

DEVELOPING COMPETITIVE ADVANTAGE THROUGH WEB ENABLED PERFORMANCE MEASUREMENT SYSTEMS

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NEED FOR CHANGE

In today's dynamic business environment change is the only constant, making companies struggle to understand and implement business strategies. This dynamic and volatile operating environment, together with globalisation, is changing the way we manage our business. In order to operate in this environment and to move ahead of others to gain competitive advantage, a company should be agile, where agility is defined as 'a business's ability to change with little or no pain'.

In order to be agile, companies require a more proactive management style. The word proactive is a very broad term, and hence, it is defined as 'a business making confident decisions, quickly, focusing on critical issues with up-to-date and correct information'. In order to promote this proactive management style, companies require the following pre-requisites:

- Up-to-date and accurate information on the business
- Present information to facilitate:
 - Identification of trends
 - Active monitoring of key areas of concern
 - Identification of root causes
- Open communication of this information
- Management acting effectively as a proper team
- Positive culture to change and improve processes.

MANAGEMENT INFORMATION SYSTEMS (MIS)

Most of the modern MIS have been developed to provide management with the right information at the right time. However, most of today's MIS store information in different sources, such as legacy systems, ERP systems, spreadsheets, databases, etc. In some companies the information is even maintained on paper based sources. The problems encountered with these systems are as follows:

- Lack of visibility because information is hidden
- Difficulties associated with gathering and sorting information from different sources (eg. time and effort)
- Lack of proper links between different sources of information
- Lack of effective communication of the information
- Changes and trends are not transparent to everyone.

As a result of these problems, companies need to invest much of their peoples' time in data gathering. As the data is stored in different formats in different departments, some of the data is duplicated and updated by different people, hence, questions always arise concerning the validity of data. As information sources are not linked properly, information is not available dynamically (ie. near real-time), which does not allow managers to make fast and confident decisions. As information is not shared or communicated throughout the organisation, managers cannot work as a team and changes occurring in one area are not transparent to everyone. This often leads to a reactive and closed management style, pointing fingers at one another rather than focusing on the issue in hand.

PERFORMANCE MEASUREMENT REVOLUTION

The performance measurement revolution started in the late 1970s and early 1980s with the recognition of shortcomings with traditional backward looking accounting systems. Since then, a number of frameworks and models have been evolved, some of them are the SMART model [3] and the Performance Measurement Questionnaire [4] developed in the late 1980's. In the mid-1990's the Balanced Scorecard [6] and Cambridge Performance Measurement Systems Design Process [7] made a significant impact by creating a simple, but effective, framework for performance measurement. The QMPMS, [11] Active Monitoring [9] and Integrated Performance Measurement System Reference Model [1] were developed in the late 1990's and the Prism framework in 2001 [8].

These frameworks and models are developed to improve the business performance by providing guidance on what should be measured and how these measures should be used. However, work done by Bourne [2] Bititci [12] and Hudson [5] suggest that a lot of the performance measurement implementations fail because:

- Most performance measurement systems are historical and static. That is, they are not dynamic and sensitive to changes in the internal and external environment of the firm. As a result, the information presented is not relevant, up-to-date or accurate. This creates a vicious circle because it has a negative effect on the perceived value and usefulness of the performance measurement system, resulting in lack of commitment and ownership, which, in turn, discourages proper maintenance and updating of the system.
- Few performance measurement systems have an integrated IT infrastructure. This results in cumbersome and time-consuming data collection, sorting, maintaining and reporting. As a result, companies cannot justify further investment of already stretched resources in data collection, sorting, maintenance and reporting type activities, which have low perceived values.

