OUTLINE OF THE PROCESS

The best approach to creating the E-factory roadmap is also the simplest and best-tested approach. The approach is based on establishing a team of people from all the organizational functions involved in the key E-factory business processes. This team of people then works together using the methodology described herein to ensure that all the necessary information is gathered and that all the relevant decisions are made. The approach consists of five simple steps, as illustrated in Exhibit 1.

This team approach is very similar to the approaches used by other methodologies such as Just-in-Time (JIT), Total Quality Management (TQM), Business Process Reengineering (BPR), Six Sigma (6 sigma), Change Management, Quality Function Deployment (QFD), and Value Engineering (VE). The reason for a team of professionals is that the combined intelligence of the team and the work output of a coordinated team will yield more than the accumulated intelligence and effort of the same number of individuals. Each of these steps and how the team operates in each are described in the following.

STEP 1: FORMING THE ROADMAP TEAM

As stated, the E-factory roadmap should be built by a cross-functional team. Although it is usually better to
have a team of people working together in general, the cross-functional team is absolutely essential in this case because of the need to build business process scenarios. The scenarios are critical to a successful E-factory roadmap, and scenarios can only be created effectively by the people who will be involved in the design and operation of the business process. The key steps in forming the roadmap team are described in the following paragraphs.

Team Selection
Selection of E-factory team members should be done by a management team that should include the most senior executive who should be the company champion, the human resource manager, and other executives who are involved in the E-factory processes. Team members are selected from existing functional organizations. The size and composition of the team should reflect the minimum skill set required to successfully execute the E-factory methodology. However, there are limits to team size. The team should ideally consist of a core group and a support group. The core group should be dedicated, co-located, and consist of members from the relevant functions.
The team should be selected on the basis of the type of business process being supported by the roadmap. For an order fulfillment process, the cross-functional team should consist of representatives from:

- Process engineering
- Production control
- Materials management
- Selected suppliers
- Selected customers
- Information technology
- Supply chain management
- Purchasing
- Customer service
- Field sales
- Marketing

A product realization process would consist of representatives from many of the same functions and include:

- Selected suppliers
- Selected customers
- Information technology
- Supply chain management
- Purchasing
- Customer service
- Field service
- Product marketing
- Engineering (e.g., systems, applications, test, process)
- Research and development (R & D)
- Manufacturing (e.g., industrial engineering, process planning, etc.)

The support group for the core team does not necessarily have to be dedicated full-time to the team although, when their services are needed, they should be available for as long as needed. The support group typically includes members whose skills are not needed except for special questions or activities.

Formal steps should be taken to ensure that all appropriate organizational functions be involved throughout the life of the project, rather than being informed at the end of their accomplishments. This implies that all members of the team will be involved in decision-making from the beginning to prevent decisions from being reworked if the job were passed from one functional organization to another as with traditional approaches.

Functional managers must recognize the priority of tasks assigned to team members and must subordinate other activities that require the team
member’s attention or involvement. Also, team members should receive a performance review that reflects their performance as a team member.

The team should have clear ownership of the E-factory roadmap project and process concept decisions. Team members must avoid any functional organization loyalties that negatively affect the team decision-making process. By bringing together all the people who can affect the innovation of an E-factory and empowering them to make decisions, teams will be able to rapidly develop the E-factory roadmap.

**Team Leadership**

Given an empowered, cross-functional team, the team leader has a special role during the life of a project. A team leader is one of the working members of the team and is assigned when the team is formed. The role of team leader should be one of support and team building, rather than control. The team leader should embody the following characteristics.

1. Have an understanding of the overall business aspects of the product line or industry segment being served
2. Have an understanding of the technologies being considered for use by the team
3. Be able to work with people from different cultures, language backgrounds, technical disciplines, and organizational functions
4. Be able to manage conflicting ideas or recommendations
5. Be able to facilitate team consensus
   a. On agreement on key issues
   b. On disagreements requiring management decision
6. Be able to articulate issues and positions clearly and fairly
7. Be able to sustain a sense of commitment and urgency with the team

The responsibilities and duties of the team leader include:

1. Project management, including the development and tracking of all schedules and costs against targets
2. Communicating the team’s progress to management
3. Facilitating the team decision-making process and serving as arbiter in resolving conflicts
4. Responsibility for securing the resources the team requires to complete all development activities
5. Ensuring that management challenge and market requirements are constantly being represented in the roadmap creation process
6. Promoting value-adding activities from all team members
7. Representing the team decision process when making recommendations to management on key issues
Team Empowerment
Empowerment of the E-factory roadmap must come from company management and the executive in charge of the team. However, the team leader will have responsibility for the day-to-day conduct of team affairs and will have signatory authority and responsibility. Ideally, the team should be empowered to make all decisions necessary to complete its mission in the best interest of the company and its customers.

