



PERGAMON

Accounting, Organizations and Society 24 (1998) 1–30

---

Accounting,  
Organizations  
and Society

---

## The use of organic models of control in JIT firms: generalising Woodward's findings to modern manufacturing practices

Suresh S. Kalagnanam, R. Murray Lindsay \*

*University of Saskatchewan*

---

### Abstract

Prior research indicates that technology plays an important role in the determination of management control systems. A fully developed JIT system represents a radical departure from the traditional approach to organising and managing mass production. In probing the management control implications of JIT, this study extends some well-established concepts from organisation theory to the modern manufacturing practices literature to develop a framework which suggests that mass production firms adopting JIT (a new technology) must abandon a mechanistic management control system and adopt an organic model of control. Findings from three case studies describing the control structures used in JIT firms are also presented as part of the theoretical and hypothesis development. In addition, survey results are reported which are highly consistent with the framework, indicating that Woodward's findings (Woodward J. (1980) *Industrial organization: theory and practice* (2nd ed.). Oxford: Oxford University Press.) generalise (are robust) to a new technology. Finally, a preliminary examination into whether improvements in certain key areas are higher for those JIT firms utilising an organic model of management was performed and found to be consistent with expectations. © 1998 Elsevier Science Ltd. All rights reserved.

---

The current business environment is characterised by intense global competition, with firms competing increasingly not only on the basis of price but also on quality, product flexibility, and response time. These competitive pressures have increasingly led organisations to focus on the manufacturing function as being of strategic importance, providing an important source of competitive advantage. For many firms, this has led to the adoption of Just-in-Time (JIT) production systems.

Although several studies have examined the impact of JIT on cost accounting and performance measurement systems (e.g. Kaplan, 1986; Neuman & Jaouen, 1986; Foster & Horngren, 1987;

McNair et al., 1989; Bhimani & Bromwich, 1991; Swenson & Cassidy, 1993; Mackey & Thomas, 1995), little empirical attention has been placed on the underlying form of management control that is most appropriate. The focus of this study is to examine the relationship between management control structure and the adoption of JIT manufacturing technology. From an accounting perspective, this area of inquiry is important because of the interdependence existing between the design of management accounting and control systems and organisational structure (Otley, 1987).

Prior research indicates that technology plays an important role in the determination of management control systems (Steers, 1988). A fully developed JIT system represents a radical departure from the traditional approach to organising

---

\* Corresponding author.

and managing mass production. With the continuous improvement philosophy driving the management of the organisation, constant change throughout the firm is sought rather than inhibited. Moreover, the increased interdependencies brought about by carrying reduced inventory levels along with the focus on flexibility requires increased levels of coordination and communication. These considerations would seem to suggest that a significant change from the bureaucratic management control structure advocated for the traditional mass production firm is necessary (see McNair, 1995 pp. E4–10).

In extending some well-established concepts from organizational theory to the modern production methods literature (JIT, TQM), the first portion of the paper makes a theoretical contribution by developing a framework which suggests that mass production firms adopting JIT technology must abandon a mechanistic structure and adopt an organic model of control. The results of three cases studies examining JIT firms are presented as part of the theoretical and hypothesis development. Following this, the empirical portion of the paper examines whether JIT mass production companies, relative to traditional mass production firms, are adapting their structural arrangements in moving towards an organic model of control. In addition, a preliminary examination is conducted into whether improvement rates in key areas for JIT firms are higher for those utilising an organic model of management.

## **1. Technology and management control system design: theory development**

### *1.1. Preliminary concepts and results*

Management control refers to the formalised relationships, procedures and systems that are used to influence the probability that people will behave in ways that will lead to the attainment of organisational objectives (Flamholtz, 1983, pp. 154; Merchant, 1985). Organisational structure is a critical component of a firm's management control system because patterns of activity, commu-

nication, behaviour and commitment are created by it (Bell & Burnham, 1989). The purpose of this section is to compare and contrast the management models of control for JIT and traditional mass production firms using Burns and Stalker's (1961) popular bipolar continuum of standardisation: mechanistic and organic. However, before proceeding with the comparison, a brief review of the key constructs is useful.

#### *1.1.1. Mechanistic and organic models of control*

Burns and Stalker (1961) posited two pure forms of management control—mechanistic and organic—that were considered to be located at opposite ends of a continuum. While most firms will be found at different points between these polarities, they have nonetheless proved to be extremely valuable constructs in examining management control systems. Mechanistic systems are characterised by centralisation of control and authority and a high degree of task specialisation and standardisation. Communication is largely formalised, utilising vertical communication and reporting paths. Decisions, rewards and punishments flow down, while information, often in the form of exceptions, flows back up. The role of line management is simply to operate the established facilities, systems, and personnel according to senior management's rules, regulations and predetermined targets. In short, mechanistic organisations are highly bureaucratic and rigid.

Conversely, organic systems are much "looser" structures. They generally exhibit greater decentralisation of control and authority, a participative style of management, and more reliance on group processes (team work) to achieve integration and adaptation in managing functional interdependencies. In particular, according to French and Bell (1984, pp. 260–261), organic structures possess two important features. First, they are adaptive and flexible. A continuous reassessment of tasks and assignments occurs in order to deal with new problems and/or opportunities facing the organisation. Second, organic structures utilise a network pattern of authority and control, whereby the formalised, vertical communication patterns underlying the mechanistic organisational structure are largely abandoned to one that

permits and encourages widespread communication throughout the firm. Communication flows are both horizontal and diagonal, as well as vertical, being dependent on where the requisite knowledge resides. Additionally, communication is now much more in the nature of consultation, information-sharing and advice-giving.

### 1.1.2. Technology

Technology has been found to play an important role in the determination of organisational structure (Mintzberg, 1979; Fry, 1982; Steers, 1988). Technology is defined as the knowledge, tools, techniques, and actions used to convert organisational inputs into outputs. It includes machinery, employee education and skills, and the work procedures used in the transformation process (Daft, 1986, p. 133).

Woodward's (1980) seminal work is of particular interest to this study. She defined three different types of technology: (i) unit or small batch production which tend to be customer order operations meeting the specific needs of customers, (ii) large batch or mass production of standardised products, and (iii) continuous process production involving the highly mechanised manufacture of a single bulk product, e.g. chemicals. She found that organisational success was contingent on having the right combination of structure and technology. The best small batch and continuous process plants had more organic structures, while the superior mass production plants were more mechanistically structured. Woodward's findings have been supported by other researchers (Zwerman, 1970; Keller et al., 1974).<sup>1</sup>

<sup>1</sup> Some readers might question the appropriateness of examining traditional production systems and concepts which were developed so many years ago when more and more firms are adopting various aspects of new manufacturing methods and management practices. We readily accept that such changes are taking place; however, while the manufacturing practices (technology) may not be invariant over time, the insights from using a "good" theory should be robust over time (see Lindsay, 1993, pp. 235–236). More specifically, our aim is to examine the key theoretical elements underlying the structural prescriptions advocated for the different technologies and apply them in the context of a new technology, JIT, to develop a theoretical position which is based, at least in part, on the use of a well-established theoretical framework.

The rationale underlying the results for unit and process firms is important to understand. The non-standardized output of unit production firms requires that they possess flexible technical systems. As Starbuck and Dutton (1973, p. 25) explain:

... the generally small lot sizes make elaborate setups uneconomical, and preference is given to equipment that sets up quickly and cheaply... They install simple, basic machines that are easily adaptable to many uses, because specialized machines are liable to be made obsolete by changing customers' orders. However, this adaptability depends on two things: buffer inventories between machines to accommodate varying machine speeds, and highly skilled machine operators, who can understand the requirements of different products and understand basic machines to different purposes.

In unit production firms the work is craft-like in nature, with operators being responsible for determining the method and sequence of operations, as well as the quality of the finished product. Coordination or integration within the production function is handled by mutual adjustment among operators themselves or through direct supervision by first-line managers (Mintzberg, 1979). Close interaction among marketing, development and production is required until the order is complete, and this is achieved through interpersonal contact on a day-to-day basis (Woodward, 1980). In summary, the *product flexibility* of unit production systems requires an organic structure.

Process production, on the other hand, is characterised by the automation of the process (Mintzberg, 1979), resulting in the various operations being tightly *coupled* to one another. The main objective is to maximise throughput in order to defray the huge capital costs involved (Woodward, 1980 p. 162). Although the production process is highly standardised, the work of the core operators is not. The operating personnel are highly skilled indirect workers whose main task is maintaining the machines in order to ensure the smooth running of the equipment (Mintzberg, 1979). Their

goal is to keep the plant from shutting down. As Hunt (1970) explains, process firms are problem solvers who are concerned with exceptions. Decisions must be taken quickly to solve any problem because the tight coupling of the processes means a disruption in one operation impacts the entire system. The need to deal quickly with exceptions requires close interaction among people who possess the required knowledge, which is best facilitated through a network structure of coordination and communication.

### *1.2. Management control in traditional mass production firms*

Traditional mass production firms are “performance” organisations (Hunt, 1970), which follow a strategy based on cost and price leadership (Nemetz & Fry, 1988). They are characterised by their use of semi-automatic or special purpose machines which have relatively complex and lengthy set-up time requirements (Mintzberg, 1979). The high level of set-up costs has led to an emphasis on pursuing economies of scale and process efficiency through high product and process standardisation and the use of long production runs (Hunt, 1970; Mintzberg, 1979).

To be successful (i.e. efficient), mass production firms have to run smoothly without interruption and this is only possible if variability (uncertainty) is either reduced or its impact dampened. Consequently, the mass production organisation has developed an obsession with control through *standardising* not only the technical process, but also human behaviour in order to increase predictability (Mintzberg, 1979; Nemetz & Fry, 1988). Stabilizing forces such as rules and regulations, highly specialised jobs or tasks aimed at routinising the work, and centralisation of decision making have all been introduced for the purpose of reducing variability. In addition, carrying large amounts of inventory has become a central tactic for isolating the plant and its departments from such disruptions as increases in orders, late supplier shipments, machine breakdowns, or defective parts, thereby reducing the need for timely coordination both within the manufacturing function as well as across functions.

In summary, a mechanistic management system or what Mintzberg (1979) calls a “machine bureaucracy” has evolved to control and coordinate traditional mass production firms. As long as the organisation can shield its operating core from high levels of variability, the mechanistic structure is conducive to achieving high levels of performance following a low cost strategy (Burns & Stalker, 1961; Hunt, 1970; Nemetz & Fry, 1988). However, the price paid for this bureaucracy is the difficulty in responding or adapting to changes in a timely manner—underscoring why firms focus on controlling (stabilising) their environments (Mintzberg, 1979, p. 326).

### *1.3. Management control in a JIT environment*

JIT is not an inventory system, nor is it just another production technique; it is best described as a philosophy of management which is dedicated towards the *continuous* elimination of waste of every form in every area of the organisation (Schonberger, 1982; Hall, 1983; Hay, 1988; McNair et al., 1989). Moreover, consistent with Senge’s (1990) logic of system dynamics, JIT is based on a holistic conception of the organisation where overall firm optimisation requires managing interdependent component parts in consideration of *total system performance* rather than simply attempting to maximise individual components via local efficiency measures (Schonberger, 1982). Finally, customer concerns are given the highest priority under JIT (Heiko, 1991).<sup>2</sup>

Following Hay’s (1988) framework, JIT has three main pillars or components. The first is production flow and this refers to the way the manufacturing process proceeds from one operation to the next. The most important element of production flow is the demand-pull system which is based on the concept of matching production with need. Second, JIT is based on “doing things right the very first time” in every activity of the organisation. In particular, achieving quality at the source, rather than through inspection, is the goal. Finally,

<sup>2</sup> The conceptualization of JIT adopted in this paper shares many common elements with the more general perspective of Total Quality Management (TQM).

employee involvement through respect for workers is the third pillar of JIT. The active involvement of those individuals best acquainted with the actual work processes and day-to-day problems is a fundamental requirement in any continuous improvement initiative (Hall, 1983; Hay, 1988).

The technology underlying JIT is radically different from traditional mass production in that JIT production attempts to synthesise the benefits of unit, mass, and continuous process technologies through the focus on achieving flexibility, efficiency, and throughput. Historically, companies pursuing these goals have adopted organic structures in order to facilitate the increased integration and decentralisation of decision making that is required (see Nemetz & Fry, 1988). JIT firms will be no different for at least three reasons.