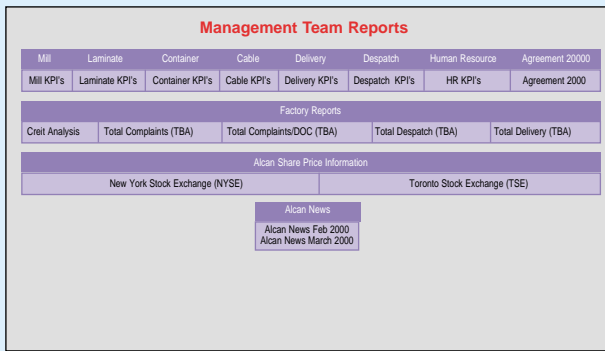
Recent times have seen the emergence of software dedicated to performance measurement to support the performance measurement models and frameworks as well as to address the problems mentioned above. These software products are available in various guises:

- As stand-alone software dedicated to performance measurement, that could be interfaced and integrated with various existing software platforms (such as ERP, CRM, etc)
- As business intelligence solutions that could also be integrated with various existing software platforms
- As modules of ERP systems.

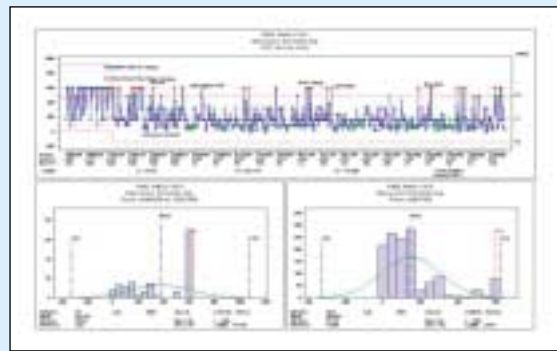
Whatever the solution, the problem is that the cost of investment is prohibitive for a small to medium size operation, ranging from a minimum of £30k for software alone plus consultancy, plus training, plus development time. It is therefore not surprising to find that a lot of these software products are implemented in large companies. In fact, the client base of one of the leading suppliers consist almost exclusively of financial institutions, insurance companies and local governments.

Figure 1

Sample pages from the AFE's MTR System



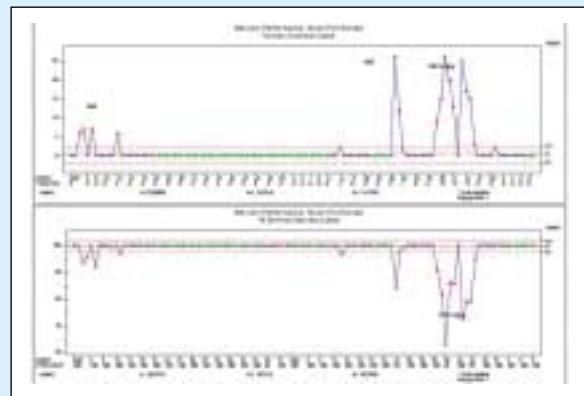
(a) Menu Page



(b) Porosity (daily)



(c) Customer complaints (monthly)



(d) Delivery performance (weekly)

It is critical that a low cost alternative is made available for small to medium sized companies, particularly manufacturing companies so that they too can enjoy the benefits of an integrated and dynamic performance management system.

Our work has established that the web, together with low cost SPC software is capable of providing an effective solution to this problem, as illustrated by the following case study.

CASE STUDY

Alcan Packaging, Foil Rolling and Technical Products, Glasgow (AFE), is a profit centre of Alcan. The site specialises in the manufacture of thin aluminium foil (such as those used for cooking, food and confectionery packaging) and laminated aluminium foil (such as those used in cigarette packaging). The main processes within the factory are rolling and laminating.

The company was suffering from the following difficulties:

- Limited transparency and communication of information
- Duplication of data with multiple data sources
- Many people involved in data collection and sorting
- Managers found it difficult to focus on key areas of business improvement and often used a reactive approach because of historical and inaccurate information
- Knowledge was only disseminated through management briefings
- Limited visibility with paper-based system
- It was easy to hide information.

To address these issues AFE implemented a Performance Measurement System - Management Team Reporting (MTR) System - using the web. The IPMS Reference Model was used to guide the management team to identify and structure the key performance measures.

Having decided on key performance measures, AFE created a simple HTML page, as shown in Figure 1a. This illustrates the main menu page providing access to all performance reports for various parts of the business. Since the page was available as an intranet site it was accessible to all individuals who had permission to see this site.

