Quality Management

QFD Project Management System

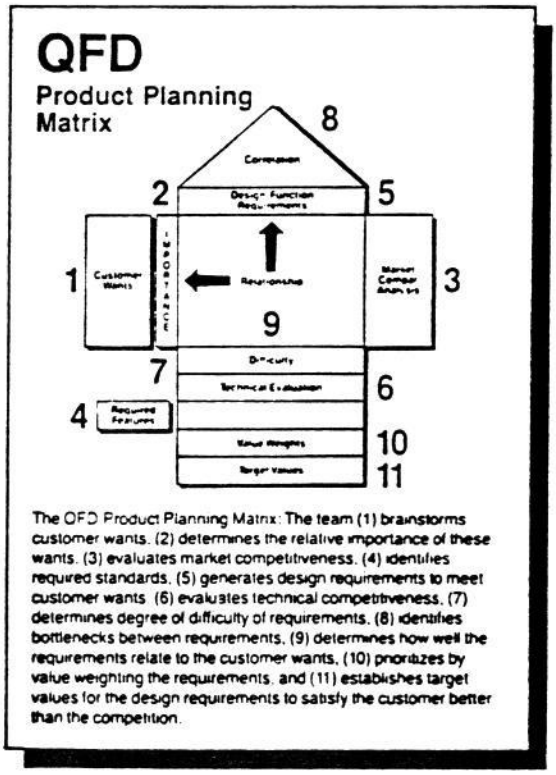
TELEFLEX INCORPORATED has reproduced this Quality Management manual for private use from the Eaton Quality Institute training series. The material included in that series was developed from information researched and compiled by Eaton for use by customers and suppliers in their own training programs.
June 1989

QFD
QUALITY FUNCTION DEPLOYMENT
CONTENTS

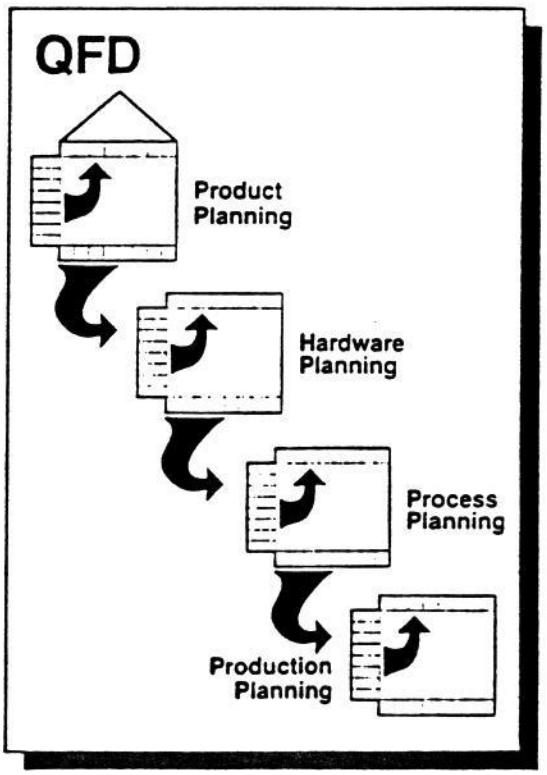
QFD
Project Management System

Eaton is one of the first U.S. corporations to develop its own QFD Project Management System — a powerful management tool for successful decision making. Many Eaton operations are using QFD to prioritize objectives, team efforts, and the use of technology and statistical methods.

The Eaton QFD process draws together a multidisciplinary team — typically, representatives from marketing, product engineering, quality, manufacturing, and general management — and focuses their thinking on the REAL needs of the customer.



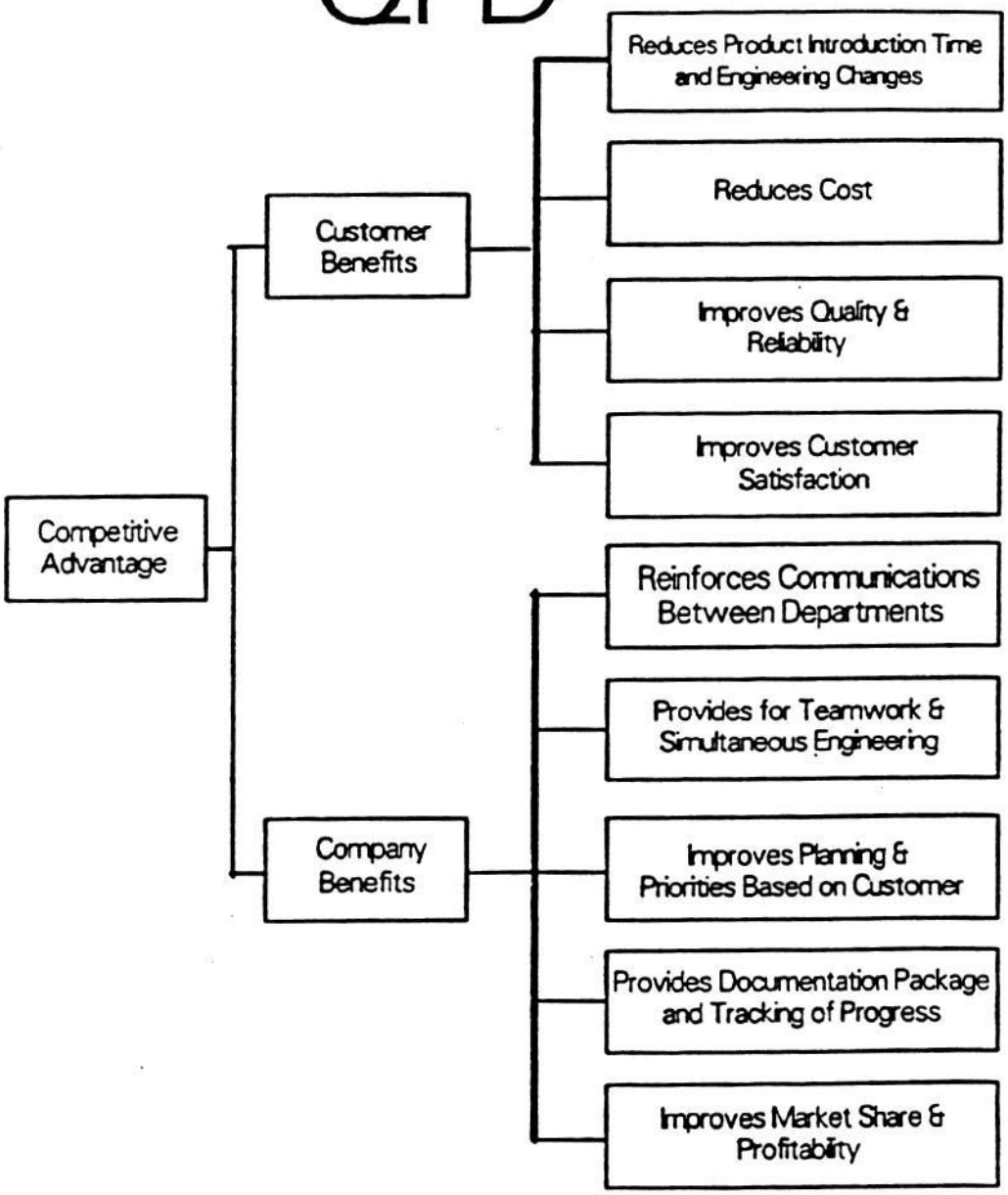
The QFD Product Planning Matrix: The team (1) brainstorms customer wants. (2) determines the relative importance of these wants. (3) evaluates market competitiveness. (4) identifies required standards. (5) generates design requirements to meet customer wants. (6) evaluates technical competitiveness. (7) determines degree of difficulty of requirements. (8) identifies bottlenecks between requirements. (9) determines how well the requirements relate to the customer wants. (10) prioritizes by value weighting the requirements, and (11) establishes target values for the design requirements to satisfy the customer better than the competition.



The heart of the process is a series of planning matrices (above) generated and applied to all or part of a product development process. The matrices help the team relate customer needs to design requirements, analyze competitive products, identify optimum features, and set goals and priorities critical to project success.

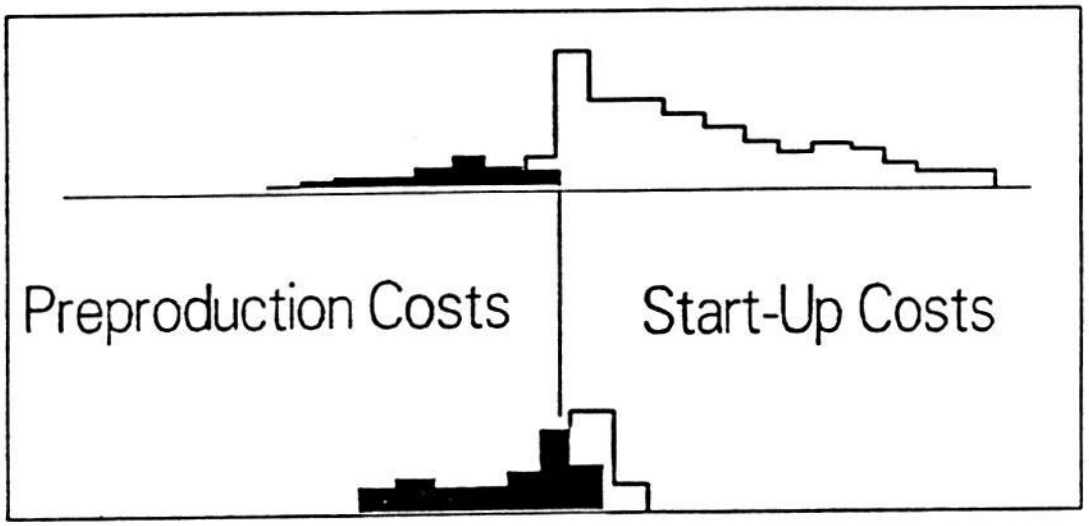
The result: a product that's on-target at a competitive cost.

QFD

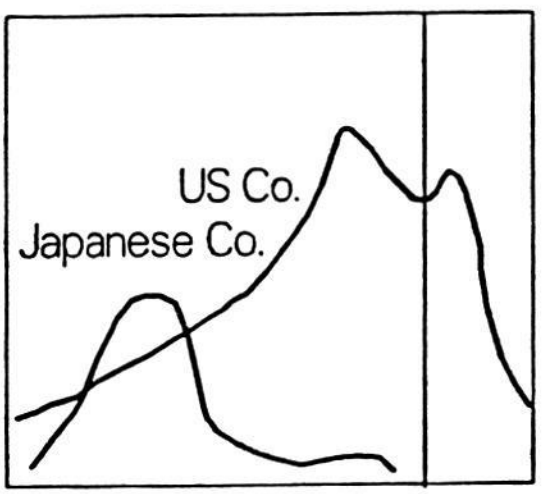


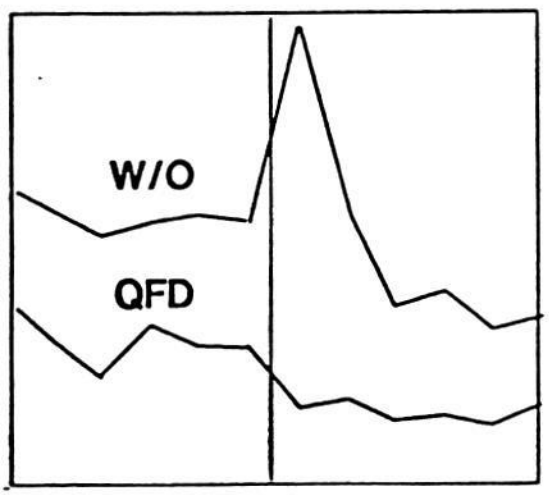
Quality Function Deployment (QFD) was developed in Japan, growing out of the need to simultaneously achieve a competitive advantage in quality, cost and timing.

