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HKSQ

Recent Advances in Quality Function Deployment

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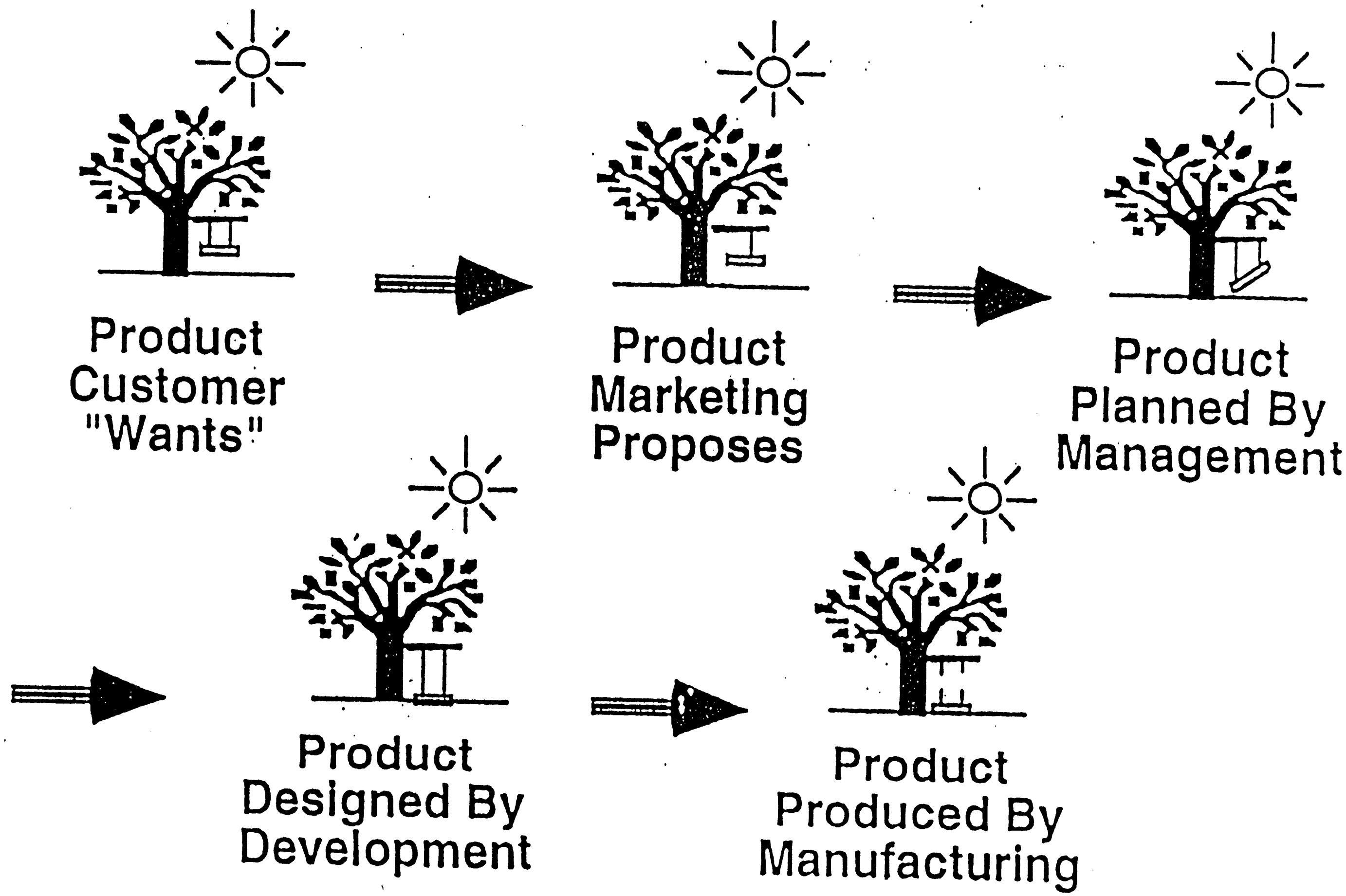
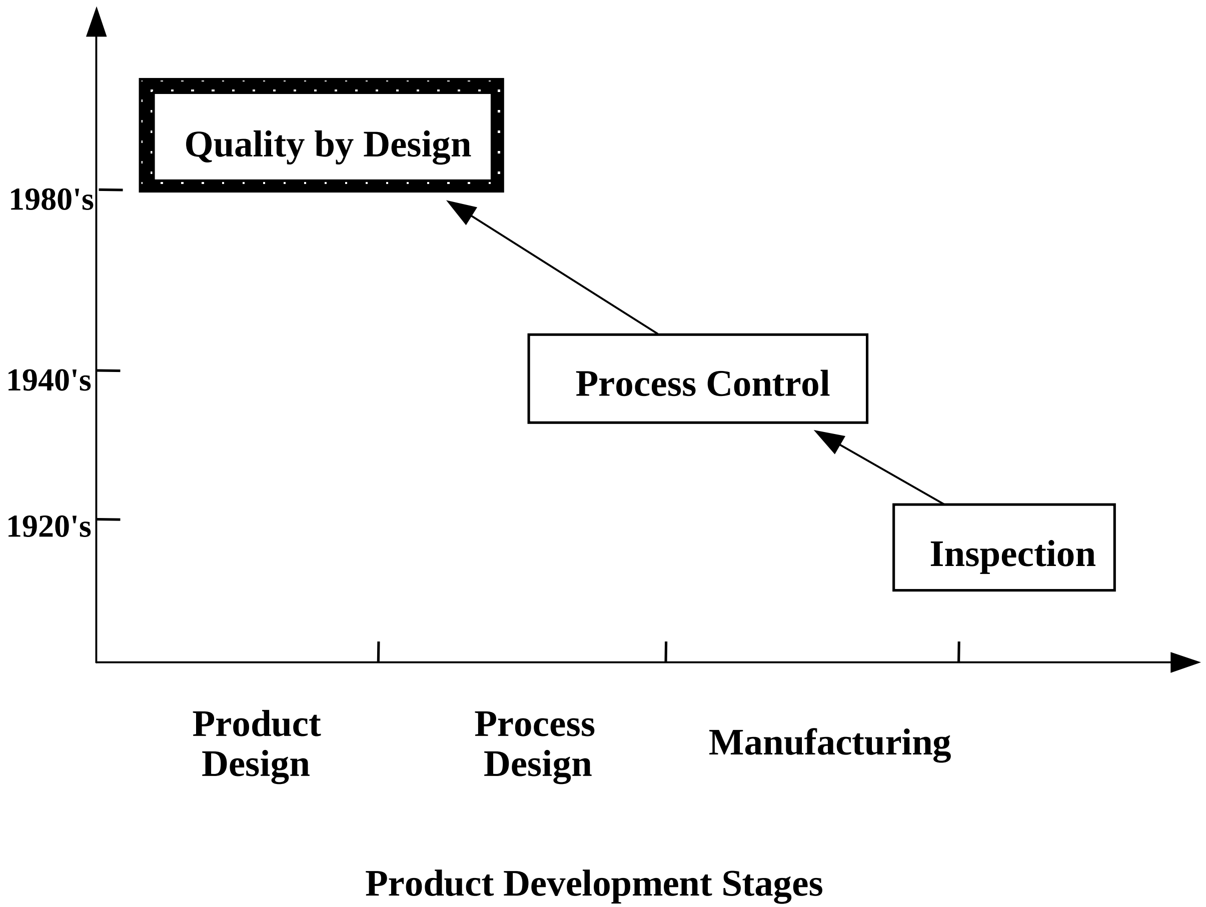
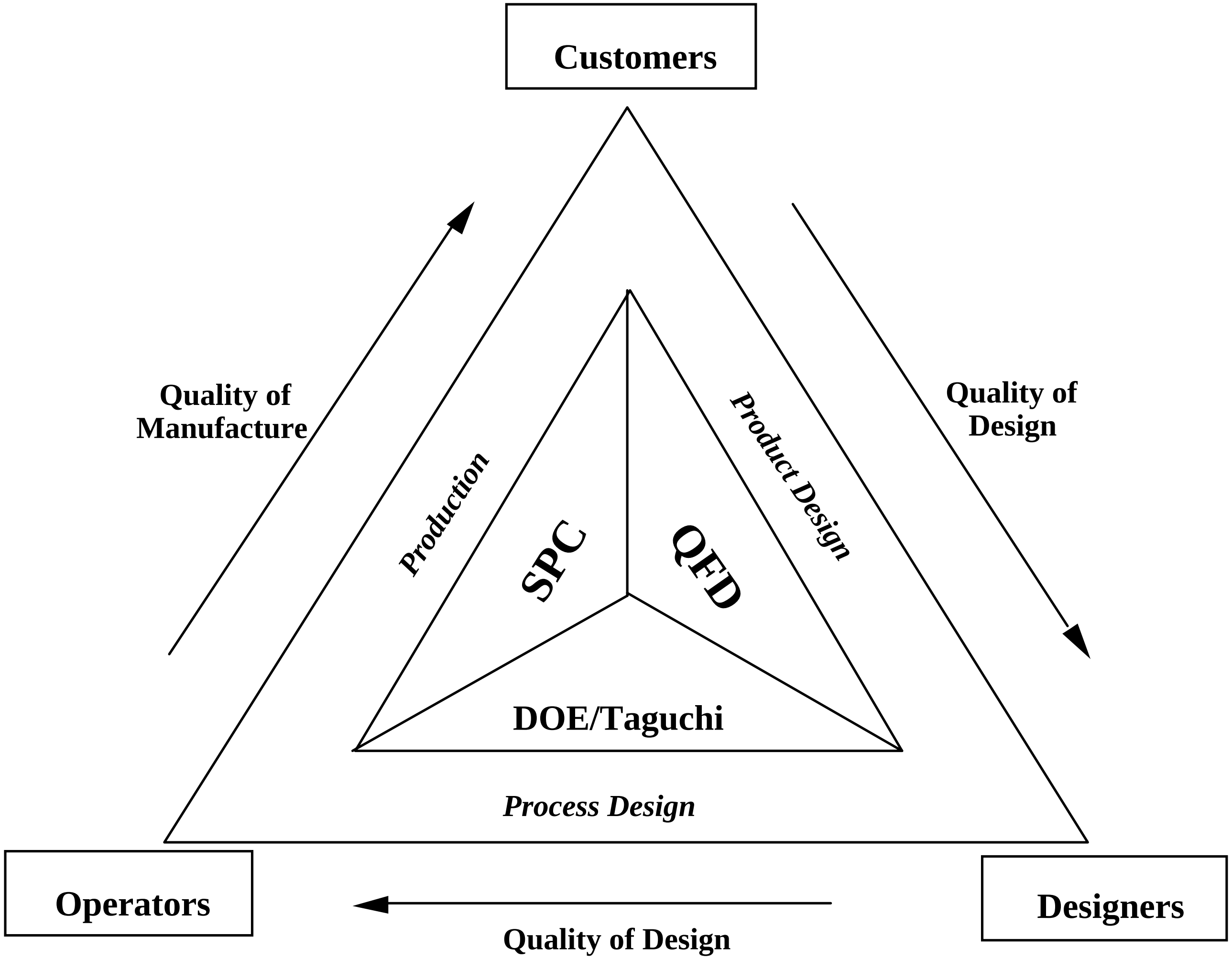