Agreeing to Team Goals and Metrics
The team is accountable for the creation of an E-factory roadmap. Specific performance metrics are used to monitor progress and to measure final results. The metrics used are determined and agreed upon by all team members and must include measures for thoroughness, quality, timing, and efficiency. Metrics should encourage teamwork for creating an E-factory roadmap for the business rather than optimizing functional preferences or old paradigms that may have previously been the norm. Useful metrics include:

- On-schedule completion
- Cost to create the roadmap
- Satisfaction of customer, supplier, and internal process requirements

In addition to establishing team goals and metrics, individual team members should also establish their personal goals within the project and the metrics to monitor achievement of those goals. The team should create metrics to gauge performance over the length of the project. This will include near-term metrics that are related to each project phase, as well as those aimed at the overall innovation project.

Performance rewards for team members should be primarily related to team performance against business-oriented metrics. These should be agreed upon by management and the team. Individuals should not be rewarded on the basis of their functional performance, but rather on the basis of their participation in an innovation project that is successful from a business standpoint.

Methodology Sign-off and Review
Prior to the methodology sign-off, the team will have received and reviewed the management challenge to create an E-factory roadmap and translated the challenge into specific E-factory goals. At sign-off, the team accepts ownership of its challenge, which are business goals translated into team goals that are measurable. Participants at the sign-off should use a checklist such as the one shown in Exhibit 2 to ensure completeness when establishing consensus on the requirements and any necessary changes.
Signature of the team members represents their approval of the team challenge and their commitment to work as a team. Establishing a cross-functional team is the single most important decision to be made for an E-factory roadmap creation project and requires a clear set of guidelines and operating principles.

**STEP 2: GATHERING THE REQUIREMENTS**

As described in previous chapters, gathering the E-factory requirements is the most important part of the total process. The requirements must come from three areas: those driven by customer needs, by supplier needs, and by the process needs internal to the company. Gathering requirements can be done in several ways, through surveys, interviews, brainstorming sessions, and focus groups (see Exhibit 3).

Brainstorming sessions are important for cross-functional teams to free their thinking and to get everyone to contribute to the thinking and analysis process. The purpose of the brainstorming session should be to identify as many ideas about what the requirements “could” be. The term “brainstorming” itself highlights the fact that these sessions are designed to get people to use their imagination of what could be possible and memory of what they have seen in other situations to suggest possible requirements. These brainstormed requirements should be viewed only as a starting point of requirements to be tested along with other datagathering activities such as interviews and focus groups. If the brainstorming team also includes customer and supplier representatives, the brain-

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**EXHIBIT 2 — Methodology Sign-off Checklist**

<table>
<thead>
<tr>
<th>Team Name:__________________________ Date:_______________</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does the team accept the project cost target of $________?</td>
</tr>
<tr>
<td>YES_____ NO_____</td>
</tr>
<tr>
<td>2. Does the team accept the roadmap goals?</td>
</tr>
<tr>
<td>YES_____ NO_____</td>
</tr>
<tr>
<td>3. Does the team accept the project schedule with completion date_____ ?</td>
</tr>
<tr>
<td>YES_____ NO_____</td>
</tr>
<tr>
<td>4. Are all critical goals satisfactorily described?</td>
</tr>
<tr>
<td>YES_____ NO_____ If not, list which ones:</td>
</tr>
<tr>
<td>5. Do any of the goals conflict with each other?</td>
</tr>
<tr>
<td>YES_____ NO_____ If so, list below:</td>
</tr>
<tr>
<td>6. Do the goals conform to the original management challenge?</td>
</tr>
<tr>
<td>YES_____ NO_____ If not, explain what actions will be taken.</td>
</tr>
<tr>
<td>7. Have individual and team appraisal criteria been developed?</td>
</tr>
<tr>
<td>YES_____ NO_____ If not, explain what actions will be taken.</td>
</tr>
<tr>
<td>8. Does each team member understand how he/she will be measured?</td>
</tr>
<tr>
<td>YES_____ NO_____ If not, explain what actions will be taken.</td>
</tr>
</tbody>
</table>
A brainstorming activity also helps reveal some of the issues that they face everyday. These issues could be opportunities for the new E-factory roadmap to pursue. The output of the brainstorming sessions can be used as material to construct surveys and interviews as well as final requirements.