Start-Up Costs Reduction



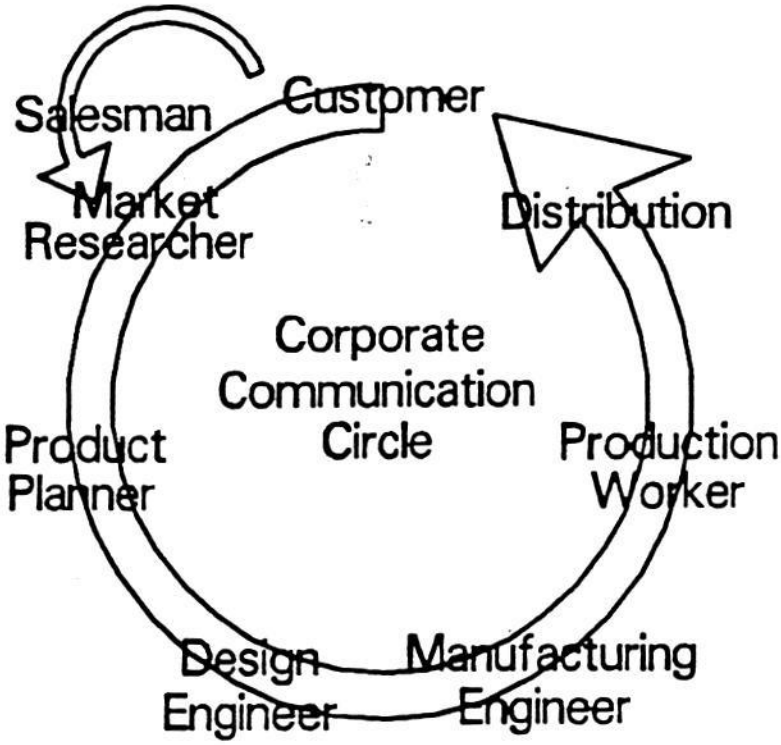
Engineering Changes/Complaints





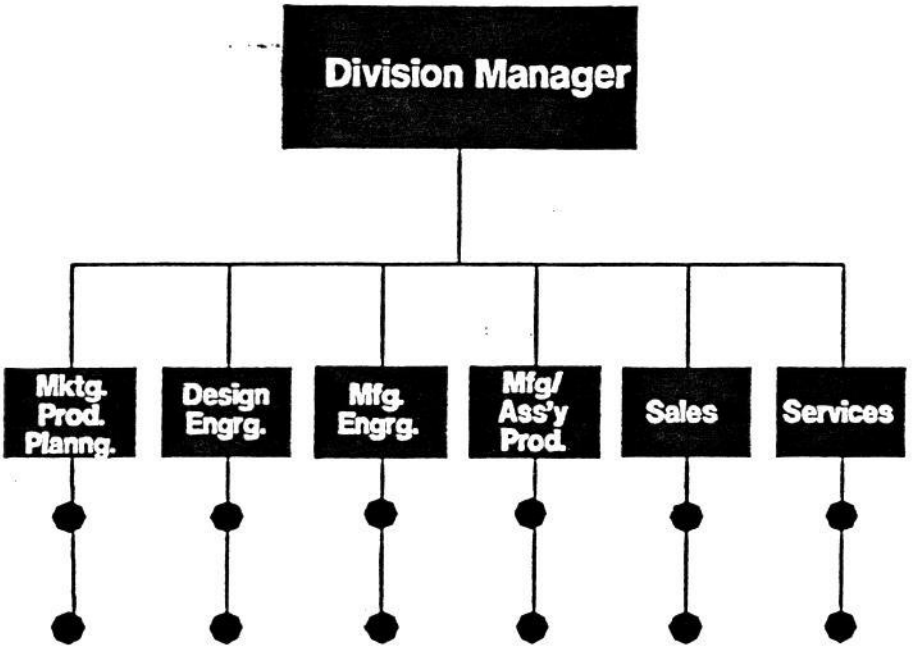
Quality Function Deployment

Don't Lose Content in Translation

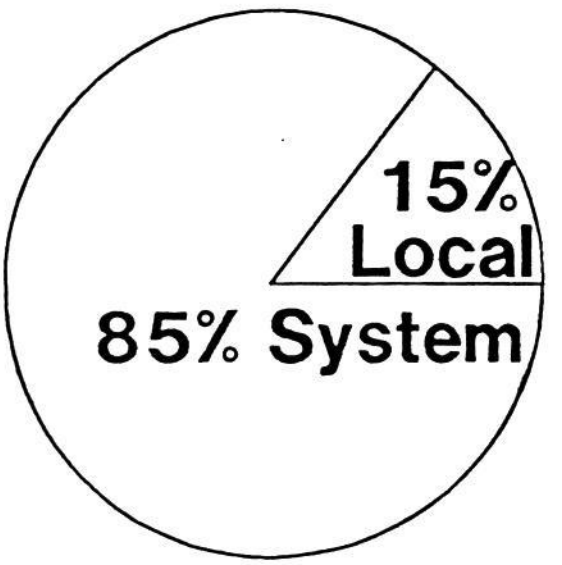


Our companies are strong vertically, we tend to talk to our own department in our own technical jargon.

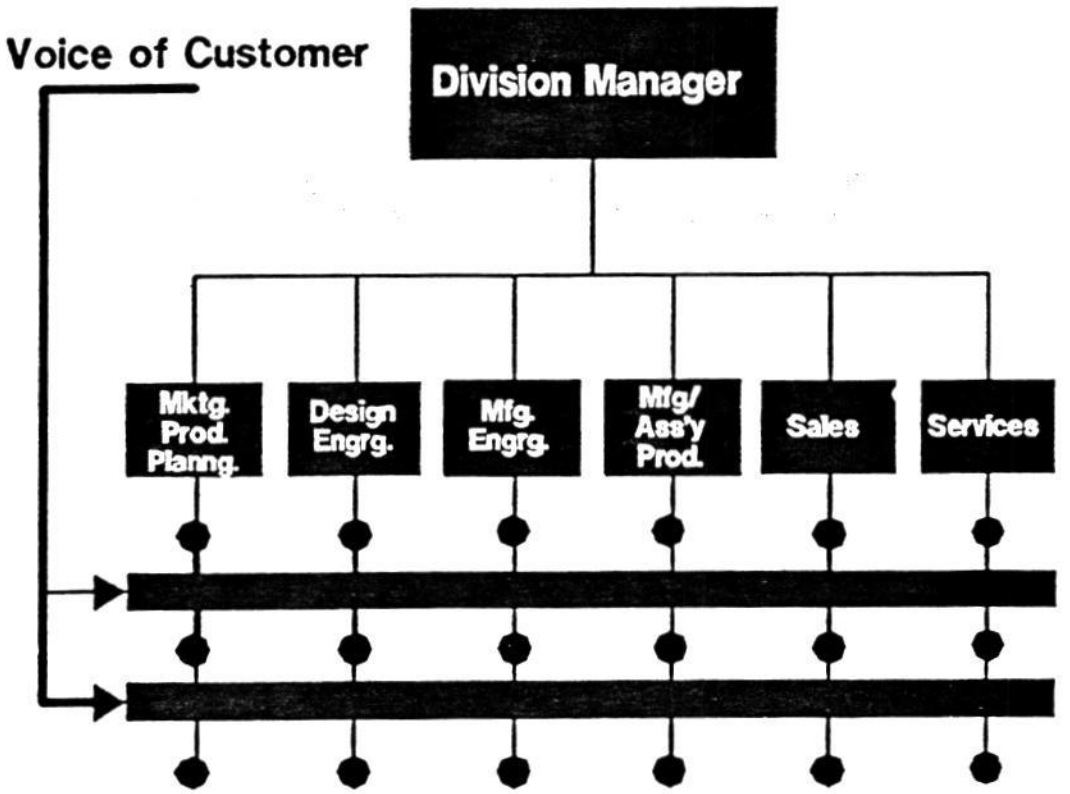
Separate Priorities and Plans



Dr. Deming: Improvement Opportunity

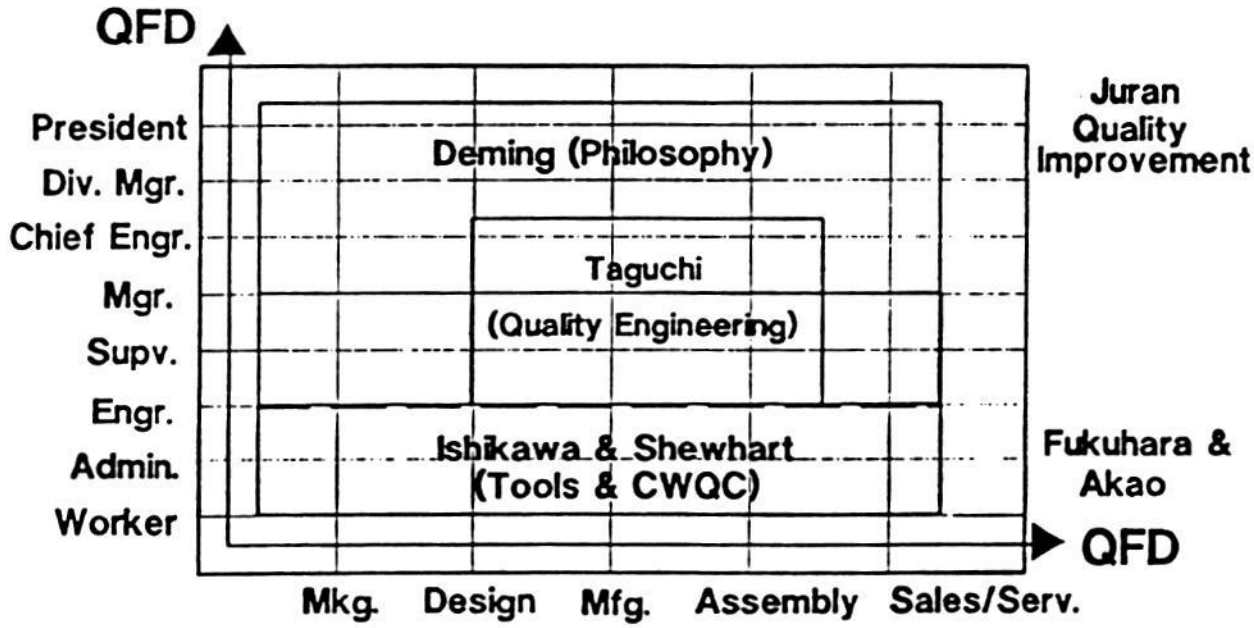


Horizontal Flow



Reinforces Horizontal Information Flow
Voice of Customer Improves Teamwork

New Quality Technology



CONCEPT

DEFINITIONS:

QFD	
QUALITY EVOLUTION SYSTEM	(JAPAN)
QUALITY FUNCTION DEPLOYMENT	(XEROX & FORD)
QFD PROJECT MANAGEMENT SYSTEM	(EATON)

ALL MEAN THE SAME

QFD - A MEANS OF **TRANSLATING THE CUSTOMER REQUIREMENTS INTO THE APPROPRIATE TECHNICAL REQUIREMENTS** FOR EACH STAGE OF MARKETING, PRODUCT PLANNING, PRODUCT DESIGN, MANUFACTURING ENGINEERING, PRODUCTION, SALES AND SERVICE.

VOICE OF THE CUSTOMER - THE CUSTOMER'S NEEDS ARE EXPRESSED IN THEIR ORIGINAL WORDS AND TRANSLATED INTO TECHNICAL LANGUAGE.

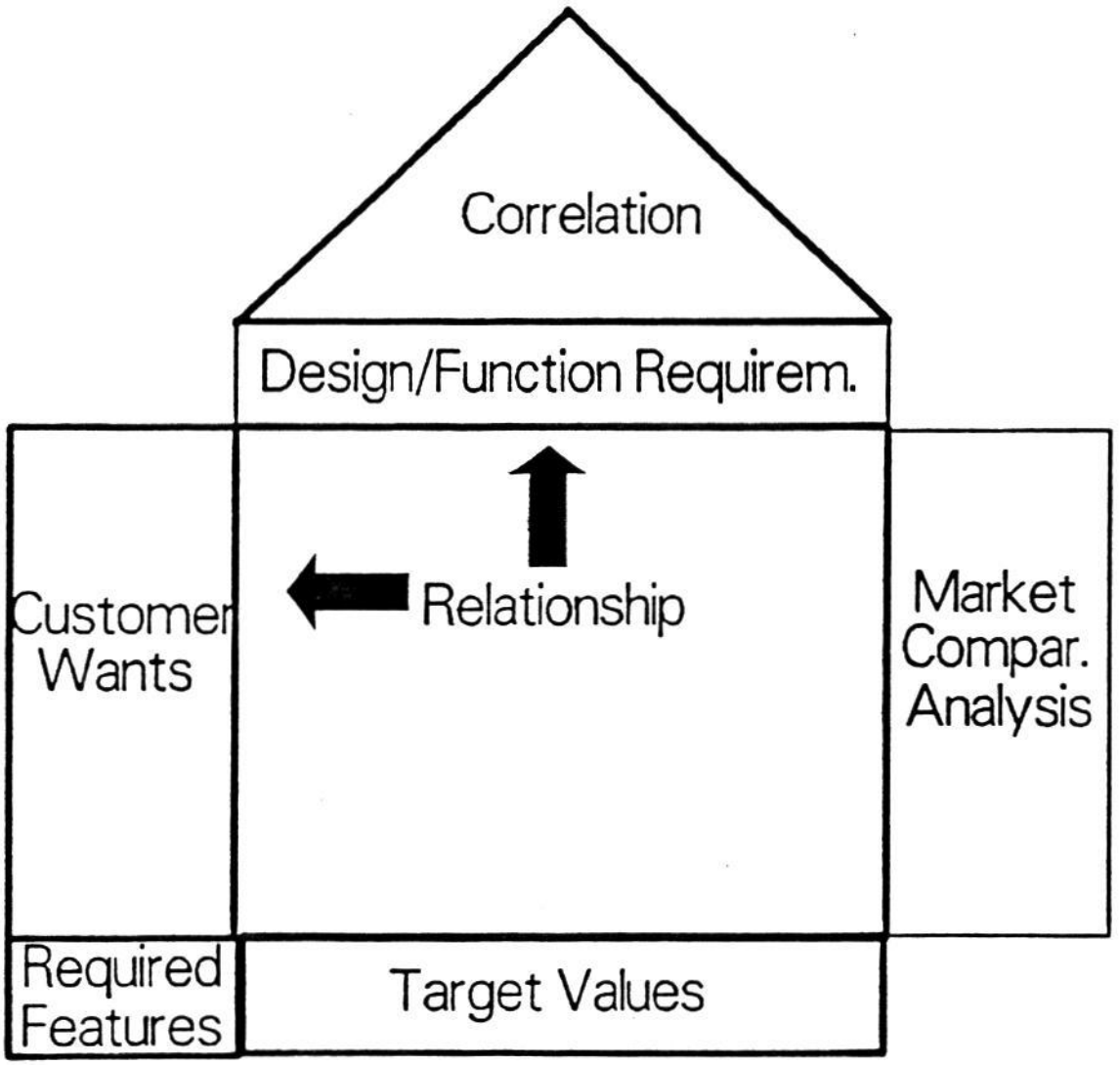
STRATEGY

QFD IS USED AS PART OF A COMPANY'S OVERALL SYSTEM. **IT IS USED TO PRIORITIZE OBJECTIVES, TEAM EFFORTS AND THE USE OF TECHNOLOGY AND STATISTICAL METHODS.**

QFD IS ALSO A MEANS OF **SYSTEMATICALLY ASSIGNING RESPONSIBILITIES** AND FOCUSING ON PRODUCT AND PROCESS DEVELOPMENT.

IT IS USED BETWEEN **UPSTREAM/DOWNSTREAM** AND **DIFFERENT LEVELS OF MANAGEMENT TO POINT OUT BOTTLENECKS, TO STRATEGIZE AND IMPLEMENT SOLUTIONS.**

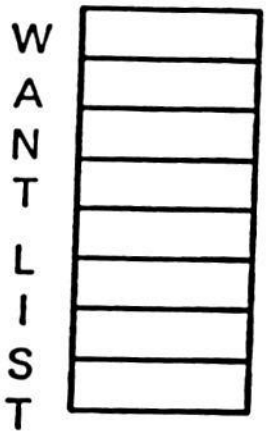
QFD


Correlation
Design/Function Requirem.
Customer Wants
Relationship
Market Compar. Analysis
Required Features
Target Values

WHAT does the customer want?

