2015 FUTURE OF QUALITY REPORT

Quality Throughout

ASQ
The Global Voice of Quality™

TABLE OF CONTENTS

William Troy

Introduction

This year's version of the Future of Quality is a bit of a departure from past editions, in both the what and the how. I began by asking myself, "What is the best way to help the quality community prepare for the challenges of the future?" The answer, I decided, was to determine what the challenges were. If we could go to sectors and disciplines wherein quality is at work every day, and give our members, friends, and colleagues a glimpse of what lies ahead—what is really important—then we will have done a good service for the community. With regard to the "how" side, while we have always had excellent collaborations with experts from around the world, I decided to try something different. I wanted you to hear these experts in their own voices, talking about the things they have studied, known, and in many cases, loved. To get them to share their thoughts, we simply asked them, "Tell us about the future of the world you know best." The depth of their knowledge and the clarity of their insights will be readily apparent to you, and we are truly grateful to each of them.

Without a doubt, quality will play an integral role in all of these areas, so businesses should pre-emptively harness this insight to further optimize the use of quality in response to what lies ahead.
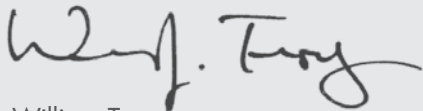
What you will see in the collection of essays is, I believe, unique in our Body of Knowledge. While such collections are not unheard of, we have reached out beyond the quality community to learn from experts who are new friends and who know a great deal about certain aspects of our future world. Our hope is that with a bit of the future thus illuminated, the quality community, in its broadest manifestation, from every discipline and profession, can then use these essays to discuss, debate, and learn. For businesses, the value lies in converting the challenges identified into opportunities. Without a doubt, quality will play an integral role in all of these areas, so businesses should pre-emptively harness this insight to further optimize the use of quality in response to what lies ahead. After having read and considered what each expert has to say, we will be better prepared for the future that awaits us.

While I think you will be pleased by the breadth of the materials we have assembled, you will also find some common threads that are woven into many of the essays. Here are three that struck me in particular:

- There is an endless but essential requirement to knock down silos of information in order to get the right information to the right places. I saw in many essays the need for high-quality information to be broadly shared to allow timely decisions. There will be a high price attached to information that is "owned," sequestered, or compartmented. Where speed of decision and speed of action is crucial, very careful decisions will have to be made about what to share and what to hold close.

- We must begin to truly think differently about things we assume we already know quite well. Take customers, for example—we think we understand them well already, but we don't. I think several of our essays would suggest that we are at the dawn of a new era of customer understanding and even with a new understanding, we will barely be able to keep pace with changes in the nature of customer demand, and it is a field that is changing perhaps faster than any of us realize.

- The implications of almost limitless connectivity will change how we think about, and do, almost everything. We've all heard the saying "Everything affects everything else." This is not really true today, but it will be tomorrow. From the connectivity that is an essential part of smart manufacturing, to medical schools holding classes for thousands of students simultaneously around the world, to city management, where a crisis in one sector can be immediately identified, communicated, and reacted to in seconds, everything will affect everything else, both for better and for worse.

One of the benefits of a collection of essays is that you aren't expected to read all of them; pick the ones that speak to your interests. I hope you will find them enjoyable, useful, and worthy of your time. I wish to acknowledge the Long Term Strategy Group (LTSG) for their considerable skill and expertise in creating this collection. Finally, I want to express my thanks to all our contributors. The heart of this effort is their work, their thoughts, their words. We at ASQ are honored to be associated with them. Their generosity in sharing the insights they've developed over many years of study and practice is humbling.

William Troy
CEO, ASQ

Stanley McChrystal   **Rodney Evans**

A world of change requires flexible organizations and adaptable leaders. The nature of competition in the global marketplace of the future will only magnify these realities, and breaking down organizational and individual barriers to flexibility will be necessary to take advantage of opportunities for collaboration and growth. Stanley McChrystal *and* Rodney Evans, *both from the* McChrystal Group, *present a case for a type of quality leadership that will drive success for teams in the future.*

THE FUTURE OF LEADERSHIP:
From Efficiency to Adaptability

In the late 19th century a near-sighted Pennsylvanian stalked factory shop floors in search of the best way to perform each task. Experienced workers railed as his precise measurements of time, materials, and labor were leveraged to standardize each activity, threatening the jealously protected value of experienced craftsmen. Opinions varied, but overall the results were impossible to ignore. Capturing and continuously refining the optimal performance of each task, and then combining them with rigorous discipline into a well-honed and carefully defined process, allowed production to skyrocket while costs fell. And within a generation, Frederick Winslow Taylor became an iconic symbol of modern efficiency—his writings and theories finding their way into society's myriad endeavors. Even modern organizations and leaders entirely unfamiliar with Taylor or his writings often reflect the pursuit of efficiency that underpinned much of the industrial juggernaut of the 19th and 20th centuries.

There is significant frustration with the reality that for many, what used to work now falters.

But in recent decades dizzying advances in information and other technologies have fundamentally changed the environment in which businesses compete, governments

Efficiency
Adaptability

Quality leadership for the future means that every individual in a system is empowered and inspired to own his or her "patch" of the place.

serve citizens, and women and men lead. There is significant frustration with the reality that for many, what used to work now falters. Against this backdrop, leaders routinely ask us how to increase in their team the initiative, innovation, and sense of ownership they associate with high-performing organizations. It's a great question to ask and reflects a significant departure from the more traditional quest for operational efficiency. But it would be better to ask how leaders can instill in their organizations levels of adaptability needed to deal with a new environment in which the only real constant is change. This represents the most important transformation in organizational leadership in generations, but what's driving it?

FROM PYRAMIDS TO NETWORKS

The reality is that we now live, work, and lead in an environment where static targets rarely exist. Activities, people, and information are linked, moving, connected, and enabled in ways that produce outcomes and effects that are fundamentally impossible to predict. More than ever, we deal in uncertainty. In the past, quality was about efficiency—getting the most x with the least y. But what if the variables aren't fixed? How can you solve for x if x is continuously changing? What if the problem you spent today solving won't be relevant tomorrow? Organizations must be able to identify and solve for emerging variables, and they must do it repeatedly.

In this environment defined by speed and complexity, top-down leadership is no longer sufficient. The inspiring, directive, strategic leader at the top of the organizational pyramid is no longer the most effective model by which to mobilize and optimize the talent within an organization. So the answer to the critical question is to create leaders at every level of an organization. Quality leadership for the future means that every individual in a system is empowered and inspired to own his or her "patch" of the place. But simply proclaiming that leadership is now the responsibility of everyone on the team doesn't make it so. It takes far more.

In 2004, despite an overwhelming superiority in superbly equipped military forces, the United States was losing the struggle against Al-Qaeda in Iraq (AQI). The loosely connected but organically adaptable terrorist network leveraged its inherent flexibility and speed to confound American forces constrained by its own hierarchical structures and processes. AQI's distributed network of operators was united by broad strategic guidance and an underlying common purpose—to do damage to the West. But the operators were otherwise free to operate autonomously using nontraditional methods. This allowed the terrorists to seize opportunity, fit structure to task, and, most critically, act faster than our more conventional structures and processes.

To succeed against this threat we had to become adaptable, both as organizations and as leaders. It required us to construct our own networks that were connected not only by communications but also by the sinew of trust and common purpose. Our cultural habit of compartmentalizing information and limiting our interaction with other military units or government agencies—to guard our prized autonomy—gave way to radical transparency and intentional interdependence. The effects were stunning as the synergies of a truly networked team of teams allowed us to reverse the tide against AQI.

When we left the service and formed the McChrystal Group in 2010, we saw similar challenges in our interactions with private clients. Our synthesis of lessons learned in the Middle East and in the private sector, called CrossLead, represents a new model of leadership and management. Firms in every sector of the economy need to radically change decision-making processes so that those nearest the issue, with the greatest understanding, are empowered to act. At the same time, we have to create communication forums so that decision makers lower in the organizations have the situational context and awareness of those at more senior levels.

The counterargument to empowerment is always, "I can't give up these decisions, because my reports don't have the big picture." Rather than holding the decisions at a senior level, necessarily slowing them down and degrading their quality, what if the "big picture" is made available to a larger group? CrossLead requires transparent leadership, a major investment of time into communication, and constantly forcing cross-functional collaboration. The result is that leaders can make fewer decisions, create ownership and accountability below their level, and have more whitespace for understanding the environment and proactively addressing new information.

This requires a shift in mindset from "pyramid" to "network" leadership. As the environment shifts and morphs, unanticipated threats emerge, key talent leaves, acquisitions

happen and lawsuits are filed—the network leader doesn't solve the problem himself or herself. Instead, he or she spends time pushing information into the system, and pulling together the nodes that have the right understanding to tackle the issue. Cross-functional teams spring up, collaborate, solve, and disband. And this can happen spontaneously because there is an understanding of the situation, the organization's purpose, and the issue to be solved. This kind of adaptability will outpace efficiency any day.

LEADERSHIP SKILLS FOR THE INFORMATION AGE

To make the shift from efficiency to adaptability, corporate leaders must possess certain fundamental skills. What we see in organizations is an overly heavy reliance on functional, technical, or subject matter excellence; and attention to leadership fundamentals tends to be focused only within small groups of "high potentials" or the top of the house. But deep technical understanding in one's field of expertise doesn't prepare leaders for today's role of leader as gardener rather than chess master. Flourishing in the 21st-century market environment requires harnessing the talent in an organization (the seedbed), effectively pumping information into the system (water), and connecting those who may be siloed (cross-fertilization). Typically, as leaders progress in their careers, they gain experience in various areas that develop their technical competence. But as they grow and progress, their reliance on these things becomes less critical and another, more general skill set takes precedence.

Adaptable leaders must be rewarded on attributes like self-awareness and constant learning, not only on meeting a sales quota or exceeding a revenue target.

Adaptability comes from mastering this more general leadership skill set. If one has to pour thought and effort into decision making, maintaining a disciplined routine, or communicating effectively, there is little space to anticipate the unexpected. Only when an individual has mastery of these timeless leadership fundamentals will he or she become truly adaptable. Whether we consider Daniel painting the fence (*The Karate Kid,* 1984), YoYo Ma practicing scales, or Coach Wooden drilling his team, we see that those who have mastery understand that "fundamentals first" is the only way to prepare for situations that can't be anticipated. This is a radical shift from how many organizations incentivize and reward performance.

Quality leadership is about taking a long-horizon view. Many corporate systems reward based on meeting or exceeding short-term goals that rely heavily on depth in one area. We rarely see leaders asked to develop and perform against leadership fundaments. It's time for a shift—adaptable leaders must be rewarded on attributes like self-awareness and constant learning, not only on meeting a sales quota or exceeding a revenue target.

Rather than focus on incremental improvement through more effort on old practices, many organizations need to make a holistic shift that has broad, significant impact over time. This takes commitment and a long-term view. Reorganizations, cost-cutting measures, and replacing executives answer a short-term need for action and deliver a brief spike in results. But meaningful, impactful change requires investment in both organizational process and leadership skills in order to be adaptable over time.

CONCLUSION

The hard part? Patience. Changing the way a complex system functions doesn't happen overnight—we're talking about altering the collection of behaviors that constitute an organization's culture. And that's no easy task. We are fortunate to be able to draw on the insights of a wonderful network of thinkers, leaders, and innovators. Conversations about long-horizon thinking, ecosystem orientation, and a move toward adaptability are happening in many academic, practitioner, and corporate circles. At the McChrystal Group, we are pulling those conversations together and continually iterating a model that answers the challenges posed by the business community today.

Jonathan Zittrain

From Edward Snowden to the Sony hacking story, societal dilemmas presented by the continuously evolving information technology revolution are not hard to identify. The future of the Internet, including the emerging "Internet of Things," presents a complex picture for the quality community. With change happening so rapidly and in such a decentralized fashion, new and unpredictable products and services are sure to arise. Harvard's Jonathan Zittrain, *the co-founder and director of the* Berkman Center for Internet & Society, *sheds light on the future of information's challenges and opportunities for the quality community.*

THE FUTURE OF THE INTERNET:
Balancing Security With Openness in the Internet of Things

I wrote a book called *The Future of the Internet—And How to Stop It.* Its thesis was that our amazing three-decade run of the modern personal computer and Internet had been fueled by the "generative" characteristics of each—but stood vulnerable to security problems brought about by their very successes.

The PC allowed anyone to write and share (or sell) software for it—with the PC and operating system manufacturers having no role in deciding what would and wouldn't run on their systems. That was unusual for its time or any time: The PC was introduced to a hobbyist community against a backdrop of nonprogrammable "information appliances" like dedicated word processors.
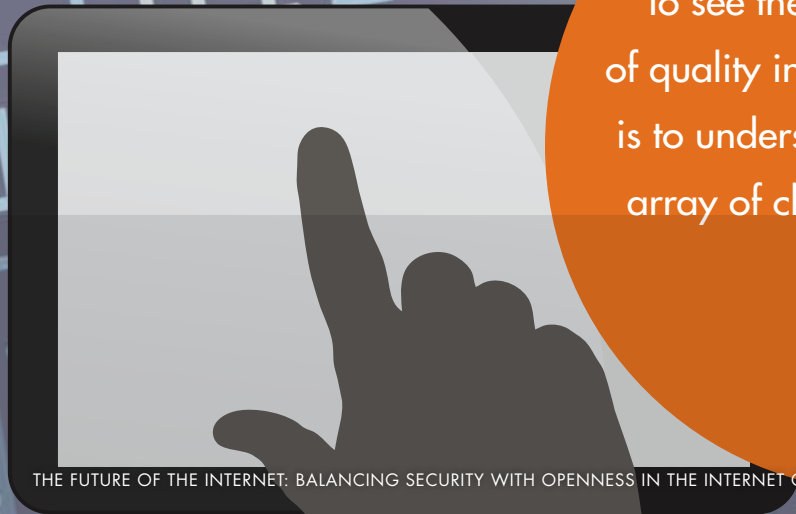
THE INTERNET

Same for the Internet. Unlike CompuServe, America Online, and Prodigy—the online services designed for the general public—the Internet allowed anyone to communicate

Balancing
Security

To see the multidimensionality of quality in the information space is to understand the breathtaking array of choices and trade-offs.

with anyone, without any refereeing of the movement of bits or code. Unlike the proprietary counterparts that it soon eclipsed, the Internet has no main menu, no CEO, and no business plan. Anything could be built on top of it without permission of a central authority, and the resulting applications could, and did, surprise us in their reach and popularity. Foremost among them is the World Wide Web, designed by Tim Berners-Lee, a genius physicist working in his spare time, its protocols gifted to the world. (When Sir Tim appeared in the opening ceremonies of the UK Summer Olympics, tweeting out "This is for everyone" from the stadium, the network television anchors covering the event had no idea who he was.)

My worry in 2007 was that the openness of the PC to new code from anywhere, and the Internet to new applications and sites designed by anyone, was being increasingly abused. The Apple iPhone had just been introduced, and in its first version it brooked no outside code at all. I saw in the iPhone the return of the information appliance, a harbinger not just of dumb flip phones becoming smart, but of a rebooting of our entire information architecture from open to closed, unowned to owned, and innovative to stable—for the cause of better security.

The iPhone was indeed the beginning of a revolution. What made it most interesting was its second version, which introduced the App Store. The App Store represented a hybrid of the original PC, running outside code, and the information appliance, countenancing none. It put Apple in the position of vetting who could code for its products, long after they left the factory. It allows for great innovation—tens of thousands of apps—while permitting velvet ropes to be strung either by category or individually to exclude certain

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kinds of programs and services that don't meet the preferences of Apple, or those who can regulate Apple. And we now see app stores across the gamut of information technology—they are in our phones, our tablets, and yes, our PCs, increasingly as the only practical sources for new code. The result is industry concentration in operating systems, and increased interest by regulators in monitoring and controlling what software is permitted to run—

and in turn, what content can circulate. As these architectures are exported to states that don't embrace the rule of law, the implications for state control become more profound.

THE EMERGING INTERNET OF THINGS

This is a future I still want to stop, while still taking seriously the security concerns that have largely prompted this enclosure of technology. Looking ahead, we can see the

same dynamics shaping up for the emerging Internet of Things. Imagine an Internet-aware shovel. It may seem pointless at first, but it doesn't take much to imagine some good applications. Perhaps it can report when it's being used, so mom can check to see if the kids have dealt with the icy walk yet. It can sound an alert, personalized to the health profile of its wielder, if his handle-measured heart rate is going too high. (Maybe it can summon an ambulance if the hand grows cold.) Data aggregated across shovels can tell the city where to send the plows, on the logic that those shoveling the most must have the deepest snow. Or perhaps it's the opposite: Where people are too daunted to shovel is where the plows should go.