The heart of the MTR System is the Quality Analyst software product, which is essentially a software platform designed specifically for supporting statistical process control applications. Equipped with Open Data Base Connectivity (ODBC), Quality Analyst can pull down data from different sources into its own database. In this case, it is being used as a tool to collect and convert numerical data into graphical Shewhart charts (more commonly known as SPC charts). In AFE the numerical data is available from a number of sources including:

- MRPII system
- Spreadsheet applications, ie. MS Excel
- Database applications, ie. MS Access
- Machine controllers, ie. the process controllers of various equipment, such as mills
- Data loggers
- Manual input.

This information is presented in different Shewhart charts to identify the business trends and root causes. Examples are shown in the Figures 1b to 1d.

In the web page in Figure 1b the top chart illustrates a Shewhart chart for monitoring variations in porosity during the rolling process. This is a critical technical measure captured by the data loggers on a continuous basis and the daily averages are reported automatically by the MTR system at the end of each day. The Figure also illustrates that the tolerances were tightened in July 1999. Annotations against August, September, November 1999 and February 2000 communicate that the required targets were not achieved during these periods due to reasons such as paper change and roll change. The system allows the line personnel to annotate the charts at the time of the problem, which are visible to all others immediately. The bottom two charts in Figure 1b illustrate the process capability histograms, one before tightening the tolerances and the other after tightening the tolerances.

The web page in Figure 1c illustrates AFE's performance with respect to customer complaints received each month. This information is captured manually. As customer complaints are received by the customer services department they are entered into a customer complaints log (MS Access Database), in accordance with the company's ISO9000 procedures. Quality Analyst picks this information from the database and presents it on the web page. The chart in Figure 1c shows customer complaints received by AFE.

Figure 1d illustrates two charts, one illustrating backlog against customer orders and the other illustrating delivery performance against customer orders. The chart shows that delivery performance has been within the target of 95%, except between weeks 36 and 41, where delivery performance has suffered considerably due to a problem with the raw material supply (as annotated).

Quality Analyst provides the main interface between the web pages and the numerical data. It enables the following:

- Collection of data, either automatically (through the MRPII system, machine controllers and the data loggers) or manually (through spreadsheets and databases)
- Annotation of data, either manually (eg. by providing a comment field within the database or spreadsheet) or automatically (through reason codes that may be available within the existing systems)
- Viewing data through AFE's intranet pages.

The Managing Director insisted that all managers use the MTR system, which resulted in a more proactive management style, which in turn resulted in significant improvements in the company's performance. The following paragraphs summarise the findings of our study.

- **Business benefits of implementing and operating MTR system** - Managers in AFE are of the opinion that the MTR system helped them in identifying strengths, weaknesses, opportunities and threats of the business by creating complete visibility and transparency of information and hence promoting continuous improvement.
- **Impact on business performance and strategy** - The consensus of people at AFE is that the business performance would have stagnated if the system were not in place. They said that management is:
 - now completely focused on areas needing improvement
 - using a systematic approach to improvement
 - achieving state of excellence on certain quality characteristics, which allowed adoption of higher technical specifications resulting in improved margins

- improving their partnership with major customers, who can view MTR system during audits and see that the issues concerning business problems are being addressed.

In one particular case a customer was ready to take its business elsewhere. Having seen how AFE was planning to tackle the problem, they got involved in the process. As a team they improved the performance of the product using the MTR system to such an extent that the customer was delighted with the results.

