

FEIGENBAUM WAS presented with the National Medal of Technology and Innovation by President George W. Bush at a 2008 ceremony at the East Wing of the White House. The National Medal is the highest honor of technological achievement for America's leading innovators.



Total Quality's Leader

Remembering
Armand V. Feigenbaum,
integrator of quality into
organizational management

by Gregory H. Watson



Photo courtesy of the *Berkshire Eagle* (Pittsfield, MA)

ARMAND VALLIN FEIGENBAUM, or “Val” to his many friends, was born in a different era. In his youth, he worked as a toolmaker for General Electric (GE), and he took advantage of GE’s exceptional educational benefits to earn a bachelor’s degree in engineering from Union College in Schenectady, NY, followed by a master’s degree and doctorate in engineering economics from Massachusetts Institute of Technology in Cambridge.

His early career was spurred by the shortage of engineers during World War II, and he rose rapidly in the GE management structure to become director of manufacturing and quality, a position he held for 10 years prior to founding General Systems with his brother, Donald.

Feigenbaum is best known for the multiple editions of his classic book *Total Quality Control*,¹ which was an expansion of an article he wrote for *Harvard Business Review* in 1956.² Feigenbaum passed away on Nov. 13 at the age of 94.

Quality pioneer

Among his major recognitions are bestowal of the National Medal of Technology by President George W. Bush, election to the National Academy of Engineering, three honorary doctorates, and selection as an honorary member by ASQ and the International Academy for Quality (IAQ).

Feigenbaum contributed his energy to the quality movement from its beginning. He was a pioneering member of ASQ and the only individual who has served as its president for two terms. As GE sought to reconstruct its European operations following the World War II, Feigenbaum focused his effort on rebuilding the manufacturing and quality competence of Europe, where he was a catalyst in establishing the European Organization for Quality (EOQ).

Along with his international quality colleagues, Kaoru Ishikawa (representing the Union of Japanese Scientists and Engineers [JUSE] and Walter A. Masing (representing the EOQ), Feigenbaum

was one of three individuals who are credited as founders of IAQ. In reflection, Feigenbaum's life serves as a role model of total commitment to quality.

GE: A stimulating intellectual environment

Early in his career, Feigenbaum was privileged to work for a company that not only respected education, but



IN 1968, Feigenbaum and his brother, Donald (left), founded General Systems, an engineering firm that designed and installed operational systems for corporations.

also strongly encouraged it. At that time, GE was an exceptionally rich environment where the pursuit of continual improvement pervaded everything. This culture stimulated innovation centered on development of engineering methods for production and its related support systems.

Following his project management work, Feigenbaum was a key executive in the development of the GE internal learning center at Crotonville, NY. In this highly inspiring environment, Feigenbaum's contemporaries also contributed ideas that merged into his total quality perspective:

Ralph E. Wareham (1914-2006) considered himself a quality engineer. After receiving a bachelor's degree in mathematics from the University of Iowa, Wareham joined GE and worked in quality. He studied under Walter A. Shewhart through an exchange program that GE maintained with AT&T Bell Laboratories.

Wareham authored the chapters on statistics that are included in Feigenbaum's 1951 book *Quality Control*³ (this book provided the core of Feigenbaum's later book, *Total Quality Control*, first published in 1961).⁴ Wareham was one of the six instructors for the course in statistical process control that was developed by Eugene L. Grant for manufacturing sites across American during the war years.

Wareham was the second president of ASQ and ran



FEIGENBAUM IS best known for his book, *Total Quality Control*.

the young society from his kitchen table. He demonstrated total commitment to quality by remaining active in ASQ until his death. Wareham's emphasis on statistical methods to control quality provided a key element of Feigenbaum's approach to total quality.

Harry A. Hopf (1882-1949) considered himself a management engineer. He applied the principles of scientific management to white-collar work, and in 1953, GE published a collection of the papers that he wrote in the decades of the 1930s and 1940s as *New Perspectives in Management*.⁵

The collection of Hopf's papers illustrates the application of scientific management principles to GE's life insurance business. It's interesting to note how he emphasized building a sound measurement system and participative management to guide the processes of organizations, as statistical methods and human relations are cornerstones of the modern quality movement.

