3-3 QUALITY FUNCTION DEPLOYMENT

Quality function deployment (QFD) is a planning tool that focuses on designing quality into a product or service by incorporating customer needs. It is a systems approach involving cross-functional teams (whose members are not necessarily from product design) that looks at the complete cycle of product development. This quality cycle starts with creating a design that meets customer needs and continues on through conducting detailed product analyses of parts and components to achieve the desired product, identifying the processes necessary to make the product, developing product requirements, prototype testing, final product or service testing, and finishing with after-sales troubleshooting.

QFD is customer driven and translates customers' needs into appropriate technical requirements in products and services. It is proactive in nature. Also identified by other names—*house of quality, matrix product planning, customer-driven engineering*, and *decision matrix*—it has several advantages. It evaluates competitors from two perspectives, the customer's perspective and a technical perspective. The customer's view of competitors provides the company with valuable information on the market potential of its products. The technical perspective, which is a form of benchmarking, provides information on the relative performance of the company with respect to industry leaders. This analysis identifies the degree of improvements needed in products and processes and serves as a guide for resource allocation.

QFD reduces the product development cycle time in each functional area, from product inception and definition to production and sales. By considering product and design along

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with manufacturing feasibility and resource restrictions, QFD cuts down on time that would otherwise be spent on product redesign. Midstream design changes are minimized, along with concerns on process capability and post-introduction problems of the product. This results in significant benefits for products with long lead times, such as automobiles. Thus, QFD has been vital for the Ford Motor Company and General Motors in their implementation of total quality management.

Companies use QFD to create training programs, select new employees, establish supplier development criteria, and improve service. Cross-functional teams have also used QFD to show the linkages between departments and thereby have broken down existing barriers of communication. Although the advantages of QFD are obvious, its success requires a significant commitment of time and human resources because a large amount of information is necessary for its startup.

QFD Process

Figure 3-5 shows a QFD matrix, also referred to as the **house of quality**. The objective statement delineates the scope of the QFD project, thereby focusing the team effort. For a space shuttle project, for example, the objective could be to identify critical safety features. Only one task is specified in the objective. Multiple objectives are split into separate QFDs in order to keep a well-defined focus.