- **Confidence in management decisions** - As the information is collected at a single source and communicated to all people in real-time or near-real time:
 - Decisions can now be made quickly, and the trends are visual on, 'active' SPC charts throughout the business
 - Information is accurate and reliable, which eliminates animosity and friction between individuals caused as a result of arguments over the validity of data - 'we are managing by fact, using a single set of data'
 - Root causes are more visible leading to more effective and efficient problem resolution.
- **Impact on management style** - MTR changed the way the people manage their business as follows:
 - Common view of transparent information, which allows managers to discuss and plan work to improve performance and then act on it
 - When things go wrong everybody knows the reason - it is annotated on the charts. 'Visibility like this makes us get on with our jobs rather than arguing about the data'.
- **Effect on management attitude and behaviour** - Although, during its early days there were some reservations, MTR affected the way managers behaved in a positive way. The following statements by AFE managers provide some insights:
 - There are no places to hide. This was difficult to get to grips with, at the start. A lot of people felt very exposed, but the open management style helped a lot to overcome the fears.
 - If you are not a 'team player' it becomes very obvious very quickly
 - In the past we used to spend hours or days preparing for weekly management meetings, trying to justify why it was not our fault. Now we just turn up to the weekly management meetings and discuss what we are going to do rather than trying to explain what went wrong and why - 'we are now managing the future'.
- **Effect on dissemination of knowledge throughout the organisation** - Prior to implementing the MTR system, only a few people knew what was happening, but now every person knows what is happening, because:
 - All critical information and knowledge is completely accessible by all members of the organisation
 - Supporting or operational staff (eg. line operatives, manufacturing engineers, quality engineers, etc.) use the information because they need to resolve the problem. Management use the information because they need to make decisions, drive improvement and create focus.

WEB ENABLED PERFORMANCE MEASUREMENT SYSTEM (WEPMS)

Based on this case experience and to make the implementation of web based performance measurement systems more accessible, we developed a 'shell', which has the touch and feel of Windows Explorer, as shown in the Figure 2. The left pane includes the basic framework in the form of a tree, within which Performance Measures are structured. This tree view can be adapted to any framework, such as the Balanced Scorecard, Integrated Performance Measurement System, EFQM, SMART Model, Performance Prism etc. The right pane includes the performance reports at each level or perspective of the framework. These reports include user-friendly filtering options to monitor the performance of processes, machines, materials, people, etc, in a specific period of time in which the user is interested.

The architecture of such a performance measurement system is shown in Figure 3. As far as the user is concerned (ie. the front end) they are just interacting with web pages through which they can view the related performance information. The performance information could be presented in various forms, such as normal charts, statistical charts, summary reports, process capability histograms, Pareto analysis, etc.

In the back end, the users can enter data into the existing software platforms (ie. databases) in the same way as they were doing before implementing this system. The system has the capability of pulling this data from various sources and presenting them in the form of different charts and summary reports.

Although, SPC charts were originally developed to monitor and manage manufacturing processes, the same approach can

easily be adopted to monitor and manage the performance of business processes as demonstrated in the AFE case study - such as order fulfilment performance and customer satisfaction performance.

CONCLUSIONS

The case study and the subsequent sections illustrated the significant benefits of implementing a web supported performance measurement system. We are also of the opinion that the following factors should accompany the implementation of an effective web enabled performance measurement solution to ensure successful operation and benefits:

- Adoption of a Performance Measurement Framework
- Deploying stakeholders' objectives and goals to performance measures
- Adopting Shewhart charts as the standard method of reporting performance information
- Senior management commitment, ie. the most senior people in the organisation should be using the system on a daily basis to manage the business
- Data collection and reporting techniques should become a part of the daily business
- A positive, tolerant and open management culture. That is if the system is used to point fingers and apportion blame then it could easily have negative effects.

