SECTION 28
QUALITY IN A HIGH-TECH INDUSTRY

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INTRODUCTION

In order to understand the role of quality in a high-tech industry, it is important first to define what both "quality" and "high tech" mean in this section. The term "quality" is interpreted very broadly and can be thought of as a synonym for "business excellence", i.e., that attribute of business systems and processes which contributes to successful and sustainable business results, encompassing a balance among employee, customer, shareholder, and other stakeholder (community, environment, etc.) values.

The term "high tech" is used to refer to any business that produces a product that has "high tech" attributes, uses processes that rely on "high tech" methods of production, or addresses a marketplace that has "high tech" product or service needs. What, then, are these "high tech" product, process, or market needs attributes? From a product point of view, "high tech" can be defined as *a product that is propelled by a powerful technology learning curve and that has a complex architecture with high feature density, speed, and/or bandwidth requirements.*

While products from the electronics and communications industries are obvious examples of high tech, the definition can be interpreted more expansively, especially when examining process and marketplace attributes. For instance, high tech processes have many of these challenges:

- Rapid time to market with shorter development and life cycles
- Very well-educated, technically excellent, multicultural work force
- A growing body of de facto global standards
- A significant reliance on "qualified" suppliers and complex manufacturing systems

The preceding characteristics represent internal aspects of high tech. The external or marketplace needs have these attributes:

- A customer base that may have little or no experience with the product or technology
- A marketplace that is willing to accept innovative solutions to problems they may not yet know they have

There are probably no aspects of total quality management (TQM) principles in "any tech" industries that do not pertain to high-tech industries as well. Therefore, no attempt will be made in this section to outline all TQM activities pertaining to industry. Only selected aspects of quality management principles that are particularly relevant to high-tech industries will be discussed.

Finally, the discussion will roughly track the 1997 U.S. Malcolm Baldrige National Quality Award Criteria, highlighting topics as they pertain to each of the following Baldrige categories:

- Category 1: Leadership
- Category 2: Strategic Planning
- Category 3: Customer and Market Focus
- Category 4: Information and Analysis
- Category 5: Human Resource Development and Management
- Category 6: Process Management
- Category 7: Business Results

This is in keeping with the intent to define "quality" as "business excellence." As the understanding of the impact of quality continues to mature and expand, it is appropriate to broadly address all areas of business excellence. This is especially true in high-tech industries, where there is a growing intolerance for mediocrity in terms of time to market, quality of products and services, competitive value, and flawless execution.

BALDRIGE CATEGORY 1: LEADERSHIP

Speed is clearly a major differentiator in a high-tech industry. This has important implications on the leadership and management systems.

Speed manifests itself in various important ways. These include

- The organization's and the leader's ability to learn
- The process and length of time it takes to reach organizational alignment
- How long it takes to channel technical breakthroughs into innovative products
- How quickly informed decisions are made

Each of these areas will be addressed in turn below.

Ability to Learn. First, good leaders are not only able to learn but they are also *willing to be seen learning.* They are in a continuous learning mode with shorter and shorter cycles. They create an environment open to learning and change, and they expect the people in their organizations to behave similarly. This enables both the leaders and the work force to continually and quickly develop the better answers that are demanded in their high-tech world.

Organizational Alignment. Second, the leaders must set direction but not overmanage. Constancy of purpose with repetitive attention to clearly articulated goals is important. The use of a policy deployment (or similar) process with mutually negotiated goals, metrics, cascaded objectives, and frequent review sessions is very beneficial. Such a process can reach all levels in the organization quickly and is helpful in a high-tech environment because technical innovation frequently can

create apparently conflicting goals. In addition, it helps leaders conduct a systematic analysis for near- and longer-term goals. It helps communicate the critical few breakthrough projects needed to make the organization successful. And it helps employees know what is important and how they personally connect to the organization's goals.

Figure 28.1 provides a sample format for the structure of an organizational policy deployment matrix. Typically, these are layered downward through the organization, with a referencing scheme (numerical or otherwise) that allows lower levels, including individuals, to relate their goals to higher-level ones. Each organization, in turn, uses the matrix/matrices of the organizations above it *and beside it* as guidance and insight into the development of its own matrix, negotiating with higher-level organizations as necessary. The essence of the matrix-development task, therefore, is to develop a set of goals and objectives that have these characteristics:

- They specifically address the scope and area of responsibility of that particular organization.
- They are aligned with the overall business goals and objectives.
- They are limited to a reasonable number of clearly understood and mutually agreed-to projects and/or metrics.
- They are synergistic but not conflicting with neighboring organizations.

Each individual employee, with the supervisor's input, now develops his or her own set of personal goals from these organizational matrices. These employee goals, representing a mutually negotiated agreement between the employee and his or her supervisor, should have the same four key characteristics as outlined for organizations above. *In some cases, the identical "individual" goals are applied uniformly to a team of employees, where the team has agreed to work as a unit, i.e., they succeed or fail together.* Figure 28.2*a* presents a possible standard template for an individual employee goal based on the higher-level matrix. Figure 28.2*b* uses this template to derive a sample goal from the higher-level organizational goals shown in the example in Figure 28.1.

