Western Region:

Product Design As a Team Sport

Product design is increasingly recognized as the best opportunity to quickly improve all manufacturing operations. New acronyms—QFD, DFM, and others—signify world-class design practices. But most critical to overall success is redesigning the culture of manufacturing.

Dave Henrickson and the Target Staff

"Get ready, fire . . . aim." "A camel is a horse designed by a committee." "Designed beautiful, built ugly." "No time to do it right the first time, always time to do it over." Old corporate adages testify that historical attempts to unify and streamline product design have often been less than successful. In design, individual brilliance has gained media attention—Steve Jobs with the original Apple PC, Bill Lear with his Lear Jet, and many others. Even when the Burt Rutans of design are not stellar in technology, they often outshine functional buck-passers in consistency of design methods and objectives.

Today, competitiveness demands design-for-everything manufacturing *performance.* Design fit for use, design for manufacturability, design for maintenance—and design which is uniquely stylish, free of mistakes, and in the customers' hands in record time. This challenge was addressed by an AME design-to-market seminar in Portland, OR in August, 1989.

A new corporate adage is that the as-measured costs of product design are five percent of total cost, but the design itself affects 70 percent of total cost. Enthusiastic plant work forces can knock themselves out working on quality and productivity problems only to be stymied by pernicious, expensive-to-change designs.

Concerns with the design process boil down to three overlapping areas:

1. Design for quality—products and services that please customers
2. Design for manufacturability—cost and quality of the total process through the supply chain
3. Product introduction time—leadtime from concept to the customer.

None of these concerns is new. They were attacked 40 years ago by early champions of value analysis who first creatively analyzed the customer-desired functions of a product, and then attacked the process problems that prevented them from being simply achieved. Then as now, the major problem was not creativity, but organizational pigeonholing. Corporate managements sapped the power of value analysis by regarding it as merely the purview of one function such as industrial engineering. Value analysis had little impact except when top management spread its use through every function of the company.[1]

In the 1980s, new tools of analysis appeared: Quality Function Deployment (QFD) and Design for Manufacturability. However, the AME seminar revealed that the most basic human problem remains the same: how to transform product design processes into a team sport. Every organizational function from raw material suppliers to customers should participate with the team.

Quality Function Deployment

QFD is a system for *planning* products and services to meet customer needs and preferences—the voice of the customer—and potentially involve everyone in the chain of providing organizations. In a technical sense, QFD uses tables (or matrices) to examine in detail the relationships between various factors associated with the product or service. In an organizational sense, QFD identifies individual and team responsibilities. "Deployment of the Quality Function" calls for rigorous analysis and disciplined execution. Most practitioners of QFD regard it as one aspect of the overall quality philosophy known as Total Quality Control (TQC).

To perform QFD in depth, numerous individuals in an organization must learn to think carefully and deeply. Working through the tabular analyses demands root-cause reflectiveness. It is interactive, people-intensive analysis when contrasted with plugging data into a software package.

Human development to work in cross-functional teams for QFD is vital. Use of the matrices is no sign that a company is creating better designs, just as the existence of control charts is no sign that a company has its processes in statistical control. How the process is conducted determines whether QFD, or analyses similar to QFD, bear any fruit — another lesson from the AME seminar.

American manufacturers are learning QFD through several different channels. It is easy for a novice to be confused by specialized jargon used in one QFD course as opposed to another.[2] However, every QFD overview begins with a table frequently referred to as the "house of quality." This table has "substitute quality characteristics" on the horizontal axis and "customer demands" on the vertical axis. Others refer to the same table as displaying "final product characteristics" versus "customer requirements." Students soon learn to be careful creating definitions for analysis. Partitioning various aspects of customer requirements must be done thoughtfully. Diligence is also needed subdividing and classifying the characteristics of the product being designed.

One overview of the development of QFD matrices is in Fig. 1. The top table in the overview is the house of quality: final product characteristics compared with customer requirements. Cascading to the second matrix, product characteristics are used to derive part characteristics. The third matrix develops process, equipment, and control points from the part characteristics. In the fourth matrix, quality control procedures are in turn derived by studying their relationship with the process characteristics.

