Assuring Economic-Quality with Systemic Thinking

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Abstract

Today's established quality management approaches, such as TQM, Business Excellence and Six Sigma, are all rooted in the basic cybernetic concept of feedback to continuously correct and improve the performance of business processes. This represented a dramatic improvement on the earlier methods of quality control based on adherence to fixed specifications and product inspection. Practitioners such as W. E. Deming have often argued for a 'systems' approach to underpin their work. We argue that this rhetoric has rarely been matched by a genuine application of established and proven systems methodologies.

In this paper the authors look at the importance of taking a 'total systems' perspective to managing for economic-quality. The authors argue that the application of systems methodologies, specifically Beer's Viable System Model, allows a more holistic view of the task of successful management, and can provide a step change improvement that will magnify the benefits of existing methods. Further they show how supplementary and elegantly simple graphical methods can reveal deep insights about the way work can be carried out more efficiently and reliably.

They argue that a systemic perspective provides a more coherent platform for structuring change programmes, and is essential for identifying critical linkages between dependant processes, thus preventing failures in the 'first metre' (the critical distance between an idea and its manifest expression to others) of the project or process journey. 'First Metre' working with its emphasis on the critical importance of operational definitions provides the key to avoiding late delivery, over spending and under-performing projects be they in computing, construction or commerce. Formal systems and process modelling allows management to exploit real-time information to extend the reach of quality programmes to deliver effective feed-forward benefits (i.e. prediction) as well as delivering more effective and sustainable improvement and innovation to that traditionally achieved by the feedback-driven approaches of contemporary quality management initiatives.

1. Background

Early approaches to managing for quality relied upon threats, targets and wholesale inspection. One of the earliest expressions of a belief in quality being the essential pre-requisite for commercial success came from Louis XIV's finance minister, Jean-Baptiste Colbert (1619-1683), who sponsored the foundation of the Gobelins royal furnishings factory in 1660, putting it under the capable leadership of Charles Le Brun, a leading artist of the day and a skilled administrator. In August 1664, noting the success of the Gobelins venture, Colbert observed that:

"If our factories, through careful work, assure the quality of our products, it will be to the foreigners' interest to get supplies from us, and their money will flow into the Kingdom."

Colbert had a narrow view of wealth creation by today's standards (he saw it being achieved by national domination rather than through international co-operation) and believed in detailed central control, such that deviation from standard procedure often resulted in punishments by fine and pillory (Howard 2003a).

In the mid 1920s one hundred percent inspection proved unequal to the task of providing reliable switches for the fast expanding transcontinental telephone lines being built across North America by AT&T. The then President of AT&T, a statistician named Walter Gifford, set its manufacturing arm, Western Electric, the task of finding a more reliable way of assuring the production of electrical product which was deemed to be of "satisfactory, adequate and dependable economic-quality" without recourse to total inspection. Under the leadership of Walter Shewhart (with the help of two interns named Edwards Deming and Joseph Juran) the control chart was devised and proven in field trials (in the bakeries around Chicago) before being successfully introduced as a real-time tool on the production lines of the fast developing US telecommunications industry (Howard 2003a).

Despite support by British engineers in the mid 1930s statistical process control (SPC) never really caught on in a widespread sense. Apparently self-evident common sense ruled the day for most companies during the rest of the twentieth century as they continued to rely upon passive, random or wholesale inspection. The application of simple statistics was too counter-intuitive to win the attention of suppliers operating in a sellers' market.

The early use of prediction to replace chance and even guesswork did none the less represent a dramatic improvement on the earlier methods of quality control based on adherence to fixed specifications. And yet when quality became a politically correct (let alone a strategically necessary) ambition under the manufacturing onslaught of the Asian Tigers in the 1970s the solutions implemented by America, and more reluctantly by Europe, were more to do with passive audit and regulation rather than the proactive search for insights and innovation.

And so the concept of hindsight, so deeply entrenched in the quality movement in the 20th century, continued to dog the movement's advance despite a growing body of evidence to show the rich benefits available to those who stopped relying on the rear view mirror to guide their journey along the global motorway and turned their attention to the view ahead by means of statistical process control related to both feedback and feedforward control loops.

