The quality gurus

This article is designed for engineers who wish to learn something about the quality management experts, who have contributed to the development of present day quality techniques. These experts are often referred to as the quality gurus. Who are they and what have we learnt from them?

by Dr Elwyn C Davies

The quality management experts, who contributed significantly to the development of total quality management (TQM), have been charismatic characters well ahead of their times[1]. The experts discussed below have made a major contribution towards business excellence, as every important aspect of total quality had a contribution from at least one of the gurus.

The early American contribution

W Edwards Deming, Joseph M Juran and Philip B Crosby are the three best-known early American quality experts. Together with William E Conway they were in the late 1980's commonly referred to as the 'Four American Gurus'[2,3]. They all emphasise management commitment, leadership, quality measurement, training and continual improvement. There are, however, differences in approach and emphasis. Deming's participative management style and emphasis towards the use of statistical techniques differs from the Juran project by project implementation. Crosby's improvement process is characterised by the attention he gives to transforming the quality culture. Conway stresses the use of six tools for quality improvement. Each expert offers a different 'road map' for organisations to establish a quality culture. The 'routes' differ, but world-class quality is the unique 'destination'.

In 1948 *Deming* conducted his first seminar in Japan having found little acceptance of his ideas in the USA, where quantity was perceived more important than quality. In 1950 the Japanese Standards Association was formed and in 1951 started the Deming Award Scheme. He introduced the concept of 'variance' and a systematic approach to problem solving, which eventually came to be called the 'PDCA Cycle' (Plan, Do, Check, Act). Deming stressed that management is responsible for 94% of quality problems and was sceptical of Crosby's 'zero defects' concepts. In his management philosophy he developed his principles for transformation of western management and provides these 14 Points for Management[4]:

1. Create constancy of purpose towards improvement of product and service.
2. Adopt the philosophy. We can no longer live with commonly accepted levels of delays, mistakes and defective workmanship.
3. Cease dependence on mass inspection. Require instead statistical evidence that quality is built in.
4. End the practice of awarding business on the basis of the price tag.
5. Find problems. It is management's duty to constantly work on the system.
6. Institute modern ways of training on the job.
7. Develop new ways of supervising production methods.
8. Drive out fear, so that everybody may work effectively.
9. Break down barriers between departments.
10. Eliminate numerical goals, posters and slogans for the work force asking them for new levels of productivity without providing methods.
11. Eliminate work standards that prescribe numerical quotas.

12. Remove barriers that stand between the hourly worker and the right to pride in his work.
13. Implement a vigorous programme of education and retraining.
14. Create a structure in top management that will insist on the 13 points above every day.

In 1954 *Juran* made his first tour of Japan. He encouraged a project team approach and believed that less than 20% of quality problems are due to the workers. He emphasised the importance of quality planning and offered ten Steps to Quality Improvement[7]:

1. Build awareness of the need and opportunity for improvement.
2. Set goals for improvement.
3. Organise to reach goals for improvement, establish a quality council, identify problems, and select projects to solve problems.
4. Provide training.
5. Carry out projects to solve problems.
6. Report progress.
7. Give recognition.
8. Communicate results.
9. Keep score.
10. Maintain momentum by making improvements part of the annual systems and processes of the company.

In the 1950s Japan was ready to take advantage of Deming's and Juan's ideas, because it was a period of consolidating the home market, adding value to products and copying ideas from the rest of the world. The low cost base of the 1960s enabled Japan to export worldwide, continuously adapting and exploiting markets. The Western perception was still one of poor-quality goods. In the following 20 years, the perception of Japanese goods and services changed to that of reliability and good value for money. This resulted in the economic balance of power shifting to Japan and the Far East in a number of industries, including motor vehicles, ship building, electrical consumer goods, electronic components, textiles, banking and financial services, photographic, video and watches.

