



Digital Hammers and Electronic Nails— Tools of the Next Generation

Editor's Note: This is the second of three articles by Gregory H. Watson on the evolution of the quality movement. Watson, vice president of research and technology for the American Society for Quality (ASQ), was instrumental in developing the Society's technology plan following his participation in the ASQ 1996 Futures Project.

**“I am wandering between two worlds, one dead, and
the other powerless to be born.”**

— Mathew Arnold, British poet, 1822-1888

Successful
future
companies
will use
relevant
information
to beat their
competition.

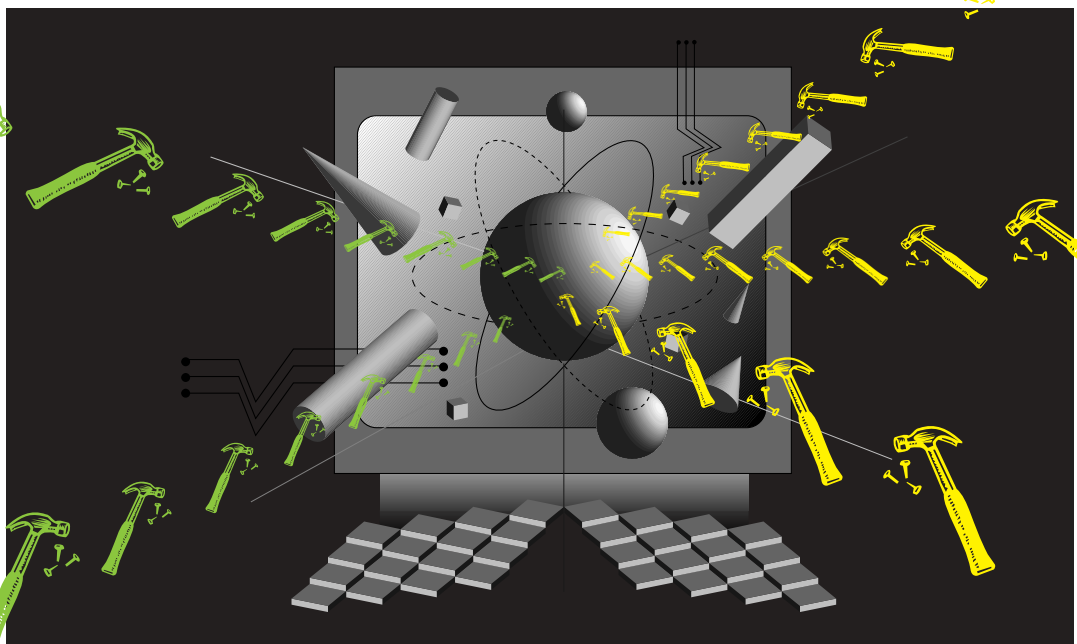
ONE OF THE FORCES DRIVING THE CONCLUSIONS of the American Society for Quality Futures Study was globalization stimulated by shrinking boundaries among businesses due to electronic commerce.

In the coming millennium, the effect of technology on the success of all businesses, not just the large multinationals, will be significant. Even a small business can benefit from advanced technology. A friend of mine, Ian Prosser, owns a small floral shop in Tampa, FL, named Botanica International Florist. Europeans who are coming to Florida to get married call him. Technology, specif-

ically the Internet, has transformed his business. International orders from his Web site match the orders from local customers. Through the magic of software and electronic commerce, his individual business can appear to be as large as General Motors or Florists' Transworld Delivery (FTD).

Today, we are routinely confronted by change. But most of us are unable to tell the difference between changes that merely present a mild inconvenience in our daily lives and changes that revolutionize the way we work. As Arthur C. Clarke once said, “Any sufficiently advanced technology is indistinguishable from magic.”¹ The role of technologists is to innovate new products and

by
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applications developments that keep the magic going. But for nonmagicians, this is a most disturbing world with disappearing buildings and floating tigers, not to mention quarters that appear out of thin air.

How can we become settled and live successfully in such a magical world? We must learn to embrace change—to seek it and not be afraid of a new and different world. As John A. Young, former CEO of Hewlett-Packard, decreed in 1985, “If you’re going to be successful in the electronics industry, then you’ve got to learn to love change. If you don’t like change, then you should go into the beer industry where the most successful beer makers work hard to preserve the traditions of the master brewers.”² However, with today’s microbreweries and other innovations, it appears that change may have penetrated even those hallowed halls. The truth is that no business is immune from change that is stimulated by new technology.