#### 1.3.1. Degree of coupling

Under JIT, the degree of coupling among adjacent processes within the manufacturing system increases (Duimering & Safayeni, 1991; Klein, 1991). As Duimering and Safayeni (1991) explain, a key characteristic of JIT, unlike the traditional mass production firm, is the idea of carrying “minimal” inventory buffers due to their negative consequences (see Schonberger, 1982; Hall, 1983). Inventory decouples manufacturing processes from one another by preventing the variability of one process from having an impact on another, thereby allowing each process to function in relative isolation from each other. Significant inventory reductions (below “critical levels”) increase the degree of coupling between linked processes because of the decreased time it takes for the variability in one process to impact upon another. Below a certain level, such things as machine breakdowns, poor quality input parts, and absent workers will begin to rapidly disrupt the manufacturing system. The critical level will be different from firm to firm depending upon a company's progress in reducing the sources of variability (e.g. stemming from suppliers, manufacturing processes, workers and other organisational functions) and their success in adopting variability handling mechanisms in place of inventory.

Duimering and Safayeni (1991) state that a good deal of the variability experienced within the

production system is created by the actions of other functions within the organisation. For example, variability may be increased by a purchasing decision to change the grade of steel in order to reduce cost or by marketing decisions which lead to frequent changes in production schedule. Thus carrying reduced inventory levels compounds the effects of variability (exceptions) introduced by other functional units.

In conclusion, JIT results in tightly coupled organisational processes (and functions). Organisationally, increased coupling in the system requires a highly adaptive process of coordination and control, i.e. mutual adjustment, in order to deal with any changes and/or problems in a timely and effective manner (Thompson, 1967; Galbraith, 1973; McNair, 1990; Duimering & Safayeni, 1991; Klein, 1991). This is in contrast to the traditional system where coordination concerns—both within manufacturing and across functional units—are managed through standardised procedures and processes. By eliminating the buffers that previously allowed departments to function in isolation of one another, JIT forces the interrelated areas of the organisation to adopt effective communication and coordination procedures to cope with variability (unexpected occurrences).

#### 1.3.2. Flexibility

The implications of the greater interdependence of operations and functions is further compounded by the increased flexibility of JIT systems. Flexibility reflects the variety and/or mix of products a production system can economically produce in response to market changes and customer needs (Abernethy & Lillis, 1995). JIT systems are highly flexible with respect to production mix (Schonberger, 1982; Hay, 1988).<sup>3</sup> Mix flexibility has been achieved largely by obtaining drastic reductions in set-up times, thereby allowing batch

<sup>3</sup> Unit production and JIT firms do not always focus on the same notion of flexibility. In the main, the former emphasizes product flexibility, while JIT firms, at least initially, concentrate on production *mix* flexibility. However, some JIT firms increase the automation of their facilities (e.g. computer integrated manufacturing), and this allows them to increase the variety of products offered in order to respond to specific customer's requirements.

sizes to be decreased significantly while still remaining cost competitive (Sepehri, 1986). Other flexibility enhancing characteristics of JIT systems are plant simplification (towards cellular manufacturing), improvements in line balancing, and the demand-pull orientation (Schonberger, 1982). Strategically, JIT firms are therefore able to be more responsive to customer demands while still being able to compete on the basis of cost (efficiency), superior product quality, and on-time delivery (Schonberger, 1982; Sepehri, 1986).

Running a flexible production system requires increased integration and coordination within the production line, across functions and with the firm's suppliers and customers, and this cannot be accomplished using standardised behaviours, formalised controls and hierarchical arrangements that are characteristic of traditional mass production firms. Meeting customers' changing requirements dependably (i.e. on-time) using reduced inventory levels requires that information and communications flow flexibly and informally, wherever and whenever they must, in order to provide for timely coordination and control of operations. For example, a change in a customer's order (model and/or quantity) requires fast and effective communication between marketing, production, and purchasing to coordinate and control the change. As Abernethy and Lillis (1995 p. 243) explain: "successful implementation of manufacturing flexibility requires cross-functional responsiveness to specific customer-initiated demands. Effective performance is the result of the combined efforts of those functional units required to satisfy customer demands." In this regard, the authors report that "flatter" organisational structures are critical to achieving effective integration. This allows decisions to be made faster and based on information that is more accurate (one operational specialist talking to another).<sup>4</sup> Additionally, markets are changing so quickly that operational

specialists must make many decisions themselves. There is no longer time for management to absorb and assimilate information obtained from people located in various operational units if the organisation is to remain flexible. Indeed, JIT systems accentuate the speed at which decisions must be made. Decision making must therefore become increasingly decentralised, occurring at the point in the organisation where the knowledge and expertise lies. To take another example, if a company produces two or more models, attaining minimal inventories and on-time delivery requires producing each product at the frequency required through mixed model scheduling. Line balancing becomes an issue when different models possess varied processing times in individual operations. To cope with this problem, foremen in Japanese firms have been given considerable line-balancing responsibility and, as a consequence, the authority to re-assign workers to achieve more balanced production (Schonberger, 1982, p. 139).

In summary, like flexible manufacturing systems in general, running JIT requires an organic structure to effectively coordinate and control activities (see Nemetz & Fry, 1988; Parthasarthy & Sethi, 1992, 1993; Abernethy & Lillis, 1995).

### 1.3.3. *Continuous improvement*

The third reason supporting the adoption of an organic form of control is JIT's continuous improvement philosophy which emphasises innovation through the continual elimination of waste in every form. Inventory buffer stocks are considered to be the epitome of waste, serving only to mask the problems underlying the causes of variability. Improvement efforts are centred around the notion of continually reducing production lot sizes through simplifying the production process, eliminating bottlenecks (or more properly speaking, creating newer, less binding ones), making improvements in set-up times, quality, and increasing preventative maintenance and supplier reliability (both in terms of quality and timeliness). A new cycle of improvement begins as further deliberate reductions in buffer stocks take place to provide workers with the motivation to ferret out new sources of variability. In this way, the JIT philosophy, and its aversion

<sup>4</sup> With respect to the issue of flatness of organisational structure, Peter Drucker's (1988 p. 46) comments are insightful. He writes "that whole layers of [middle] management neither make decisions or lead. Instead, their main, if not their only, function is to serve as 'relays'—human boosters for the faint, unfocused signals that pass for communications in the traditional ... organisation."

to carrying inventories, provides an internal mechanism which drives cycle upon cycle of improvement (Schonberger, 1982).

The organic form of management control fosters innovation (Burns & Stalker, 1961; Linsu, 1980; Steers, 1988)—and this is a claim which is not a matter of dispute (Daft, 1982, p. 144). The following passage by Daft (1982, p. 135) explains some of the reasons why:

The success of the organic organization is attributed to its ability to introduce new ideas into the organization... Lateral communications are a mechanism for achieving cross-fertilization of ideas from different perspectives. Less emphasis on control and authority levels enables lower participants to take initiatives to propose changes... The lesson from the organic model is clear: decentralization, participation, ... minimal control, lateral communication and other organic characteristics are conducive to innovation.

Innovation requires granting more responsibility and control to the workers or doers: those who know the work best and confront (or are forced to confront through deliberate withdrawals of buffers) the problems and/or opportunities for making improvements. As Schonberger (1986, p. 18) indicates, employee involvement does not consist of mere participation and the occasional consultation of workers; instead, it requires “massive involvement in the minute to minute problems that operators face on the shop floor.”

In conclusion, the organic model—which focuses on breaking down both vertical and horizontal *barriers*—appears much more conducive towards achieving innovation.<sup>5</sup>

#### 1.4. Comparison of production systems

The above discussion suggests that JIT firms share commonalities with unit, mass and process production firms in varying and differing respects. First, both unit production and JIT firms focus on flexibility. Unit production firms focus on product flexibility, and this is achieved through the use of machines that set up quickly and are adaptable to

many uses. Conversely, JIT firms emphasize production mix flexibility, and this is achieved by drastically reducing set-up times, using simpler plant configurations, and balancing production lines through mixed-model production. Second, both JIT firms and traditional mass production firms are interested in increasing the efficiency of their processes through a focus on standardisation. However, unlike the traditional counterpart, JIT production systems place a priority on being flexible enough to absorb internal and external variation without relying on the use of high inventory levels (Schonberger, 1982, p.134). Third, similar to process production systems, operations are tightly coupled in JIT firms, due to reduced buffer inventory levels, the sequential (cellular) layout of the production process (as opposed to the use of complex spaghetti paths commonly found in traditional mass production firms), and the use of the demand-pull system. Finally, and unlike the other systems, continuous improvement is an integral part of the JIT philosophy. Table 1 presents a comparison of the four production systems.

## 2. Case studies

There is a paucity of material in the academic literature which describes the control structures used in JIT firms along with an explanation of why they use them and how they work (i.e. in terms of organisational processes). As a consequence, three case studies were conducted for the purposes of determining the soundness of the

<sup>5</sup> Following Klein (1991), it should be noted that the JIT view on employee involvement is quite different from the viewpoint put forward in the socio-technical literature espousing individual and group autonomy over the pace of work and work methods. Under JIT, employee contributions relate to participating in making changes to task *design* rather than to task *execution*. There is no flexibility with respect to task execution because JIT production systems can only operate with reduced inventory buffers by reducing unexpected consequences (variability), and this is achieved by utilising a high degree of standardisation throughout the manufacturing process (a basic feature of quality organisations in general). Other avenues of involvement include control over production flow and management of quality and resources (Klein, 1989).

Table 1  
Comparison of production systems

	Unit production	Traditional mass production	Process production	Just-in-Time production
Dominant theme(s)	Product flexibility	Efficiency	Throughput	Production mix flexibility Efficiency Throughput
Characteristics:				
Product flexibility	High	Low	Low	Low to medium (unless automated)
Production mix flexibility	Low to high	Low	Low	Medium to high
Standardisation	Low to medium	High	High	High
Degree of coupling	Low to medium	Low	High	High
Continuous Improvement	Low to medium	Low to medium	Low to medium	Medium to high

above theoretical framework, to add to the theory underlying the structuring and control of JIT firms, and to provide a firmer basis for constructing the study's hypothesis. Each case study was comprised of a four day site visit by the researchers.<sup>6</sup>

## 2.1. Plant 1

### 2.1.1. Background

Plant 1 is a branch plant of a Canadian subsidiary of a large American corporation. The plant manufactures over 1500 different parts, consisting of bearings, sleeves, axles, stub shafts, journals and ball yokes for Ford and General Motors. While the main activities are machining and assembly operations, the plant is also involved in forging. Its production is sold in both North America and Europe. The plant employs 225 people and has sales of \$34 million. JIT has been pursued for approximately six years.

### 2.1.2. Continuous improvement

Continuous improvement has become a buzz word in the automotive industry and this is one area that both corporate management and the plant's customers stress. In this plant, continuous improvement is emphasized every day because, as the quality manager put it, "if you stay where you are, you are going backwards." Consequently, each

year's improvement targets become increasingly rigorous. In order to overcome the "plateau effect" that can occur upon reaching intermediary objectives, the plant's long run objectives are communicated in the form of ideals: zero inventories, zero scrap, zero setup time, etc.

Many of the ideas for continuous improvement are presented and discussed at four different kinds of meetings that are held in the plant: daily, safety, project team, and, in particular, JIT improvement meetings. Several JIT groups have been formed within the plant, one for each production line. Typically, each group consists of the foreman, the setup man and process engineer in charge of the line, and two or three operators; however, the circumstances of each project determine the specific group members and the timing of their participation. The group selects the chairperson (who cannot be a foreman) to direct the meeting. They normally meet once a month, although they can meet more often if necessary. Through the use of these meetings, management is consciously attempting to get factory workers to accept ownership of their problems and the solutions proposed to counter them.

The meetings are typically focused around solving one problem at a time. These problems are either suggested by group members or are reflected in the organization's measurements, e.g. scrap. Once a specific problem is identified to be pursued, the group attempts to trace the problem to its source. Often this requires data from a variety of sources—data which must be specifically tracked.

<sup>6</sup> Portions of the first two case studies presented are excerpts from a much wider discussion found in Lindsay and Kalagnanam (1993).