Will the shovel's features be determined only by its maker, or will there be an application programming environment made available for it? Will its data telemetry be owned and directable by the user, or proprietary to the maker? Our hypothetical shovel invites us to ask generally: Will Things be able to talk to one another across vendors, or only to their makers? Who owns a Thing—the purchaser? Or is it more like a service than a product?

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CONCLUSION

These questions remind us that so much is yet to be determined in our information ecosystem, and that the distinctions between owned and unowned, generative and sterile, remain as vital as ever. And they should inspire us to reflect on what we mean when we invoke quality. A quality shovel won't break down with lots of use and it won't be made of toxic parts. But a quality Internet-enabled shovel? That's much murkier. To some, security should be paramount—so having the shovel able to talk to the tea kettle only invites trouble, with little upside. To others, quality is optimized when open-ended populations of coders can try a hand at improving the way things (and Things) work. To see the multidimensionality of quality in the information space is to understand the breathtaking array of choices and trade-offs, and to begin working through the puzzle of just who should be making and guiding the answers among consumers, producers, regulators, and communities across each that are yet to gel.

Stephen P. Rosen

The global aerospace and defense industry is inherently complex. Militaries require exquisite and reliable technological systems because the missions they carry out are vital to the security of their countries. This guarantees that technological and geopolitical trends will drive immense change in the next decade. As an expert on the future security environment, Stephen P. Rosen, *the Beton Michael Kaneb Professor of National Security and Military Affairs at* Harvard, *is well positioned to demonstrate what change in the industry will mean for the quality community moving forward.*

THE FUTURE OF GLOBAL AEROSPACE AND DEFENSE:
Implications of International Trends for Quality

International trends—including demographic contraction and the spread of high-tech knowledge and information—have generated conditions that will make quality and continuous improvement in the aerospace and defense (A&D) sector even more important in the future than it has been in the past.

Both intrinsic factors and competitive pressures have historically led the A&D sector to prioritize quality, understood as ensuring not simply uniformity of product but also the performance of components and systems as intended. By its nature, the work of developing and employing high-technology products at the limits of their performance envelopes and beyond requires the most severe and refined approaches to quality and continuous improvement. A&D systems operating for long periods of time in unforgiving environments such as earth orbits, the undersea domain, or the deserts, cities, and jungles where counter-terrorist and counter-insurgency operations occur demand the highest quality of which we are capable. The intensity of competition in the commercial aviation industry requires efficiencies of operation derived from components and systems that perform

Aerospace and International Defense Trends

Interconnectedness thus increases the need for quality at the component and the system level, so that errors and failures are eliminated before their effects propagate throughout the system.

reliably as designed and at the lowest possible cost. In short, the A&D industry has focused on quality because it was, and is, important for components and systems not to fail due to flaws in design or production.

Against this backdrop, several trends in the international security environment will only increase the salience of quality. First, political and economic constraints are driving the United States and other rich industrial societies toward unmanned autonomous systems. Component failure in such systems will not necessarily lead to the loss of human life but could result in mission failure that might be less crippling in manned systems. Second, the global spread of high-tech and engineering know-how and the incentive of hostile forces to exploit vulnerabilities embedded in systems will increase the need to identify and eliminate defects that can be exploited. We no longer face only the need to guard against component and system failures that are the result of physical weaknesses or defects; we must also use quality and continuous improvement to eliminate design features or flaws that can be exploited by intelligent and hostile adversaries. Finally, the interconnectedness of systems is more and more a force multiplier, but it also generates the risk of cascading effects if one part of the network falters or introduces faulty information. Interconnectedness thus increases the need for quality at the component and the system level, so that errors and failures are eliminated before their effects propagate throughout the system.

KEY INTERNATIONAL TRENDS AFFECTING QUALITY IN THE A&D SECTOR

Corporate planners must make investment decisions, formulate merger and acquisition strategies, and develop internal human capital in anticipation of what they will need to be able to do years from now. They know that the future will not look exactly like the present, but predictions and forecasts of market behavior are notoriously imprecise. Current events are flashy but also full of noise and possibly misleading. A more reliable point of departure for corporate planners are dynamics that can be observed over long periods to establish whether they are stable and have internal characteristics that lead them to be self-sustaining. Moore's Law has held true for close to 50 years. It endures not because of laws of physics but because people believe it is true: If everyone believes that the number of transistors on a chip doubles every two years, then everyone will invest a huge amount of effort in figuring out how to make the next advance because if they do not, their competitors will. With all that effort along multiple lines, someone always has figured out how to make the next advance.

> **We must also use quality and continuous improvement to eliminate design features or flaws that can be exploited.**

What can we say about trends in the international security environment and their implications for the A&D industry looking ahead 10 years?

POPULATION BUST

While the population of the world has grown, contrary to expectations, the number of children being born to women in all areas of the world except sub-Saharan Africa and in some Arab countries has declined. It has declined to sub-replacement levels not only in the industrialized areas of the world, including China, but also in much of the Muslim world, including Iran. Because of the surge in the number of children who were born and survived to adulthood in the 1960s and 1970s, world population is still growing, but on current trends it will level off, decline, and create a reduction in the number of men and women of working age relative to the older population born before the decline in birth rates. Labor will be more scarce, and capital will be substituted for labor. One way in which this will be done is through the use of autonomous systems for many activities now performed by people. While there is distrust of "robots" in the United States, other countries such as South Korea are already far down the road in the utilization of autonomous systems for military as well as nonmilitary purposes.
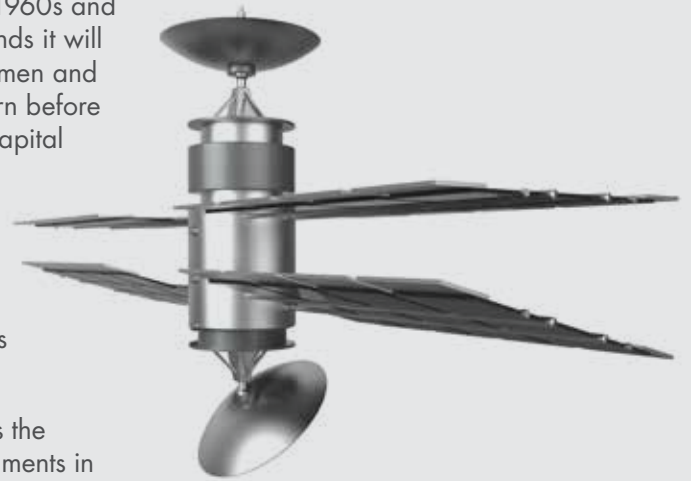
Such systems have functioned well and will do so as long as the interactions between those systems and the complex environments in which they operate are carefully reviewed. Autonomous systems have large problems when encountering unexpected issues. For instance, the loss of the American RQ-170 autonomous drone is said to have been the result of the drone's going into an automatic landing when it encountered an issue while in flight. The fact that it was over Iran when this happened was a problem of quality requiring efforts to remediate the flaws in the software that led the system to execute undesirable actions. The more autonomous systems there are, the more continuous improvement of this kind will be necessary.

DIFFUSION OF KNOWLEDGE

If you visit the campus of any major American university, you will be struck by the number of students speaking Chinese or Hindi or Arabic. This is only one visible manifestation of the large number of very intelligent young people from around the world who have access to educators doing advanced research. Less visible to Americans are the students going to universities in Europe and Singapore. Add to that the multiple reports of the theft

of intellectual property by way of the Internet. Given the availability of smart engineers worldwide, Internet access, and state funding of national technology development programs, the leading industrialized societies should expect other countries to follow rapidly behind them in ways that will reduce their military-technological advantage. This will have particular relevance in the following areas:

- The diffusion of capabilities will affect the **competition in the area of precision strike versus stealth**. Briefly put, on the surface of the ocean, in the air, and for fixed locations on land, the application of information technology to military affairs—often referred to as the modern Revolution in Military Affairs—has given the most advanced militaries the ability to detect, characterize, and target military assets that are not low observable in nature. Other states are today acquiring the same suite of capabilities, ranging from reconnaissance satellites and reconnaissance drones to radars and other sensors. What states can find, they can increasingly hit and destroy with precision-guided weapons. Surviving in this environment means being low observable or stealthy. Stealth is a matter of design but also of paying attention to details that inadvertently give the adversary a way to detect you. Submariners have long known that sloppiness is the enemy of stealth. Machine bearings that make noise and operational practices that generate transient acoustic signals can be enough to give away the position of a submarine. B-2 bombers require exquisite maintenance so that their stealthiness is not eroded by wear and tear. Airplane cockpits must be redesigned so that radar returns from sharp corners do not pass through radar transparent canopies. As competitors become increasingly capable thanks to the diffusion of knowledge, the A&D industry will have to become more and more focused on eliminating small flaws in components and systems that may expose the location of systems. This is fundamentally an issue of quality.

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- The diffusion of knowledge has also enabled the **rise of hacking and computer warfare cultures** in other countries. The United States is alleged to have conducted the first serious peacetime cyber attack against the Soviet Union in 1982 as part of Operation Farewell, by manipulating the computer codes that affected the gas pumping turbines imported by the Soviet Union, causing the largest recorded manmade non-nuclear explosion in history. The United States is also alleged to have been in involved in the Stuxnet attack on Iranian uranium enrichment centrifuges. But cyber warfare has equally been employed by Russia against small neighboring

states, and by North Korea. The diffusion of knowledge is a trend that we can expect to continue and which will enable more and more sophisticated attacks on friendly computer systems.

- **Cyber warfare has emerged as perhaps the dominant form of nonkinetic attack** that can be employed in peacetime as well as in wartime. Although details of cyber attack and defense are classified, available reporting suggests that these attacks begin with a search for a weakness in the cyber defenses of the target. These can be human weaknesses, but flaws in software code give intruders access to the operating systems of the target. There is a constant search for aspects of code that are not conventional errors, in that they do not cause problems for the intended users of the programs, but which can be used by hostile attackers to manipulate the program against its owners. Eliminating these aspects of the programs is essentially a matter of quality, of carefully reviewing and evaluating a system to make sure its components are not unwittingly hazardous for the operator of that system.

DIFFUSION OF DATA

Finally, along with the diffusion of knowledge has come the diffusion of data—i.e., a deliberate effort to make it possible for people and systems continuously to report their position, status, and behavior to other people and systems, so that multiple actors can adjust their behavior in close to real time. This can bring about great improvements in efficiency, as long as bad data is not introduced into the system and as long as bad or misinterpreted data, when entered, is identified and neutralized. We have seen what happens when bad or misinterpreted data is not weeded out in highly connected, automated financial trading systems, when flash crashes have led to massive, transient, and artificial spikes in the price of shares of stock leading to massive and real financial loss. The entry of bad data into military systems was associated with the mistaken shoot-down of an Iranian passenger jetliner by the USS Vincennes in 1987, and with the bombing of the Chinese embassy by the United States in Serbia in 1999. The unintended consequences of the propagation of bad or misinterpreted data will become more and more of a problem as more activity is networked and automated, enabling rapid and dysfunctional propagation of data. Identifying and eliminating the problems that could be caused by more and more rapid sharing of data before it occurs is a problem of quality.

CONCLUSION

Quality is not just a matter of ensuring uniformity of production. It is a matter of ensuring that components and systems do not have flaws that will lead them not to perform as intended. Understood in this way, and taking into account observable international trends, the future of quality in the A&D sector will be even more important in the future than it is today.

Jim Davis

Manufacturing has long been at the core of the quality community, and today we stand on the brink of the era of "smart manufacturing," thanks to the information technology revolution and the wealth of data that can now be collected, communicated, and analyzed. Jim Davis, *of the* University of California-Los Angeles (UCLA) *and the* Smart Manufacturing Leadership Coalition (SMLC), *demonstrates quality's enduring role in manufacturing domains that will be increasingly enhanced by information technology in the coming decade.*

THE FUTURE OF MANUFACTURING:
Bridging Seams and Transactions to Integrate Next-Generation Information Technology

Next-generation information technology (IT) is about network-based data, unprecedented modeling capabilities, mobile computing, social networking, and IT clouds that go far beyond today's infrastructure and software services. It is clear that the number of intelligent, connected devices is skyrocketing, with well-promoted estimates in the range of 30 billion by 2020. This explosion in systems of integrated devices, data, and information sets the stage for applications that provide unimaginable new insights and solutions, unprecedented opportunities, and relentless forces for changing how every major industry does business.

More narrowly, there is no longer any doubt that manufacturing is an industry that needs to adopt these new IT systems and technologies to meet future manufacturing expectations. It is in what way, at what speed, and how well the IT is applied that will impact the future of individual manufacturers and the supply chains in which they participate. In concept, smart manufacturing (SM) is the opportunity-based application

Next-Generation
Technology

Can enterprise performance with new IT be predicted so that entry points for smart manufacturing (SM) systems can be identified?

of these technologies. In business terms, SM is the end-to-end use of real-time, networked, data-based intelligence for enterprise integration of dynamic market demands, high-velocity technologies, and added-value products in conjunction with increased economic, energy, and material productivity, zero incidents, reduced industry energy usage, and environmental sustainability.

ENVISIONING SMART MANUFACTURING'S POTENTIAL THROUGH A FOOD INDUSTRY EXAMPLE

SM and the roles for new IT capabilities in a manufacturing enterprise must grow from the interoperation of physical, cyber, and workforce elements. Myriad questions boil down to asking how these three elements come together to improve enterprise operations involving increasingly complex products and markets: Can enterprise performance with new IT be predicted so that entry points for SM systems can be identified? To this end, thinking about enterprise modeling in terms of basic changes in the nature of manufacturing "seams" and "transactions" offers insight into the new business of SM.

A seam is a location where two or more parts of a manufacturing enterprise or supply chain (processes, systems, or organizations) are joined together by a transaction. The transaction is the traditional approach to bridging a seam. It resembles a business purchase and delivery process in which minimal information is shared upstream or downstream from the seam. Seams form as a result of different data definitions, standards, supplier products, factory operations, actionable windows in time, and operational constants. Seams and transactions exist in operational layers at the micro level (people to machines, or machines to machines), the meso level (across suppliers of similar components, or factory operations), and the macro level (across factories, or supply chains). Material, energy, and information are often stored around seams to facilitate transactions.

> **SM and the roles for new IT capabilities in a manufacturing enterprise must grow from the interoperation of physical, cyber, and workforce elements.**

The existence of seams and transactions is not a surprise, but the scope and scale of their existence in the sense of enterprise compartments—and therefore opportunities for optimization—is literally shocking. As an example, consider a food industry supply chain where consumers purchase a food product at a grocery store. The final product must meet specifications for composition and packaging, be free of contaminants, meet defined taste requirements, and comply with regulations. In production, variations in ingredients from multiple suppliers must be managed into recipes that produce a consistent product. Ingredients from multi-tier suppliers and growers must be procured, warehoused, evaluated to verify properties, and transported to manufacturers. Increasingly stringent regulations require traceability from the store to suppliers and growers, and variables such as weather patterns impact the process. The whole chain needs to respond to dynamic demands for the product in different markets around the world.

This farm to fork description of the food industry supply chain demonstrates the concept of seams being continuously bridged to produce a product. Seams create discontinuities among physical materials and facilities, cyber control systems and information flows, and the workforce in farms, transportation, and production. The industry currently manages seams and transactions throughout the chain from source to product and orchestrates the chain with a model that uses predictions of customer purchasing behaviors and sales to drive inventories and operations from customer to source.

The food industry example changes dramatically if we apply SM to automate, redefine, and in some cases eliminate seams and transitions. For example, early notification by suppliers of variations in ingredients can allow operations to prepare process adjustments before receipt of the ingredients. Or early notification by manufacturers of production problems can allow suppliers to adjust distribution of their products before shipment. This proactive approach reduces delivery time and cost, and can enable integration of traceability into operations. Ultimately operations can be driven by direct one-for-one product-supplied and product-purchased models that reduce shelf time, inventory, and spoilage. With SM systems, a supply chain with dynamic enterprise predictability suddenly offers unlimited, untapped opportunities for improvement.

INITIAL SM ADOPTION

Absent new enterprise infrastructure, SM adoption will proceed slowly because of awareness, risk, and return on investment (ROI) barriers. Capturing the future benefits of SM requires timely access and progressive development of new IT systems built to bridge seams in all enterprise functions. However, the complexities, the diversity of entrée points, and the cost of adoption will make it nearly impossible for companies to "own" all the necessary capabilities for SM implementation. In the recent ASQ 2014 Manufacturing Outlook Survey, 700 respondents representing diverse industries such as aerospace, automotive, food, medical devices, pharmaceutical, and utilities were asked about SM. Of those surveyed, 80 percent were not aware, did not see a need, or indicated that cost was a barrier or that management was resistant, even though the 13 percent who are already applying SM have experienced significant benefit.