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A parallel course in the USA indicated a slow development of conventional quality control techniques with a transfer of quality circles during the 1960s. During this period, *Crosby* introduced the 'zero defects' concept as a performance standard within the framework of his 'four quality absolutes'. He realised the importance of quality awareness and is well known for his concept of 'do it right first time'. He emphasised that management is responsible for quality, giving his Four Absolutes[5,6]:

1. The definition of quality is conformance to requirements.
2. The system of quality is prevention.
3. The performance standard is Zero Defects.
4. The measurement of quality is the price of non-conformance.

Crosby also provides a quality programme in the form of his ten steps to quality improvement[5]:

1. Make it clear that management is committed to quality.
2. Form quality improvement teams with representatives from each department.
3. Determine where current and potential quality problems lie.
4. Evaluate the cost of quality and explain its use as a management tool.
5. Raise the quality awareness and personal concern of all employees.
6. Take action to correct problems identified through the previous steps.
7. Establish a committee for the Zero Defects programme.
8. Train supervisors to actively carry out their part of the management improvement programme.
9. Hold a Zero Defects day to let all employees realise that there has to be change.
10. Encourage individuals to establish improvement goals for themselves and their groups.

The least known of the 'four American gurus' was *Conway*, who followed Deming and is referred to as a 'Deming disciple'. He believed that senior management lacked conviction and that quality increased productivity and lowered costs and lists his six tools for quality improvement[2]:

1. Human relations skills. Management has to create at every level, among all employees, the motivation and training to make the necessary organisational improvements.
2. Statistical surveys. The gathering of data about customers (internal and external),

Table 1: The four early American quality experts compared[3]

	Deming	Juran	Crosby	Conway
Definition of Quality:	A predictable degree of uniformity and dependability at low cost and suited to the market.	Fitness for use.	Conformance to requirements.	No definition.Incorporated in the definition of quality management—Development, manufacture, administration and distribution of consistent low cost products and services that customers want and/or need.
Degree of Senior Management Responsibility:	Responsible for 94% of quality problems.	Less than 20% of quality problems are due to workers.	Responsible for quailty.	Bottleneck is located at the top of the bottle.
Performance Standard and Motivation:	Quality has many 'scales'; use statistics to measure performance in all areas; critical of 'zero defects'.	Avoid campaigns to 'do perfect work'.	'Zero defects'.	Remove waste; measure on a monthly basis.
General Approach:	Reduce variability by continuous improvement; cease mass inspection.	General management approach to quality, especially 'human elements'.	Prevention, not inspection.	'Right or new way' to manage; Deming 'disciple'; 'Imagineering'.
Structure:	14 points for management.	10 steps to quality improvement.	4 absolutes and 14 steps to quality improvement.	6 tools for quality improvement.
Statistical Process Control (SPC):	Statistical methods of quality control must be used.	Recommends SPC, but warns that it can lead to a 'tool-driven approach'.	Rejects statistical acceptable levels of quality (ALQs).	Advocates use of simple statistical methods to identify problems and point to solutions.
Improvement Basis:	Continuous to reduce variation; eliminate goals without methods.	Project-by-project team approach; set goals.	'A process' (not a programme); improvement goals.	Constant in all areas, statistical and industrial engineering basis.
Teamwork:	Employee participation in decision making; break down barriers between departments.	Team and quality circle approach.	Quality improvement teams.	Human relations skills.
Costs of Quality:	No optimum; continuous improvement.	Quality is not free; there is an optimum.	Cost of non-conformance; quality is free.	Measure waste in all areas (including inventory).
Purchasing and Goods Received:	Inspection too late; allow defects to enter system through ALQs; statistical evidence and control charts required.	Problems are complex; carry out formal surveys.	State requirements; supplier is extension of business; faults due to purchasers themselves.	Call for improvement; includes suppliers; use statistics.
Vendor Rating:	No; critical of most systems.	Yes, but help supplier improve.	Yes and buyers; quality audit useless.	Statistical surveys.
Single Sourcing of Supply:	Yes.	No; can neglect to sharpen completive edge.	—	—

employees, technology and equipment, to be used as a measure for future progress and to identify what needs to be done.