"The power of decision making should be placed as closely as possible to the point where action originates," Hopf wrote.⁶ In this emphasis, he echoes Mary Parker Follett (author of *The Creative Experience*)⁷ and Chester I. Barnard (author of *The Functions of the Executive*).⁸

Hopf's extension of the principles of scientific management and integration with participative ideas contributed two elements to Feigenbaum's approach to total quality.

Lawrence D. Miles (1904-1985) considered himself a value engineer. He worked in GE purchasing to improve productivity and cost of supplied material, and described his method in *Techniques of Value Analysis*.⁹

Miles' approach to value engineering applied creativity tools such as brainstorming, as first popularized by Alex F. Osborne (author of *Applied Imagination*)¹⁰ to develop alternative, lower-cost ways to provide the same functionality in products through different material use or design changes. Currently, value engineering is required in all major procurements by the U.S. Department of Defense.

Miles' emphasis on cost effectiveness of operations and materials also enriched Feigenbaum's idea of total quality. In a 2006 QP interview,¹¹ Feigenbaum acknowledged that value engineering was making a major contribution to the tool kit used for total quality improvement.

Blending a coherent systems approach

Feigenbaum's ideas also were stimulated by a variety of peers within the original post-World War II quality community. Many were pioneers in establishing the American Society for Quality Control (ASQC, ASQ's original



MODEL TRAINS were a hobby Armand and Donald began as children.

name), and several engaged in the creation of the IAQ.

These individuals included: Leon Bass, Charles A. Bicking, Paul C. Clifford, Simon Collier, W. Edwards Deming, George D. Edwards, C. Eugene Fisher, Joseph M. Juran, E. Jack Lancaster, Sebastian B. Littauer, Julius Y. McClure, Thomas C. McDermott, Ellis R. Ott, William R. Pabst, Leslie Simon and Shewhart.

These individuals were actively engaged in developing the core of the modern quality body of knowledge (QBoK), and their engagement evolved out of activities that were related to the support of wartime industries.

Prior to Feigenbaum's development of the concept of total quality, there were two dominant schools of quality thinking:

1. During the first half of the last century, Deming, Harold F. Dodge, Grant, Ott, Harry Romig and Shewhart focused on using statistical methods to achieve high-quality products through a combination of acceptance testing and statistical process control.
2. In the early 1950s, Deming, Juran and Peter Drucker emphasized management-based systems for improving manufacturing performance and business practices with stronger emphasis placed on human relations aspects.

Feigenbaum served as an intellectual systems integrator for quality thinking. He advanced technology management by defining a new approach to quality based on economics, industrial engineering, which included the emerging engineering discipline related to systems, and management science. He combined this with preexisting statistical and management knowledge, and the resulting integration was called total quality.

Personal intellectual contribution

Key contributions by Feigenbaum were documented in his 1961 book, *Total Quality Control*, which has undergone updates in three editions to maintain its currency during the past 50 years.¹² According to Feigenbaum, quality must be emphasized because of three factors:

1. Customers keep increasing their requirement for quality performance of products and services. This greatly amplifies competition for market-share gains by delivering perceivably greater value than is available from other suppliers of similar products or services.
2. Due to the increased demand for higher-quality products, traditional approaches, practices and techniques for delivering quality results become obsolete, and quality performance can no longer be considered as value adding. Rather, it has become a baseline qualification in commercial competition.
3. Quality costs are not visible, but hidden in the managerial financial reports of most organizations. These costs are often higher than the bottom-line profit achieved for the products. For some organizations, these costs may be so high as to undermine their competitive position in the market.

Feigenbaum said that if these are the factors that motivate management to develop a strong quality capability, total quality control (TQC) is the answer for ensuring an organization has a robust system that delivers quality in all areas of its business operations. So, what did he mean by TQC?