In response, the nonprofit industry-led Smart Manufacturing Leadership Coalition (SMLC), of which ASQ is a member, is using next-generation IT to develop the SM platform to provide missing infrastructure and make it highly accessible. This infrastructure will provide real-time, data-based application development, deployment, performance, and

reuse implemented in "as-needed services" accessible through a cloud. Importantly, the SM platform is being designed as industry-driven, truly open infrastructure, i.e., with the following characteristics:

- **Open architecture**—vendor agnostic standards-based integration and interfacing with commercial and open-source platform technologies

- **Open access**—low-cost access to SM platform technologies

- **Open marketplace**—open access to composable, market-driven, commercial, and open-source application libraries inclusive of deployment, data management, modeling, analytics, and metrics applications along with associated nonproprietary deployment data, certifications, and services

SM platform infrastructure is designed to facilitate low-cost, secure, and timely bridging of seams and use of information to optimize beyond transactions. The nature of such a heterogeneous environment requires bridging across a wide range of technology, workforce, and organizational readiness levels. Ongoing discussions involving practitioners, suppliers, manufacturing consortia, agencies, laboratories, universities, boards, and committees now recognize the importance and promise of optimization through platforms and enterprise modeling. Below are SM vignettes describing current commercial activities involving enterprise modeling drawn from work by Mike Yost for the Manufacturing Enterprise Solutions Association and from the California Manufacturing Technology Consulting 2014 Survey:

LEVERAGE DATA TO INTEGRATE OPERATIONS

- "Real-time visibility to suppliers so demand volumes and timing are served with minimal inventory in the supply chain and consuming locations"

- "Electronic chain of custody from suppliers including quality variations so production processes can be adjusted prior to receipt of components or materials"

OPTIMIZE EFFICIENCIES ACROSS AN ENTIRE CHAIN

- "Data and information from across a supply chain to build intelligence in end-to-end business processes, and unlock new solutions to drive optimization"

- "Synchronized supply chains with real-time demand forecasts to reduce problems such as order changes, expediting, premium freight, and just-in-case inventory"

COOPERATE TO IMPROVE INDIVIDUAL MANUFACTURING PROCESSES

- "Batches reduced to one-piece flows by communicating consumption transactions, quality variations, and response priorities to suppliers instantaneously"

- "Corrective action workflows triggered from process variations to integrate functional personnel in real time, regardless of global location"

HIGH DEGREES OF PRODUCT CUSTOMIZATION

- "Increased product complexity managed by digitizing production processes and using this intelligence to give customers more freedom to customize products and manufacturers more ability to deliver them"

- "Control over production processes, changeovers, and varying order sizes to match output with demand and be more responsive to customer needs"

- "Sequenced production to synchronous assembly of automotive instrument panels, door panels, and consoles with the flow of components across a supply chain"

CONCLUSION

Seams and transactions are so ingrained in the structure of manufacturing industries that they often go unnoticed in the context of current operating models. Even the International Society of Automation's ANSI/ISA 95 System Layer Classification manifests itself as multiple, discreet layers of supplier products and systems (seams) that must be bridged (transactions). These long-held models are a barrier to entry for SM, and one of the reasons that SM is still in the early stages of awareness and adoption, as shown in the ASQ 2014 survey.

However, if we relax current business models, then seams and transactions provide core insights into the interoperation of new IT capabilities with physical, cyber, and workforce elements. They also provide a point of entry with predictable performance improvements for SM systems. Modeling across seams is likely to start small, but as more and more seams are bridged, built up layer by layer, and extended across an entire supply chain, a new enterprise model emerges. A true industry-driven ecosystem can form and create a virtual enterprise model that incorporates physical assets as components to execute production of the right product, at the right time, in the right amount. In manufacturing industries, this model has the potential to shift business value from physical facilities to virtual enterprises.

The nature and diversity of seams and transactions that need to be bridged return us to the point that the ability to capture the full potential of SM involves infrastructure that no one practitioner or provider company can "own" or provide and still meet all of the necessary capabilities for SM implementation. Also, current market drivers do not align. We project the need for industry-driven and orchestrated infrastructure that is architected for market-driven, commercial, and open-source platform and application partnerships to unlock numerous untapped opportunities for greater economic prosperity, product value, environmental sustainability, and broad-based protection of material and energy resources. Smart manufacturing is not just about individual interests.

**Izabel Christina
Cotta Matte**

Trends in city dwelling and local government budgets may be headed in opposite directions. As urban government leaders face increased challenges with decreased resources, new models of governance may be needed. To learn more about how quality is viewed from the perspective of a city's leaders, Izabel Christina Cotta Matte, *the chief strategic planning and budget officer of Porto Alegre, draws from her experience as a public management leader in Brazil.*

THE FUTURE OF CITIES:
Quality, Planning, and Excellence in Public Sector Management

As global urbanization continues apace, the coming decade will see city governments across the world facing a cacophony of old and new challenges in managing resources and delivering services to their residents. Brazil's southernmost state, Rio Grande do Sul, is home to one prime example of governance adapting to and thriving in a dynamic context. Porto Alegre, Rio Grande do Sul's capital city, is striking in its diversity. The city was first settled in 1772 by 60 couples from the Azores. In the early 19th century, African, German, Italian, Jewish, Lebanese, Polish, and Spanish immigrants began arriving in Porto Alegre. Today the city boasts a population of over 1 million from myriad religious, linguistic, and ethnic origins. Porto Alegre is a cosmopolitan and multicultural regional capital whose government has upgraded its management practices to ensure better quality public services for the future, which, in turn, will contribute to greater social and economic development.

Before looking at how Porto Alegre goes about planning for the future, it is helpful to have some understanding of its overall context. Apart from gaining recognition for promoting a participatory budget over the last 25 years, the city is also known for having hosted the World Social Forum and for systematically increasing community

Public Sector Management

"To be recognized as a reference for its high quality of life, its excellent public services, and building a sustainable and participatory environment, ensuring plurality, through strong local governance."

—*Porto Alegre long-term vision*

participation in its administration. Another defining feature is the city's strong tradition of urban and environmental planning. Porto Alegre was the first capital in Brazil to establish a master plan. Approved in 1999, the Urban Development and Environmental Master Plan acted as a foundation for Porto Alegre's future vision. It incorporated a strong focus on development with clear guidelines and strategies for implementing projects while emphasizing popular participation and economic, social, and environmental sustainability.

These guidelines are key principles that direct the city's strategy to build the metropolis we imagine for the future. In 2005, a political and administrative decision was taken that Porto Alegre should sign an agreement with the State Quality and Productivity Program and the Movement for a Competitive Brazil. Thereafter, the city began developing a management model that focused on results. This was a major innovation because at that time the idea of quality-focused management was still incipient in Brazil.

We had two main challenges: to reinforce our culture of participatory democracy and to improve the quality of our public management. At that time, public policy was implemented across departments in a disconnected or uncoordinated manner, often leading to unsatisfactory results.
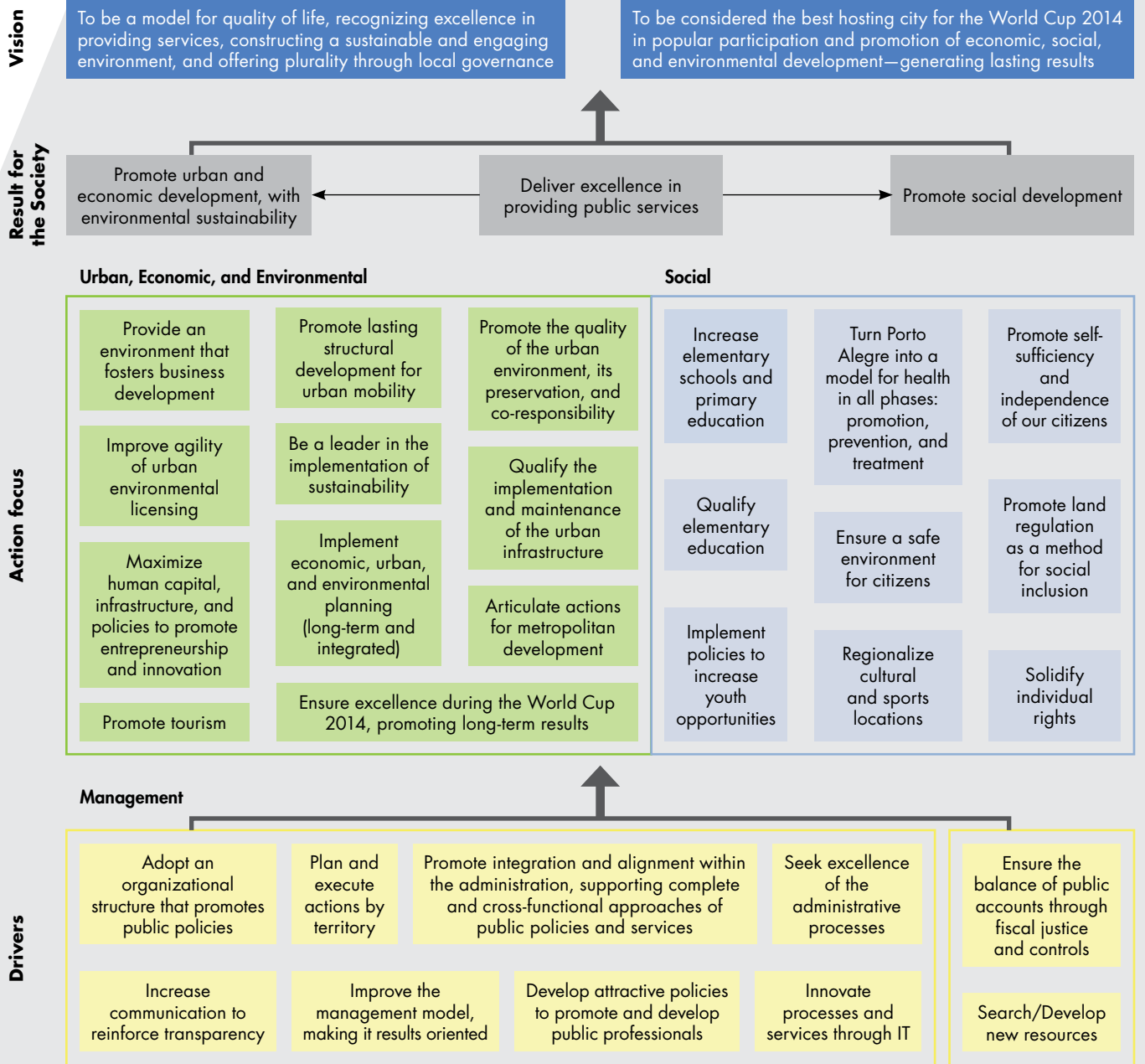
PORTO ALEGRE'S MANAGEMENT MODEL

Over the last 10 years, Porto Alegre has reorganized how the city is managed. First, we defined a new management model. Designed horizontally, it broke down functional or departmental silos. In addition, the city also developed a new governance system that would allow it to improve its management of technical issues, to enhance senior management decision making, and to ameliorate the dialogue between government and society.

The four premises of Porto Alegre's management model are:

- Executing public policy in an integrative and cross-functional manner

- Differentiating between city zones

- Promoting transparency—enabling citizens to access information on key projects and initiatives

- Ensuring the leadership's empowerment of public servants in their respective fields of expertise

Porto Alegre's strategy map (as per Kaplan and Norton's balanced scorecard methodology) sets out the city's key strategic objectives and its long-term vision, which is, "To be recognized as a reference for its high quality of life, its excellent public services, and

Balanced scorecard for the city of Porto Alegre, Brazil

Vision

To be a model for quality of life, recognizing excellence in providing services, constructing a sustainable and engaging environment, and offering plurality through local governance

To be considered the best hosting city for the World Cup 2014 in popular participation and promotion of economic, social, and environmental development—generating lasting results

Result for the Society

Promote urban and economic development, with environmental sustainability

Deliver excellence in providing public services

Promote social development

Action focus

Urban, Economic, and Environmental

Provide an environment that fosters business development

Promote lasting structural development for urban mobility

Promote the quality of the urban environment, its preservation, and co-responsibility

Improve agility of urban environmental licensing

Be a leader in the implementation of sustainability

Qualify the implementation and maintenance of the urban infrastructure

Maximize human capital, infrastructure, and policies to promote entrepreneurship and innovation

Implement economic, urban, and environmental planning (long-term and integrated)

Articulate actions for metropolitan development

Promote tourism

Ensure excellence during the World Cup 2014, promoting long-term results

Social

Increase elementary schools and primary education

Turn Porto Alegre into a model for health in all phases: promotion, prevention, and treatment

Promote self-sufficiency and independence of our citizens

Qualify elementary education

Ensure a safe environment for citizens

Promote land regulation as a method for social inclusion

Implement policies to increase youth opportunities

Regionalize cultural and sports locations

Solidify individual rights

Management

Drivers

Adopt an organizational structure that promotes public policies

Plan and execute actions by territory

Promote integration and alignment within the administration, supporting complete and cross-functional approaches of public policies and services

Seek excellence of the administrative processes

Ensure the balance of public accounts through fiscal justice and controls

Increase communication to reinforce transparency

Improve the management model, making it results oriented

Develop attractive policies to promote and develop public professionals

Innovate processes and services through IT

Search/Develop new resources

Courtesy: City of Porto Alegre, Brazil

building a sustainable and participatory environment, ensuring plurality, through strong local governance."

The five-year plan and the budget were reorganized along the lines of cross-functional strategic programs, thereby breaking down vertical departmental silos. A public servant, who has received specific training in our chosen methodologies and tools, manages each of these programs. Every initiative has an identified leadership to work together with other leaders and a program manager. Over the years, many public servants have received training on this model, thereby ensuring that we retain knowledge within the organization, independent of political changes that can occur every four years. Furthermore, we have adopted a systematic approach to training and recognition to stimulate meritocracy, giving recognition to managers whose performance is outstanding. In 2008, for example, 15 civil servants were awarded sponsored enrollment in a 15-day course on public administration at George Washington University.

Over the last 10 years, a systematic update of the strategy map has taken place, as well as a realignment of the city's strategic programs. To further increase alignment, a decision was taken in 2013 to merge our strategic planning and budgeting departments into a single unit, thereby ensuring our priorities are rigorously planned within budgetary constraints—something we consider a major step forward for the public sector.

As a result, we have laid to rest a planning culture based on narrow departmental priorities. Every day, managers and civil servants participate in various mid- to top-level meetings to evaluate planned initiatives, review performance indicators, and seek out the best possible result.

Another innovation was the adoption of management contracts for all municipal departments. Heads of departments lay out their goals for the year ahead, signing a management contract that is their commitment to society. Each year, the mayor, deputy mayor, the heads of departments, and managers attend an event at which the previous year's results and the coming year's targets are publicly announced. In addition, awards are handed out to the teams with the best performance.

ACHIEVING RESULTS AND BUILDING FOR THE FUTURE

Another important achievement was an improvement in our fiscal management. After three consecutive years of deficit, Porto Alegre posted a surplus. This improved fiscal position made it possible for us to access loans and, therefore, invest in large-scale infrastructure projects required to build the city of the future. Structural improvements, first proposed in our last master plan, to increase Porto Alegre's drainage system's capacity to absorb rainwater, and to increase urban mobility, were given further impetus when Porto Alegre was chosen as one of the host cities of Brazil's World Cup in 2014. More than $500 million was invested in projects, such as bike lanes, upgrades in public

transport, and the expansion of sewage treatment capacity. Furthermore, investments in resettlement programs and jobs training have provided new opportunities for residents located in high-risk areas.

Through our integrative approach, the problem of children living on the streets was turned around. In 2004, 670 children were identified as living on the streets. By 2012, such cases were rare. We were able to expand basic healthcare provision, growing the number of family healthcare teams working alongside

Quality concepts and the spirit of continuous improvement will be crucial to consolidating a new culture of public administration.

doctors and nurses in different areas of the city to 205. When the management model was first implemented, there were only 84 such teams. Today more than 21,000 children up to the age of six are in daycare centers, as opposed to 15,000 in 2006. Another 46,000 kids between the ages of seven and 14 are studying in local schools.

The municipal plan for the creative economy targets the installation of creative incubators in areas in need of urban and environmental regeneration. Moreover, by automating the city's urban environmental licensing procedures for building projects we were able to foster new economic growth and, with it, an expansion in jobs as well as incomes. The implementation of an integrated center for video surveillance provides daily live-action footage of different areas across the city. Such initiatives led to Porto Alegre being recognized as a "resilient city" by the Rockefeller Foundation, giving us special status among a peer group of 100 cities worldwide considered most ready to deal with natural disasters.