Deming often made references to a systems outlook, or appreciation. At the very outset of his work in Japan from 1950 onwards he introduced his student managers to see their organisation together with its customers as all parts of "a system of production" at both the company and national levels.

Contemporary quality models are generally founded on attending to 'entities' – i.e. products, specifications, count data (often financial) and incidents. While adequately suitable for managing static or slowly changing low-technology organisations (typically in the service sector) when the pace of change increases beyond a certain rate – say nearer annually as in the information, computing and telecommunications industries - entities assume less importance as a management target than the 'connectivities' linking them – i.e. processes, variations, real-time sampled non-financial data and associated dependencies.

Business Excellence, TQM and Six Sigma models for quality management are all characterised by a binary (black or white) outlook intent on inspecting out defects or at least implementing improvement. The step function basis of specifications lead to over-simplistic decision making that inhibits a continuing search for true excellence in line with the realities of the Taguchi loss function (Wheeler 1995). The more powerful analogue 'shades of grey' outlook (that, incidentally, determines our every thought process) is generally ignored as a basis for management despite the pioneering work of visionaries such as Shewhart, Beer, Taguchi and others.

Interestingly as the world of business refuses to reject the perceived benefits of binary opportunities it is also refusing to fully evaluate the advantages of an analogue outlook that recognises the realities of dependent connectivities before the distraction of entities. Just as Robert Louis Stevenson observed in Virginibus Puerisque (1901) that *"To travel hopefully is a better thing than to arrive and the true success is to labour"* so we would say that 'Continuous improvement is better than a belief in zero defects while the true success is to gain insight.'

2. Systemic Thinking

In talking about 'systems' in this paper, it is important to recognise that we are not talking about systems in the sense of 'a quality management system' which may consist of no more than a document on a shelf, nor are we talking about IT systems. 'Systems' is a discipline that came from the recognition that traditional scientific method based on reductive analysis often failed to deal with the most important aspects of the subject being studied. 'Systems' is the study of whole entities and of what makes them what they are.

No formalised methodology for quality management employs viable systems principles. Some have adapted their earlier proscriptive, audit based approaches to recognise the benefits of process analysis both at a structural and a behavioural levels. Before embarking on presenting our case for introducing a systems vector (recognising the key value creating property of emergence) into our approach to managing for quality we need to be clear about what we mean when we use the word 'system' – a word that is too often associated explicitly with computers by those who fail to acknowledge the true complexity and consequent elegant simplicity of the real world and are seduced by the prospect of clean and tidy numerical solutions which at best inform but rarely yield constructive insights.

The word 'system' is variously defined and it will serve us well if in agreeing a definition for the purposes of this paper we provide an example of an important concept to which we will return later. The concept is called 'operational definition' and was first identified by P.W. Bridgman (1927) as an essential pre-requisite for understanding and knowledgeable progress. It is no more complicated than a means to make sure that people agree the meaning of the terms they use when co-operating to bring about creative change. As Bridgman observed *". . . the true meaning of a term is to be found by observing what a person does with it, not by what they say about it."*

Thus for the purposes of the argument advanced in this paper the authors use the word 'system' to describe an arrangement of inter-connected and inter-dependent parts that exhibits properties which are not present in any of its component parts. This single defining characteristic of a system therefore is what is called 'emergence'. Without evidence of emergence there can be no (harmonious) system – only a (noisy) mess.

As Beer (1926-2002) provocatively noted *"A system is what it does."* And what a system does can only be defined by people as it is dependent on their particular perspectives. A business is a fine example of a socio-technical system, and it cannot be described adequately by an organisation chart!

While defining our terms it would also be worth clarifying the difference between a system and a process. Just as a ship is defined as a passenger carrying vessel (with lifeboats) and a boat is defined as a simple water-going vessel (without a lifeboat), so the difference between a system and a process is defined by its purpose. As a system has distinctive, emergent properties not found in any of its sub-systems or component processes – it is the parent of its process siblings - so a process is no more than the sum of its linked actions lacking any emergent distinction. As Deming noted in a letter to one of the authors "*a system is one thing, and a process is something else*." (Deming 1992).