For example, in tracing the major cause of scrap on the journal line, the group members proceeded in the following manner (as reported in the minutes of the meeting).

We decided to start at the trunnion grinders as our first objective at reducing scrap. As we investigated the problem we found that over a period of 1 year, 4000 pieces were scrapped out at the grinders. We have 10 grinders, so when you break it down daily it is less than 2 pieces a day per grinder. Then we looked at the Kingsbury drill scrap. It was 2600 pieces for the year and we only have 2 machines. . . Less than half our production goes through this operation, so we are double the percentage scrap off the Kingsbury drill. We will now work on reducing scrap at the Kingsbury.

Following the identification of the troublesome operation, attention would then be placed on determining the specific causes of the problem, perhaps through running “experiments.” Once determined, the group decides on alternative courses of action. Determining the solution might require further tests and trial runs.

The plant operates in an environment where mistakes in implementing improvement ideas are not only tolerated, they are viewed as a positive outcome providing for organizational learning. To cite the plant manager:

There’s nothing wrong in making mistakes. Because if you want to change, you have to try, and in trying, one will make mistakes. Yes, we will do things in small steps so that the mistakes we make are not severe and affect our customers badly. . . Unless you try and make mistakes you don’t learn. If a thing doesn’t work, you learn more from that decision because you can try to get at the root cause of the mistake.

The plant manager argues that this attitude must prevail (to the extent possible) even when you know a person’s idea is poor. Such mistakes must be tolerated in order to encourage people’s active involvement and participation at continuous improvement.

Even if we know that it’s a bum idea we’ve got to let them do it. They will realize the mistake themselves. The next time he will evaluate his idea more carefully. If you nip [their idea] in the bud, they’ll never come back with another idea. If you do not encourage them, then it is [hypocritical] if you say that people are your most important asset. We don’t want his muscle, we want his brains too.

### 2.1.3. *Management style*

A conscious effort has been made by the current plant manager to push decision making, where possible, down to the lowest level possible in the organisation and to encourage participation. As one foreman explains:

[Y]ears ago it was based on position [hierarchy]. Now, although the person with position has the final say, it is done with everybody’s input. If there is any change in the situation, it then goes back again to the people that will be affected to get their input, and goes back upwards. . .

The plant manager focuses on strategic planning and liaises with corporate and parent company personnel. Most day to day operating decisions have been delegated to the management team and foremen; however, the plant manager does exert authority with respect to large capital expenditures. He believes in giving considerable freedom to his five member management team comprised of the production manager, plant accountant, production control manager, quality manager, and facilities manager. As he sees it, his role is to provide the plant with its direction and vision, and guidance towards it. Once the direction is established, it is the management team’s responsibility to implement it and derive specific solutions.

Each of the five managers are fully responsible for what’s underneath them. I don’t stick my nose into what they do. They have to understand where they are going; once they understand, I have to leave them to do their jobs the way they like.

The plant manager has made a conscious effort towards instilling a team spirit within the organisation—centred around serving the customer better—by shedding the functional boundaries which guided people's thinking in the past. The focus is on getting involved with each others' jobs and accepting new responsibilities. This is evident at the management level, where everyone possesses a good understanding of the details of the entire operation and the developments which are occurring in each area. Comments by the facilities manager are illustrative of this orientation.

I think we have a common goal to make this plant better and we all strive to just continually improve. Our attitude is that if something needs to be done, we go and do it without thinking [whether] it's so and so's responsibility or mine. We talk about it though. We don't have the luxury of saying that's not my job... We are all here for one reason, that is to make sure we satisfy the customer. We don't want a customer to be [mad] at us.

Notwithstanding this boundary overlap, department heads do not direct the subordinates of their management colleagues.

The plant manager explained that his organisation is moving from the traditional organisational structure, with its hierarchical approach to control and decision making, to a transitional model, where functional boundaries overlap, people relinquish their ownership of a particular job in the course of becoming more flexible, and decision making and control is increasingly pushed to lower levels. In the end, his vision is to attain a "participative model" of organisational structure and control.

The participative model (in its extreme version) represents a highly integrative organisation which is characterised by the absence of functional boundaries. Under this model, there is no need for symbols of power (e.g. plant manager and departmental heads) because decision making authority and control resides at the shop floor. Members of the organisation are highly flexible and oriented towards pursuing a common goal—serving the

customer. The thinking underlying this model is that the removal of functional boundaries will facilitate a holistic approach to decision making; specifically, making people realise that the outcomes of decisions are not isolated, but impact upon the entire organisation. In other words, there is recognition that maximising local criteria may not necessarily lead to a global optimum.

#### *2.1.4. Decentralisation*

The implementation of the transitional model has resulted in a number of structural changes. According to the plant manager, the speed of decision making increases under JIT. His response has been to reduce the number of administration personnel and to combine responsibilities. The result is improved coordination; moreover, everybody's job is closer together and they begin to appreciate how their decisions affect people located in other functional units. In the long run, the plant manager wants his direct subordinates (members of the management team) to eliminate their jobs by getting the system to run smoothly and to decentralise tasks on the shop floor. His thinking is based on the viewpoint that the most important person in the organisation is the individual "drilling the holes." Everyone else, according to him, is burden. In this connection, it is the corporation's long run target to operate each plant with a maximum of two organisational levels and fewer than two hundred people.

Although decision making is considerably widespread within the plant, the plant manager believes that the involvement of foremen and operators is still lacking. To this end, management is striving to empower production floor people with more responsibility. The long run plan is to implement the "participative model" by treating each production line as a separate business with the foreman becoming its "manager." Foremen will be eventually responsible for their own raw material, work in process, and finished goods inventory levels. This idea is currently being piloted in one production line. The foreman is responsible for his own buying and meeting the cost budget as well as achieving assigned production targets. Although the budgeting seems to be more "top-down" than negotiated, which has led

to some perceptions of unfairness, management's intent is to get foremen to appreciate the financial aspects of their decisions.

Under the new arrangement, both the foreman and the process engineer share the responsibility for ordering tools and other supplies. Previously this was done by a central buyer for the entire plant. Several benefits are expected to be obtained under the new system. Only the foreman and process engineer's signatures are now required to authorise a purchase, whereas five signatures were previously required (the latter three being management personnel). As a consequence, the authorisation process led to unnecessary and often lengthy delays (e.g. a manager might be out of town for a week)—hindering the plant's JIT objective of purchasing in small quantities as and when required. In addition, shop floor personnel have a better knowledge of the quality of tools and parts they purchase as compared to the buyer who is far removed from the production line. Analysis of cost benefit trade-offs is therefore facilitated. Moreover, the foreman can deal directly with the supplier on quality problems, rather than having to go through a third party (i.e. the buyer). Finally, one department is responsible for both on-time delivery and purchasing (and eventually inventory levels), thus facilitating both JIT purchasing and maintaining small inventory levels. Visual stock control becomes possible, thereby reducing problematic and costly administrative control systems and procedures.<sup>7</sup>

#### 2.1.5. *Decision making*

The early morning production meetings provide the key coordinating mechanism for running the plant. The participants in the meeting typically consist of the foremen of the various production lines, the quality supervisor, production manager, production control manager, facilities manager, metallurgist and the plant accountant (the latter does not always attend). Among other things, these meetings discuss such issues as progress appraisal, customer updates, changes in scheduling, troubleshooting, expediting, purchasing of raw materials, critical repairs, the use of premium freight, and updating personnel on external developments.

The production manager plays the critical role of directing the meeting. Much of the discussion centres around questioning each foreman of any impending problems and the corrective action to be implemented or, if the department did not meet the previous day's schedule, the problems experienced, the remedial steps being undertaken, and whether the missed production can be recouped within the time remaining in order to meet the customer's delivery date. Based on such information sharing and updating, the production manager, in consultation with the production control manager (scheduler), makes production schedule changes and may authorise overtime in order to reduce the backlog. He also provides advice to individuals. In addition, other items such as the priorities list for the month, plant and machine maintenance, scheduling problems and options, customer feedback and concerns are discussed, with the relevant person updating or informing the rest of the group.

Although the production manager makes many of the decisions at these meetings, and to some extent plays an authoritarian role, they are based on input received from most people in attendance. The meetings are short (typically 45 min) and provide day to day feedback and control of the plant's operations. The multi-functional representation allows everyone to be informed about developments occurring throughout the plant. Prior to the adoption of JIT, these meetings were held once or twice a week rather than daily.

Nonoperating decisions (e.g. strategic, long term, capital expenditures) are typically made on a consensual basis in either management meetings or project team meetings consisting of members possessing the required knowledge or information. Typically, at least some members of the management team are present in these meetings. On the basis of being involved in both operating and nonoperating meetings, management is able to exert strong direction and receive constant feedback on the activities of the organisation.

<sup>7</sup> As this discussion suggests, the benefits of decentralising purchasing decisions appear to be great; however, one needs to be cognisant of the potential internal control problems that may arise from such practices and incorporate appropriate measures [see the teaching note to the Stanadyne Diesel Systems [A] case in Robinson (1989)].

### 2.1.6. Operator involvement

The major form of operator involvement (including the setup person assigned to a particular line) occurs through attending JIT improvement and safety committee meetings; however, not everyone belongs to these groups. Another source of involvement stems from ad hoc meetings of shop floor personnel. They discuss scrap reduction and quality improvements. In addition, the foremen and process engineers seek operator input (either in improvement meetings or on the shop floor) with respect to changing production line lay outs and their concerns are addressed (typically ergonomic and ease of operation). However, once the process and layout are decided, the operators follow a set procedure. Thus, they have input into task design but relatively little in task execution. The pace of work is largely under the control of the operator (inventory is not yet minimal).

The operators have considerable control over the quality of the parts they produce. Each shift they check the reliability of their measurement gauges. They also prepare their own statistical process control (SPC) charts and adjust the machine's specifications if the results lie outside the SPC control limits. They stop their machines if the SPC chart indicates that the part specifications lie beyond the tolerance limits set by the customer. In this situation, the entire line does not usually stop because the plant does not operate hand to mouth as considerable WIP still exists. Operators do their own cleaning of machines and many perform routine maintenance on their machines (e.g. changing belts, sharpening drills). They typically replace their own tools based on a pre-determined standard established for each tool, as well as performing tool adjustments. The extensive experience of the operators has lead them to becoming very knowledgeable about their equipment and many are able to run a number of machines (although they do not practice work rotation methods). On one line, they assist the foreman with scheduling decisions.

Plant management's long term objective is to have operators performing the bulk of their own setups. Currently, operators only perform minor setups, with the more complex ones being undertaken by

the production line's setup mechanic (typically with the assistance of the operator).

## 2.2. Plant 2

### 2.2.1. Background

Plant 2 is a Canadian branch plant of a division of a large U.S. company. It operates a 100,000 square foot plant which stamps automotive parts primarily for the Big Three auto makers, with most shipments going to the United States. Some assembly work is also performed. Examples of some of the products include bumpers, car door trim mouldings, and side door beams. The plant employs 142 people and has sales of \$20 million. JIT has been in operation for approximately two years in an attempt to achieve World Class Manufacturing (WCM) status.

The switch to JIT was mandated by the need to survive in an increasingly difficult industry, where the customer is truly king. Survival requires continual improvement through innovation and waste reduction. The days of maintaining the status quo are gone. As the production manager put it:

The only guys that are going to win the battle are the guys that are innovating to allow them to lower their real costs or at least maintain their costs [in times of inflation]. To win the game, you must show that you are trying to meet the customer's whims and needs, and are improving as you go along. If that customer knows that you are proactive and knows you are trying to do everything in your power to meet his needs, you aren't going to lose that customer's respect, their trust, and their business.

### 2.2.2. Continuous improvement

Both the plant manager and the production manager associate WCM with the possession of an attitude—that perspective of simply wanting to be the best. This attitude is manifested in continually questioning current practices, and never being totally satisfied with past accomplishments. Although this attitude appears to be straightforward, organizational tendencies tend to counter it particularly

when things are going well. The production manager elaborated with the following comments.

