From process measurement to performance improvement

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Abstract *This paper uses basic principles from complexity theory, psychology and management theory to demonstrate that many traditional methods of identifying performance measures may not result in improvements in overall performance. In order to illustrate this, the paper first identifies the answers to six fundamental questions that are critical to the success of Process measurement, if it is to move away from just measuring performance to a fully integrated approach to improving process performance. The paper then addresses a final question on the type of measurement approach that is most likely to improve organizational performance. The answers to these seven questions make a compelling argument for a reassessment of many different established approaches to measurement. However, rather than proposing yet another, different approach, it outlines the steps that integrate other approaches into a single, unified measurement approach to improving process performance.*

Introduction

Measurement has become such an accepted approach within organisations that considerable effort is expended in trying to identify "What" can be measured and "How" to measure it. However, few people genuinely challenge "Why" they should measure in the first place. Every measurement activity incurs costs to both implement and maintain. Every additional measure is potentially reducing the efficiency of the process. Without the knowledge of the exact circumstances under which a measurement system either will or will not improve the performance, it is difficult to genuinely justify the additional cost of implementing a measurement system.

In order to identify a method of developing a cost-effective way of using measurement systems to improve performance, this paper outlines answers to seven critical questions.

- How can the use of measurement assist in improving the performance?
- How does measurement affect human behaviour and motivation?
- When are measurement systems likely to create a deterioration in performance?
- How can a minimum set of measures be identified for an individual process?
- How can the overall performance of a complete supply chain of processes be improved?
- How can individual process measures be aligned with organizational objectives?
- What overall approach should be taken to ensure that a process measurement system will genuinely improve the overall performance of an organisation?

The answers to these questions suggest that many organisations may need to reappraise the way they implement and use measurement systems.

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How can the use of measurement assist in improving performance?

The usual justification for measurement tends to rely on clichés such as "What gets measured gets done" or "If you cannot measure it, you cannot manage it." The inference that is often drawn from such statements is the more that is measured, the more that will be managed and the more that will be improved. However, as there is an almost infinite number of ways of measuring performance, many managers find that the sheer magnitude of organizational measures creates "paralysis by analysis" (Langley, 1995; Miller, 1990; Callaway, 1999)

Before trying to identify all the possible factors that could be measured, we need to be clear that the main reason to implement measurement systems is to give the greatest opportunity of increasing the overall effectiveness of the business processes. Measurement systems that are not contributing to an overall improvement in performance, need to be urgently reassessed.

In order to reassess the measurement activity, we need to identify exactly how measuring performance can lead to an overall improvement in the effectiveness of a business process. Only then we will be able to identify the very minimum set of measures of process performance that will enable the greatest return on the investment of implementing and maintaining the measurement systems. In order to achieve this, we require an understanding of both the mechanical and motivational aspects of measurement.

From the mechanical point of view, measurement can assist in managing performance when it is part of a Control System (Fowler, 1999). A control system has four main elements: sensing, assessing, selecting, and acting. A room thermostat is an example of a feedback control system (Nanni *et al.*, 1990). In effect, it senses the room temperature, assesses it by comparison with the pre-set temperature, selects and sends the appropriate signal to the heating/air conditioning system, which then acts to remedy any deficiency in the room temperature.

In the same way, a measurement system can be used to "sense" a current level of performance. However, it is only possible to assess the meaning of this measurement by comparison with another value (Curtis, 1994). For example, taking a person's temperature is a waste of time if you have no idea about what the normal temperature should be. Likewise, this assessment is only going to be of great value if you can select and act on a strategy that can take steps to remedy any problem indicated by an abnormal temperature.

This means that Control Systems implicitly include "Rules" that link the assessing, selecting and acting components of control. For example, the room thermostat acts as if it was following two rules. The first might be "if the sensed temperature of the room is more than half a degree below the setting, turn the heating on". The second rule would be "if the sensed temperature of the room is more than half a degree above the setting, turn the heating off". The thermostat control system is not concerned with the almost infinite number of different events that might cause the room temperature to change. It simply focuses on the issue of keeping the room temperature within a small variance of the pre-set level.

