Design of an integrated throughput based control and information system for a medium sized textile manufacturer.

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Introduction

SMEs are increasingly becoming an important part of the manufacturing sectors of many economies, both in Europe (Levy and Powell 1998, Trau 1997) and elsewhere (Rishel and Burns 1997) and perhaps a strong contributory factor to this is their ability to provide for the changing nature of markets in today's customer driven volatile environments. Whilst customer needs drive change, it seems that the business relationship between producer and customer is becoming increasingly important and developments in these relationships may be a source of competitve advantage. In this paper we present a case of the development of an information and control system that fulfills the needs of a specific SME, and that provides a potential competetive advantage by developing the relationship between customer and producer. The approach is to initially place SME growth in the context of manufacturing and the changing environment, and then to define throughput based control systems for manufacturing. These issues are then brought together by showing how SMEs can benefit from throughput control systems that are cost effective. The case provides an example of the development of just such a control system and how such a system could help the small manufacturer to fulfill some of the criteria listed above. We finish with some tentative suggestions as to potentially productive research that could be undertaken, stemming from issues raised by the case.

SMEs and the manufacturing context.

The past decade or so has seen a substantial change in the environements in which business organisations operate. In particular manufacturing organisations have experienced a multitude of paradigm shifts that have largely made the traditional production lead approach defunct (Hill 1985, Hum and Hoon 1996). The new paradigms emphasise the ability of orgnisations to be flexible, and indeed even agile (Kidd 1994) in response to the changing requirements of customers both in terms of quality and time based service. This growth is symptomatic of a number of changes that have occurred in business environments in the past decade, and are likely to continue (Bolwijn and Kumpe 1990). These changes have by necessity increased the profile of systems and techniques that emphasise flexibility and quick response (Blackburn 1991, Barker and Helms 1992, Wisner and Fawcett 1991), such as Just-in-time, process reengineering etc., and also imply a need for alternative methods of performance measurement (Howell and Soucy 1988). Forza and Vinelli (1997) provide specific examples of these issues in the textile industry, in particular the importance of quick response. Another important concept in many of these techniques was the idea of holistic views of processes and the removal of internal organisational boundaries in order to get closer to the customer by ultimately allowing fast throughput and response times .

Whilst the larger organisation struggles with reorganisation in order to meet the needs of contemporary markets, the SME it could be argued, is better placed to cope. It is often the case that the smaller the organisation then the fewer are those types of barriers commonly found in the larger organsation that obstruct the attainment of competitive advantages in critical areas such as fast response and the provision of variety (Raymond et al 1998). Additionally it could be said that SMEs tend to operate in the high value low volume product areas, subsequently implying that they drop into the make-to-order and engineer-to-order categories. Whilst clearly this may not be true in all situations due largely to unique situations in different types of markets (for instance in the textile industry in West Yorkshire many SME manufacturers supply the high volume low value end of the market) it is generally the case. The critical point here is the relatively low number of “objects” or “orders” in the production system at any point in time and this has implications as will be shown later in the case, for the application of throughput based control systems. As stated SMEs tend toward MTO/ETO systems of production, and additionally tend to display relatively closer relations with customers. Critical success factors include accurate delivery, fast response to customer queries, and the ability to provide flexibility both in delivery time and often even product structure. Because of the nature of SMEs, they are often best placed to provide these requirements (Ahire et al 1996, Levy and Powell 1998), and the structures used by SMEs tend to facilitate the application of throughput based control systems.

Information & throughput based control systems

Increasingly information has become a central tenet of competitive advantage, and Kaye (1995) provides a useful classification of information types, two of which are process information, i.e. performance, and information for supporting decisions. It is these two types of information that are at the centre of throughput based total control systems. Additionally the smaller the organisation then the easier it becomes to apply “total” control systems. (due to shorter distances that information has to travel and fewer people who will be generally more task/job flexible). The term Total control system refers to production control and reporting systems that use single performance measures, and can be used and accessed by all departments in the manufacturing organisation. Whilst this might sound like an integrated manufacturing system, the main difference is the emphasis on live information, and time based performance measures, in particular throughput efficiency. Throughput efficiency is a simple performance measure based on the idea of measuring “objects” in terms of time consumption. An object is any item (in manufacturing it could be a customer order or any discrete product) that can be monitored through a process from beginning to end. The object is monitored in terms of time consumed, and the measure of throughput efficiency is simply calculated by dividing the value added time (actual process time for the object) by the total time that the object is in the system. So as a simple example if product A requires 2 hours total processing time, and is planned in on day 1, and then delivered on day 7, we can assume it is in the system for 6x24 hours. (In reality shift times and so on will be considered in calculating total time in the system). Throughput efficiency can thus be calculated:

Value added time/Total time in system or 2/24. This gives a percentage figure of 1.4%

By mathematical deduction we can assume that none value added time amounts to 142 hours, or 98.6%. This calculation can be easily carried out for products at the end of a process, but as will be seen in the case it can be used in a "real-time" sense during the actual process, thus facilitating closer control, and providing useful real-time live information.