CONCLUSION

The city of the future must provide sustainable development and citizens' emancipation with coordination between government, private initiative, and civil society. Porto Alegre of the next decades will have prepared citizens through universal access to healthcare, quality education, and vocational training that meets the demands of the labor market. The population will be culturally strengthened to act responsibly in an environmentally conscious way. They will be able to monitor global changes and economic and technological development. These citizens will enjoy a public transportation system able to minimize the negative impacts of mobility of big cities. Public spaces will be landmarks where people can celebrate and interact with the environment.

City dwellers will be the protagonist of change in the coming decade, committed and informed about their responsibilities. The approach to public management implemented by smart cities in the next 10 years will lead us to advance in social development, sustainability, and economic growth. Recognition, knowledge, and information are prerequisites if we are to continue improving. In this context, quality concepts and the spirit of continuous improvement will be crucial to consolidating a new culture of public administration.

Devi Shetty

Healthcare stands out as the segment of the economy positioned to grow and evolve the most in the coming decade. This period of growth has the potential to usher in unprecedented enhancement of quality of life for millions of people. How the developing world views quality and its role in healthcare will be critical. Devi Shetty, *a renowned cardiac surgeon and founder of* Narayana Health, *India, offers his view of challenges facing any effort to expand care throughout the developing world.*

THE FUTURE OF HEALTHCARE:
Toward a Global Medical University

Cardiac care standards are very high in India, but cost impediments have often prevented those in need of surgery from obtaining it. My hospital system, Narayana Health, seized upon economies of scale—derived from a larger medical campus with greater utilization rates of high-cost equipment—to deliver expanded access to care without sacrificing quality. Scaling health access more broadly moving forward will require rethinking business models and similarly expanding and efficiently utilizing pools of resources. Education and the supply of skilled medical professionals are key factors influencing the ability of international healthcare entities to innovate in terms of care and cost structures. This is obvious on a global scale where one can observe a wide variation in quality of care available across different healthcare systems. What follows is an exploration of one path toward delivering more affordable care worldwide. The waypoints along this path all attest to the enduring value of quality—in teacher-student relationships, in practitioner-patient relationships, and throughout the management and medical

Scaling health access more broadly moving forward will require rethinking business models and similarly expanding and efficiently utilizing pools of resources.

Global Medical University

Less than 15 to 20 percent of the world's population can afford any of the surgeries of the heart, brain, joint replacement, or those standard in cancer treatment.

architectures empowered to deliver innovation in care and cost while maintaining the highest degrees of quality and attention to continuous improvement.

THE CHALLENGE OF QUALITY IN GLOBAL HEALTHCARE

More than 100 years after the first heart surgery, less than 15 percent of the world's population can afford it. In fact, less than 15 to 20 percent of the world's population can afford any of the surgeries of the heart, brain, joint replacement, or those standard in cancer treatment. The dearth of access to these often life-saving treatments is no surprise when one considers that surgical procedures on the human body require precise skill and certification, which are in high demand and provided at significant cost by medical schools, nursing schools, and paramedical schools. Such institutions are scarce across the world, especially in developing countries, and very tightly regulated to guarantee high quality.

To drive radical change in global access to care, it will be necessary to expand the pool of trained personnel in developing countries. The quality of healthcare delivered in any country is directly proportional to the quality and quantity of skilled manpower available. Countries with little skilled manpower cannot have high-quality healthcare—unless they are wealthy enough to pay to import doctors, as is done in the Middle East. Cuba, with the highest doctor-patient ratio in the world, has proved that high-quality healthcare can be achieved by opening the medical, nursing, and paramedical education systems and producing surplus manpower that can serve the needs of Cuba and its surrounding countries.

Expanding the pool of manpower in currently underserved countries can be accomplished through the development of medical, nursing, and paramedical schools across the developing world, under the umbrella of a virtual global medical university. Creating a university is an expensive affair. It requires capital investment and sophisticated infrastructure that leaves medical education at these universities under the control of a select group of professionals and organizations. Even launching new, innovative courses in medical education is a significant task; creating new institutions of medical education is all the more difficult. I experienced this difficulty when I was governor of the Medical Council of India, the apex body regulating Indian medical education.

> **To drive radical change in global access to care, it will be necessary to expand the pool of trained personnel in developing countries.**

THE CONTRIBUTION OF A GLOBAL MEDICAL UNIVERSITY

To address this challenge through a global medical university, it will not be necessary to commission massive buildings and hire hundreds of full-time employees. If the GMAT exam can be conducted in more than 150 countries without massive infrastructure, everything in distance medical education is possible. An effort of this nature focused on the developing world will require global support, however, including from the stalwarts of medical education in the United States, Europe, Asia, Africa, and Latin America. Partners who are true visionaries and progressive could be called on to contribute to the curriculum and syllabus for medical, nursing, and paramedical education programs.

Unfortunately, universities across the world often deliver knowledge without the translation tools to help their students develop reliable skills.

According to the U.S. Bureau of Labor Statistics, out of the 20 fastest-growing occupations in the United States, 15 are in healthcare. Unfortunately, a corresponding training program exists in India for none of these 15 occupations. One example of this disparity can be seen in the United States, where almost all surgeons have a physician assistant (PA) who helps them prepare patients for surgery, assists in operations, and takes care of patients in the ICU and other post-operation and outpatient settings. The experience of the United States demonstrates that PA contributions can significantly reduce morbidity and mortality rates following any procedure in any hospital across the world. Despite this reality, PA training programs are virtually non-existent in India. Governments across the developing world are desperate to initiate and expand paramedical education programs that can significantly reduce mortality and morbidity rates at relatively low cost. For this reason, paramedical training may present a ripe domain for learning how to bring together the respective authorities across the developing world, create a curriculum, and conduct educational programs globally. Demonstrating that such an effort can be accomplished with adherence to quality in training and outcomes may go a long way toward nullifying the negative forces that have stunted development in care in the developing world.

IMPLEMENTING A GLOBAL MEDICAL UNIVERSITY

Unfortunately, universities across the world often deliver knowledge without the translation tools to help their students develop reliable skills. A global medical university serving the developing world is based on the requirement to train people with great skills and impart some knowledge, not the other way round. Since the goal of the program is local

outcomes, it will be important to incorporate 20 percent local content catering to the needs of the local population alongside a core 80 percent standard curriculum.

Developing and implementing a curriculum that can be recognized globally will require working with various governments in Asia and Africa. That enables the graduates to be recognized within their localities and to deliver relevant care legally. A global medical university may require an anchor sponsor to provide leadership and the support of local governments as discussed, but it will also require the support of international entities such as the World Health Organization (WHO), the World Bank, the International Monetary Fund (IMF), and other organizations that finance healthcare initiatives across the world. The goal in building strategic partnerships with these multinational bodies would be recognition of the global medical university as a precondition for countries seeking grants and loans.

CONCLUSION

Skilled manpower is in short supply across the world. If you look at the process of delivering healthcare, finding skilled manpower constitutes the majority of the challenge. People with skills will invariably find ways and means to offer their services by working with local bodies, governments, and anyone who can help them. This is the only way skilled workers can earn a living, building their reputations and developing stature as high-quality leaders in their fields. Building a greater pool of skilled manpower through a global medical university addresses one of the main challenges limiting the quality of healthcare in the developing world. Once you have skilled manpower, you can deliver medicine, perform procedures, carry out immunization, and monitor every aspect of healthcare remotely because of the knowledge workforce. Ultimately, delivering healthcare is not about building hospitals, buying medical equipment, or developing

new medicines. Rather, it's about building manpower that can use the machines, use the hospitals, and dispense the medicines. Until a skilled workforce is achieved in developing countries, no matter what other steps we take, quality healing processes will not reach people in need.

A WHO Report from 2006 forecasted a shortage of 4.3 million skilled health workers by 2015 in 57 countries that are critically short of manpower including physicians, nurses, and paramedical workers. While more recent studies have shown that the shortage may not be as great as expected, there will still be a major shortage of healthcare workers throughout the world.

Developing countries can lead the world in dissociating healthcare from affluence. We can prove to the developed countries that the wealth of a nation has very little to do with the quality of the healthcare that citizens enjoy. Delivering on this challenge can begin with a focus on education and training programs in the developing world.

JoAnn Sternke

There are common ingredients to successful learning environments at all levels of education. The eagerness of students, the dedication of teachers, and the nature of the context that brings them together all go a long way toward determining the quality of learning outcomes. JoAnn Sternke, *the superintendent of schools at* Pewaukee School District, *Wisconsin, USA, offers a view of the future of education marked by new technologies being incorporated into learning environments and digital natives increasingly taking the reins of classrooms across the globe. The Pewaukee School District received the Malcolm Baldrige National Quality Award in 2013.*

THE FUTURE OF EDUCATION:
Quality Teachers for the 21ˢᵗ Century

I was always one of *those* kids who loved everything about school. Sure, there were children around me who complained about the routine. I just didn't understand them. For me there was so much to relish, starting with the trappings—the new notebooks, the ritual trip to the store with my mom to select just the right school supplies. My mother would always treat me to something extra special that wasn't on the lengthy, predetermined school supply list. What would be the coveted purchase this year? A special Bic pen that writes in four colors, not just one? A Trapper Keeper, that "one-stop shop" binder? An extra special folder, not in a mundane plain color, but one with the newest heartthrob on it? The trappings of school contributed for me to the sense of expectation that every new school year brought.

The trappings of school contributed for me to the sense of expectation that every new school year brought.

I remember that when we would get our textbooks on the first day of the year, I would hop right on my Schwinn bike and ride two miles to the Ben Franklin Variety Store. Why? Because I had to get about a yard-and-a-half of that special slightly smoky

Personalized
Learning

In the future we will have more data about student learning than ever before, and we will have better systems to help us analyze it.

yet clear plastic oilcloth to cover my books. It was a ritual that my dad and I enjoyed together. I loved sitting at the kitchen table with him covering my books on the first night of school. Folding the corners just right was, in truth, a basic geometry lesson. Yet I also relished perusing the pages and pondering all the new things I would learn that year. It built excitement … and great memories of my dad.

And then there was the classroom. Sitting at my desk with the lid and organized contents, I could stay in my row and listen to a great teacher all day. The way Mrs. Ehm brought U.S. history to life. The way Ms. Roach made those tough math concepts clear for me, always with the use of chalk or Saran Wrap on an overhead projector. The way Ms. O'Donnell inspired an appreciation of literature. To this day I love reading novels because of her. Teachers were revered in my home, and I grew up believing that being a teacher was a special calling.

Flash forward 40-some years to the present. No surprise here—I entered the field of education. I became a teacher, and then an assistant principal, and now I serve as a superintendent of schools in a wonderful K–12 award-winning public school system, the Pewaukee School District. For a long time I didn't realize how much my childhood shaped who I have become. Today I fully recognize that my education experience was more than a bit idyllic in comparison to that of many others, and that because of it I still love going to school each day, even now. That's my bias and I'm proud of it, and it is my mission to create those experiences for the students who attend my schools.

The advent of digital technology, big data, and customization—will impact education at all levels and of all types.

Yet some of the experiences I treasured from my youth will not be a part of the experience for students in the future. No longer will students be covering books, as most content will be delivered online with students using technology to access information. How about practicing penmanship with that special pen or pencil? Penmanship, too, is in the crosshairs, as the keyboard is becoming the communication tool to master. And students certainly won't be filing papers in paper folders; they're already using digital ones instead. It's clear that the trappings of education will change greatly as we look to the future.

But beyond the trappings, it is also clear that the fundamentals of the education landscape are rapidly evolving. While I can speak to public education from experience, I believe three key changes—the advent of digital technology, big data, and customization—will impact education at all levels and of all types. The larger and more important question is, what will transcend? What may stay the same in education in the future? Let's begin with the changes.

TECHNOLOGY CHANGING THE LEARNING SPACE AND PROCESS

No doubt the influx of technology and digital resources is changing how students learn, and this will only grow in the future. The impact of technology, to be honest, is old news. Technology is already in the hands of students. In fact, schools are being built with bandwidth to accommodate four technology devices per person. People have phones, personal technology, computers, and more. The technology will keep on coming, and it will be smaller and more powerful. Yet in my school district we say, "It's not about the stuff (referring to technology). It's what you do with it." It won't be about the stuff in the future—it will be about what we do with it.

Where we are on the cusp of seeing great change in education is in the impact of technology on the teaching and learning process. Learning will become more personalized and learner-driven. As students have access to a greater amount of content

Personalized learning has the potential to better meet student needs. That part of the future excites me as an educator.

and global connectivity via technology, they will demand to drive their learning more and more. Independence will grow. Student voice will grow. All of this is a good thing, but it will change the teaching model. Currently, the teacher parses the knowledge, and the students are receivers, all in a group setting, all at one time. In the future, first of all, the space where learning occurs will change. There isn't the need for 100 percent of learning time to be in a group. Sure, students will need to learn collaboration; that is a key job skill. Yet particularly as students age, they won't need all their learning to take place in a traditional classroom setting. Right now the Khan Academy offers people the opportunity to learn 24/7 whenever, wherever. Schools will need to reproduce this accessibility of information … or students will just get it elsewhere.

I am most excited to see how "personalized" learning will take place in the future. In this model, students will be able to direct their own learning. As such, teachers will be more facilitators than traditional pedagogues. Moreover, students will be able to learn at their own pace; and that, I feel, is a very good thing. For too long we have been "one size fits all," with the "fit" taking second fiddle to the "one size." I like the idea of meeting student needs using time as the variable, not the constant. That part of the future excites me as an educator. Personalized learning has the potential to better meet student needs.

DATA TO BETTER INFORM INSTRUCTION AND THE LEARNING EXPERIENCE

Seriously, would you expect someone who believes in the Baldrige Criteria like I do to not say that results will shape the learning experience? I believe in the future we will have more data about student learning than ever before, and we will have better

systems to help us analyze it and make instructional decisions based on each student's results. In light of this, we will better know students' needs—and that will in turn require us to adapt our systems to better serve students.

This adaptation will hopefully entail better customization and personalization of learning. I see better systems for data analysis as the "big data" movement comes to education. That is exciting if we know how to use the data to inform. We don't need bigger data warehouses. We need better analysis, and we need a more expedient response when we see kids not learning.

I also predict that schools will have more graduation options than a traditional diploma for qualifying seniors.

MORE DIVERSITY, MORE CHOICE

When I grew up, in that idyllic world of my youth, my parents had two choices. I could go to public school for free, or I could go to private or parochial school on my parents' dollar. Now there are many more options for a child's education. These options will only continue to grow. Specialization will become more prevalent as will more flexible options within schools themselves.

I also predict that schools will have more graduation options than a traditional diploma for qualifying seniors. I see education moving to more of a certification role, rather than a traditional diploma where everyone jumps through the same hoops to get that sheepskin. Specialization will continue to grow and occur earlier and earlier in the educational experience. In the workforce, a diploma will be less important than the possession of knowledge and skills that an employer will be able to recognize, thanks to our reliance on data systems.

BUT WHAT TRANSCENDS?

Amidst all these changes, what will transcend? Will schools exist as we now know them? What will children in 2030 experience in their education? No doubt there will be profound changes—changes in learning spaces, in delivery model, in what is learned and how it is learned. Certainly customization and personalization will be the norm.

But here's the comforting news: We will still depend on schools. Our society is based on schools for custodial care of young people. I may be naïve, but I don't see that changing. It's part of our social fabric.

Even more important, though, I don't see great teachers ever being replaced. Sure, their skills will need to change. They will need to facilitate learning more than stand

and deliver it. Yet I believe that teachers will hold a dear place in the hearts of students and parents for years to come. Education, while it will become more technological and more personalized, will still depend on great teachers to instill direction, passion, and excitement in the learning process. Teachers will continue to ignite learning, just as they do today. That is something I find comforting.

CONCLUSION

It excites me to think of digital-native students becoming digital-native teachers. They will see interconnectivity as something to be celebrated. They will not see technology as something new to learn—it was how they learned. These new teaching post-millennials will be the transformers of learning. That is an amazing thought, and so exciting.

So you see, even though students of tomorrow may not experience covering textbooks, buying new manila folders, or sitting at traditional desks like I did, I hope they will find their learning to be relevant and vital in preparing them for their future. Educators give students life chances … and that must remain true in the future.