Business factors in the knowledge age

Peter Drucker christened this new age, in which information is a dominant factor, as the “knowledge age”—a time when the economic value of knowledge is becoming greater than the economic value of durable goods. In this age, the act of creating new knowledge will be synonymous with designing a new product. People will be valued for what they know, not just what they do. Information will become a freely trad-

ed commodity, just as food and consumer electronics have been.

In this future age, wars may be fought over copyright, trademark, or patent violations, instead of border disputes. As Nicolas Negroponte, director of the Massachusetts Institute of Technology media lab pointed out, “Being digital is to reflect on the difference between bits and atoms.”³

The future of the business world will not be in physical trade, reflected by our current trade policies, but in electronic bits that store the knowledge that is

central to an information economy. The physical world (atoms) will be less important than the world of ideas (the electronic world of bits).

What is the character of the emerging world? One premise is that successful future companies will take advantage of their knowledge bases of intellectual property and will seek to find ways to use this property to better serve their customers.

The most successful companies in this knowledge age will integrate quality thinking into their business model, creating a holistic, or integrated, enterprise. Many of these critical success

factors come from successful quality management and can be summarized as:

- **Vision directed.** Closing the gap between the current state of the business and the vision if its future is the strategy of the organization. The mutual understanding and support for the organization’s vision are required to harness the energy of its members to pursue the greater goal of organizational success.
- **Values driven.** The organization’s common culture and shared set of beliefs build collaborative, committed relationships among its stakeholders—both internal and external—and networks among unrelated businesses that share common interests.
- **Customer focused.** The organization exists to serve its customers and considers customer expectations and feedback in all phases of its business life cycle—from new product development to field service. The voice of the customer is heard clearly and used as a compelling source of information about what products to design and what changes need to be made in the organization’s customer service model.
- **Process controlled.** All work is managed as processes that are not only documented and measured, but use the in-process measures to guide the operation so that outcomes meet targeted results. Adaptive feedback and control mechanisms are one element of the information age that has been around for some time, but will grow in sophistication and application as technology becomes more advanced.
- **Team based.** Putting two heads together has been demonstrated to be better than having a single head dedicated to a problem. Teamwork will continue to be required—even in the way that future factories will be designed. According to the tongue-in-cheek prediction of management consultant Warren G. Bennis, “The factory of the future will have only two employees: a man and a dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the computer.”⁴ Now that’s the ultimate in teamwork.
- **Quality engineered.** Work processes will be quality engineered to prevent defects in output, reduce cycle time and waste, and eliminate lost productivity. The companies that take these steps forward move closer to a goal of six sigma operation—working at a level where problems are a rarity because failure opportunities have been both anticipated and eliminated at the process design stage through the application of advanced quality methods.
- **Technology aided.** Organizations have come to realize that technology is not a panacea, but can provide a competitive differential when applied to an organization that has its processes controlled and quality engineered. Technology for the sake of technology did not prove itself, as General Motors demonstrated by its 1980s-era investments in automated factory equipment projects that did not make any impact on its bottom-line financial or market performance. In the final analysis, appropriate technology used at the appropriate time will win.
- **Results oriented.** Organizations will be focused on achieving the results described in their visions. These results will be defined in the strategic plan, and all action plans will focus on delivering the long-term result—the vision—while meeting the short-term commitment to financial goals required by stockholders.

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New sources of knowledge, new sources of competition

Although most quality professionals have dedicated their careers to microeconomic considerations—the business of a firm—the quality professionals of the future must concentrate on a more macroeconomic world, a world that is affected by global politics and emerging sources of business competition. We will not only be concerned with what our historical competitors are doing, but also with what potential, or latent competitors—those with the resources and capability to compete against our firm if they should so choose—are going to do.

Years ago, the United States Postal Service and the United Parcel Service (UPS) had a friendly monopoly on the transportation of packages within the United States. Competitors, including FedEx, arose, along with the rise in popularity of the fax machine. FedEx has been a direct competitor focused on the movement of “atoms” for business. The fax represents the movement of “bits” and is a competitor of a different sort. FedEx also directly competes against airlines, representing the old way of doing things—moving physical packages. The fax machine is a competitor of a different type—a virtual competitor that has been spawned from technology to move virtual packages such as documents and mail via the Internet and World Wide Web. The Internet takes this competition one step further toward electronic communication of knowledge, as represented by documents.

