A Process For Manufacturing Objectives Deployment

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Abstract

Literature on existing manufacturing strategy is very much focused on the formulation and setting of manufacturing objectives, little is available on the process of translating these objectives into action plans. This paper addresses this gap by presenting a three stage process: decomposing the objectives, identifying alternative actions and evaluating these actions. The process operationalises Burbidge's Connectance Model for identifying variable relationships, and uses Analytic Hierarchy Process (AHP) for evaluating alternatives. The early findings of the application of this process in industrial cases are briefly described.

Introduction

Manufacturing is now undertaken in an increasingly competitive global environment. The pace of change has accelerated during the past decade in many respects, and many more 'best practices' and improvement programmes have become available. This makes it increasingly hard for manufacturing managers wishing to improve their operation to identify the range of options available and decide on which to pursue.

Traditional manufacturing strategy frameworks and processes (Skinner, 1969; Wheelwright, 1978; Hayes and Wheelwright, 1984; Platts, 1990) seem to focus on setting the manufacturing objectives, but lack sufficient detail on how these objectives are translated into action plans. These frameworks do not deal directly with issues of the interface between manufacturing objectives and choice of action plan. The action plans could be improvement programmes such as Total Quality Management (TQM), Just In Time (JIT) or specific decisions like reducing tooling set-up time on the work centre.

Some researchers (Ward, et al. 1988; Kim and Arnold, 1996; Boyer, 1998) use survey results to explore the subject, providing insights into the coherence links between a company's manufacturing objectives and choice of action plans. In general, these studies focus on what type of action plan a company selects to meet or align with the set manufacturing objectives. Cagliano and Spina (2000) point out that some studies (Imai, 1986; Schonberger, 1986; Shingo, 1981), however are more focused on discussing the benefits that may result from the specific improvement programmes. By and large, these studies suggest the expected links between manufacturing objectives and choice of action plans.

A review of manufacturing strategy literature reveals that little is available to guide managers in the process of objective deployment, that is translating a set of manufacturing objectives into actual action plans for further execution. Choices of action plans are difficult because the strategic priorities – quality, delivery performance, cost, flexibility and innovativeness (Leong, et al. 1990) are too highly aggregated to direct decision making. These priorities are broad and generic categories with a multitude of possible interpretations (Garvin, 1993).

For a successful deployment of manufacturing objectives, a manager must be able to identify a range of feasible alternative plans before the final decision is made. How then can a factory manager identify a range of potential alternative actions that can be taken to achieve the given objectives? There are many idea-generating techniques like brainstorming, force field analysis, ideas mapping and lateral thinking, but these tools seem to be more suitable for subject exploring and facilitating group discussion than providing a range of relevant alternatives. In a study in six companies on the generation of alternatives by using force field analysis, Platts and Maslen (1996) point out that managers have difficulty in listing all the relevant driving and restraining forces.

There are some specific techniques, for example Quality Function Deployment (QFD) (Cohen, 1995) and Hoshin Kanri (Akao, 1991), but these are mainly directed towards objective definition rather than generating action plans. QFD is more directed for step by step customer needs deployment and has been mainly used in the new product development process. Hoshin Kanri is useful for managing process changes and depends on objective decomposition based on the 'catch ball' concept.

There is a remaining area of concern to managers that has not been widely addressed in the literature on manufacturing strategy and which existing deployment techniques have not solved - that is how to generate and choose the right action plan (Tan and Platts, 2000). Malone, et al. (1999) point out that to improve organisational practise in a particular situation, a manager must be able to imagine alternative ways of accomplishing the same things as well as some way of judging which alternatives are likely to be useful or desirable in which situations. Consider a manager who wants to meet a particular manufacturing objective, how could he identify the range of potential action plans that might enable the achievement of that objective? And having identified a range of possible action plans, how should he choose between them? For example, in order to meet the manufacturing objective of improved delivery performance, what is the range of potential action plans that can be taken? If he did identify the range of action plans, say by having more buffer stock, by reducing manufacturing lead time or increasing productivity, which action plans should he choose then?

It is acknowledged that in practice, most managers generate and evaluate action plans based on past experience and intuition. This is of course, limited by the extent of their experience and tends to prevent them taking a wider view. This 'experience bias' could cause a failure to ensure that the objective is properly deployed with the right action plans. Arnold (1993) points out that our largely unconscious and habitual ways of thinking through choices predisposes us to making decisions that in the longer run may not be in our best interest. Although they help us cope with life on a day to day operating basis, they also tend to keep us in ruts, so we fail to recognise and seize upon innovative alternatives to the historical choices we make, day in and day out.