Total quality control

Feigenbaum defined TQC as: “An effective system for integrating the quality development, quality maintenance and quality improvement efforts of the various groups in an organization so as to enable production and service at the most economical levels which allow full customer satisfaction.”¹³

Consider each word in the phrase “total quality control” and what it contributes to the overall definition of TQC:

Total: Feigenbaum believed the total engagement of an organization is required to ensure quality. By this, he meant everyone, at all layers of the organizational structure and across all functional areas, has a duty to ensure the quality of his or her work and the outcome provided to external customers.

In this way, quality is not merely delegated to factory workers, with the rest of the organization able to disengage from the work required to deliver the consistently high value that satisfies customers. Feigenbaum identified this effort as a “prime responsibility of general management and of the operations of marketing, engineering, production, industrial relations, finance and service, as well as the quality control function itself.”¹⁴

Quality: Feigenbaum said that, “Quality is, in its essence, a way of managing the organization.”¹⁵ The core ideology of Feigenbaum’s systematic approach is summarized using the following concepts of quality:

- Quality is an organizationwide process.
- Quality is what the customer says it is.
- Quality and cost are a sum, not a difference.
- Quality requires individual and teamwork zealotry.
- Quality is a way of managing.
- Quality and innovation are mutually dependent.
- Quality is an ethic.
- Quality requires continuous improvement.
- Quality is the most cost-effective, least capital-intensive route to productivity.
- Quality is implemented as a total system connected to both customers and suppliers.

Feigenbaum’s quality emphasizes the customer-oriented activities of the organization and requires that the internal activities be conducted in a disciplined way so control of the outcome quality is maintained at the level of customer expectation.

Control: Feigenbaum defined control as “a process for delegating responsibility and authority for a management activity while retaining the means of assuring satisfactory results.”¹⁶ He described four steps to develop control in a process:

1. Setting standards.
2. Appraising conformance.
3. Acting when necessary.
4. Planning for improvements.

Feigenbaum’s development of the idea of total quality was influenced by individual thought leaders, as well as the post-war atmosphere following World War II. To learn more about these topics, read the online-only sidebars “In-

tellectual Precursors to Total Quality,” “Post-War Atmosphere of Collaborative Transformation” and “Evolving the Concept of Total Quality,” which are available on this article’s webpage at www.qualityprogress.com.

Consistent results require leadership

Feigenbaum recommended that business leaders approach quality improvement by using a set of imperatives for focusing improvement efforts and driving actions—that they emphasize management innovation based on the principle that whatever you do to make quality better makes everything else better.

This view of improvement from a management leadership point of view involves:

- Making quality leadership a business centerpiece for revenue growth and competitive strength.
- Delivering value to customers as the motivation for improvement action.
- Achieving complete customer quality satisfaction, which drives buyer acceptance.
- Developing effective supplier and other business quality partnerships.
- Maximizing the effectiveness of quality data.
- Accelerating sales and earnings growth through quality cost management.
- Forming an integrated quality system that builds customer, producer and supplier relationships.
- Encouraging the use of tools and resources to create an individual quality improvement emphasis.
- Recognizing that quality is an international business language.
- Ensuring quality leadership is a foundation for successful ethical behavior.

Unfortunately, standard measurement systems often hide the real impact of quality losses from examination by management because allocation methods in accounting practice fail to identify the sources of problems of excessive cost and obscure the causal relationship for actions that are the results of responses to poor quality.

Total quality requires that everyone take responsibility for the effect of their work on the level or degree of quality that is perceived by the customer—emphasizing not only the quality of a product’s performance, but also the degree to which it accomplishes the customer’s requirements.

Quality cost

By using the language of finance and introducing the concept of quality cost, Feigenbaum emphasized that quality



BORN IN 1920, Feigenbaum’s early career was spurred by a shortage of engineers during World War II. He’s shown here as a boy with his younger brother, Donald (left).

must be actively managed and have visibility at the highest levels of management. When Shewhart introduced economic cost in his 1931 book, *Economic Control of Quality of Manufactured Product*,¹⁷ he was focused on the cost of scrap and rework that occurred when products were not produced right the first time.

Feigenbaum extended this idea to include the sum of direct and indirect costs of doing business in a way that creates customer dissatisfaction. This emphasis was totally new and not found in the prior works of either Grant or Shewhart.