Zheng Mingguang

Globalized production and consumption of energy resources has led to increasingly complex ties between far-flung geographies and industry sectors. Advances in technology and the pursuit of efficiency will deliver new modes of production and consumption in the future, as the need for sustainable solutions to energy challenges becomes even more pronounced. Zheng Mingguang, *president of the* Shanghai Nuclear Engineering Research and Development Institute, *reviews energy trends and their implications for the energy systems that touch every part of the global economy.*

THE FUTURE OF ENERGY:
Long-Term Trends and Global Implications

Energy provides the basis for all social activities, and a secure, reliable supply of energy is indispensable for a nation and the happiness of its citizens. We demand many things of the systems that supply our energy. We want them to be affordable, clean, reliable, and sustainable. While these goals have often been in conflict with each other in the past, micro-changes that improve efficiency are resulting in breakthroughs that make it possible to achieve all of our goals for energy supply. A wide variety of measures that improve efficiency and reliability are happening quietly in the fields of electricity, transportation, industry, and building. These are all changes that depend on quality understood as optimizing the energy efficiency of system design and the reliability of nuclear reactors.

IDEAL ENERGY GOALS AND LONG-TERM TRENDS

The following trends give us objective reasons to state that we will make progress toward our goals:

Trends and Implications

A wide variety of measures that improve efficiency and reliability are happening quietly in the fields of electricity, transportation, industry, and building.

- The portfolio of energy will be dominated by renewable energy, while fossil energy becomes complementary. Increasingly diverse sources of energy will mean more options for energy consumers and more flexibility in the supply of energy.

- The production of energy will shift from "mining" resources to "manufacturing" them, which will mean there will be an increasing emphasis on technological innovation. Dispersion of energy production will increase, and capital intensity will decrease.

- The utilization of energy will change from being isolated, closed, and linear to an intelligent synergistic mix of complementary sources and uses of energy, based on system efficiency optimization. Instead of oil, electricity will be the core of the energy system.

- The nature of energy will be shifted from being focused on acquiring and distributing commodity resources to being centered on knowledge-driven and technology-based renewable energy. This will mean that research and development (R&D) will be more important than ever before.

- Developing countries will be the center of new energy demand.

The nature of energy will be shifted from being focused on acquiring and distributing commodity resources to being centered on knowledge-driven and technology-based renewable energy.

SOLUTIONS FOR THE NEW ENERGY ERA

Oil and electricity are the main drivers of energy use. According to the Rocky Mountain Institute, carbon emissions of oil and fuel power plants account for more than 40 percent of the total in the United States. Further, nearly 75 percent of U.S. oil is used for transportation, and about 75 percent of U.S. electricity is consumed by buildings, with the remainder mostly going to industry. (In China, 70 percent of electricity is used by industry.) Therefore, efficient uses of energy in transportation, buildings, and industry are the keys to conserving oil, coal, natural gas, and electricity. Keys to efficiency include smart grids, distributed technology, renewable energy combinations, the Internet of Things, (see "The Future of the Internet," pp. 12–15) and smart buildings.

ELECTRICITY

Given current conditions and global trends, the best solution for electricity involves a mix of centralized and distributed renewable energy. By means of advanced smart control

systems, electricity systems will ensure that national and regional grids work together to ensure a real-time balance between demand and supply. At the same time, micro-grids that can be operated independently will improve system flexibility. Specifically, the following developments are likely to improve electricity efficiency:

- **Information technology** will promote efficiency through the development of electricity system monitoring, control, and transmission. Through smart chip data communication, the smart grid will manage itself and stay stable.

> **Given current conditions and global trends, the best solution for electricity involves a mix of centralized and distributed renewable energy.**

- The system will be based on modular technology. Instead of small numbers of custom-built, large-scale, centralized power plants, there will be **multiple, distributed, small energy systems** that are mass produced. These multiple small units will be combined into a system that is capable of quick learning. The combinations of small units are unlikely to all break down simultaneously, so system reliability will be improved compared to systems based on small numbers of large units. Distributed high power density batteries, distributed generation, and micro-grids will facilitate this new network.

- **There will be more options for electricity users.** Electricity companies and other traditional service providers will not only provide a wider range of services and price systems but also provide services such as distributed generation, storage, and management options. More and more users will generate electricity by themselves in cases where smart grid and family power generation systems are cost-effective. Responding to their specific needs and economic signals from the power grid, these users will choose to sell, buy, or store electricity.

TRANSPORTATION

Transport and industry are the forms of social activity in which energy plays the most prominent role. Excessive dependence on oil cannot be eliminated, and so we have no choice but to design and use transportation based on oil in innovative ways. The following developments would generate significant energy savings in the transportation field:

- Innovative design and manufacturing can provide solutions that will allow us to fabricate lighter and stronger cars, reduce air and road surface resistance, and avoid the loss of the energy from the fuel tank to the wheels.

- In addition to focusing on better public transport, we need also to focus on building better modes of social interaction when considering alternative transportation solutions. For example, online ordering can reduce the need for trips. In general, better-designed communities will require fewer, as well as faster and shorter, modes of travel for residents.

- Clean energy will drive our vehicles. Electricity, hydrogen, natural gas, and advanced bio-fuels offer plenty of options. Although aircraft, heavy trucks, and ships cannot achieve cost-effective electric drives, bio-fuel can be a substitute for oil.

INDUSTRY

If vehicle power comes from hydrogen and electricity in a 50-50 split, requirements for energy processing will be reduced, but further reductions can be achieved by industry if the following changes are made:

- The required energy for basic operations as well as losses in energy distribution systems can be reduced.

- Fuel can be de-carbonized via two options—one is more and more renewable power, and the other is solar energy offering industrial heat.

- Waste can be recycled. We should eliminate the existing bias that favors the extraction of raw materials from the earth over the use of recycled materials, and make use of various forms of cogeneration.

BUILDINGS

As standards of living increase, energy consumption in buildings is rising due to uses connected to heating, hot water, refrigeration, lighting, and electronic equipment. In the future, buildings will be hubs of energy production and storage as well as consumption. Intelligent buildings may be able to produce and store electricity, and their physical properties will change according to the weather and a wide range of energy

In the future, buildings will be hubs of energy production and storage as well as consumption.

supply and demand factors. We will need an interdisciplinary perspective and innovative spirit to solve the problem of low energy efficiency in buildings, such as using new materials for high-performance thermal insulation construction. We can make full use of solar energy through micro-grids to generate electricity and heating. All roof, façade, and window space can be used for solar power generation. Finally, the way that residents use buildings will have to change. The Internet of Things can be applied to

strengthen communication between people and buildings, and the energy consumption of buildings can be analyzed through information technology.

ENERGY REVOLUTION IN CHINA

According to a 2015 article in the *Journal of the Beijing Institute of Technology*, China's per capita power generation for 2014 was 4,200 kilowatt-hours, less than half that of the world's developed countries. In the long term, energy demand will increase gradually. For China, the energy revolution means building a modern Chinese energy system.

Distinctive features of the energy revolution in China:

- Coal is still the main resource.

- China is still at the stage of accelerated development of industrialization and urbanization.

- Due to climate change concerns, the international community has recently proposed new requirements for renewable energy and green development.

Therefore, the energy revolution in China is complex. Green energy, electricity, and oil and gas revolutions are being carried out simultaneously. By the end of 2014, China's installed electricity capacity exceeded 1,300 gigawatts (GW). In that portfolio, the installed capacity of coal power, hydropower, wind power, photovoltaic power, nuclear power, and biomass power accounted for 66.4, 22.4, 6.7, 2.2, 1.5, and 0.8 percent, respectively. We can expect the installed electricity capacity of China to reach 3,000 GW in 2030. In that portfolio, we prefer for nuclear power combined with hydropower to provide 1,000 GW for base load requirements; wind power and solar power together to account for 1,000 GW; and coal power and oil and gas power together to generate 1,000 GW (with half of that total going to meet base load requirements). So climate concerns will be substantially addressed as China's energy structure is reformed and coal consumption is reduced.
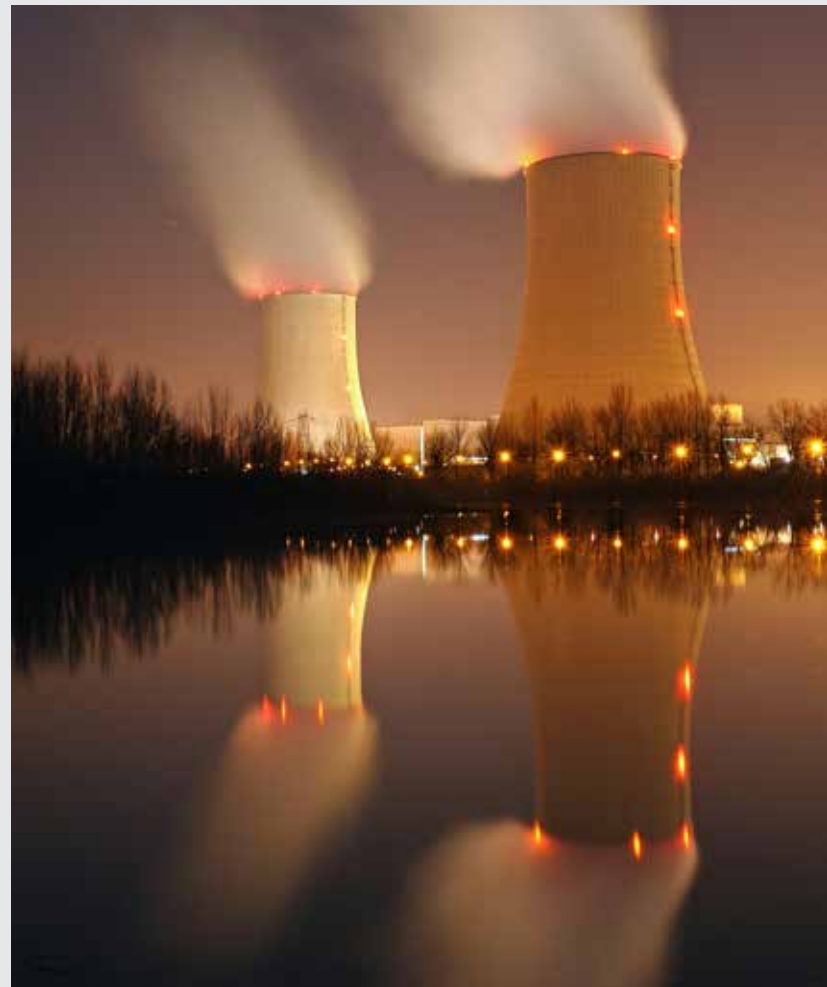
NUCLEAR POWER IS INDISPENSABLE IN CHINA

China's southeast coastal area is poor in fossil fuels, but it is the center of Chinese economic activity and energy consumption. The regional mismatch between power demands and supply, together with the pressure of carbon emissions reduction, will make large-scale advanced nuclear power the right choice for China's southeast coastal area. The highest levels of the Chinese government have committed to a policy of constructing third-generation reactors, such as CAP1000 and CAP1400, as the country's main nuclear power plants in the future. This initiative will be guided by the principles of safety first and quality first.

However, no matter what types of reactor are chosen, in order to achieve a large expansion of nuclear power, four critical problems must be overcome. First, nuclear safety and public security should accommodate social development. Second, the economics should be competitive compared to other energy sources. Third, radioactive waste should be minimized. Fourth, proliferation should be under control.

CAP1400 based on Westinghouse's AP1000 technology is able to meet most of the above-mentioned requirements. Some of CAP1400's main technical specifications and performance features include:

While developed countries are progressing in the larger and more various power applications, we shouldn't forget that 1.4 billion people still live without electricity.

- A passive safety concept with advanced nuclear safety standards

- A standardized design for each type to expedite licensing, reduce capital costs, reduce construction time, and simplify site condition requirements

- A simpler and more robust design, making them easier to operate and less vulnerable to operational upsets

- Higher availability (about 93 percent) and operating life extended to 60 years

- Further reduced possibility of core melt accidents and large radioactivity release frequency

- A substantial grace period, with no need for operator action within 72 hours

- Resistance to serious damage from a commercial aircraft crash

- Higher burn-up to use fuel more efficiently and reduce the amount of waste

- Daily load following and frequency response capability for most of the core's lifetime

China's nuclear power equipment manufacturing industry realized a leapfrog development over the last 40 years. Today, China possesses world-class equipment and could produce 12–15 GW nuclear power main equipment annually to meet the needs of China's nuclear power development.

After seven years of development, the CAP1400 qualified supplier chain covering mechanical, electrical, materials, design, and construction is basically established. Eighty-eight Chinese companies have obtained qualified supplier qualification, and design analysis and test verification capabilities have been significantly improved. Eighty-five percent of CAP1400 equipment and materials—including reactor pressure vessels, steam generators, reactor internals, control rod drive mechanisms, main pipes, main pumps and steam turbines, and pumps and valves—can be locally produced.

CONCLUSION

The solution to our energy concerns depends on the context and on how you define the problem. The idea of a set of measures that can be applied to all states is not feasible. While developed countries are progressing in the larger and more various power applications, we shouldn't forget that 1.4 billion people still live without electricity. Although a huge gap exists for energy solutions in different countries, every energy solution will be helpful as long as we guarantee the quality.

Gregory Watson   **Andrew Watson**

The role of customers in the design process is changing before our eyes. The evolution of "customer centricity" is bound to have far-ranging implications for the quality community. Gregory Watson, *a leading global voice on quality, and* Andrew Watson, *an artist and educator, provide a compelling look at the history of customers and design and the way forward for organizations that wish to remain at the cutting edge of product development and market success.*

THE FUTURE OF CUSTOMER EXPERIENCE (CEx):

CEx Becomes the Dominant Design Force Influencing Markets

Over the past half-century two transformations have changed the way products and services are developed—the first relates to a transition in the way customers are engaged in the process of design, while the second deals with changes inherent to the design process itself. These transformations will continue to influence the process of gathering market insight and its effect on the design of new products and services. Below, we address the significance of this customer domain shift and identify what will be most important for organizations to do in the future if they wish to design success into the core of their culture and its operating processes for product and service development.

FOCUSING ON CUSTOMER CENTRICITY

Peter F. Drucker framed the purpose of a business as to "create a customer" in his 1954 *The Practice of Management.* Customer centricity and the priority of delivering value to customers are principles that were developed in the 1950s and 1960s in the tradition of Japanese quality management under the thought leadership of Kaoru Ishikawa (1915–1989), Shigeru Mizuno (1910–1984), and Tetsuichi Asaka (1914–2012). Customer

Customer
Experience

Superior customer-perceived quality drives profitability.

—Robert D. Buzzell and Bradley T. Gale

centricity became the focus of Japanese business in the following decades, as the core principles of Japanese quality management evolved to concentrate on understanding the motivations of customers to achieve their satisfaction and create loyalty to commercial brands. This key concept experienced a reverse migration as it returned to the West in the guise of the Japanese total quality management (TQM) movement during the late 1970s and early 1980s, which came into full fruition in the quality-focusing years of the late 1980s. Customer centricity became firmly imprinted in the minds of Western executives when a 1987 Wharton Graduate School study by Robert D. Buzzell and Bradley T. Gale identified it as a critical success factor that enabled development of profitable markets. That study concluded, "Superior customer perceived quality drives profitability." The lesson was learned that the best customers are the ones who are profitable and whose trade is retained, and that consistent delivery of quality, in its broadest sense, is the strongest determinant of loyalty in commercial relationships. Today this perspective is commonly accepted as a fundamental principle.

As the customers' experience with the product or service develops over time, so they will tend to develop trust and confidence with the brand, provided their experience is positive.

Finnish architect and designer Alvar Aalto represents an archetype for simplicity in blending form with function in the design process. He identified the ubiquity of the requirement for quality as a principal design criterion: "If you leave quality out of the product, then the whole design exercise is nonsensical in every discipline." For successful outcomes, organizations must design a quality emphasis that is aligned with insight gained from understanding true customer needs to fulfill their desired experience with a product or service. A desire for simplicity in design must be balanced against the need to embrace the chaotic uncertainty that occurs across the diversity of customer-centric points of view regarding the utility and value of the experience that is delivered through the product or service received.

BUILDING CONSUMER CONFIDENCE

Successful products and services must appeal to the inherent needs of customers, and as the customers' experience with the product or service develops over time, so they will tend to develop trust and confidence with the brand, provided their experience is positive. While this trust must be earned through experience, it can be destroyed during a single poorly managed customer experience. However, if an enduring trust can be established, then the confidence of customers will increase brand value. Single

experiences can provide gratification of customer desires, i.e., customer satisfaction; but only when these satisfactory events accumulate over time will enduring satisfaction create brand confidence, build customer loyalty, and establish a foundation for expectations of future service that is "fit for continuing attraction." Such achievement is an outcome that must be "purposefully designed into" the product or service proposition and not be merely a serendipitous possibility left to chance.