In the absence of explicit means of making key decisions, a company has no way to ensure its managers make the right choices. In order that managers make decisions that are consistent with the overall objective of the business, rather than responding to short term concerns it is important to have an explicit, structured decision process for objective deployment.

This paper addresses the gap identified above by presenting a three stage process: decomposing the objectives, identifying alternative actions and evaluating these actions. The process operationalises Burbidge's Connectance Model for identifying variable relationships, and uses Analytic Hierarchy Process (AHP) for evaluating alternatives. The early findings of the application of this process in an industrial case is briefly discussed.

The Overall Deployment Process

A process which integrates the connectance model and AHP has been developed to approach manufacturing objective deployment (see Figure 1). The process serves as interface between manufacturing objectives and strategy deployment. The process comprises three stages a) decomposition; b) alternative mapping and c) evaluation. Decomposition is the process of refining the manufacturing objectives into narrower categories and specifying the production variables that are likely to contribute to objective improvement. Alternative mapping is the process of determining a list of feasible improvement alternatives using the connectance concept. Evaluation is the process of using AHP carrying out pairwise comparison of the potential alternatives, to decide the ones that will be pursued further.

(See Figure 1)

Stage 1: Decomposition of Objectives

The first stage of the process is to translate and more narrowly define the given objectives. When the objectives are more precisely defined, managers will be able to determine the production variables that have an effect and contribute to the achieving of given objectives. For example, if improved delivery is the objective, there are long lists of feasible options for achieving it. Managers will need to carry out an initial screening of the current manufacturing situation and decide which factors such as production capacity, finished good inventory, lead time etc. should be the focus for further analysis. For example, if delivery is poor due to insufficient production capacity, then the manager will know capacity is the variable that he should focus on to improve delivery performance.

This stage uses a number of forms to collect data on existing facilities, achieved performance, targeted performance and relevant production variables.

Stage 2: Alternative Mapping

This stage aims to develop a list of alternative action plans that could contribute to the achievement of objective. It uses the connectance concept (Burbidge, 1984) which states that '*providing one does not attempt to specify relationships in quantitative terms, it is possible to make statements about system variable connectance, which are always true, but may not be relevant in all production situations'.* Using this concept a variable connectance network is drawn from which the identification of actions can be made.

The first step in applying the connectance concept is to identify the connectance variables that have an impact on the variable being study. A form is given to managers to identify and map out the variable connectance based on their own understanding. Once the variables are identified, a variable connectance network is then drawn using a prototype tool (Tan & Platts, 2000). These variables are classified using filter functions that are incorporated in the prototype tool, and the variables information is stored into database. Two types of filter information are used in the database, which relates to the variable and its connectance. Filter information on variables would enable managers to single out the type of variable that he/she is looking for. Whereas, filter information on connectance would enable managers to decide on the type of connectance variables that he/she would like to focus on.

The filter functions are particularly useful to structure the variable connectance information and highlight the high impact variables. The alternative action plans are then identified from those high impact key variables. The following shows an example:

(See Figure 2)

From the connectance network, key variables can be identified based on the current production operating data and knowledge of the team. For example, the monthly production records will indicate how much production time was utilised on set-up, breakdown or idle time. Variables that contribute to high percentage of production down time will be the ones needing attention. A form is used to record and rank the key variables based on their perceived importance. From those key variables, actions can be suggested. For example, the action plans could be one or more of:

- reducing (indicated by a (-) sign) work centre down time (o3314);
- reducing machine set-up frequency (IP308);
- reducing the amount of idle time on work centre (o3311);
- reducing lateness of machine operator (o7303);
- increasing (indicated by a (+) sign) overtime (IP316);
- increasing the number of working shifts (IS310);
- increasing the number of machines (IP205).

Stage 3: Evaluation

This stage aims to evaluate and prioritise the merit of all the identified feasible alternatives. It results in a decision indicating that which action plan is most favoured to achieve the set objective.

This is a process that needs rigorous analysis and management insight. In the process managers must consider the ‘benefits’ or other concerns that each alternative offers. The Analytic Hierarchy Process (AHP) method is used here for detailed pairwise evaluation of the alternatives.