Philip B. Crosby later became renowned for his expansion on the cost of nonconformance and cost of poor quality, but he credited Feigenbaum with the origination of this concept. Subsequently, Genichi Taguchi extended

Feigenbaum's concept to include the costs incurred by society after it is released to society.

Hidden plant

A related contribution from Feigenbaum was his concept of the "hidden plant," which generates waste and cost of quality. This happens when extra work is performed to correct mistakes in production control and is due to:

- Poorly worded orders that don't get the customer's requirements right.
- Time that is wasted in searching for lost parts or replacing parts of poor quality.
- Activities required to expedite performance when schedules are not met for various reasons.

When considering all of these activities, Feigenbaum estimated that up to 40% of a plant's ideal production capacity may be lost because things are not done correctly. He identified this loss with what he called the "hidden plant"—a "factory" that loses money within the factory that produces the products.

The idea of the hidden factory still exists today and can be observed in the loss of process capacity for productive output. In plants in which efforts to reduce waste through quality and lean methods are not practiced, this loss may still be as high as 40% of the designed production capacity. The concept of the hidden plant helps to crystallize the loss that occurs when quality is not right from the viewpoint of the consumer customer and the shareholder.

Feigenbaum's legacy

Feigenbaum's legacy comes from the integration of quality concepts into a system for management of an organization. In his book, *What is Total Quality Control? The Japanese Way*, Ishikawa credited Feigenbaum's ideas with stimulating the Japanese approach to quality.¹⁸ The Japanese system for TQC integrated the teachings of Deming, Drucker and Juran into their concepts along

with the motivational ideas of Frederick I. Herzberg and Abraham Maslow—all interpreted within the context of Japanese tradition and culture.

Feigenbaum's systemic approach also can be observed in the framework created for criteria of the Malcolm Baldrige National Quality Award, which codified his comprehensive approach to quality as a business issue.

While no specific tool can be attributed to Feigenbaum, he delivered to our community something perhaps richer: a broader way of thinking about our work and its importance in the activities of mankind. From all of us, thank you, Val. **QP**

REFERENCES

1. Armand V. Feigenbaum, *Total Quality Control*, McGraw-Hill, 1961, 1983 and 1991.
2. Armand V. Feigenbaum, "Total Quality Control," *Harvard Business Review*, November-December 1956, pp. 93-100.
3. Armand V. Feigenbaum, *Quality Control*, McGraw-Hill, 1951.
4. Feigenbaum, *Total Quality Control*, see reference 1.
5. Harry A. Hopf, *New Perspectives in Management*, Hopf Institute of Management/General Electric Co., 1953.
6. Ibid.
7. Mary Parker Follett, *The Creative Experience*, Longmans, Green and Co., 1924.
8. Chester I. Barnard, *The Functions of the Executive*, Harvard University Press, 1938.
9. Lawrence G. Miles, *Techniques of Value Analysis*, third edition, Lawrence G. Miles Value Foundation, 1989.
10. Alex F. Osborne, *Applied Imagination*, Bombay, 1961.
11. Thomas M. Kubiak, "Feigenbaum on Quality: Past, Present, and Future," *Quality Progress*, November 2006, pp. 57-62.
12. Feigenbaum, *Total Quality Control*, see reference 1.
13. Ibid.
14. Ibid.
15. Ibid.
16. Ibid.
17. Walter A. Shewhart, *Economic Control of Quality of Manufactured Product*, ASQ Quality Press, 1931.
18. Kaoru Ishikawa, *What is Total Quality Control? The Japanese Way*, Prentice-Hall, 1988.