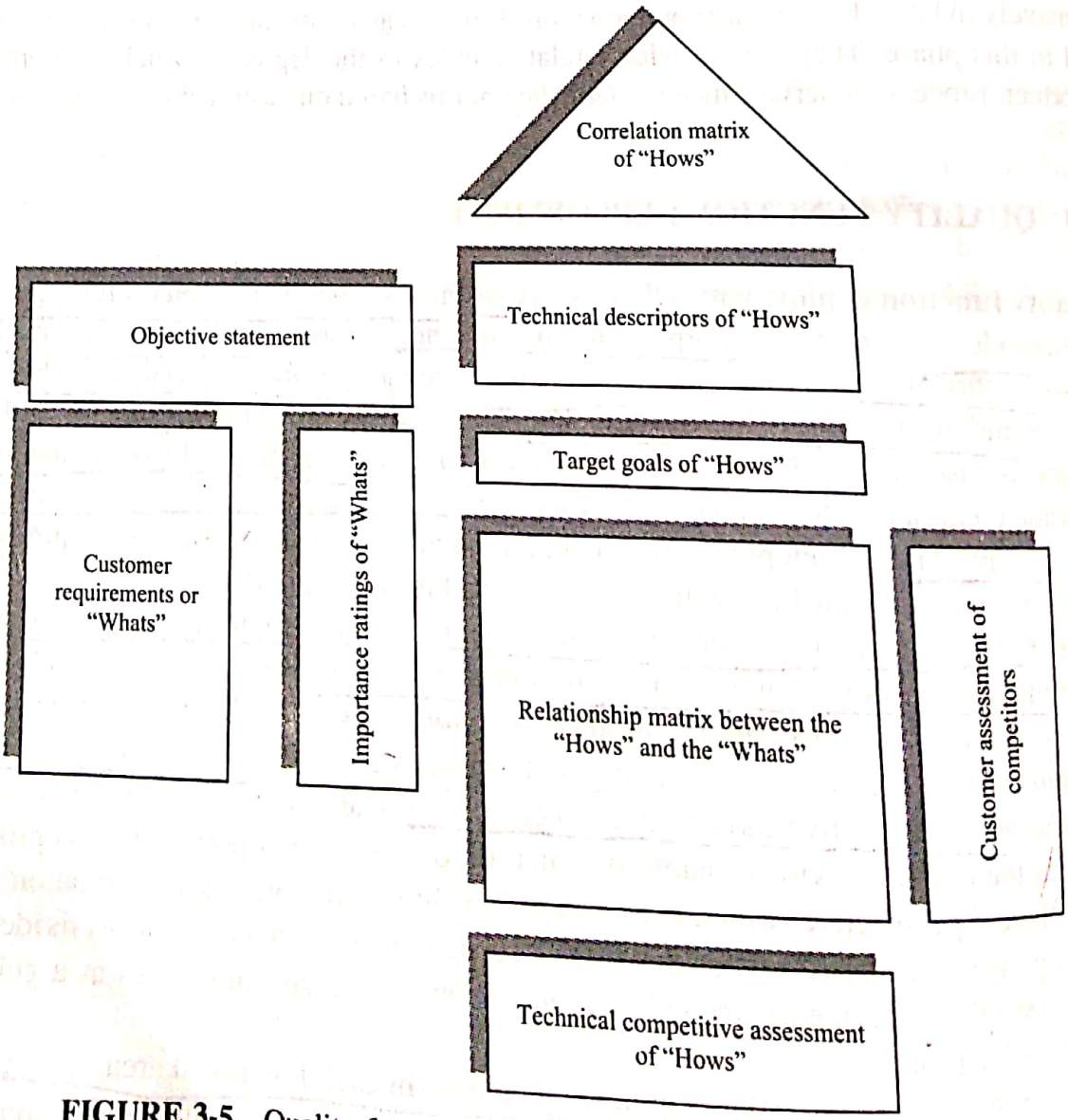

FIGURE 3-5 Quality function deployment matrix: the house of quality.

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TABLE 3-1 Importance Rating of Credit-Card Customer Requirements

Customer Requirement ("Whats")	Importance Rating
Low interest rate	2
Error-free transactions	5
No annual fee	1
Extended warranty at no additional cost	3
Customer service 24 hours a day	4
Customers' advocate in billing disputes	4

The next step is to determine customer needs and wants. These are listed as the "whats" and represent the individual characteristics of the product or service. For example, in credit-card services, the "whats" could be attributes such as a low interest rate, error-free transactions, no annual fee, extended warranty at no additional cost, customer service 24 hours a day, and a customers' advocate in billing disputes. The list of "whats" is kept manageable by grouping similar items. On determination of the "whats" list, a customer importance rating that prioritizes the "whats" is assigned to each item. Typically, a scale of 1 to 5 is used, with 1 being the least important. Multiple passes through the list may be necessary to arrive at ratings that are acceptable to the team. The ratings serve as weighting factors and are used as multipliers for determining the technical assessment of the "hows." The focus is on attributes with high ratings because they maximize customer satisfaction. Let's suppose that we have rated attributes for credit-card services as shown in Table 3-1. Our ratings thus imply that our customers consider error-free transactions to be the most important attribute, and the least important to be charging no annual fee.

The customer plays an important role in determining the relative position of an organization with respect to that of its competitors for each requirement or "what." Such a comparison is entered in the section on "customer assessment of competitors." Thus, customer perception of the product or service is verified, which will help identify strengths and weaknesses of the company. Different focus groups or surveys should be used to attain statistical objectivity. One outcome of the analysis might be new customer requirements, which would then be added to the list of "whats," or the importance ratings might change. Results from this analysis will indicate what dimensions of the product or service the company should focus on. The same rating scale that is used to denote the importance ratings of the customer requirements is used in this analysis.