An important point to note is that policy deployment can be used to define and track incremental business goals as well as breakthrough goals. It is helpful to keep the number of breakthrough goals very small, e.g., two to three, because too many large projects will dilute the benefit of concentrated effort. Having a clear understanding of which goals are breakthrough versus those which are incremental will help ensure that appropriate effort, staff, reporting timeframes, expectations, and rewards are instituted commensurate with the type of goal.

The use of the traditional plan-do-check-act model here helps to show the importance of linking strategic planning to policy deployment. The entire goal-setting and cascading portion of the organization's policy deployment process should be completed before the beginning of the fiscal year and should be integrated with the strategic planning process for that year. This can be thought of as the "plan-do" steps, i.e., "plan" through the development of the strategic plan and the more tactical policy deployment matrices, and then "do" through the cascading of the policy deployment matrices throughout the organizations. The review portion of the policy deployment process, the "check" and "act" steps, should be arranged so that every organizational metric is reviewed daily, monthly, and/or quarterly, i.e., checked, as appropriate. Figure 28.3 is a sample of a monthly metric reporting sheet. Trending data are required and corrective action, i.e., the "act" portion, instituted against root causes in cases where the trends are in the wrong direction or behave outside expected control limits. (See Baldrige Category 2: Strategic Planning, below, and Section 13 for a broader discussion of strategic planning.)

These monthly metric reports, or a condensed version of them, can be "made visible" to all employees as a continuous reminder of priorities and goals, i.e., constancy of purpose. A simple example of a visibility method is the use of video monitors mounted in high-traffic hallways. Information is refreshed daily and has a simple choreography designed to catch the eye. Such a display can summarize policy deployment metric status as well as community announcement activities, e.g., new employee arrivals, upcoming ISO audits, etc.

One note of caution is necessary regarding the reporting portion of policy deployment. Most often policy deployment fails because the entire process is allowed to degenerate into the creation of a stack of arcane monthly reports that no one looks at, responds to, or is held accountable for. This could be indicative of a number of root causes:

Corporate goal	Subproject	Project owner	Metric	Metric reporter	Target (current year)	Long-term target
1.0 Increase customer satisfaction	1.1 Institute rigorous survey method	J. Smith	1.1a Monthly survey results	K. Andersen	10 months	1 every month
			1.1b Quarterly survey analysis	B. Baker	3 of 4 quarters	Every quarter
	1.2 Create customer response team	R.Johnson	1.2a Percent customer complaints resolved	V. Jones	60%	95%
	1.3 Achieve ISO registration	D. White	1.3a Successful external audit	O. Thompson	During 3rd quarter	N.A. (Need long-term goal for ISO)
2.0 Enhance employee engagement	2.1 Pilot self-directed team concept	E. Edwards	2.1a Choose and train pilot group	E. Edwards	End of 1st quarter	N.A.
			2.1b Percent favorable response to questionnaire	P. Brown	80%	95%
3.0 Create additional share owner value	3.1 Decrease accounts receivable	W. Green	3.1a Percent product DOA	Q. Director	75%	99%
		R. Johnson	1.2a See above			
	3.2 Reduce COGS	C. I. Owe	3.2a Manufacturing cost reduction	T. Bender	10%	35%

FIGURE 28.1 Policy deployment matrix.

GOAL DEPLOYMENT TEMPLATE

Goal: (State what the goal is in one sentence.)

Goal Reference Number: (In order to keep the numbers consistent, use a reference number that refers back to the policy deployment matrix.)

Plans/Steps/Process to Accomplish Goal: (Outline briefly what are the steps that are needed to accomplish this goal. Note: This is not a replacement for a detailed work plan but a vehicle to clarify expected work effort.)

Possible Barriers to Overcome: (Identify any issues or situations that could impede progress. Note: This helps to visualize areas for special attention for both the employee and his/her support manager.)

Probability of Meeting Goal (High, Medium, Low): (Identify probability of success. Note: Most goals have a high probability of success. However, if the goal is a "stretch" goal that is perceived to be very difficult, a medium or low probability may be more realistic. This does not mean that the employee will not work hard to accomplish it, but it does give the employee the sense of support from his/her manager that the manager acknowledges the difficulty of the goal. In this case, there should be an accompanying discussion in the "Steps" and "Barriers" paragraphs above about ways to increase the probability of success.)

To Whom Is Goal Deployed: (Note: This is normally the employee. It also frequently includes other people that the employee is expected to influence or work closely with.)

Metric(s) to Measure Progress:

Name: (Identify some metric that is measurable that will show progress or completion.)
Source: (Identifying the source of the metric helps eliminate vague metrics.)
Target: (Helps to realistically assess the usefulness of the goal and the metric.)

Goal Owner: (Person responsible for the goal. It may be the employee, the employee's manager, etc.)

Signatures for Concurrence:

Employee: **Date:**

Goal Owner: **Date:**

Manager/Support Person: **Date:**

FIGURE 28.2a Goal deployment template description.

EMPLOYEE GOAL DEPLOYMENT

Goal: Become a productive team member for the new customer response program.

Goal Reference Number: 1.1

Plans/Steps/Process to Accomplish Goal: Take training to become certified in product knowledge. Complete workshop on "Talking with Unhappy Customers." Develop spreadsheet to help analyze customer call statistics.