BIBLIOGRAPHY

- Feigenbaum, Armand V., "Changing Concepts and Management of Quality Worldwide," *Quality Progress*, December 1997, pp. 45-48.
- Feigenbaum, Armand V., "How to Manage for Quality in Today's Economy," *Quality Progress*, May 2001, pp. 26-27.
- Feigenbaum, Armand V., "Is It Any Surprise? World Class Companies Are Remarkably Similar!" *Journal of Quality and Participation*, March 1992, pp. 10-12.
- Feigenbaum, Armand V., "Raising the Bar," *Quality Progress*, July 2008, pp. 22-27.
- Feigenbaum, Armand V., "The Power Behind Consumer Buying and Productivity," *Quality Progress*, April 2002, pp. 49-50.
- Feigenbaum Armand V. and Donald S. Feigenbaum, "The Future of Quality: Customer Value," *Quality Progress*, November 2004, pp. 24-29.
- Stratton, Brad, "Connecting With Customers and Other Sage Advice," *Quality Progress*, February 1996, pp. 58-61.
- Watson, Gregory H., "Feigenbaum's Enduring Influence," *Quality Progress*, November 2006, pp. 51-55.
- Watson, Gregory H., "Total Quality—Total Commitment," *Quality Progress*, November 2008, pp. 20-26.



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A LEGACY LIVES ON

Feigenbaum's ideas about total quality control and influence on the quality world live on in the articles he authored for ASQ publications and in articles discussing his contributions. Find pieces he wrote for ASQ publications by visiting bit.ly/ASQauthoredarticles (case sensitive) as well as those discussing his contributions to quality at bit.ly/qualitycontributions, and read more about his career by visiting bit.ly/aboutcareer.

INTELLECTUAL PRECURSORS TO TOTAL QUALITY

In a 1675 letter to Robert Hooke, Sir Isaac Newton commented, "If I have seen further, it is because I have stood on the shoulders of giants." This is also true of the development of quality thinking. Many individuals contributed to the development of the intellectual atmosphere and managerial dialogue from which Armand V. Feigenbaum created his concept of total quality control (TQC) in the late 1950s.

Feigenbaum is best known for the multiple editions of his classic book, *Total Quality Control*,¹ which was built upon an earlier 1951 book on quality control and expanded upon an article that he wrote for the *Harvard Business Review* in 1956.² Such great ideas that influence the direction of human thought, however, do not always leap into existence independently. Most often, they are encouraged by the milieu of the times.

To comprehensively understand the idea of total quality, it is necessary to learn something about those intellectual precursors and thought leaders of that time.

The historical thinking and current intellectual capital being discussed during Feigenbaum's formative years as a student at Massachusetts Institute of Technology, where he studied engineering economics, shaped his development of the concept of total quality. Some ideas then at the forefront of management thinking had an influence over the contemporary environment because the books of thought leaders were required reading for informed executives.

The following contributions are presented in the order that the concepts were delivered for public consumption through their primary publications:

Harrington Emerson (1853-1931), in his book, *The Twelve Principles of Efficiency*,³ presented a set of characteristics that should be included as principles and lead to a more efficient operation of any organization. Emerson was an early practitioner of what was called "scientific management," although he was not particularly aligned with Frederick W. Taylor (1856-1915), who specialized more on the time study of worker's tasks to streamline labor. (In his book, *The Principles of Scientific Management*,⁴ Taylor popularized the task of studying work content to increase efficiency while not degrading quality).

Emerson had a broader perspective of efficiency, and he included some aspects that were incorporated into Feigenbaum's concept of total quality. Emerson recommended:

- Clearly defined ideals or goals.
- Use of common sense.
- Listening to competent counsel from knowledgeable professionals.
- Exercise of discipline in the workplace.
- Providing a fair deal for employees.
- Maintaining adequate, reliable and immediately available work records.
- Dispatching or controlling the timing of work in organizations.
- Establishing work standards and schedules for performance.
- Standardizing working conditions.

- Standardizing operations of work processes.
- Documenting the standard practices as work instructions.
- Linking performance efficiency to systems of reward and compensation.

Henri Fayol (1841-1925) wrote *General and Industrial Management*⁵ to describe a systematic process of management: planning, organizing, coordinating, commanding and controlling. He also introduced many management innovations into his organization as a mining industry executive: strategic analysis through long-term planning (10-year horizon) using alternative scenarios, as well as employee health and fitness programs.