A systemic perspective provides a more coherent platform for structuring change programmes, and is essential for identifying critical linkages between dependant processes. Indeed only by means of systemic thinking guiding process working will organisations be able to conform with Myron Tribus' Zeroeth Law of Quality Management: "*The producer of highest quality will tend to be the producer of lowest cost.*" (Tribus 1985)

3. Product, Process and Systemic Approaches

The great leap forward that modern quality management methods made was the switch from focusing on the product to focusing on the process. Product focus involved product inspection (often nominally 100%) and rework. Process focus involves developing an understanding of the process that produces the product. It also involves monitoring the process performance to know whether it is "capable" i.e. consistently reliable in turning out an acceptable level of quality. Having developed this understanding, the process approach then requires activity to continuously improve performance either by changing the process itself, or the inputs to the process. The process based approach has worked extremely well and has produced some dramatic results, so why would we need to move beyond it ?

We argue that although a process focus is essential, in many situations it is not sufficient and that there is a real need to look beyond it at the larger 'system' – the bigger picture. The practical limitations of a process focus for quality management are precisely the limitations of process as a concept. The three most obvious limitations being: single perspective, levels of complexity and the issue of emergence.

Firstly process models assume a single given purpose, we can only talk about the process to make a widget if we accept that making widgets is what we are interested in. In reality, however much we would like things to be this simple, they rarely are, your process for making widgets is my process for earning a living and the sales director's process for keeping customers happy. Quality management texts are littered with stories of inherent conflicts between the pressures to deliver accurate quality and the need to deliver on time and these conflicts are often presented as if they were an aberration. But they are not. They are part of the same system that has different meanings and purposes depending on the perspective of the different stakeholders involved. Taking a purely process perspective is reductionist in that it inevitably ignores significant aspects of the situation. This doesn't make it wrong or flawed, but it does mean that it needs to be contextualised within a systemic view if it is not to risk either creating conflict or "missing the point".

Secondly, process models cope better with linear sequences of events than they do with non-linear sequences, or parallel interdependent events. Once again, we can map the process of making a widget, but what about the complex set of relationships and decisions that got us there: decisions about resourcing and skills, agreements about delivery and sales? There is a world of complexity that is apparent both upstream and downstream of many processes, that has a very real and tangible effect on the narrow issue of quality. Using only a process based approach does not give us the tools we need to deal with the wider issues that effect quality. As a result, we often see quality professionals bemoaning the attitude of the rest of their organisation and either making demands that their colleagues see as unreasonable, or attempting to tell the rest of the organisation how it should work. This in essence was behind Deming's urging to see the company "as a system", a refrain which has been taken up by many in the quality movement. However we would argue that this has often been rhetorical rather than practical and that quality professionals have generally not equipped themselves with the systems based methodologies that would allow them to do this effectively.

The third area of weakness for a purely process based approach is in dealing with 'emergence'. One of the definitive statements about systems is that they are more than the sum of their parts. The property that a system has that is not a property of any of its component elements is known as the emergent property. Typically, emergent properties are the most important things we experience about a system. If we take the system that is a car as an example, one of its emergent properties is speed. Speed is not one of the components of the system, nor is it a property of any of the components, it emerges from their interaction. Despite this elusiveness, it is one of the most important features of the system – without it we wouldn't buy the car. A huge number of quality issues actually have to do with emergence, because often what we are buying is a system, and we are buying it precisely for its emergent properties. We may be able to define and control the process for making a widget such that it conforms to our specification, but how do we guarantee that when it goes together with other elements it has the required emergent properties? Process based approaches on their own are not good at dealing with these sorts of problems. Something more holistic, something that takes into account the context and perspectives, that is something more 'systemic' is needed to supplement the process focused approach.