A total control system is really just a system that integrates performance measurement, production control and management decision making into one system. By necessity they are based on a few critical performance measures that can be understood and used by all employees. Most manufacturing control systems have developed over a period of time, usually within the confines of the extant paradigms. The emphasis was on production efficiency and control, and effective stock management. Customer requirements rarely entered the equation in the development of these systems, mainly because it was unnecessary. Additionally manufacturing control & performance systems tended to be developed in isolation from other information systems causing many of the subsequent IT integration problems (Singh 1997). Total control system application is made more difficult where:

1. There are many departments to integrate.
2. The departments have their own agendas.
3. There are a relatively large number of production batches/orders in the system
4. There is a high level of variety within batches/orders in the system
5. Existing control systems have been developed independently (i.e. old departments)

Since many contemporary initiatives in manufacturing control tend toward integration of these issues it would seem that benefits must accrue to such an approach (Vlietstra 1994, Howard et al 1998) and it could be said that SME structures would exhibit characteristics that are generally opposite to the five cited here, thus perhaps facilitating the application of total control systems. The larger organisation generally makes use of its resources to apply the complex technology required to integrate departments although smaller organisations often do not have sufficient resources to apply this type of technology. In order to provide an illustrative example there follows a case of a medium sized manufacturer where an integrated total control and information system, based on the performance measure of throughput efficiency was developed.

Research methodology

In 1995 a medium sized manufacturer approached the author with a view to investigating a number of problems related to their processes. After some initial exploratory sessions it became clear that the situation of the organisation could provide a fruitful testing ground for some theoretical work . This area is in time based total control systems, and in particular in the use of throughput efficiency as a "real-time" control and performance measure. Clearly in using the case method there is always the problem of wider application, and in particular due to the problems involved in classification in manufacturing types, then it seemed that the case approach may be suitable from which some specific issues could be drawn. So the case was intended to be exploratory in nature, with perhaps some potentially useful research issues being raised. Clearly we had a major advantage in that this firm was a classic make-to-order type with relatively few objects in the system at any one time, i.e those types of conditions that may suit effective real-time control, and as such any attempts to suggest wider applications may be limited.

The investigators were essentially given free reign to approach data collection in whatever manner was appropriate. The only real requirement on behalf of the organisation was that some central problems were addressed. Given the open brief, and lack of a time constraint it was possible to take a pseudo-ethnographic approach, in so much as the investigator spent a considerable amount of time working with various employees in order to ensure a clear understanding of some of the problems. Almost all of the information collected was done so using a very informal questioning technique, through direct observation, and by actually working with employees in various positions within the plant. The situation of the investigator was helped considerably since all the employees were both aware of the problems, and in many cases how they might be solved. Most importantly though, all employees had been thoroughly briefed about the invstigation.

CASE:Textile manufacturers Ltd.

Textile manufacturers Ltd. are located in the North of England. They produce printed cloth for the home furnishings market in the UK and abroad. In the UK they control around 20% of the market and have about 40 customers, the top 6 of which take around 70% of the business. The design process is long and complex, but essentially geared toward converting a customers' idea into a finished product. The manufacturing process is relatively straightforward, consisting of essentially four processes through which every basic order must pass. Exceptional orders requiring perhaps special treatment may loop in the system and run through some processes more than once, or may run through an additional process altogether. The approach to scheduling the system involves planning orders into the printing process using a simple due delivery date, and assumption of four week lead time for the manufacturing process, so it could comfortably be classed as a MTO process. Printing hours are allocated to particular customers, and used up for their orders. Under-utilisation and deviation from schedule are handled in the shorter term by adjusting the print plan, but this can cause problems since most plans result in deviation from said plan , and the bulk of actual plans that are executed tend to be prepared only a short time before the print run.