Fayol observed "experience is an expensive teacher" and that management is an "activity that is spread across all members of the 'body corporate.'" He envisioned business as a system and said that management was responsible for maintaining discipline in the work processes while maintaining a "constant search for improvements that can be introduced into every sphere of activity."⁶

Fayol encouraged professional members of the technical staff to assure they "completed staff work" before submitting any recommendations to senior management for decisions.

Thus, Fayol stimulated a great deal of thinking about the topics that were to become core elements of total quality thinking. His work was written in French, however, and not widely available until after its English translation in 1949, although his ideas were widely discussed in academic circles.

Mary Parker Follett (1868-1933) was called the "Prophet of Management" by Peter F. Drucker. In her books, *The New State*⁷ and *The Creative Experience*,⁸ she emphasized group organization and recognized that in an organization, authority not only flows vertically through structured lines of authority, but it also can flow laterally through informal processes that achieve recognition through the "authority of their expertise."

Parker Follett coined the phrase "transformational leadership" and is considered to be the originator of organizational development and participative management methods. She believed the process of control should focus on facts, not on controlling people. She said coordination of activities represented a third way for managing through integration and cross-functional systems that share a joint responsibility for operations. This, she believed, engages everyone in the process of managing.

Eugene L. Grant (1897-1996) is perhaps most widely known for his teachings related to the ideas of Walter A. Shewhart and statistical process control (SPC). A decade earlier, however, he was a pioneer in developing an economic understanding of the activities of engineers.

Grant's book, *Principles of Engineering Economy*,⁹ explains the principles related to the acquisition of capital equipment in support of manufacturing operations. This addresses issues related to the costing of production facilities and the analysis of their performance to ensure an adequate payback for initial investment occurs within a reasonable timeframe.

Grant's work provided the baseline from which Feigenbaum

expanded his concepts related to the economic effects of poor quality and moved the conversation from capital budgeting considerations to that of an operational management problem.

Walter A. Shewhart (1891-1967) wrote *The Economic Control of Quality of Manufactured Product*,¹⁰ which can subsequently be considered the dawning of the age of quality. In this book, he identified a theory of control, which encompassed levels from naïve chaotic interpretation of the universe to the exact laws of science.

Stability of production methods allows a probability basis to predict future performance based on the mastery of the causal conditions that are identified and that change the outcome performance of the process quality.

In addition to the creation of SPC, Shewhart made an even greater contribution that has only been partially realized: the development of the intellectual capital for the quality movement by its positioning within the stream of human thought.

The pragmatic philosophy that pervaded America at this time focused on the application of the statistical control methods. The urgency of need for such methods that was stimulated by World War II caused many of his deeper ideas to go unnoticed until recent times.

G. Elton Mayo (1880-1949) conducted the famous Hawthorne experiments at Western Electric in the late 1920s and documented his findings in *The Human Problems of an Industrial Civilization*.¹¹

Mayo studied the problems of fatigue and monotony in repetitive manufacturing work. In an unexpected outcome of his study, he discovered that increased morale resulted from a perceived change in the social order, and this had a large effect in the hygiene aspects of the work environment.

In fact, the group perception of the workers changed as management made both positive and negative changes to their environment. In recognition of this observation, Mayo initiated the study of employee motivation as a significant factor for the productivity improvement and laid the thought foundation for future motivation studies by Frederick I. Herzberg and Abraham H. Maslow.

Chester I. Barnard (1886-1961) wrote the most highly influential books on the subject of leadership, *The Functions of the Executive*.¹² Barnard was president of AT&T New Jersey and then held several significant executive positions.

In his book, he changed the way efficiency was defined: from an operational time-motion study that was the focus of Taylor's scientific approach to managing work to a broader definition that focused on building cooperation within the organization to achieve its overall purpose.

Work process efficiency, under Barnard's scheme, is just an aspect of effectiveness (this is like a "little e" type of efficiency that is focused on working tasks—note that Barnard did not use this nomenclature of "little e" and "Big E" which are used in a similar context to the use by Joseph M. Juran of "little q"

and "Big Q" for identifying different ways that quality is applied in organizations) as compared to strategic level efficiency ("big E" type of efficiency, which increases the capability of the organization to achieve its overall purpose).