Possible Barriers to Overcome: Training material may not be available in time. May need to find more informal ways to learn about products. (My manager can help negotiate training schedules, etc. on behalf of the new team.)

Probability of Meeting Goal (High, Medium, Low): High

To Whom Is Goal Deployed: I. M. Worker

Metric(s) to Measure Progress:
Name: Course completion rate
Source: Training records
Target: 2 courses, one each quarter, completed by end of 2Q.

Name: Spreadsheet usage
Source: Monthly reports
Target: All team reports produced by this software from 3Q on.

Goal Owner: I. M. Worker

Signatures for Concurrence:

Employee: *I. M. Worker* **Date:**

Goal Owner: (*Same*) **Date:**

Manager/Support Person: *U. R. Boss* **Date:**

FIGURE 28.2b Employment goal deployment sample.

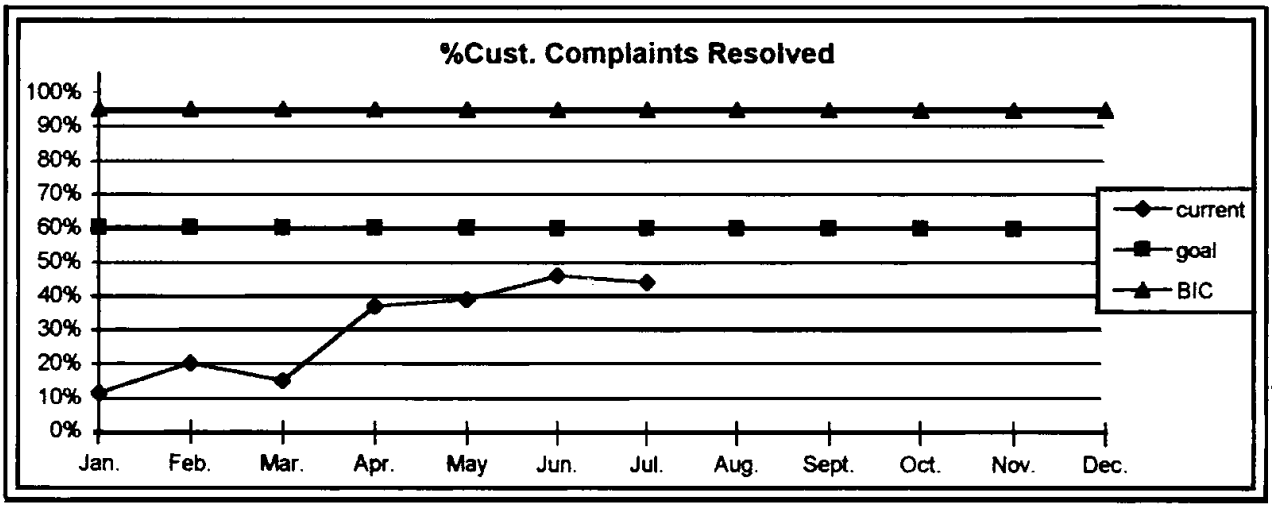
Metric: *% Customer Complaints Resolved* **Sponsor:** *R. Johnson*

Cascade Reference Number: *1.2a*

Policy Deploy.Objectives:
Level 1: *To Increase Customer Satisfaction*
Level 2: *To Create Customer Response Team*
Level 3:

QI Story -or- Improvement Plan
Step 1: *Need systematic way to respond to customer complaints.*
Step 2: *Data of current situation shows no repeatable "system".*
Step 3: *Root cause analysis shows need to formalize responsibility, et al.*
Step 4: *Currently instituting needed countermeasures.*
Step 5: *Some early results are beginning to show improvement.*
Step 6: *Will formalize new approach next year if continued successful.*
Step 7: *Will start next level of work toward BIC of 95%.*

Trend Chart: (Show this year's goal and B-I-C or competitive benchmark.)



Person Tracking This Data: *V. Jones*

Explanation of Spikes/Dips: *Begun to implement Q.I. Story Countermeasures in March. Results beginning to show improvement in April. Final Countermeasures will be in place by August.*

FIGURE 28.3 Monthly metric report.

- Wrong choice of metrics
- Lack of a suitable venue for review and action
- Waning attention to the need for constancy of purpose

The first two causes can be addressed through the use of problem-solving techniques. The third cause, however, may be a symptom of waning leadership attention. It requires direct leadership intervention.

Finally, at the individual employee level, performance evaluation against goals is a major tool in the overall human resources performance management process. (See Baldrige Category 5: Human Resource Development and Management.) Individual goals should be reviewed at least quarterly and updated as necessary because individual assignments and goals are likely to change more frequently than overall organizational goals.

Product Innovation. A third leadership challenge is to channel technical excellence into innovative products rapidly. Policy deployment, coupled with a systematic approach to ensuring that customer needs are well understood by the R&D community, can help this. (See Baldrige Category 3: Customer and Market Focus, Reaching the R&D Work Force.) A dual-reporting organization that allows a program manager (one who manages a new product or service) to operate as the link between research and development (R&D) and the customer, while offloading administrative overhead to a functional manager, has shown success in some areas. This can be augmented by a strong focus on teams and teamwork for that product or service, including team members from business, marketing, and sales. All team members must be fully conversant in the technology. Lack of understanding on anyone's part will slow down or misguide that information flow between technology capability and customer needs. (See more in Baldrige Category 5: Human Resource Development and Management.)