Company strategy

The industry is quite competitive, and the ability to add value for the customer is seen as critical. How customers are dealt with is considered to be critical in this organisation, and this has been highlighted through a recent customer survey carried out by the marketing department. This revealed issues such as on-time delivery of orders, prompt and accurate response to information requests on the progress of orders, and the ability to be flexible as extremely important. Unofficially the ability to provide prompt information to customers on the progress of their orders by sales staff was considered to be the most important issue due mainly to the unusually close relationships developed during the design development process. Based on this information the company has formulated a manufacturing strategy statement that has as its central objective the attainment of 100% performance in each of these areas. To facilitate this stated strategic intention it is realised that support must be in the form of the development of internal unique competency through the use, and combination of existing resources. The organisation understands that it is only through unique internal competency that they can gain a lead over competitors. As the Chief executive stated:

> *"Having state of the art kit, well trained and knowledgeable people, and appropriate IT systems is fine, but our competitors have the same. Its how we combine what we have that will give us the edge"*

Operational problems

The organisation has identified that it has some fundamental issues it needs to address if it is to Maintain and improve its position within the industry. Most of these problems are related to information and information use. There is an existing IT system called "Core system" but it is quite dated, and is considered to be complex. Existing employees criticise it on the following grounds:

1) Too many options, causing complexity.
   There are around 400 options in various menus.
2) System options never updated.
   90% of options are not used.
3) Too few access points, with only one in production.
   A very small proportion of employees use the system.
4) Options rarely provide appropriate information
   Output is considered unuseful for needs of the organisation.

Perhaps the most urgent problem is that of progress tracking and throughput performance of discrete orders through the system. Currently process information is collated and input to the system every 24 hours. This time delay is considered to be next to useless especially in this type of organisation, with the ultimate time wasting exercise resulting, i.e. people from different departments physically looking for orders in the system. In terms of operational control, the problem creates delays as decisions are delayed, and management is forced to engage in regular "location and status" meetings, in order to ensure critical delivery times are met.

Developing a "total" information & control system

The MTO nature of this organisation indicated that improved cycle time performance, and more importantly throughput control might come from better, more timely information, and accurate tracking of orders. Also accurate time based information was required by sales and marketing to fulfill customer requirements in terms of requests for order status. It was decided that in order to provide these requirements, a real-time total control & information system was required. In the development of this system a number of fundamental rules and requirements were adhered to, namely:

1. Simplicity
Simplicity refers to both system operations and type of data. Fig.1 indicates the basic architecture of the system showing input/output connections with users. The actual input data required was centered around 3 basic types:

a) Required customer delivery date. This came from sales, and can be input to the system by planning, similar to the current system.

b) Planning in date. Again this is calculated by planning.

c) process times on each process. This data needs to be captured in a "real-time" sense and can be obtained by operators entering the appropriate data. The location number 1-9 (fig.1) would be pre-programmed so that the system would automatically pick up appropriate locations.

2. Real-time data capture.
A major problem with all "real-time" control and performance measurement systems is the issue of data collection from the process. In line with the view that the system should be simple, the method of data collection would be manual. The alternative would be to find some system that could automatically register the arrival and departure of objects at the various locations in the system, but the only way this could possibly be achieved would be through a bar coding system. The cost involved in this would be too inhibitive, but was rejected mainly on the grounds of over-complication, and anyway the system could conceivably support such an upgrade in the future. Using a manual method it was considered would also engage the input of operators into the process of decision making. The method of data input would not add any additional work load as it would simply replace the manual method currently used. The operator would simply input the order number and the system would immediately pick up this locational information and update the records and performance for that order.

3. Universally accessible information.
The information available had to be utilised by varying groups in the organisation. For instance production personnel can immediately access location information and status information for an order, and from the information produced make "real-time" intervention decisions, perhaps in response to changed customer needs, or in order to support expediting of orders. Sales and marketing can make accurate responses to customer inquiry, and even provide expected delivery times. The planning department can access performance information, and the system is intended to assist in the planning process.