Historical Evolution of Quality Practices



Tools for Quality Improvement



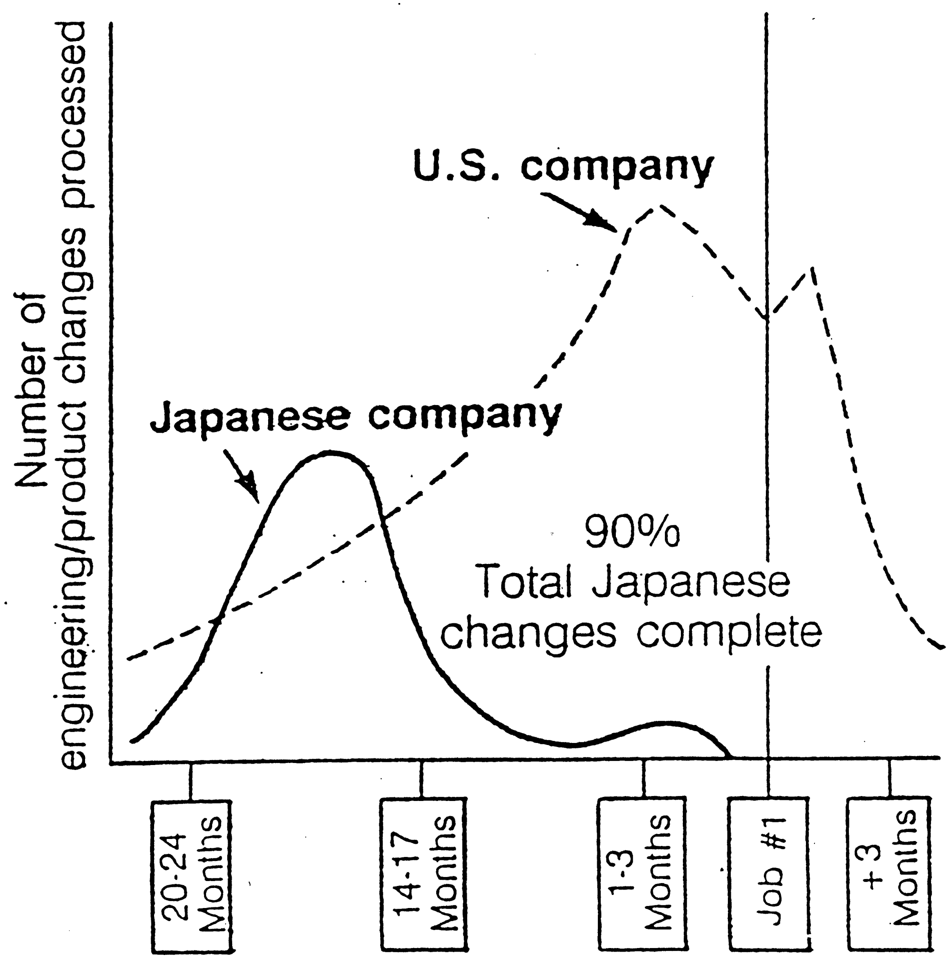
QFD: Concept

...We may think of **Quality Function Deployment** as representing a shift from Traditional Manufacturing Quality Control upstream to **Product Design Quality Control**.

