

More than a mismatch: Mindset discordance between operations researchers and manufacturing Managers concerning *Control*

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Abstract:

Manufacturing Management and Operations Research should be complementary disciplines. Effective dialogue and partnership between the two would enable productive change in both professions. Since Ackoff (1979), the relationship frequently has been described as ineffective. However, justifications for this view have been generally anecdotal and couched in ambiguous language. This has not provided the operations research profession with either a framework to understand the problem, or a motivation to make the changes required for more effective dialogue. This paper develops an empirically based analysis of one aspect of manufacturing management of interest to both groups. From the data it is clear that manufacturing managers and Operations researchers have significant difficulty in communicating concepts such as control because of their clearly divergent mindsets.

Introduction

Operations Research (OR) had its genesis in the late 1930's, (Rosenhead 1992) in a world where the internal constraints of the organization were the dominant barriers standing between the organization and its goals. In this brave new world, Taylor's, *'The Principles of Scientific Management'* (1911) could still be relied upon as a manual for operations management. After using the emerging techniques to win the war, men left the military systems of command and control and proceeded to solve the problem of business with the same rational approaches. The 1960s and 1970s saw the emergence of successful export orientated economies in Japan and Germany, and the saturation of many mass markets of the US and the UK. As markets became saturated, constraints moved outside the boundaries of the operations function, and often outside the boundaries of the organization. It was no longer sufficient to have capacity, you also needed to meet the demands of consumers in mass markets.

In this environment, the well-established abstractions of the operations research profession (diagnosis with a reductionist approach; analysis with quantitative techniques against single goals; and treatment of the technology of the process) were not enough. Companies needed to compete using (at least) product variation, service speed, reliability and flexibility and product cost and quality. Operations researchers have developed techniques that could, for example, optimise overall product mix to maximize gross margin. Managers, however, are confronted with a market that requires satisfaction on multiple goals, contains unrevealed and unknown alternatives, and has constraints lying outside the domain of the organization, and behaviours in most of the organisation's systems that are mathematically intractable and reflexive.

This paper analyses the discourse of manufacturing managers and Operations research professionals and exposes the gaps between their mindsets. The control function is used as an example to explain how these two groups have different and distinct mindsets that act as a barrier to their communicating let alone their understanding one another.

Control in Manufacturing Management

Planning and controlling operations is the dominant activity for manufacturing managers. Surveys of operations managers in the UK in 1978 and 1986 and Australia in 1999 indicate that the proportion of time spent in this area was 68% in 1977, 59% in 1986 and 57% in 1999 (Gill and Lockyer 1978, Oakland and Sohal 1989, D'Netto and Sohal 1999). The control activity can be defined as a "regulatory process that directs or constrains an iterative activity to some standard or purpose" (Green and Welsh 1988, p. 291). This is a cybernetic "process in which a feedback loop is represented by using standards of performance, measuring system performance, comparing that performance to standards, feeding back information about unwanted variances in the system, and modifying the system's comportment". (Green and Welsh 1988, p. 289) This control concept is applied within a function to a resource depending on the importance of that resource to the organization, and on the feasibility of establishing control (Green and Welsh 1988). One of the most widely used examples of this form of control is found in the balanced scorecard promoted by Kaplan and Norton (1996).

Sub-systems of control identified by Slack et al. (1998) for the manufacturing area include capacity, inventory, supply chain, MRP, Just-In-Time (JIT), project planning, and quality. Control in these sub systems could be related to both resources and strategic goals. The resources of materials, labour and assets are critical to the operational efficiency of the function. Capacity relates to asset utilization while inventory, supply chain, MRP and JIT relate to materials flow and labour utilization through scheduling. In principle, measures taken from supply chain and MRP systems can be used to respond to strategic capabilities of the function such as dependability and flexibility. Quality can be regarded as a strategic goal of the function, or as a strategic capability, but in operational use, quality as *quality control*, is a synonym for the concept of operational control using the cybernetic feedback loop.

Thus performance measures are essential components of control systems and the selection and use of particular performance measures is clearly indicative of preferred approaches to control. Specific performance measures in the manufacturing domain can cover a very wide range of variables. The measures need to include indicators of strategic performance and operational effectiveness. The first will be the measures that relate to the need to maintain the market fit of the organization. These types of measures will indicate how competitive the products of the organization are. This could be based on, for example: quality; price; product performance; delivery reliability; delivery lead-time; customized products; time to market; and volume flexibility (Jenkins, Hyland and Sloan 2000, Schmenner and Vollmann 1993). Measures that indicated the performance effectiveness, related to internal consistency, of the function include, for example; machine efficiency; labour efficiency; process throughput times; direct cost; overhead cost; and machine utilization.