The need for earning trust through design creates the second transformation—a shift in responsibility for getting the design right from the customer perspective, and the need to align the deliverable to the customer's explicit and implicit needs. Designers have fulfilled this responsibility in four differing manners over the past century. The initial model is the one that humans have used for centuries—the craftsman-designer

While this trust must be earned through experience, it can be destroyed during a single poorly managed customer experience.

model directly and intimately connects the designer, who is also the engineer and artisan, with the customer, as a custom product is designed in an iterative process of alignment to the customer needs. The design of a sword for a knight in medieval times is a classic example.

The second model evolved out of the possibilities created by the industrial revolution, when products were designed for mass consumption. In this model the designer-engineer is separated in time and space from the customer-user-consumer. The intimate connection to the customer is broken, and the nearest human to the designer-engineer, who serves as the subject of the latter's trials, is sitting at the next bench in the R&D laboratory. Testing or market research is thus separated from customer experience, creating a gulf that must be bridged.

The third model attempts to do this by designating marketing professionals to solicit input from customers that can then be dispensed to the R&D team for their interpretation. The goal is to create a "killer" application or product that generates runaway excitement with features designed for generic customers based on interpretations made from the far-removed laboratory.

The fourth model is the approach that is currently evolving toward maturity. In this model the customer acts as craftsman and through direct involvement in the design selects how to tailor product or service functionality to satisfy his or her particular, and perhaps unknown or unexpressed and therefore ambiguous, requirement. Through experiments in the process of design, the customer becomes engaged in sequentially creating his or her desired experience with the product.

A transition is thus implied in engaging customers in the process of design:

- an evolution from the *craftsman model* (where the designer interprets customers and experiments to develop the entity delivered based on an intimate knowledge of the product),

- to the *engineering model* (where a technical specification drives the design, but the designer is quarantined from direct observation of customer experience during the design process and totally removed from after-sales observations),

- to the *marketing model* (where researchers ask customers for ideas and input to align customer-perceived needs to the design created by the R&D team),

- to the emerging fourth-generation model, the *customer-driven model* (where the customers select from a menu of available designed functions or features of the product or service that they wish to experience).

The question then shifts to how this menu of potential customer-selectable functions is to be populated with alternative elements for inclusion.

For years, marketers have modeled the process of consumer choice as a decision funnel that narrows or filters alternative choices from multiple purchase options down to the final selection. This model assumes that the process is moving in a linear fashion from awareness to interest to desire and, finally, to purchase. However, the ways that people choose and the psychological approach for making choices are more complex and less linear than the model suggests. In his 2011 best seller, *Thinking, Fast and Slow*, the economist Daniel Kahneman pointed out that only 30 percent of human decisions are governed by rationality while the remainder are the result of emotionally based choices that do not follow logical guidelines. Online discussions about this sales decision funnel by Nicole Kelly and others have indicated that more than half of consumers have a strong idea of which brand they will be buying before they begin to shop. Customers aren't coming into a purchasing decision with a blank slate—purchase decisions are driven by implicit, passive, or *a priori* considerations as well as

Customers don't know what they need, and different customers perceive their needs based upon their unique psychological circumstances.

by explicit criteria. These *a priori* considerations create bias in the purchasing decision before the choice even enters into the active cognitive domain of the consumer! Thus the rational behavior of markets may not be a sound economic assumption for investigating patterns of consumer behavior or learning—perhaps the chaos theory of Edward Lorenz

and James Glick would be more appropriate. In the future, high-powered analytics processing big data may help create order out of the disorder of human behavior, but there are no guarantees.

IDENTIFYING CUSTOMER REQUIREMENTS

Customers don't know what they need, and different customers perceive their needs based upon their unique psychological circumstances. A customer's point of view is defined by his or her gestalt—a combination of attitudes, cultural influences, and the like. When asked, customers might not be able to accurately capture their own gestalts. In his 1949 *Language in Thought and Action*, Samuel I. Hayakawa (1906–1992) observed that customers tend to mumble when asked about their needs, confusing reports with judgments and inferences. This inability of customers to fully understand and express clearly their need or requirement means that ambiguity will be inherent in the design function—until the customers' consumption of the product or service can be observed directly and in real time. Lack of clear communication obscures genuine customer requirements.

Mindfulness in design attends to the hidden, latent needs that even the customer cannot articulate.

In 1984 Noriaki Kano introduced the theory of attractive quality, which used the psychological theories of Abraham Maslow (1908–1970) and Frederick I. Herzberg (1923–2000) to describe the relationship between design excellence and customer perception of satisfaction with the execution of the design. While this theory has been widely accepted within the community of quality specialists and technical designers, its integration with industrial designers is ongoing. The psychological focus of Kano's theory has strong implications for product and service design because it highlights the need to develop profound knowledge of the customer's utility function. The goal is to develop this understanding to the point where it is reflected in product or service design. Customer intimacy thus means more than comprehension of the physical user experience—it means getting into the minds of the customers to grasp what they will perceive as attractive. Successful design excites customers because it delivers a product or service feature that is "fit for attraction." This requires more than just attention to what designers call the UX or the user experience—it requires intensive, comprehensive learning about the broad spectrum customer experience, designing CEx into technical specifications.

The psychological lens of the Kano theory of attractive quality means that customers make purchase decisions by comparing the design promise of a given product or service with the alternative promises from competing options. Following the purchasing decision, the CEx will demonstrate how well that product actually works with respect to what

Clayton M. Christensen has called "the job that needs to be done"; customers assess how the product or service actually suits their need in an experiential manner, as opposed to the rational-emotional judgment behind the purchase decision. This is the way that knowledge about products and services is gained through execution of the "work" that defines the experience for customers.

Mindfulness in design attends to the hidden, latent needs that even the customer cannot articulate but that he or she will immediately recognize as "fit for love"—the attractive quality that is the innovative state of design in Kano's theory. This is the same attraction that creates "love at first sight!" Steve Jobs encouraged Apple product designers to seek this state when he recommended that they should "design the buttons so that the customers want to eat them!" Transitioning design thinking from the explicit to the implicit, latent requirement space represents a leap that advances the design process beyond science with its laboratories and places it within the artist's studio.

INTEGRATING QUALITY INTO DESIGN

Design creates a bridge between the internal perspective of functionality in a desired feature of a product or service and the external use or application of that feature in the domain of the customer's experience. Building a design thus requires both technical and artistic capacities. Designers must be able to put themselves in the place of customers to understand their needs and to bridge the gap between the laboratory and the environment in which a service or product will be used. Thus, successful design reflects study of the real-world environment—not just knowledge of engineering and technical functions. Innovative capacity is not the skill that is necessary; innovation is an outcome of the process. Rather, improved design is the need, and improved design requires

improvement of the entire process, not just the engineering and technical functions. Quality design outcomes are generated through inclusion of artistic thinking in the effort to humanize the technology so that it performs well in the hands of the customer.

DESIGNING FOR INDIVIDUALIZED TECHNOLOGY

What will change in the coming decades with respect to the customer experience and the way that organizations respond? An increase in intimate knowledge of customer points of view will stimulate the design of individualized technology, and product architecture will complete the transition from the pre-industrial revolution craftsman model to the mass production of the factory environment. The outcome will be mass customization, i.e., the ability to introduce variety through options in the process. The final stage of this transformation will be reflected in the engagement of customers in design at the point of sales. The possibility of customization of products is already a reality for athletic shoes; Nike and Converse both allow customers to design their own shoes, creating an opportunity for shoe-wearers to choose their shoes' style, color, fabric, treads, etc. This capability involves the customer in the design process and makes the shoe reflect his or her individuality, effectively creating a personal brand.

> **This capability (of customizing shoes) involves the customer in the design process and makes the shoe reflect his or her individuality, effectively creating a personal brand.**

How can an organization design individualized technology that adds value to the customer experience? The traditional areas of competence within product development and industrial design have tended to reflect the science, technology, engineering, and mathematics (STEM) disciplines. Supplementing these inputs with considerations from the humanities, including behavioral economics and the arts, would enable development of products in a more holistic manner. Concepts from the fine arts, studio work processes, and rapid cycles of experimentation and innovation (e.g., agile design in software) could be used to learn more about the user's experience. The goal would be to cultivate empathy—to develop knowledge of the customer's inherent need. For this to occur, developers of new products will need to build their creative confidence.

A recent TED Talk by IDEO founder David Kelley describes the need for building creative confidence by citing the example of Doug Dietz, an engineer at GE Medical. Kelley described the situation as follows:

Dietz creates complex medical imaging equipment, including an MRI machine that is incredibly important to the medical process. But one day, Dietz saw a little girl crying, scared of the treatment she was about to receive. And whereas he'd once been proud of the lives he'd helped save, now he was disappointed to realize the fear the machine caused. And so he turned the machine into an adventure. The results were dramatic: From 80 percent of kids who had previously needed to be sedated, now only 10 percent required anesthetic. Repeating a story that has by now entered GE lore, Kelley recounts Dietz waiting with a mother for her child to come out of a scan. The little girl ran up: "Mommy? Can we go again tomorrow?"

Design thinking can succeed when it is stimulated by empathic understanding of the customer experience, in this case converting a frightening medical procedure into an adventure worth repeating. The enabler for the transformation of this customer experience was insight gained through direct observation of the user, which built Dietz's confidence to design differently.

CONCLUSION

What will organizations need to do to be service leaders in the future? Profound knowledge, rather than profane knowledge, is required. Profane knowledge is subjective and based on cursory or surface-level observations, with extrapolations regarding future performance based on assumptions about average performance. On the other hand, profound knowledge is systemic and holistically integrates analytic and behavioral insights to formulate designs that address all aspects of the customer experience. This means that designers of the future will need to develop a more comprehensive and inclusive understanding of the various motivations behind customer requirements, and will need an increased appreciation for the system in which the customer is operating. The challenge is to design customer product or service interactions so that they consistently deliver attractive quality—quality that is worthy of affection. An important ingredient is empathy with customers, and such intimacy requires moving deeper than a surface-level focus on the end-user experience.

Reliability will instead become more broadly defined as performance that customers can count upon and will encompass the total customer experience.

On this journey the process of design will become more social, and customers in their market settings will become the design laboratory of the future. Increasing responsiveness to the customer, now a critical ingredient in agile software design,

will expand into all aspects of the design process, so that reliability will no longer be limited to hardware. Reliability will instead become more broadly defined as performance that customers can count upon and will encompass the total customer experience. To achieve this outcome, innovations will not be the principal requirements; rather, innovations will be the outcome of this work. Thinking differently and designing for humanity will be the actions that are required; humanized technology at the point of use will be accomplished through a process of "mindfully designing," integrating customer empathy, and artistic thinking. This means that insightful democratic design will be more tightly coupled with reliable engineering execution.

How should educational systems evolve to create this new "opportunity space" in the future? Educational curricula will need to become more integrated as a cross-disciplinary system. This implies a series of transitions in the organization of education from individual disciplines (e.g., engineering, art, business, etc.) to a more interdisciplinary approach (e.g., the current linking of science with technology, engineering, and mathematics in STEM) to a new cross-disciplinary paradigm. The addition of human considerations occurs by adding "art" into the STEM acronym to create STEAM; STEAM is a holistic approach for educating designers of the future. This transition will yield insight into desirable customer-centric attributes by broadening the point of view beyond the generic user experience to ensure that future products and services perform the "job that they need to get done" at a cost that is "worth what the customer paid for it."

The imperative of strategic planning is to create what IBM calls a "customer-activated enterprise" that welcomes customer influence as a primary, intentional contribution to its business. An enterprise that embeds customer centricity into all aspects of its organization can be sure that an ever-enhanced customer experience will beget continued success in the future.

Ronald Snee   **Roger Hoerl**

As many of the articles in this volume illustrate, advances in technology and shifting modes of production will impact the role of the quality community within the leading organizations of the next decade. Ronald Snee, *an expert in Six Sigma, and* Roger Hoerl, *a professor of mathematics at* Union College, *describe how the "century of quality" and job creation can be achieved through, among other advances, addressing the inevitable role of human variation in innovation.*

THE FUTURE OF QUALITY:
Getting Better All the Time

Quality improvement has been important to humankind since the age of primitive food gatherers. One of our former employers, the DuPont Company, was founded in 1802 to produce high-quality black powder, as the black powder available in the United States was of very poor quality at that time. Guides at the Hagley Museum in Wilmington, Delaware, the site of DuPont's original powder mill on the Brandywine River, explain that one of DuPont's advantages was development of a device to measure the explosive charge of gunpowder in manufacturing, which enabled reduction in variation below that of competitors.

Many such examples of the need for quality improvement can be cited and will continue to arise in the 21st century as customers increasingly demand quality products and services. Organizations using Lean Six Sigma have made great strides over the last 20 years through quality improvements that have enhanced organizational health and added billions of dollars to the bottom line. Quality pioneer Joseph M. Juran predicted that the 21st century would be the "century of quality."

What is next on the horizon? Predicting the future is a risky business. Yogi Berra admonishes us, "It is tough to make predictions, particularly about the future." A fruitful way to proceed is to identify the unmet needs and opportunities and then discuss solution strategies and approaches. There are many unmet needs today including quality healthcare and education at a lower cost, better government services at lower costs at all levels, and improved performance of nonprofit organizations. Job creation is of particular importance in the United States, where middle-class jobs are disappearing due to

Getting
Better

Big problems and issues are
all associated with big opportunities,
and a quality focus can provide critical
guidance to exploit them.

automation and outsourcing to other countries. The pharmaceutical and biotech industries are focusing on using quality by design to speed up product development, improve the quality of manufacturing and services, and meet regulatory requirements at a lower cost. These big problems and issues are all associated with big opportunities, and a quality focus can provide critical guidance to exploit them.

There are five specific advances that we believe are much needed, and that can help organizations improve their performance going forward:

- Apply holistic improvement approaches that include all processes, from services, administration, and R&D to sales, marketing, and manufacturing.

- Focus on identifying and solving mission-critical problems.

- Use big data to solve problems that were previously thought to be beyond solution.

- Learn how to better address human variation.

- Enhance learning regarding how to use innovation to create jobs.

The needs and opportunities of the 21st century are of improvement; hence our sub-title, "Getting Better All the Time." We believe that the five advances noted above (see figure below) will take businesses and organizations of all types a long way toward major improvements and development of competitive advantage. This view will enable management to think broadly about the continual improvement opportunities in their organization. We will discuss each of these needs and opportunities in some detail and show how a quality focus can produce advances.

21st century needs and opportunities
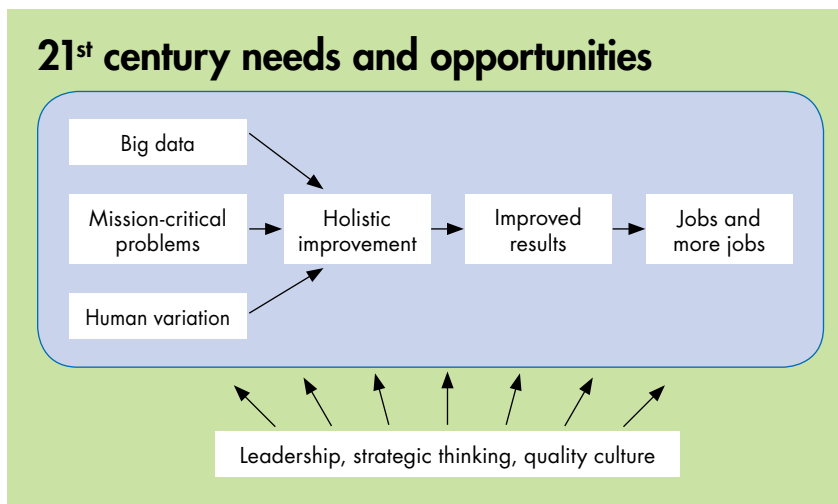
HOLISTIC IMPROVEMENT

The approaches we use to design, control, and improve our products, processes, and services have evolved over the last 100 years or so. Today we are recognizing more and more that organizations are systems, and a systems view is needed to create significant and lasting improvements. In 1964 Peter Drucker pointed out

that "only the overall review of the entire business as an economic system can give real knowledge," and a decade ago our colleague Gregory Watson (see "The Future of Customer Experience," pp. 54–63) discussed how a business systems engineering approach could be applied to business improvement. As we have written more recently, the holistic improvement approach views an organization or business as a system that can be improved at any location around the world, in any culture, in any business function. Accordingly, a focus on holistic improvement moves improvement well beyond the factory floor. No one technique or methodology is universally best for all problems, despite the frequent fads and bandwagons that arise.