3. Simple statistical techniques. Clear charts and diagrams to identify problems, track work flow, gauge progress and indicate solutions.
4. Statistical process control (SPC). The statistical charting of a process, whether manufacturing or non-manufacturing to help identify and reduce variation.
5. Imagineering. Visualising a process, procedure or operation with all waste eliminated.
6. Industrial engineering. Techniques of pacing, work simplification, method analysis, plant layout and material handling to achieve improvement.

The similarities and differences in the approaches of Deming, Juran, Crosby and Conway are shown in Table 1[3]. It should be observed that in the 1989 edition[3] of 'Total Quality Management' Oakland describes the 'Four American Gurus', but Conway is not included in the 1993 edition[7] in the description of the 'Three American Gurus'.

Quality development in Japan

The work of Deming and Juran in Japan encouraged several Japanese quality workers to develop important aspects of total quality.

In 1949 *Kaoru Ishikawa* was the first to recognise that quality improvement is too important to leave in the hands of specialists. He stressed that it should be company-wide from the directors to the shop floor, top to bottom and an all-pervasive influence on the way business is conducted. He used the cause

and effect diagram to great affect to assist groups (e.g. quality circles) with their improvement efforts[8]. Another name for this tool is the Ishikawa diagram[1]. Isikawa's three major contributions to quality have been:

1. The use of simplified tools, referred to as the seven basic tools used by quality teams and everyone in an organisation;
2. His contribution to the concept that quality is a company-wide issue, referred to as company wide quality control (CWQC); and
3. The quality circle movement in Japanese companies.

The following structured methods of solving problems are referred to as Ishikawa's seven basic tools:

1. Process flow charts. To ensure a full understanding of the inputs and flow of the process and answer the question: what is done?
2. Tally charts (or check sheets). For recording direct observations and helping to gather in facts rather than opinions about the process and answer the question: how often is it done?
3. Histograms. To show in a clear pictorial way the frequency with which a certain value or group of values occurs and answer the question: what do variations look like?
4. Cause and effect (or Fishbone or Ishikawa) diagrams. These are a useful way of mapping inputs that affect quality and answer the question: what causes the problem?
5. Pareto analysis. To establish, which are the major problems. The probable result is that the bulk (typically 80%) of the errors or waste derives from a few (typically 20%) of the causes.
6. Scatter diagrams. These can be used to establish the association (if any) between two parameters or factors and answer the question: what are the relationships between the factors?
7. Control charts. These are used as a form of traffic signal, whose operation is based on evidence from small samples taken at random during a process and answer the question: which variations to control and how?

Tally charts are useful for recording direct observations and helping to gather facts. They answer the question: how often is it done?

Shigeru Mizuno is the Japanese quality expert, who developed the interrelated tools, whose promotion leads to better designs in less time. Mizuno's seven new tools for quality improvement are[9,10]:

1. Relations diagram (or interrelations digraph) method. To clarify intertwined casual relationships in a complex problem or situation to find an appropriate solution. It is used to analyse problems with a complex network of cause and effect relationships to solve problems a team composed of many members as necessary drafts diagrams several times to generate ideas to lead to an effective solution.
2. KJ (or Affinity diagram) method. To clarify important but unresolved problems by collecting verbal data from disordered and confused situations and analysing that data by mutual affinity. KJ is the trade mark of the Kawayoshida Research Centre. This method attempts to clarify the nature, shape and exact extent of the problems that affect the new and distant future in fields where there is little or no prior knowledge and/or experience. It consists of gathering ideas and opinions in the form of verbal data and drawing a complete diagram based on the common relationships and similarities found among the data. It is based on participatory group formation.
3. Systematic (or Tree) diagram method. To search for the most appropriate and effective means of accomplishing given objectives. It systematically clarifies important aspects of the problem to enable an overview of the whole situation at one glance, effectively delineating the means and measures necessary to achieve the desired objectives.
4. Matrix diagram method. To clarify problematic spots through multidimensional thinking. It identifies corresponding elements involved in a problem situation or event. These elements are arranged in rows and columns on a chart that shows the presence or absence of relationships among collected pairs of elements. This method assists in specifying with a two-way layout the nature and/or location of problems, enabling a conception on the basis of two-dimensional relationships. Effective problem solving is facilitated at the intersection points (or idea conception points). Matrix diagrams are classified on the basis of their pattern (e.g.