Surveys are useful for gathering requirements from customers and suppliers on a broad scale. If the markets being served are mass markets in nature with a large number of customers, then electronic, telephonic, or written surveys can be used to try to cover a statistically significant number of customer requirements. For industries that serve a small number of customers or several large customers, face-to-face interviews are more effective. The output of surveys can be used as material to construct or refine interview guides for the face-to-face interviews as well as the final requirements.

Face-to-face interviews are useful for gathering requirements from key customers or key individuals inside of the key customers. Interviews should be structured so that the interview time can be spent efficiently. However, the interviewer should be trained to allow the course of the interview to flow into areas that the customer considers important even if the pre-interview preparation may not have identified them. The interview process should be interactive. The interview structure should be reviewed and revised after each set of interviews to ensure that any new interviewing techniques or issues can be quickly incorporated for future interviews. The output of the interviews can be used as material to construct focus group as well as final requirements.

Focus groups can be useful when there are very specific issues that have to be determined in an uncertain environment. If there is confusion or conflict in the requirements gathered by other means, then a focus group may be needed. A focus group of people from one or more of the three key requirements source groups is also a useful way to get a final determination of the true evaluation of the interaction and prioritization.

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**EXHIBIT 3 — Gathering Requirements**

- Brainstorming
- Surveys
- Interviews
- Focus Groups

- Quality Function Deployment
- Requirements List
of the gathered requirements. Focus groups require significant preparation and skillful facilitation to ensure that group members respond from actual feelings and are not biased by the format or content of the questions asked.

After all the data is collected, it must be transformed into a list of requirements that reflect the specific needs identified during the data gathering. The list should be prioritized and should have specific target values if possible. One of the best methods for this is a technique called quality function deployment (QFD). Developed more than 20 years ago by people in Japan and the United States, the technique was originally intended to be an organized way to design products and processes by forcing a cross-functional team to compare and contrast quality or functional requirements and specify solutions to those requirements. Over time, it has been used to facilitate requirements analysis and decision-making.

The QFD tool was invented in Japan during the 1970s. It resulted from the desire of government-sponsored researchers in Japan to capture in analytical form the best practices of the successful Japanese manufacturing companies. Although developed there, QFD was actually not practiced extensively in Japan. Also, it is probably misnamed because of its generic capability. However, it was brought to the United States by the Ford Motor Company who found it to be a useful tool for product development and process design in bringing together the many “voices” in its operations to form one voice — the voice of the customer. Since its inception and introduction in the United States, its use has evolved to the point that it can become a major factor in reducing the cycle time of making decisions about requirements for new products and new processes. It assists in ensuring the capture of the “voice of the customer” as well as the “voice of the supplier” and the “voice of internal operations.”

QFD can be an important factor in defining a set of requirements that originate from a variety of sources. It provides a structure for organizing the thoughts, impressions, and data that may exist in different functions in an organization. It provides a means by which a multi-functional team can work together early in a product development program to form a consensus on what the product should be. It provides the basis of a common language or communication mode for the multi-functional team.

The Q stands for quality, which in the simplest of terms is defined to be whatever makes the customer happy; it is the satisfaction of the customer’s needs; it is the delivery of what the customer wants. It is easy to talk about what quality is not: it is not products that do not work properly or business processes that are inefficient or ineffective. Quality should be defined in terms of customer expectations met or exceeded.

This definition of quality is, of course, extremely broad. However, by using the broadest definition possible for quality, all of the issues associated with the success of a product or process can be incorporated. For
example, a product or process should be designed to provide only the quality for which a customer is willing to pay. A product or process should be designed to provide the quality as it is perceived by the customer, as well as to provide quality surprises when the customer has an unfulfilled desire or expectation.

