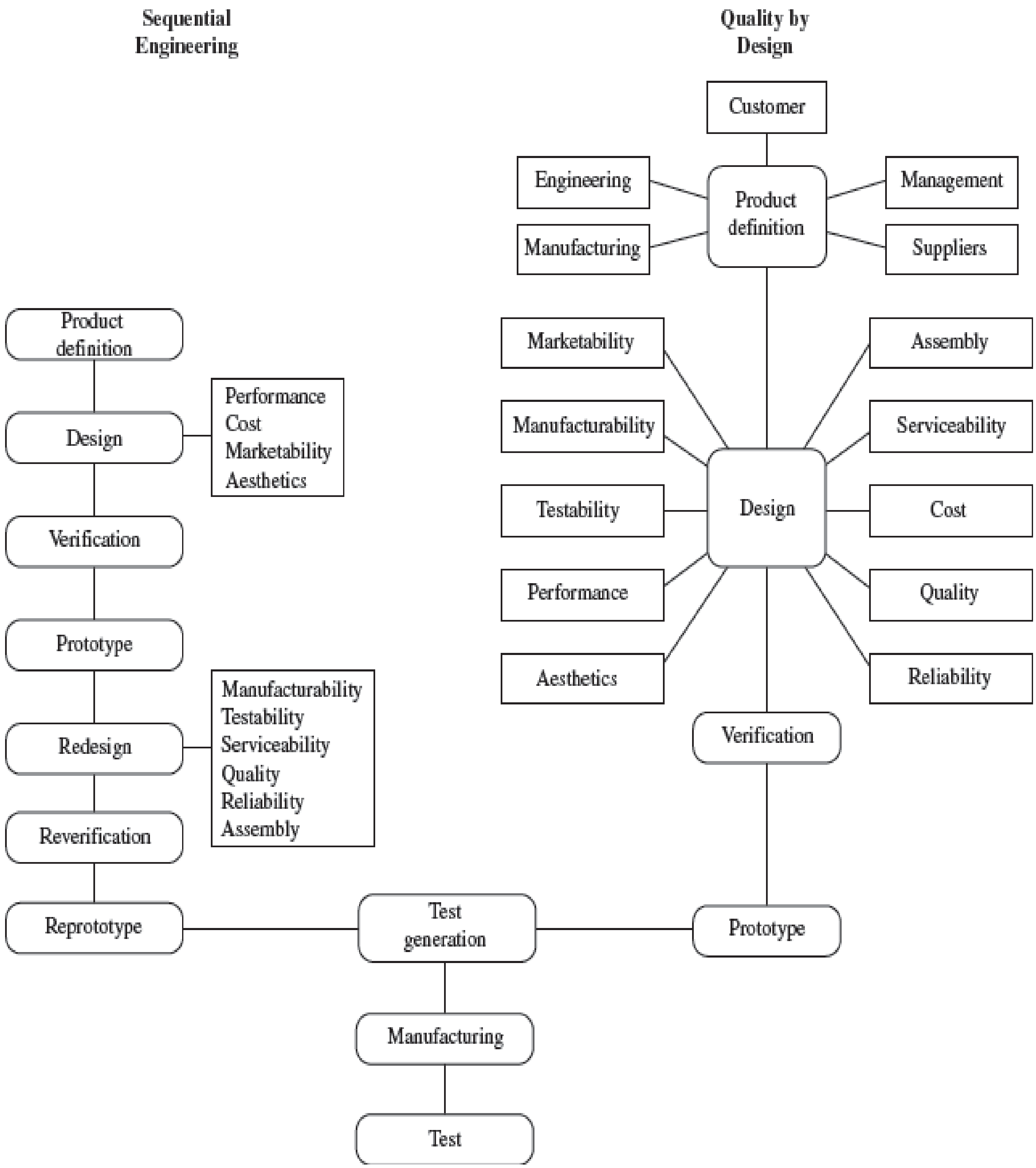