The three measures that dominate the manufacturing function are direct cost reduction, machine efficiency, and labour efficiency (Malhotra, Steel and Grover 1994, Schmenner and Vollmann 1993). As with other work in the area, Schmenner and Vollmann (1993) expressed concern with the prominence of these measures. They argued strongly for the development of measures that would enable effective control of other, more strategic systems such as new product development and customer service. Draaijer and Boer (1995) also expressed surprise to find, in their work, that even though cost was not a main performance indicator for most companies, "cost effectiveness, and related indicators such as productivity, still seem to be the only criteria for measuring performance in many companies" (Draaijer and Boer 1995, p. 13). These findings support earlier work in the area by Skinner (1986) who argued that since the work of Taylor, the role of factory managers has been "...not as architects of competitive systems but as custodians of large, capital intensive assets. Their job was to control and coordinate all factors of production so as to minimize costs and maximize output." (Skinner 1986, p. 57)

It appears that the historical roots of the profession have led to a current approach that emphasizes a perspective of internal consistency rather than external factors such as market fit or even normative response. In this position a traditional, operational, perspective dominates a strategic and risk taking perspective. It is widely accepted that managers of the manufacturing function should adopt a strategic perspective. The performance of the function however, is measured by what appear to be short-term tactical measures having little bearing on the competitive strategy of the business. If these formal measures constitute the dominant part of the managers' relationship with the function then this suggests that managers do not take a strategic perspective.

The truth may of course, lie in between. As people become experienced in a process and develop skills in the operation then the measures that they use to achieve control of the operation can be subtle or tacit (Nonaka 1991). Managers, over time may develop strategies to control their environment that are independent of the formal measures developed outside the function. These formal measures provide a framework for structured communication and aids to long-term control. Short-term control will exist in a context shaped by the formal measures, but given detail and short-term structure by tacit, sense based, knowledge.

The interactions which exist between the organization, its markets and technology suggest that any simple approach to defining systems of control are unlikely to capture the required level of complexity of the system. The presence of technology will influence where the control is based. Early work on organizations and technology argued that choices of technology explained much of the variation observed in organization (Woodward 1965, Thompson 1967, Braverman 1974, Perrow 1986). Co-alignment is located in the organisation; technology is explicit and highly determined. To the extent that this is the case, then control will be operationalized in an organizational context distorted by the technologies the organization seeks to control. Technology change will lead to organizational change, and ideally, a change in the types of measures used. It has also been argued that organizations create and enact technology, at times selecting technologies that reinforce pre-existing structures of the organization (Berger and Luckmann 1966, Perrow 1983, Wilson 1982). In this case the process of co-alignment will act more on the technology than the organization, either through selection of technologies that are consistent with existing processes, or through co-alignment during the adoption process. Control measures in this case will be stable despite changes to technology. Technology, however, has a capacity to distort more than the structure of the adopting organization. Managers typically will have a wide range of choice of technology to achieve competitive alignment to markets (Draaijer and Boer 1995). The technology that is chosen may enable the organization to compete in new markets that were not anticipated when the technology was assessed (Schroeder, Congden, and Gonipath 1995). If the process of co-alignment leads the company to take on a new market segment, a higher value added segment for example, then old measures based on a low-cost, high-volume products will be inadequate. A system that simultaneously includes market forces, technological change and organizational change is unlikely to be controllable using a simple set of explicit, stable measures, such as material and labour cost. The use then of 'measures'

as a proxy for the real system that must be controlled is thus likely to be of limited validity (Johnston & Brennan 1996).

The measures, then, of direct cost reduction, machine efficiency, and labour efficiency are likely to form only part of the system used by managers to control their environment. There will be a role for unusual measures, and these unusual measures may be tacit. These tacit measures may not be represented in the formal control domain, they may only exist in the tacit mindsets the managers have of the work environment. In addition, some elements of the system may be so context dependent, that the basic requirements of cybernetic control, the iterative process, are simply unattainable (Johnston 1995, Despres 1996, Johnston and Brennan 1996). The nature of the control problem suggests that this area is very complex, and probably a source of significant variation between manufacturing managers and Operations Researchers. The difference may lie in a variation in the level of prominence of concepts depending upon the balance between tacit and explicit systems of control.