Decision Making. Lastly, the leadership and management system must be able to make informed decisions quickly, particularly where new products are concerned. A well-followed and well-cared-for "gate process" has the potential to move product decisions along expeditiously. While the basic purpose of a gate process (see process flow in Figure 28.4) is to ensure that the right things are done at the right time via checklists at each gate review (everything from funding approvals to documentation available at time of product ship), it has the added benefit of creating a rhythm for moving the product along through its various stages or "gates." If the process is followed, with aggressive target dates set for passage through each gate, it is expected that new products will be introduced sooner, more smoothly, and with a better sense of cost of development, while at the same time weeding out false starts early.

BALDRIGE CATEGORY 2: STRATEGIC PLANNING

This area touches on two aspects of strategic planning: (1) a comprehensive and thorough plan-development process that includes feedback loops and (2) a deployment and execution process. If either of these areas is incomplete or performed outside the normal flow of business, the effort will fall short of its potential. It is important to note that the planning process needs to include an update-cycle capability. In high-tech industries, the rate of change demands continuous evaluation and improvement.

Plan Development. The process that develops the plan must include many constituencies, but in a high-tech industry it is essential to include technology (i.e., where the technology is going, what breakthroughs are needed, and how fast the technology will change) as a major component. To accomplish this, real diversity of ideas is needed. In high-tech businesses, not all strategy ideas are "found" at the top. Therefore, it is important to include the "diversities" of the organization regardless of hierarchy. [A *Harvard Business Review* article (Hamel 1996), addresses this issue in detail.]

Each project, before it is approved to move to the next stage, i.e., through a "Gate", must undergo a "Gate Review". (Note: this requires that a detailed project schedule has been defined, including the projected dates for each Gate Review at the time of initiation of the project.)

A "Gate Review" is a formal meeting, conducted by a moderator with the assistance of a scribe, that systematically reviews a checklist of items that are required in order to allow the project to move through the gate. The review is conducted by a set of "gatekeepers", i.e., a cross-functional group of people representing each organization that has responsibility for some part of the project. Consensus is usually required.

The "Gate Process" has a formal process owner who works with the organization to define the five checklists and other process details, keeps track of gate review statistics (projects, schedules, etc.), and applies process improvement suggestions, as needed.

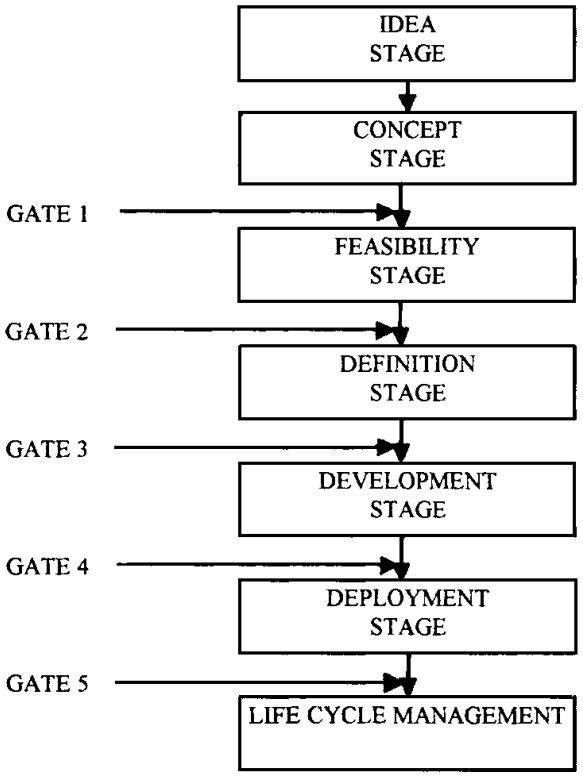


FIGURE 28.4 Gate process.

A second impact of high tech, and an outgrowth of this diversity, is the need to ensure that R&D breakthrough project plans and foundational technology work that is clearly linked to the goals of the business are included in the strategic plan.

A third consideration for plan development in a high-tech business is integration of contingency planning. When speed to market is important and the product is based on new technology, the product-development process, as well as the product delivery and customer expectation management processes, must account for the risk implied from the unknown.

This leads to the last, albeit most important, consideration: that of input from the customer, together with input from the market and the sales channels. This feedback loop is essential. As more and more high-tech business becomes "customized," the ability to see, hear, and accommodate the "customer of one," i.e., the individual needs of every customer, is critical. Also, when designing a new product concept, it is important to understand the impact on the customer/market that was created by a previous product. This is due to the ability of new high-tech products to actually define new markets or cannibalize old ones. A comprehensive "voice of the customer" system can fulfill this need for systematic and comprehensive customer input. (See more on this topic in Baldrige Category 3: Customer and Market Focus.)

Deployment and Execution. The deployment and execution phase of strategic planning can be linked directly to and accomplished by policy deployment and human resources performance management practices. The objectives set out in the policy deployment matrix can be captured directly from the strategic plan. As discussed earlier, regular reviews of progress toward these objectives is essential to maintaining the relevancy of the strategic plan, i.e., constancy of purpose.