In this way customer requirements are translated into the technical needs which are thought necessary to fulfill them. The voice of the customer ("VOX") is thereby deployed into the detailed operations of the company. If it all seems exceedingly meticulous, that is intended. The purpose is to figure out how to satisfy the customer in every detail that can be uncovered.

According to Robert M. Adams of Rockwell International, most QFD processes in American companies never go beyond the first matrix, relating customer requirements to product characteristics. However, this table usually has several appendages. Quality characteristics are compared with competitors. An outline of a quality plan to overcome the perceived weaknesses may be sketched out. A fully-loaded house of quality table may be one of the most sensitive documents a company possesses. If it fell into the hands of competitors, damage would be severe. Therefore, all the examples used in classes and meetings are either fictional or too dated to be of value. *Target* cannot publish a live example.

Detailed analysis through the matrices is time consuming. Conceptual planning time is much extended by QFD. However, the overall design-to-market time should be cut because the design effort focuses on the most important areas.

Although Japanese have been using QFD longer, even in Japan half or fewer of all QFD processes are believed to progress beyond the first house of quality matrix. Detailed analysis through the matrices is time consuming. Conceptual planning time is much extended by QFD. However, the overall design-to-market time should be cut because the design effort focuses on the most important areas. The initial design should be closer to customer target and relatively free of unexpected glitches that must be revised — often at great tooling expense.

Aside from developing close organization and patience, one of the major demands (and benefits) of QFD is that it reinforces detailed study of customer requirements. There are many ways to extract data on customer requirements. For example:

- Customer surveys
- Matrix data analysis
- Segmentation of customers' views
- Customer complaints and returns data
- Failure analyses
- Panel tests of customer trials
- Or plain, old focus group sessions.

Without doubt, QFD forces companies to clarify information they obtain from customers: what they obtain, how they get it, and in what detail.

QFD analyses commonly refer to different kinds of customer satisfaction. The most basic kind is "one dimensional quality." If a customer experiences it, they are happy; if not, they are displeased. Another kind is expected quality. A car buyer expects brakes to be highly reliable, and is displeased, to put it mildly, if brakes fail. These classifications of quality are determined by asking for both positive and negative feelings about attributes of quality and comparing answers, as shown in Fig. 2.[3]

The kind of quality everyone would like to design into a product is exciting quality — the kind the customer did not anticipate. Ford calls it "things gone right" as opposed to "things gone wrong." To have exciting quality, a company must anticipate the evolving expectations of the customers, giving them what they want shortly before they themselves realize they need it. As Bob Adams of Rockwell points out, features such as anti-lock brakes may be exciting quality now, but expected quality five years from now.

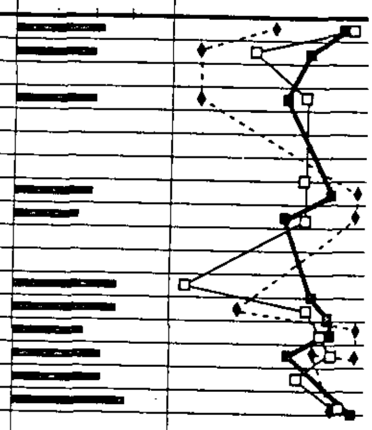
Adams also notes that customers cannot describe quality characteristics they have never seen, never heard about, and perhaps cannot imagine. In this case, the design team has to put itself in the place of the customer, trying to project reactions to possibilities the customer cannot comprehend. Adams uses the example of Sony and the Walkman to make the point. There was no way to do a detailed analysis on the first Walkman. Sony brought it out and immediately began work on a smaller, lower-priced version. So far as is known,