Methodology

Technology Focus

Innovation and the adoption of technology are critical to the health of any economic sector, and manufacturing is no exception to this generalization. In order to examine the issue of potentially discordant mindsets between Manufacturing Managers and Operations Researchers this research examined the adoption and use of Discrete Event Simulation (DES) by a group of Australian managers. DES is a software-based technology used to develop models of operational processes. These models can then be used to examine the impact of process change, or policy change, on the performance of the process. The technology has received considerable attention in the Operations Research area and has been presented as an extremely valuable tool for practicing managers facing difficult decisions involving process and system restructure or improvement.

The Frame as a Construct

It is argued in this paper that it is possible to represent the cognitive structures used to make sense of issues, and this can be based on an analysis of the agent's discourse. This construct, termed a frame in this paper, can then be regarded as a representation of part of what was in the mind of the informant at the time the discourse was created (Carley 1997). The definition of a frame used in this paper is based that of Entman (1993). This definition is widely used in the communication literature, and is similar to a range of implicit definitions in the management literature. Entman (1993) proposed that a frame would identify concepts, identify their salience and expected associations, and finally, represent these concepts within a normative context. This paper uses the term frame to refer to a construct developed through some form of discourse analysis which represents the abstract notions of the world used by managers as they work to make sense of issues, make decisions and control systems for which they are responsible. The frame sensitises the agent to particular elements of the environment, making those elements prominent for the agent. Concepts in the frame will be given salience, and placed in a framework of associations. Agents operating with a frame will be sensitive to the presence of salient concepts, and will seek out concepts that have not been observed if the frame suggests they should be present.

Spoken versus written discourse

Two sources of discourse were used to study the mindsets of OR professionals and manufacturing managers - text for OR professionals and transcripts of interviews for manufacturing managers. Professions are defined loosely as "exclusive occupational groups applying somewhat abstract knowledge to particular cases." (Abbot 1988, p.8) This body of knowledge will be developed

within a community of practice (Brown and Duguid 1991), and will be expressed in internal communication processes that the profession must engage in (Abbott 1988, Déry, Landry and Banville 1993). For an academic community, written text is the mode of communication, and the structures and organization of this community cannot be understood without reference to the written text (Bazerman 1988). Spoken discourse was chosen as the mode of communication for the managerial community for this paper. This reflects the importance of such activities as spokesperson, negotiation and liaising (Mintzberg 1990) for the manager. Managerial talk is the media through which much of the structures of organizations are enacted and maintained (Mangham 1986), and thus talk is the media which will reflect the mindset of managers, and through which the managerial mindset will evolve.

The Samples

Manufacturing Managers (MM Group)

Managers participating in this research were all manufacturing managers based in Australia, employed in a group of companies with international and domestic ownership. Eleven companies were involved, ranging in size from sales of \$20 million to \$700 million. The smallest was a private Australian company, six were publicly listed Australian companies and the remaining four were local subsidiaries of international companies.

A case protocol with interview guide was developed and modified after use in a pilot study in a related operations site. The interviews were semi structured. All questions in the interview guide were put to the interviewee, but considerable variation was permitted as the interviewee responded to the detail within each question. The case database was embodied in the software used for this research. LINGO, which was used to develop the frames, requires that each transcript has a source label and this ensures that all analysis is linked to the case in which it belongs. Data that related to non-frame categories or variables (such as company size and number of raw materials in process) was recorded in tabulation format that enabled ready validation of source. The frame, as produced by LINGO (based on the methodology used by Carley, 1997 and the work of Gephart, 1997) is termed a cognitive map.

Operations Researchers (OR Group)

The OR Group frame was developed based on analysis of a number of papers selected from a major international conference specializing in the area of DES. This conference was the Winter Simulation Conference (WSC), which is held in the US once per year. This conference is a long running conference and attracts contributions from an international group of researchers in the area. The wide range of participants enables it to claim an international perspective, although the US perspective is obviously dominant in both the authors contributing to the conference and in the technology that forms the focus for the conference.