QFD: Definition

- **Translate customer requirements into the technical requirements for product development and production:**
  - Planning
  - Product design and engineering
  - Prototype development
  - Production
  - Sales
- **Customer Driven Product Development**

Japanese / U.S. Engineering Change Comparison



Source: "The House of Quality" (Hauser and Clausing, Harvard Business Review, May-June 1988)

QFD: Concept (revisited)

"Measure a thousand times

and cut once."

(Turkish Proverb)

QFD: Goals / Advantages

- **Product-Related Improvements**
  - Improved design reliability
  - Fewer startup problems
  - Warranty claim reduction

- **Process-Related Improvements**
  - Shorter product development cycle / lead time
  - Lower cost to commercialization
  - Intangible benefits

- **Increase in the Market Share**

QFD: History

- **Created in the late 1960's**
- **Mitsubishi's Kobe Shipyard Site (1972)**
- **Toyota (since mid 1970's)**
- **Ford (since 1985)**
- **US-based Companies (since mid 1980's)**
  - More than 100 firms including:

    General Motors, Budd, Kelsey Hayes, Motorola, DEC, Hewlett-Packard, Xerox, AT&T, ITT, NASA, Goodyear, Kodak Eastman, NCR, Procter & Gamble, ...
  - Annual QFD symposium since 1989

QFD: Applications

- **Manufacturing**

  Automotive, Electronics, Computer, Aerospace, etc.

- **Service**

  Healthcare, Education, Hotel, Telecommunications, Energy, etc.

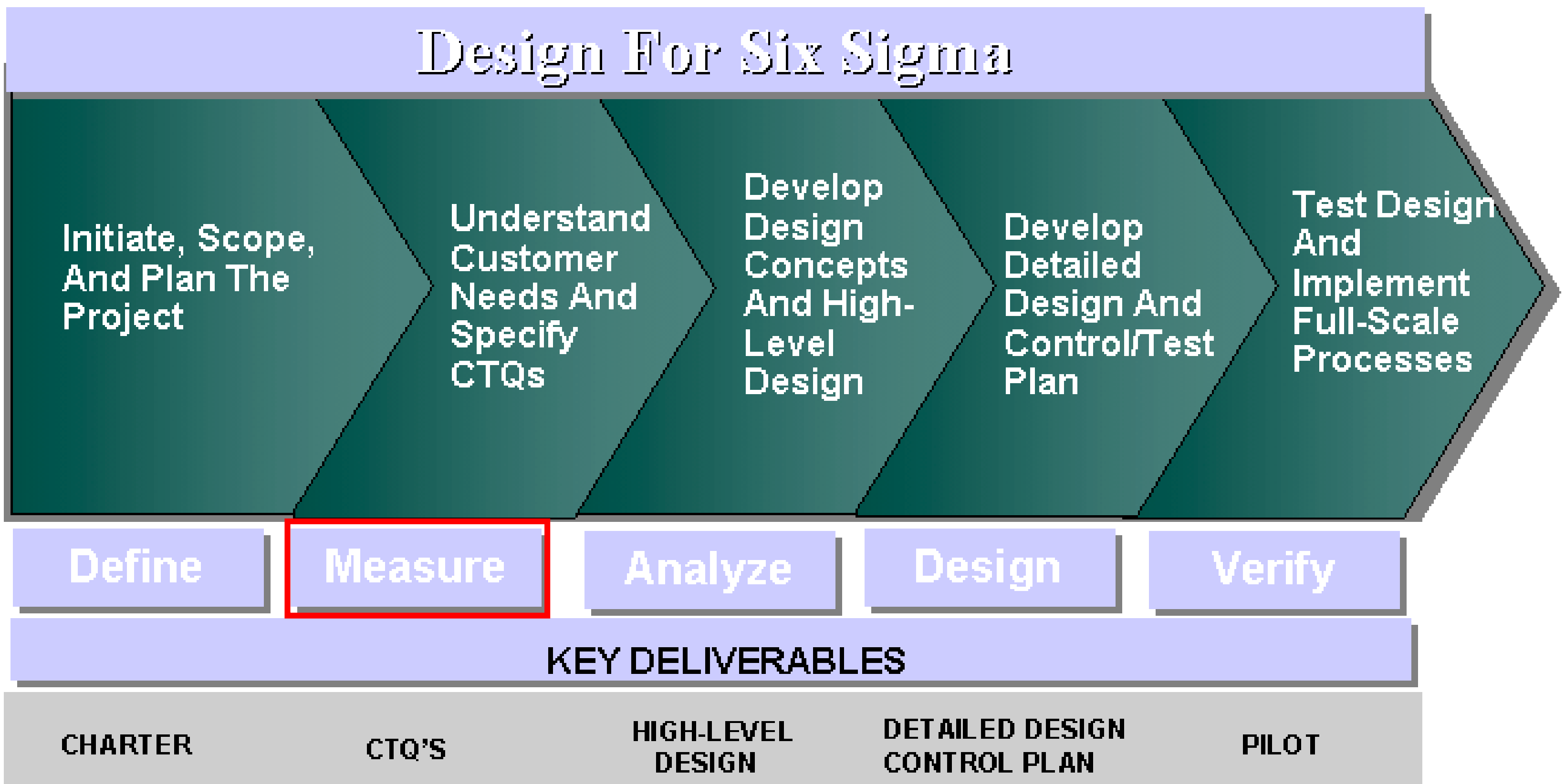
- **Administration**

  Strategic planning, Organization/Process Reengineering,
  Human resource management, Marketing, Auditing, etc.