The revelation here two years ago was we had one product line where we were making a bundle of money. It was told to corporate staff that as soon as this job was over [the plant] would lose money. We were abruptly told “That’s none of your concern” and within six weeks of [finishing the job] we were losing money. But it’s the old theory of just-in-time manufacturing. When the water is up to here [pointing high], nobody sees the rocks. Then all of a sudden the water was gone. All the rocks started showing up. For years and years those problems were there, but everybody had the attitude, “Hey, we’re making money, we don’t have a problem.” But the attitude here now is whether we’re making money or not, let’s go and see what else we can do to make more money.

Without this mindset, people will simply continue perpetuating the old system or become satisfied with small gains, while large ones continue to elude them. For example, for many years the plant was scrapping approximately 28% of the bumpers they made. This scrap level became normal: the plant would order extra material and produce approximately five bumpers for every four they needed.

Continuous improvement requires that you look at processes from a different perspective by asking “Do we have to do it that way?” An example provided by the production manager illustrates the mindset required.

I remember the first WCM meeting [at Parent Company] I attended. A fellow got up and stated how they took so many people out by combining operations and doing this and this. They took it from 8 operators to 4 operators and they cut down on material handling. I got up and said to the guy, “Yeah, you really improved the process, but could you change the whole process?” Everybody just looked and said “What do you mean?” Who says you can’t do that in a totally different way?

We had one [job] where we changed the whole process. It came in like this [from corporate] and we said, “No, we’re going to change the whole process.” So we did. And we cut \$2 [per unit] out of the manufacturing costs. Without that attitude we would’ve scratched our heads for months trying to improve on the process they had given us instead of thinking, hey, do we have to do it that way? Who said you can’t do it this way.

In instilling the continuous improvement attitude within the organization, it is essential for top management to set the example and be open to change. As the traffic coordinator put it: “Although we talked about WCM four years ago, the difference is that the plant manager and the production manager are doing it rather than just talking about it.” In addition, top management must have the attitude that mistakes will occur and that they represent a useful learning experience. This point is critical because reducing inventory levels often results in the organization walking on a tightrope. However, the solution is not to return to high levels of inventory; instead, it is to learn why the problem occurred, and to keep trying to find a way to make it work.

### 2.2.3. *Management style/decentralisation.*

The management style and philosophy of the plant manager is an important component of the control system, and is characterised by several aspects. He believes strongly in the necessity of teamwork and has endeavoured to harmonise his staff into a well blended team. This team orientation was visibly apparent to the researchers. Virtually all non-operator personnel talked in terms of “we are a team” and the important role that everyone contributes towards achieving the joint objective—meeting the customer’s requirements. As the coordinator put it:

We’re all a team. We all have to work together. I couldn’t do it without [the production manager], and the other supervisors [foremen] and the people on the machines... I have to have that feedback from them in order to get

back to the customer and [the customer] is the most important person in the organisation.

The plant manager has orchestrated his team towards “the customer is first” attitude. The parochial orientation that is so often witnessed in traditional pyramid structures is virtually non-existent. The activities of the plant are focused totally around meeting the requirements of the customer. The importance of the customer is apparent to everyone, from the plant manager down to the operator level.

The plant manager operates on the basis of hiring good people and letting them make decisions. He is adamant about the wealth of knowledge possessed by employees. He keeps informed and wants to know the benefits of proposed changes, but allows people to make decisions. A recent example typifies his management style. The plant recently made its first quote on a job (previously all quotes were performed at corporate). The quote was worth \$1.5 million per year and required tooling of \$1 million (significant amounts for this plant). The plant manager assigned the entire responsibility for the job (pricing, tooling and designing the process) to an ad hoc team consisting of the production manager, quality assurance manager, general foreman, controller, plant engineer, tool room supervisor, and purchaser. The quality assurance manager summarised the outcome of the final meeting as follows:

[The plant manager] was part of the meeting, but he didn’t direct us to do anything. We looked at tool shops, fixture shops, this type of stuff and decided on where the quote should fall. He was there, he definitely wanted to know what the discussion was and how the [previous] meetings went. But it became a consensus decision. I think that was pretty gutsy!

#### 2.2.4. *Decision making*

The plant’s decisions consist of two types. For the day to day operations, the production manager is the nerve centre for the plant, where he directs the operations of the organisation based on consultation and information sharing with people. But

to stop at this description would inaccurately depict the information flows in the plant. As Fig. 1 illustrates, to a considerable extent the plant utilises a network structure of control, with two way communication flowing throughout the organisation. People possessing the required information rather than hierarchical position dictate communication paths. The only break in the network (as indicated by the dashed line in Fig. 1) appears to be between the “traffic coordinator” (marketing/customer liaison) and purchasing, where in most cases coordination is achieved via the production manager because of the need to incorporate production information. Communications take place in the form of informal meetings as the need arises, sometimes several times a day (e.g. between production line supervisors and the production manager). Constant communication among the production manager, traffic coordinator, general foreman, and purchaser is, according to the production manager, the key requirement in running operations JIT. When inventories are low, any deviation causes potential problems and mutual adjustment is required. The bulk of the communication is consultation and information sharing.

For all other kinds of decisions (e.g. future planning of day to day operations, new orders, problems, improvement projects) the plant relies almost exclusively on consensus decision making within *teams*. For improvement projects, self-directed, ad hoc teams are created consisting of personnel possessing the required knowledge. As the project progresses, people are pulled off the team and others are added according to information requirements. Any person can chair the meeting. Everybody provides input into the meetings, and decisions are arrived at on the basis of consensus. For all other decisions, the management team consisting of the plant manager, production manager, quality assurance manager, general foreman, tool room foreman, and the plant superintendent (engineer) meet bi-weekly.

The researchers attended a management team meeting and were left with the two following impressions. The first is the extent of democracy existing in the meetings. Every person contributed to the discussion, with decisions being clearly

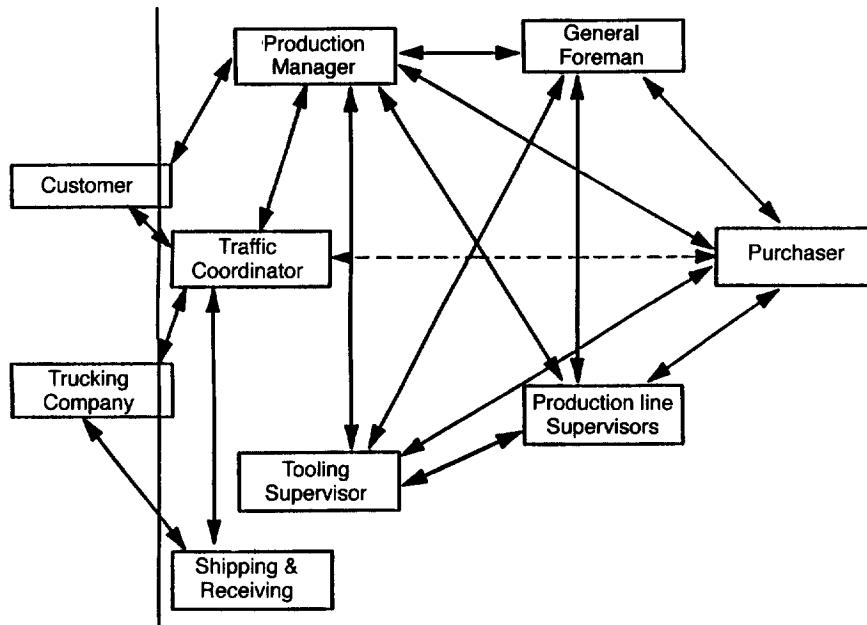


Fig. 1. Communication flows in plant 2.

arrived at on the basis of consensus. The purpose of the meeting was to provide an exchange of information en route to making a consensus decision. The meeting provided an opportunity for the plant manager to keep abreast of developments occurring within the factory. His role was to bring his external information bearing on the discussion (e.g. corporate directives, information received from customers), to direct the discussion, and to ensure that all relevant personnel's input was obtained. The second impression was the shortness of the meeting and the rapidity of the decisions taken. Information was shared, pointed questions were asked, and decisions were taken, or, if insufficient information existed to properly make a decision, people were assigned the task of acquiring the necessary information.

#### 2.2.5. Operator responsibility, motivation, and involvement.

The JIT/WCM implementation strategy of management is to concentrate on improving the process first before focusing on worker involvement. Nonetheless, operators have been consulted

for determining problem areas and their ideas are actively encouraged and responded to.

A considerable amount of responsibility has been placed on operators for assuring that quality parts are produced. They do their own inspection, utilizing statistical process control. Operators are also empowered to stop a line if necessary. The foreman then has the ultimate responsibility to either continue producing or to shut the line down and repair the problem. In general, the operators have welcomed this increased responsibility. It has led to them becoming more quality conscious and more involved in the quality process.

Presently, operators make few machine adjustments. Setups are usually performed by tool room personnel and repairs by maintenance staff. The manufacturing process consists primarily of presses and welding machines. With respect to presses, the setup of the die is critical and requires experienced and trained personnel. It is not realistic to expect that most operators could perform this task. With respect to the welders, the equipment is quite sophisticated and requires engineers to adjust the machines. However, management is considering allowing operators to change welding tips in the future.

Each foreman schedules the production for each day and the work procedure is set, with little or no variation possible. Workers are given a standard rate that they must meet each day (they do have input for overriding an unfair standard); however, within this rate, they have considerable leeway in pace during the day (work in process is not yet minimal). In the two cells at the plant, the operators discuss among themselves when they will take their breaks in order to keep everyone's work as evenly balanced as possible.

The use of work cells provides operators with an important controlling influence that the production manager attempts to capitalize upon. In cells, poor workers are either brought up to speed by peer pressure or they tend to leave the plant. Through this use of group dynamics, management can rely more on the operators to control themselves rather than resorting to disciplinary action for poor workers.

### 2.3. Plant 3

#### 2.3.1. Background

Plant 3 is a branch plant of a wholly owned Canadian subsidiary of a large US based multinational corporation. The plant manufactures thousands of controls that regulate the temperature, humidity, cleanliness, ventilation and security of homes and buildings. Although sales of this plant's products are primarily in Canada, there are products produced for sale in numerous foreign markets. This plant employs 640 people and has sales of over \$425 million (including inter-divisional sales). The plant has been following the JIT philosophy for six years in the course of pursuing its objective of achieving manufacturing excellence through continuous improvement. An important change on the production shop floor has been the implementation of flex lines that can accommodate model changes within a product family thereby increasing production mix flexibility. For example, on one line, as many as thirty-two models within a product family can be produced.

#### 2.3.2. Continuous improvement

Continuous improvement (CI) is becoming a way of life. For example, the receiving manager

mentioned that "the only thing to remember about JIT is that you don't do it once and leave it... There's always a way to improve what you have done." Similarly, the design manager indicated that employees are motivated to always think about how to do better rather than regret past mistakes. As the production manager explains:

I guess there is always an element of dissatisfaction, there's something you can do better and you are never quite satisfied. You have to reward or acknowledge the improvement that people have made but in the next breath you are always saying "well what's next, how do we get one step better?"... In every case, we have started conservatively, we have started with a pilot and then, once we have proven it out, we have gone and done more. It just never ends ... that is why ... [acquiring] the MRP-II system may have been the right investment to make five years ago. Would we make the same investment now? Probably not. But that is something you have to accept in a JIT mode, in a CI mode, that a decision you made even a year ago might have been the right decision ... at that time but a year down the road you are doing something different.

#### 2.3.3. Decentralisation

The plant manager is attempting to push the responsibility for decision making down into the factory floor as much as possible, where he is beginning to get small groups of people to run their areas like small businesses. For example, one group leader on the shop floor has been assigned the responsibility for buying his own cartons for packaging. He faxes his daily carton requirements directly to the supplier. All requests faxed before 10:00 a.m. are delivered by noon the following day. This system is called FAXCAN (similar to KANBAN) and is being extended to all packaging materials. The production manager's ultimate objective is to make the group leaders on the line responsible for buying all their raw materials.

Production line supervisors, set-up personnel, and operators all have more responsibilities than



they did a few years ago. Production line supervisors are more involved in production scheduling. Operators have been given more responsibility with respect to quality. They now do their own statistical process control and are responsible for the calibrations of the switches, a task which was formerly done by inspectors. According to one quality control manager, “there is no longer a need for inspectors, they are an extra burden, an extra cost.” In some areas, operators have the authority to stop the line due to quality problems. For knowledge reasons, they do not have the authority to adjust machine set-ups—which is the task of set-up personnel. However, if a problem exists, the operator takes the tool to the tool room where it gets fixed.