Papers were selected from WSC 1998 to be used in order to develop the OR Group frame. Papers were considered appropriate if they were directed at the exploration of applying DES to manufacturing, in a non-hypothetical manufacturing environment. Papers of this nature could be seen to be acceptable to groups such as manufacturing managers who might be attempting to inform themselves of the capability of the technology. Three criteria were used to determine the acceptability of a paper for the purposes of this research. Firstly the paper needed to be contained in the Manufacturing Applications Stream of the conference. This was a defining criterion for a piece of communication that could be expected to promote DES in the manufacturing environment. Secondly, papers authored exclusively by employees of a software company, and were expositions of the capability of the software were rejected. The paper may well have been a valid statement on what the software is, but it would not be accepted as a valid representation of its manufacturing application. It may also be seen to be unduly biased towards the vendor's product. Thirdly the paper needed to be based on an application of the software in a manufacturing environment. This criterion was used to

reject some papers that were using DES as a vehicle to explore some inventory or scheduling strategy in a hypothetical manufacturing environment. These criteria allowed the majority of DES related papers in the manufacturing streams of the conferences to be used in the analysis. A total of 21 papers were selected from the Manufacturing Applications Stream of WSC98 using the above selection criteria. The text-based content of these papers was then analysed using the same methodology as that for the interview transcripts of the manufacturing managers.

Mapping methodology

Mapping of the construct of a frame is not restricted to any particular representation. Measures of association and prominence of concepts can be represented in matrix form, as a graphic map or as tabulated data of comparisons. If the focus of the representation is on relationships between concepts then a graphic representation is an effective approach. In this representation it is possible to report concept prominence and associations simultaneously and extensively.

Associations between concepts can be represented in at least three ways, causal, taxonomic or collocate. LINGO, the software developed for this research, uses the collocate method to develop associations. Collocation occurs when two concepts are found in a specified sub text, or window of a specified size, in the whole text. Carley (1997) described the process as moving a window of a specified size throughout the full text. If two concepts are seen at any stage in the window then that is counted as a collocate. The process, termed collocate analysis in this research, is based on tagging the co-occurrence of words in the text. The concept of control has been studied using this technique (Barley, Meyer and Gash 1988) and in the context of that study the technique was placed in the field of pragmatics. The notion expressed in the field of pragmatics, that the sense of individual words is dependent on context, also underlies the approach followed in the work reported in this paper, and in the work of Gephardt (1997) and Carley (1997), the works which strongly influenced the approach embedded in the LINGO software. Gephardt (1997) used the collocate technique in a study of sense-making practices during a hazardous incident on a gas-drilling rig. This study used transcripts of the committee of enquiry into the incident. This technique has been adapted and extended in this study and a new software tool (LINGO) has been developed to assist the Content and Collocate Analysis. The analyses undertaken within LINGO are explained in detail in the following section.

LINGO: Content and Collocate Analysis

The first stage of the analysis carried out by LINGO is commonly termed content analysis. A group of key functions have been identified as desirable in software used to conduct content analysis and these have been incorporated in LINGO. Stone (1997) listed the first four of the following group; the fifth function is not commonly identified as part of the content analysis approach, but is required to develop data on association (or collocation) between concepts. It performs the function identified by Carley (1997) and Gephardt (1997). The five functions of LINGO are thus:

- Search for specified text strings.
- Count word and concept frequencies (Content analysis).
- Standardize the text in the source document, the 'Raw Text', into a smaller subset of concepts that are relevant to the research framework. (concepttags)
- Confirm the sense of words through the display of local and document level context through a Key Word in Context (KWIC) module.
- Be able to search for combinations using the text windowing technique (Collocates)

The first four functions are common in much software used to analyse text. The fifth function, collocate analysis, is not normally found in content analysis, but enables a much richer representation of the discourse, which will indicate the context of word use as well as a simple frequency. This allows the mapping to indicate the context of the word rather than just its prominence. This technique

moves a window (of variable size, ten for this paper) through the full text and accumulates all combinations of words (concepttags for this paper) in the window as it progresses through the text. It creates an array, which represents the way in which words are collocated in the discourse. This provides the analyst with one perspective on the way in which different concepts are associated in the discourse. This gives the frame a deeper level of representation than is possible with a simple content analysis approach, which is only based on frequency of occurrence. LINGO represents the collocations between concepts in both numerical and graphical format.

Analysis of text.