▷

Quality Deployment Tables

1. House of Quality Table (Customer Requirements to Product Characteristics)

Customer Requirements \ Characteristics	Performance – Swing Char. – Swing Weight	Performance – Swing Char. – Shaft Deflection	Performance – Shape Characteristics – LCFT Angle	Shape Characteristics – Lie Angle	Shape Characteristics – Bounce Angle	Shape Characteristics – Head Resist.	Appearance – Grip Hardness	Appearance – Finish – Head Surface	Finish – Head Poros	Finish – Shaft	Finish – Face Pattern	Markings – Stamp Depth	Markings – Paint Adhesion	Reliability – Fatigue Life	Reliability – Wear Resist.	Safety – Pull-off	Safety – Torque	Customer Importance	Competitive Rating
Gets Ball Out – Sand – Dry	●	▲	●	○	●	▲									▲				
Gets Ball Out – Sand – Wet	●	▲	●	○	●	▲									▲				
Gets Ball Out – Sand – Sloping	▲	▲	●	●	●	▲									▲				
Gets Ball Out – Sand – Buried In	●	▲	●	○	●	▲		▲			▲			▲	▲		▲		
Gets Ball Out – Other – Tall Grass	●	▲	●	○	▲						○			▲			○		
Gets Ball Out – Other – Short Grass	○	▲	○	▲	○						▲								
Gets Ball Out – Other – Hard Surf	○	○		▲	●										○				
Acts Right – Produce Backspin	○	▲	●	○							●								
Acts Right – Doesn't Dig In	▲		○		●	▲		▲			▲			○	▲		▲		
Acts Right – Ball Travel – Sand	●	○	●	▲	▲														
Acts Right – Ball Travel – Fairway	●	○	●	▲	▲						▲								
Acts Right – Forgiving – Partial Swing	○	○	▲	▲	●	▲	▲				▲								
Acts Right – Forgiving – Swing Depth	○	○	▲		●	▲	▲												
Feels Right – Grip Comfort	▲						●												
Feels Right – Weight – Distribution	●	●			▲														
Feels Right – Weight – Total	●													▲					
Meets PGA Rules		▲	▲	▲	▲		●				●	○							
Life – Corrosion Resistance							○	●	●			○							
Life – Damage Resistance			▲		○			▲	▲	▲				●	●	●	●		
Safety – Head Stays On	○								▲	○						●	●		
Characteristic Target Values	LPGA Std.	Defl. PGAs	56°	64°	10° 6°	Drag Coeff. 4.8 3.1	Duro-meter 4.1	60 V	Visual Std.	Chr. thick-ness .0008 finish 308	X5 X3	.020	Pull off guage	3000 cycles	Rc 45	520 lbs.	2500 in-lbs.	Mfg. Cost Targets 6.50	
Components:																			
Head	●		●	●	●	●		●	●		●	●	●	○	●	●	●	1.50	
Shaft	●	●								●				○		●	●	1.50	
Grip	▲						●									●	▲	.50	
Assembly																●	●	1.00	



● Strong Relationship
▲ Moderate Relationship
○ Possible Relationship

■ —— U.S.
□ —— Competitor A
♦ - - - - Competitor B

4. Q.C. Process Chart

(Process Characteristics to Quality Control Characteristics)

Part	Process	Control Item	Control Instructions	Effects	Control Methods – Control Chart	Control Methods – Sampling	Inspection Method
Head	Inj. Mold	Mold Temp. 45°F ±2°	Adjust chiller temp.	Porosity (head finish)	Check sheet	2/hour	Thermocouple (Gauge)
		Wax Temp. 140°F ±5	Add wax and adjust heater	Hold fill (part shape) Pattern softness	Circular chart	2/hour plus when wax is added	Thermocouple (Gauge)
		Loft angle 56°F ±1/2°	Review pattern handling methods and increase dwell	Loft angle	$\overline{X}$ - R	n=5 every 2 hour	Loft gauge (Gauge)
		Scratches	Review die handling procedure	Finish	np	n=50 every 4 hours	Visual sample (Gauge 1 %48)

Fig. 1. Quality Deployment Tables

2. Component Deployment Table

(Product Characteristics to Part Quality Characteristics)

Part	Final Product Characteristic	Part Quality Characteristics
Head	Bounce Angle	Angle A Radius C Dimension X
	Drag Coefficient	Angle A Angle B Dimension Y
	Face Pattern	Pattern Dimension Hole Depth

A part deployment table can be constructed for each component of the product. (Complex products may be analyzed by first constructing a similar table for each sub-assembly.)