The transition from a traditional assembly line layout to flex lines has resulted in a substantial amount of training which will facilitate increased decentralisation. A corporate newsletter outlined the training program as follows:

Last year, hourly employees began training to prepare for their coming responsibilities. The training involves facilitation and problem-solving skills, communications and personal development. Once the factory is running full-tilt with autonomous flex lines, hourly employees will be involved in the decision making process. The team will be an autonomous unit and will receive continuous training in areas as safety, MRP and Just-In-Time.

#### *2.3.4. Cross-functional communication patterns*

Given the rather large size of this plant, formal communications are still prevalent. For example, the plant manager was informed about the implementation date for KANBAN by a memo from the production individual responsible for its implementation. Nonetheless, the level of informal (verbal) communications, particularly across functional areas, has increased considerably, allowing the plant to respond more quickly to problems.

Several structural changes have facilitated the change in cross-functional communication patterns. Production engineering, which used to be

under engineering, is now under production. Moreover, production engineers have been relocated and are physically closer to the manufacturing area so that they can work more closely with staff. This relocation is intended to contribute to quality and delivery improvement through their continuous interaction with shopfloor personnel. Similarly, purchasing and production control have merged in order to increase coordination between the two areas.

In addition, the formidable barriers which used to exist between the marketing, production engineering, process engineering, design and quality departments have been largely removed. For example, production engineering personnel now talk directly to the quality control group, rather than following the chain of command, in response to solving a problem. Similarly, sales people communicate directly with production people if required. The concept of removing cross-functional barriers has also been extended to external parties, where partnerships are being formed with customers and suppliers. Supplier and customer representatives now visit the plant and interact directly with technical employees. They are much more involved in the new product development process as well as in modifying existing products. These partnership efforts, resulting in what Ross (1990) calls the “meta-firm”, produce considerable benefits. For example, working in consultation with the plant, a supplier changed the design of a three-way zone valve and made it into a two-way valve with no loss in functionality. This allowed the supplier to eliminate five forging operations, reduce the set-up time for this product by 80%, and increase yield by 15%. The plant was able to enjoy significant cost savings from this partnership in the form of obtaining lower prices from the supplier. Moreover, the modified zone valve was much lighter than before and easier to handle.

Finally, the increased use of teams within the plant also facilitates communication within and across functional areas. There are several ad hoc teams which have been created to work on special projects. These teams consist of individuals who can contribute to the issue under discussion. For example, a product development team may consist of the marketing person, the sales person, product

specialist, and the customer. In addition to using ad hoc teams, the plant also uses program teams, which are more or less permanent, to deal with ongoing concerns and issues or large projects. Program teams are comprised of individuals from different specialist functions and are under the direction of a program manager. Unlike the special project teams, which typically follow a matrix approach resulting in dual reporting responsibilities for members, program team members report to their program managers for everything—even vacation requests. They are also evaluated by their program manager.

#### *2.4. Discussion of case findings*

The case studies describe the approaches that the three plants have adopted in order to increase their flexibility and to deal with the increased interdependencies created by running JIT. The first two plants, and to a lesser extent the third plant, have eschewed the traditional hierarchical structure of communication, authority and control and are moving towards a network structure.<sup>8</sup> To an increasing extent, decision making authority rests with the people possessing the relevant knowledge (at least above the operator level). Information and decision processes flow flexibly and informally wherever they must in order to provide the necessary coordination and control over operations (particularly in plants 1 and 2). Consensual decision making for nonroutine decisions was also prevalent (plants 1 and 2). Team meetings of multi-disciplinary specialists are used extensively for coordination and control of operators (particularly in plant 1), as well as to define problems and to develop solutions for them (all three plants). Moreover, there is a conscious effort to remove, or at least reduce, functional boundaries between people. This was accomplished through the extensive use of team meetings (in all three plants), by assigning people increased responsibilities that overlap traditional

boundaries (plant 1), by restructuring and merging functional areas (plant 3), and by utilising self-managing product teams (plant 1 and, to a lesser extent, plant 3). In general, more people are being involved in decision making and their responsibilities are being broadened (all three plants).

The necessity of moving towards the organic model of control was clearly indicated by three factors in all three organisations. First, customer concerns are receiving the highest priority and this is dramatically facilitated by introducing mechanisms for reducing cross-functional barriers. Indeed, the pursuit of customer satisfaction is reaching the point where customer concerns have become the ultimate arbitrator in resolving jurisdictional disputes. Second, an implication of carrying reduced inventory levels is that the time available to react to problems and/or changes is considerably compressed, thereby requiring a quick means of adaptation and integration. Third, senior management is increasingly recognising that people at lower levels play a vital role in producing quality products and assisting in the innovation process.

In conclusion, the case study descriptions are largely consistent with the theoretical framework developed on the basis of the literature review: organisations that pursue JIT are moving towards an organic form of management control. While each organisation is finding its own particular way in becoming more “organic”, the common thread is the increasing use of informal and lateral (cross-functional) communications, the extensive use of teams composed of individuals from different functional areas, and decentralisation of decision making to lower levels. In addition, self-managing teams (mini-factories within the factory) which are charged with being highly responsive to their customers’ evolving needs and requirements are beginning to be used.

### **3. Hypotheses**

The theoretical discussion along with the case studies examining JIT firms suggest that while the mechanistic form of control is appropriate for

<sup>8</sup> The fact that plant 3 is considerably larger than the other two plants should be considered when assessing their greater reliance—relative to the other two plants—on facets of the traditional hierarchical structure (see Mintzberg, 1979).

traditional mass production firms, it is not appropriate for those mass production firms pursuing the JIT philosophy, resulting in the following hypothesis:

H1: JIT mass production firms will utilise an organic model of control to a greater extent than traditional mass production firms.

Following from contingency theory, performance should be expected to increase for firms whose structure more appropriately matches their technology. This was a main finding in Woodward's (1980) study. In addition, Abernethy and Lillis (1995) observed a positive association ( $r = 0.38$ ) between the use of integrative liaison devices and firm performance for those firms committed to pursuing flexibility. Finally, Duimering and Safayeni (1991) reported substantial negative correlations between total system inventory (as measured by plant lead time) and cross-functional coordination ( $r = -0.704$ ) and cooperation ( $r = -0.935$ ). This leads to the following hypothesis:

H2: With respect to JIT mass production firms, the utilisation of an organic model of control will be associated with higher rates of improvement in key manufacturing performance areas.

This hypothesis will be assessed by examining seven key areas of performance improvement: quality, inventory reduction, production cycle time reduction, on-time delivery, setup time reduction, production lot-size reduction and overall cost reduction. A review of studies examining JIT implementation reveals that the first four were ranked among the top five reasons reported by firms for implementing JIT (see Horngren et al. 1994, p. 848).

The logic underlying the importance of these areas is as follows. The basic idea of JIT is to produce and deliver the right quantity at the right time without relying on the use of buffer inventories (Schonberger, 1982; Hay, 1988). This is not possible without making changes within the manufacturing system. First, it is essential to improve quality at the source, without which there is no

way to eliminate inventories. Second, setup times must be reduced to facilitate production in small lot sizes, resulting in reduced inventories and increased production mix flexibility. Third, shorter production cycle time results in less inventory being required to meet customer requests. Taken together, improvements in quality and reductions in production lot size and cycle time allow firms to respond more quickly to customer demands. On-time delivery represents an external assessment of the firm's performance which is based on the customer's viewpoint. "The ability to deliver a product precisely when that product is required to complete a sale is a pivotal objective of JIT" (Dodd, 1995, p. A3–7). Finally, Schonberger (1982) argues that the overall effect of better quality and lower inventory translates into cost savings through less material waste (scrap), fewer rework labour hours, lower carrying costs for inventory and plant space, less administrative tracking of inventory, and reduced obsolescence.

## 4. The survey

### 4.1. Sample and data collection

A total of 1580 questionnaires were mailed to plant managers (addressed by name in most cases) of Canadian manufacturing plants in 1991. These firms operated in eleven major industry groupings, located in the Atlantic, Ontario and Western regions. Process type industries (e.g. petroleum refining, textiles) were not included in the population because the literature indicates that JIT is used primarily in unit and mass production firms. Follow-up letters were mailed four weeks after the initial mailing; simultaneously, a number of firms were contacted by telephone in order to increase the response rate.

A total of 169 questionnaires were returned to the researchers, providing a response rate of 10.7%. Of these, eleven missed the cut-off date and three were unusable, resulting in a useable total of 155. In assessing the response rate, it is important to consider the results of the telephone calls, presented in Table 2, which were undertaken in the hope of increasing it.

The telephone calls resulted in mailing another 142 questionnaires because the first copy was not received in 80% of the cases for such reasons as the addressee was no longer with the company, the mailing address had changed, or the survey had not been forwarded to the correct person. This result indicates that many people had no chance of participating simply because they never received the original questionnaire. The remaining 20% of the 142 cases reported that the original questionnaire had been misplaced. In addition, item numbers 5, 7, 8, 9 and 11 in Table 2 suggest that another significant percentage (17.6%) had a very low or no probability of responding. If these two results are extrapolated to the population, more than a third of the sample had no chance of responding. The conclusion to be drawn from this analysis is that, although the response rate remains low, it is significantly higher than 10%. This conclusion receives further support by the result that 42 of the 142 additional questionnaires sent to respondents were returned to the researchers (these 42 responses are included in the summary total of 155), providing for a 29.6% response rate on this subset.

An analysis was performed to examine the threat of nonresponse bias (see Wallace & Mellor, 1988; Wallace & Cooke, 1990). A comparison of this study's respondent firms with those in the population suggests that the sample is reasonably representative of the population on at least two key criteria—type of industry and firm size (as measured by total employees). Despite the results of this analysis, the researchers cannot rule out the possibility of nonresponse bias. The respondents might be different than non-respondents on many other variables. Indeed, evidence was obtained suggesting that the proportion of JIT firms in the sample is not representative of those existing in the population in that the respondents appeared to be biased towards being employed in JIT firms (see below). Readers are therefore cautioned against making sweeping generalisations.

## 4.2. Measures

### 4.2.1. Classification of firms

As previously discussed, JIT is considered to consist of three primary components: production

Table 2

Results of telephone calls made to the initial group of nonrespondents

	N	%
1. Concerned individual/assistant requested another copy.	142	27.2
2. Addressee not available	123	23.5
3. Addressee not available at the time of calling, nobody available or willing to take a message	88	16.8
4. Agreed to participate	30	5.7
5. Not a manufacturing facility	29	5.5
6. Declined to participate	26	5.0
7. No one answered on repeated callings	21	4.0
8. Addressee no longer with the plant, no replacement	16	3.1
9. Plant closed down or closing	15	2.9
10. Given to another individual to complete	11	2.1
11. Addressee on vacation, nobody in charge	11	2.1
12. Other	11	2.1
13. Total	522	100.0%

flow, total quality control, and employee involvement (Hay, 1988). Although all components are important, the extant literature consistently indicates that it is the demand-pull concept that is the chief characteristic of JIT production (Hall, 1983, 1987; Sepehri, 1986; Manoochehri, 1988; McNair et al., 1989; Wilkinson & Oliver, 1989). This is because the pull system facilitates producing to demand, which is the basic idea behind JIT (Schonberger, 1982). Firms were therefore classified as JIT or non-JIT on the basis of whether they had implemented a demand pull system in at least some of their production operations.

Of the 155 usable responses, 106 firms (68.4%) implemented JIT to some extent. Given the fact that JIT production was relatively new to North America at the time the survey was conducted, this percentage is higher than one might expect, perhaps indicating that the study was of more interest to individuals employed in JIT firms, thereby resulting in a biased estimate. Random telephone calls to fifty non-respondents indicated that this suspicion was warranted and that a more realistic population estimate of JIT firms was 42%. It is also important to stress that the JIT classification

method used in this study does not imply that a firm has adopted a fully developed JIT system. The median proportion of production capacity running JIT is only 47%.