Because of these limitations of a process based approach to quality management, we argue that quality managers need to supplement their current efforts with well established and generally accepted systemic methods. We are arguing that what is needed is supplementing, not supplanting. We are arguing for evolution, not a revolution such as occurred with the historic shift from a product based approach to a process based approach. Many quality managers will protest that they already have a holistic view of their organisations, and in our experience this is often true, but it is usually based on intuitive, tacit models that are difficult to share with others in the organisation, and often lack precision, thus failing the 'first metre' test. The perception in the quality movement that there is a need for a more holistic approach which encompasses the organisation has given rise to the development of approaches such as the EFQM Business Excellence Model which are process rather than systemically based. Whilst we would agree that there is a serious need for holistic models and that quality managers are well placed to be the champions of a holistic approach, the linearity of process based models such as the EFQM means that they lack much of the precision in understanding the connectivity and interdependence that characterise the real world and truly systemic models can provide.

Systems as a management discipline emerged in the 1950s almost in parallel with the quality movement and has developed a whole set of tools, models and methodologies to deal with precisely the sorts of issues raised above. Three strands of the systems movement are of particular relevance here: Soft Systems Methodology (SSM), System Dynamics (SD) and Viable Systems Modelling (VSM).

SSM was first developed by Peter Checkland (1981) as an approach for dealing with the multiple perspectives that we encounter in understanding systems and particularly in change situations. It involves assessing and mapping the viewpoints of the different stakeholders involved in a system, building operational definitions of the existing or any proposed system, and modelling the activities necessary to carry out the defined objective. It has a significant role to play in handling the 'first metre' issues of projects, through identifying player's objectives, and their likely objections to change.

SD is a discipline founded by Jay Forrester (1961) and is concerned with examining the causal loops and non-linear relationships in complex dynamic systems. In its pure form it relies on building mathematical models to understand the counter-intuitive behaviour of systems. System dynamics has been used in all sorts of businesses, and to help with many sorts of business problems, from resource management, through logistics planning to major strategic issues. As a discipline, rather than just managing the present, it seeks to help manage a turbulent future either through predicting the future behaviour of the system, or by surfacing and testing managers' assumptions and mental models about their system's future.

In the context of this paper, SD is an approach that use rigorous mathematical techniques to extend the potential scope of quality management from its focus on the present to beginning to manage the future.

VSM was developed by Stafford Beer (1975) building on the early work of Norbert Wiener (1948), Warren McCulloch (1965) and especially Ross Ashby's work (1965) on variety and complexity. Stafford sought to develop a 'science of organisation', and the VSM embodies a set of fundamental laws about organisation that are applicable to organisations of any size or type. In the context of quality management, the significance of the VSM (see Fig 1) is that it provides a rigorous tool for understanding the organisational context of quality. Ultimately, quality itself is an emergent property of the system that is defined as 'the organisation operating in its environment'. Our ability to control and predict quality depends on how good our model of the system is. VSM provides a framework for modelling the specific key relationships necessary for the organisation to remain viable through time. It ensures that each element of the organisation is offering a distinctive contribution and thereby tends to remove conflict, confusion and tampering. In doing this, it is significantly more precise and holistic than traditional purely process based models. Modelling the relationships between different parts of the organisation shows how the operation of the system drives behaviours, affecting everything from basic operations through to the politics of strategy formation. Experience shows that the VSM also provides a good platform for planning organisational change.