- **Others**

  Software design, Information systems, Military, Construction industry,
  Environment, etc.

QFD: Role in DFSS

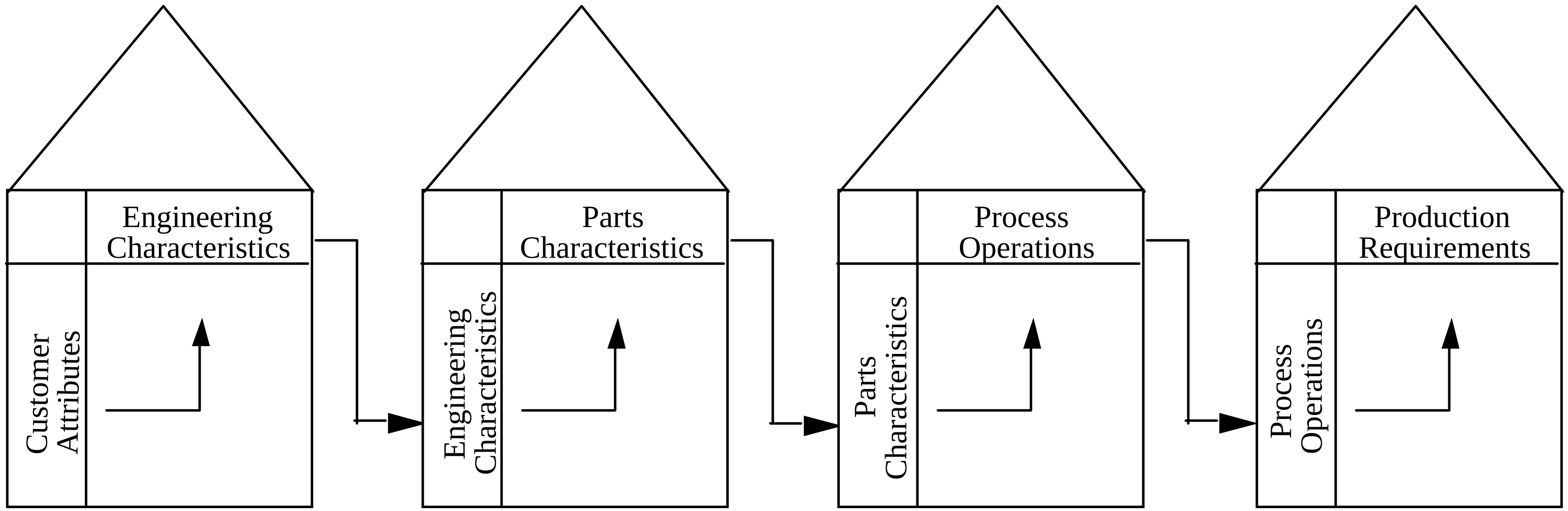


*Source : K. Bang, "DFSS Methodology," DFSS Conference, Nov. 11, 2000, Korea.