BALDRIGE CATEGORY 3: CUSTOMER AND MARKET FOCUS

Customers are just as important in a high-tech environment as in any other environment. However, since there is a temptation in high-tech industries to focus more on the technology of the product or the process, some aspects of customer satisfaction should be highlighted. These include

- Achieving balance between a customer and a product focus
- Systematic surveying
- Reaching the R&D work force
- Managing customer expectations

Note that the term "voice of the customer" is used informally several times. It implies a recognition that input from the customer comes in many forms and through many different channels and that these sources should be analyzed and integrated systematically.

Balancing Product and Customer Focus. In high-tech industries, there is an obvious need to focus on technology leadership. However, attention to the voice of the customer is a critical balance if the new product is to fit a useful application. Being mindful that the introduction of new technology can create discontinuities in the market, it is vital, therefore, to listen both to existing customers/markets and to those who would become users of the newer technology. (Wireless telephony that allows someone to carry a phone with them wherever they go rather than being tethered to fixed locations is an obvious example of this discontinuity. Computing technology that moved from mainframes and timeshare to PCs and client/server is another.)

While much emphasis is placed on the chain of traceability from customer requirements through product delivery, it may be useful for high-tech companies to initiate this chain even before the customer is necessarily aware of what is desired or wanted. Gale (1994) discusses the concept of product attributes and their seven-stage life cycle, from "basic" attributes, i.e., required with no competitive edge, to "latent," i.e., not yet visible or apparent in the marketplace. Table 28.1 describes each of these seven stages.

When searching for and listening to the voice of the customer, high-tech businesses that are mindful of this hierarchy can now probe for clues about new product possibilities based on what customers portray as "unique," "desired," or "latent" attributes, i.e., needs they have that are not yet fulfilled and hence are new product opportunities.

TABLE 28.1 Stages of the Attribute Life Cycle

Stage	Description
1. Latent	Not yet visible or apparent
2. Desired	Known but not currently supplied
3. Unique	Only the pioneer scores well
4. Pacing	One supplier is already ahead
5. Key	Differences in performance determine competitiveness
6. Fading	"Catch-up" moves begin to take away the top performer's edge
7. Basic	All suppliers perform well—no competitive edge

Source: Gale (1994).

Systematic Surveying. Speed and the acceleration of change in a high-tech industry also influence when and to whom to listen in the customer/market environment. Systematic surveying processes, showing trends in the market and the competition, are particularly useful if executed at regular intervals that keep tempo with market and technology changes. Surveys and surveying techniques that crosscut the management hierarchy of the customer base, including key decision makers, technology directors, and line technicians, fill in a more complete picture of how the customer needs are being perceived and met. Next, feedback to the customer to clarify what was heard and what should be expected helps to manage the risk of wasting ill-affordable time on bad assumptions. Finally, an aggressive action plan to assimilate and act on what was heard reassures customers that their time was used productively.

Reaching the R&D Work Force. High-tech industries need to have a wide, heavily used, and effective channel by which the voice of the customer can be clearly heard throughout the ranks of the technical community. While this may be difficult to create because of the distance in the value chain from R&D to the customer (customer to sales to marketing to product management to product planning to design to development to research), user group programs, technical seminars, formalized customer-visit processes, and creative partnering are examples of such channels. High-tech leaders who demonstrate equally high respect for the customer and the technical community and recognize the necessity to bring these groups together lay a good foundation for effective channel implementation.

Customer Expectations. Customer focus is *bidirectional.* Since uncertainties and unfamiliarities are intrinsic to new technology, it is just as important for the company to *speak* to its customer/market as it is expected to *listen* to its customers. Educating the customer/market about the new technology and helping to align expectations regarding the capabilities of the new technology are responsibilities that a high-tech company or industry must assume.

BALDRIGE CATEGORY 4: INFORMATION AND ANALYSIS

Topics to be addressed here fall into four broad areas:

- Finding and using the right metrics
- Using information technology
- The role of benchmarking
- The methods and benefits of overall organizational assessment

Metrics. It is not easy to find the right metrics. Relating back to policy deployment, any metric that is chosen for tracking should pertain to the objectives on the policy deployment matrix in some way and should support the greater good intended by the highest-level matrix. An example is useful here. Suppose one of the highest-level goals of an organization is to increase customer satisfaction. Further suppose that root-cause analysis of customer feedback data indicates that one of the issues for many of the customers is that installation time is too long. In response, a tools group within a product support division in the organization decides to invent tools to ease the installation burden for existing products. (Product re-engineering is surely one of the objectives for the design group, but that is longer term.) A metric for the tools group, therefore, might have to do with the speed with which they develop tools. This metric of development speed would pertain to the higher-level metrics of customer satisfaction and installation time and, at the same time, support the intended greater good. If, on the other hand, the tools group chose the metric "number of tools built," it could potentially build many tools that were not very useful even though their metric performance would be good. This attention to avoiding local optimization is what is meant by supporting the greater good. One therefore can see that while a metric might be far too detailed and obscure at the highest levels, it can nevertheless be a valid metric at lower levels if it can affect directly the performance of a higher-level metric.