SOLVING MISSION-CRITICAL PROBLEMS

Lean Six Sigma as currently practiced tends to miss the large, mission-critical problems that an organization faces. These problems are typically large, complex, and unstructured—too big to be solved by one Lean Six Sigma project. For a variety of reasons, including fear of failure, management may overlook them in favor of lower-hanging fruit, where success is almost guaranteed. But success in a series of minor projects does not bring the breakthrough improvements that senior leadership expects. In our view, this was one of the limitations of total quality management as practiced in many organizations.

> **The good news is that large, complex, unstructured problems are exactly the type of problems that the statistical engineering approach was designed to handle.**

The good news is that large, complex, unstructured problems are exactly the type of problems that the statistical engineering approach was designed to handle. Two examples of such problems include a fill weight targeting system for a large corporation with hundreds of products and NASA's system for planetary entry, descent, and landing. Statistical engineering's five building blocks for such problems are problem identification, creation of structure, understanding the context of the problem, development of an overall strategy, and creation of tactics.

USING BIG DATA TO GENERATE NEW KNOWLEDGE

Data mining has been in vogue for the last 15–20 years. Around 2005 the trend picked up steam with the advent of "big data," fueled by the ubiquitous availability of the Internet and IT hardware and software. We are now talking about terabytes and petabytes of data. We also have software such as SAS, R, Hadoop, Python, and JMP that can help us "tame" big data. The big data focus, as with all new developments, is a good news/bad news situation.

Big data offers the opportunity for quality professionals and others to solve problems previously thought to be unsolvable. While much progress has been made in medical research and Internet marketing, one area overlooked to date is the design and improvement of products, services, and process quality. Customer surveys can help us better understand

customer needs and experiences. Collection of manufacturing data and integrating it with customer data can help improve products and processes. This is the good news.

On the other hand, many have adopted a philosophy of: big data + fancy algorithms = great results. If things were only so easy. First we are reminded that the data of big data studies are observational data at best, typically collected without attention to study design and measurement accuracy. It is also important to recall that analyzing observational data requires a great deal of detective work to find those critical variables that are producing the majority of the variation in the system. In many situations the main contribution of analysis of a set of big data is the identification of theories and hypotheses to be evaluated in a series of future studies.

The popular view that big data will provide all the answers to a given problem unfortunately ignores what has been learned over the years regarding problem-solving fundamentals. As Tim Harford has written, even in the era of big data, problem solving still requires attention to:

- The sequential nature of problem solving, as studies are rarely completed with a single data set but typically require the sequential analysis of several data sets over time

- Strategic thinking, which is needed to identify the strategy that will be used to execute the project and conduct the data analysis

- Data pedigree, which must be assessed to determine the value of the data for solving the problem, the quality of the data, and how the data will be analyzed. Statistically designed surveys and experiments are still needed to generate quality data.

- Subject matter knowledge, which should be used to help define the problem, assess the data pedigree, guide analysis, and interpret the results

These fundamentals are all part of the statistical engineering philosophy and methodology. As big data are frequently associated with large, complex, and unstructured problems, the statistical engineering approach provides concepts, methods, and tools to deal with them.

HUMAN VARIATION

Recent world disasters make it clear that improvement initiatives need to pay closer attention to human error, which is better characterized as "human variation." Humans are arguably the largest source of variation on the face of the planet. Airplane crashes, train derailments, chemical plant explosions and the like continue to happen, even when we know how to prevent them. Unfortunately, knowledgeable humans don't always do what they have the knowledge to do.

Our improvement strategies and Lean Six Sigma methodologies must do a better job of dealing with human variation. Sometimes the solutions are simple and easy to implement.

In a 2010 book, Atul Gawande showed how effective checklists are in reducing surgery infection. More generally, checklists, when used properly, can be very effective in reducing human variation. Mistake proofing and visual management are other useful tools.

Short timelines, fear of failure, and inadequate budgets that flow directly from management can result in products and process that do not take human variation into account. One opportunity to redress this situation is to use the concepts, methods, and tools of robustness, as described by the Japanese quality pioneer Genichi Taguchi and his co-author Yuin Wu. In this way we can create products, manufacturing processes, and human work processes that are robust to sources of human variation, including:

- User-friendly IT and software that are robust to lack of computer literacy

- Home-use medical instruments

- Pharmaceutical tablet design that minimizes patient medication errors

- Auto bumpers that are not damaged by low-speed collisions

Human variation will always be with us. Problems will continue to arise. Improvement professionals need to do more to mitigate this variation by creating products and processes that perform well even in the face of a lack of human attention, experience, or expertise.

CONCLUSION

We noted at the outset that one of the big problems, particularly in the United States and perhaps in other Western countries, is the loss of middle-class jobs to automation and lower-cost labor abroad. This trend will continue. Quality improvement defined as innovation has a major role to play here to create a win-win where all countries can benefit.

As Deming pointed out many years ago, quality improvement leads to more jobs. Deming's chain reaction starts with quality improvement innovation, which produces lower costs and higher productivity, which begets an increase in market share, which in turn leads to staying in business and producing more jobs. Innovative quality improvement can also protect existing jobs by creating new technology and designing products and processes that reduce material and labor costs. Economic opportunity is increased, and the standard of living, particularly for the middle class, is enhanced in the process. As Deming pointed out, no nation need be poor.

The work goes on to improve quality just as it has for decades, even centuries. There are and will continue to be big problems to solve and opportunities to be seized, all with high risks and large benefits associated. Strategic thinking and leadership focus on quality culture are needed more than ever before. The future is certainly bright for the quality profession and others engaged in producing quality products, services, and organizations. Individual action and change is required to capitalize on the opportunities; no one said it would be easy!

Noriaki Kano

In this piece, Noriaki Kano, *professor emeritus at the* Tokyo University of Science *and a leading global expert on quality, draws on a wealth of experience and knowledge to share a view of quality's future informed by the inclusion of quality for sales. Dr. Kano's over half a century of experience has featured countless contributions to the pursuit of quality, including the development of the Kano customer satisfaction model. He has also been honored with three ASQ Medals of Distinction and has been elected an Honorary member of ASQ.*

THE FUTURE OF QUALITY:

Toward Quality for Sales in Addition to Quality for Cost Through Enhancement of Customer Satisfaction

Needless to say, the objective of quality management is to enhance customer satisfaction, which in turn has considerable impact on the financial results of the organization. Customer satisfaction in turn is impacted by quality for cost (QfC); quality management has thus far focused efforts in this realm primarily on paying out warranty claims, recalling products, and guarding against the repetition of past failures in new products. However, in the highly competitive future environment emerging in the global market, there is a need to develop a concept of quality for sales (QfS) that has to be practiced in addition to QfC.

To begin with, what are we talking about when we talk about sales? At the simplest level, sales is a function of demand (D), coverage (C), and success rate (SR), where

Enhancement of Customer Satisfaction

In the highly competitive future environment emerging in the global market, there is a need to develop a concept of quality for sales (QfS) that has to be practiced in addition to quality for cost (QfC).

D is the total population of potential customers who might desire the product, C is the subset of that population reached by marketing, and SR is then the subset of customers reached by marketing who actually make a purchase. Thus, SR/D is an equation for market share (MS), and unrealized sales, representing both potential customers unreached by marketing and reached customers failing to purchase the product, can be expressed as (1 − MS), where the universe of all potential customers is normalized to 1. Conversely, realized sales can be understood as (D * MS), and MS can be expressed as (C/D * SR). This is visualized in Figure 1.
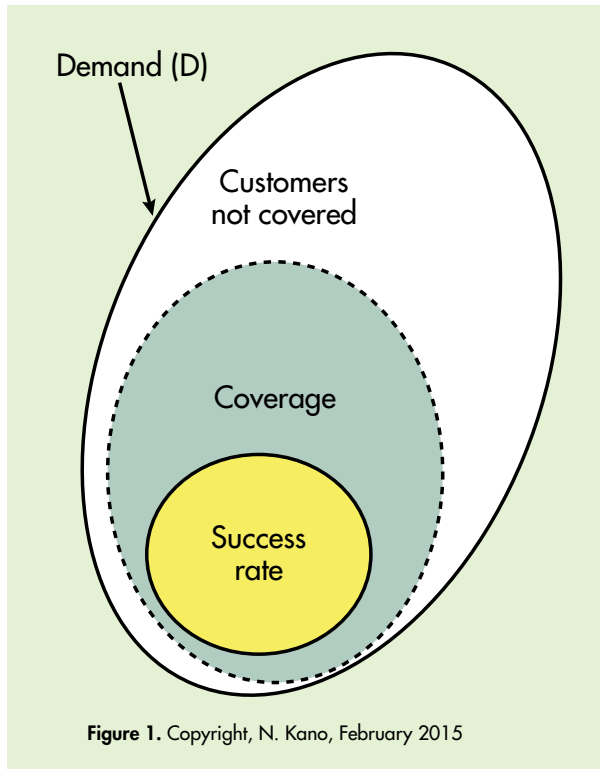
Of course, many of these factors are impacted by variables outside the realm of quality. Marketing efficacy and brand strength are the largest determinants of how many customers one reaches (C), for example, and a customer's initial selection of a specific brand among alternatives (SR) is likely to be shaped by the product's price and payment conditions (P&PC) and delivery (Del) options, among other factors.

The nature of sales as an output resulting from many inputs is visualized in Figure 2 (on p. 73).

That being said, however, quality still plays a critical role in the overall process of sales. For illustrative purposes, let us consider the particular case of replacement purchases, where customers seek to replace aging semi-durable products such as refrigerators, cars, or keyboards. In this case, we might divide the question of quality into "past quality" (Q1), or what the customer has experienced thus far of the quality of current product, "present quality" (Q2), or how attractive the customer currently finds the product relative to its competitors, and "future quality" (Q3), or how the customer expects a product to safely and reliably serve him or her as time elapses under expected or unexpected usage conditions.

Demand (D)

Customers not covered

Coverage

Success rate

Figure 1. Copyright, N. Kano, February 2015

As an example of how these different aspects of quality interact, we might consider a driver who has used a car from a particular brand for the past five years, and is now looking to replace it. In this case, the three Qs would be as follows:
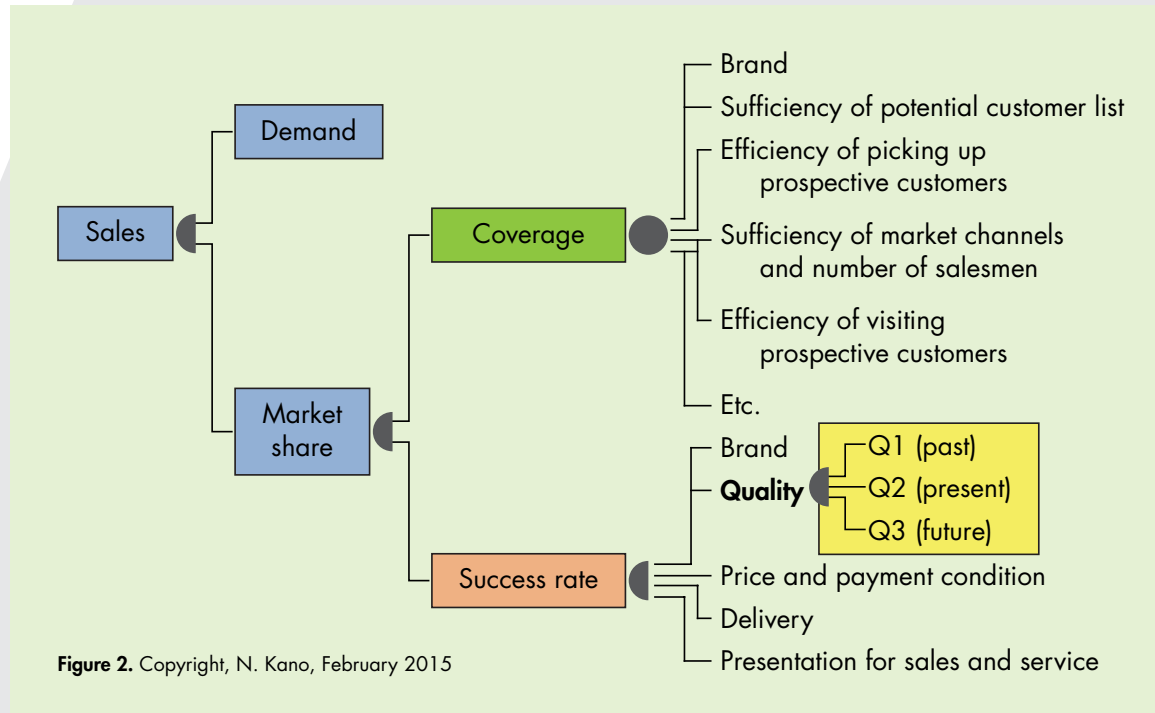

Figure 2. Copyright, N. Kano, February 2015

- Q1: The customer, having driven the car around for half a decade, is either content or unhappy, having experienced between zero and many problems with the vehicle.

- Q2: A competing brand offers a new model, and the customer either finds said brand more attractive than the new model of his or her current brand, or vice versa.

- Q3: This is a quality of a product that may change after lapse of time in use under expected or unexpected conditions and is expected by the customer at the time of purchase. Safety and reliability are typical examples of Q3.

In the above case, assuming that the customer selects a brand only based on quality, even if the customer has a positive Q1, curiosity might still drive him or her to choose a competitor

due to superior Q2. Conversely, even if the customer has a negative Q1, risk aversion might still lead him or her to stay with the brand.

For a car maker, the issue of greatest concern is when a customer who currently uses the brand's car decides between replacing it with the brand's new car or switching to a competitor's model. In this case, the factors that influence the selection of brand will in general depend on these Q1, Q2, and Q3, as well as other factors of product power as discussed above.

Let us now generalize our discussion of the three Qs.

What is Q1? Q1 is the customer's impression of the current car, which can be further subdivided into Q1a, Q1b, and Q1c:

- Q1a: The customer's perception of treatment received during the warranty period when compensation claims are filed, in terms of responsiveness and degree of resolution.

- Q1b: The customer's perception of problems not covered under warranty, or problems leading to inconvenience and discomfort due to inappropriate design specifications, such as poor air conditioning or difficult-to-read signs in small lettering on the dashboard. These are problems that cannot be solved by repair, rework, or reform. In addition, there could be minor problems the customer thinks are not worth filing claims for.

- Q1c: The customer perception of the product overall in terms of likes and dislikes, as dependent on the strengths and weaknesses of the product in usage, the provision of good or bad service, or the provision of appropriate or inappropriate information to the customer after purchase. Style belongs in this category.

Importantly, however, how one approaches the three Qs differs depending on whether one adopts a QfC or QfS framework.

Among the subdivided category, Q1a covers warranty claims that obviously lead to extra cost and hence lower profitability for the manufacturer. If the cost is benchmarked against

that of competitors, it will motivate the manufacturer to focus on Q1a to enhance profit and control cost. For this purpose, cost is analyzed on the basis of problems as they occur in the relevant phases of production, with measures to prevent recurrence being widely investigated. In this context, Q1a can be thought of as a typical example of QfC. In addition, Q1a influences the buyer's replacement purchase decision. Therefore, Q1a also falls under QfS.

On the other hand, the manufacturer does not incur any cost at all for Q1b and Q1c. However, the manufacturer will be rewarded or punished by the consumer's purchase decision based on both Q1b and Q1c, and thus these both fall under QfS.

What is Q2? New models with specialized attractive features may be released by various brands as replacement options for the customer. For example, in the case of a car, automated driving is considered one of the hot features today. Evaluation of such features by customers falls under Q2 and influences brand selection. Therefore, Q2 is QfS. Fashion should be considered a very important factor by the manufacturer when offering new features. This is especially the case in B to C, relative to B to B.

Management might seek to orient the development of said new features. For example, instructions could be given to focus on: high-tech features, stylishness, or a reasonable operating cost, among others.

In order to realize these developments, there are two approaches:

- Find an application for an already-developed technology.

- Explore customer needs through a customer usage survey, and then find appropriate technology to fill them.

While the former approach has been the dominant method for a long time, the latter approach will become more important for matured products. One way to revitalize sales of these goods would be to implement attractive quality creation, as based on the Kano model's attractive quality theory as linked with the Yoneyama model. (For more on the Yoneyama model, the reader is encouraged to visit *http://www.juse.or.jp/english/archives/#anc01*.)

An illustrative example: In July 2006, Indian company Mahindra and Mahindra (M&M) launched the "Shaan" farm tractor, a multipurpose vehicle useful not only for agriculture, but also for transporting goods, people, and the family. M&M realized that customers were not just using their products for farming, and thus added to their new tractor model a built-in trolley, higher road speed, and a soft-top canopy. These initiatives assisted M&M with becoming the world's largest seller of tractors in 2009.