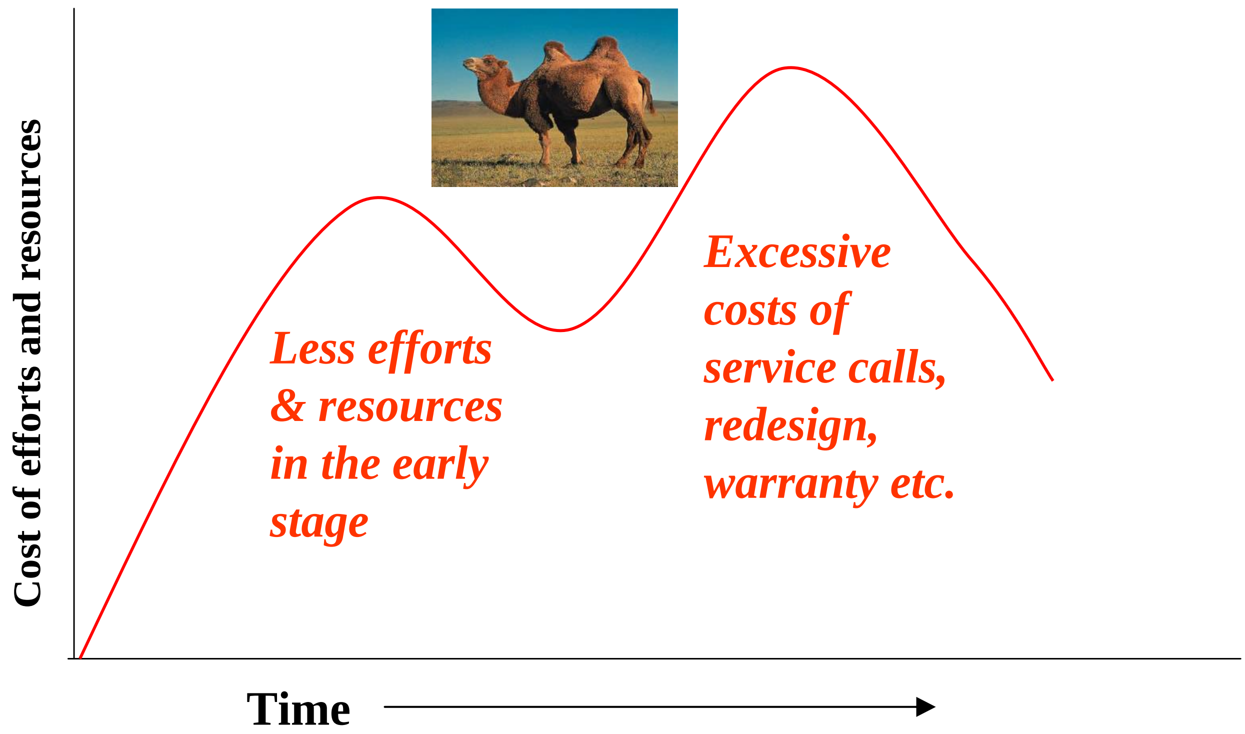
Chapter 3