Figure 2

Customisable Performance Measurement Framework

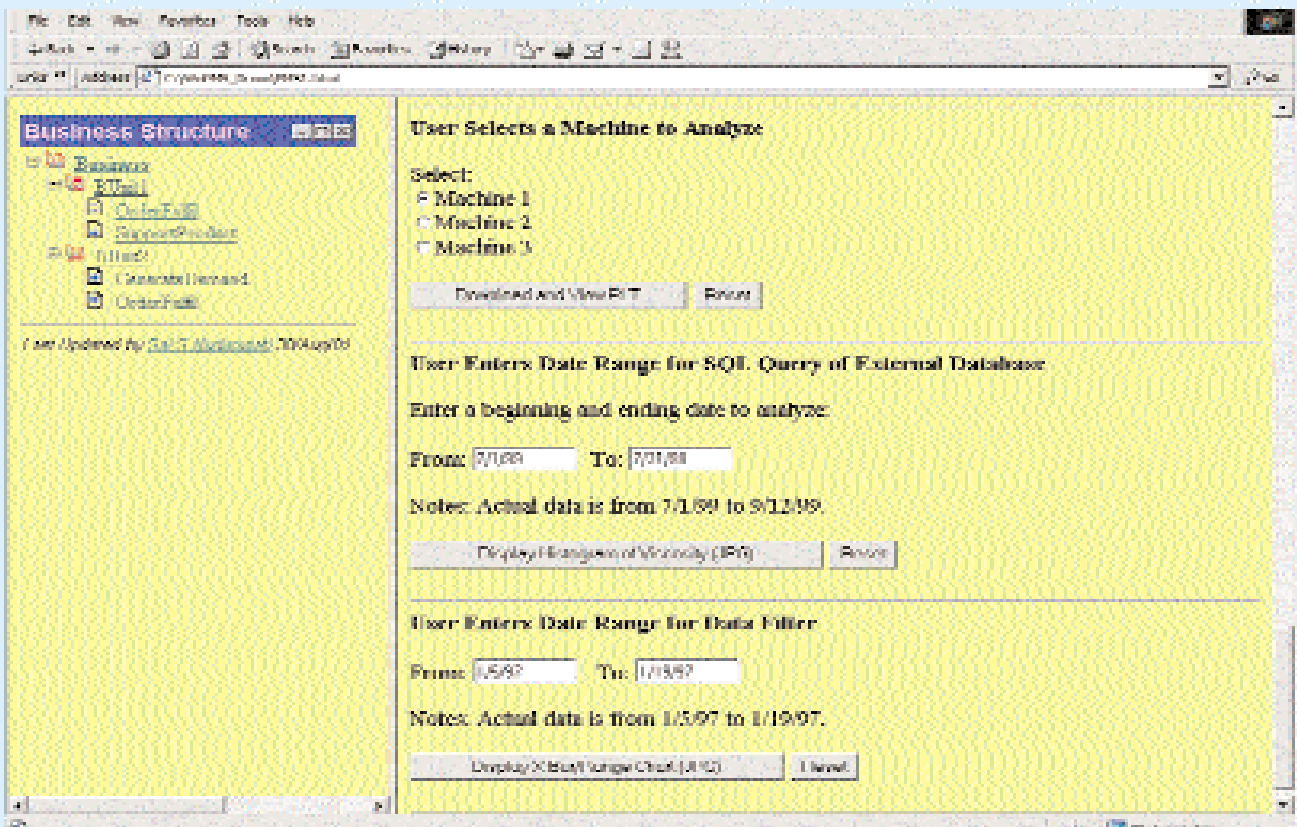
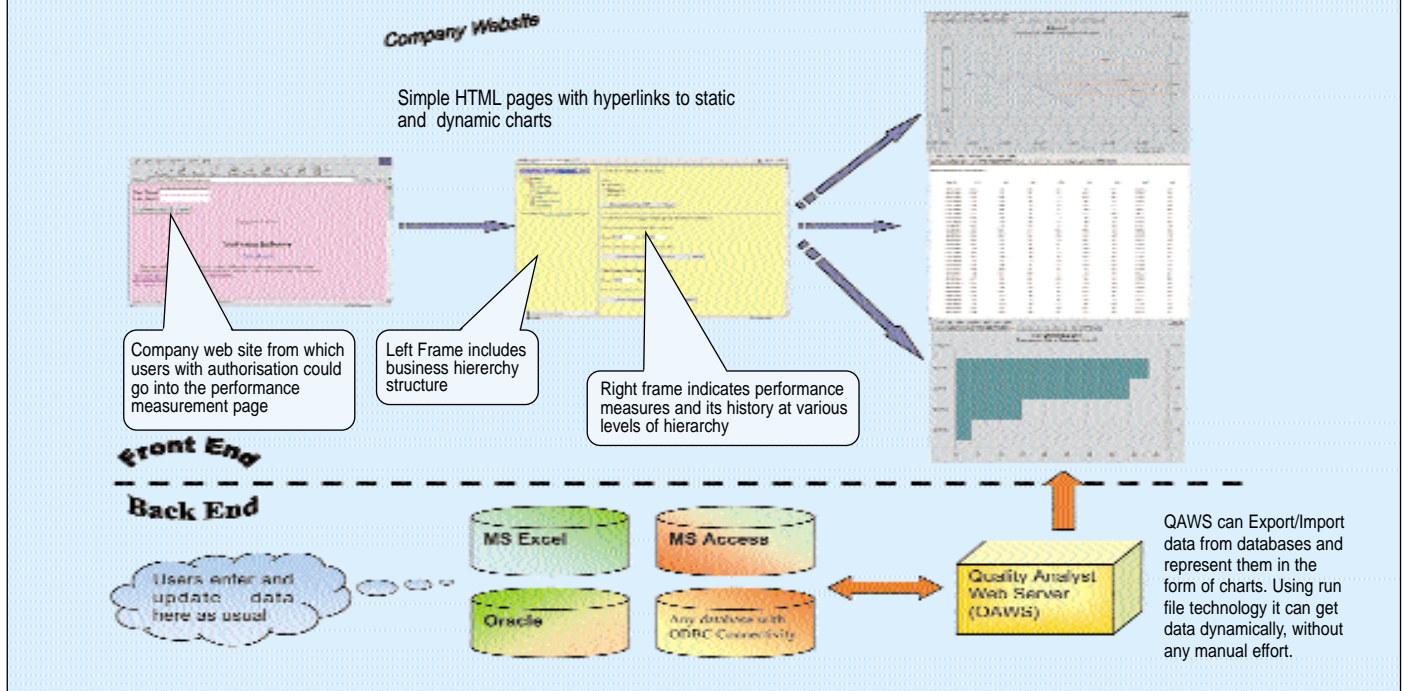