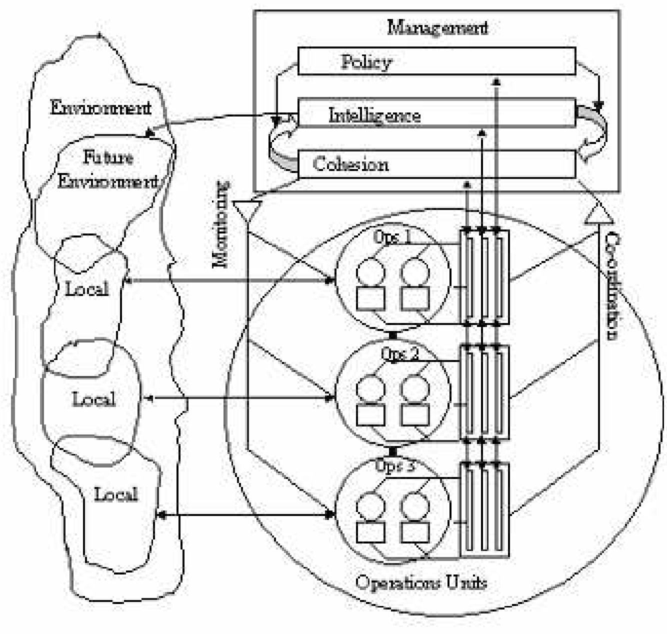

Fig. 1 The Viable System Model

4. Feedback & Feedforward – Extending the Timeframe of 'Quality Management'

Both the nineteenth century approach to quality management based on inspecting the product, and the late twentieth century approach based on managing the process rely on the principle of feedback and we can use the classic systems models of single and double loop learning to describe them. Fig 2 shows a single loop learning model in which a process turns out product which is inspected according to set criteria, and defective product goes through a feedback loop into the process for rework.

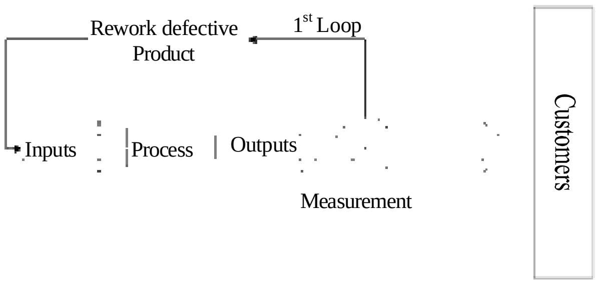

Fig. 2 Single Loop Learning Model

The modern process focused approach follows the double loop structure Fig. 3. Again, the process outputs are measured, hopefully using some form of SPC, but this time the first feedback loop is directed at changes to the process and/or its inputs. In addition, there is a second loop which looks outside the process to assesses the suitability of the measurement criteria and drives continuous improvement.

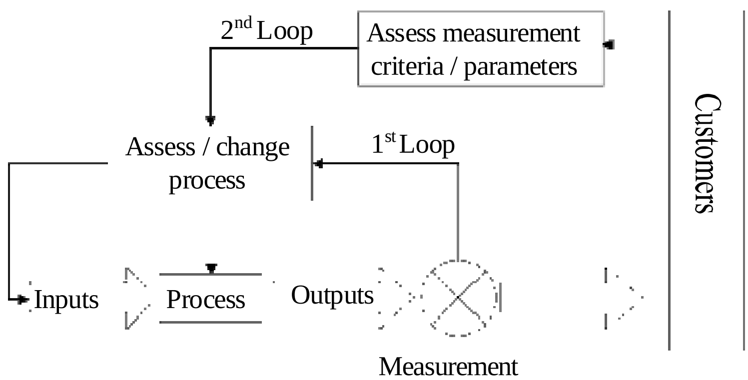

Fig. 3 Double Loop Learning Model

Obviously, the double loop, process based, continuous improvement approach is a big improvement over the single loop model, and represents a big leap forward conceptually and in terms of practical performance – not least because it derives some of the information to manage the process from customers outside the process. (It is significant to note that W.E. Deming introduced the significance of the second loop to his audiences in Japan as early as 1950 when he first drew his famous chart of 'production viewed as a system' in which customer feedback was highlighted more than process feed back.)

Even so this method has its limitations, and the most obvious of these is that it relies purely on feedback, which by definition is reactive and based in the past. It can be argued that the customer feedback which forms part of the second loop of the model is not purely reactive and will represent customer aspirations or expectations of the process. This is of course true, it represents one side of the gap between what the process needs to achieve and what it is capable of achieving, but it isn't the "voice of the process".