Product and process are being used interchangeably in this description of QFD because of the value that the QFD approach has in facilitating the collection of requirements. This is important because in the era of E-commerce, the process is, in many ways, the product. With the rapid response required from the E-factory and the enlarged customer experience that the E-factory must provide, the process by which a product is presented and provided to a customer will determine the degree of satisfaction that a customer has just as much as the product itself.

To help explain this concept, consider the simple example of the home kitchen device usually called a bread toaster. Assume that extensive market surveys have been performed and it has been discovered that the typical customer expects a toaster to produce a crunchy brown bread for breakfast. To delve deeper into more detail about this expectation, questions would be asked about safety, cost, exterior shape, messiness, degree of control, number of slices of bread that can be accommodated, types of bread that can be accommodated, and other items that a customer might want to toast. It is all of these requirements that define expected quality. Addressing process issues, questions would be asked about how likely a customer is to buy on-line, what they would expect during that buying experience, and what type of response and service would they like or expect after making a purchase order. For the E-factory, other questions about the speed of response from the retail experience to delivery and usage should be included. With such a broad definition of quality, it is often difficult for two people on the same roadmap team, much less an entire organization, to have the same definition and concept of quality. The QFD enabling tool provides a valuable mechanism for achieving a common concept and common set of goals within a cross-functional team and within an organization.

The F stands for function, that is, what function must be provided by the product or process to satisfy the customer’s expectation. Where quality was defined to be the customer’s expectations, function is the set of measurable factors or processes that are necessary to satisfy those expectations.

The D stands for deployment — deployment as in how the quality functions are deployed in the product (in the form of parts or features) or in the production process. Deployment is critical because it is the manifestation of decision-making. There can be much discussion and a wide variety of opinions within the team of quality and function, but deployment is where the decisions have to be made as to how the product will be realized to satisfy customer requirements.
The use of QFD at the start of a project is important because it forces the cross-functional issues to be identified and addressed. The tool acts as a forcing function by requiring that a consensus be formed on customer, supplier, and internal requirements; that a consensus be formed on what the technical functions must be to be successful; and that the E-factory strategy of the company be clear and integrated into the roadmap.

The output of QFD is a requirement matrix that summarizes the best thinking and research of a cross-functional E-factory roadmap team. However, it is not so much the matrix itself that is valuable as it is the discussion, the research, and the effort that goes into creating the matrix. QFD represents a disciplined approach to collecting and analyzing data and defining requirements about the E-factory that should be developed to satisfy the market needs. Successful companies go through most of the requirements generating activities called for by the QFD process anyway. The benefit of using QFD is that any company can force itself to perform the analysis and decision-making that the best companies do and do it as early as possible.

The goal of the QFD analysis is to have the voices of the customer, the supplier, and internal operations permeate and promulgate throughout all the activities associated with creating the E-factory roadmap. This is based on the theory that what the customer wants can be defined, and that every activity associated with the business processes that get the product to market should be driven by the requirement of satisfying those wants. An example of a QFD matrix that would be useful to a roadmap team is given in Exhibit 4.

Constructing a QFD Matrix

The process of building a QFD matrix can be delineated in a straightforward fashion. Performing the data gathering and analysis takes effort. However, the questions asked as part of the QFD activity should be asked as part of an interview, focus group, or brainstorming process. The difference is that the QFD activity is organized in a very disciplined way and forces the questions to be asked early and to be answered by a cross-functional team. The QFD data capture and documentation approach has been electronically integrated into the database tools used for the E-factory roadmap process.

Presented in the following is an example of how to build the first QFD matrix. The steps involved in building the matrix are easy to explain; answering the questions they ask is the challenging part. Exhibit 4 is referred to frequently in the following discussion. Each step necessary to construct the first QFD matrix is discussed. By walking through each step, it is possible to see how much decision-making must be done at the earliest stages of a roadmap project by a cross-functional team.
EXHIBIT 4 — The Requirements QFD Matrix

<table>
<thead>
<tr>
<th></th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Chain Requirements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technical Requirements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Market Importance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Competitor Satisfaction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E-Factory Vision Plan</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emphasis Level Factor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Absolute Rank</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Normalized Rank</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correlation Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Normalized Rank</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Customer Requirements