The essential feature of the AHP is that it enables a decision maker to structure a multiple attribute problem visually in the form of an attribute hierarchy. Application of AHP is based on following four principles (Saaty, 1994): decomposition; prioritization; synthesis and sensitivity analysis.

Once the criteria for the evaluation have been agreed, the developed prototype tool will be used to perform the AHP analysis and answer ‘what-if’ questions through sensitivity analysis of the results.

At this stage of the research, preliminary testing of the process in real industry context has been carried out. The case study had been conducted by a process approach using action research (Platts, 1993) to test its feasibility, usability and utility.

Case Study

Company X is one of the leading companies in the field of innovative thermosetting polymers. It has an annual turnover of £115 million and employs 300 people. Forecast increase in demand prompted the company to look into increasing its existing capacity. The managers knew that the existing packing plant capacity was under-utilised and they wanted to find a solution to increase capacity utilisation. The company adopted the deployment process and set-up a project team. Five workshops were undertaken to guide the project team the process.

This paper focuses on stages 2 and 3 of the process where action plans were generated and evaluated. It is these stages which form the main focus of the following discussion.

Discussion

The feedback from the project team indicated that the process was very useful in enhancing their understanding of the issues involved. The process enabled them to have an overview of the capacity issues and provided them with a structured way to approach it.

Once the unit of analysis (production work centre) had been identified, the team generally found it easy to determine the relevant capacity variables. With help from the facilitator, the team found that the prototype tool was easy to use to construct a variable connectance network (see figure 3). However, they mentioned that they would like more practise sessions to become familiar with some of the prototype tool built-in functions.

With regard to the prototype tool, the filter functions were found particularly useful to allow the team to prioritise and focus on high impact variables upon getting an overall view of the situation. Additionally, they highlighted that with the connectance concept, the tool seems to be more robust than conventional approaches like brainstorming or fish-bone diagrams in that the variable's network model shows the relevant connectance comprehensively. This visual network assists managers in getting an overall view of the variable being studied and its connectance, and thus, it helps to clarify thought.

(See Figure 3)

The variable connectance network (figure 3) shows that the factors affecting 'capacity' in a work centre are many, and interrelated. Previously the team had only considered changing the number of labour or machine hours when they required to change capacity. The network made it much clearer to identify the variables that could be changed to affect capacity.

The key variable proforma was considered a good way to rank the connectance variables according to their impact on capacity. Once the key variables had been identified, and with the aid of the connectance network, the team felt it was easier to suggest potential improvement action plans.

The AHP evaluation process was particularly useful in prioritising the identified action plans. However, some difficulty was experienced in rating within the nine-point scale. The team felt that an additional warm up workshop for AHP process would be particularly helpful in understanding the AHP concept. Finally, the built-in sensitivity analysis of the prototype tool was extremely useful in helping them to answer 'what-if' questions regarding to the set of criteria and action plans.

In general, the team believes that the process and tool allow firms to communicate and make decisions more effectively – whether alone, in a group or geographically separated. The process gives a clear and systematic approach to analysing and diagnosing a particular problem.

One project team member pointed out that using the process and prototype tool does not guarantee correct judgement or decisions. But applying them would indeed raise the probability of making the right choice, getting buy-in and identifying range of feasible actions.

Conclusions

The idea of using a structured decision making process is nothing new; during the past few decades, several decision making techniques and tools have been developed. These techniques, however, by and large seem to fail to address the challenge of translating a given objective to choice of action plans.

This research has involved the development and testing of a prototype tool for generation and evaluation of action plans. The tool has been integrated into a process and provides a structured and practical approach for managers to approach objective deployment.

The result of the preliminary case study indicates that the process is feasible and useful. However, several issues pertinent to the process need further investigation in order to make it more robust:

a) Could this process help to minimise 'experience bias' of individual team members?
b) How could the alternative generation process ensure that the team members are aware and take consideration of best practises (JIT, TQM, SMED et al.) into their considerations?

These issues, amongst others, remain to be answered by future case studies in order to enhance the understanding of using the process for objective deployment.