If we look at this as an equation to be balanced between expectations on one side and actual performance on the other, where a balanced equation means a satisfied customer, we can see that we are using quite different types of criteria on each side of the equation. On the expectations side, we have feedback about past and current expectation and about probable future expectations. On the process performance side, we only have data about the past. This equation cannot be balanced through time. Many theorists have sought to address this issue by talking about "stable processes" which is fine as long as we are not trying to operate a stable process within an unstable environment of changing expectations. Others have sought to address it by stressing the need to 'delight' the customer – in other words ensuring that the process is capable of higher standards than the customer has yet anticipated. Both these responses are practicable in some circumstances, but systems theory does offer another alternative strategy which is to use not just feedback about process performance, but also feedforward.

A simple example of feedforward control would be where a temperature sensor is placed outside a room which has its own thermostat controlling the room temperature. This external sensor would warn the room thermostat about any sharp and unexpected drop in the outside temperature, so that it could start the heating system before the outside temperature drop had time to affect the inside temperature.

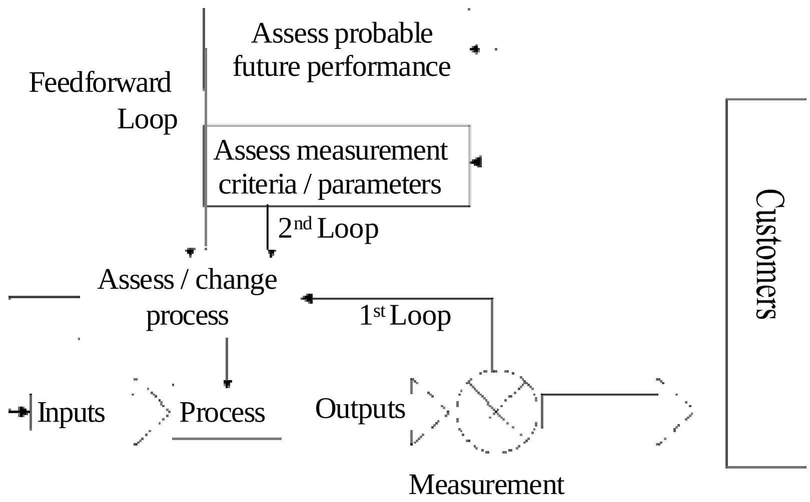

Fig. 4 Feedforward Model

Now, suppose that instead of a traditional feedback approach using statistical process control we used a feedback and feedforward program, what would this look like and more importantly what would it tell us that we didn't already know? Well, in common with SPC approaches, it would tell us whether the process was behaving in a stable way according to the criteria we had set down for it from a systemic perspective. If we were sensible, instead of it telling us it had been stable, we might want it to let us know only when it was no longer stable, in other words when something significant was happening. Something significant happening to a previously stable system could mean several things, but SPC based feedback alone is very limited in the help it gives a manager in understanding the nature or meaning of a change in, or in the vicinity of, a process.

By contrast, a feedforward program can help us by interpreting the statistical data and indicating the most likely meaning for changes in performance and therefore what the future performance is likely to be. If change is occurring it can identify whether it is most likely to be a) an isolated event, b) a step change in performance, up or down c) a gradual change in performance, up or down, or d) whether the system has become unstable and therefore unpredictable. Significantly this extends our control of the process through time. Potentially, at least, it allows us to take steps to manage situations and problems before they have fully developed, reducing the risk or extent of underperformance. Of course, the capabilities of feedforward are limited because we are dealing with the future, and the available process tuned algorithms make 'most likely' assessments within known criteria. Dealing with real time data and using feedforward methods takes us from immediate management of operations into the management of the wider system within which those operations sit.

5. The 'First Metre'

Metaphors are useful in communicating the details of recognised concepts. The concept of the process journey is not unusual. While working with a major US telecoms company some years ago the first-named author was struck by the power of the industry's 'last mile' metaphor that had served it so well through the last century. It was apparent that now that technology was but a commodity availale to all competitors customer service would become the differentiator. Interest was therefore moving back from the traditional 'last mile' focus to increasingly concentrate on the 'first metre' issues of customer capture, service definition and service provisioning.. Thus was the 'first metre' metaphor born.