QFD: Basic Idea

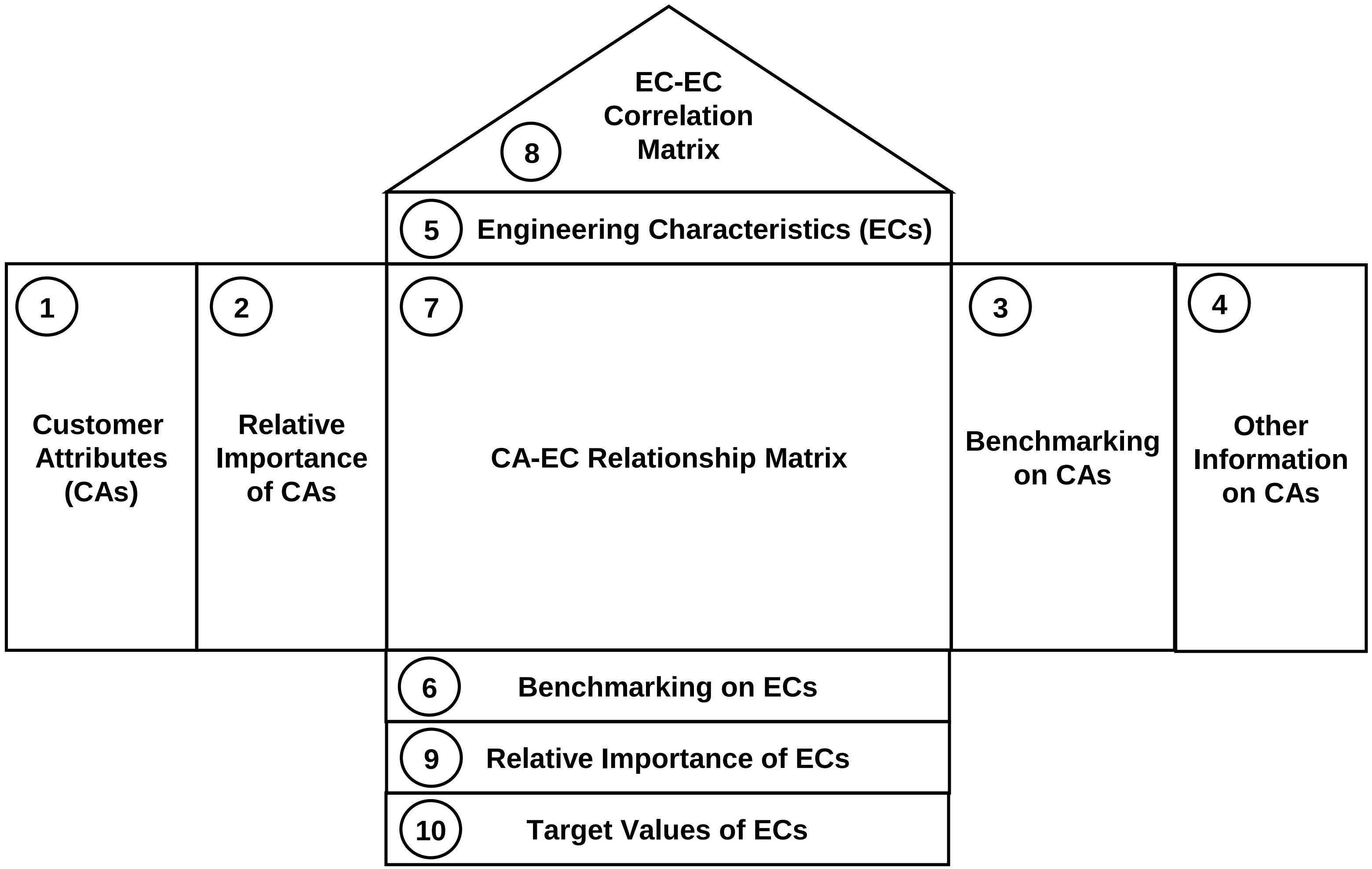
Translation	***Rust Study***
Customer Attributes	***Rust Resistant***
Engineering Characteristics	***No Visible Exterior Rust in 3 Years***
Parts' Characteristics	***Paint Wt: 2-2.5 gm/m2*** ***Crystal Size: 3 max***
Process Planning	***Dip Tank*** ***3 coats***
Production Requirements	***Time: 2.0 minutes min.*** ***Acidity: 15-20*** ***Temp: 48-55 C***

Translation of Customer Requirements



Product Planning　　Parts Planning　　Process Planning　　Production Planning

Framework of a HOQ Chart



Enhancing Usefuleness of QFD: Things to Consider

- Assessing Relative Importance of CAs
- Assessing Relationships between CAs and ECs
- Checking Consistency between Relationship and Correlation Matrices
- Checking Consistency between CA and EC Benchmarking
- Evaluating CA Coverage
- Analyzing Sensitivity of EC Importance
- Complexity Reduction of a Large HOQ Chart
- Setting Target Values of ECs

Assessing Relative Importance of CAs

- **1~5 or 1~10 scales are typically used.**
- **Ranking vs. Interval scale**
- **Alternatives:**
  - Multi-Attribute Decision Making (Keeney and Raiffa 1976)
  - Analytic Hierarchical Process (Saaty 1980; Armacost et al.1994; Park and Kim 1998)
  - Conjoint Analysis (Hair et al. 1995)
  - Linguistic Data based on Fuzzy Set Theory (Shen et al. 2001)

Assessing Relationships between CAs and ECs

- **1-3-5 or 1-3-9 scales are typically used.**
  - 30 QFD cases in the literature :

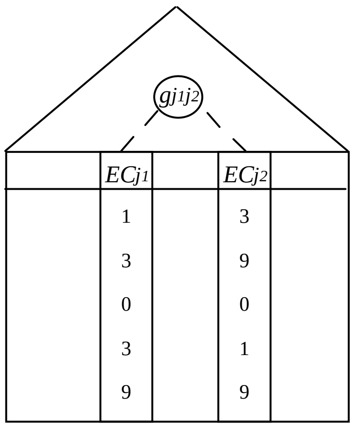
    1-3-9 (17 times), 1-3-5 (5 times), Others (1-2-4, 1-6-9 etc.) (8 times)