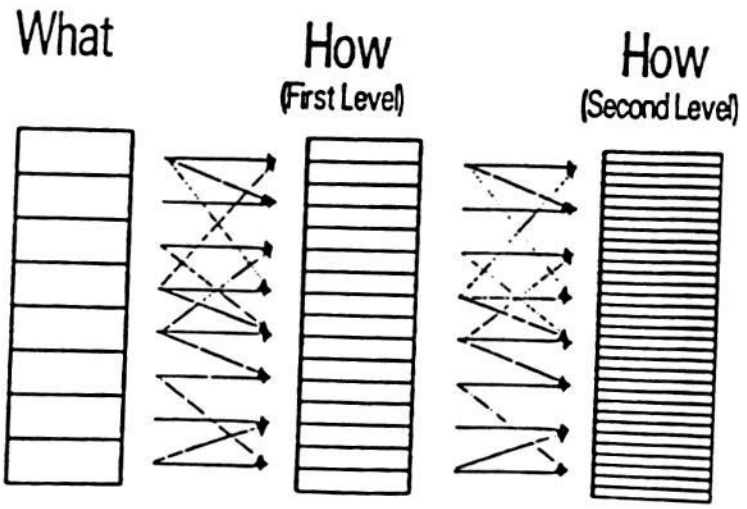
QFD starts with a list of customer objectives or a want list. (It is developed with surveys, brainstorming and affinity techniques.)

What

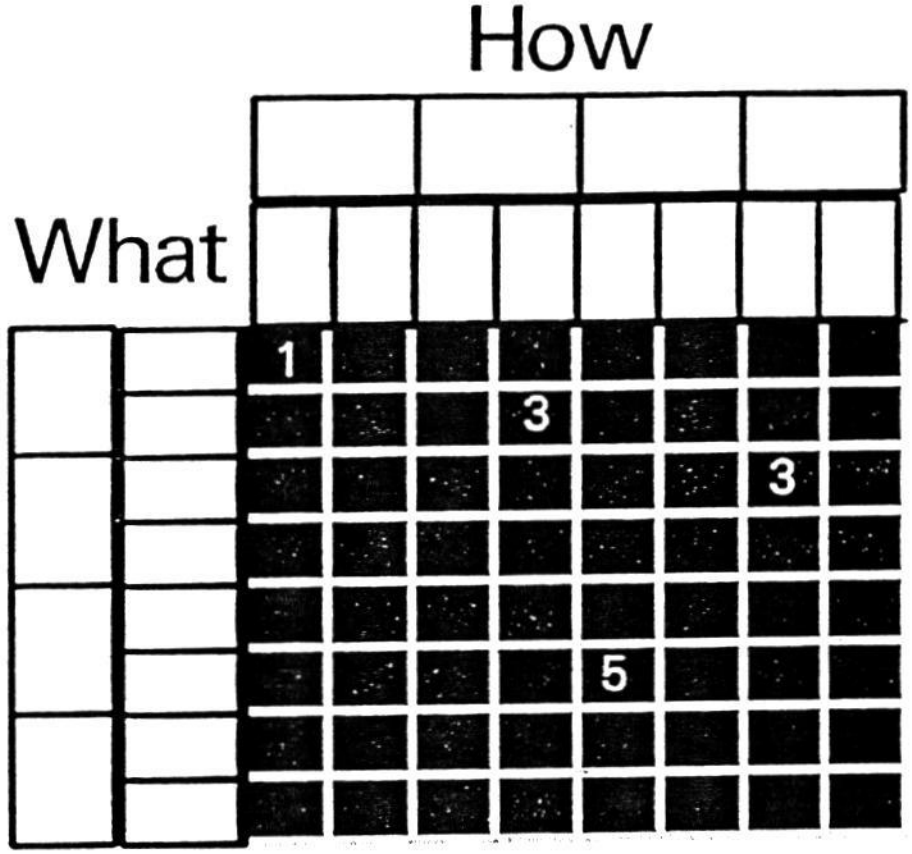


How are we going to satisfy the customer?

Next we need a list of technical requirements of how to satisfy the customers objectives or wants. Unfortunately a simple list does not clarify the interrelationships and the trade-offs.



Matrix: The Basis of QFD



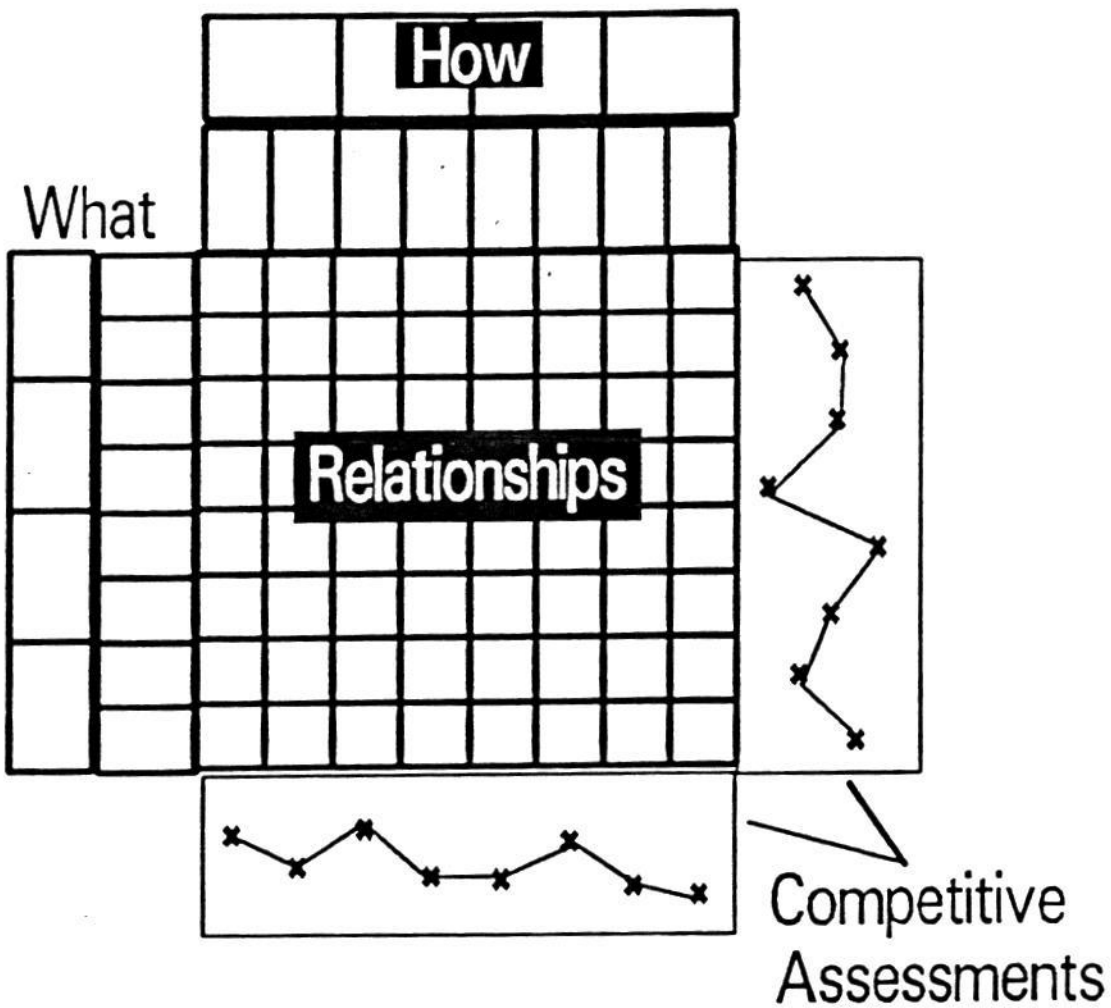
Complex Relationships are depicted and interpreted with little experience

Weak Relationship - 1

Strong Relationship - 3

Very Strong Relationship - 5 or 9

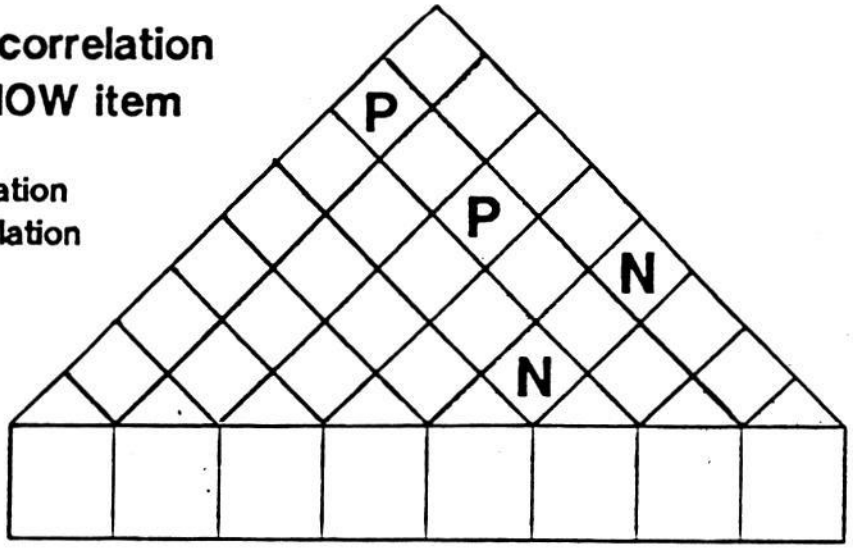
Competitive Benchmarking:
For Customer Evaluation and In-house Standards



The Correlation Matrix

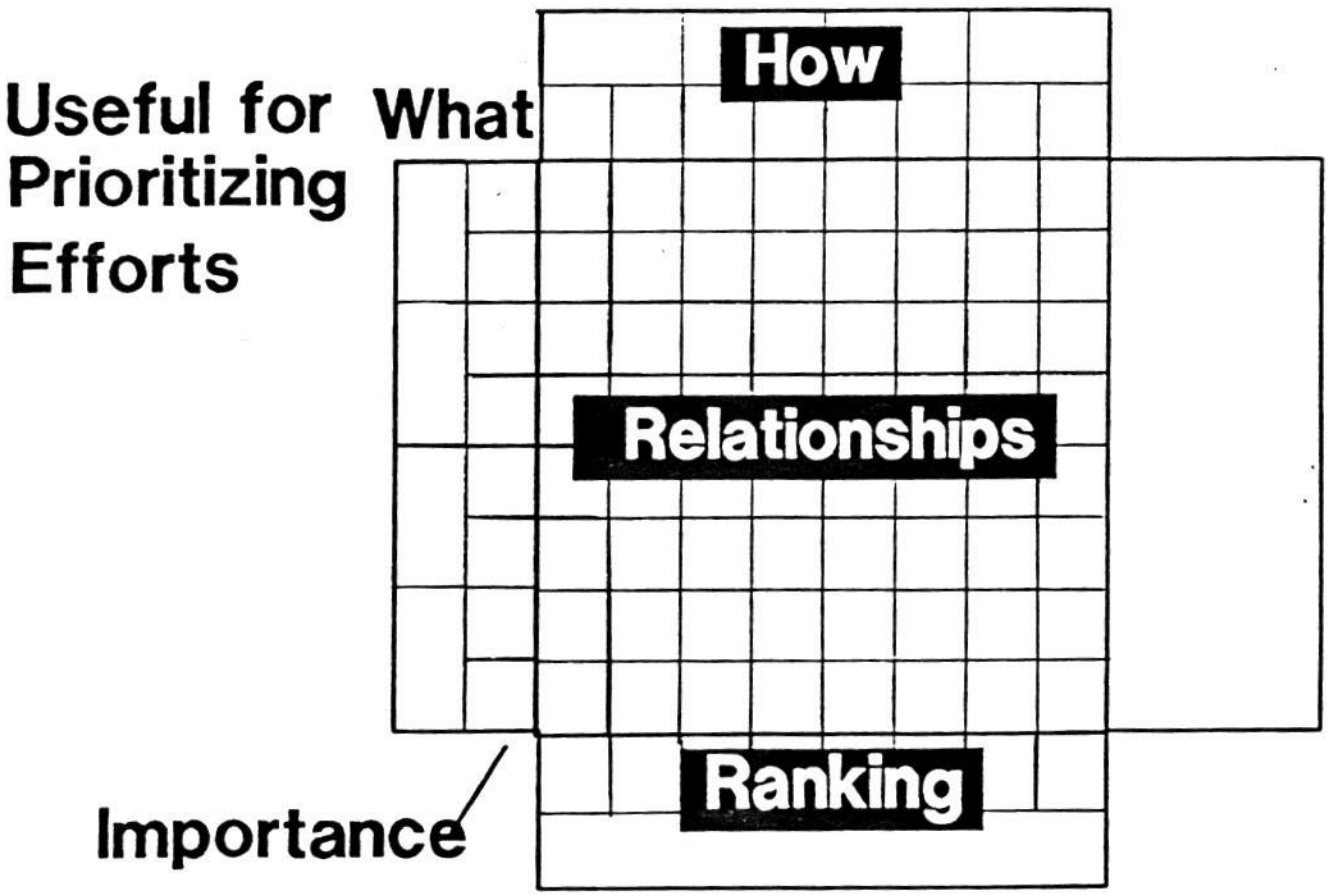
Establishes the correlation between each HOW item

P - Positive Correlation
N - Negative Correlation

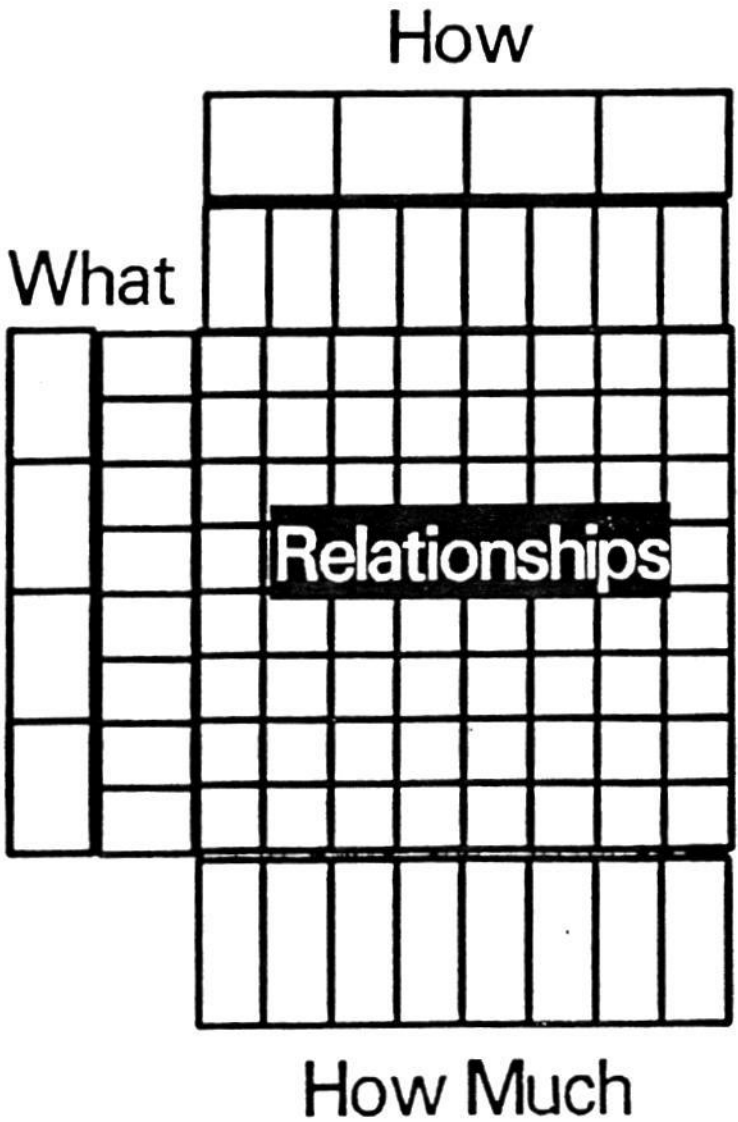


The conflicts are extremely important, as they represent points at which trade-offs must be resolved.