Text, either in the form of conference papers or interviews transcripts, was pre-formatted using a small Microsoft Word macro before entry to the LINGO system. This pre-formatting was used to strip non-analysed punctuation and to convert a number of double barrel words, such as 'trade off', into single strings. The text was then converted to a single column of words and periods. This column of text is referred to as rawtext. For interview transcripts, the text spoken by the interviewer was tagged with an 'Author' string to enable the LINGO software to ignore words that were used by the interviewer. All further analysis is carried out in Microsoft Excel, using a worksheet and set of Visual Basic modules referred to as LINGO. The following section describes the modules in LINGO as a new document is introduced to the system. The single column of text, the rawtext is copied to the LINGO rawtext worksheet.

In building a concordance, the rawtext is analysed to produce a list of words found in the text that are not recognized by the existing concordance in LINGO. The researcher then examines this list for words which are significant but which have not been previously encountered by the system. If required, words are selected from this list, tagged with a concepttag and then entered into the system concordance. The concordance is a two-column list. The first column contains the words likely to be encountered in the rawtext, the second column contains the concepttag that will be applied to that word in the LINGO analysis. Content and collocate analysis in LINGO is done at the concepttag level. The researcher selects the concepttags that are used for the analysis. All text analysed for this paper was processed with the same configuration of LINGO.

During rawtext coding once the rawtext has been reviewed for unrecognised words it is then tagged. In this process each word in the rawtext column is tagged with its concepttag as dictated in the Concordance. Words that are not successfully tagged are excluded from the list at this stage. Each word is also tagged with its Author. The tagging process is simple. Words that have a sense of 'strategy' can occur as for example; 'strategic', 'strategically', 'SWOT', or 'tactics'. The program searches for 'strateg*', where '*' has the normal Boolean truncation function. All words that satisfy the criteria listed in the Search column of Table 1 will be tagged with the associated concepttag.

Table 1 LINGO Examples of concepttag Concordance

Concepttag	Search for Raw text
Strategy	Strateg*, swot, tactic* ...
Control	Control*, feedback, feedforward , incentive* ...
People	Friend*, human, humans, operator* , person* ...

Key word in context analysis (KWIC) is carried out once the rawtext Coding is complete using the KWIC module. The KWIC module is a crucial step in achieving validity in the content and collocate analysis. The rawtext associated with each occurrence of the concepttag is reported in context. This tabulated data is used to confirm that the search process has located words with the correct sense. If for example a concepttag was based on the occurrence of the rawtext term 'bank', then it is possible to find the word 'bank' used in the sense of a place where financial transactions occur, as the edge of a river, or as a flight manoeuvre in an aircraft. LINGO does not include logic to distinguish sense in the occurrence of a word. This analysis is carried out by the user in the KWIC module. If occurrences of the concepttag are inconsistent with the intended sense of the search then the search rules can be

modified. If this is not feasible then the target word may be excluded from the concordance. Next content analysis is carried out, during which LINGO typically tagged about 30% of the words of a piece of rawtext, and then computed the frequency of occurrence of each concepttag in the full document.

For collocate analysis LINGO calculates and records the number of collocates for every pair of concepttags in the concepttag listing. The collocate is the most important entity for the analysis used in this research. Gephart (1997) codes the significance of the collocate using a Z-score, which is a function embedded in the software used in his study (Gephart 1997, p. 594). This function is based on the standard statistical test used with proportions developed from samples drawn from a normal distribution (See Levine, Berenson and Stephan 1999, p. 401). LINGO counts the number of collocates found in the text for all pairs of concepttags. The Z-score is a measure of the probability of finding that number of collocates by chance, given the frequency of occurrence of the separate concepttags in the text. A high Z-score indicates that the collocates, which were found, were not likely to have occurred by chance. Consequently the associations reflect some purposeful combination by the author of the text. There is some debate on the validity of assumptions of normality in this form of text analysis, but the Z-score is used to rank the collocates, and it is the ranking that is used in all subsequent analyses. This is the strategy followed by Gephart (1997) and is likely to be insensitive to reasonable levels of deviation from normality in the text data.

Collocates are included in the analysis if they satisfied the criteria used by Gephart (1997). These criteria required the collocate to have an expected, or observed, frequency of at least three and a Z-score of at least seven. The requirement that at least three collocates are expected, or observed, eliminates collocates with high Z-scores which arose from single (or potentially two) occurrences of low frequency pairs. A Z-score of at least seven indicates that the collocate could not have occurred by chance in that population. Collocates are referenced in three ways in this paper; strong collocates have Z scores which rank them in the 90th or higher percentile, secondary collocates have Z scores which rank them between the 70th and 90th percentile, and significant collocates have Z scores greater than seven and a frequency of occurrence of three or more.