Consequently, in order for a measurement system to assist in controlling performance, it needs to be part of a complete control mechanism (Boland and Fowler, 2000). That mechanism should have, at the very least, a rule that defines where the comparison value can be identified, how to assess the information, when to act and what type of action is required. If the process of measuring is not part of an effective control mechanism, the cost incurred in measuring is highly likely to be a wasted cost and could, thus, potentially decrease the level of performance.

It is important to emphasise the word "effective" here. In theory, virtually any performance measure might be used as part of a control. However, if a measure is never actually being used effectively to implement actions that are controlling or improving performance, no matter how useful it might potentially be, it is still incurring an unnecessary cost. It cannot seriously be considered effective management to rely on an implicit rule of "Someone will start to complain if they are not happy with the measurement, and I will decide what to do when that happens".

How does measurement affect human behaviour and motivation?

Apart from the pure mechanics of feedback control, we need to take into account the effect of such systems on human behaviour, because in some situations, they can have a beneficial effect on performance, in others they can actually have an adverse effect (Kohn, 1993).

The reason for this is that the human body itself is a massive set of feedback control systems (Powers, 1998). Virtually every internal bodily function is controlled by natural control systems, as is our external behaviour. Measurement can interact with our natural behavioural control processes through the mechanism of the "Perception of Control" (Powers, 1973). When a person assesses the difference between two values of a measure, if the deficiency is perceived as important and in need of urgent action, then the person will be motivated to act. If the measure displayed on your petrol gauge is close to the empty mark, you will urgently try to find a petrol station.

What is important here is to understand that for a person to act as a complete feedback control system, the same person has to be sensing, assessing, selecting and acting. Every time these processes are separated, more barriers and inefficiencies are being designed into the system. These barriers are not just about communications; they can have considerable emotional effects as well. The quality movement demonstrated this over four decades ago (Deming, 1986).

Previously, the typical arrangement in manufacturing was to have operators operating the equipment and inspectors inspecting the products. In effect, the action of adjusting the equipment to keep the products within specification was separated from the assessment aspect of the control loop. This typically lead to considerable resentment and conflict between inspectors and operators as well as creating high levels of faulty components because there was little ownership of the quality problem by the people who could affect it most. When the operators were skilled to be able to carry out the inspection instead of the inspectors, the loop was closed. Quality, motivation and ownership are all increased.

This demonstrates, why the phrase "What gets measured gets done" has some validity, but only when it is extended to "What gets measured gets done by the person doing the measuring". When there is this type of closed loop, it can create what is termed as intrinsic motivation to take control and eliminate the perceived deficiency. Measurement control systems can also be used to create extrinsic motivation, by connecting a reward or punishment to a measurable level of performance. However, as will be demonstrated, it is important to understand the difference between intrinsic and extrinsic motivations, as they can create very different types of behaviour (Herzberg, 1968).

There is also another, potentially even more important way in which control systems can affect the behaviour of people and the way they organise. This understanding has come from the developing science of complexity. For some time, complexity theory has been able to demonstrate that the incredibly complex, self-organising behaviours observed in Nature are "emergent" behaviours (Waldrop, 1992). These complex behaviours can emerge from the interaction of a very small set of rule/control systems. For example, Reynolds (1987) showed that the behaviour of a flock of birds or a shoal of fish could be very realistically simulated on a computer screen of "Boids". Each Boid representing an individual creature whose behaviour emerges from the application of just three such rule/control systems.

- steer towards the average heading of local flock mates;
- steer to avoid crowding local flock mates; and
- steer to move towards the average position of local flock mates.

In order to implement such rules there has to be three separate feedback control systems capable of determining the deficiency between desired steer and actual steer, and then taking the necessary corrective action.