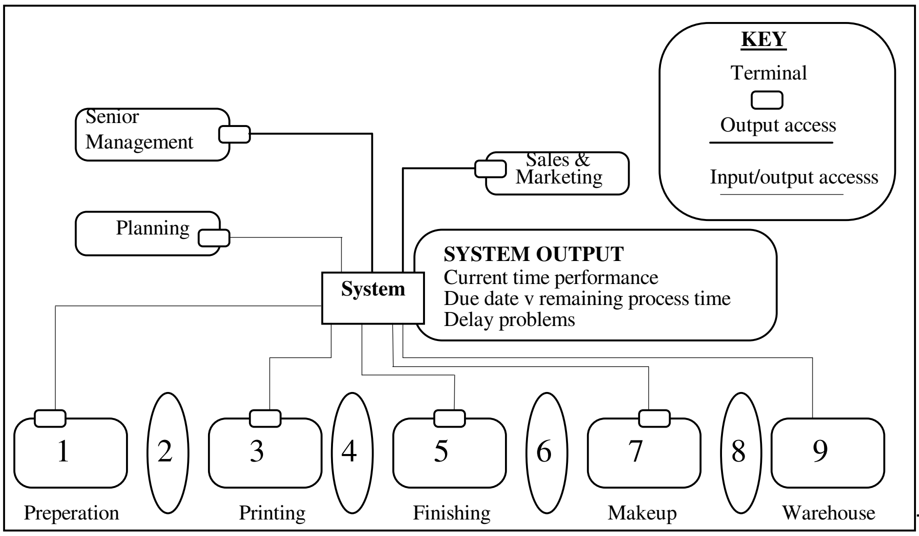

fig.1

System output

Essentially there are very few critical measures that would be required by all functions in the organisation. From the few menus available it is envisaged that perhaps one would be used most consistently. This would be the menu that provided current throughput efficiency measures with flagged delays and prospective delivery/completion dates. Four simple report menus can be accessed by different functions in the organisation (fig.1) to provide a mix of real-time and historical performance information. In the production departments it is planned that the system will automatically produce alarm reports for problem orders.

A linking framework

Fig.2 is intended to illustrate the overall rationale used in defining the important linkages between time, information and strategy in this companies' context. The basic requirement, and driver is the production reporting system that uses "real-time" object centered performance measurement. Operations managers can use the information from all menus to obtain "real-time" order (object) oriented performance. Theoretically this helps to reduce non value-added activity related to slow problem solving, and improves intervention scheduling by providing accurate, time based up to date performance information from within the process. Commercial and sales staff can draw on the same information in order to give timely response to customer queries, in the knowledge that the information is accurate.

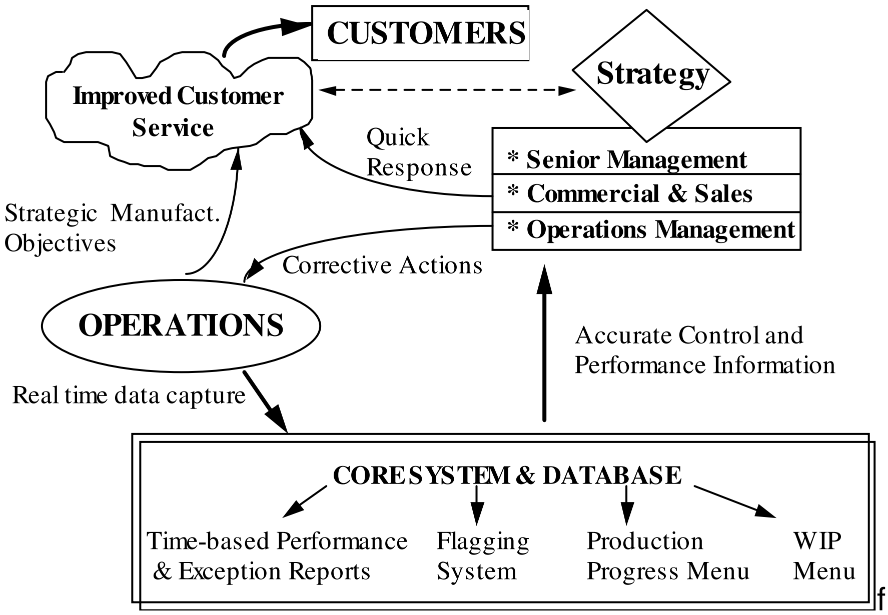

fig.2

Next stage of development
The manufacturer in question has agreed in principle to the recommendations of the project, and has taken the next step of assessing the appropriate hardware and software. A problem still remains in the integration of the management accounting and financial systems. Part of the recommendation was a tentative suggestion to investigate the possibility of building in a costing function that is based on a hybrid version of throughput accounting making use of value added principles. It is thought that this could be run alongside the existing financial systems.

Summary
This case presented has provided a unique view of the application of a throughput total control systems in SME manufacturing. Clearly the nature of this particular manufacturer facilitated the application of the total system based on the measure called throughput efficiency. The information provided, enhanced the relationship between manufacturer and customer, an important issue for this company, and additionally provided benefits in other areas of the plant, such as in scheduling, problem solving and so on. Furthermore it could be said that the system could conceivably be of benefit in integrating the organisation thus ensuring alignment in all departments with the organisations strategic goals. Further research would be required in order to investigate the applicability of total systems based on throughput efficiency to different types of SME manufacturer. This would inevitably involve the classification problem, although a first step may be to classify the importance of the relationship between the SME and the customer. The effective application of the metric called throughput efficiency needs to be investigated in terms of its relation to complexity of the operations system and of the product, although we suspect a direct negative correlation between the complexity of and number of orders in the system and ease of application of the measure. The authors feel that it is important that SMEs make full use of their relative strengths, which it is argued make them uniquely placed to be able to operate effectively in today’s, time based, customer oriented environments.

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