Results

Control

The *control* concepttag coded text such as 'control, feedback, and regulate'. It was intended to code text that had some control sense. Diagrammatic representations of the OR and MM frames can be produced through collocate mappings which show all relevant associations. These mappings are presented in Figures 1 and 2.

OR group

Control is ranked at the 49th percentile based on content analysis and it has a 54th percentile ranking based on the median ranking of the significant collocates. The mapping as can be seen in Figure 1 indicates a strong collocate with *techmat* and secondary collocates with *strategy*, *design*, *model*, *abstract*, *rules*, *problem* and *choice*. This is a network for the *control* concepttag that is consistent with a context of designing and building models that are associated with the technology of material conversion (*techmat*). The network does not contain collocates with *people*, *finance* or *measure*. These *models* require detailed consideration of modelling *rules*, process *choices* and would be evaluated in an *abstract* or theoretical context. *Strategy* is not collocated with other concepttags in the network. The control strategies referred to more likely to be control strategies for the *model* than for *techmat*.

MM group

Control is ranked at the 57th percentile based on content analysis and it has a 52nd percentile ranking based on the median ranking of the significant collocates. The mapping as shown in Figure 2 indicates a single strong collocate with *act*, and secondary collocates with *techmat*, *people*, *measure*, *prescribe*, *causal*, *plan*, and *problem*. The context for *control* is action orientated, directed at *people* and *techmat* and is related to the need to find *causes*, take *measures* and make *plans* and *prescriptions*. This set of associations is consistent with the cybernetic feedback model of control as discussed previously. It is a well-integrated network with no concepttags isolated with single collocates. While the context includes *people* and *techmat* it does not include *strategy*, *market* or *organize*. This indicates a sense for *control* that is focused at the internal, operational, environment of the role. The exclusion of *finance* also suggests that *control* is contextualized at an operational, non-abstract, level.