In the knowledge age, competition can come from a variety of unanticipated sources because it will be easier to compete when the traded commodity is “bits of knowledge” rather than the physical presence of a product. These companies must consider the possibility of virtual competitors. As Joel Barker has preached for over a decade, “What would happen if an excellent company shifted the paradigm of business and discovered a completely different way of doing things?”⁵ The digital world provides just the sort of mechanism that companies can use to change the paradigms of their business models.

Meaning for quality professionals

Many of the old paradigms that have been part of the quality profession will shift over time as the digital representation of the world becomes more important to our lives. What does this mean for the quality professional?

For one thing, we cannot act like ostriches and put our heads in the sand, pleading technological naivete or fear of technology. We must face this emerging technological world head-on.

Mikel J. Harry, founder of the Six Sigma Academy, often preaches to people he trains as black belts: “We don’t know what we don’t know.”⁶

In the future, we will be able to collect and access data so easily that we will be tempted to analyze the data that are easy to obtain, which is not necessarily the data that we need to characterize the performance of work systems. This means that we must become more proficient in sorting, searching, and converting data to meet our requirements, rather than taking the easy way out and producing reports because data are readily available.

Care will be required to identify meaningful measurements that provide actionable findings.

Bill Gates has observed: “The computer is just a tool to help in solving identified problems. It isn’t, as people sometimes

seem to expect, a magical panacea. The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second [rule] is that automation applied to an inefficient operation will magnify the inefficiency.”⁷

Gates’ statements or rules seem to reinforce the need for process management and problem solving in the world of the future—two of the fundamental roles of quality professionals.

How is our world going to change as the knowledge age approaches?

What are the social shifts that are changing today’s world and will have far-reaching effects in the future? We need only read the headlines of the *International Herald Tribune* or watch CNN’s world news to become aware of some of the major trends that are changing today’s world:

- Social democracy has become accepted as the most acceptable form for governance across the world. This proliferation brings with it an emphasis on the choices of individuals and their ability to determine what they want for themselves—two of the essential ingredients of a free-market economy.
- The free-market economy has become the norm as regional groups band together to gain economic strength and ensure that their part of the world will be fully competitive in the future. Consider the European Economic Union and the North American Free Trade Agreement as two illustrations of this. Today, almost all global markets are represented by such collective bodies.
- Telecommunications deregulation has been a global trend with two related outcomes. First, the proliferation of national telecommunications providers is leading to consolidation. A few global providers are emerging that are capable of making the significant investments in the infrastructure required to support the digital world. Second, the national focus on regulation of these global entities has become meaningless as they become cross-national entities whose operations reach far beyond the jurisdiction of any national body. This means that individual nation-states will have less influence or control over what information is available to their people, furthering the influence of the social democratic principle of equal access to information.
- Technological breakthroughs will continue to be introduced

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to society. In a recent product announcement, Intel claimed that Moore's law (each new generation of microchip electronic memory will have twice the capability of the prior generation at half the cost) is dead. It is working on producing new technology that will multiply, not double, capability.

This trend has enormous implications in quality and process-control applications. As computer processing power and speed of access to data increase, so do the complexity of the problems analyzed and the number of sources for data.

This is due to the interconnection capability that extends beyond a single machine to a factory floor and beyond. This increase in problem complexity and interconnection density for data sources may preclude the use of traditional quality control techniques and push the envelope to new areas for information processing and data transformation.

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- One trend offsetting consolidation tendencies resulting from the spread of social democracy is the emergence of strong cultural and religious identification that is evident in many of the local conflicts that exist within our world. The building of a unique ethnic and religious identity is a reaction to the fact that most of us resist being in boxes that all look just the same.
- Despite this need for a unique identity, there is a strong movement toward standardization of business practices. Standardization is necessary when the hardware and software that different companies produce must work together in a single operating system—as occurs in the open system architecture for computer systems—or when the operations of business processes must work across the boundaries of

collaborative firms. Standardization will no longer become the job of a few individuals with esoteric technical backgrounds. It will become the “real politik” of the geopolitical world.