Although the behaviour of Boids may not seem to be relevant to human behaviour, it should be remembered that the point here is that all complex living organisation, including human organisation, is apparently created by similar principles (Lewin and Regine, 1999). In fact, these three rules actually deal with three common issues:

- direction towards the moving goal;
- obstacle avoidance; and
- relationship with others.

In the Boid example, these rules were directed to the local environment of other flock mates. However, it is possible to create complex behaviour in the flock as a whole, by adding just two additional global rules of directing towards an external goal whilst avoiding external obstacles. The rule for the external goal is hierarchically higher (Simon, 1962), but applied with less weighting than the local rules.

This understanding has profound implications for organisations in general (Eisenhardt and Sull, 2001) and process performance measurement in particular. It suggests that, in principle, the most effective forms of organisation, capable of dealing with unforeseen events, are most likely to occur when the group of people involved in a process are monitoring a small number of measures that are critical to the success of the process (Parnaby, 1994; Longenecker *et al.*, 1994).

When are measurement systems likely to create a deterioration in performance?

Simply because a control system is usually an essential requirement in improving process performance, it should not be assumed that every control system will have an improvement effect. Feedback control can easily produce chaotic systems (Wilding, 1998) and there are probably more reasons for such control systems to decrease efficiency than to increase it (Neave, 1990). These reasons often fall into three main categories: inappropriate rules, imbalance, and variance.

The most common type of measurement-system problem, which can actually encourage a deterioration in relative performance, is caused by inappropriate rules. This usually occurs because of a complete misunderstanding of how measurement is used in feedback control. Although a room thermostat is a control system to keep the room temperature relatively constant, the error correcting action (turning the heating system on or off) is only triggered if a deficiency from the norm is detected. If an error is not sensed, no action is initiated. A measurement system is likely to impede the process of improving performance if it is set-up to suggest that there is no problem in the first place (Luther, 1992).

For example, consider the situation of a parcel delivery organisation by measuring its performance on delivering parcels within 24 hours. A performance measure of 94 per cent on-time delivery may seem quite reasonable, and not motivate anyone in the organisation to improve performance. Yet, if a million deliveries were made each year, this could mean, for example 60,000 missed deliveries each year. This is potentially 60,000 unhappy customers, who may decide to try a different supplier next time. Measuring the 94 per cent success rate of the on-time delivery performance was likely to maintain the status quo. However, measuring the deficiency, the 60,000 errors, has far more potential to create a feedback control system that will motivate the behaviour to improve the system.

Imbalance in the control systems is equally likely to cause decreases in overall process performance (Fry and Cox, 1989; Estes, 1996). An example of this can be demonstrated using our previous example of improving manufacturing quality by ensuring that the operators were inspecting the quality of the products. Clearly, this would only focus them on improving quality, and would have no particular effect on improving the throughput of the process. In this sense, it is an unbalanced control system. It is equivalent to the Boids only having one rule. It would not create the overall behaviour required.

However, inappropriate attempts to balance the system can also lead to further deterioration in overall performance. For example, imagine the likely outcome if the productivity rate was carefully monitored, and to extrinsically motivate the operators, managers set up a productivity bonus scheme based on the number of components produced. It really should not surprise anyone if quality levels were to suddenly decrease and independent inspectors had to be reinstated.

The final, but most overlooked and in many ways the most difficult category of factors that are likely to decrease overall levels of performance, are caused by variance (Joiner, 1994). Even if the average level of a particular aspect of performance remains unchanged, individual values of the performance measurement will vary around that average. Thus, a particularly good, or a particularly poor level of performance for a particular period may not be more than the outcome of the natural variance of the system. It may not necessarily give any indication of a change in the underlying capability of the system to perform at a certain level (Deming, 1986).

The problem here is that feedback control systems may well inappropriately assess such a measurement as meaning that there is a requirement for remedial action. In such situations, that action, which incurs additional costs, is also likely to be inappropriate and could well cause additional problems in the future.