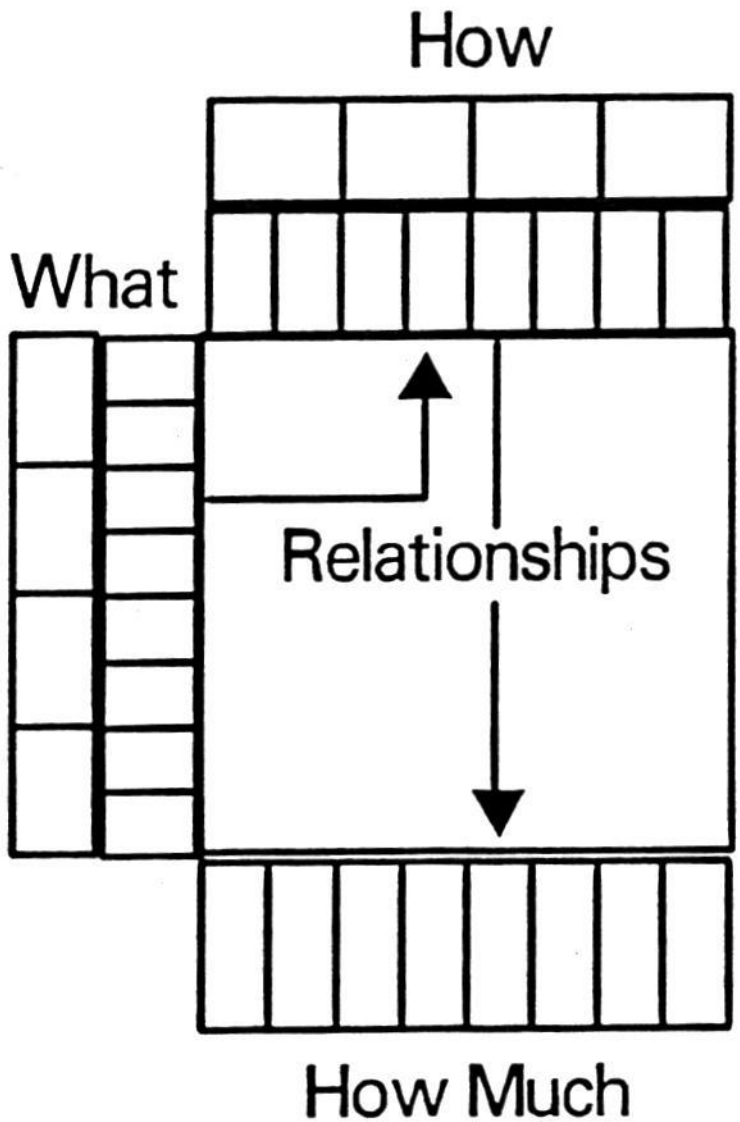
Importance and Ranking



Next: How much values are established for each how? These are goals or objective values to be obtained.

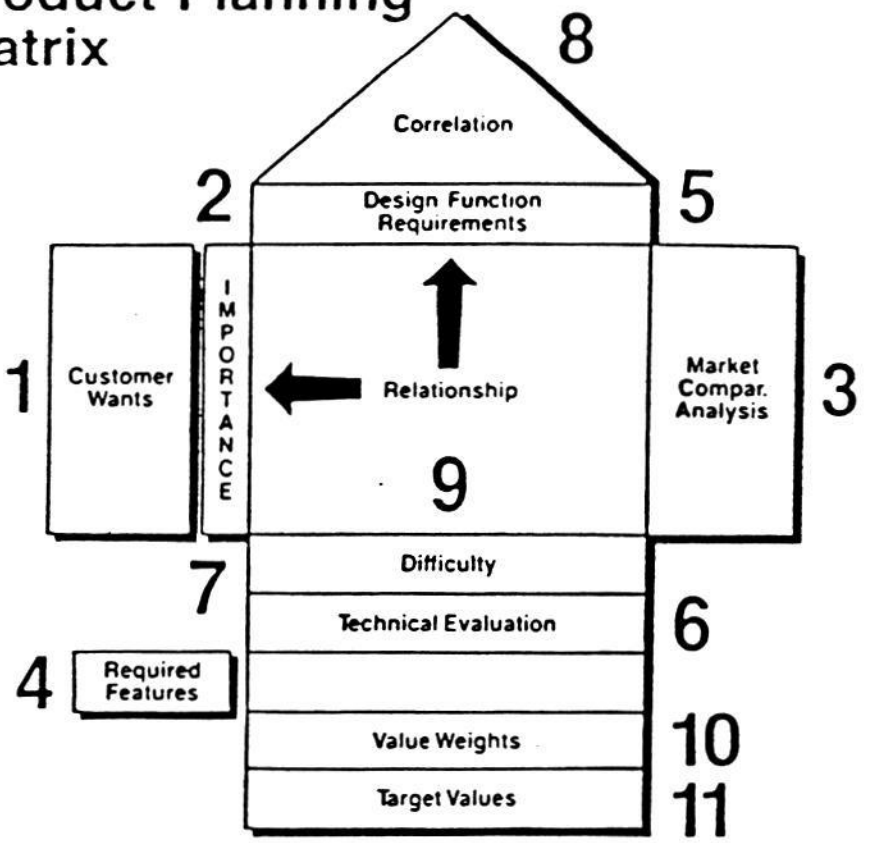


Flow of Information is Common Through Most QFD Charts



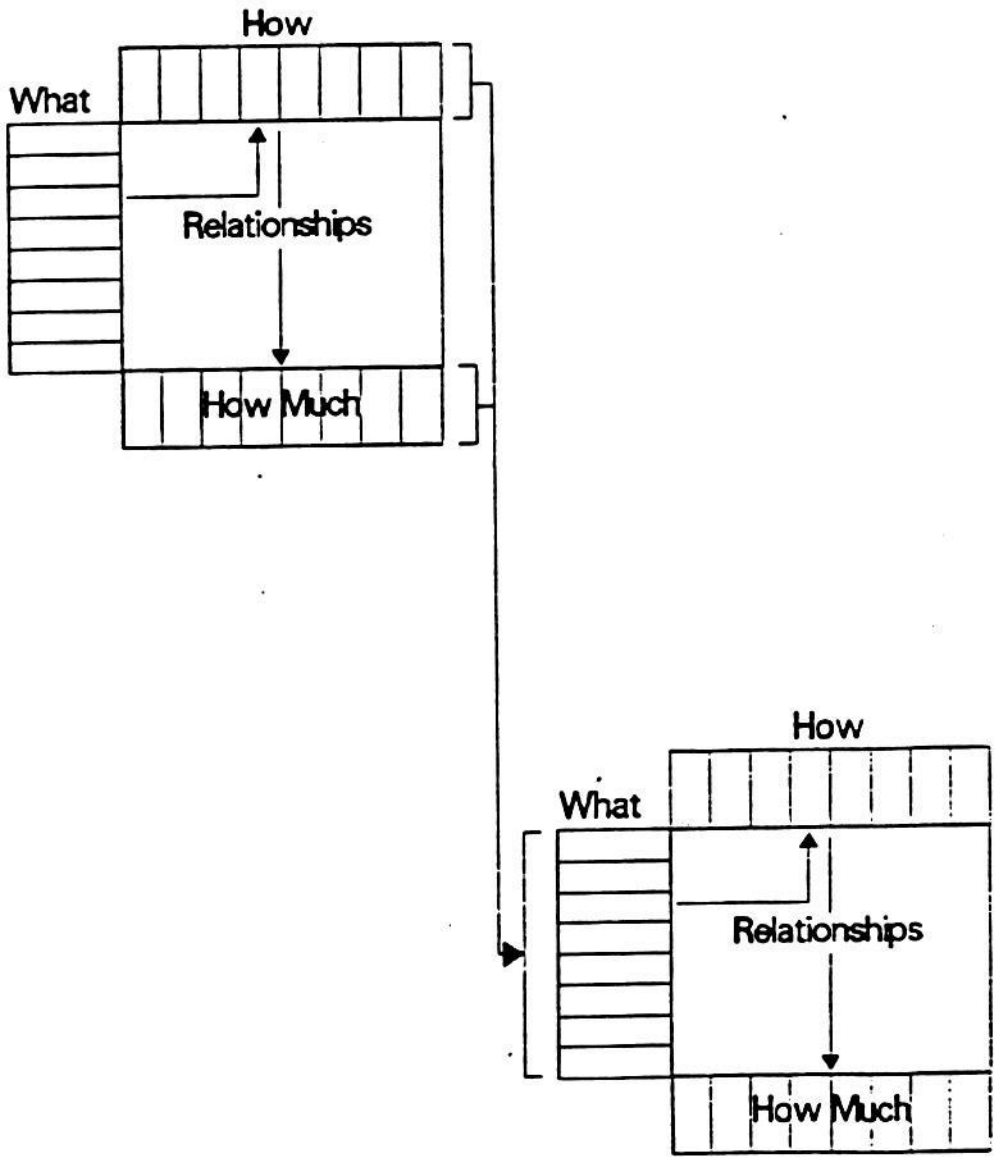
QFD

Product Planning Matrix

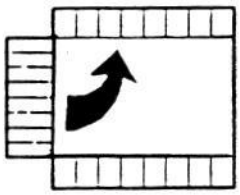


The QFD Product Planning Matrix: The team (1) brainstorms customer wants, (2) determines the relative importance of these wants, (3) evaluates market competitiveness, (4) identifies required standards, (5) generates design requirements to meet customer wants, (6) evaluates technical competitiveness, (7) determines degree of difficulty of requirements, (8) identifies bottlenecks between requirements, (9) determines how well the requirements relate to the customer wants, (10) prioritizes by value weighting the requirements, and (11) establishes target values for the design requirements to satisfy the customer better than the competition.

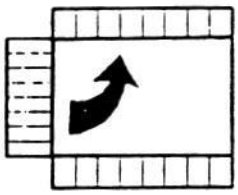
System Concept



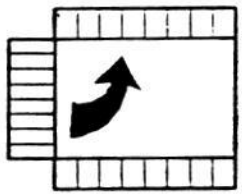
QFD



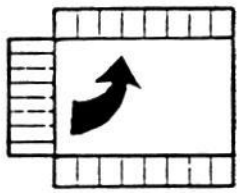
Product Planning
(Wants vs Design Requirements)



Hardware Planning
(Design Reqm. vs Part Qual Char.)



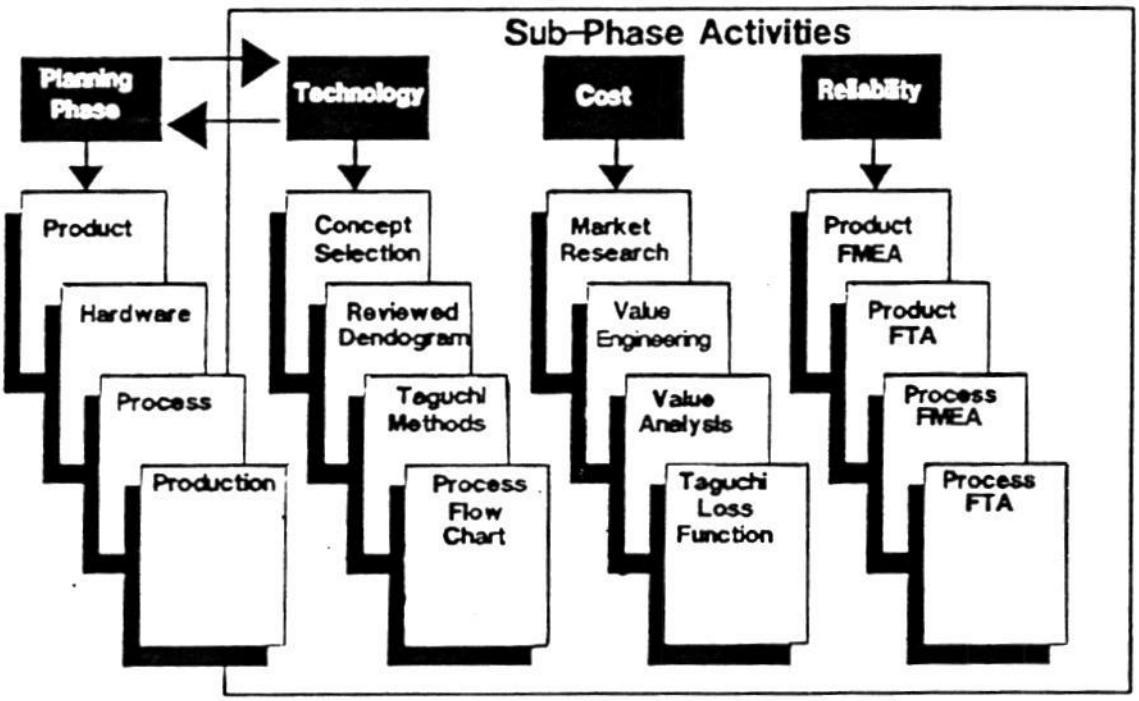
Process Planning
(Char. vs Proc., Parameters)