- Electronic commerce and global communications will change the way we work and live. They will provide business capabilities among individuals and companies that could not have existed previously. They will be an outgrowth of networks, special interest groups, forums, and chat groups and will provide the means to establish

new economic entities that had not been considered previously.

What will be the outcomes of these social shifts? No prediction can be completely correct, but the roots of the future can be observed in the past. We can chart a future view that is roughly right from our historical perspective. Some projections include the following estimates:

- Economic entities will be more important to the world than will be the individual nation-states. Although the types of economic entities will most probably change, they will likely rise to dominate the nation-state in influence.
- Regional trade affiliations will be more important than national political associations.
- Cultural and religious preservation will remain a strong counter-current to mainstream changes.
- Global businesses will influence international relations more strongly than the political agendas of local and national governments.
- Technology access will be critical for economic growth.

How will technological change influence our work in the near term?

Because information technology will become critical for business, it is most important for us to understand its future. Information technology consists of two categories that will ultimately converge and drive many business realities:

- **Telecommunications technology and the Internet.** This technology consists of wide-area networks (including the Internet), telecommunications protocols, data transmission technology, and network management systems that assure both personal privacy and economic security. The convergence potential of telecommunications technology comes from the choice as to where intelligence should be located—on the network or at the control of the user?

This choice is not as straightforward as it seems. We already have given up personal choices to computer systems that select news articles for us to read, determine when a security check needs to be made based on our buying habits, and sort our incoming messages for significance.

- **Personal computing, networks, and thought machines.** This technology includes such elements as personal computers, high-speed modems, optical storage devices, artificial intelligence, agent technology, relational databases, local-area networks, and groupware computing environments. The potential convergence for personal commuting with telecommunications comes from the merging of computer technology with modems, cellular phones, and personal data assistants in order to integrate our personal information environment.

These two technologies may be on a potential collision course, and many businesses that support these technologies may become candidates for mergers and acquisitions as multinational companies seek to position themselves to dominate global market share of these highly valuable technologies. Consider what the outcomes of these techno-shifts will mean for businesses:

- Automated, real-time access to business data and information sources will be available to monitor business developments as they occur, taking much of the guesswork out of decision making and eliminating time lags that occur due to

- end-of-the-reporting-period delays.
- This extensive access to information will pressure management teams to urgently develop new goods or services that not only meet the observed requirements of customers, but also anticipate their desires. Time-to-market improvements will be insufficient because customers will become aware of opportunities much more rapidly.
- As the knowledge of competitors' actions emerges, the faultless execution of strategy and enhanced productivity of operations will become the battle trenches for business. No time will be allowed to correct design or operating problems or to correct a misperception of the market.
- As product offerings merge and lose their distinctive quality, the level of service that an organization offers will become a critical product differentiator.

How do these techno-shifts change the work of quality professionals?

We should begin thinking about the future of the world by observing that the various disciplines of management (planning, finance, marketing, engineering, operations, personnel, information systems, and quality) have taken different paths in their evolution. It should not be surprising that the practitioners of these disciplines have developed unique cultures, values, and vocabularies in their efforts to coexist as an identifiable vocation within the milieu of the organization.

This, however, creates the problem that drives top management crazy—management becomes wrapped up in the care and feeding of its function while ignoring the greater-value business processes that deliver value to external customers.

The organization that reinforces functional thinking in the vocational subcultures therefore perpetuates this strong disconnect and builds high walls that serve as boundaries to the free flow of the business. The organization of the future will eliminate these boundaries through the appropriate application of technologies.

Virtual presence through teleconferences and videoconferences eliminates much business travel, with its time lost from work and often aggravating and frustrating side effects. However, it is not clear that a company will just make a few technology purchases and then walk into the new era. As Soshana Zuboff has said, “Unless informing is taken up as a conscious strategy... it is unlikely to yield up its full value. The centerpiece of such a strategy must be a redefinition of the system of authority that is expressed in and maintained by the traditional ... division of labor. The informing process sets knowledge and authority on a collision course. In the absence of [a] strategy to synthesize their force, neither can emerge as a clear victor, but [and] neither can emerge unscathed.”⁸

Knowledge and authority confront one another. This transition requires leadership and planned change. Teamwork and groupware drive knowledge to the lowest level of authority and the driving forces that encourage an organization to consider restructuring its decision-making processes. This pushes the decisions down to the lowest level of authority, where the information is best understood, and in most organizations this is the true meaning of empowerment. So, what will be the impact on quality professionals?