Quality by Design

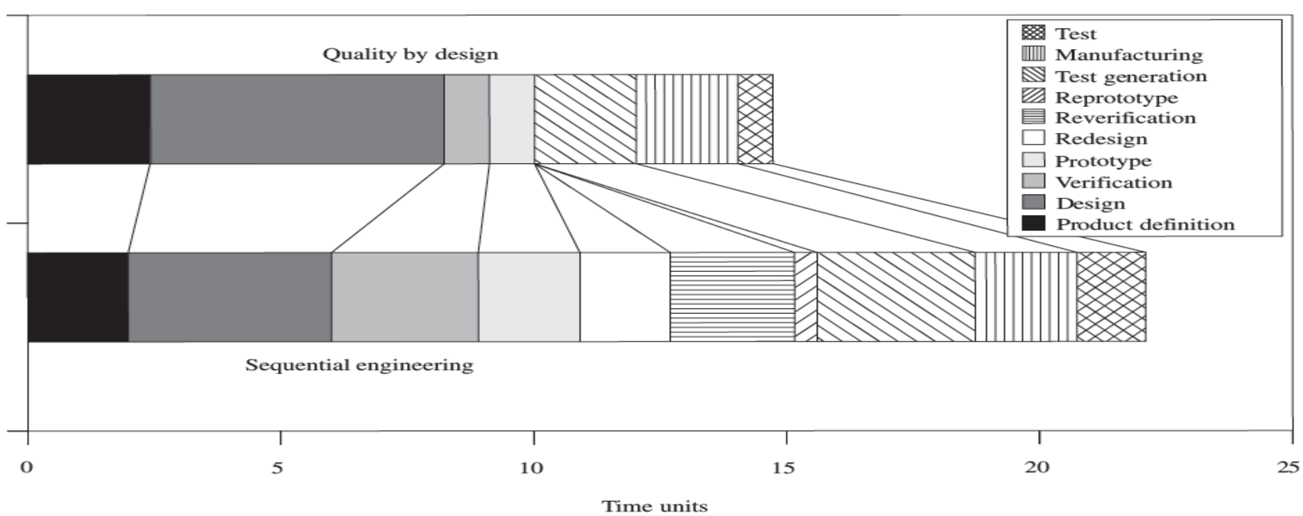
1. Sequential Engineering Vs Quality by Design



2. The Double Hump Camel



3. Comparing Sequential Engineering and Quality by Design



Hypothetical Product Development Time Line

4. Design for Six Sigma (DFSS)

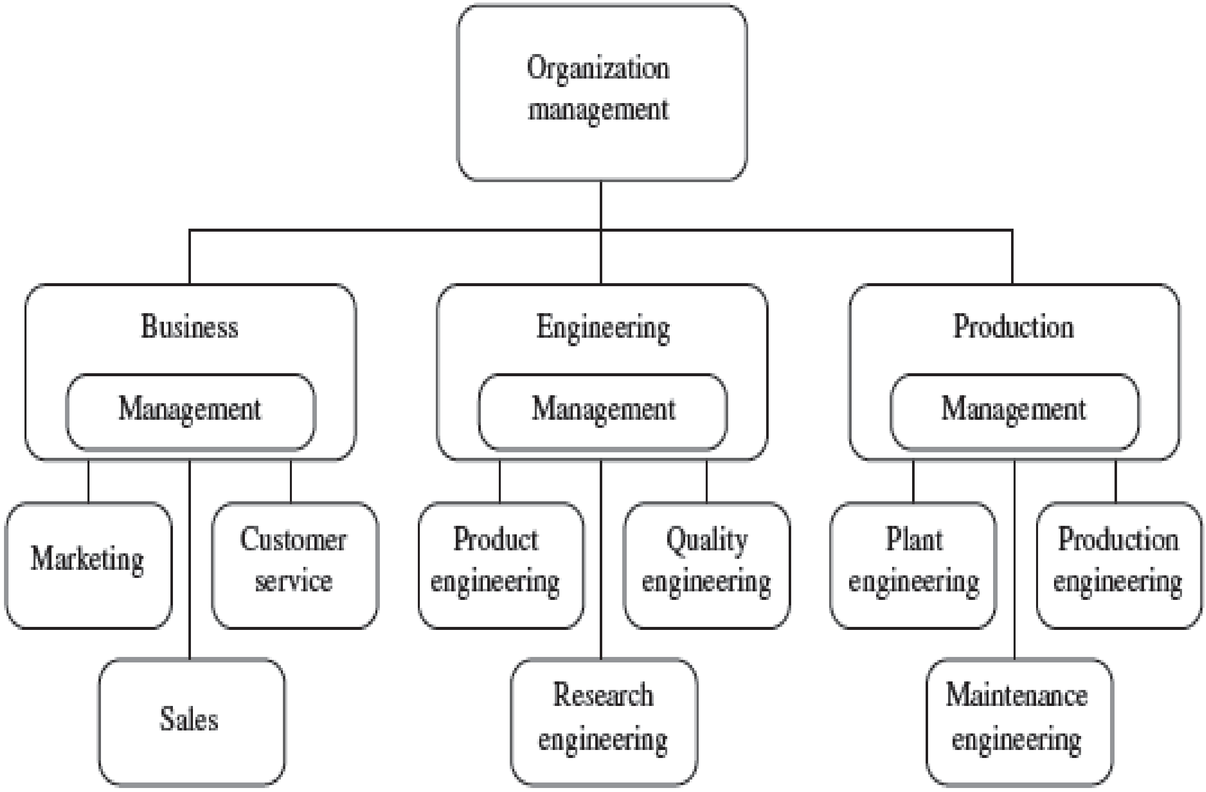
- **D**efine the project goals and customer deliverables.
- **M**easure and determine customer needs and specifications.
- **A**nalyze to generate innovative concepts, and evaluate and select the best concept for the design.
- **D**esign details, optimize the design, and plan for design verification and validation. This phase often requires simulations.
- **V**erify and validate the design reliability and capability to meet customer requirements.