Consider, for example, the customer assessment of competitors shown in Table 3-2, where A represents our organization. The ratings are average scores obtained from various samples of consumers. The three competitors (companies B, C, and D) are our company's competition, so the maximum rating scores in each "what" will serve as benchmarks and thus the acceptable standard towards which we will strive. For instance, company C has a rating of 4 in the category "customer service 24 hours a day" compared to our 2 rating; we are not doing as well in this "what." We have identified a gap in a customer requirement that we consider important. To close this gap we could study company C's practices and determine whether we can adopt some of them. We conduct similar analyses with the other "whats," gradually implementing improved services. Our goal is to meet or beat the circled values in Table 3-2, which represent best performances in each customer requirement. That is, our goal is to become the benchmark.

Coming up with a list of technical descriptors—the "hows"—that will enable our company to accomplish the customer requirements is the next step in the QFD process.

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TABLE 3-2 Customer Assessment of Competitors

	Competitive Assessment of Companies			
Customer Requirements ("Whats")	A	B	C	D
Low interest rate	3	2	④	2
Error-free transactions	4	⑤	3	3
No annual fee	⑤	⑤	2	3
Extended warranty at no additional cost	2	2	1	④
Customer service 24 hours a day	2	2	④	3
Customers' advocate in billing disputes	④	2	3	3

Multidisciplinary teams whose members originate in various departments will brainstorm to arrive at this list. Departments such as product design and development, marketing, sales, accounting, finance, process design, manufacturing, purchasing, and customer service are likely to be represented on the team. The key is to have a breadth of disciplines in order to "capture" all feasible "hows." To improve our company's ratings in the credit-card services example, the team might come up with these "hows": software to detect errors in billing, employee training on data input and customer services, negotiations and agreements with major manufacturers and merchandise retailers to provide extended warranty, expanded scheduling (including flextime) of employee operational hours, effective recruiting, training in legal matters to assist customers in billing disputes, and obtaining financial management services.

Target goals are next set for selected technical descriptors or "hows." Three symbols are used to indicate target goals: ↑ (maximize or increase the attained value), ↓ (minimize or decrease the attained value), and ⊙ (achieve a desired target value). Table 3-3 shows how our team might define target goals for the credit-card services example. Seven "hows" are listed along with their target goals. As an example, for how 2, creating a software to detect billing errors, the desired target value is zero: that is, no billing errors. For how 1, it is desirable to maximize or increase the effect of employee training to reduce input errors and

TABLE 3-3 Target Goals of Technical Descriptors

"Hows"	1	2	3	4	5	6	7
Target goals	⊙	⊙	↑	⊙	↑	↑	↑

Legend	
Number	Technical descriptors or "hows"
1	Software to detect billing errors
2	Employee training on data input and customer services
3	Negotiations with manufacturers and retailers (vendors)
4	Expanded scheduling (including flextime) of employees
5	Effective recruiting
6	Legal training
7	Financial management services
Symbol	Target goal
↑	Maximize or increase attained value
↓	Minimize or decrease attained value
⊙	Achieve a target value