This situation was most graphically demonstrated by Professor Deming (Aguayo, 1991), the American professor who was one of the leading influences in bringing about the Japanese Quality Revolution. He designed the Red-Bead experiment to demonstrate to an audience how easy it was to inappropriately act on "factual" information. The experiment consisted of volunteers from the audience acting as workers who assembled products from a number of components. The experiment recreated a not untypical set of rules used by managers to reduce error rates. Workers with the lowest defect rates were praised and congratulated, whilst those with high defect rates were retrained, reprimanded or dismissed. The workers with the lowest error rates were then paid double-rate overtime to cover the shortfall in production.

However, as the experiment clearly demonstrated, the variation in the level of defects (components that included a red bead) was in no way related to the competence of the volunteers. It was wholly caused by the complete random variations in the number of red (as opposed to white) beads supplied to each worker. The actions of the manager appeared to be necessary to keep the process under control when, in fact, the actions were ensuring the deterioration of process performance. This was because, the real problem was further up the supply chain, but was being masked by statistical variation.

Variance is present virtually in every measure of performance (Wheeler, 1993). Yet, with the exception of the Statistical Process Control quality approaches (Neave, 1990), including the Six Sigma approach (Pande *et al.*, 2000), very few established measurement systems even consider the problems caused by variance.

How can a minimum set of measures be identified for an individual process?

Too many, too few or inappropriate process performance measures can easily create a deterioration in overall performance. Simply identifying everything that can be measured gives no indication as to whether or not the complete set of critical system measures are being identified. The overall performance of a process needs, at the very least, to take into account both the capability of the process to provide the predicted level of service, as well as the cost of providing that service. Thus, a more effective approach is to try to identify the minimum set of measures that would identify whether the overall performance of a process was unacceptable. The exact value of each measure that should trigger corrective action should then be defined.

In other words, the aim is to identify when the process will NOT be delivering the desired level of service and efficiency. It may seem odd to focus on failure at such a stage. However, the whole point of control is often to achieve success by ensuring that failure is avoided. Such an approach can be used at both the micro and macro level. For example, consider General Electric as a Macro Process. As early as 1986, Jack Welch had set-up four parallel rule/control systems that were to be used to consistently improve the performance of GE. The global rules of performance (Tichy and Sherman, 2001) were:

- market Leadership: be number one or number two in the market;
- profitability: well above average real returns on investments;
- competitive advantage: distinct and not easily matched; and

- leverage: must focus on GE strengths (Large scale complex pursuits that require massive capital investment).

Few observers have realised that these are comparable to the set of Boid rule/control systems. Many consider these simply as strategies or ideal goals. In fact, they were part of the control systems that were implemented to deal with anything that failed to meet these measurable criteria. There was a control activity for those parts of GE that failed to meet the minimum measures of performance. The options within the contingency process were fix, sell or close. In this way, the four global rules provided a classic minimum set of performance control systems that were capable of driving the organizational changes that gave GE the desired continual improvement in performance.

Identifying the critical-to-failure measures is a powerful way of identifying the minimum set of necessary control systems (Harry and Schroeder, 2000). However, the GE example also highlights another powerful approach to improving performance.

Imagine every process as having three different aspects. The first aspect is the process in its desired future state, operating at the highest levels of overall performance. The second aspect is that of the process in its current state, with all its usual, day-to-day operating activities and problems. The final aspect is the process of changing the current state into the desired future state. Now consider the three aspects as three separate processes, the future and current processes, joined by the change process. This trio of processes is implicit in GE's rules. The rules state the minimum requirements for the organisation process in the future. The current organisation process defines the current operational process that is focused on supplying the customer today. However, by conceptually (but not necessarily functionally) separating the improvement process from the operational process, it also becomes possible to measure the performance of the improvement process itself.

For example, consider the delivery organisation that was achieving a 60,000 per million error-rate. This is a measure of the capability of the operational system, and in itself is of limited value. What would be of far more interest would be to know the capability of the improvement process. If that information were available, it would be possible to predict how much it would cost and how long it would take to halve the failure rate (Joiner, 1994). In a rapidly changing world, with ever-increasing competition, the effectiveness of the improvement processes is almost certainly more critical to long-term survival than the current level of performance of the operational processes.