5. Teams

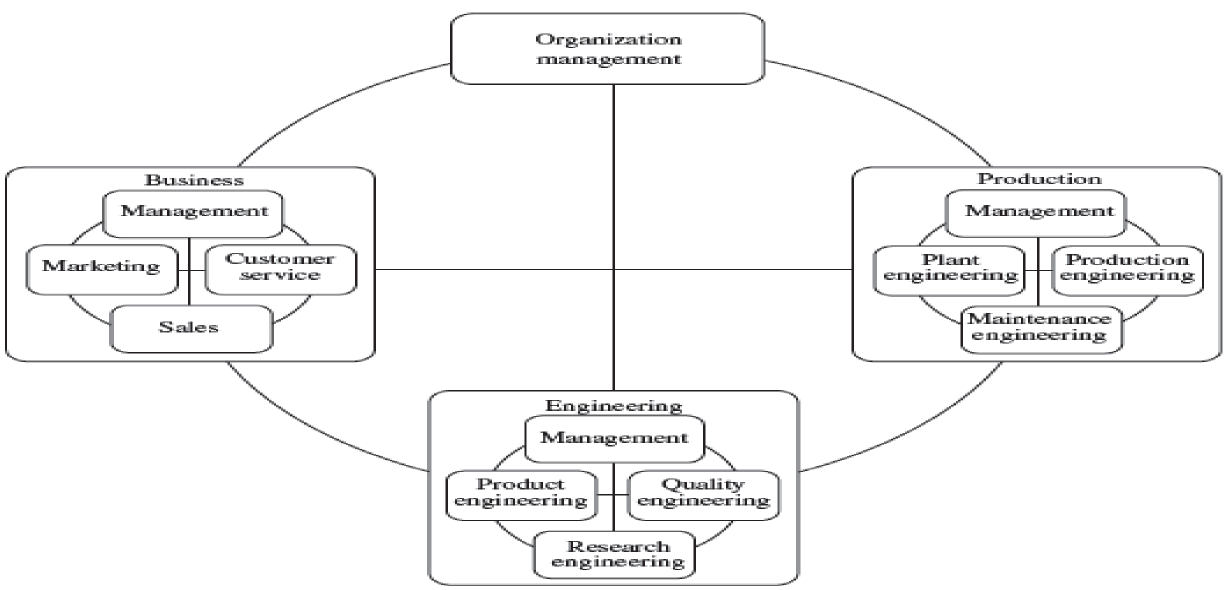
- 60% and 95% of the overall product cost is determined during the design phase.
- Quality by design utilizes teams
- These teams include product developers from marketing, research and development, design, production, test, and logistics, along with project and program management
  - Teams should also include suppliers and customers where appropriate
- More produceable designs will be achieved through better interaction between design team members.
- To avoid problems with teams, reward team members for extra work, level the playing field, and compensate
- team members more or less equally

6. Communication Models

- The communication flow for sequential engineering is in series, compared with quality by design (or concurrent) engineering, which has a parallel communication flow.
- In the traditional organizational structure, each level in the hierarchy should only perform duties that are assigned from the level above.
- In the quality by design organizational structure, information paths are opened up between departments in different disciplines.