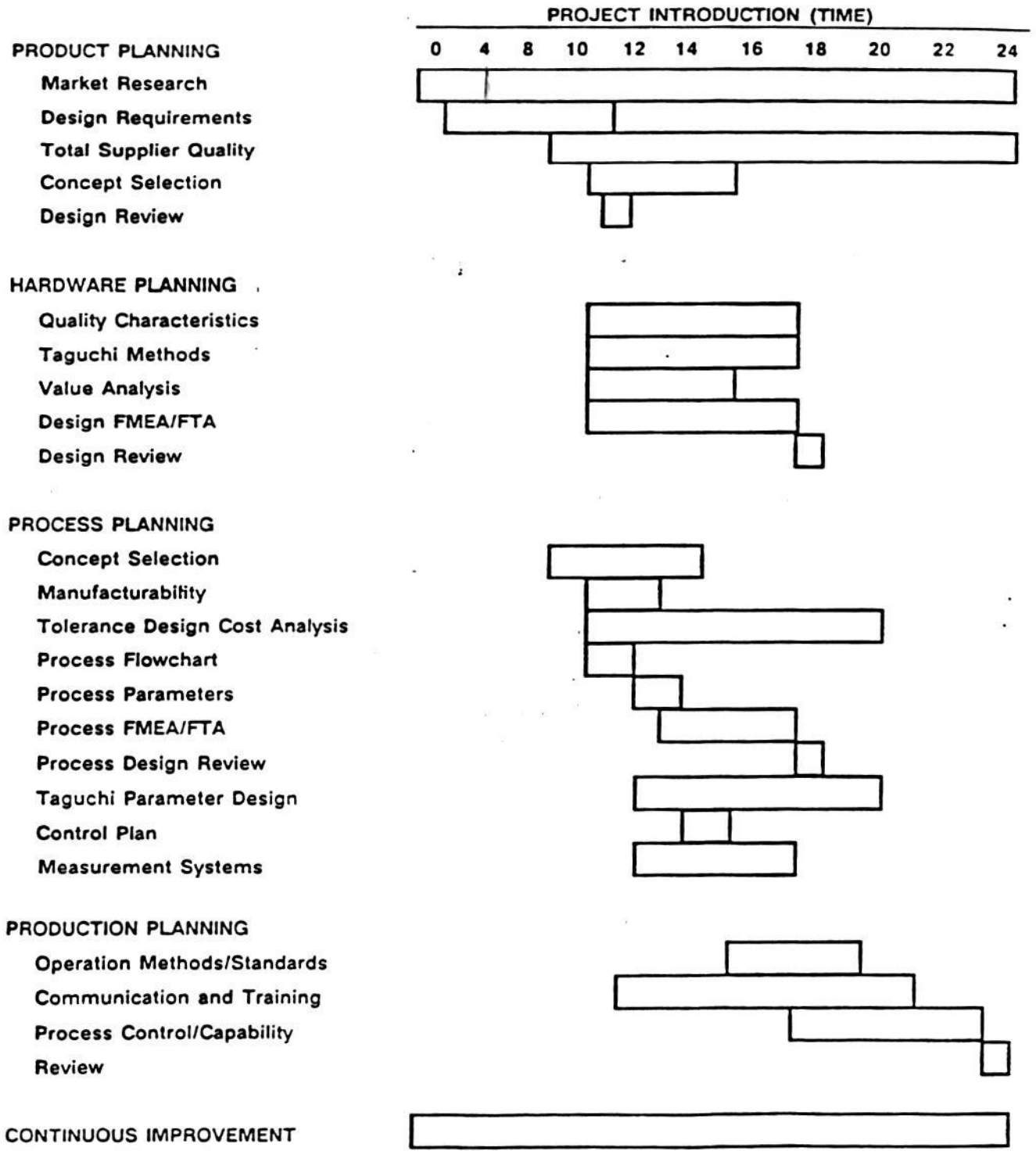
Production Planning
(Processes vs Production)

Deploying . . .
What is New,
Important & Difficult

Project Management Elements



QFD GANTT CHART EXAMPLE



	QFD TEAM						
	Marketing & Sales	Product Engineering	Quality Reliability	Manufacturing Engineering	Manufacturing	Materials Management	Accounting
PRODUCT PLANNING							
Market Research	X	X	X	X			
Design Requirements	X	X	X	X			
Total Supplier Quality	X	X	X	X		X	
Concept Selection	X	X	X	X			
Design Review	X	X	X	X	X	X	X
HARDWARE PLANNING							
Quality Characteristics	X	X	X	X			
Taguchi Methods		X	X	X			
Value Analysis		X		X			X
Design FMEA/FTA		X	X	X			
Design Review	X	X	X	X	X	X	X
PROCESS PLANNING							
Concept Selection		X	X	X	X		
Manufacturability			X	X	X		
Tolerance Design Cost Analysis		X		X			X
Process Flowchart			X	X	X		
Process Parameters		X	X	X	X		
Process FMEA/FTA			X	X			
Process Design Review	X	X	X	X	X	X	X
Taguchi Parameter Design		X	X	X			
Control Plan		X	X	X	X		
Measurement Systems		X	X	X	X		
PRODUCTION PLANNING							
Operation Methods/Standards			X	X	X		
Communication and Training	X	X	X	X	X	X	X
Process Control/Capability			X	X	X	X	
Design Review	X	X	X	X	X	X	X
CONTINUOUS IMPROVEMENT	X	X	X	X	X	X	X

DEVELOPING OUR OWN SYSTEM

QFD IS **NOT A TURNKEY SYSTEM.**

IT HAS TO BE **CUSTOMIZED** TO YOUR EXISTING SYSTEM.

IT **EVOLVES OVER TIME.**

QFD IS **APPLIED DIFFERENTLY FOR EACH PROJECT.**

TEAM MEMBERS **FIND DIFFERENT WAYS TO USE IT.**

QFD IS THE **MOST ADVANCED QUALITY SYSTEM.**

THE **BEST JAPANESE COMPANIES** ARE USING IT.

MOST ARE **ONLY PARTIALLY IMPLEMENTED.**

IN **U. S.** MOST ARE ONLY WORKING ON THE **CHARTS 1 & 2.**

IT CAN BE USED FOR **PRODUCTS AND SERVICES.**

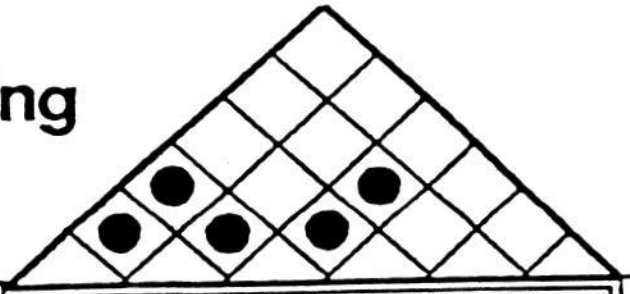
INNOVATE

QFD Product Planning
Autobody Rust

BACKGROUND

TOYOTA IDENTIFIED A PROBLEM WITH ITS MINI-VAN SOLD IN EUROPE. THE WARRANTY COST FOR RUST WAS FOUR TIMES THE PROFIT GENERATED BY THE SALES OF THESE VEHICLES. SUBSEQUENTLY A QFD STUDY WAS INITIATED.

QFD Product Planning
Autobody Rust



Cust. Want / Importance / Dgn. Req.		Initial Stage: End Rust	Initial Stage: Weld/Joint Rust	Initial Stage: Drilled Hole Corr.	Anti-Spot: Damp Sep.	Anti-Spot: Sealer	Anti-Spot: Surf. Rust	Compar. Analysis
Long Life	4.5	5	5			3	5	
Many Miles	4.3	3	5	3			3	
Full Load	3.0		3		3			
Minor Collisions	3.5			1	3	1	1	
Difficulty				▼			▼	
Tech. Eval.								
Required Testing: Rust Int.	5	5	5				5	
Required Testing: Vehicle Wt.	5		1					
Required Testing: Door Fit	5		1	1				
Required Testing: Panel Gem.	5			3				
Value Weights: ABS		60.4	88	36.4	26.5	17	63.9	
Value Weights: Rel		21	30	12	9	6	22	
Value Weights: Rank		3	1	4	5	6	2	
Target Values		30 Cyc. Cor. Tt	30 Cyc. Corr. Tt	3mm Max TAC Test	340 Ht. Salt Spy.	880 Ht. Salt Spy.	60 Cyc. Scab Tt	

HARDWARE PLANNING MATRIX

Autobody Rust

Design Req. / Weighting / Qual Char			Material				Water Drainage		Sealer
			Anti-Rust Steel	Resin	Body Sealer	Joint Adhes	Hole Posit	Hole Shape	Appl Area
REQ.	TGT.								
Weld Joint Rust	30 Cycl. Corr.	3	9			3	9	9	3
Surf. Rust	60 Cycl. Scab	2	9	1	9		3	3	3
Sketch									
Value Weights	ABS		45	2	18	9	33	33	15
	Rel		29	1	12	6	21	21	10
	Rank		1	7	5	6	2.5	2.5	4
Target Values			85μ Zinc Coat	Tsk 1000	Tsk 751	Tsk 870	Lowest End	Bend 45	Sketch

PROCESS PLANNING MATRIX

QUALITY CHARACTERISTICS / KEY PROCESSES & PARAMETERS	Weighting Factors	RECEIVING INSPECTION				PUNCH PRESS					CONTROL POINTS
		Carbon Content	Coating Adhesion	Coating Thickness	Formability	Hardness of Cutter	Cutter Step (taper min. 30°)	Clearance	Die Condition	Deflection of Thrust Bearing	
ANTI-RUST STEEL	3	1									Chemical Cert.
			9		3						Bend Test
				9							Spot Test
		1			3						Temper Color
HOLE POSITION	2				1			9	3	3	Visual Check
HOLE SHAPE	2				1	3	9	3		3	Visual Check
VALUE WEIGHTS — ABSOLUTE		6	27	27	22	6	18	24	6	12	
VALUE WEIGHTS — RELATIVE		4%	18%	18%	15%	4%	12 %	16%	4%	8%	
VALUE WEIGHTS — RANK		7	1	1	4	7	5	3	7	6	
TARGET VALUES		Ins Test Minimum 60%	No Flaking @ 180° Bend	Spec No E-188 15 sec. ; 1	By Limestain Sample	R_c 55-60	2mm ; 0 5	6 to 8% of Plate Thickness	Punch Holes After Shape Forming	0 05 mm Maximum	

Relationship
9 Strong
3 Medium
1 Small
Blank None

MATRIX SUMMARY

- FROM THE COMPLETED MATRIX, KEY PROCESSES, CONTROL POINTS, AND TARGET VALUES CAN BE ANALYZED TO DETERMINE:
  - WHERE PROCESS TECHNOLOGY NEEDS TO BE DEVELOPED
  - HOW TO ACHIEVE BETTER CONTROL OF THE PRODUCTION PROCESS
  - WHICH ITEMS TO FURTHER DEPLOY INTO OPERATION STANDARDS

- KEY PROCESS PARAMETERS AND CONTROL POINTS ARE SELECTED FROM THIS MATRIX TO BE USED AS INPUT FOR DEVELOPING A COMPREHENSIVE CONTROL PLAN.

- A GAGING REQUIREMENTS PLAN MAY ALSO BE DEVELOPED, USING MEASUREMENT SYSTEM ANALYSIS STATISTICAL TECHNIQUES FOR EVALUATING GAGES SPECIFIED BY THE CONTROL PLAN.

QFD
PRODUCTION PLANNING

Material or Process Name	Process Flowchart		Check Items (process parameters & control points	Method of Control			Problem Reaction Plan & Responsibility	C_{PK} Status
	Incoming Material	Process		Frequency & Sample Size	Measurement Method	Control Records		
Anti-Rust Steel			Coating Adhesion	5 samples per lot	Bend Test	Check Sheet	Impound Lot, Contact Supplier for Resolution	---
			Coating Thickness	5 samples per lot	Chemical Spot Test	Probability Paper		1.6
			Formability	1/lot	Color Limitation	Check Sheet	SQA/ Purchasing Responsibility	---
Press		10	Cutter Step	1/5,000 pieces	Micrometer	Run Chart	Notify Tool Room Foreman	---
			Thrust Bearing Deflection	1/10,000 pieces	Dial Indicator w/Magnetic Base	Run Chart	Notify Foreman/ Maintenance	---
Weld		20						

INPUTS TO OPERATING INSTRUCTIONS

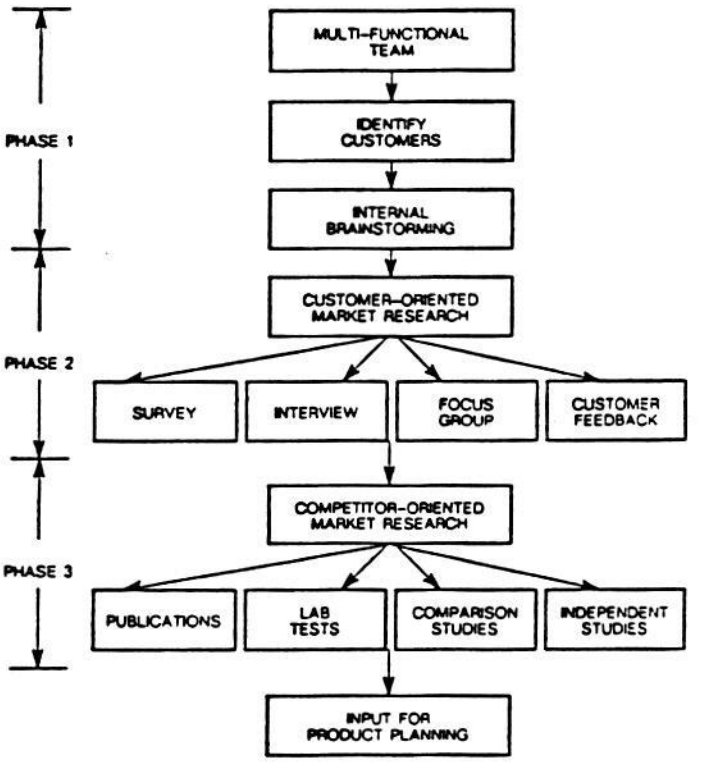
PRODUCTION PLANNING TABLE EXAMPLE

Additional optional column headings may be:

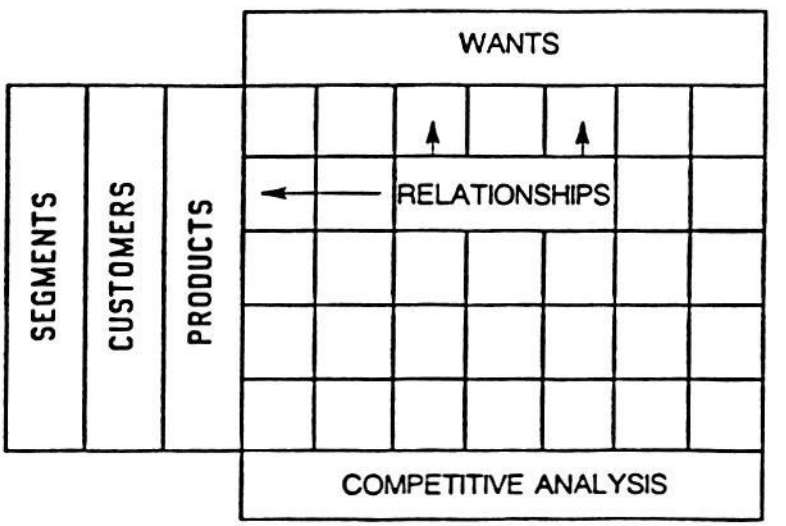
- Process Equipment Type
- Target/Specification Value (for check items)
- Operation Standard Number

MARKET RESEARCH PHASES

MARKET RESEARCH INCLUDES AN ASSESSMENT OF WHO THE CUSTOMER IS. GROUPING THESE CUSTOMERS BY SEGMENTS AND/OR PRODUCT FORMS A BASIS FOR SELECTING A TARGET MARKET AND STUDYING WANTS.