- **(Strong – Medium) vs. (Medium – Weak)**

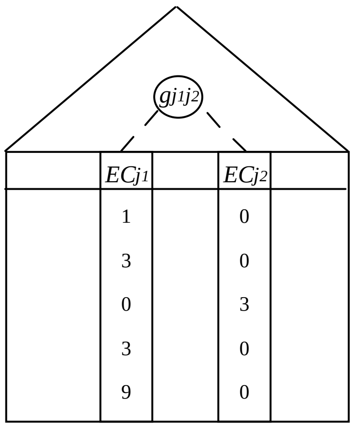
- **Alternatives:**
  - Multi-Attribute Rating Techniques (e.g., SMART) (Eppel 1990)
  - Multivariate Statistical Methods
  - Design of Experiments (Ross 1988; Breyfogle 1992)
  - Simulation (Lorenzen et al. 1993)
  - Linguistic Data based on Fuzzy Set Theory (Shen et al. 2001)

Checking Consistency between Relationship and Correlation Matrices

Concept of Consistency / Inconsistency



(a) Highly Consistent Case



(b) Highly Inconsistent Case

Sources of Inconsistency

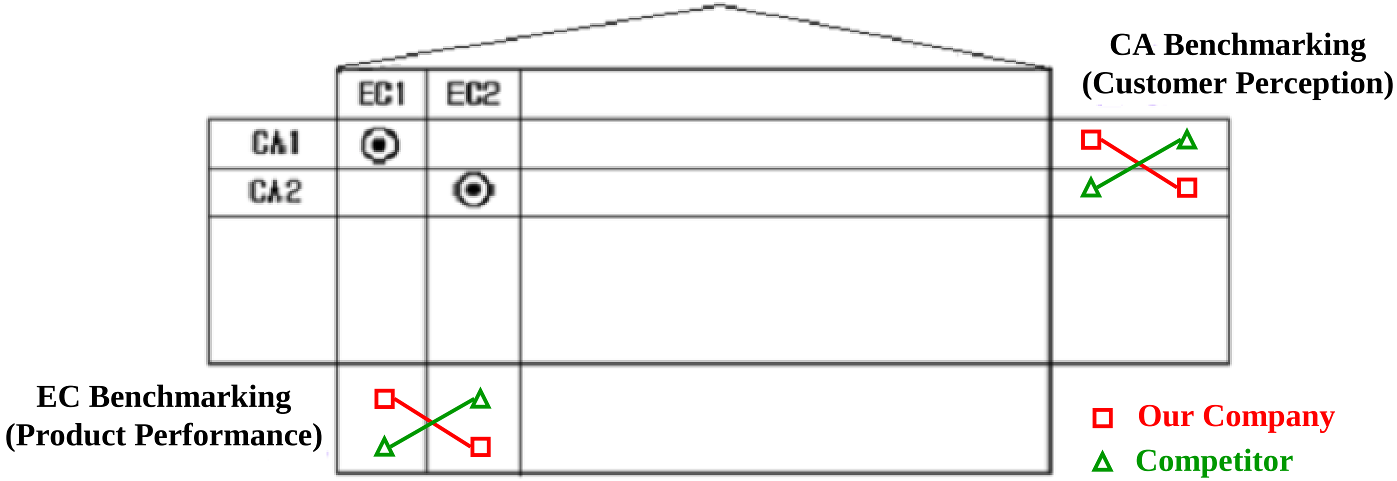
- Mistakes in assessing relationship / correlation
- Unclear definition of CAs or ECs

Checking Inconsistency (Shin, Kim, and Chandra 1999)

- Checking the existence of Inconsistency
- Identifying the location and degree of Inconsistency

Checking Consistency between CA and EC Benchmarking

■ Concept of Consistency / Inconsistency



■ Sources of Inconsistency

- Effect of brand image
- Omission of importance ECs
- Mistakes in assessing relationship or errors in benchmarking data

■ Checking the existence of Inconsistency (Kim, Cho, Jung, and Lim 2001)

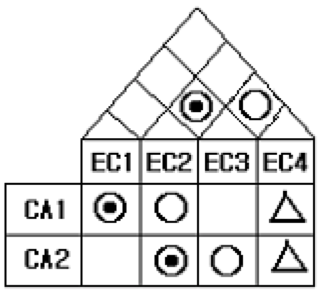
Evaluating CA Coverage

CA Coverage

- Is defined as the degree to which a CA is explained by the given set of ECs
- Can be used in developing CA improvement strategies

Evaluation of CA Coverage (Kim, Cho, Jung, and Lim 2001)

- Coverage Index (CI)



$$CI_1 = 9 + 3 + 1 = 13.0$$
$$CI_2 = 9 + 3 \bullet (1/3) + 1 \bullet (2/3) = 10.7$$

- Standardized Coverage Index (SCI)