A firm was classified as being predominantly mass production if the total active production capacity devoted to large batch production is 40% or more and the remaining two types (e.g. job or process) are less than 35% each. For JIT firms, this classification criterion was based on the situation prior to adopting JIT. Although it was recognised at the outset that such a stringent classification procedure would likely cause the sample size of mass production firms to decrease, it was felt important that the classification method reflect the dominant technology. This is because a firm's structure and other control mechanisms will likely receive the greatest influence by the predominant technology (Woodward, 1980). Given this procedure, a total of 12 plants were classified as traditional mass production firms and 40 firms were classified as JIT mass production. JIT mass production firms are larger than their traditional counterparts based on the median (mean) number of employees (170 (435) and 140 (107), respectively) and plant sales (\$37.5 (\$48) and \$17.5 (\$15) million, respectively).

Finally, various tests on the validity of the JIT classification procedure indicate that it was highly satisfactory. These tests are displayed in Table 3. Spearman rank correlation coefficients between production classification (JIT scored 1, non-JIT scored 0) and measures on the extent of total quality control and extent of employee involvement were 0.57 and 0.48 respectively. Moreover, these correlations increase substantially when only "high JIT" firms are examined (firms with 60% or more production capacity devoted to JIT production). Reducing setup time is a key component in moving towards a JIT production system (Schonberger, 1982). A substantial difference exists in setup times between JIT and non-JIT firms, particularly for "high JIT" firms. Similarly, cellular manufacturing is utilised much more extensively in JIT firms. Finally, and although they are very weak, the correlations associated with machine availability and supplier lead times are also in the predicted direction.

#### 4.2.2. *Dimensions of organisation structure*

Within the organic conceptualisation of management control, participation, decentralisation, and network structure of control were a priori dimensions of primary interest. Thirty statements (referred to as variables) representing these various dimensions were included in the questionnaire. Of these, eleven statements were developed by the researchers in order to capture the specific area of interest to the study (production and its relations within itself and with other departments). The balance were chosen from the work of Burns and Stalker (1961), Keller et al. (1974) and Robbins (1983).

An initial examination of the correlation matrix indicated that five variables did not have substantial correlations with at least one other variable and were therefore eliminated from the analysis. The remaining variables were factor analysed using principal components analysis with oblique rotation. Oblique rotation, rather than the more customary varimax method, was used because the researchers expected the underlying dimensions to be somewhat correlated (see Kim & Mueller, 1978, p. 59; Kass & Tinsley, 1979, p. 134). Six factors accounting for 60.2% of the variance were extracted. Table 3 shows the questionnaire items (variables), along with the factor loadings, percentage of variance explained and eigenvalues for each item. Only variables with unambiguous loadings on factors were included in the construction of the scales. Factor 4 could not be meaningfully interpreted and was therefore deleted from further analysis. All other factors could be easily interpreted and were called network structure of control, authority and communication (factor 1), task flexibility (factor 2), job codification (factor 3), hierarchy of authority (factor 5), and participation/decentralisation (factor 6).

The internal consistency of the items comprising the five scales (factors) was then tested. Factors 1 (eight items), 2 (two items), 3 (two items) have coefficient alpha reliabilities of 0.84, 0.85, and 0.82, respectively, all highly satisfactory. The reliability of factor 5 is 0.51. Nunnally (1967) argues that reliability coefficients of 0.70 or more are considered adequate. On this basis factor 5 was deleted from further consideration. Finally, the analysis indicated that the reliability coefficient of

Table 3  
Tests for the adequacy of the JIT classification

Item	Non-JIT	JIT	High JIT <sup>d</sup>	$r_s$	
				All JIT <sup>c</sup>	High JIT <sup>d,e</sup>
1. Cellular manufacturing <sup>a</sup>	16.3	57.5	50.0	0.39	0.36
2. Total quality control (TQC) <sup>b</sup>	2.6	4.9	5.8	0.57	0.76
3. Employee involvement (EI) <sup>b</sup>	2.6	4.5	5.3	0.48	0.65
4. Level of machine availability <sup>b</sup>	5.7	5.9	6.0	0.05	0.16
5. Longest set-up time (mean hours)	6.4	3.9	3.0	−0.11	−0.23
6. Shortest set-up time (mean hours)	0.9	0.4	0.3	−0.14	−0.22
7. Longest supplier lead time (mean days)	91.0	96.0	81.7	−0.02	−0.14
8. Shortest supplier lead time (mean days)	13.0	9.0	12.0	−0.11	−0.08
Total number of firms <sup>c</sup>	49	106	36	106	36

<sup>a</sup> Figures in columns 2 to 4 represent the percentage of firms that have adopted cellular manufacturing.

<sup>b</sup> Figures in columns 2 to 4 represent mean values determined from a seven point Likert scale.

<sup>c</sup> Not all firms completed every question concerning rows 1 to 8 above.

<sup>d</sup> "High JIT" represents those firms with 60% or more production capacity running JIT.

<sup>e</sup> "Spearman rank correlations between non-JIT(=0)/JIT(=1) classification and the corresponding item in column 1.

factor 6 increased from 0.64 to 0.84 if item number 22 is deleted. Thus only five items were included in the final version of this scale.

In conclusion, the factor analysis was successful in developing the scales (variables) of interest: network structure of control (factor 1) and participation/decentralisation (factor 6). These scales will be used in examining hypothesis 1 and 2. On an a priori basis, decentralisation and participation were considered to be separate, although closely related, variables (see Schermerhorn et al., 1985, p.402). The factor analytic results suggest that they can be meaningfully combined into a single scale. In addition, a correlation of 0.63 was obtained between the network structure of control and participation/decentralisation variables. Given such a high correlation and in the interest of parsimony, the decision was taken to sum the two variables into a single variable, representing the mechanistic/organic form of management control.<sup>9</sup> The internal reliability for the combined thirteen item variable is 0.88.

<sup>9</sup> Running the hypothesis tests separately for the two variables produced very similar results to those using the combined variable.

#### 4.2.3. An examination of the validity of the mechanistic/organic measure of control

Attempting to measure quantitatively the degree to which a firm is mechanistic or organic using an arms-length questionnaire is a difficult undertaking (Mintzberg, 1979, p. 225; Parthasarthy & Sethi, 1993; Abernethy & Lillis, 1995). In acknowledging this concern, the validity of the control measure was examined from a number of perspectives. First, the case study results support both the conceptualisation of the mechanistic/organic form of management control as well as the operationalisation of the construct. In particular, the findings depicting the increasing use of informal and lateral (cross-functional) communications, the extensive use of teams composed of individuals from different functional areas, and decentralisation of decision making to lower levels are all represented by the measure used (see items 1 to 8, 20, 21, 23, 24, 25 in Table 4). The only sub-dimension that appears to be missing from this study's operationalisation is the use of self-managing production teams (i.e. mini-factories) and the case study results indicate that they were just beginning to be used.

Second, it is possible to examine the measure's construct (theoretical) validity by examining the

Table 4  
Results of principal component analysis (oblique rotation)

Statement (variable)	F1	F2	F3	F4	F5	F6
1. People from different departments and/or functions often work in groups to solve important problems.	<b>0.77*</b>	0.04	−0.16	0.20	0.09	0.04
2. Work teams are used by production workers to solve problems.	<b>0.73</b>	−0.02	−0.21	0.10	0.10	0.003
3. Hierarchical position, not knowledge, determines the stature of an individual.	<b>0.64</b>	0.09	0.01	−0.07	0.10	0.05
4. The Production Department often works very closely with the Design and Engineering Department in designing products for ease of manufacturing.	<b>0.64</b>	−0.10	0.20	0.08	−0.13	−0.09
5. Marketing and Production Departments work together very closely in achieving customer satisfaction.	<b>0.57</b>	−0.12	−0.03	−0.08	−0.32	−0.14
6. Communication is both vertical and horizontal, depending upon where needed information resides.	<b>0.51</b>	0.12	0.06	−0.12	−0.06	−0.33
7. Subordinates are normally consulted before a decision is made.	<b>0.49</b>	−.11	0.01	−0.09	0.35	−0.20
8. The management control system in your plant provides flexibility for all managers to respond to problems as they occur.	<b>0.42</b>	−0.20	−0.08	−0.25	−0.12	−0.30
9. Managerial employees are allowed to deviate from standard procedures.	−0.16	<b>0.90</b>	0.02	0.02	−0.04	−0.05
10. Non-managerial employees are allowed to deviate from standard procedures.	0.11	<b>0.87</b>	−0.03	0.04	0.06	0.03
11. Written job descriptions are available for all non-managerial employees.	0.04	−0.05	<b>0.89</b>	−0.004	−0.002	0.05
12. Written job descriptions are available for all managerial employees.	−0.18	0.02	<b>0.87</b>	−0.04	−0.02	−0.02
13. For many decisions, the rules and regulations are developed as the decision making progresses.	0.17	−0.07	0.06	<b>0.71</b>	0.02	−0.10
14. Inter-departmental interactions are normally done through integrators or liaison people.	−0.06	0.19	−0.13	<b>0.60</b>	−0.18	−0.08
15. The Marketing Department works closely with the Design and Engineering Department in designing new products.	0.41	0.20	−0.003	−0.43	−0.39	−0.18
16. People have to check with their superiors before doing almost anything on important matters.	0.21	0.08	−0.10	−0.05	<b>0.69</b>	−0.07
17. People here always get instructions from their superiors in dealing with important matters.	−0.18	0.07	0.02	−0.09	<b>0.60</b>	0.17
18. Tasks tend to remain rigidly defined unless altered formally by top management.	0.04	0.17	0.21	−0.02	<b>0.50</b>	−0.32
19. Superiors often seek advice from their subordinates before decisions are made.	0.35	−0.08	0.01	−0.06	0.36	−0.28
20. Production workers are encouraged to suggest product design improvements which are then followed-up.	0.09	0.03	0.12	0.25	−0.18	− <b>0.74</b>
21. Middle managers are granted latitude to make decisions.	0.03	0.26	−0.08	−0.20	0.13	− <b>0.69</b>
22. In this plant rules and regulations exist in writing.	0.32	0.22	0.26	0.09	0.11	0.67
23. All employees are encouraged to make suggestions when decisions are made.	0.19	−0.02	−0.02	0.09	0.18	−0.66
24. Production workers are encouraged to suggest process improvements which are then followed-up.	0.25	−0.11	−0.35	0.25	−0.01	− <b>0.63</b>
25. First-line managers are granted latitude to make decisions.	0.22	0.24	−0.01	0.03	0.25	− <b>0.57</b>
Eigen values	6.70	2.58	1.78	1.47	1.32	1.19
Percentage of variance (cumulative)	26.8	37.1	44.3	50.1	55.4	60.2

Statements 3, 11, 12, 16, 17, 18 and 22 are reverse scored.

\*Variables comprising factors based on unambiguous high factor loadings.

network of relationships existing between the mechanistic/organic construct and other variables (see Neale & Liebert, 1986, p. 47). It is well established in the organisational literature that, all things being equal, the larger the organisation, the more mechanistic the control structure is expected to be (Mintzberg, 1979, pp. 230–235), and this is the case for the findings of this study. The rank correlation between size and CONTROL (low values = mechanistic) is  $-0.27$  for traditional small batch production firms ( $n = 16$ ),  $-0.42$  for traditional mass production firms ( $n = 11$ ) and  $-0.12$  for JIT firms ( $n = 105$ ). In addition, Abernethy and Lillis' (1995) field research indicates that "flatness" in the managerial authority structure is critical to promoting effective integration among functions, i.e. becoming more organic. The Spearman correlation coefficient between CONTROL and the number of hierarchical levels in the current study is  $-0.20$  ( $n = 123$ ) and this increases to  $-0.29$  ( $n = 123$ ) when SIZE is controlled.<sup>10</sup> In other words, firms which possessed more organic structures also tended to be flatter. Finally, Woodward's results indicate that traditional small batch and process firms should have more organic structures than traditional mass production firms. A correlation was therefore computed between CONTROL and a dummy (0/1) technology variable for non-JIT firms (0 = mass; 1 = small batch or process) with size being held constant. The Spearman semi-partial correlation obtained was  $0.25$  ( $n = 36$ )—a result which is consistent with Woodward's findings. Taken together, these results indicate that the mechanistic/organic control variable has a reasonable level of support attesting to its validity. Accordingly, the broad scale statistical tests of the hypotheses can proceed with some degree of confidence.