Figure 1 OR group concepts collocated with Control

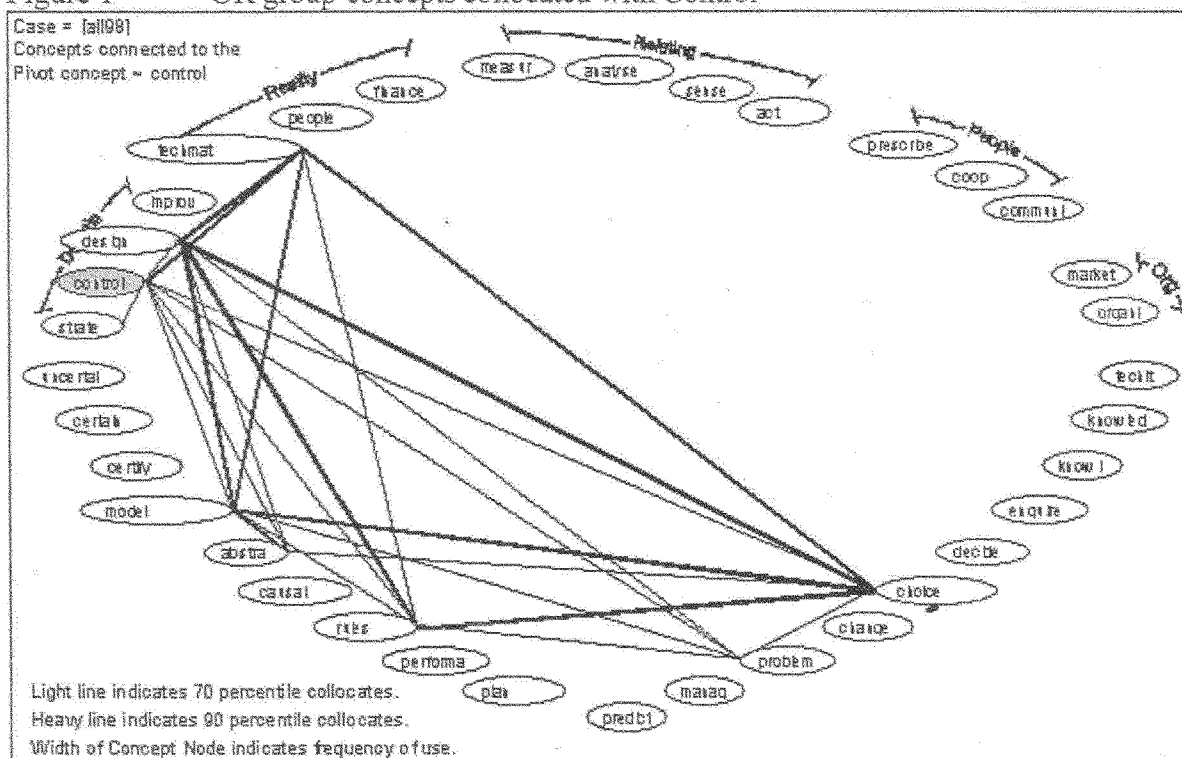
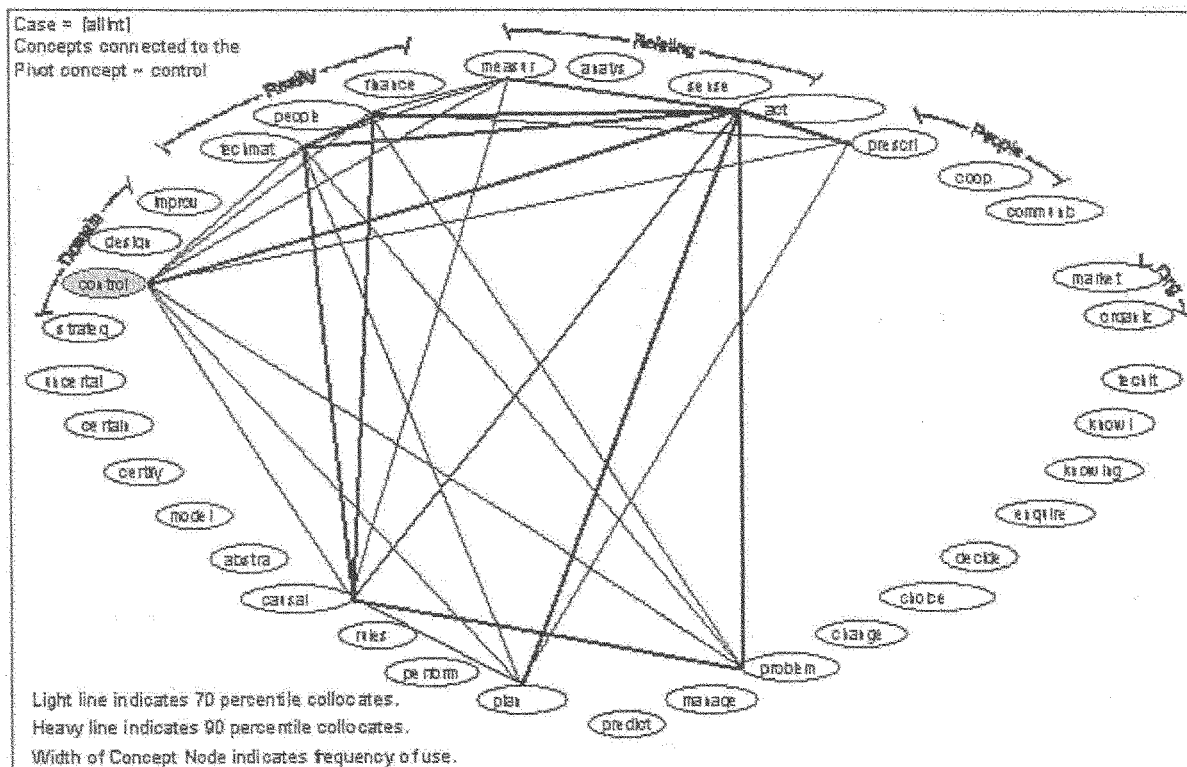


Figure 2 MM group concepts collocated with Control



Comparison of the Groups

There are two aspects of *control* that are different for each of these two groups. First, the operations researchers apply the *control* concept in the context of a goal of designing *control* into *models* of *techmat* based systems. This has led to a need to identify *rules* and *choices* in the system, to enable *models* to be *designed*. The managers use *control* as part of a cybernetic process dominated by the need to *act*. The elements of cybernetic control are present, i.e. *Measure*, *causal*, *plans*, *problem* and *act*, but *act* is strongly associated with every mapped concept. Neither *rules* nor *choices* are included in this mapping of the managers' frame as can be seen in Figure 2, which suggests a tacit dimension to the concept. Second, the operations researchers do not include *people* in the control mapping as shown in Figure 1. Their system is adequately defined by *techmat*, and models can be constructed simply by reference to the technological system. The managers give *people* equal prominence to *techmat* in the *control* mapping. The inclusion of *prescribe* in the mapping is consistent with the inclusion of *people*.