Traditional Organization Structure and Information Paths



Quality by Design Organization Structure and Information Paths

7. Organizational Tools

- Total Quality Management philosophies.
- Computer networks.
- ISO 9000.
- ISO 14000.
- Total productive maintenance.
- Quality function deployment.
- Information technology.
- Electronic meeting software.
- Enterprise resource planning software.

8. 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.

9. 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.

10. 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

11. 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.

12. Statistical Tools

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

13. 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.

14. Avoiding Pitfalls

1. Team members should be assigned to functional departments, as in sequential engineering; however, their primary loyalty lies with the quality by design team. *Do not eliminate the sequential engineering process*; instead, perform all design up front as a group with improved communication.
2. Avoid promising to meet an unobtainable schedule, because missing an unobtainable schedule carries a more severe penalty than meeting a longer one. For instance, do not inflate a fabrication lead time to allow for anticipated or uncontrolled design changes.
3. Avoid using tight tolerances and stringent requirements to obtain a one-pass design.
4. Avoid changing product definition and specifications during the design phase. Costs increase exponentially when features are added through the development cycle that cause design, tooling, and production systems to change.
5. Avoid “business as usual” parts vendoring by using the low bidder.
6. Avoid automating the product development phase before it is simplified.

15. Quality Function Deployment (QFD)

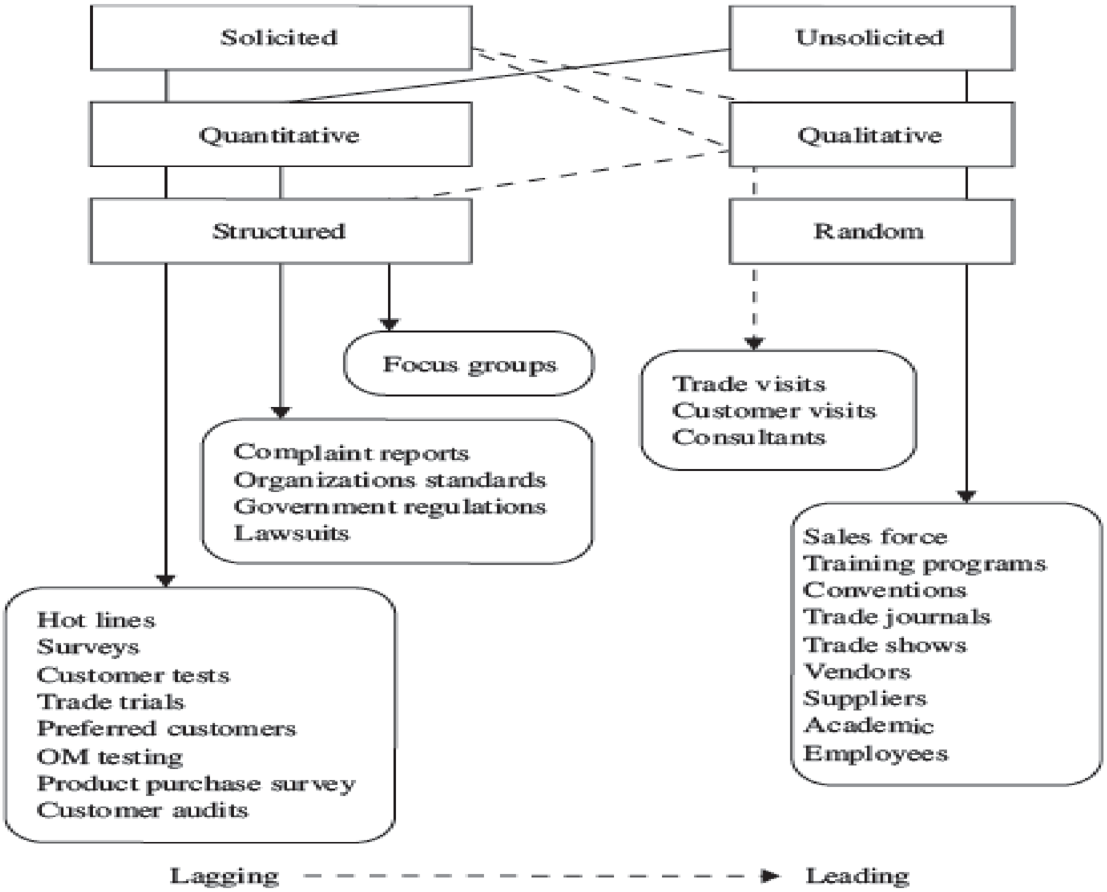
15.1. What is QFD?