In addressing an additional point that metrics also need to be truly measurable and quantifiable, some metrics must be broken down into constituent parts to be measurable. For example, in an R&D community, technical excellence, while very important, is in itself quite vague. It could, however, actually be decomposed into individual excellence, team excellence, and technical leadership excellence. Now how does an organization measure something like individual excellence? Individual excellence could be further broken down into attributes that address hiring, continuing education, and retention. Specific measures for these attributes can now be enumerated, such as hiring statistics from target schools and markets, attrition rates, participation in training programs, and so on.

Product-development indicators are especially important for high-tech products. One category of product-development indicator covers the overall development process, such as the frequency with which new products are being introduced or how effective vis-à-vis revenue is to the development process. A second category that is especially important for high-tech products pertains to the product at different stages of its development cycle, such as a metric having to do with testing and performance uncertainty. For instance, in many cases, hardware test data results are heavily dependent on the resolution of available test instrumentation, which, in an area of high technology, may approach the tolerances of the product. Hence empirical and testing data from field trials, prototyping, etc. are essential from the *earliest stages* because of the higher degree of uncertainty.

In summary, every level or function in the organization will likely have its own set of metrics, some of which are common across the organization and others of which relate directly to locally derived objectives. Identifying the right metrics, especially to ensure traceability to the customer, may take analysis of the task and insight into what behavior or outcome is sought. Typical metrics categories might include revenue, customer value, cycle time, productivity, cost (including cost of quality), reliability, defect rate, on-time delivery, technical excellence, product-development indicators, and manufacturing statistics.

Information Technology. Due to the combination of a global work force and a need for speed, the technology of the information systems is important. The systems must be integrated and able to gather, process, distribute, and share data quickly. This helps to close the geographic gap, make the employees more knowledgeable, and enhance the sense of awareness of the current situation. All these aspects help to bring a global work force together faster. The example of a hardware-development process illustrates the point here. Traditionally, the R&D group would design a circuit board, for example, and then create a working model, test it, and finally send it to the factory for manufacture. In turn, the factory engineers would redesign aspects of the circuit board to better accommodate supplier and production issues that had not been fully considered by the R&D staff. Today, a highly integrated design database coupled with a "concurrent" engineering process, i.e., R&D and factory working from the same design database at essentially the same time, can bring the two work groups together from the very beginning of the design phase even if not colocated. Significant interval reductions can be achieved, as well as side benefits such as better overall design and a stronger sense of teamwork.

Benchmarking. Benchmarking of product attributes is sometimes very difficult because new product performance characteristics are generally a closely held and well-controlled body of knowledge. However, high-tech companies can benchmark process capabilities. Benchmarking can help an organization to quickly study, assimilate, and improve processes based on the experience of others. High-tech companies in particular that are driven by speed can benefit from this because it helps them avoid the loss of time due to a more traditional trial-and-error method.

The areas for benchmarking include almost any process that is part of the day-to-day business. An obvious example of this is the 6σ improvement process that has been adopted by many companies interested in defect reduction (Harry n.d.).

Management System Assessment. Finally, a systematic management assessment process is essential to maintaining leading-edge performance. Because of the rate of innovation and change in a high-tech industry, it is important to guard against the tendency to fall behind if the organization is not growing, learning, and improving continuously. An efficient method of regular and periodic assessment with improvement planning built into the policy deployment process is a good countermeasure.

There are many different models against which an organization may audit itself for this purpose. The U.S. Malcolm Baldrige National Quality Award and the European Quality Award are two such models.

These models can be modified and used outside the intended formal award structure to bring the assessment process directly into the management and governance structure of the business. For a high-tech company whose survival depends on speed and quality, an integrated assessment process can serve as a constant barometer of its health. In this environment, the assessment process can be streamlined in time (e.g., on a regular basis, the leadership team can perform a self-assessment under the guidance of a trained examiner) and/or focused on a specific area (e.g., the R&D community might perform an assessment focusing on its ability to innovate.) Figure 28.5 is an example of an assessment process that falls between the formality of a national quality award application process and a simple leadership brainstorming session. It serves to suggest the existence of useful alternatives.

BALDRIGE CATEGORY 5: HUMAN RESOURCE DEVELOPMENT AND MANAGEMENT

The most obvious challenge in a high-tech business is to ensure that the organization has motivated and correctly trained people when and where it needs them in the global business environment. This applies not only to the R&D work force but also to the factory, business, sales, and customer service employee base. This requires lead time and is an important consideration in the strategic planning process and the policy deployment process.

In addition, highly trained technical work forces create the need for HR-related processes that specifically address the following needs:

- Nourishment of a feeder pool through trade school, university, and research partnerships
- Expectation of obsolescence and how to avoid it through a constant learning mentality
- Motivation to excel and incentive to innovate
- Tolerance for failure and risk-taking
- Retention of a scarce resource

Innovative processes that bring together technical expertise, corporate education, and HR can produce insights into core competency skills. They also can design and provide the best and quickest ways to acquire, develop, and maintain these needed skills.