The only concepts held in common between the two mappings are *techmat* and *problem*. The context for these two concepts is however dictated by the bias to modelling evident in the mapping of the operations researcher, and the bias to action evident in the mapping for the manager. The concepts are held in common, but they have different meanings for each group. The operations researchers use the concept of *problem* in a context dominated by the need to construct models, it is not associated with *techmat*. The managers associate *problem* with all concepts in this mapping except *prescribe*, *measure* and *plan*.

Conclusion

The analysis of the discourse from the two groups clearly show that the Manufacturing Managers' conceptualisation of the concept of control is dominated by the cybernetic model, in an action orientated, technological and social system. If operations researchers are to effectively understand the needs of manufacturing managers, in the area of control, they will need to understand how to apply

the control concept in the manager's system. Currently when operations researchers use the control concept it is in a very different way to that used by managers. Managers contextualize control in a system where technology and people are of equal and important prominence, and managers associate control with action. The operations researchers conceptualize control as the problem of constructing models of technology.

If operations researchers are to increase the concordance between their mindset, and the mindset of the manufacturing managers then they will need change their models, and the role of the models in the interaction between the operations researcher and the manager. Manufacturing contains people and technology, not just technology. The model needs to reflect this, but modelers should be cautious in their inclusion of people in the model. Models should be designed to fulfil a role within a flexible overall learning process that incorporates the role of people. The consequences of attempting this transition, assuming that the modeler has a bounded rationality, will be simpler models in a broader context. An associated outcome will be a less prominent place for models in the techniques used by the group. This is part of the approach followed by the profession when it does promote the use of OR techniques in the wider manufacturing management process (for example Akkermans and Bertrand (1997)). The emphasis is shifted to a process of consultation and communication, rather than modelling. This places the model within a broader, soft OR process, where the informal, tacit and messy attributes of the situation will be allowed to co-exist with that portion of the manager's reference system which is able to be formally modelled.

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ABOUT ANZAM

(AUSTRALIAN AND NEW ZEALAND ACADEMY OF MANAGEMENT)

ANZAM is the peak professional body for management educators and researchers, with about 300 individual members from Australia, New Zealand and other Asian/Pacific countries. It now has over 30 institutional members, representing almost every Australian university and increasingly is playing a leading role in presenting a common view to government and industry bodies on strategic issues relevant to management education. The basic objective of the Academy is to advance scholarship in management research and education and related disciplines by:

- (a) furthering the development of management education and associated disciplines in universities and colleges in Australia and New Zealand
- (b) encouraging scholarship and research
- (c) holding conferences and publishing material as a means for disseminating ideas and information and promoting their discussion
- (d) promoting closer relations between management educators, researchers and practising managers or others who may be interested in the advancement of these objects.

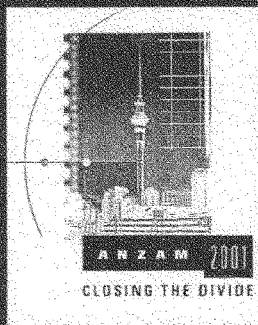
Over the years, ANZAM has been involved in various initiatives for the purpose of heightening the status of management research and education in Australia. In 1997, ANZAM co-funded the ARC (Australian Research Council) Report on *Management Research in Australia*. ANZAM was given an ARC Special Research Initiatives grant of \$150,000 in launching a pilot program in management research networking and collaboration in 1998-2001. ANZAM has also helped to raise the recognition of management as an important research discipline in Australia through establishing closer links with the ARC. These efforts culminated in the appointment of Professor Geoff Soutar, one of our ANZAM Executive, to the ARC Social, Behavioural and Economic Sciences Expert Advisory Committee. ANZAM has also grown locally and internationally - ANZAM is a member of the International Federation of Scholarly Associations of Management (IFSAM) and a joint ANZAM/IFSAM Conference will be held at the Gold Coast on 10-13 July 2002. Strategic alliances have also been established with the US Academy of Management, the Asia Academy of Management and the British Academy of Management.

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- Windows 3.1 or those who have switched off the 'autorun' feature in Windows 95/NT

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