- 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

15.2. Benefits of QFD

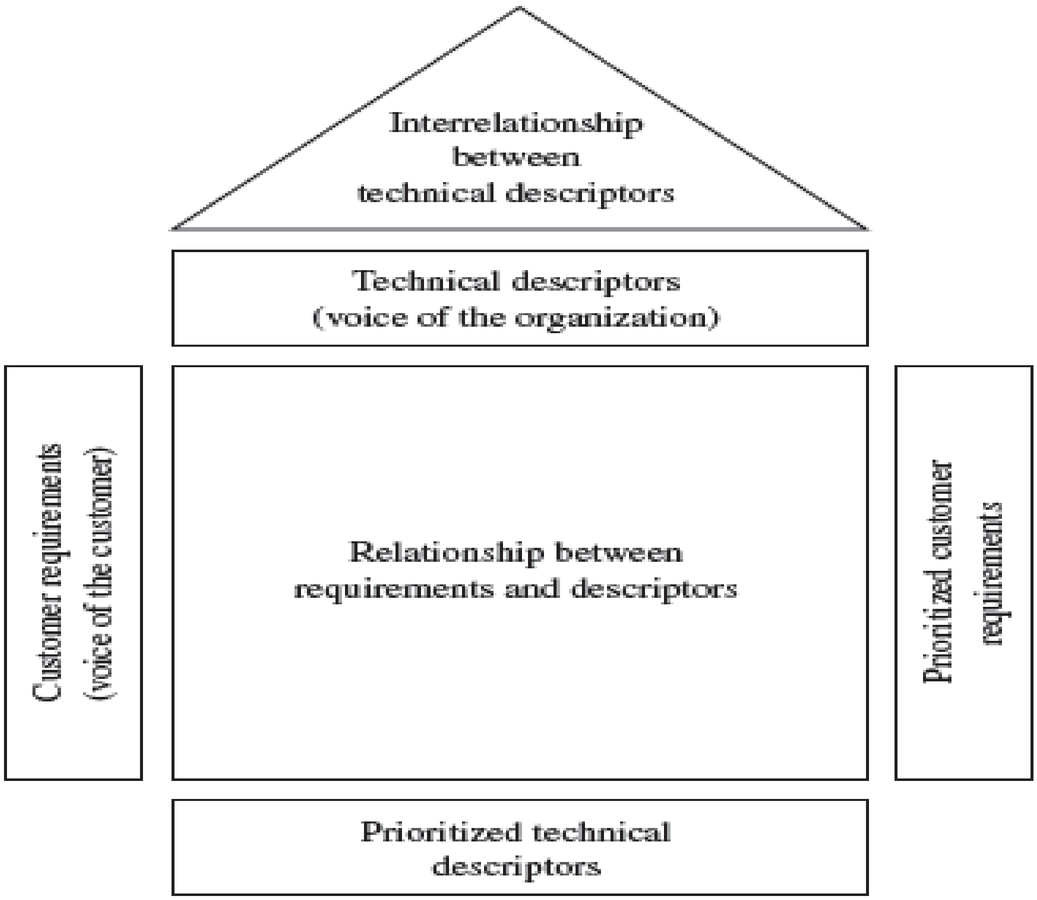
- Improves Customer Satisfaction
- Reduces Implementation Time
- Promotes Teamwork
- Provides Documentation