- Greater access to information will mean that any failure of a

company with one customer will be visible to all customers and could appear to be a major failure. Greater emphasis will be placed on faultless delivery of products and services to customers.

- Getting products right during their design will be a priority that gives added emphasis to reliability engineering for both hardware and software products.
- Maintaining predictable manufacturing processes will increase emphasis on process characterization, monitoring, control, and adaptive correction systems.
- The need to understand the voice of individual customers will expand the use of statistical sampling and analysis techniques in the survey of customers and will drive companies to use direct customer communications as the primary vehicle for collecting and analyzing customer data.
- Micro-marketing of information will be required to understand how customers perceive each moment of truth in their relationship with their supplier-partner organizations. Not every moment of truth is conceived equally in the eyes of customers. Some provide a much stronger competitive discriminator than others, and it will be necessary to measure these moments, monitor their performance, and prioritize service quality improvement efforts to ensure that the most dominant competitive discriminators yield differentiated performance.

Some of the trends that will change the way quality professionals work in the future include:

- The technical content of our work will increase. Does this mean that quality will merge with information technology?
- The breadth of a professional's expertise will be highly valued. Does this mean that quality will merge with industrial engineering?
- Human interaction will become more important to the success of individuals who work in this field. Does this mean that quality will merge with human resources?
- The importance of strategic thinking will become a critical differentiator between those quality professionals who are focused on an ever-increasing technological profession and those whose breadth and depth of knowledge earn them a place at the top management table as executive coach and team facilitator on strategic matters.

Although it is unclear what potential professional consolidations will take place in the future, it is significant that each of these proposed mergers represents a choice that already has been made by at least one *FORTUNE* 100 firm over the past few years. To prepare ourselves for such events we should act in accordance with the observation of author H.G. Wells, who said in 1920, “Human history becomes more a race between education and catastrophe.”⁹ We need to educate ourselves to avoid catastrophe.

How will these changes affect the competitive advantage of your firm?

The new knowledge age and digital world will bring forth its own rules for competitive businesses. Some of these rules are extensions of the past that we can be sure will play a role, while others will need to be discovered during the trials of life. A few that appear to be relevant include:

- First to market with the best product will win. All product development will compete simultaneously on both time and

excellence parameters. Complicating this trend, the first to achieve acceptance as an industry standard further wins because everyone else will need to pay them homage in terms of royalties and license fees or decide to sit out a generation of product technology in the hope of riding the next wave.

- Business process benchmarking, technology assessment, and strategic planning will become an “evergreen” or continuous process of significant value to top management.
- Reaction time in work processes will become a synonym for lost business. He who hesitates will be lost. At Motorola, former chairman Bob Galvin rated his managers on their ability to anticipate trends and commit to new ways of working. Response speed will be of the essence in winning the future customers’ loyalty.
- Value-chain thinking extending to global alliances, collaborations, and other types of partnering will become the common wisdom in organizational development.
- Innovation and information savvy will be the treasured skills of the next generation of managers.
- Continuous learning will be needed to provide the firm with exposure to innovative ideas and options for strategic choice.

In his book *The Road Ahead*, Gates said, “Education is society’s great leveler....Part of the beauty of the electronic world is that the extra cost of letting additional people use educational material is basically zero.”¹⁰ This means that as technology continues to change, we must create a robust means to educate people about how that change will affect them and give them the tools that prepare them for the new future.

Because the rate of technological change will likely continue to accelerate, we must create an ability to anticipate change, integrate new concepts into our business models, and build on proven work processes. These will be the critical success factors for achieving and maintaining operational excellence in the knowledge world.

As is true today, the reliance on competent people and use of business alliances and partnerships to extend the capability of our firms will be fundamental keys to success. In order to achieve this level of performance, both executives and quality professionals will need to become technologically astute to lead their firms into the 21st century. We must learn to wield digital hammers and use electronic nails—the tools of the next generation.

The great British statesman Winston Churchill forecast in *Onwards to Victory*, “The empires of the future are the empires of the mind.”¹¹ We must prepare ourselves for the new competencies of quality to have a leadership role in the future.

So, what should we do on Monday morning when we get back to the office? We must ask two questions: How do we influence our colleagues to think strategically and focus on developing the skills that will be needed in this future, and what are these skills that will be required?

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