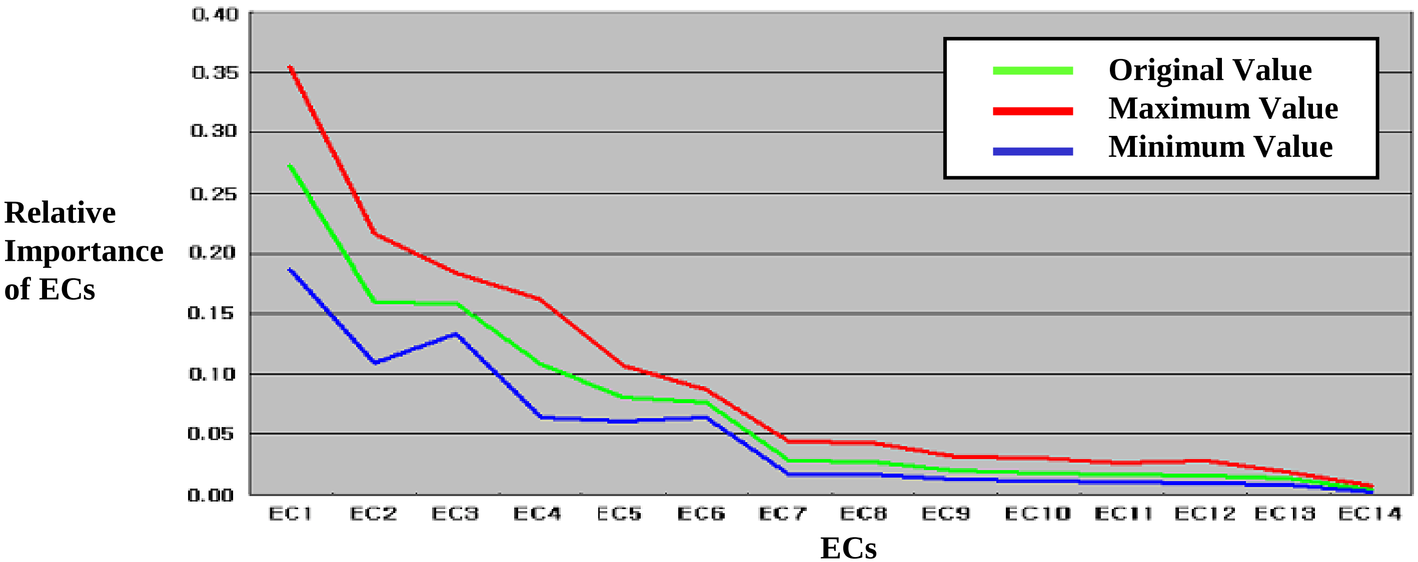
$$SCI_i = 1 - e^{-t \bullet CI_i} \quad (0 \le SCI_i \le 1)$$

- Overall Coverage Index (OCI)

$$OCI = \sum_{i=1}^{m} (\text{RI of } CA_i) \bullet SCI_i \quad (0 \le OCI \le 1)$$

Analyzing Sensitivity of EC Importance

- RI of $EC_j = \sum_{i=1}^{m}$ (RI of CA_i) •(Relationship score between CA_i and EC_j)
- Sensitivity Analysis w.r.t. Changes in CA Importance or Relationship Score Scales
- (Example) When relative importance of CAs is allowed to change up to 10%:



Insights:

- EC1 always ranks #1 or #2.
- EC4 could rank as high as #2.
- EC1~EC6 are always among top 6.

Complexity Reduction of a Large HOQ Chart

- **As the size of a HOQ increases, complexity increases very fast.**

  (Example) Raychem (28 CAs & 52 ECs), Siemens (40 CAs & 103 ECs)

- **Complexity Reduction Strategies**
  - Pre-planning Matrix (QFD “Phase 0”)
  - Systematic Analysis Methods
  - HOQ Size Reduction

- **Approaches to HOQ Size Reduction**
  - HOQ Decomposition (Kim, Shin, and Moskowitz 1997; Shin and Kim 2000)
  - HOQ Restructuring (Shin and Kim 1997; Shin, Fong, and Kim 1998)

Setting Target Values of ECs

Difficulties in Setting EC Target Values

- Tradeoffs among CAs
- Complicated Relationships between CAs and ECs and among ECs
- Vagueness and Uncertainty in Information

Systematic Approaches to Setting EC Target Values

- Multi-Objective Optimization Model (Kim 1997; Kim et al. 2000)
- QFD Optimizer (Moskowitz and Kim 1997; Kim and Seppala 2000)

Pitfalls in QFD Application

- **Incorrect Focus (QFD everything)**
- **Lack of Teamwork**
- **“Hurry-up and Get-done” Attitude**
- **Stuck on Traditional Designs**
- **Inadequate / Changing Priorities**
- **Too much focus on “Charts”**

*Source : Quality Function Deployment for Products, American Supplier Institute, 1997

For a Successful Application of QFD…

"There is no magic to QFD; just plenty of intelligent, thorough work."

"QFD is not an easy process. It takes leadership and determination on the part of many people to dedicate the time and energy needed. But that effort pales in comparison to the effort expended in a poorly planned project."

Find reasons to succeed, not excuse for failure!

*Source : Quality Function Deployment for Products, American Supplier Institute, 1997

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