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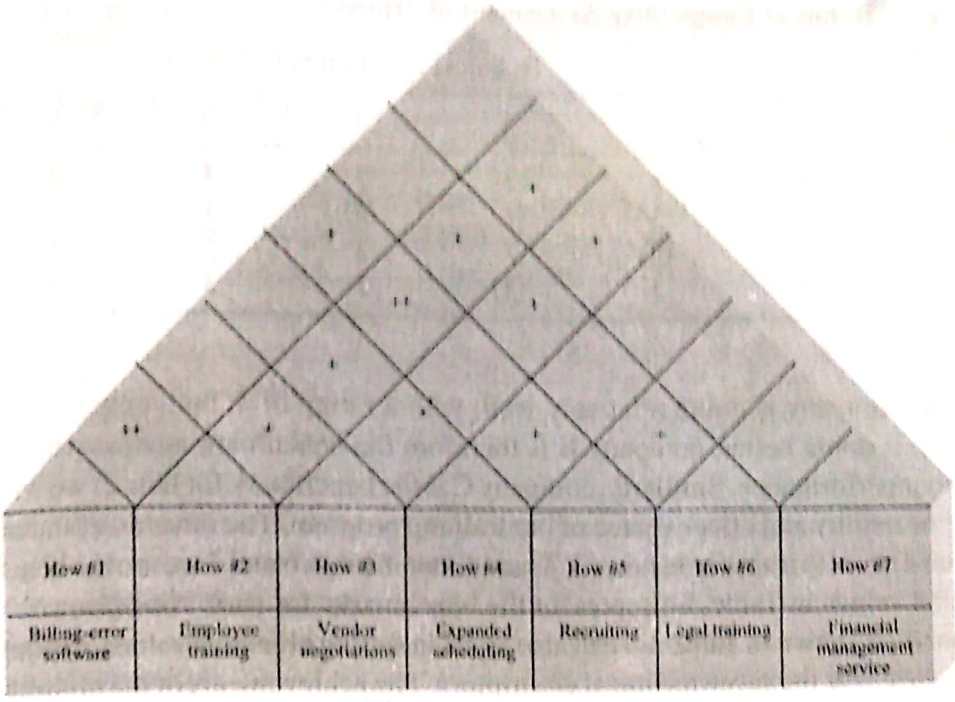

FIGURE 3-6 Correlation matrix of "Hows."

interact effectively with customers. Also, for how 4, the target value is to achieve customer service 24 hours a day. If measurable goals cannot be established for a technical descriptor, it should be eliminated from the list and the inclusion of other "hows" considered.

The correlation matrix of the relationship between the technical descriptors is the "roof" of the house of quality. In the correlation matrix shown in Figure 3-6, four levels of relationship are depicted: strong positive, positive, negative, and strong negative. These indicate the degree to which the "hows" support or complement each other or are in conflict. Negative relationships may require a trade-off in the objective values of the "hows" when a technical competitive assessment is conducted. In Figure 3-6, which correlates the "hows" for our credit-card services example, how 1, creating a software to detect billing errors, has a strong positive relationship (+-+) with how 2, employee training on data input and customer services. The user friendliness of the software will have an impact on the type and amount of training needed. A strong positive relationship indicates the possibility of synergistic effects. Note that how 2 also has a strong positive relationship with how 5; this indicates that a good recruiting program in which desirable skills are incorporated into the selection procedure will form the backbone of a successful and effective training program.

Following this, a technical competitive assessment of the "hows" is conducted along the same lines as the customer assessment of competitors we discussed previously. The difference is that instead of using customers to obtain data on the relative position of the company's "whats" with respect to those of the competitors, the technical staff of the company provides the input on the "hows." A rating scale of 1 to 5, as used in Table 3-2, may be used. Table 3-4 shows how our company's technical staff has assessed technical competitiveness for the "hows" in the credit-card services example. Our three competitors, companies B, C, and D, are reconsidered. For how 1 (creating a software to detect billing

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TABLE 3-4 Technical Competitive Assessment of "Hows"

Company	Technical Descriptors ("Hows")						
	1	2	3	4	5	6	7
A	4	3	2	3	4	④	⑤
B	⑤	3	1	④	1	2	3
C	3	⑤	2	2	⑤	3	2
D	2	2	④	1	3	3	4

errors), our company is doing relatively well, with a rating of 4, but company B, with its rating of 5, is doing better; company B is therefore the benchmark against which we will measure our performance. Similarly, company C is the benchmark for how 2; we will look to improve the quality and effectiveness of our training program. The other assessments reveal that we have room to improve in hows 3, 4, and 5, but in hows 6 and 7 we are the benchmarks. The circled values in Table 3-4 represent the benchmarks for each "how."