Using the 'first metre' metaphor over the past few years has been helpful in concentrating the attention of participants from many types of business on the critical first steps of any process or project journey. Whether it be a national gas company re-organising its control centres, a government agency re-organising itself or an examinations board improving its responsiveness the 'first metre' outlook has proved powerful in shaping attitudes and bringing about change. For in any business it is here, at the outset of implementing business projects and processes, that so many simple short cuts are traditionally taken without due consideration of the consequences. And as evidence shows the consequences can be severe. The UK Government alone estimates its failure to heed this message has cost its tax payers over £1.5 billion in the past six years (OGC 2003) on IT projects alone.

The path followed by the constituents of a product (tangible component flows in the case of manufacturing; intangible information flows in the case of services) can readily be traced and the value adding steps identified along the way. The steps in formulating a project can be treated in the same way - indeed, a project is but a one-cycle process as a process may be seen as a repeating project. A key tool in the 'first metre' approach is what the authors call deployment flowcharting, or FlowMapping (Howard 1993b). This simple technique correctly carried out will reveal more insights about opportunities for process improvement than any other mapping technique seen by the authors in the course of their consulting work. Over the years the greatest danger to good 'first metre' working has been from the too popular and premature use of 'casetools' to map processes by IT specialists before mapping of the process has been carried out by the uniquely knowledgeable process operators themselves! A rush to code will always ensure sizeable, unpredictable downstream penalties.

Leadership and management styles will condition how the 'first metre' challenge of a new business project or process is handled but there are some essential aspects which experience shows must be taken seriously from the start if (the definition stage) the execution and delivery stages are to be conducted with economic-quality and excellence.

There are six 'first metre' steps that need to be taken, or reviewed, at the outset of any stage of a process or project journey and they cover five key actions:

Step 1 – Establish and confirm process/project Operational Definitions.
Step 2 – Define the Current Problem (or process/project challenge) and identify the Ownership, the Cast of Characters and Stakeholders.
Step 3 – Envision (sketch, map, chart) all Entities and Connectivities
Step 4 – Establish the Timescale and identify distinctive Behaviours
Step 5 – Identify Trial Solutions and select the preferred Implementation.
Step 6 – *Recycle to 2 above*

This methodology appears deceptively simple, but of course, several of the steps require a much more involved practice than managers tend to apply. For example Step 2 - identifying stakeholders requires managers to recognise the different perspectives that different stakeholders have about the situation, project or problem, and to deal with the implications of these, which is no trivial exercise. Similarly, Step 3 could easily require mapping the system of interest possibly using a systems methodology such as VSM or system dynamics to identify key connections between component elements of the system.

6. Economic-Quality

To date much quality is what the authors would term iconic-quality – quality which is primarily (though not exclusively) directed at customer perception and results in a badge, a certificate or some other re-assuring totem which can be displayed on letterhead, vehicles, brochures or as brass plaques in the entrance lobby. A whole market sector exists to, in effect, sell icons to industry that proclaim acceptance and conformity to standards. As with all markets there are the good and the bad operators. You get what you pay for and the value received will usually be proportional to the effort invested by the recipients, not the suppliers. Some would say that quality is the marketing department's best ally. Indeed one of the biggest drivers for certification is doubtless the fear of losing business rather than a primary concern for improving product quality. Iconic-quality can lead too easily to what we are tempted, for shall we say alliterative reasons, to call 'ironic-quality', the condition when what is claimed by the suppliers (by whatever slogans or third party means they prefer) does not match what is experienced by the customers. We all have come across numerous examples of ironic-quality in our daily lives albeit away from our own offices and factories (of course).

Economic-quality (as will be described in more detail below) is very different. It focuses not on perceptions but on experiences. It is an emergent property of good business itself.