Step 1: Using Baldrige criteria, the coach prepares a set of questions. The coach then conducts an initial round of sessions with focus group(s) (a group of subject matter experts from the organization, preferably the leadership team). Done in two adjacent half-day sessions, using a timekeeper:

- Each question is displayed on a Vugraph. 2 minutes to read.
- 5–10 minute brainstorm, "What are we doing?"
- 5 minutes to highlight strengths.

Step 2: The coach prepares summaries of focus group results for each question.

Step 3: The coach reconvenes original focus group(s) to

- Review and validate the findings
- Score the question
- Identify gaps based on the findings
- Propose possible countermeasures

The coach guides and helps calibrate scoring. An average score is developed.

Step 4: The coach prepares a summary by question, identifying strengths, gaps, and score for each question.

Step 5: [Optional] The coach leads an independent assessment team through the focus group findings. They develop an independent score, compare it to the focus group score, and resolve differences.

Step 6: Coach prepares executive summary and shares results with leadership team.

FIGURE 28.5 Simplified Baldrige assessment process.

In addition, to quickly and efficiently tap the potential of the large, skilled, distributed work force, it is important to avoid creating "linear systems." (Linear systems here generally imply processes that serialize events between and across groups of people.) The use of "parallel processes", e.g., policy deployment or concurrent engineering, and distributed information networks, serves to facilitate parallel yet coordinated activity. Here again, as mentioned in Baldrige Category 1: Leadership, a management approach that sets clear direction, expectations, and accountability but does not serialize or micromanage, i.e., one that has "loose hands on the reins," is essential to the success of parallel systems. One would not like to envision an organization where its manager inserts himself or herself into every decision, thereby throttling back decision frequency to a point that is commensurate with the "bandwidth" of the manager!

No amount of process, leadership direction, training strategies, and so on will succeed, however, if the employee body is not motivated to contribute to the success of the business. One technique that tends to couple approaches for motivation, resource retention, and business goal alignment is the use of a broad recognition system. Assuming that business values and goals have been communicated clearly through leadership initiatives and policy deployment processes, a follow-up system that formally and informally rewards behaviors aligned with those values and goals can be motivational in itself. For a highly technical work force in which recognition traditionally has been realized through intellectual and frequently individual achievement, a recognition program can highlight the value of team participation, speed, and innovation. Regardless of the monetary value of a recognition "event" (anything from a simple thank-you note to an expensive gift or free vacation), such an overall program serves to reinforce across the work force the power and the value of its individual and team contributions.

An even more powerful approach starts with the selection of the employees through a testing system that measures individual tendencies with respect to the core values of the business. Simply stated: Those who have the values that align with the organization's values are invited to join the team. For instance, if the need for collaboration among team members is identified as an essential element for success, then potential employees are interviewed to ascertain their affinity for collaboration before they are hired or invited to join the team. *Only those who demonstrate the desired attitudes, in addition to having the needed technical skills, are acceptable for that position.* A prerequisite to this approach is the existence of a set of principles or core values against which to measure candidates.

While this approach is probably part of every hiring practice to some degree, a thorough and systematic application uniformly across the organization can quickly set up an environment that has a very high probability of operating according to its stated principles and core values. For a high-tech company, the values of teamwork, collaboration, the need to be respectful of others, the drive to demand respect for every individual, a predisposition to excitement about new things, and the need to achieve and celebrate are the types of values that can positively influence the productivity of an organization. The other two essential ingredients in this formula are that there is a "structure" that supports and nurtures this environment—e.g., a separate location, perhaps, or no privileged parking (other than customers)—and that everyone *lives* the principles. If a transgression is sensed, any employee can and will speak to the transgressor, regardless of level. A related requirement that aligns with this approach is the use of process. Any process that has been adopted is rigorously followed with substance and conviction.

BALDRIGE CATEGORY 6: PROCESS MANAGEMENT

In the past, "process" has been considered anathema by many in the technical community. In practice, however, processes, whether formal or informal, are the repositories of organizational learning. The better the management of process (not to imply unnecessary complexity or overhead), the better is the ability to systematically produce quality results repeatedly and, hopefully, faster and faster. Therefore, a discussion of the management of process in a high-tech business is an important first step before addressing the issue of engaging the technical community in process.

The Management of Process. To meet the high-tech challenges of speed, global work force demands, and other issues, processes need to be well documented, effective, speedy, tolerant of very

little variation in output, easy to use, easy to change, and integrated with each other. In addition, processes need a supportive environment around them, including tools, owners, coaches, and related "care and feeding," such as management support and recognition programs. ISO 9000 registration, when accompanied by a healthy corrective action process, invites consideration of the preceding aspects and has helped organizations introduce process discipline into their activities.

ISO 9000 requires that processes are monitored for trends that indicate that sloppiness is creeping in. (*Sloppiness* here means things like missing quality records, processes not being followed, and dwindling leadership involvement.) When and if this is detected, root-cause analysis and corrective action are performed. If, however, the "corrective action" clause is not invoked frequently in order to maintain processes that are continually refined, the tendency is to tolerate or, worse, circumvent a system of processes that have become stagnant and obstructive.

It has been said that "if you do anything the same way twice, you are not learning to do it better." The point here is an interesting one. This idea, which on the surface may appear to be in conflict with the requirement of repeatability, is actually quite aligned with it, as can be seen in the simple process management flowchart in Table 28.2.