Ensuring that every critical operational process conceptually has a sister improvement/change process does not mean that different functions are responsible for the different processes. In fact, where it is appropriate for the same group to be involved in both processes, it can create a number of additional benefits.

This is because team spirit and levels of motivation to solve problems are most likely to increase in different and challenging situations, such as a perceived crisis or outward-bound/team-building courses, which are completely different from the normal, daily, operational activities. In this type of situation, groups can progressively learn to become more effective at problem solving and work more as a team. Psychologically, it is often far easier to build up team spirit (Katzenbach and Smith, 1998) by making a clear distinction between the operational and change processes. The teams can then use performance information about the operational process

(Davenport and Beers, 1995), to improve their problem-solving capabilities within the context of a distinct improvement process, even though the same group is involved in both processes (Luther, 1992).

How can the overall performance of a complete supply chain of processes be improved?

The identification of an independent but related improvement process has another, potentially even more powerful benefit, because it is critical to optimising the overall performance of a complete supply chain of processes.

The supply-chain of processes can be considered as defining the "horizontal" flow of goods and services from the external supplier processes, through the internal processes to the external customer processes. One of the consistent problems with focusing managers and staff on improving the performance of their local processes is that often, the local measurement systems are in conflict with improving the overall performance (Fry and Cox, 1989). This becomes particularly obvious when measures have been chosen on the basis of whatever is the easiest to measure and then used as part of a reward system. A classic example is the stores manager whose bonus was set on reducing the cost of stock holding. Within no time at all, he had brought the organisation to a standstill by not ordering any new stock.

A traditional approach to avoiding this is to set up service level agreements (SLA) between internal business processes. Where these include performance levels, they are usually the outcome of a compromise between the level of service that the internal customer desires, and the level of service to which the manager of the internal supply process is prepared to commit. Typically, it leaves a situation where neither party is happy. Thus, if an internal delivery process was currently operating at 94 per cent, and the customer process was demanding 99 per cent, the managers may compromise and produce an SLA with a level of service of 96 per cent on-time delivery to the internal customer process.

However, the alternative is for the internal customer to initially accept that the service is currently operating at a level of 60,000 parts per million missed deliveries. The SLA can then be structured around the improvement process, identifying the strategy and time scales for halving the error rate. Using this approach, it is possible to work back from the head of the supply chain, identifying those few performance measures that are critical to failure at each interface and agree a strategy that will progressively improve the overall performance of the whole chain.

How can individual process measures be aligned with organizational objectives?

Strategically, it is not unusual for high-level measures for organizational objectives to be identified and then "dis-aggregated" and cascaded down through the management structure. However, this procedure often attempts to dis-aggregate measures, such as customer satisfaction, which have never been aggregated from the critical front-line supply-chain of processes. This leads to the usual "what can be measured at this level" approach to performance. In other words, by default, the strategy of every separate part of the organisation is to achieve whatever is most easily measurable, rather than supplying the desired level of service in the most effective manner. This can cause massive misalignment, particularly if it is connected to a reward system. It also leads to the processes producing the primary goods or services being heavily monitored, with little control over the internal services that are often considered “too difficult” to measure, but which may well be adversely affecting the performance of the main processes.

In order to ensure that the process measurement systems are aligned with organizational objectives, this procedure has to be reversed. The control measures are initially identified, working back from the customer, through the supply chains (Harry and Schroeder, 2000). The performance of internal services that are critical to operational performance should be treated in exactly the same way as any other process. Only, after the supply chain measures have been identified, can they be progressively aggregated “upwards” through a hierarchy of processes. The desired supply-chain process benchmarks can only then be identified after the direct upward chain of measures have been established.