Finally, what is Q3? Q3 is dependent on future issues, and represents the consumer's confidence about the safety and reliability of the product, including the risk of critical accident or failure related to newly introduced features.
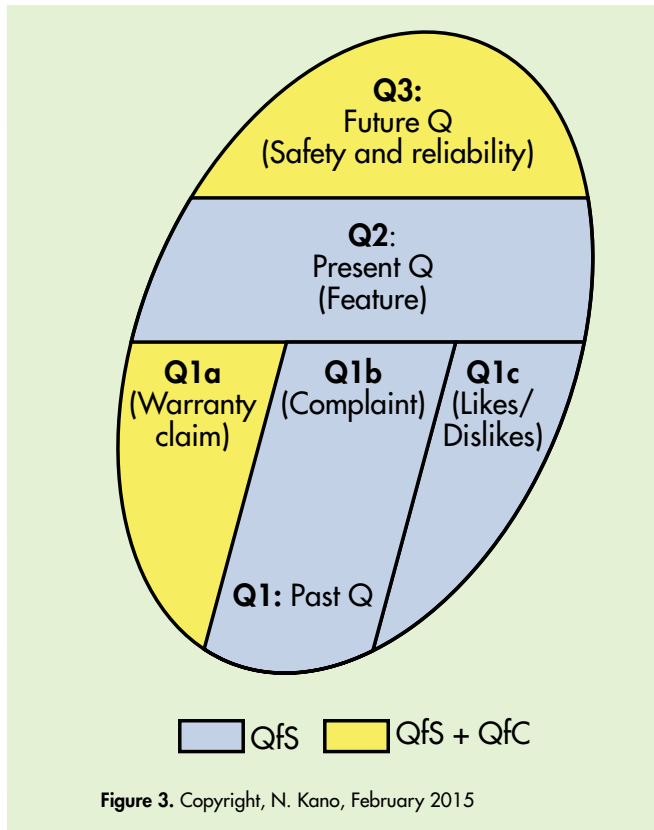

Figure 3. Copyright, N. Kano, February 2015

Working in Q3 thus involves instilling conviction in the customer that the product is safe and reliable, including through systematic activities such as failure mode and effects analysis (FMEA). There is no doubt that when a customer purchases a product, especially a safety-related one, that this confidence is an important key factor for brand selection. Therefore, this is a factor that falls under QfS. If an accident or failure happens or occurs in usage, however, it becomes Q1a for the purchased car as a factor under QfC. In addition, Q3 also includes the trends of governmental regulation or insurance in case accidents happen or occur. It is affected by brand too.

Another example is illustrative: The personal information protection law was established in Japan in May 2003. Executives who bring back documents that contain personal information were sensitive to this issue. For shredder makers, this was a business opportunity, and a shredder was developed for family use. This was only a downsized version of the office-use machine, and the opening slit for feeding the paper was kept the same. Sales steadily increased and this penetration into a new segment seemed to be very successful. However, on March 10 and July 15, 2005, two infant children lost their fingers. (For more on this case, the reader is encouraged to see the news release by the Ministry of Economic, Trade and Industry, at *http://www.pref.miyagi.jp/uploaded/attachment/7256.pdf*.)

Finally, see Figure 3 for a visualization of the three Qs.

One more question remains: How important are these aspects of quality, relative to each other? As Q3 is evaluated after a probable brand is proposed, we might regard our comparison as strictly being between Q1 and Q2. In truth, however, this question lacks a single answer, as the relative weight of Q1 and Q2 is likely to differ by customer. Even for the same person, Q1 and Q2 may possess differing levels of importance for different products.

That being said, however, we might generally say that young people, in particular, tend to select trendy features and thus place a higher priority on Q2, while those who are older are likely to exhibit relatively conservative purchasing behavior, and thus prioritize Q1.

As discussed above, the area of quality activities should be expanded to QfS in addition to QfC, which is already the responsibility of quality professionals. It is not realistic to expect that all activities will be their responsibility; however, quite a wide area can be covered by them. In this case, we should start preparing for the new challenge.

Cecilia Kimberlin, Ph.D.

CONCLUSION:

Quality for the Future

As I look back over more than 30 years of experience in healthcare and medical products, I am confident of a future where quality will be even more essential and impactful to the global economic and social environments. What observations and experiences as a quality leader and executive support this optimistic view?

Quality is essential to brand development and loyalty. We know of examples where innovative products that lacked quality were not successfully sustained. In an age of instantaneous public media, quality issues have sent stock prices spiraling downward. Organizations, whether public or private, for-profit or not-for-profit, have lost credibility with stakeholders and brand loyalty when they have failed to deliver quality. Annual reports often cite quality issues as future risks and reasons for poor performance.

To consistently achieve successful outcomes, quality must be an organizational mindset—not a set of policies, rules, and tools governed by the quality function. When quality is integrated into the way we do business—finance, marketing, design, development, operations, supply chain, customer interactions—we experience the benefits of all that quality promises: customers who loyally promote us; elimination of waste, saving time and money; a reliable, cost-competitive supply chain; profitability; a positive organizational reputation; and trusted brands. When quality is fundamental to the organization's culture, from the CEO or organizational leader to the frontline employee or member,

When quality is fundamental it is integrated as an organizational philosophy that supports and enables innovation, growth, positive customer experience, and talent development.

it is integrated as an organizational philosophy that supports and enables innovation, growth, positive customer experience, and talent development. Quality is fundamental to sustainable business and organizational success.

Future
Quality

Quality is essential to
brand development and loyalty.

There are also examples when an organization is not successful because quality is limited, positioned as a program, a function, a set of tools, or a reactive failure management system. In these situations, innovation suffers; bureaucracy and complexity grow; people are not empowered and have little ownership of the underlying issues.

Let's turn to the future. What will the future bring that enlivens and challenges our current thinking and practices of quality? What factors impact the way we will lead quality in the future?

Change is accelerating at an unprecedented pace. Technologies are advancing, and our familiar frameworks are more quickly obsolescing. Innovation is key. Access to data and media is evolving, with the amount of data becoming overwhelming to analyze, making it harder to distinguish relevant information for knowledge and timely decision making. The globe is continually shrinking. More and more organizations will be "global" directly through their own markets, or indirectly, because of global and regional supply chains. Evolving and potentially destabilizing social and economic factors, from exchange rates and natural resources to politics and demographics, are becoming harder to predict.

The role of quality professionals will evolve so that they are partners, collaborators, and leaders, not only technical specialists.

HOW DO THESE FACTORS AFFECT THE QUALITY OF THE FUTURE?

Tomorrow's organizations need leaders who embrace quality as an enabler for success. Leaders at every level, in every function, will lead more successfully if they imbed quality into their thinking, analytics, strategies, planning, and execution. In the future, the leadership of quality is shared. The role of quality professionals will evolve so that they are partners, collaborators, and leaders, not only technical specialists. They must lead and serve at every level regardless of title by providing their best insights, guidance, practices, and innovative solutions for achieving quality outcomes.

The approaches, skills, and tools of the past may not be sufficient. They may actually stifle future organizational ability to drive innovation, leverage real-time information and "big data" analytics, design quality into innovative products and processes, remain agile, adapt new technologies and materials, and redefine understanding of unmet needs and how to meet them.

To prepare for this challenging and exciting future, change is needed in how we develop quality professionals and how quality is integrated into professional development overall. Professional societies like ASQ must change as well. ASQ's mission is to increase the

use and impact of quality. To fulfill this mission in the future, new partnerships and collaborations with businesses, business schools, and academia, other professional societies, industry groups, and government agencies are needed. ASQ must support quality professionals to strengthen capabilities and broaden skills in business acumen and organizational excellence while innovating and updating our body of knowledge and quality tools.

An equally exciting opportunity will come with other professionals by broadening their understanding of quality and its relevance to organizational success. Imagine interactive and shared learning about quality occurring throughout education in science, technology, business, social enterprise, and leadership development—collectively becoming more knowledgeable and capable about how to deliver quality outcomes. Creating new knowledge networks and interfaces will contribute to novel solutions and applications. Two areas in particular are rapidly advancing toward these goals: the first is the integration of innovation and quality to more quickly allow innovations to become operational; and the second is the integration of quality and social responsibility to foster a more holistic approach to quality outcomes.

What is quality for the future? Imagine a future where quality is an essential connector—a framework and network—for developing and advancing capabilities to create a better world and society.

Cecilia Kimberlin

Cecilia Kimberlin
2015 Chair, ASQ

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STEPHEN ROSEN is the Beton Michael Kaneb professor of national security and military affairs at Harvard University. He was the civilian assistant to the director, net assessment in the Office of the Secretary of Defense, the director of political-military affairs on the staff of the National Security Council, and a professor in the Strategic Department at the Naval War College. He participated in the President's Commission on Integrated Long Term Strategy, and in the Gulf War Air Power Survey sponsored by the Secretary of the Air Force. He has published articles on ballistic missile defense, the American theory of limited war, and on the strategic implications of the AIDS epidemic. His books include *Winning the Next War: Innovation and the Modern Military* and most recently *War and Human Nature.*

JIM DAVIS is UCLA's vice provost, information technology, and chief academic technology officer—an executive leadership role focused on UCLA's academic research and education mission. Davis has broad oversight of campuswide planning, governance, and strategic investment of IT, manages the Office of Information Technology, and has responsibility for the Institute for Digital Research and Education. Included in his portfolio are UCLA's digital presence, cyberinfrastructure, informatics, policy, mobility, and the Office of the UCLA Chief Privacy Officer. Among the many initiatives Davis is involved with, he currently co-leads a national initiative on smart manufacturing and U.S. manufacturing competitiveness. Davis is also a professor in the Department of Chemical and Biomolecular Engineering at UCLA, where his research interests are in the areas of data analysis, decision support, and intelligent systems.

IZABEL CHRISTINA COTTA MATTE is an architect and urban planner, with a postgraduate diploma in project management from Project Management Institute and a specialization in public management from George Washington University. Cotta Matte has been a civil servant of Porto Alegre City Hall for 22 years—with responsibilities for the implementation of the Porto Alegre Management Model in 2005. Nowadays, she is chief strategic planning and budgeting officer, responsible for managing strategic government programs and special projects. She also leads the planning and budget execution—monitoring the physical and financial implementation of government programs.

DEVI SHETTY, a renowned cardiac surgeon and Indian philanthropist, is chair and founder of Narayana Health. He received his medical degree in general surgery from Kasturba Medical College and subsequently completed specialization training in cardiac surgery at Guy's Hospital in the United Kingdom. Upon returning to India in 1989, Dr. Shetty initially worked at B.M. Birla Hospital in Kolkata, where in 1992 he performed the first neonatal heart surgery in the country on a nine-day-old baby. He later operated on Mother Teresa after she had a heart attack and also served as her personal physician. Shetty has performed more than 15,000 heart operations. In 2001, he founded Narayana Hrudayalaya, now known as Narayana Health, a multispecialty hospital located outside Bangalore. Among other honors, he has been awarded the Padma Bhushan, the third highest civilian award in India for his contributions to the field of affordable healthcare.

JOANN STERNKE considers herself very lucky to be a part of the Pewaukee School District (PSD) since 2001. Under Sternke's tenure, numerous program improvements have been implemented to increase student achievement. Some of these initiatives include a successful 1:1 laptop initiative in elementary through high school, four-year-old kindergarten, advanced high school course offerings with Northwestern University, elementary world language, middle school 5x5 block schedule, and increased high school graduation requirements. In 2010, the PSD was the first education recipient of the Wisconsin Forward Award. In 2013, the district received the Malcolm Baldrige National Quality Award. Sternke was recognized as Wisconsin Superintendent of the Year for 2013.

ZHENG MINGGUANG has a Ph.D. from Shanghai Jiaotong University and is the president of Shanghai Nuclear Engineering Research and Design Institute, chief designer of the large advanced PWR nuclear power plant (NPP), National Science and Technology Major Project, and also an adjunct professor and doctoral supervisor at Shanghai Jiaotong University. Dr. Zheng is an expert in the fields of nuclear reactor technology, instrumentation and control, safety analysis, and NPP simulation. He presently serves as a member of the National Nuclear Safety Expert Committee, National Nuclear Safety Administration (NNSA), a member of the International Committee and the board of directors, American Nuclear Society (ANS), a member of the Technical Working Group on Advanced Technologies for Light Water Reactors (TWG-LWR), International Atomic Energy Agency (IAEA), as well as a member of the Standing Advisory Group on Nuclear Energy (SAGNE) to the director general of the IAEA.

GREGORY WATSON is an industrial engineer and quality consultant. He is past president and Fellow of ASQ and past president and Honorary member of the International Academy for Quality. He has received more than 40 personal quality awards in North America as well as Europe and Asia; and he is the first non-Japanese to have received the W. Edwards Deming Medal from the Union of Japanese Scientists and Engineers. He has been elected Honorary member of national quality organizations in Australia, Argentina, Azerbaijan, Finland, Hungary, Israel, Kazakhstan, Latvia, Russia, Singapore, and the United Kingdom. He is the author of 10 books and more than 300 papers.

ANDREW WATSON is a visual and media artist, educator, and STEAM education policy advisor. He teaches digital art, design, animation, and game design at the Falls Church High School for the Fairfax County Public Schools in Virginia. He volunteers his time regionally as a member of the board of directors of the Northern Virginia Mini Maker Faire and nationally as a founding member of the board of directors of the Innovation Collaborative. He also serves as an advisor to the National Art Honor Society and the Smithsonian Institute's National Portrait Gallery.

RONALD SNEE is founder and president of Snee Associates, LLC, a firm dedicated to the successful implementation of process and organizational improvement initiatives. He was employed at the DuPont Company for 24 years prior to pursuing a consulting career. Snee also serves as adjunct professor in the pharmaceutical graduate programs at Temple University School of Pharmacy and Rutgers University Pharmaceutical Engineering. He received his bachelor's degree from Washington and Jefferson College and master's of science and Ph.D. degrees from Rutgers University. He is an academician in the International Academy for Quality and Fellow of ASQ, American Statistical Association, and American Association for the Advancement of Science. Snee's work has been awarded ASQ's Shewhart and Grant Medals, ASA's Deming Lecture Award, as well as more than 20 other awards and honors. He has co-authored three books with Roger Hoerl on statistical thinking and Six Sigma.

ROGER HOERL is the Brate-Peschel assistant professor of statistics at Union College in Schenectady, NY. Prior to this assignment Hoerl headed the Applied Statistics Lab at GE Global Research, which supports new product and service development across the GE businesses. Dr. Hoerl has been named a Fellow of ASQ and the American Statistical Association, and has been elected to the International Statistical Institute and the International Academy for Quality. He has received the Brumbaugh and Hunter Awards, as well as the Shewhart Medal from ASQ, and the Founders Award from the American Statistical Association. In 2006 he received the Coolidge Fellowship from GE Global Research, honoring one scientist a year from among the four global GE research and development sites for lifetime technical achievement. He used his six-month Coolidge sabbatical to study the global HIV/AIDS pandemic—spending a month traveling through Africa in 2007.

NORIAKI KANO is one of the world's leading experts in the field of quality management. He is the developer of a customer satisfaction model known as the Kano model, which has a simple ranking scheme that distinguishes between essential and differentiating attributes related to concepts of customer quality. He is a professor emeritus at the Tokyo University of Science. Dr. Kano completed his undergraduate and graduate studies in the engineering school of the University of Tokyo. He was the 1997 recipient of the Deming Prize for Individuals, administered by the Union of Japanese Scientists and Engineers (JUSE). In 1997 he also received the Deming Lecturer Award from the American Statistical Association. Kano is an elected Fellow of ASQ and he was the recipient of two ASQ Medals of Distinction—the E. Jack Lancaster Medal in 2002 and the E. L. Grant Medal in 2007.

ABOUT ASQ

ASQ is a global community of people dedicated to quality who share the ideas and tools that make our world work better. With millions of individual and organizational members of the community in 150 countries, ASQ has the reputation and reach to bring together the diverse quality champions who are transforming the world's corporations, organizations, and communities to meet tomorrow's critical challenges. ASQ is headquartered in Milwaukee, Wisconsin, with national service centers in China, India, Mexico, and a regional service center in the United Arab Emirates. Learn more about ASQ's members, mission, technologies, and training at **asq.org**.

ABOUT LTSG

The Long Term Strategy Group (LTSG) is a multidisciplinary research and consulting firm based in Washington, D.C. The firm's leadership has contributed to the development and execution of many long-range planning efforts in the U.S. government and private sector, including the National Intelligence Council's Global Trends publications. LTSG helps clients diagnose critical threats and opportunities in their competitive environments and develop winning strategies built on enduring strengths. The LTSG team can be reached at **inquiries@ltstrategy.com**.