15.3. Voice of Customer



Types of Customer Information and How to Collect It

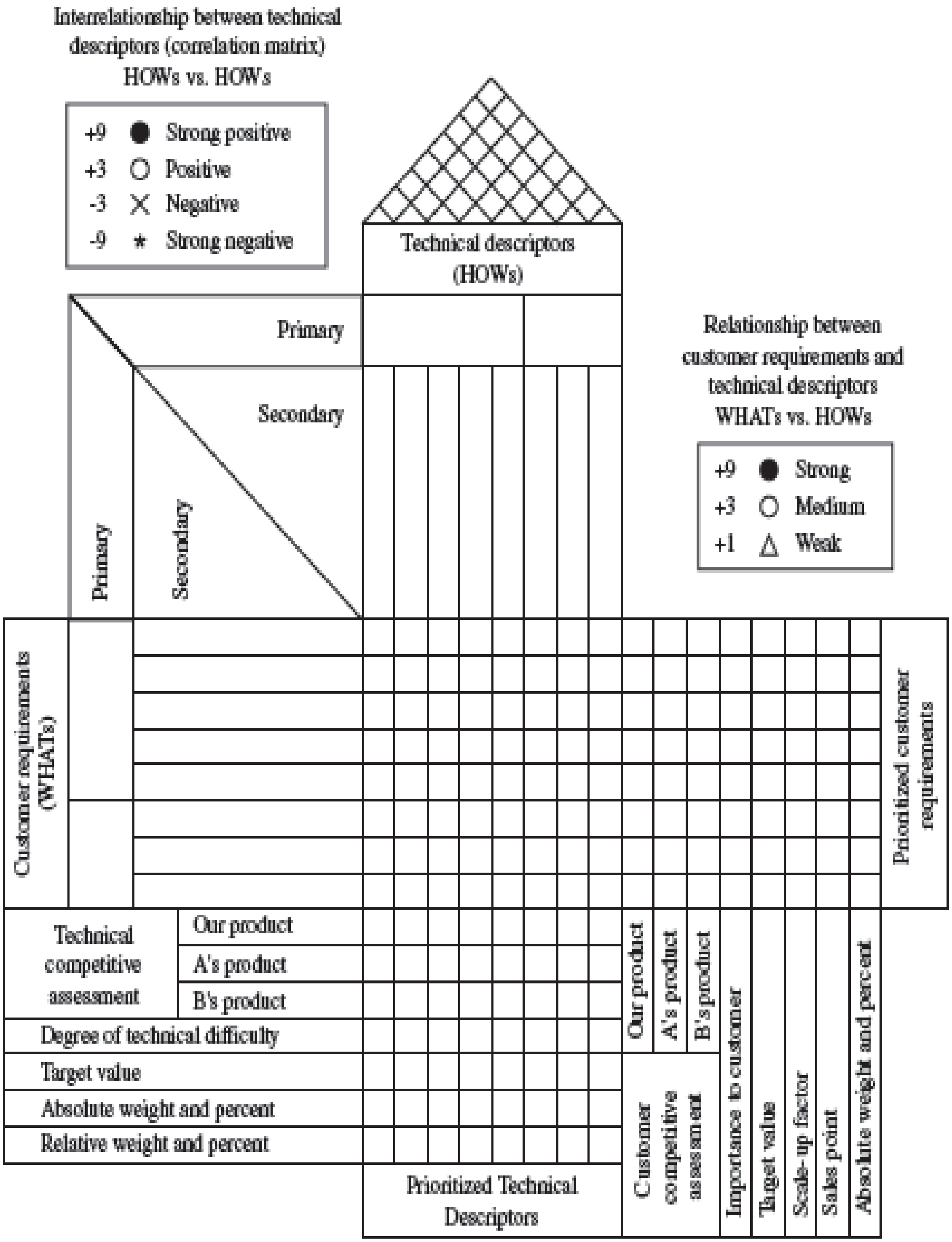
15.4. **House of Quality**



15.5. **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

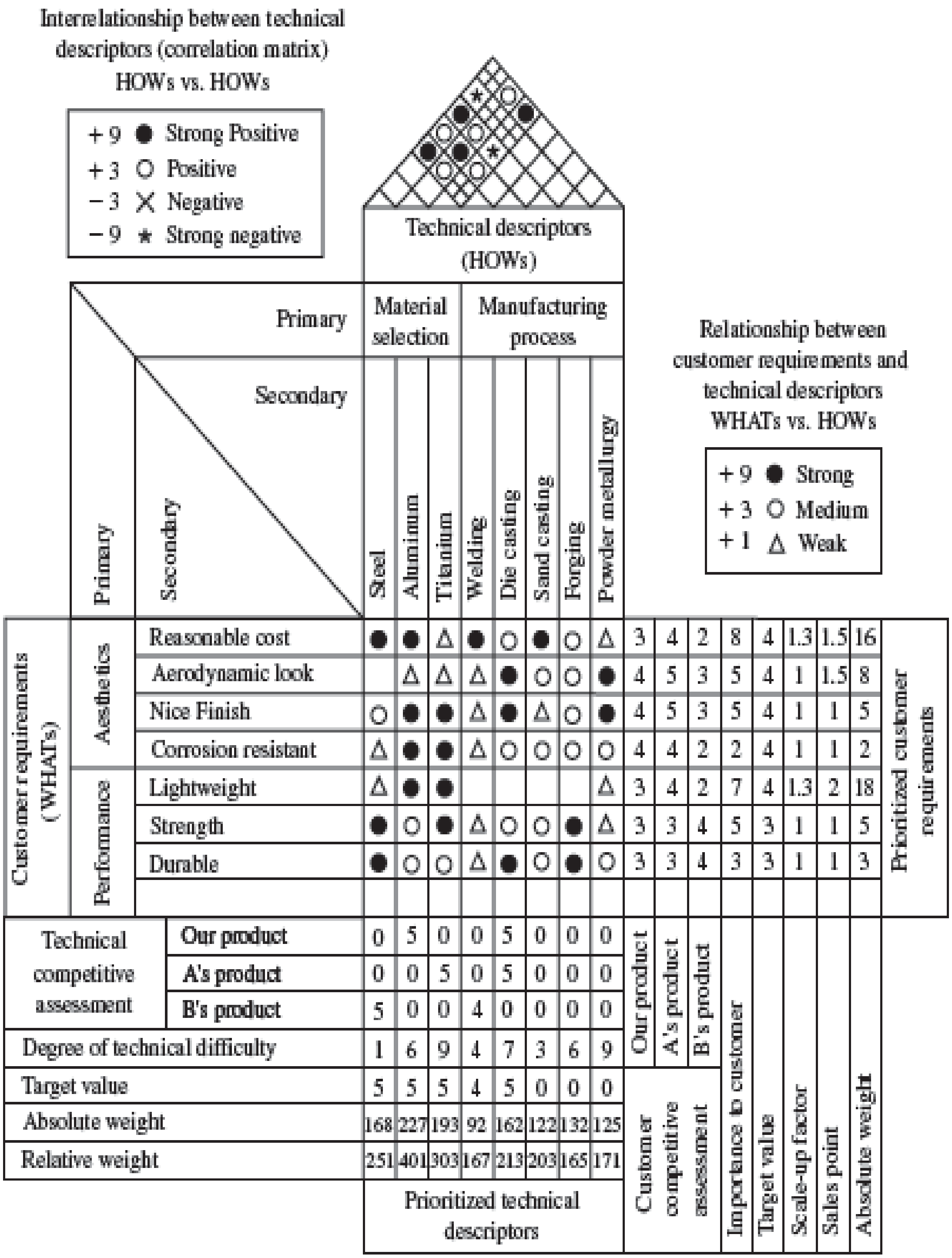
15.6. Basic House of Quality Matrix



15.7. Refinement of Technical Descriptors

	Primary	Secondary	Tertiary
Technical descriptors (HOWs)	Material selection	Steel	
		Aluminum	
		Titanium	
	Manufacturing process	Welding	
		Die casting	
		Sand casting	
		Forging	
		Powder metallurgy	

15.8. QFD Example



Example of a handlebar stem for a mountain bike