Supplier Requirements

Correlations

Internal Process Requirements

Correlation Total

Normalized Rank

Specification
List the Supply Chain Requirements

This is obviously the first and often the most difficult step. This list represents the all-important elements of the voice of the supply chain, that is, the voice of the customer, supplier, or internal business process. This list should contain all the desires and needs perceived by the customer, supplier, or internal process. It can also contain items that have not yet been perceived as being needed, and items that could be viewed as a quality surprise or unexpected benefit. Demands tend to fall into the following types:

1. Physical demands, such as:
   a. Cycle time
   b. Reliability, durability, frequency of breakdown, consistency
   c. Service performance
   d. User friendliness
   e. Safety
   f. Style
   g. Cost
   h. Volume, lot size, shipment size
   i. Packaging
2. Emotional demands, such as:
   a. Esteem
   b. Loyalty
   c. Perceived value
3. Information demands, such as:
   a. Order status
   b. Quality status
   c. Flexibility in content or performance
   d. Access time for information
   e. Data security
   f. Failsafe operation

Although the physical and information demands are the easiest to design for, the emotional requirements can be the deciding factor.

As the requirements data is collected, it should be organized in hierarchical fashion using the format illustrated in Exhibit 4. This allows for clearer and more careful consideration by the team during the remaining QFD activities. For example, a first-level customer requirement might be “rapid quotation response.” The second level for this first-level requirement might be “shopping cart feature required.” The shopping cart feature requirement might have a third-level requirement, which is “prevent products that do not operate with what is already in the shopping cart from being placed in the cart.” These demands or supply chain requirements should be placed in the vertical list.
Generate the Technical Requirements

Technical requirements are those technical parameters necessary to satisfy or provide the satisfaction of the customer requirements. Technical requirements must be measurable or definable in measurable terms. One technical requirement may be applicable to many customer requirements. The team generates the technical requirements by considering the customer requirements and articulating the necessary technical requirements. The technical requirements must be measurable because they will be used to define the technical specifications for the E-factory business process or technology.

Using the example above, a technical requirement for the “prevent products that do not operate with what is already in the shopping cart from being placed in the cart” customer demand would be “product configuration database” and “product configuration analyzer.” As the technical requirements for each demand are identified, they should be placed in the horizontal list.

List the Market Importance for Supply Chain Requirements

One of the benefits of the QFD matrix approach is that it requires that there be a ranking of all the key factors. For supply chain requirements, a rating or ranking provides a means to discriminate between the more important and lesser important items. The ranking is important because it gives the team a quantified measure of the importance of customer requirements that can be useful if trade-offs have to be made about process or technology features or cost.

The ratings for each customer requirement can be generated in several different ways, including:

- Included as part of original data gathering surveys
- Included as part of focus group activity
- Assessed as a team exercise

The team exercise approach provides little reliability because it is the voice of the team that is being used to rank the requirements rather than the voice of the customer, supplier, or internal operations. However, it is included as an option here because it does force a consensus within the team as to the ranking. Once the requirements are captured, the ranking of the requirements can be tested and measured in an independent survey without diluting the value of the requirement list. If there is great controversy among team members about the rankings, then that is an indicator that the ranking issue must be addressed immediately using an intensive data gathering effort. The range for this column should be from 0.0 to 1.0, where 1.0 is the highest level of importance.
Degree of Supply Chain Satisfaction Provided by Competitors

This data is actually benchmark data. For each requirement, competitors as well as the company are rated on how well the requirement is being satisfied with current processes, if there are any that can be compared. If the roadmap is for a greenfield facility, then any competitors that offer a relevant capability should be included. This rating makes a quantitative statement of the relative strengths and weaknesses among competitors in the market being targeted by using customer, supplier, or internal process satisfaction as the main criterion. This rating allows the display of market benchmarking and competitive information in a simple format so that the entire team can understand the situation. In actual practice, this array of ratings is often one of the most valuable aspects of the QFD matrices because it brings into the clear light of day all the key competitive issues. The ratings in this column should range from 0.0 to 1.0, where 1.0 is for the highest level of satisfaction.

Describe the E-Factory Plan or Vision

In the previous paragraph, the performance of competitors and the company is measured in terms of achieving supply chain satisfaction. In this step, the goals of how much supply chain satisfaction is to be achieved by the E-factory under development is quantitatively articulated. This rating of E-factory goals is done on a requirement-by-requirement basis. It then becomes a clear and unambiguous mapping of the company strategy that evolves into a vision for the e-factory. This is a step that is usually not done in traditional requirements planning methods. In fact, in actual practice, performing this step may create questions that have not been answered by the company strategy, thus requiring that additional work be done on the strategy or that the team must take a position on the strategy in order to complete the project. Either way, there is a benefit because any strategy issues are identified and resolved early in the total process.