The relationships shown at the bottom of the quality table determine which final product characteristics apply.

Part quality characteristics are dimensions or features of the part that are critical in determining the function of the product. (The drag coefficient is determined by two angles and a dimension on the golf club head.) These are identified through experimentation.

3. Process Planning Table

(Part Quality Characteristics to Process Characteristics)

Process	Equipment	Part Characteristics								Process Control Pts.
		Angle A	Angle B	Radius C	Weight	Porosity	Dim X	Dim Y	Hole Depth	
Inj. Molding (helix)	Machine II	◎			◎	◎	◎	◎	◎	Temp., pressure, time, material, die, damage/scratches
Tree Build	Assembly stations 1 lot plat	○				◎				Temp. (ambient) Part damage
Ceramics	Etch tank Robot Slurry pots 1 & 3				◎	◎	△	△	◎	Humidity, time, temp., material (sand, etching), slurry viscosity
Melt Out	Autoclave					◎				Temp., time
Casting	Furnace mfg.				○	◎			◎	Time, temp. (furnace), metal temp., pour rate
Knock Out & Cut off	Power hammer Band saw	◎	◎							
Finish	Sand blaster, reamer, grinder, polisher	◎	◎	◎	◎		○	○	◎	Grind limits (attributes), angle measurement, visual sample

Adapted from training materials of Chris Fosse, Blount, Inc. ▷

Sony does not employ QFD in the formal sense. The company has, however, used informal means to deploy the voice of the customer (VOX) throughout the design process and throughout other processes within Sony.

In any case, the most important aspect of QFD is probably not the matrices, but VOX. It comes from "Vox Emptoris," Latin for Voice of the Customer," replacing "Caveat Emptor," or "Let the Buyer Beware." This new buzzword may be destined to become the symbol of the 90s. By any method, formal or informal, the objective is to detail the VOX in every operation of the company.

Design for Manufacturability

If the objective of QFD is to please the customer, the focus of Design for Manufacturability (DFM) is to provide quality at a price that will also delight the customer. DFM is less a specifically-defined technique than an umbrella term for a collection of practices that, taken together, create designs to simplify overall operations.

DFM intersects QFD most directly in the transition shown in the third matrix down in Fig. 1, the transition from part characteristics to the processes, equipment, and controls necessary to make them. However, all the way through the QFD tables, thorough analysis begs answers to the kinds of questions posed by DFM considerations.

One can classify the concept of robust design as part of DFM. Robust design is the use of analysis and ingenuity, and perhaps design of experiments, to confine the demands of a product design for miniscule process variances to only a few places where mini-variance really counts.

Design for Assembly is now commonly practiced among the world's better manufacturers. Most have some system to encourage engineers to make maximum use of common parts. Other objectives of designing for assembly are well-known. Avoid the use of: extra parts, especially moving parts; varieties of material; fasteners, particularly screws or threaded bolts; parts that need adjusting or inspecting; complex parts; delicate parts, and so forth.

As pointed out by Dave Brown of Tektronix, by designing product families we promote commonality of processes, and also make forecasting easier. Family aggregates are easier to forecast. In addition, response to customers is improved by designing so that unique product differentiation is added at the end of the process. An example is adding optional feature boards to computers — at the time of installation on the customer's site.

Popular also are designs that avoid expensive, messy processes. For example, replace chrome plated parts with parts coated with polymers. Then a "trouble process" like chrome plating can be designed out of product lines.