L-type, T-type, Y-type, X-type and C-type).
5. Matrix data-analysis method. To arrange data presented in the matrix diagram, so that the large array of numbers can be visualised and comprehended easily. The relationships between the elements shown in the matrix diagram are quantified by obtaining numerical data for the intersection cells. It is the only numerical analysis made in the seven new tools.
6. Process decision program chart (or PDPC) method. Helps to determine the processes to use to obtain desired results by evaluating the progress of events and a variety of conceivable outcomes. Implementation plans do not always progress as anticipated and problems, whose solutions are frequently not apparent, arise. PDPC anticipates possible outcomes and prepares countermeasures leading to the best possible solution. This method is borrowed from operational research.
7. Arrow diagram method. Establishes the most suitable daily plan and monitors its progress efficiently. It is a programme evaluation and review technique (PERT) network for a daily plan.

The objective of a continuous improvement programme is to deduce the variation of key product performance characteristics about their target value

Masaaki Imai is the Japanese guru, who originated the Kaizen Process to encourage logical systematic thinking by quality teams[11]. His nine basic steps in the plan, Do, Check, Act (PDCA) process are:

Plan
1. Select the project.
2. Understand the current situation.
3. Set clear objectives.

Do
4. Gather information.
5. Analyse the facts.
6. Develop countermeasure and try out.

Check
7. Confirm the goals are satisfied.

Act (sometimes referred to as action)
8. Officially adopt countermeasures.
9. Review project.

Genichi Taguchi developed a methodology for minimum prototyping product design and trouble shooting in production[12,13]. His methodology is concerned with the routine optimisation of product and process prior to manufacture, rather than the use of inspection as a quality tool. The Taguchi methods have been extended to all aspects of product, service and product quality can be considered under four headings[7].

Total loss function. An important aspect of the quality of a product or service is the total loss to society that it generates. The loss (or cost) increases exponentially as the parameter value moves away from the target. It is at its minimum when the product or service is at the target value.

Design of products, services and processes. Taguchi distinguishes between 'off-line' quality control in the 'design' of products and processes and 'on-line' quality control in the 'production' of products or services.

Reduction on variation. The objective of a continuous improvement programme is to deduce the variation of key product performance characteristics about their target values. Taguchi's three step approach involves system design—the art of creating a design concept or an 'up and limping' prototype, parameter design—the crucial step involving testing the design features to ascertain the ones that are the least sensitive to outside changes, and tolerance design—applied to further reduce variations. If necessary, better raw materials or equipment would be purchased.

Statistically planned experiments. Taguchi suggested that such experiments should be used to identify the settings of product and process parameters that will reduce variation in performance.

Taguchi's methods should not be used in isolation, but as an integral part of continuous quality improvement. This type of thinking reflects the Japanese philosophy of invest last not first[1].

Shigeo Shingo was a key figure in the development of just-in-time (JIT) manufacture and its promotion outside Japan[14]. He has been a great engineer, who not only contributed to the thinking process behind quality improvement, but also the methodology of the process. Shingo worked on machine set-up time reduction for engineering companies to

develop methods of reducing or minimising set-up time. This methodology is called single minute exchange of die (SMED). He is also remembered for his work on mistake proofing or defect=0 (Poka Yoke) for production processes based on the use of preventative measurers. The process should be stopped whenever a defect occurs to exhaustively investigate and take steps to elaborate the cause to prevent reoccurrence of the defect by eliminating the cause. This requires constant monitoring of potential error sources to eliminate them before they become a problem[1].