This "Big E"-type of efficiency is achieved by obtaining cooperation among the informal processes of the organization (with a citation for the influence of Parker Follett) and by finding "zones of indifference" within worker motivation.

These zones satisfied internal conflicts within organizations that often inhibit cooperation (an "us versus them" division between functional groups) by resolving problems in areas where the feelings of the conflicting subgroups are the least intensive. In this scheme of thinking, the executive's most important function is communication in a way that fosters internal cooperation.

Herbert A. Simon (1916-2001) was a 1978 Nobel laureate in the field of economics who also received prestigious awards for computer science, artificial intelligence and cognitive psychology. His most important book, *Administrative Behavior*,¹³ addressed many concepts around organizational decision making and the concept of bounded rationality.

He said decision making requires three steps:

1. Identification and description of all alternatives.
2. Understanding the potential consequences of each alternative.
3. Comparing the potential results of these decisions.

Bounded rationality means decisions must be made in the context of constraints imposed on the organization. Simon described two ways of viewing administrative science—the first as a theoretical construct as he did in his book, and the second as pragmatic applications of improving organizations.

Feigenbaum did not focus on the theoretical aspects of administrative science. Instead, he chose to focus on the pragmatic approach of improving a total organization by creating participation of an entire group to achieve the state of cooperation that Follett, Barnard and Simon described as the essential ingredient toward creating organizational effectiveness. —G.H.W.

REFERENCES

1. Armand V. Feigenbaum, *Total Quality Control*, McGraw-Hill, 1961, 1983 and 1991.
2. Armand V. Feigenbaum, "Total Quality Control," *Harvard Business Review*, November-December 1956, pp. 93-100.
3. Harrington Emerson, *The 12 Principles of Efficiency*, Engineering Magazine, 1912.
4. Frederick W. Taylor, *The Principles of Scientific Management*, Harper & Brothers, 1911.
5. Henri Fayol, *General Industrial Management*, paperback edition, Martino Fine Books, 1916.
6. Ibid.
7. Mary Parker Follett, *The New State*, 1918, paperback edition, Kessinger Publishing, 2009.
8. Mary Parker Follett, *The Creative Experience*, Longmans, Green and Co., 1924.
9. Eugene L. Grant, *Principles of Engineering Economy*, fifth edition, Ronald Press, 1970.
10. Walter A. Shewhart, *Economic Control of Quality of Manufactured Product*, ASQ Quality Press, 1931.
11. G. Elton Mayo, *The Human Problems of an Industrial Civilization*, reprint edition, Routledge, 2003.
12. Chester I. Barnard, *The Functions of the Executive*, 30th anniversary edition, Harvard University Press, 1971.
13. Herbert A. Simon, *Administrative Behavior*, fourth edition, Free Press, 1997.

POST-WAR ATMOSPHERE OF COLLABORATIVE TRANSFORMATION

Another significant influence on Armand V. Feigenbaum was the collective effort that Americans put into production in support of World War II. One of the participants in the wartime efforts to support American industry in its role as the “world’s factory” was Arthur M. Squires (1916-2012), who authored *The Tender Ship: Governmental Management of Technological Change*¹ to describe his experience and insights into how the government used “technical maestros” to manage change.

Squires was a chemical engineer who worked on the Manhattan Project. The technical maestros that Squires described included: scientists on the Manhattan Project, professorial ship riders of the Operations Evaluation Group (OEG) and teachers of industrial statistics for the War Production Board. The insights of these groups were captured in a series of postwar publications that created the professions of the quality engineer and operations research analyst, among others.

While the Manhattan Project is familiar to most people, and most quality professionals are aware of the industrial statistical developments, not everyone will be as familiar with the OEG. The OEG was established as a research center charged with recruiting and deploying mathematicians and scientists on naval vessels during World War II to study warfare at the engagement level to determine how to improve naval operations. This group was responsible for the development of operations research as a discipline for the improvement of processes through mathematical modeling.