<sup>10</sup> The reporting of  $p$ -values obtained from running significance tests is not considered to be appropriate in this study. This is because no random sampling mechanism was introduced into the study's design (a questionnaire was sent to every firm in the population, from which a percentage of responses was obtained). As a result, it is virtually impossible to define what chance means and, in turn, what constitutes a valid probability distribution (see Lindsay, 1995). Instead, the emphasis in this study is on the size and sign of the obtained correlations and observing the network of relations among the various variables.

#### 4.2.4. Improvement variables

The improvement rate variables were measured by simply asking respondents to indicate the approximate percentage improvement (or diminishment) experienced by their plants since introducing JIT. Improvement rates rather than absolute levels are the focus in this study because the researchers were interested in examining performance changes after the implementation of JIT. Readers should recognise that the measurement of improvement rate variables in this study is rather weak in terms of reliability. Not all respondents can be expected to have used the same operationalisations. Moreover, a number of the firms contacted by telephone indicated that their information system did not measure some improvement items. This resulted in respondents estimating the level of improvement or, more frequently, leaving the item blank. Finally, both Parthasarthy and Sethi (1992) and Abernethy and Lillis (1995) provide persuasive arguments in suggesting how the contingency "fit" hypothesis between performance and structure is impacted by various internal and external factors which typically manifest themselves in making it difficult to obtain results which support prior expectations.

### 4.3. Results

#### 4.3.1. Tests of hypothesis 1

The first hypothesis states that relative to traditional mass production firms, the structural (control) arrangements for JIT mass production firms will be more organic.<sup>11</sup> This hypothesis will be tested at two different levels of JIT adoption: (1) all JIT firms regardless of the level of JIT adoption and (2) firms with 60% or more production capacity devoted to JIT manufacturing ("High JIT"). This two level approach to testing is based on the underlying premise that the results should provide greater support for the hypothesis—a higher semi-partial correlation coefficient—as more of a firm's production capacity is converted to JIT. The effect

<sup>11</sup> Hereinafter, all references to JIT firms should be read as JIT firms that were predominantly mass production firms prior to the adoption of JIT.



of this approach is to test the hypothesis twice, resulting in a more severe test, and therefore greater corroboration for the hypothesis (see Lindsay, 1995, pp. 40–42).

A multiple regression analysis was used in order to statistically control for organisational size (total employees). Although there is some controversy with respect to the primacy of either technology or size on structure, the literature indicates that both have an affect (Hickson et al., 1969; Mintzberg, 1979, pp. 262–263; Steers, 1988, p.66). This leads to the use of the following regression model:

$$Y = b_0 + b_1X_1 + b_2X_2$$

where,  $Y$  is the form of management control: low values = mechanistic; high values = organic;  $X_1$  is size (based on the surrogate of total employees); and  $X_2$  is a binary variable (mass = 0/JIT = 1) representing technology.

An examination of the residuals revealed that the normality assumption of ordinary least squares regression was not being met. The data were therefore transformed into ranks before running the normal regression procedure. This transformation results in a “robust regression method that is not sensitive to ... non-normal distributions to the extent that the regular regression methods on the data are affected” (Conover, 1980, p. 338). The testing of hypothesis 1 is based on examining the semi-partial (rank) correlation coefficient associated with  $X_2$ , denoted as  $sr_2$ . The semi-partial correlation represents the correlation between that portion of  $X_2$  (technology) that is uncorrelated with the remaining independent variable (in this case  $X_1$  or size) and  $Y$  (Cohen & Cohen, 1983, p. 101).

The results are consistent with the hypothesis, as illustrated in Table 5. The semi-partial correlation for the technology variable is 0.50, with the coefficient ( $b_2$ ) being in the predicted direction (positive). The adjusted  $R^2$  for the model is 0.23—particularly high by behavioural research norms. Moreover, as predicted,  $sr_2$  increases to 0.65 when only “high JIT” firms are examined. The adjusted  $R^2$  for this model increases substantially to 0.38. The regression results for these firms are presented in Table 6.

The results also indicate that SIZE influences the form of control structure in the correct direction (i.e. the coefficient is negative) but that this influence is clearly secondary to the technology variable. This result is not necessarily inconsistent with Hickson et al.’s (1969) since the firms considered in this sample are much smaller. The mean size of firms in this study was 351 employees as compared to 3370 in theirs. As they state, “the smaller the organisation the more its structure will be pervaded by such technological effects” (Hickson et al., 1969, p. 394).

In conclusion, the results are highly supportive of the first hypothesis. Obtaining such high correlations is rare in organisational and behavioural research. Moreover, the fact that the results were stronger for the “High JIT” group (as predicted) and that the SIZE variable had the correct sign provides further evidence for the validity of the study’s classification of JIT firms and the construct validity of the CONTROL variable.

#### 4.3.2. Tests of hypothesis 2

The second hypothesis states that JIT mass production firms possessing organic forms of control will achieve higher rates of improvement. This hypothesis will be examined using several important areas of improvement for JIT firms. Given the low reliabilities of the performance improvement variables, the small sample sizes, as well as the “third-variable” problems associated with examining the contingency “fit” hypothesis between performance and structure, the examination

Table 5

Regression (based on ranks) of the form of management control on size and technology (for “all JIT” mass firms)  
CONTROL =  $b_0 + b_1\text{SIZE} + b_2\text{TECH}$

Variable	Coefficient	Estimate	Standard error	Semi-partial correlation coefficient
Constant	$b_0$	14.01	5.03	—
SIZE	$b_1$	−0.23	0.12	−0.23
TECH	$b_2$	0.66	0.16	0.50

$n = 52$ ; adjusted  $R^2 = 0.23$ ;  $F_{2,49} = 8.75$ .

CONTROL = The form of management control: low values = mechanistic, high values = organic.

SIZE = Number of employees.

TECH = Technology (Mass = 0/JIT = 1).

Table 6

Regression (based on ranks) of the form of management control on size and technology (for “high JIT” firms)  
 $\text{CONTROLS} = b_0 + b_1\text{SIZE} + b_2\text{TECH}$

Variable	Coefficient	Estimate	Standard error	Semi-partial correlation coefficient
Constant	$b_0$	5.01	3.00	–
SIZE	$b_1$	–0.10	0.14	–0.11
TECH	$b_2$	0.69	0.16	0.65

$n = 28$ ; adjusted  $R^2 = 0.38$ ;  $F_{2,25} = 9.10$ .

CONTROL = The form of management control: low values = mechanistic, high values = organic.

SIZE = Number of employees.

TECH = Technology (mass = 0/High JIT = 1).

of hypothesis 2 is best considered preliminary, and as a consequence, only simple Spearman rank correlations are used to identify whether the expected relationships emerge.

The results are presented in Table 7. All correlations have the expected (positive) sign; moreover, the correlations obtained for quality improvement, set-up time reduction, inventory reduction, lot-size reduction and overall cost reduction are of considerable magnitude, particularly given the concern for the low reliabilities of the performance improvement variables which act to attenuate the observed correlations (O’Grady, 1982). The correlations for production cycle time reduction and on-time delivery improvement are more modest but nonetheless offer support for the hypothesis.

In summary, the results support the hypothesis that JIT firms adapting their structural arrangements towards an organic model of control will have higher improvement rates than firms whose structures remain bureaucratic or mechanistic.

## 5. Further discussion and conclusion

This study sought to determine whether Woodward’s theory—developed for different technologies—could be extended and generalised in the context of a new technology, JIT. In finding that JIT mass production firms are adapting their structural arrangements in moving towards an

Table 7

Spearman rank correlations between performance improvement variables and CONTROL (mechanistic/organic structure) for JIT mass production firms

Performance improvement variable	Spearman rank correlation coefficient
Quality	0.72 ( $n = 25$ )
Set-up time reduction	0.39 ( $n = 24$ )
Inventory reduction	0.45 ( $n = 33$ )
Production cycle time reduction	0.22 ( $n = 27$ )
On-time delivery	0.26 ( $n = 24$ )
Lot size reduction	0.53 ( $n = 21$ )
Overall cost reduction	0.56 ( $n = 20$ )

organic structure, the results of this study and others suggest that the theoretical framework in this paper appears to be fairly robust; it is definitely not a flash in the pan.

In elaborating, while the survey’s low response rate precludes the *statistical* generalisability of these findings to specific populations, the *results* are already displaying a high degree of *analytical* or theoretical generalisation over different populations possessing variations in the conditions of observation (see Yin, 1989; Scapens, 1990, 1992; Lindsay and Ehrenburg, 1993; Lindsay, 1995). In analytical generalisation, the researcher is striving to generalise a particular set of results to some broader theory (attempting to explain some process) rather than to some specific population. Analytical generalisation for the main finding is shown in several ways. First, as the theory predicted, the size of the expected relationship increased as a greater amount of production capacity was converted to JIT. Second, the results are consistent with the Canadian study of Duijmering and Safyeni (1991) reporting a correspondence between functional changes in support of JIT and increased levels of cross-functional communication ( $r = 0.845$ ) and cooperation ( $r = 0.758$ ). Similarly, they complement Abernathy and Lillis’ (1995) findings in Australia of a substantial correlation ( $r = 0.46$ ) between firms pursuing flexibility and the use of integrative liaison devices. The latter is particularly significant in that there is preliminary evidence to suggest that the results may

generalise across countries (at least Western, capitalist countries). Third, the robustness of the main finding is all the more remarkable given that three different approaches (i.e., methods, instruments) were used to study the phenomenon in the three different papers, i.e., the results appear to be invariant to method. Fourth, the results of this study are affected by the size of the firm—consistent with a highly replicated finding in the organisational literature—although the technology variable dominates, suggesting that the finding is somewhat invariant to the size of the plant, at least in its application to the manufacturing plants comprising this sample. Finally, and although the sample size was too small to check for this directly by stratifying the data, the results may generalise to most industries in Canada as a check on the overall sample found it to be reasonably representative of the study's population with respect to industry. Such industry invariance would be expected based on our current state of knowledge (although much more work needs to be done in this area). In summary, a considerable amount of analytical generalisation for the theory has already emerged, although further studies examining these and other conditions are still necessary.

This study also examined whether the adoption of the organic form of control in JIT firms leads to greater rates of improvement being observed in seven key performance areas for JIT firms. In all seven improvement areas, the survey data were consistent with this hypothesis, with the bulk of the correlations being of considerable magnitude. Again it needs to be repeated that the data underlying the improvement rate variables are weak and that the study's research design did not attempt to control for the various "third-variables" that could contaminate the results; consequently, the results should only be considered preliminary with further research in this area being necessary. Nonetheless, these results are encouraging and provide an important starting point for follow-up activities. Increasingly, firms are changing their performance metrics and obtaining reliable data on a wide scale should now be feasible.

Finally, this study makes a methodological contribution in providing a method for classifying JIT firms and measuring the mechanistic/organic

construct. In both cases, the extensive checks undertaken to examine their validity indicate that the measures are highly satisfactory for survey-type research; moreover, the large correlations obtained (by behavioural research standards) in the examination of the first hypothesis along with observing the expected network of relationships provide further evidence attesting to their validity. Nonetheless, improvements to the mechanistic/organic measure are possible. One possible modification would be to include information pertaining to the use of self-managing teams. Another would be to determine whether and how to incorporate the number of hierarchical levels (flatness) into the measure given Abernethy and Lillis' (1995) results indicating its importance in achieving effective integration.<sup>12</sup>

The fact that JIT firms are adopting organic structures has several implications for future management accounting research. First, the increased emphasis on *self-management* (i.e. empowerment and self-guidance) creates a need for lower level employees to have information so that they can monitor their own performance, determine the cause of their problems, learn about the efficacy of their changes, and receive the satisfaction that comes with the recognition of making improvements. Empowerment alone is not enough; frequent feedback of relevant and reliable information is also necessary (Schonberger, 1982; Drucker, 1990). Statistical process control, pareto charting, cause and effect diagrams, and the use of non-financial performance measures are all important tools in this endeavour. The use of micro-profit centres also has possibilities (see Cooper, 1995), but much more research needs to be performed on understanding their dynamics and behavioural consequences. For

<sup>12</sup> As a start in this direction, a factor analysis was performed on the set of variables comprising (a) factor 1, (b) factor 6, and (c) the number of hierarchical levels (flatness) to determine how flatness relates to the other two factors. The results indicated that flatness loaded on a separate (third) factor. In addition, running the test of hypothesis 1 with flatness rather than CONTROL as the dependent variable did not produce any significant patterns. Thus it is not clear how or even whether flatness should be incorporated within a measure of the mechanistic/organic construct. Progress on this issue will likely require theoretical development and guidance.

example, Stata (1989) reports that the adverse behavioural consequences attributed to Analog's transfer pricing system led to its discontinuation for internal purposes. Finally, the balanced scorecard measurement concept—which puts strategy and vision, and not control, at the centre—appears valuable in focusing individuals' behaviour strategically (Kaplan & Norton, 1996). Thus, the information bricks supporting self-management appear to be in place; however, what is now required are more implementation stories (cases) and studies examining their consequences on job performance and job satisfaction.