Quality is example of a word, familiar to this audience, which will none the less defy simple unanimous definition. This is not too important so long as when groups work together for a common reason they can at least agree what they mean as they each try to operationalise their belief. The authors maintain that quality is a word that should be reserved for careful use by recipients as opposed to suppliers. Care is needed. Consider, for example, a school canteen. There are at least three levels of recipient. The supplier's customer (the primary purchaser, i.e. the school catering manager); the immediate users of the product (the school cooks) and the final beneficiaries, the end-users (the school children)..

Your judgment of quality (good or bad) will be hard to operationalise in a way that is useful to others. What you prefer and call best will be unlikely to be the same as many other people's definition. There will be a spectrum of preferences laden with variation and it is the understanding of the associated bell curve of preferences that will provide suppliers with the basis of whereabouts in the marketplace they pitch their offerings.

Considering the question of quality from the viewpoint of a supplier which has studied the marketplace and decided where to enter the commercial fray. The production processes and systems within their plant must be on target with their assessment of the market opportunity (in both volumetric and price terms) and operate as economically as possible. In other words they must deliver economic-quality if they wishes to optimise their profits. Indeed, only they can control the costs of production and supply. If customers and end-users do not perceive good value for money they will not buy the product. Passing on the costs of inefficiency to the customer may best be seen as a bad-business premium that will not be acceptable to prospective purchasers.

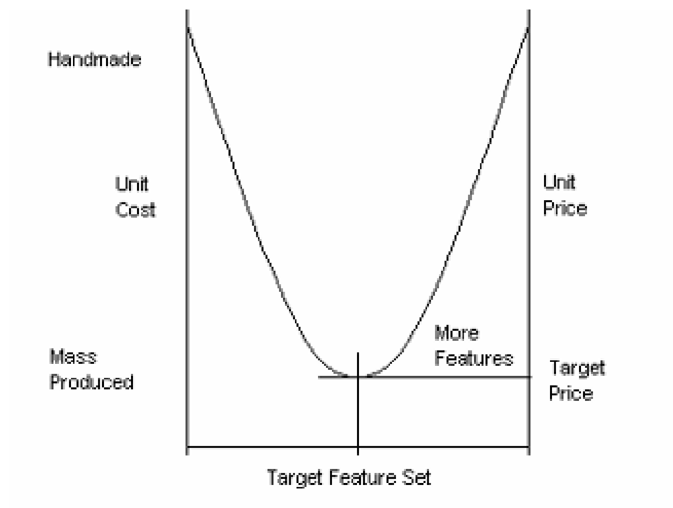

Fig 5. Economic Quality seen as a Loss Function.

It was Walter Shewhart who first introduced the term economic-quality when developing his control chart and associated PDSA (Plan Do Study Act) improvement cycle that carries his name. Some thirty years late in the 1960s Genichi Taguchi developed the loss function and applied it to quality management. He said: *"The quality of a product is the (minimised) economic loss passed to society once the product has been shipped".* A Taguchi loss function expresses the non-linear, quadratic (second order) relationship between two parameters varying one against the other. An example would be the (quadratic) arc followed by a ball thrown into the air as its vertical momentum is consumed by gravity. At its peak its loss of upward momentum is matched by its gain in altitude and potential energy. By contrast imagine the cost of achieving a certain production target and the price payable in the market. Add additional features and the cost will rise, perhaps more than the market will pay. There is thus a unique point of minimum loss/optimum value to both parties that operationally defines the economic-quality setting for the product. Of course the target, ultimately set by the marketplace, will tend to move towards the direction of increasing value for no expectation of any additional payment. Unless the supplier can reduce unit production cost as well as increase the feature set his profits will soon disappear. In fact Genichi Taguchi defined world class quality (as long ago as September 1960) with reference to his loss function work as being *"on target with minimum variation"*.

In conclusion all we all need to remember in deciding how to approach the future is the wise observation of Dr W Edwards Deming who often noted when addressing senior managers that *"Survival is not obligatory!"* Each of us has to decide between iconic- or economic-quality. The key for practitioners lies in how they approach the 'first metre' of the quality journey and how they use systemic thinking to guide process working.

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