Figure 3

Web enabled Performance Measurement System



REFERENCES

1. Bititci US and Carrie AS, "Integrated Performance Measurement Systems: Structures and Relationships", *EPSRC Final Research Report*, Grant No. GR/K 48174, Swindon UK, 1998.
2. Bourne M and Neely A, "Why Performance Measurement Initiatives Succeed and Fail", *Proceedings of the 1st International Conference on Performance Measurement: Theory and Practice*, Cambridge UK, 1998.
3. Cross KF and Lynch RL, "The SMART Way to Define and Sustain Success", *National Productivity Review*, Vol. 9, No 1, 1988-1989.
4. Dixon JR, Nanni AJ, Vollmann TE, "The New Performance Challenge: Measuring Operations for World Class Competition", Dow Jones -Irwin Homewood IL, 1990.
5. Hudson M, Bennet JP, Smart A and Bourne M, "Performance Measurement in Planning and Control in SME's Global Production Management", edited by Mertins K, Krause O and Schallock B, Kluwer Academic Publishers, 1999.
6. Kaplan RS and Norton DP, "Translating Strategy into Action: The Balanced Scorecard", Harvard Business School Press, Boston, Mass 1996.
7. Neely A, Mills J, Gregory M, Richards H, Platts K and Bourne M, "Getting the Measure of Your Business", University of Cambridge, Manufacturing Engineering Group, 1996.
8. Neely A and Adams C, "The Performance Prism Perspective", *Journal of Cost Management*, Jan/Feb 2001,
9. Turner T.J, Bititci US, "Maintaining Reliability of Business Processes using Active Monitoring Techniques", *International Journal of Business Performance Measurement*, Vol. 2, 1997.
10. Creighton S, Turner T, and Bititci US, "An Intranet-based Performance Measurement System at Alcan Foil Europe in Glasgow", *International Conference on Integrated Production Management (IFIP WG 5.7) Conference Proceedings* (pages 15-23), 2000.

11. Suwignjo P, Bititci US, Carrie AS, Turner TJ, "PMS: Auditing and Prioritisation of Performance Measures", *International Conference on PMS, University of Cambridge*, 1998.
12. Bititci US, Turner T and Begemann C, "Dynamics of Performance Measurement Systems", *International Journal of Operations Management*, Vol.20, No. 6, pp692-704.

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