All of this contributes to the creation of a vision of the E-factory. The range for this column is from 0.0 to 1.0, where 1.0 for a supply chain requirement implies that the E-factory vision must satisfy this requirement. A score of 0.0 implies that the vision does not include satisfying this requirement. A score of 0.5 implies that the vision does include some form of this requirement. By deciding on the scale for this column, the roadmap team is making a statement about the nature of its vision. If the team decides that partial requirement satisfaction is not acceptable, then the score in this column can only be one of two values, 0.0 and 1.0. If the team decides to have a range of values, this will create a ranking for the requirements a part of the vision.

List Emphasis Levels

An emphasis level factor is a way to give additional weight to specific requirements on top of what has been defined in previous steps. The con-
cept of emphasis is that there may be certain requirements that are more directly related to supply chain success than other requirements. While customers may rank a feature 35th in importance when compared to the other requirements, they may respond to this feature 30 percent more enthusiastically than other features. Therefore, a multiplier of 1.3 would be the emphasis level factor for this feature, while all the other features would be 1.0. This extra weighting would then move the ultimate ranking of this feature up the list from 35.

**Calculate the Absolute Rank**

This step is simply the multiplication of the Market Importance by the Competitor Satisfaction Ranking by the E-factory Vision Plan by the Emphasis Level Factor. The total of this column then becomes the denominator for the next step.

**Calculate the Normalized Rank**

This step is simply the division of each item in the Absolute Rank by the total of the Absolute Rank column. This calculated number now becomes the new rank order for the supply chain requirements that incorporates the E-factory vision, the competitive situation, and the supply chain importance. For most roadmap applications, building the QFD matrix to this point is sufficient to produce a rank-ordered set of supply chain and technology requirements for the roadmap methodology. However, the next few steps are useful to generate even more detail on how requirements should be satisfied.

**Create Correlation Values**

Creating correlation values between the supply chain requirements and the technical requirements is a somewhat tedious task due to the sheer number of requirement pairs. The job is to identify whether a given technical criterion correlates to a supply chain requirement. Correlation is defined as the degree of relationship between two entities. If technical criteria are extremely important in achieving the satisfaction for a specific supply chain requirement, then it is highly correlated to the customer requirement, and the correlation should be 0.9. If technical criteria are moderately important in achieving the satisfaction for a specific supply chain requirement, then it is only moderately correlated to the customer requirement, and the correlation should be 0.5. If technical criteria have no importance at all in achieving the satisfaction for a specific customer requirement, then it is not correlated to the customer requirement, and the correlation should be 0.0. Because the technical criteria were generated by working down the customer requirement list one by one, there will be at least one high correlation for each technical requirement.
**Sum the Technical Requirement Correlation and Normalize**

Summing the total of the correlation values of the technical requirements will produce a relative ranking of the technical requirements. The normalized ranking is produced by summing the total of the correlation sums and dividing this into each correlation sum. This row of numbers becomes the normalized forced ranking of the technical requirements.

**List Specifications for Technical Requirements**

An additional feature of the first QFD matrix is the ability to include numerical specification values for each of the technical requirements generated in an earlier step. This set of specifications becomes the baseline from which evaluation criteria for solution set components can be established.

**Summary of QFD Benefits**

The QFD approach focuses attention on generating E-factory requirements. The entire objective and purpose of the QFD activity is to have the voice of the supply chain transformed into details that directly drive the E-factory process design. By using the matrix technique, a tremendous amount of information about the requirements and the relationships of the design details to the supply chain requirements can be displayed easily and shared with everyone on the team. The QFD activity begins and ends with attention focused on the three sources of E-factory needs and requirements.

The QFD approach forces the selection of target values for the technical requirements that will ensure supply chain satisfaction. All E-factory technical requirements are chosen on the basis of what is necessary to satisfy supply chain requirements. There is no room in this approach for any individual or functional element in the organization to insert technical requirements that are not related to E-factory requirements.