For example, consider a situation where the internal delivery process already discussed, was a process within a company with organizational rules similar to General Electric. The performance of the delivery process would need to be aligned with those aims. It may well be estimated that to maintain market leadership, it would be necessary to halve the level of delivery failures within the next six months. It may also be identified that in order to keep within the gross profit rules, the cost per consignment would need to be reduced by 15 per cent within the next 12 months. Various strategies for the improvement process could be developed to identify if and how this could be achieved (Kaplan and Norton, 2000). In this way, the local set of performance measures for the improvement process (and subsequent emergent organisation) would be fully aligned with the organizational aims. In effect, the supply chain of the improvement/change processes is the strategy for transforming the organisation from its current capability, to the level of performance that is required to ensure future organizational success.

What overall approach should be taken to improve the overall performance of an organisation?

The various principles described above demonstrate that improved performance is not a natural outcome of initiating measurement systems. In order to be useful, measurement systems have to be an integral part of a set of effective control systems that have been carefully and specifically designed to improve the overall performance.

Such an approach would include methods that:

- identify the main set of organizational rules and criteria critical to failure and which are fundamental to the competitive success of the organisation;
- define the horizontal supply-chain of operational processes, from the customers, through the internal processes, back to the external suppliers;
- identify the interfaces that need to be controlled for each process;
- work back from the customer processes and identify the minimum set of critical failure indicators at each interface. Typically, these will include at least the Quality of Service and Unit Cost (or profitability) measures, but may also include other critical factors such as on-time delivery, cycle time, etc. However, they will only be initially included if control was deemed critical to the supply performance;

- create the hierarchy of processes that will allow the supply chain performance measures to be progressively aggregated through the vertical hierarchy;
- identify critical performance mismatches both through the operational supply chain and with organizational goals;
- create improvement/change processes for the operational processes that need to achieve higher levels of performance, and identify the control rules necessary to improve the effectiveness of those change processes;
- ensuring the improvement aims are not set as an arbitrary percentage improvement on current performance standards, but are identified by working back from external benchmarks and organizational objectives;
- account for the motivational aspects of measurement when designing the measurement systems. Identifying "who" is measuring and taking action is just as important as defining as what is being measured; and
- validate every process measure to ensure that it is not adversely affecting the performance with problems associated with inappropriate rules, imbalance, or variance.

When viewed individually, none of these steps would be considered as either unique or revolutionary. Each one of them is utilised in one or more of the various, widely implemented approaches to performance improvement. These approaches include Six Sigma (Harry and Schroeder, 2000), Strategy Maps (Kaplan and Norton, 2000), Quality Function Deployment (Akao, 1990), Benchmarking and gap analysis (Balm, 1996), Moments of Truth (Carlzon, 1987), Service Blueprinting (Shostack, 1984), Process redesign and Goal setting (Longenecker *et al.*, 1994), Balanced Scorecards (Kaplan and Norton, 1996), Measuring Business Performance (Neely, 1998), to name but a few.

However, the overall approach described has not been created by attempting to aggregate a variety of traditional approaches. It has been developed from a theoretical analysis as to what is required to ensure that a measurement system can be used in the most effective way for improving performance. This theoretical basis is such that it acts as a foundation that automatically allows the integration of the most beneficial aspects of the whole range of different approaches to improving performance, into a single, unified system. However, when working through the various stages, it is essential not to underestimate the importance of working sequentially backwards from the ideal future and customer requirements. The process of working back from the future is critical to the alignment process (Davis, 1987; Ackoff, 1981; Geneen, 1984). Implementing all the same processes, but in a haphazard or reverse order, will not necessarily align the performance measurement systems to assist in moving an organisation towards a clearly defined future state.

To many, it may seem that applying such a method in order to align an organisation would be too costly and time consuming. However, it only appears that way because organisations never even attempt to measure the costs that would be saved by eliminating the wasted effort caused by organizational misalignment.

Conclusions

Complexity theory has allowed us to create a unified approach to improving performance, which relates the psychology of behaviour to the practices that are often observed in the most successful organisations. Given that the average life of a commercial organisation is currently less than 25 years and rapidly falling, it seems likely that failure to align a whole organisation to the improvement of its competitive performance could prove to be fatal.

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