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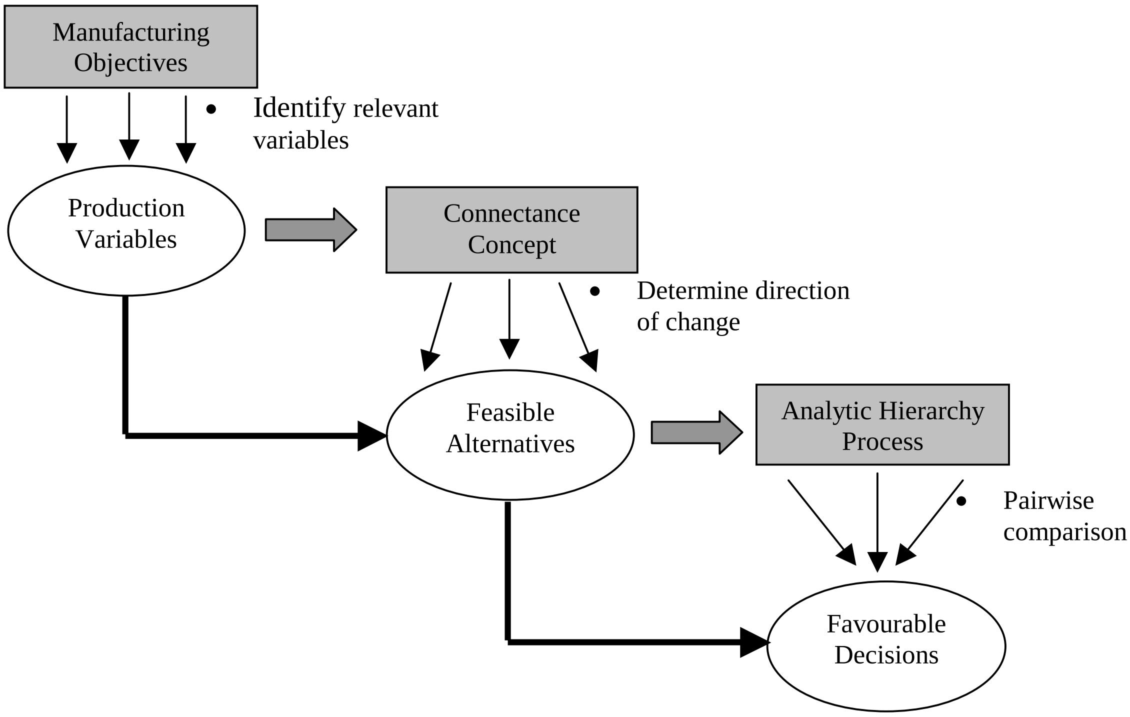