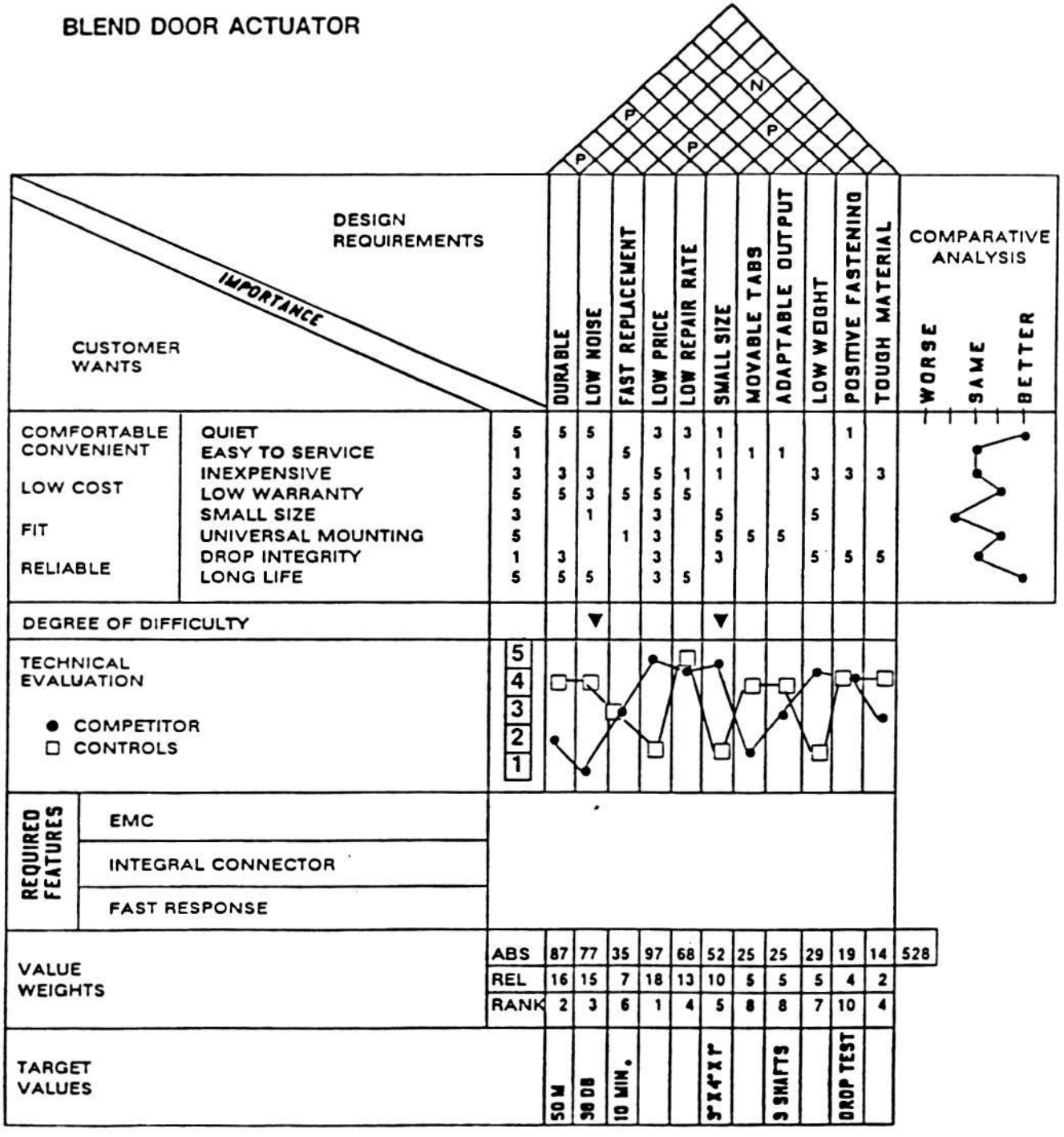


MARKET SEGMENTATION

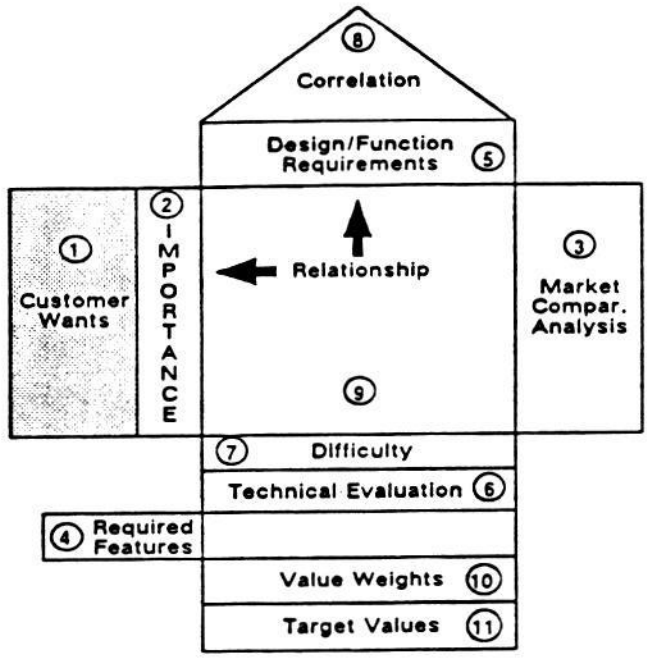


QFD
Product Planning Matrix

BLEND DOOR ACTUATOR



Product Planning Exercise



① Brainstorm at least 4 wants for your product.

② Assign relative degree-of-importance ranks using a scale of 1-5.

③ Evaluate market competitiveness of your product for these customer wants. Compare one competitor's product with yours.

④ Identify 2 required features or standards applicable to your product (e.g., FMVSS, NEMA, etc.).

⑤ Generate one design requirement that addresses each customer want. This step translates the voice of the customer into technical terms.

⑥ Evaluate technical competitiveness for one or more requirements **as time permits.** Typically, this includes results from testing competitive products.

⑦ Determine one or two of the most difficult requirements to achieve from among those identified.

⑧ Identify several positive and negative correlations between design requirements **as time permits.**

⑨ Determine the strength of the relationship (either positive or negative) between wants and requirements. Use a 0, 3, 5 scale where:

5 = strong; 3 = medium; 0 = none or small.

⑩ Determine the value weights.

Importance x relationship rank = value weight.

Absolute value weight = Total of value weights in each column.

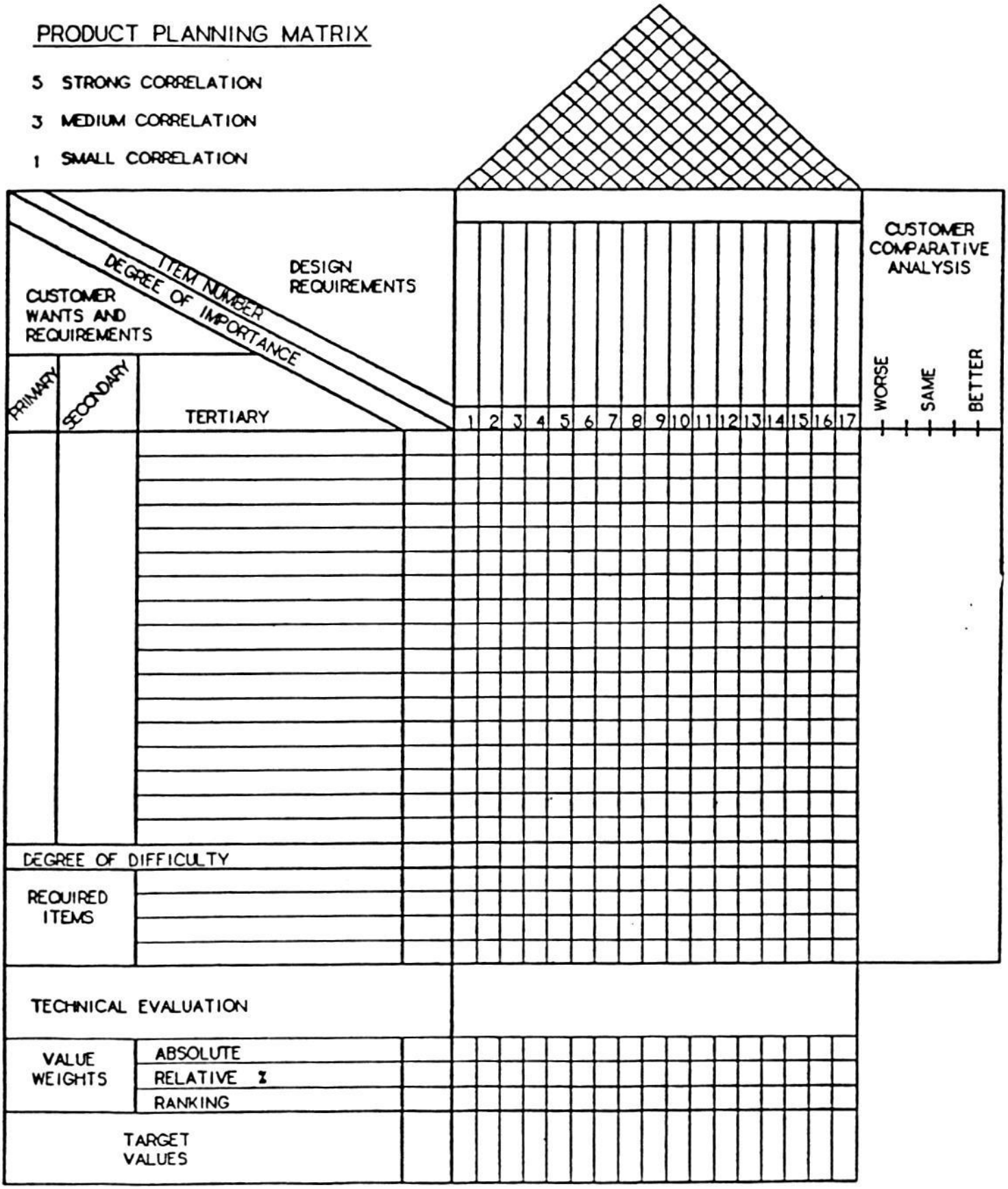
⑪ Establish a measurable target for the first and second highest ranked requirements—considering all the above steps.

PRODUCT PLANNING MATRIX

5 STRONG CORRELATION

3 MEDIUM CORRELATION

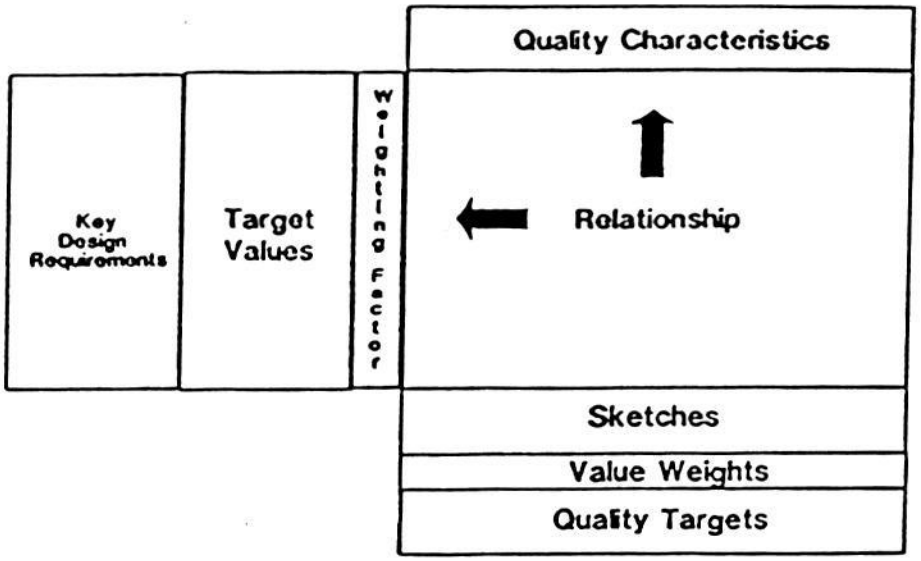
1 SMALL CORRELATION



BLEND DOOR ACTUATOR CONCEPT SELECTION MATRIX

FEATURES	RANKINGS		CONCEPTS								
			PRESENT BDA	NEW BDA	VAC. SERVO	STEPPER	BOWDEN WIRE	RATCHET SOL.	ELEC. W.V.	NEW BDA	ELEC. W.V.
DURABLE	16			S	S	S	–	–	S		S
LOW NOISE	15			+	+	+	+	–	+		+
FAST REPLACE.	7			S	S	S	+	S	+		+
LOW SELL PRICE	18		E	+	+	–	+	–	+	E	+
LOW R/100	13		S	S	S	S	–	S	S	S	–
COMPACT	10		A	+	–	S	+	S	+	A	+
MOVEABLE TABS	5		B	+	S	S	+	S	+	B	+
ADAPT. OUTPUT	5			+	+	+	+	S	+		+
LOW WEIGHT	5			+	S	S	+	S	+		+
POSITIVE FAST.	4			–	+	–	+	–	–		S
TOUGH MATERIAL	2			S	+	S	+	S	S		S
SUM +				58	44	20	71	0	65		65
SUM –				4	10	22	29	53	4		13
NET				54	34	–2	42	–53	61		52