Many DFM decisions do not depend on cost comparisons. However, trade-offs often require numerical comparisons — at least ratios, if not cost numbers. Here

Type of Quality	**Dominant reaction of customers if condition is:** ***Present***	***Not Present***	**Examples from Hotels**
One-Dimensional	Like it	Don't like it	Helpful attitude of desk clerk
Expected	Expected, or don't notice	Don't like it	Clean room, hot water
Exciting	Like it	Don't notice, or accept it	Fruit basket in room
Unappreciated	Expected, or don't notice	Don't notice, or accept it	Flexible room layouts easily changed or remodeled

Fig. 2. *Classifying results of listening to the voice of the customer. (Adapted from the work of Dr. Noritake Kano.) The type of quality associated with a design feature is a good guide to its priority in product and process development.*

DFM teams run into that old bugaboo, standard cost systems apportioning big overhead pools to direct labor or direct machine hours. With new cost systems, engineers will need to sort out the relevant items to cost rather than accept a "magic number." Without waiting on a different cost system, however, rough cost comparisons are possible by just looking at resource use in three major categories.[4]

1. *Functional costs:*
   The normally-assigned cost of making and assembling parts. Functional costs themselves are strongly driven by the total number of parts and the total number of processes necessary to manufacture a new design. (Minimize special parts and non-standard routings.)

2. *Variety costs:*
   Special parts rather than previously-used parts increase cost of a design by adding tooling and sometimes by adding equipment. Non-standard processing sequences also inhibit possibilities to simplify and automate. (Minimize special parts and non-standard routings.)

3. *Control point costs:*
   The cost of control itself is related to the total number of control points required for complete manufacture, including that done by suppliers. Many control points can be identified by flow charting engineering data, materials, customer orders, and supplier operations. Processes with stops for counting, quality, cost recording, and other purposes are loaded with opportunities to avoid waste. Simple processes with few stops also lead to simpler quality assurance. (Minimize the number of control points.)

Just-in-Time Artistry

One frequent objection to improving design methods is that rationalizing the creative process can turn it into prosaic drivel. Bob Stasey of Coopers & Lybrand refutes that notion, citing an illustration from a client, a small greeting card company bobbing along in Hallmark's wake. The small company cut its greeting card introduction time, from concept development to retail rack, from 18 months to six months for everyday cards by computerizing and "Kanbaning" its creative processes.

With a reduced leadtime and improved artistic productivity, the company now has an opportunity to change its total card line every year, based on the prior year's trends. That's better than revising half the line each year based on data two years old. While direct dollar savings were crucial to keeping the company in business, this flexibility to respond to market changes is the most impressive result. Artists have twice as many opportunities to respond to consumer preferences.

Cards are created in stages:

1. Development of product line mix
2. Theme development for a line of cards
3. Lettering a message
4. Photography or artwork
5. Creative checking (that lines are suitable, compatible, and complete).

Some cards require both photography and artwork; most need only one of the two. Work on cards is done on media which are mounted on frames large enough to fit printing presses. Frames transfer between operations.

Mounting similar cards on each frame, employees use frames as the basis for transfer of roughly similar blocks of work between each of the work stations for creative processes. In the company's Kanban system, each station transfers empty frames back to the previous station to pick up more full frames. Work is done in FIFO (first in, first out) order, not according to an artist's personal preference.

All the cards in a given card line should emerge from the process about the same time to allow printing, packing, and shipping on schedule.

Setup times on the presses were reduced by two-thirds. Thus, printing lot size and throughput time in printing decreased.

Another boon to timely design: Artwork is stored on computers. Suppose an artist plans to create a card with roses. A search of the system may turn up a design similar to the desired illustration. On the computer, the rose images are quickly altered in size, color, intensity, and configuration — becoming a finished product in minutes rather than hours of detailed drawing.

Card design quality has improved. Although the company is not advanced in TQC, faster feedback between functions clarifies communications and cleans out mistakes faster. Employee involvement using cause-and-effect diagrams have reduced the number of completed cards scrapped.

As in other examples, the most important change is in the attitude of the card company employee. Faced with a company crisis and the prospect of unemployment, people transformed themselves from top to bottom, learning to break down barriers between fellow workers.