Figure 1: Strategy Deployment Process

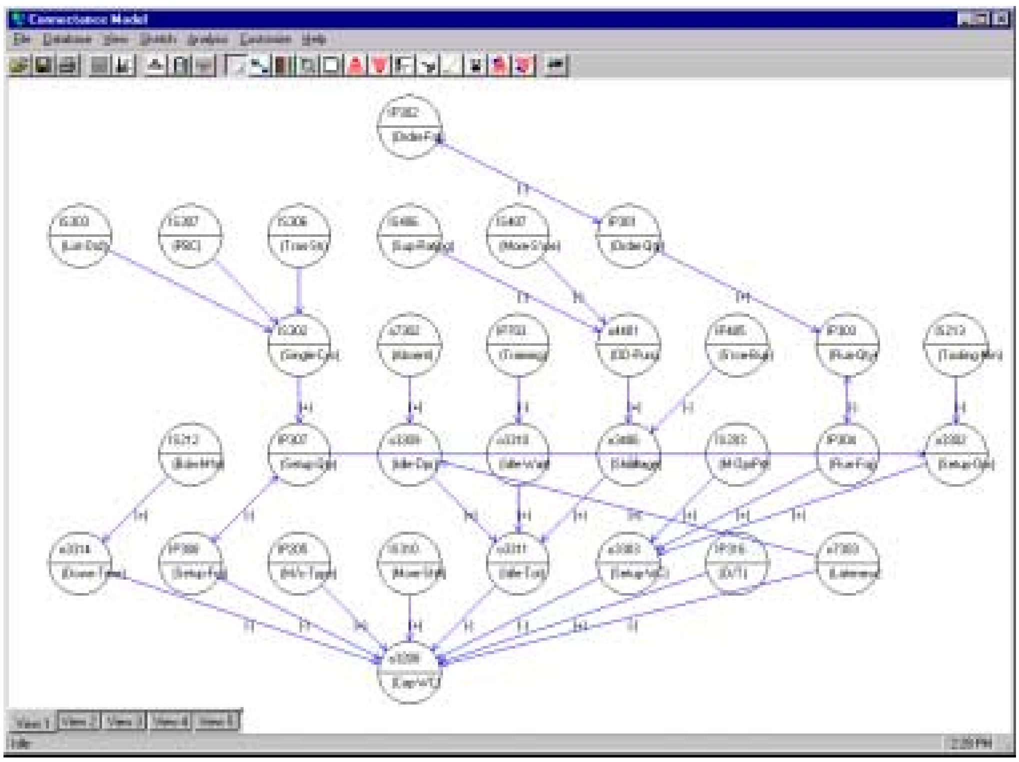

Figure 2: Connectance Network for The Variable 'Work Centre Capacity'

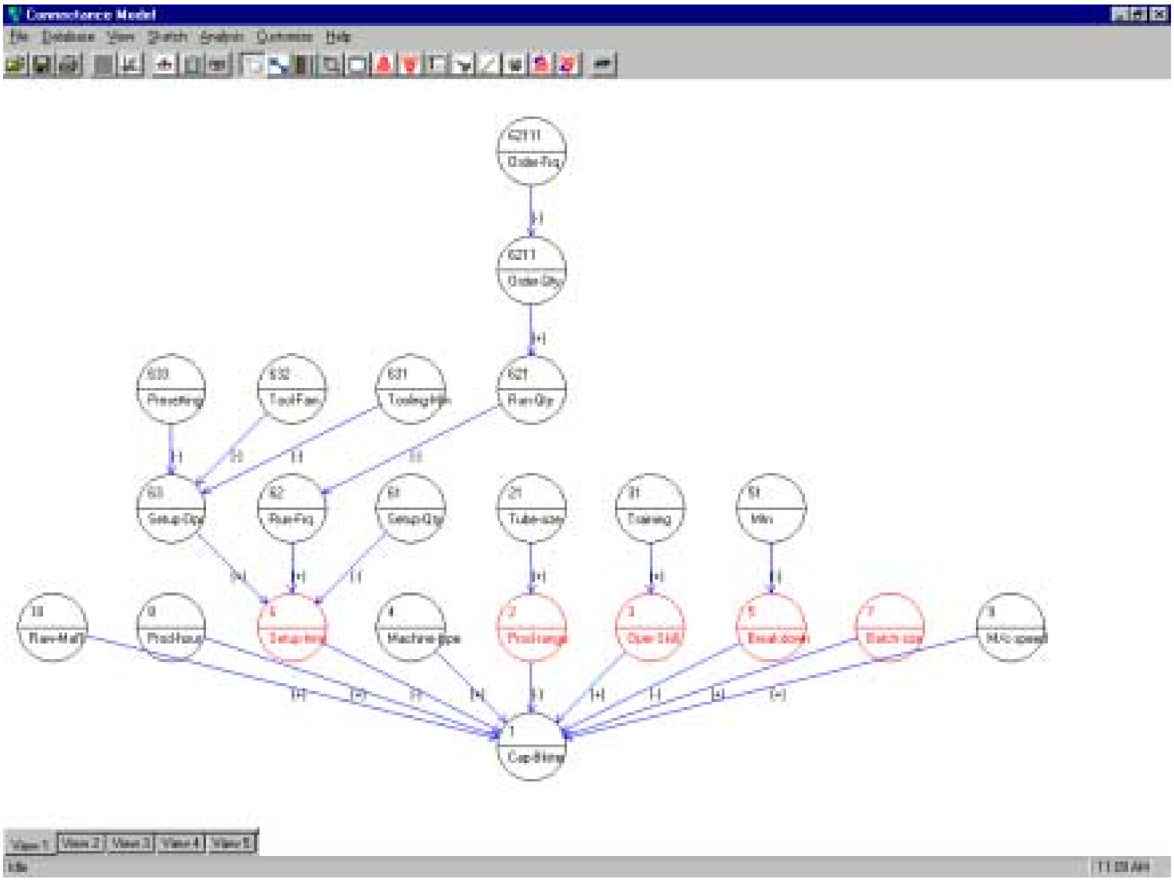

Figure 3: Capacity Variable Connectance Network from Case