QFD
Hardware Deployment

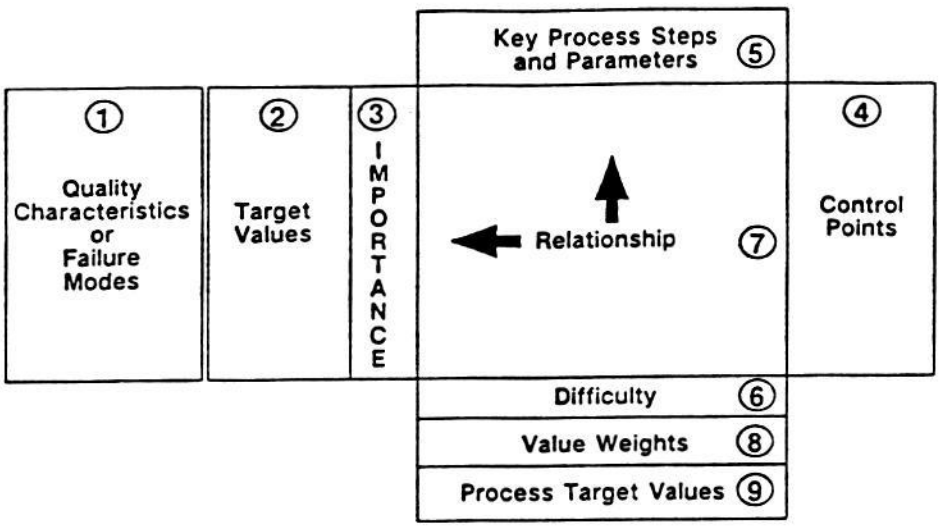


BLEND DOOR ACTUATOR

Quality Char. / Weight / Design Req.		Worm					Motor		
		Concentricity	Finish	Molding defect	Material	Clean	Noise	Size	Speed
Durable	16	9	9	9	9	3			3
Noise	15	9	3	9	1	9	9		9
Sketch									
Value Weight	Abs	279	189	279	159	183	135	-	183
	Rel	20%	13%	20%	11%	13%	10%	-	13
	Rank	1	3	1	6	3	7		3
Target		± .xxx	No part	Mat. spec.	Self lube	Mat. spec.	30 db	x - y	Max RPM

QFD

PROCESS PLANNING



BLEND DOOR ACTUATOR EXAMPLE (PARTIAL)

	QUALITY CHARACTERISTICS	TARGETS	IMPORTANCE	KEY PROCESS STEPS AND PARAMETERS: INJECTION MOLDING — MELT TEMPERATURE	INJECTION PRESSURE	RECHARGE TIME	CLAMPING FORCE	MATERIAL SIZE		RECEIVING INSPECTION	CONTROL POINTS
WORM	CONCENTRICITY	.XXX MAX.	3	3	1	9	3	1			RUNOUT
WORM	CLEANLINESS	NO FLASH	2		3		9				VISUAL
WORM	SURFACE FINISH	NO PARTING LINE	2		1		1	3			VISUAL
WORM	MOLDING DEFECTS	ACCEPTANCE SPEC. YY	3	9	3	3	1	3			---
MOTOR	SPEED	MAX. RPM	2							9	RPM CHECK
										3	MAGNETISM
DEGREE OF DIFFICULTY				1.5	1	1	1	1		1	
VALUE WEIGHTS	ABSOLUTE			54	20	36	32	18		24	SUM 184
VALUE WEIGHTS	RELATIVE (%)			29.3	10.9	19.6	17.4	9.8		13.0	
VALUE WEIGHTS	RANK			1	5	2	3	6		4	
	TARGET VALUES			HHH°F	VV,VVV PSI	WW SECONDS	XXX TONS	Y OUNCES		DEPLOY TO SUPPLIERS	

QFD
PRODUCTION PLANNING

BLEND DOOR ACTUATOR COMPONENTS

Material or Process Name	Process Flowchart: Incoming Material	Process Flowchart: Process	Check Items (process parameters & control points)	Method of Control: Frequency & Sample Size	Method of Control: Measurement Method	Method of Control: Control Records	Problem Reaction Plan & Responsibility	C_{PK} Status
Motor	▽		Motor Speed	10 Samples per Lot	Tachometer	Control Chart	Impound Lot and Contact Supplier, Purchasing	1.8
Plastic Shot	▽		Shot Size	5 Samples of 10 per Lot	Weight Scale	Control Chart	Impound Lot and Contact Supplier, Purchasing	0.9
Injection Molding		10	Melt Temp.	1 Every 15 Min.	Thermometer	Run Chart	Stop, Find Special Cause	--
			Recharge Time	1 Every 4 Hours	Stopwatch	Check Sheet	Notify Maintenance	--
			Clamping Force	1 Per Hour	Machine Gauge	Run Chart	Notify Maintenance	--

INPUTS TO OPERATING INSTRUCTIONS

PRODUCTION PLANNING TABLE EXAMPLE

Additional optional column headings may be:

- Process Equipment Type
- Target/Specification Value (for check items)
- Operation Standard Number

Reprint from the *Product Quality Assurance Reporter* - Issue 18, January 1988

QFD Ties Engineering, Manufacturing To Market Pull

Eaton is one of the first U.S. corporations to develop company-specific QFD techniques as a comprehensive tool that can be used to enhance any part of the total project management system — from the perception of a need for a product, through conception, design and test, production, distribution, and support of the product in use.

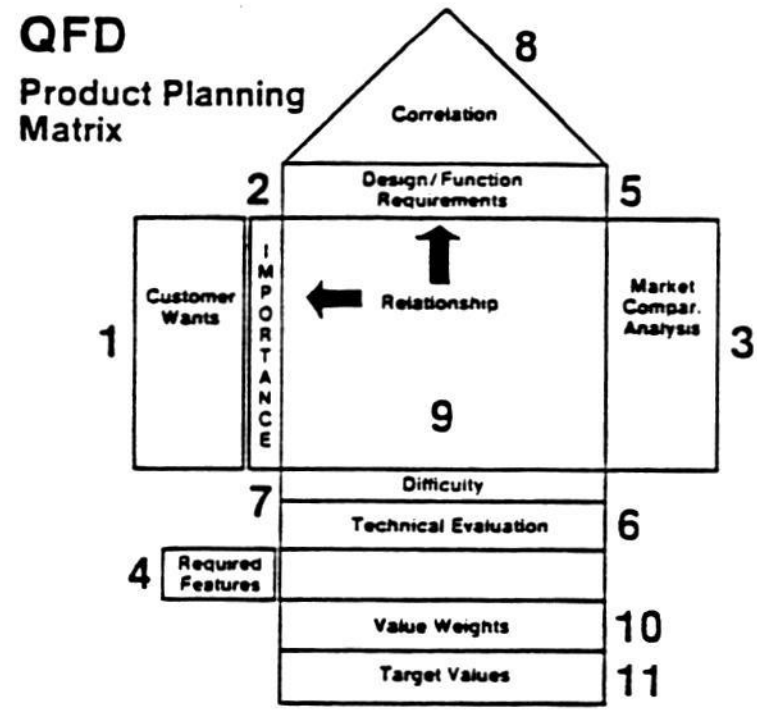
QFD techniques maximize the commercial potential and success of new products by leading, structuring, and documenting the technical decision-making process. They assure that the product development team addresses the needs of the customer, and that teamwork is focused — from the onset — toward those areas most significant to project success.

"QFD is the most powerful product development tool I have come across in my 40 years in industry," said Warren Offutt, Vice President - Technical Management. "Unlike anything before it, QFD bridges market need to technical resource by bringing the customer into our research and onto our engineering teams."

The QFD process begins by assembling a multidisciplinary team within an operation — cutting across the traditional functions of engineering, manufacturing, marketing, sales, and administration. The team then collectively identifies customer wants in an area of market interest, along with the design requirements to satisfy these wants. The next step is to identify the relationships between these wants and requirements, along with the correlations among the requirements, in the form of a planning matrix — like that presented above.

This matrix is typical of the series of interrelated matrices that can be generated depending on the mission of the development team. A team pursuing a product concept would construct and use a matrix like that above. If their mission was to go further in the total manufacturing chain, they could subsequently develop matrices for part deployment, process planning, production planning, and so on, all the way downstream to customer support.

The Eaton Quality Institute has synthesized the best QFD techniques into a flexible, Eaton-specific QFD Project Management System.



The QFD Product Planning Matrix: The team(1) brainstorms customer wants, (2) determines the relative importance of these wants, (3) evaluates market competitiveness, (4) identifies required standards, (5) generates design requirements to meet customer wants, (6) evaluates technical competitiveness, (7) determines degree of difficulty of requirements, (8) identifies bottlenecks between requirements, (9) determines how well the requirements relate to the customer wants, (10) prioritizes by value weighting the requirements, and (11) establishes target values for the design requirements to satisfy the customer better than the competition.

Most divisions have proven procedures for product development — processes they are comfortable with and that work for them. Therefore, the QFD Project Management System is structured as an aid that can be selectively applied to reinforce or improve a part of an operation's overall development process.

Participants at the Quality Institute QFD Workshop are encouraged to attend in multidisciplinary teams, and come with specific project goals. They then can apply the training material to their own project throughout the workshop — and thus leave with both knowledge and immediate results.

Louis T. Horvath
Vice President — Quality Management

CASE STUDY

NEW HIGHWAY TANDEM AXLE PRODUCT PLANNING

Gary Broda
Joe Holtzhauser
Frank Palmeri
Axle & Brake Division
Kalamazoo, Michigan

CASE STUDY SUMMARY

DIVISION & LOCATION	PRINCIPLE AUTHOR(S). TITLE
Axle & Brake, Kalamazoo, Michigan	Gary Broda – Manager, Supplier Quality Assurance and Metallurgical Services Frank Palmeri – Product Manager Joe Holtzhauser – Chief Engineer, On–Hwy Axles

OBJECTIVE AND STRATEGY

1. Tailor QFD Techniques to our own time and resource constraints.
2. Implement QFD Techniques as screen for understanding customer wants and needs.
3. Obtain measurable results at the first stage of QFD.
4. Develop more cohesive teamwork throughout division.

QFD AND STATISTICAL METHODS USED

- QFD Product Planning Matrix
- Concept Selection

COST/TIME EXPENDED

500 manhours

QUALITY/PRODUCT IMPROVEMENT AND COST REDUCTIONS

- Product is more tailored to OEM and user customer.
- Opportunity for genuine product differentiation identified.

CONCLUSIONS AND SIGNIFICANCE OF STUDY

Major change in design focus and concept.

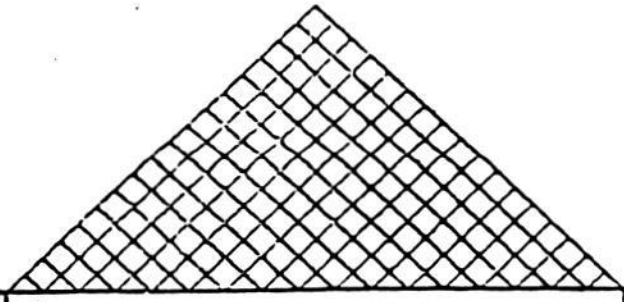
EATON AXLE/BRAKE

HIGHWAY TANDEM
PRODUCT PLANNING MATRIX

5 STRONG CORRELATION

3 MEDIUM CORRELATION

1 SMALL CORRELATION



PRIMARY	SECONDARY	TERTIARY	ITEM NUMBER / IMPORTANCE RATING (5.3.1) USER/OEM	1 BEARINGS	2 ELECTRONICS/DIAG.	3 SEALING	4 FASTENERS	5 GEARING	6 CASTING	7 HOUSING	8 LUBRICATION	9 POWER DIVIDER	10	11	12	13	14	15	16	17
		PURCHASE PRICE (INCLUDING WARRANTY)	3/5	3		3	1	5	1	1	5	3								
		COST OF OWNERSHIP	5/3	3		5	1	1		1	5	3								
		LIFE TIME LUBRICATION	5/3	5	1	5		3			5	1								
		END PLAY	3/1	1	1						3	5								
		LIFE/DOWNTIME	5/3	5		5		3			1	3								
		CHASSIS COMPONENT WEAR	3/1	1		5				1										
		DRESSED AXLE	1/4			5	3			3										
		FIT-UP	1/4					5		5		5								
		WIDE BASE TIRE	3/1	3						5										
		RATIO COVERAGE	5/5	3				5	3			1								
		WEIGHT	3/3					5	3	1										
		TRACTION CONTROL	3/3	3	5							3								
		DIAGNOSTICS	1/1		5				1	1		1								
		RATINGS	4/4	5			3	5	1	5		5								
		PROGRAMMABLE RATIOS	1/1		5			5				3								
		INTEG. AXLE SPEED SENSOR	1/4		5	1			3	1		3								
DEGREE OF DIFFICULTY																				
REQUIRED ITEMS		INVESTMENT																		
		MARKET TIMING																		
VALUE WEIGHTS		ABSOLUTE USER		130	36	105	23	115	35	55	79	105								
		OEM		103	49	89	32	128	37	74	61	111								
		RANKING USER		1	7	3	9	2	8	6	5	3								
		OEM		3	7	4	9	1	8	6	5	2								
		TARGET VALUES																		

CUSTOMER COMPARATIVE ANALYSIS

WORSE — SAME — BETTER

CUSTOMER WANTS AND REQUIREMENTS

MECHANISMS

12-16-8

EATON

HIGHWAY TANDEM
GEARING: CONCEPT SELECTION

WANT/REQUIREMENT	IMPORTANCE		ALTERNATIVE CONCEPTS							CONCEPTS
	USER	OEM	1	2	3	4	5	6	7	
INITIAL COST	3	5	-	-	-	-	-		S	1 HYPOID/6 CUT/SHOT P.
OWNERSHIP COST	5	3	-	-	-	S	S	D	S	2 HYPOID/6 CUT
LIFE TIME LUBE	5	3	S	S	S	S	S	A	S	3 HYPOID/COMPLETE
LIFE	5	3	-	-	-	S	+	T	S	4 S. BEVEL/6CUT/SHOT P.
FIT-UP	1	4	+	+	+	S	S	U	S	5 S. BEVEL/COMPLETE/CBN/SHOT P.
RATIO COVERAGE	5	5	S	S	S	S	S	M	S	6 S. BEVEL/COMPLETE/CBN
WEIGHT	3	3	S	S	S	-	S		S	7 S. BEVEL/COMPLETE/SHOT P.
RATINGS	4	4	S	S	S	S	S		S	
INVESTMENT	5	5	++	++	+	++	-		+	
TIMING	5	5	S	S	S	S	S		S	
+ TOTAL (USER)			11	11	6	10	5		5	
+ TOTAL (OEM)			14	14	9	10	3		5	
- TOTAL (USER)			13	13	13	6	8		0	
- TOTAL (OEM)			11	11	11	8	8		0	
NET (USER)			-2	-2	-7	4	-3		5	
NET (OEM)			3	3	-2	2	-5		5	