Another lesson learned from the war effort was the value of building civilian-managed professional organizations. This encouraged the creators of the American Society for Quality Control (ASQC), ASQ’s previous name, based on the local groups that clustered around cities that were deeply involved in the defense effort and were formed to expand the use of quality methods.

The stimulus for creating total quality included a healthy dose of inspiration from the application of scientific thinking to problems for improving the state of warfare during World War II and to transfer technical competence in quality attained during the war years to America’s next generation.

One of the key ingredients had been the massive application of statistical methods to improve the quality of the American systems of war production—an industry that General Electric (GE) and the young Feigenbaum deeply supported.

Feigenbaum was a war-time program manager in the GE Aircraft Engines unit developing the first combat jet engines that were used on the Air Force’s F-80 Shooting Star. This project transitioned from design to flying prototype in just 143 days, and later it was modified to become the F-84 Starfire, which flew during the Korean War.

After leading these projects, GE assigned Feigenbaum as project manager to develop the engine for the first nuclear-powered jet fighter using the GE direct air cycle engine. The program was cancelled before a flyable prototype was developed; however, the assignment showed GE’s top management held Feigenbaum in high esteem.

Such was the intellectual environment at the time that the idea for total quality crystallized in Feigenbaum’s mind.

Feigenbaum had the right mind at the right time to integrate the intellectual capital of his day and forge it into a comprehensive approach to management. Total quality was a natural outcome of the intellectual forces brewing at that time, but it required a person of great insight to transform the divergent elements into a comprehensive method. —G.H.W.

REFERENCE

1. Arthur M. Squires, *The Tender Ship: Governmental Management of Technological Change*, Birkhäuser, 1986.

EVOLVING THE CONCEPT OF TOTAL QUALITY

The concept of total quality grew out of the academic research in Armand Feigenbaum’s doctoral studies as well as his practical experience and internal training while at General Electric (GE). The initial systems of quality management were published between 1922 and 1950 by George S. Radford,¹ Egon Pearson,² Leslie E. Simon³ and Paul Peach.⁴

Out of these developments of the application of quality to manufacturing operations, Feigenbaum initially concentrated on the development of a quality system for GE that served his needs as he eventually was promoted to director of manufacturing and quality organizationwide.

Feigenbaum’s first book was published in 1951 under the title: *Quality Control: Principles, Practice and Administration*.⁵ In 1951, Joseph M. Juran published his *Quality Control Handbook*⁶ as a comprehensive description of quality control. This book was translated into Japanese and published under the title of *Total Quality Control*.⁷ It is not evident that Feigenbaum was aware of this translated title because he was not active in Japan and had

no knowledge of the Japanese language.

In 1956, however, Feigenbaum published a brief article in the *Harvard Business Review*,⁸ which introduced the term total quality control to the Western world. This article outlined Feigenbaum’s concept and introduced this topic, which became fully formed by 1961 as Feigenbaum converted his 1951 book into his principal contribution—*Total Quality Control*.⁹ —G.H.W.

REFERENCES

1. George S. Radford, *The Control of Quality in Manufacturing*, The Ronald Press Co., 1922.
2. Egon Pearson, *The Application of Statistical Methods to Industrial Standardization and Quality Control*, British Standards Institute, 1935.
3. Leslie E. Simon, *An Engineer’s Manual of Statistics*, John Wiley & Sons, 1941.
4. Paul Peach, *Industrial Statistics and Quality Control*, Edwards and Broughton, 1943.
5. Armand V. Feigenbaum, *Quality Control: Principles, Practice and Administration*, McGraw-Hill, 1951.
6. Joseph M. Juran, *Quality Control Handbook*, 1951.
7. Izumi Nonaka, “The Recent History of Managing for Quality in Japan,” which appeared in Joseph M. Juran, ed., *A History of Managing for Quality*, ASQ Quality Press, 1995, p. 539.
8. Armand V. Feigenbaum, “Total Quality Control,” *Harvard Business Review*, November-December 1956, pp. 93-100.
9. Armand V. Feigenbaum, *Total Quality Control*, McGraw-Hill, 1961, 1983 and 1991.