The analysis shown in Table 3-4 can also assist in setting objective values, denoted by the "how muches," for the seven technical descriptors. The achievements of the highest-scoring companies are set as the "how muches," which represent the minimum acceptable achievement level for each "how." For example, for how 4, since company B has the highest rating, its achievement level will be the level that our company (company A) will strive to match or exceed. Thus, if company B provides customer service 16 hours a day, this becomes our objective value. If we cannot achieve these levels of "how muches," we should not consider entering this market because our product or service will not be as good as the competition's.

In conducting the technical competitive assessment of the "hows," the probability of achieving the objective value (the "how muches") is incorporated in the analysis. Using a rating scale of 1 to 5, 5 representing a high probability of success, the absolute scores are multiplied by the probability scores to obtain weighted scores. These weighted scores now represent the relative position within the industry and the company's chances of becoming the leader in that category.

The final step of the QFD process involves the relationship matrix located in the center of the house of quality (see Figure 3-5). It provides a mechanism for analyzing how each technical descriptor will help in achieving each "what." The relationship between a "how" and a "what" is represented by the following scale: $0 \equiv$ no relationship; $1 \equiv$ low relationship; $3 \equiv$ medium relationship; $5 \equiv$ high relationship. Table 3-5 shows the relationship matrix for the credit-card services example. Consider, for instance, how 2 (employee training on data input and customer services). Our technical staff believes that this "how" is related strongly to providing error-free transactions, so a score of 5 is assigned. Furthermore, this "how" has a moderate relationship with providing customer service 24 hours a day and serving as customers' advocate in billing disputes, so a score of 3 is assigned for these relationships. Similar interpretations are drawn from the other entries in the table. "Hows" that have a large number of zeros do not support meeting the customer requirements and should be dropped from the list.

The cell values, shown in parentheses in Table 3-5, are obtained by multiplying the rated score by the importance rating of the corresponding customer requirement. The absolute score for each "How" is calculated by adding the values in parentheses. The relative score is merely a ranking of the absolute scores, with 1 representing the most

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TABLE 3-5 Relationship Matrix of Absolute and Relative Scores

Customer Requirements ("Whats")	Importance Ratings	Technical Descriptors ("Hows")						
		1	2	3	4	5	6	7
Low interest rate	2	0 (0)	0 (0)	5 (10)	0 (0)	0 (0)	0 (0)	5 (10)
Error-free transactions	5	5 (25)	5 (25)	0 (0)	3 (15)	5 (25)	0 (0)	0 (0)
No annual fee	1	0 (0)	0 (0)	3 (3)	0 (0)	0 (0)	0 (0)	5 (5)
Extended warranty	3	0 (0)	1 (3)	5 (15)	0 (0)	0 (0)	3 (9)	3 (9)
Customer service 24 hours a day	4	1 (4)	3 (12)	0 (0)	5 (20)	5 (20)	3 (12)	0 (0)
Customers' advocate in billing disputes	4	1 (4)	3 (12)	5 (20)	0 (0)	3 (12)	5 (20)	1 (4)
Absolute score		33	52	48	35	57	41	28
Relative score		6	2	3	5	1	4	7
Technical competitive assessment		5	5	4	4	5	4	5
Weighted absolute score		165	260	192	140	285	164	140
Final relative score		4	2	3	6.5	1	5	6.5

important. It is observed that how 5 (effective recruiting) is most important because its absolute score of 57 is highest.

The analysis can be extended by considering the technical competitive assessment of the "hows." Using the rating scores of the benchmark companies for each technical descriptor—that is, the objective values (the "how muches") from the circled values in Table 3-4—our team can determine the importance of the "hows." The weighted absolute scores in Table 3-5 are found by multiplying the corresponding absolute scores by the technical competitive assessment rating. The final scores demonstrate that the relative ratings of the top three "hows" are the same as before. However, the rankings of the remaining technical descriptors have changed. Hows 4 and 7 are tied for last place, each with an absolute score of 140 and a relative score of 6.5 each. Management may consider the ease or difficulty of implementing these "hows" in order to break the tie.

...importance of teamwork in this process. An

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