CASE STUDY

MULTIPLEXING QFD STUDY

MULTIPLEXING: CUSTOMER NEEDS

RELIABILITY*

- -MINIMUM WIRES (PURE CONNECTIONS)
- -NOISE IMMUNE - DURABLE

DIAGNOSTIC*

- -FAULT ISOLATION
- -SYSTEMS STATUS CHECK
- -SELF DIAGNOSTICS
- -WARNING

PERFORMANCE

- -LOW CURRENT
- -FAST RESPONSE TIME*

ASSEMBLY

- -INSTALLATION
- -REPLACEMENT (EASE OF)

FEATURES

- -GREATER NUMBER OF OPTIONS*
- -EASY TO EXPAND*
- -FLEXIBLE (INTERFACE)
- -MINIMUM PARTS/MANY JOBS*

FAULT TOLERANCE

- -LIMP HOME*
- -MANUAL OVERRIDE*

VMI/RFI

- -DON'T AFFECT RADIO*

MANUFACTURING COMMONALITY

COST

- -LOW INITIAL COST*
- -LOW REPLACEMENT COST*
- -DIAGNOSTICS

ERGONOMICS

- -VISIBLE UNDER ALL LIGHTING CONDITIONS*
- -TACTILE FIELD THROUGH A GLOVE
- -TACTILE FIELD*
- -AUDIBLE FEEDBACK
- -QUIET RESPONSE*
- -BUTTON SHAPE
- -VISUALLY ATTRACTIVE
- -SELF EXPLANATORY*
- -GRAPHICS

PACKAGING

- -SIZE/WEIGHT
- -MODULAR
- -DURABLE TO WITHSTAND HANDLING
- -SPILL PROOF*
- -NO MOVING PARTS*

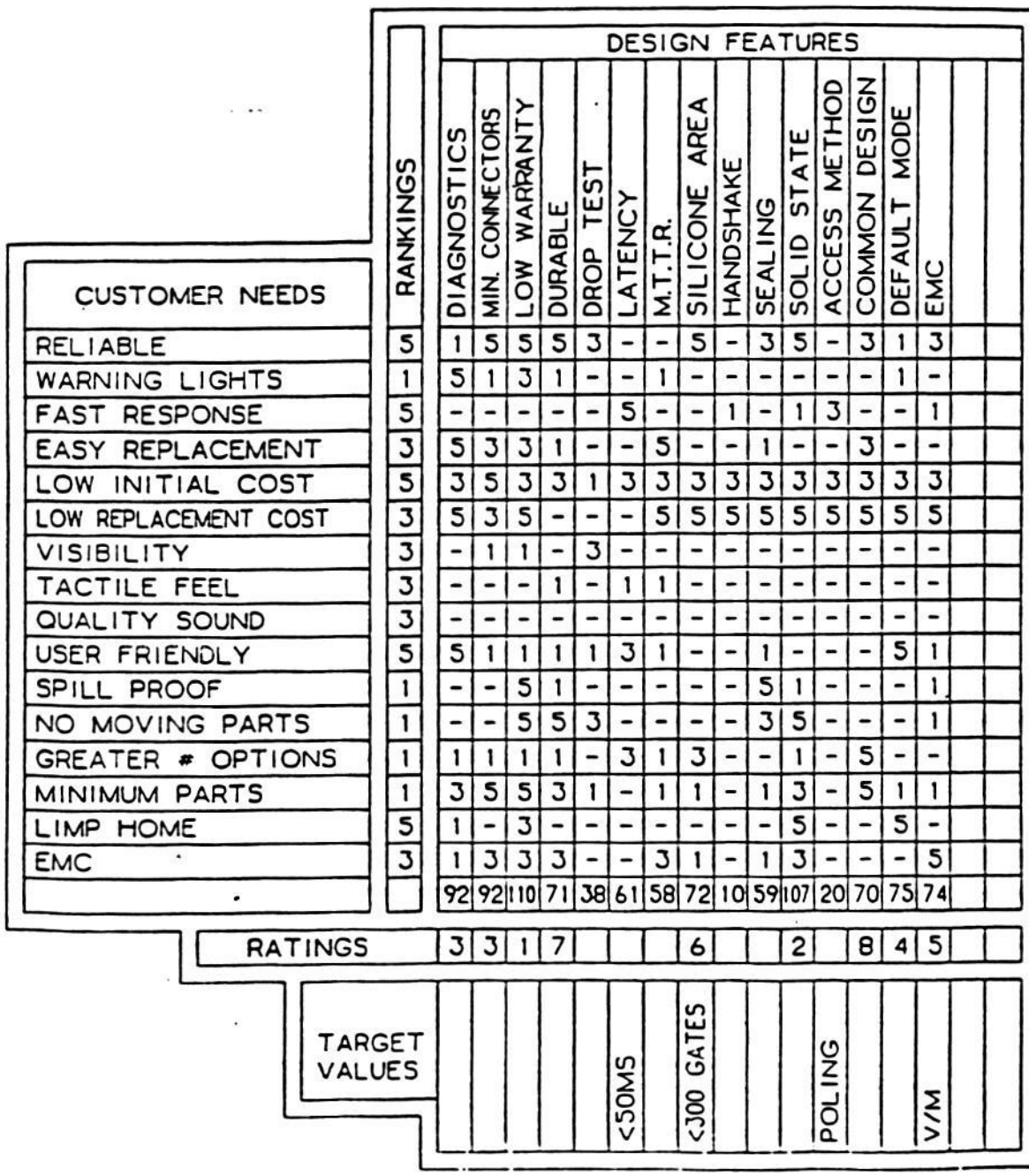
*SELECTED FOR HOUSE OF QUALITY "VOICE OF CUSTOMER"

MULTIPLEXING QFD STUDY

FEATURES	RANKINGS	CONCEPTS									
		C.S.C.	J1850/SAE	C.A.N/BOSCH	C²D	V.N.P.	ALENTE	A-BUS	U-ART	SPI	STD. HARNESS
DIAGNOSTICS	9	-	STANDARD	S							-
MIN. CONNECTORS	9	+		-							-
LOW WARRENTY	11	+		-							-
DURABLE	7	S		S							S
DROP TEST	4	S		-							S
LATENCY	6	+		+							+
M.T.T.R.	6	S		-							-
SILICONE AREA	7	+		-							+
HANDSHAKE	1	-		S							-
SEALING	6	S		S							-
SOLID STATE	11	S		S							-
ACCESS METHOD	2	S		S							+
COMMON DESIGN	7	-		-							-
DEFAULT MODE	8	S		S							-
EMC	7	+		-							-
RATINGS		23	0	-45							-38

CONCEPT SELECTION

MULTIPLEXING QFD STUDY



CUSTOMER NEEDS	RANKINGS	DIAGNOSTICS	MIN. CONNECTORS	LOW WARRANTY	DURABLE	DROP TEST	LATENCY	M.T.T.R.	SILICONE AREA	HANDSHAKE	SEALING	SOLID STATE	ACCESS METHOD	COMMON DESIGN	DEFAULT MODE	EMC		
		DESIGN FEATURES																
RELIABLE	5	1	5	5	5	3	-	-	5	-	3	5	-	3	1	3		
WARNING LIGHTS	1	5	1	3	1	-	-	1	-	-	-	-	-	-	1	-		
FAST RESPONSE	5	-	-	-	-	-	5	-	-	1	-	1	3	-	-	1		
EASY REPLACEMENT	3	5	3	3	1	-	-	5	-	-	1	-	-	3	-	-		
LOW INITIAL COST	5	3	5	3	3	1	3	3	3	3	3	3	3	3	3	3		
LOW REPLACEMENT COST	3	5	3	5	-	-	-	5	5	5	5	5	5	5	5	5		
VISIBILITY	3	-	1	1	-	3	-	-	-	-	-	-	-	-	-	-		
TACTILE FEEL	3	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-		
QUALITY SOUND	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
USER FRIENDLY	5	5	1	1	1	1	3	1	-	-	1	-	-	-	5	1		
SPILL PROOF	1	-	-	5	1	-	-	-	-	-	5	1	-	-	-	1		
NO MOVING PARTS	1	-	-	5	5	3	-	-	-	-	3	5	-	-	-	1		
GREATER # OPTIONS	1	1	1	1	1	-	3	1	3	-	-	1	-	5	-	-		
MINIMUM PARTS	1	3	5	5	3	1	-	1	1	-	1	3	-	5	1	1		
LIMP HOME	5	1	-	3	-	-	-	-	-	-	-	5	-	-	5	-		
EMC	3	1	3	3	3	-	-	3	1	-	1	3	-	-	-	5		
		92	92	110	71	38	61	58	72	10	59	107	20	70	75	74		
RATINGS		3	3	1	7				6			2		8	4	5		
TARGET VALUES							<50MS		<300 GATES				POLING			V/M		

MULTIPLEXING QFD PROGRAM

1. SYSTEM QFD

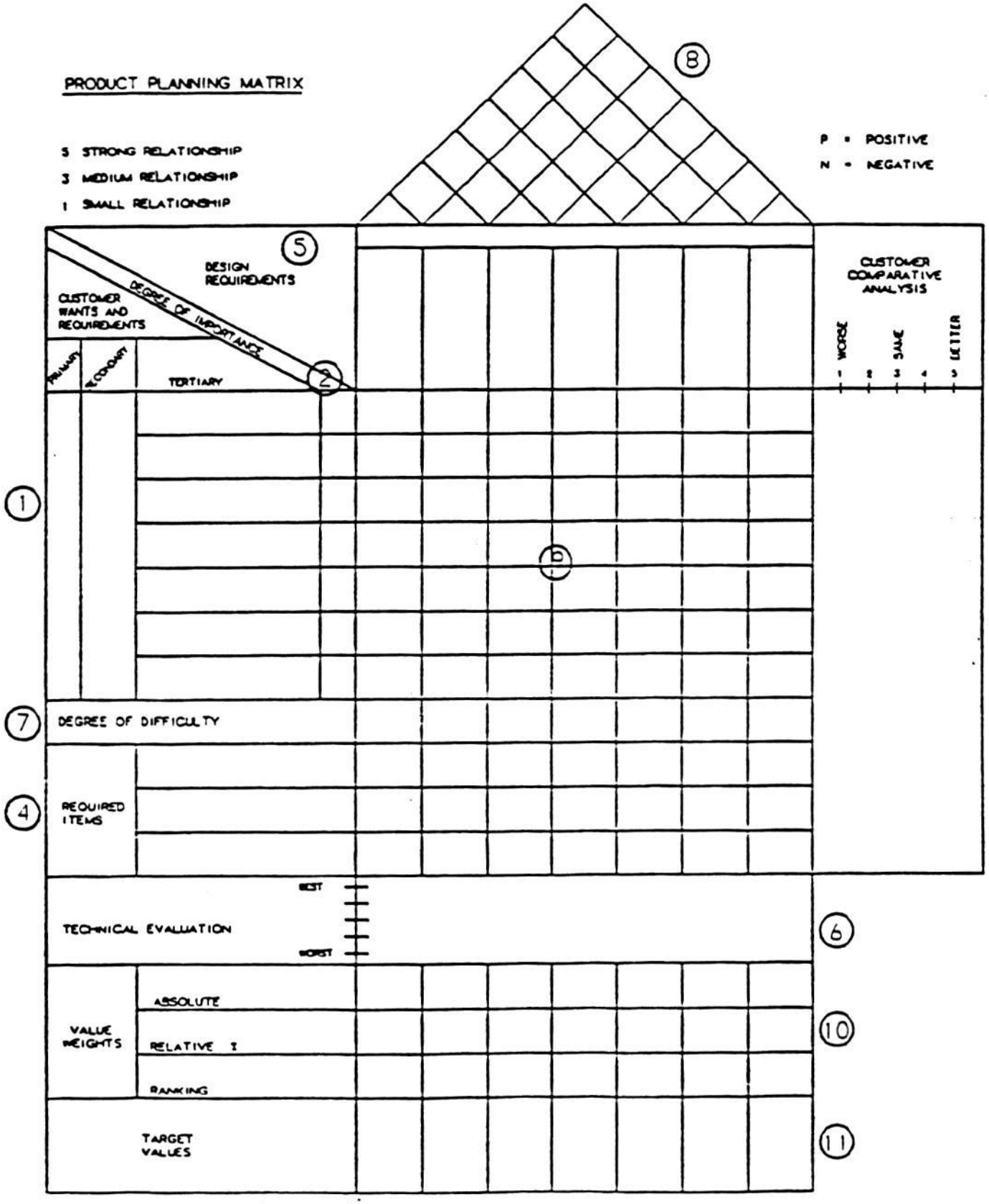
   -WHAT MULTIPLEXING SYSTEM IS MOST APPROPRIATE FOR CONVENIENCE SWITCHES?

2. COMPONENT QFD

   -DEFINE CUSTOMER NEEDS FOR CONVENIENCE SWITCHES.

3. COMPONENT QFD

   -WHICH SWITCH CONSTRUCTION IS MOST APPROPRIATE FOR CUSTOMER NEEDS AND FOR INTERFACING WITH THE MULTIPLEXING SYSTEM DEFINED ABOVE?


PRODUCT PLANNING MATRIX
5 STRONG RELATIONSHIP
3 MEDIUM RELATIONSHIP
1 SMALL RELATIONSHIP
P = POSITIVE
N = NEGATIVE
8
5
DESIGN REQUIREMENTS
CUSTOMER WANTS AND REQUIREMENTS
DEGREE OF IMPORTANCE
2
PRIMARY
SECONDARY
TERTIARY
CUSTOMER COMPARATIVE ANALYSIS
WORSE
SAME
BETTER
1
2
3
4
5
1
6
3
7
DEGREE OF DIFFICULTY
4
REQUIRED ITEMS
BEST
WORST
TECHNICAL EVALUATION
6
VALUE WEIGHTS
ABSOLUTE
RELATIVE %
RANKING
10
TARGET VALUES
11