The new approach eliminated the need for a complex work-in-process control system — which had been under consideration — and the artists like it better for three reasons:

1. Because of smoother flow and shorter leadtime, management rarely needs to expedite artistry — creativity is less pressured.
2. Assigning work by the FIFO rule eliminated feelings of favoritism parceling out choice jobs.
3. Improving communication between theme development and the artists created both a better product and artists who are enthusiastic about coming to work in the morning.

In practice, all discussions of DFM as well as QFD refer to the word "team" — cross-functional teams. To many companies, simultaneous design across several functions is a venture into a new world. Even those who have had cross-functional teams operating for some time still do not feel comfortable with the new way of life.

Time-based Design Competition

Shortening design time depends on designing right the first time. Listening to VOX extends planning, but done thoroughly, the execution stages of new product development take minimal debugging. If a design has half the parts and processes of an old one, it should not only take less time for material to flow through the production process, it should take less time to set up the production process — both by the designing company and by its suppliers.

According to Chris Fosse of Blount, Inc. (Omark), allowing time for QFD to work its way has been frustrating. Instinct is to stop planning and get on with it, but stretch out product introduction time patching up oversights. But as Fosse says, patience pays. "Every project has resulted in significant discoveries about customers and performance . . . some teams have reported that they were able to decide in about an hour what used to take weeks to decide."

However, design work is itself a process. Administrative processes — even creative ones — can be improved through the same logic as production processes. Sometimes it is even possible to "JIT" (Just-In-Time) a design process, as illustrated in the accompanying box copy.

Redesigning Our Culture

The Portland Seminar on Design-To-Market came to an important conclusion. There is no magic formula. QFD and DFM do not represent techniques to be acquired. They represent ways of life — behaviors you *do*, differently. From chain saw blades to desk top printers and truck axles, the message

▷

is the same: Integrating VOX into designs is vital. Doing so with manufacturable designs is harder than almost anyone imagined. Doing it well takes nothing less than a shift in corporate culture.

"A fundamental change must occur in your company culture and in the way you conduct business."

As Bob Adams of Rockwell expressed it, "A fundamental change must occur in your company culture and in the way you conduct business. We found that QFD not only precipitated a cultural change, but its form had to be modified and integrated into our way of doing business."

Rockwell originally began QFD for two reasons. First, competitive pressures created demand for a product with higher quality, higher reliability, and also lower price at the same time. There was no way to meet those objectives simultaneously without becoming smarter. Second, Ford, a major customer, asked Rockwell to participate in QFD with them, and later the other two major auto companies also began to practice QFD.

Bob Adams describes the advent of QFD at Rockwell as part of a broader experience in overall business improvement. There are many other aspects to Rockwell's overall quality process. QFD, like other three-letter "isms," is a booster pushing the organization further and further on a road of performance improvement. To gain the benefits of QFD, Rockwell had to engage in a process that will ultimately change the way they do business. Adams advises others not to be misled that QFD is a quick fix for long-standing problems. Like other parts of performance excellence, QFD contributes to continuous improvement, provided the company invests in human change. To interlock all these parts, companies need to carefully and deliberately reconstruct their culture.

As Adams sees it, culture change consists of four major attitude adjustments necessary for QFD to become viable. First, a company must actively seek the input of its customers to enter into its design process, avoiding hunches and second guesses if at all possible. Second, the concept of the internal customer must become reality. Third, the organization has to develop an abhorrence for waste, and look beyond narrow departmental responsibilities to seek it. And fourth, there must be faith that the initial increase in planning required will shorten the overall product development leadtime and decrease the total cost of quality.

Adams suggests that performance measures, including those used for top executive bonuses, should focus on the top priorities of the new mindset: quality improvement and customer satisfaction. Like everyone else, Rockwell is still in the throes of this cultural transformation.