A thorough grasp of total quality strategy with a hands-on style and total quality processes are the single most powerful change agent for companies today

Western workers

Armand V Feigenbaum developed the concept of total quality control (TQC), where a systematic approach is used, which involves all the functions of an organisation and not just manufacturing[15]. He considered that quality improvement is the single most powerful force leading to organisational success and growth. Quality should be built in at an early stage and should be allowed to develop gradually. His concept of total quality control shows that 'quality is in essence a way of completely managing the organisation'[15]. He originated the concept of TQC in the USA and states that quality is in essence, a way of completely managing the organisation. TQC requires a clear understanding of international markets, management needs, a thorough grasp of total quality strategy with a hands-on style and total quality processes are the single most powerful change agent for companies today[1].

Tom Peters emphasises the importance of customers, innovation, people, leadership and systems. He sees leadership rather than management as the central issue behind quality improvement[16,17]. He promoted the principle of management by walking about (MBWA) for listening (caring), teaching (value transmission) and facilitating (helping). In his book 'Thriving on Chaos' writing about customers he deals with each key area in terms of prescriptions as a way to bring about the necessary management revolution[18].

Claus Møller developed the concept of personal quality as the central element of total quality, stresses improvement in administrative procedure rather than of production processes[1]. His twelve golden rules to aid quality improvement are:

1. Set personal quality goals
2. Establish own personal quality account
3. Check how satisfied others are with your efforts
4. Regard the next link as a valued customer
5. Avoid errors
6. Perform tasks more effectively
7. Utilise resources well
8. Be committed
9. Learn to finish what you start
10. Control your stress
11. Be ethical
12. Demand quality

John Oakland has been called the 'British guru of quality management', having developed a pragmatic approach to introducing quality management. His 1989 total quality model[3] showed that business excellence requires management commitment (and a quality policy), teamwork, a quality system and tools and techniques. He developed a later model[7], which indicated that total quality requires five soft outcomes (identifying customer/supplier relationships, managing processes, changing the culture, improving communication and showing commitment) and three hard management necessities (quality systems, tools and techniques and quality teams). In order to achieve business excellence, Oakland has stressed the integration of total quality into an organisation's business strategy. He emphasises that effective leadership is the key to business excellence and states that it must be demonstrated by:

1. A commitment to customer improvement
2. A right first time philosophy
3. Training people to understand customer/supplier relationships
4. Managing systems improvements (through ISO 9000 registration)
5. Modern supervision and training

6. Managing processes through quality teamwork and improved communications
7. Eliminating barriers and fear
8. Constant education and expert development
9. A systematic approach for integration into the business strategy[19]

Summary of contributions to business excellence

The major contributions of each of the quality experts reviewed above are:

1. Deming—Management philosophy
2. Juran—Planning and quality
3. Crosby—Awareness, zero defects, do it right first time
4. Conway—Six tools for quality improvement
5. Ishikawa—Seven basic tools for quality improvement, quality circles, company-wide quality control (CWQC)
6. Mizuno—Seven new tools for quality improvement
7. Imai—Kaizen teams
8. Taguchi—Minimum prototyping, Taguchi method
9. Shingo—Just-in-time, Poka-Yoke
10. Feigenbaum—Total quality control (TQC)
11. Peters—Management by walking about (MBWA), customer satisfaction
12. Møller—Personal quality, twelve golden rules to aid quality improvement
13. Oakland—Quality models, integration of total quality models into an organisation's strategy and effective leadership

Conclusion

An examination of the common features associated with these workers in the field of quality suggests that six principles must be taken into account when considering the development of quality assurance processes in an organisation:

1. Management commitment and involvement are essential and must start with the chief executive.
2. Relevant measurements are necessary to determine the current position and set goals are essential.
3. The work force must be encouraged and trained in quality teamwork and problem solving. This will usually include Ishikawa's seven basic tools.
4. System-based tools such as just-in-time (JIT) can be used to improve productivity. If these tools receive proper consideration, they can also enhance the quality as well as the volume of a product or service.
5. Prevention is better than inspection. The product or system must be designed, so that the possibility of error is eliminated or (at least) greatly reduced.
6. Quality improvements should be customer-focused. Both internal and external customers are of the same high importance.

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