The QFD approach facilitates the multi-disciplined team approach to product design. The nature of the QFD activity requires that there be contributions from different functions. Marketing and sales provide their input based on their working knowledge of the customers and the market. Engineering provides input on the basis of what has been used in the past and what could be possible in the future. Manufacturing provides input on what the production processes need to be. Strategic planning provides input to (or learns from) the activity because there must be a connection to the E-factory strategy for the matrix to be completed.

The QFD approach documents the decisions made during the E-factory process. Each mark on the matrix documents a decision made about observations, technical alternatives, or specifications. If any decisions that follow come into conflict or contradict previous decisions, then the
consequences can be determined by tracing back to the original document.

The QFD approach provides for better communications between functions. Because the QFD matrix is created by a cross-functional team, the entire team is exposed to the same thought process, exploratory discovery of customer requirements, and decision-making about technical approach. While the matrix is being constructed, there will likely be members of the team who will be coming up to speed, so to speak, on the total business process. In the era of specialization, very few, if any, professionals are expected to understand the entire business process of which they happen to be part.

The QFD approach forces collaboration. Collaboration may be too strong a term to describe what happens. The reality is that the QFD activity requires that there be a conclusion drawn on every question that is represented by cells in the matrix. The information entered in the matrix is a documentation of that conclusion. The team participates in the creation of the matrix and in the conclusions drawn. The team environment should be strong enough that, given each decision, everyone on the team works together to implement the decisions. This eliminates the time consumed that sometimes occurs in lesser processes by debating issues and second-guessing decisions later in the project. It also forces early involvement. Because the matrix requires input from different functions and because it is created at the initial stage of a project, early involvement in the key enterprise functions is mandated.

**STEP 3: CREATING THE VISION**

Step 3 is the creation of the vision using the methodology described in Chapter 7. The team continues to work together to build the vision using the steps defined in the methodology.

**STEP 4: CREATING THE ROADMAP**

Step 4 is the creation of the roadmap using the methodology described in Chapter 8. The team continues to work together to build the roadmap using the steps defined in the methodology.

The methodology relies heavily on process scenarios to integrate the requirements and to force the identification of alternatives of how technology and process design can best work together. Scenarios are based on object modeling concepts; it is not sufficient merely to use object orientation. The ultimate goal is to describe what the requirements need to have in the process and technology design.

A scenario is a sequence of transactions in a system initiated by a user of the system. A scenario has a complete flow of events with a well-defined beginning and a well-defined termination.
Scenarios link together different models of a business or an information system. For example, the analysis model can be linked to the design model. They each have an important role in the link between a business model and its information system. When building scenarios, the team must define the workflow of activities for people; the information flow for human, machines, and data resources; the information systems that support the workflow; and the controls for the total system of people and capital.

When the team builds a scenario, it must define the objects; identify which are human, machine, and data objects; and define the control hierarchy level for each object. The team must also define the scenarios by identifying each activity needed to execute the scenario.

**STEP 5: CREATING THE IMPLEMENTATION PLAN**

Creating the implementation plan is the final step for the roadmap team, but is not necessarily the easiest step. Considerable judgment is required in deciding how to approach several of the key questions that must be answered to complete an implementation plan.

For example, one outcome of the roadmap process is the identification of the solution set components in terms of software and hardware suppliers and packages. From this list must come the identification of what must be purchased and when each component should be purchased. This information will have to be put on a project implementation schedule.

Equally important is the definition of the sequence of implementation activities. The roadmap process provides an ordered list of implementation activities. The roadmap team must put specific milestones and dates on that ordered list. This enhanced list of implementation activities then becomes a project schedule.

In addition to this time schedule, the resources that will have to be committed to the project must be identified and the impact of their commitment estimated. If external resources are required, then their cost and time must also be estimated.

After the implementation plan is created, it must, of course, be submitted to the steering committee or to management for approval and budgeting.

**SUMMARY: CREATING A USABLE ROADMAP**

Creating a usable roadmap requires the commitment of a dedicated team of people from a variety of functions from the company, as well as the involvement on a part-time basis of other internal resources, customers, and suppliers. Organizing this team is the first key step in the E-factory roadmap process. It will also likely reveal either new opportunities or issues that the company has with suppliers and customers because it will
depend on direct communication with them. The result from the team using the described process should be a roadmap defining the E-factory technology solution set and the business processes.

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