Adams also emphasized that "generic QFD" could not be dropped into Rockwell. In the beginning, the QFD facilitators were only half a lesson ahead of stu-

Forty Things To Do For More Competitive Product Designs

Throughout the presentations at AME's Design-to-Market seminar, attendees anonymously wrote their ideas on the overall theme and various topics on small slips of paper and gave them to an analyst. By the end of the presentations, 942 responses had been collected. (This is called the "Crawford slip technique" — really.)[6] Some of the slips were the usual engineer's complaint about never "freezing" designs and so on, but many demonstrated breaks with old thinking.

The next day, the comments on the slips had been transcribed as originally written and given to work groups of participants to trigger their group discussions. The work groups concentrated on what needs to be done to make product design and product introduction more competitive. From all this collective hubbub emerged THE LIST, the collective wisdom of the participants at the seminar after distilling it down into a manageable framework.

Management Commitment

1. Develop vision — a clear-cut product strategy and a theme everyone can rally around.
2. Revise organization structures; empower teams to make decisions.
3. Match the number of projects under development with the available resources. (Don't overcommit.)
4. Review development *methods* as well as progress.
5. Adopt supportive recognition and reward systems.
6. Key to reducing design leadtimes: completing work at the right level.

Marketing

7. Use QFD and segment the market.
8. Through QFD validate that a market segment exists.
9. Involve customers in market research.
10. Define customer needs, matching their needs and your capabilities.

Systems and Techniques

11. Define a standardized formal development process with detailed up-front planning.
12. Create a prevention-oriented system.
13. Use design of experiments (DOE) and/or process modeling.
14. Use technical analysis and risk management (QFD and DFM plus more).
15. Use CAD/CAM (Computer Aided Design/Computer Aided Manufacturing). Electronically transfer part geometry to suppliers.

Organization

16. Develop cross-functional teams. They are *necessary.*
17. Involve *all* cross-functional team members *early* in the project.
18. Establish strong project leaders (not coordinators without resources).
19. Clarify team and project goals (and boundaries).
20. Empower the teams to do the planning. All team members should agree to tasks in the plan.
21. Allow teams to contact customers.
22. Consider "cradle to grave" product responsibility for teams if product life cycles are short.
23. Measure performance of teams, then of individuals within the teams.
24. Establish feedback mechanisms for information flow.
25. The company recognizes the team, then teams in turn recognize individuals.
26. Recognize and reward behavior as well as results. Stop rewarding fire-fighting.

Development of People

27. Initiate and sustain culture change from the top.
28. Expect different rates of progress for different projects and different teams.
29. Create an environment of openness, teamwork, and continuous improvement.
30. Focus training on quality, teamwork, and an orientation to the customer.
31. Emphasize training of project managers and process facilitators.
32. Train thoroughly on the tools at the rate employees can accept and use them.

Suppliers

33. Reduce their number and establish long-term trust with the remainder.
34. Select suppliers based on 1.) ability to control both their design process and production processes, 2.) technical ability, 3.) delivery, 4.) financial stability, and 5.) price.
35. Establish clear expectations of suppliers; train them if necessary.
36. Commit *early* that suppliers have the job.
37. Involve suppliers throughout the design process.
38. Use supplier expertise. Design to their process.
39. Develop software in parallel with hardware.
40. Share cost savings and overruns with suppliers.

dents, and they soon realized that in order for the majority of managers, engineers, and others to accept QFD, the concepts had to be adapted to Rockwell. Everyone could more easily see how QFD could apply to Rockwell products and other processes after examples, terminology, and benefits were tailored to their experience.

The benefits came slowly. Some of Rockwell's early benefits were of the mixed kind. One version of a product which was nearing launch was cancelled because newly-applied QFD analysis revealed that it failed to meet several key requirements derived from VOX. Better to enter a market later than enter with a flop. This experience also made a deep impact on Rockwell's "cultural habits." Previously, entries to the market were prodded and hurried, not delayed.