Note that "cycle" in the flowchart is loosely defined to imply some time period of homogeneous work, e.g., a software release, a major contract development, or a yearly performance review cycle. In some sense, the shorter the cycle and the more meaningful the improvement, the better the organization is at learning, innovating, and changing. Care needs to be taken, however, not to introduce a feeling of chaos. Further, quantum changes in technology could render parts or all of a process obsolete, or competition could demand significantly better performance. In these cases, aggressive process re-engineering is required.

In addition to ISO 9000 and the specifics of process management, supporting tools and environments that help build a healthy process management system include the following:

- *Leadership's constancy of purpose:* Continually reinforcing and rewarding process improvement. Leaders themselves should "own" breakthrough process changes.
- *Policy deployment:* This is a useful process to gather attention and promote momentum for breakthrough process re-engineering efforts.
- *Quality improvement story* (Qualtec 1991): This is a useful seven-step tool for tackling process-improvement activities. See Table 28.3 for a simplified chart of the seven steps.

Engagement of the Technical Work Force. And now to the question of engaging the technical community in process. The scientific method is in itself a process but is not labeled as such. In software, there is a growing body of evidence that careful application of process can substantially improve productivity and quality. Well-known processes such as quality function deployment (QFD, a.k.a. "house of quality") clearly provide R&D with a credible (to them) understanding of customer needs. These observations explicitly demonstrate to the technical world the benefits of process as a daily approach to product development. Leadership reinforcement, together with a responsive corrective action system, signals to this community that process is the acceptable approach. Process audit practices such as the Capers Jones CHECKPOINT software measurement method (Jones 1991) and the Software Engineering Institute's Capability Maturity Model (Paulk 1995), in addition to ISO audits, are

TABLE 28.2 Simplified Process Management Flowchart

Step	Action	Effect
Step 1	Define and deploy the process.	Stabilize the process and define the baseline.
Step 2	Use it for a cycle.	Measure it and gain experience with how the process operates.
Step 3	Change it via the corrective action process.	Improve the process per the experience gained by using it.
Step 4	Deploy the changes.	Systematically track the state of the process.
Step 5	Go to step 2.	Create an opportunity to improve the process again.

TABLE 28.3 Quality Improvement Story Simplified Flowchart

Step	Description
Step 1: Reason for improvement	Identify a theme (problem area) and reason for working on it. Identify team and schedule.
Step 2: Current situation	Select a problem (problem statement), set a target, and collect data on all aspects of the problem.
Step 3: Analysis	Identify and verify the root causes of the problem via cause and effect analysis.
Step 4: Countermeasures	Plan and implement countermeasures to the selected root causes of the problem.
Step 5: Results	Confirm that the problem and its root causes have been decreased and that the target has been met.
Step 6: Standardization	Systematically prevent the problem and its root causes from reoccurring. Replicate solutions, as appropriate, in other areas.
Step 7: Future plans	Plan how to tackle remaining problems. Evaluate Team's effectiveness.

Source: Qualtec Quality Services, Inc. (1991).

practices that help maintain alignment with process improvement. Finally, when connected to the customer, process has the added benefit of ensuring that customer input is systematically made available to the technical community, something generally sought but not always available.

Regarding this connection to the customer, a strong relationship between the sales/marketing organizations and the R&D organization provides a foundation for productive customer-R&D interactions, i.e., forums where R&D people discuss technology visions with customer groups and receive feedback on the visions. For more in-depth product understanding, process tools such as QFD can provide systematic support to the development process from the point of view of product definition. ISO 9000 then plays a strong role because of the discipline it implies in the development and manufacturing environment for the creation and deployment of the product with traceability to the customer.

Fundamentally and in summary, all this comes back to the organization's ability to accept and improve processes. The true measure of process-management capability then becomes the *speed at which small process improvements or major breakthroughs can be transferred into the mainstream operation* without losing efficiency, integration, and other aspects of the processes.

BALDRIGE CATEGORY 7: BUSINESS RESULTS

Results are really the ultimate metrics that show how well or how poorly a process or set of processes is producing sustained performance. It is important that the metrics represent not just financial results but a balance among shareholder, employee, customer, and other stakeholder values. For high-tech businesses, indicators of innovation, work force effectiveness, product quality, supplier quality, process management (especially speed), and customer satisfaction are essential. The major question to answer, then, is, "Are results meeting the goals defined by the strategy and policy deployment processes, and are the goals aggressive enough, i.e., best in class, breakthrough, or incremental, to sustain the desired trajectory?"

SUMMARY

Quality in a high-tech business has to do with a well-balanced mix of customer focus, process management and improvement, and engagement and alignment of skilled employees in support of clearly understood and cascaded goals. Particular tools and methods help to achieve the desired results. The major tools and methods that have been highlighted here include

- Policy deployment
- Process management and ISO 9000 certification
- Management system assessment against Baldrige criteria
- Customer interaction programs
- Employee engagement processes, e.g., training, recognition, etc.

The leadership of the business or industry, through its behavior, defines the approaches that will be used for each of these components. The customers of the business or industry ultimately decide the effectiveness of those approaches.

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