Unproductive hurry-and-debug instincts were major "cultural" impediments that Rockwell found difficult to change. Managers and engineers often operated under the misconception that they possessed the one-and-only-quick-and-dirty secret responsible for Japanese success. They wanted results without patiently going through the entire change process — including soothing of the inevitable cultural indigestion.

Changes at Blount, Inc. (formerly Omark Industries)[5]

Chris Fosse recalls the beginning of QFD at what was then Omark. Most engineers were all for it because QFD would force the marketing types to stop their creative waffling and work with data — like engineers. The marketers themselves held mixed feelings. Some saw QFD as a shiny new way to romance the customer. Others saw QFD as an attempt to impose engineering on a product idea too early in its concept, thus hampering creativity or failing to make use of existing field experience with customers.

Five years later, some of QFD's early detractors have become champions of the process. Through QFD, many people who previously would not have had the opportunity to be involved can now exercise a measure of creativity. Fosse is not sure whether total product introduction time has yet been cut by QFD. All major products are now designed using QFD, and project records prior to QFD were not very precise.

The major benefit at Blount is that QFD has allowed the company to set far more aggressive design goals than five years earlier. Seen from the current perspective, new product goals of five years ago seem soft, mushy, and easy — and product development times have not increased. More specifically, development teams have been forced to confront the facts of customer satisfaction and deal with process changes necessary to improve customer satisfaction.

As at Rockwell, QFD is only part of Blount's overall quality improvement program, and part of the overall culture change. However, one culture change specific to QFD was the creation of strong cross-functional product development teams. Prior to QFD, the company had used a "weak project

▷

manager system" for product development. Project managers had no resources to control, but acted as coordinators guiding each product development across functional department fences.

After QFD incorporation, product development is conducted by a defined team having more access to resources. The only organizational factor that has since correlated with success was the functional identity of the project manager. Projects led by engineers were less successful — at least in the beginning. Projects led by marketers were more successful. The reason is that the early steps in QFD depend on marketing — the understanding of VOX. If the understanding of VOX is not done well, neither is any later activity.

As the QFD planning moves along, engineers and product team members devise the parts and processes, but marketing is involved in more steps of the QFD process than any other function.

After five years' experience with QFD, Blount now has engineers who can successfully lead a product development team. They have a much better appreciation of the value of market research, and much better understanding of the methods by which customer satisfaction data can be obtained. One of the great benefits of QFD has been educating a great number of employees about the value of concern for the customer.

A set of complex social skills as well as intellectual skills must be developed to actually reduce the time to design and introduce a superior product. On such a subject, the preaching can continue ad infinitum and ad nauseam. The conclusions of the AME Design-to-Market seminar (in box copy) is a concise and relatively complete list of things to do in the cause.

[1]For example, Art Mudge quoted in "Larry Miles and Value Analysis: 'Blast, Create, Then Refine,'" by Lea Tonkin, *Target*, Winter 1987, p. 17.

[2]Training is offered by several of the larger manufacturing companies and several consulting companies. The best-known training is conducted by the American Supplier Institute, Dearborn, MI and GOAL/QPC, Methuen, MA.

[3]These classifications of quality originated with Prof. Noritake Kano, as described in *Better Designs in Half the Time*, by Bob King, published by GOAL/QPC, Methuen, MA, 1989.

[4]This framework of cost analysis is liberally lifted from *Variety Reduction Program*, by Kodate and Suzue, a forthcoming book translation by Productivity Press, Cambridge, MA.

[5]Omark Industries has been featured in several stories as exemplary in their pursuit of continuous improvement. However, the Omark name is now used in only one division. Omark is owned by Blount, Inc. Early in 1989, Omark Industries ceased to exist as a separate subsidiary of Blount, Inc. The Omark headquarters operations were folded into the Blount headquarters operations. The same Omark product lines and plant operations continue as before.

[6]For more information, contact Dr. Robert Krone, University of Southern California, Productivity Network University Park VKC 368, Los Angeles, CA 90089–0041, 213/743-2241.

Author:
Dave Henrickson is manager, Western Region, Motorola Training and Education Center, Phoenix, AZ.