Second, the focus on *horizontal integration* poses new informational demands. Drucker (1988, p. 49) made the observation that everyone needs to ask: "Who in this organisation depends on me for what information? And on whom do I depend?" In addition, we must consider: "Who is affected by my actions and decisions?" This list will not only include superiors and subordinates, but also colleagues in other departments with whom coordination must occur. This requirement will become increasingly necessary as more and more middle management jobs are withdrawn. In this connection, the role of the management accountant is to create the kind of information that enables individuals or teams to see more quickly the impact of their actions on overall performance (Vowles, 1993). The basic point is that without such information it is difficult to determine whether a proposed modification is truly an improvement, or whether it simply makes things look better in one corner only to makes things worse overall. Activity-based responsibility accounting is one approach that has been advocated for managing interdependent activities (processes) and measuring group performance (see McNair, 1990). The use of strategically-driven, integrated performance measurements which integrate actions across functional boundaries is another (see Nanni et al., 1992). Again, more research is needed on how organisations are actually grappling with the information requirements posed by horizontal integration.

Finally, the concepts of horizontal integration and teamwork run counter to the prevailing social and organisational culture of North America

emphasising individuality, competition and individual achievement. In particular, the case studies performed by the researchers indicate that companies are struggling with how to modify incentive systems to better promote teamwork. At a practical level, cultural and union impediments hinder attempts at changing the reward structure. At another level, management is struggling with the issue of what performance *level* should be the basis for offering rewards: individual vs team vs company performance. Lastly, once the answer to the latter issue is known, there still exists the further issue of determining the appropriate performance measure(s) and, if there is more than one measure, the manner in which they should be combined. Armitage and Atkinson's (1990) study is an important starting point in this regard but much more research on the innovative reward systems being adopted by leading companies is necessary.

### Acknowledgements

We thank Mark Covalesski, Bob Miller, Marilyn Sagrillo, K. R. Subramanyam, Urban Wemmerlöv, participants at the 1995 AAA Mid-West regional meetings in Dearborn, MI and the 1996 Strategic Management Accounting conference in Edmonton, and the Strategic Management Accounting conference's anonymous reviewer for their helpful comments and suggestions. Research support from the Society of Management Accountants of Canada is gratefully acknowledged.

### References

- Abernethy, M. A., & Lillis, A. M. (1995). The impact of manufacturing flexibility on management control system design. *Accounting, Organizations and Society*, 20, 241–258.
- Armitage, H. M., & Atkinson, A. A. (1990). *The choice of productivity measures*, Hamilton, Ontario: The Society of Management Accountants of Canada.
- Bell, R. R., & Burnham, J. M. (1989, September–October) The paradox of manufacturing productivity and innovation. *Business Horizons*, 58–64.
- Bhimani, A., & Bromwich, M. (1991). Accounting for just-in-time manufacturing systems. *CMA Magazine*, 65 (1), 31–34.
- Burns, T., & Stalker, G. M. (1961) *The management of innovation*. London: Tavistock Publications.

- Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Conover, W. J. (1980). *Practical nonparametric statistics* (2nd ed.), New York: John Wiley & Sons.
- Cooper, R. (1995). *When lean enterprises collide: competing through confrontation*. Boston, MA: Harvard Business School Press.
- Daft, R. L. (1982). *Bureaucratic versus nonbureaucratic structure and the process of innovation and change*. In S. B. Bacharach (Ed.), *Research in the sociology of organizations*, Vol. 1 (pp. 129–166). Greenwich, CT: JAI Press.
- Daft, R.L. (1986). *Organization theory and design* (2nd ed.). St. Paul, MA: West Publishing.
- Dodd, A.J. (1995). The just-in-time environment. in B.J. Brinker (Ed.), *Handbook of cost management*. Boston, MA: Warren, Gorham & Lamont.
- Drucker, P., (1988, January–February) The coming of the organization. *Harvard Business Review*, 45–53.
- Drucker, P. (1990, May–June). The emerging theory of manufacturing *Harvard Business Review*, 94–102.
- Duimering, P. R., & Safayeni, F. (1991). A study of the organisational impact of the just-in-time production system, In A. Satir (Ed.), *Just-in-time manufacturing systems: operational planning and control issues*, (pp. 19–32). New York: Elsevier.
- Flamholtz, E. G. (1983). Accounting, budgeting and control systems in their organisational context: theoretical and empirical perspectives. *Accounting, Organizations and Society*, 8, 153–169.
- Foster, G., & Horngren, C. T. (1987). JIT: Cost accounting and cost management issues. *Management Accounting*, 68 (12), 19–25.
- French, W. L., & Bell, C. H. Jr. (1984). *Organisational development: behavioral science interventions for organization improvement* (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.
- Fry, L. W. (1982). Technology-structure research: three critical issues. *Academy of Management Journal*, 25 (3), 532–552.
- Galbraith, J. R. (1973). *Designing complex organizations*. Reading, U.K: Addison-Wesley.
- Hall, R. W. (1983). *Zero inventories*. Homewood, IL: Dow-Jones Irwin.
- Hall, R. W. (1987). *Attaining manufacturing excellence*. Homewood, IL: Dow-Jones Irwin.
- Hay, E. J. (1988). *The just-in-time breakthrough: implementing the new manufacturing basics*. New York: John Wiley & Sons.
- Heiko, L. (1991). The conceptual foundations of just-in-time. In A. Satir (Ed.), *Just-in-time manufacturing systems: operational planning and control issues* (pp. 3–18). New York: Elsevier.
- Hickson, D. J., Pugh, D. S., & Pheysey, D. C. (1969). Operations technology and organization structure: an empirical reappraisal. *Administrative Science Quarterly*, 14, 378–397.
- Horngren, C.T., Foster, G., & Datar, S. (1994). *Cost accounting: a managerial emphasis*, 8th (ed.), Englewood Cliffs: Prentice-Hall.
- Hunt, R. G. (1970). Technology and organization. *Academy of Management Journal*, 13 (3), 235–252.
- Kaplan, R.S. (1986). Accounting lag: the obsolescence of cost accounting systems. *California Management Review*, 28 (2), 174–199.
- Kaplan, R. S., & Norton, D. (1996). *Translating strategy into action: the balanced scorecard*, Boston, MA: Harvard Business School Press.
- Kass, R. A., & Tinsley, H. E. A. (1979). Factor analysis. *Journal of Leisure Research*, 11, 120–138.
- Keller, R.T., Slocum Jr., J. W., & Susman, G.L. (1974). Uncertainty and type of management system in continuous process organizations. *Academy of Management Journal*, 17, 56–68.
- Kim, J. & Mueller, C. W. (1978) *Introduction to factor analysis*. Beverly Hills, CA: Sage Publications.
- Klein, J. A., (1989, March–April). The human costs of manufacturing reform. *Harvard Business Review*, 60–66.
- Klein, J. A. (1991). A reexamination of autonomy in light of new manufacturing practices. *Human Relations*, 44 (1), 21–38.
- Lindsay, R. M. (1993). Achieving scientific knowledge: the rationality of scientific method. In M. J. Mumford & K. V. Peasnell (Eds.), *Philosophical perspectives on accounting: essays in honour of Edward Stamp* (pp. 221–254). London: Routledge.
- Lindsay, R. M., (1995). Reconsidering the status of tests of significance. an alternative criterion of adequacy. *Accounting, Organizations and Society*, 20, 35–53.
- Lindsay, R. M. and Ehrenberg, A. S. C., (1993, August). The design of replicated studies. *American Statistician*. 217–228.
- Lindsay, R. M., & Kalagnanam, S. (1993). *The adoption of just-in-time production systems in Canada and their association with management control practices*. Hamilton, Ontario: The Society of Management Accountants of Canada.
- Linsu, K. (1980). Organisational innovation and structure. *Journal of Business Research*, 18, 225–245.
- Mackey, J., & Thomas, M. (1995). Costing and the new operations management. In D. Ashton, T. Scapens, & T. Hopper (Eds.), *Issues in management accounting*. London: Prentice Hall, pp. 87–112.
- Manoochehri, G. H. (1988). JIT for small manufacturers. *Journal of Small Business Management*, 26 (4), 22–30.
- McNair, C. J. (1990). Interdependence and control: traditional vs. activity-based responsibility accounting. *Journal of Cost Management* (Summer), 15–24.
- McNair, C. J. (1995). Responsibility accounting and controllability networks. In B. J. Brinker (Ed.), *Handbook of cost management* (pp. E4–1–E4–33). Boston, MA: Warren, Gorham & Lamont.
- McNair, C. J., Mosconi, W., & Norris, T. F. (1989). *Beyond the bottomline*. Homewood, IL: Dow-Jones Irwin.
- Merchant, K. A. (1985). *Control in business organizations*, Boston, MA: Pitman.
- Mintzberg, H., (1979). *The structuring of organizations*. Englewood Cliffs, NJ: Prentice Hall.

- Nanni Jr., A. J., Dixon, J. R., & Vollman, T. E. (1992). Integrated performance measurement: management accounting to support the new manufacturing realities. *Journal of Management Accounting Research*, 4, 1–19.
- Neale J. M., & Liebert, R. M., (1986). *Science and behavior: an introduction to methods of research* (3rd ed.), Englewood Cliffs, NJ: Prentice Hall.
- Nemetz, P. L., & Fry, L. W. (1988). Flexible manufacturing organizations: implications for strategy formulation and organization design. *Academy of Management Review*, 13, 627–638.
- Neumann, B. R., & Jaouen, P. R. (1986). Kanban zips and cost accounting: a case study. *Journal of Accountancy*, 162 (2), 132–141.
- Nunnally, J. C., (1967). *Psychometric theory*. New York: McGraw-Hill.
- O'Grady, K. E. (1982). Measures of explained variance: cautions and limitations. *Psychological Bulletin*, 92, 766–767.
- Otley, D. T., (1987). Accounting for divisional planning and control. In K. R. Ferris and J. L. Livingstone (Eds.), *Management planning and control: the behavioural foundations*, (pp. 83–120). Revised ed., Beaver Creek, OH: Century VII Publishing.
- Parthasarthy, R., & Sethi, S. P. (1992). The impact of flexible automation on business strategy and organisational structure. *Academy of Management Review*, 17, 86–111.
- Parthasarthy, R., & Sethi, S. P. (1993). Relating strategy structure to flexible automation: a test of fit performance implications. *Strategic Management Journal*, 14, 529–549.
- Robbins, S. P. (1983). *Organization theory: the structure and design of organizations*. Englewood Cliffs, NJ: Prentice Hall.
- Robinson, M. A. (Ed.) (1989). Stanadyne diesel systems (A). In *Cases from management accounting practice* (Vol. 5, pp. 19–26). Montvale, NJ: National Association of Accountants.
- Ross, G. H. B., (1990, November). Revolution in management control. *Management Accounting*, 23–27.
- Scapens, R. W., (1990, September). Researching management accounting practice: the role of case study methods. *British Accounting Review*, 259–282.
- Scapens, R. W. (1992, December). The role of case study methods in management accounting research: a personal reflection and reply. *British Accounting Review*, 369–384.
- Schermerhorn Jr., J. R., Hunt, J. G., & Osborn, R. N. (1985). *Managing organisational behavior*, (2nd ed.), New York: John Wiley & Sons.
- Schonberger, R. J. (1982). *Japanese manufacturing techniques: nine hidden lessons in simplicity*. New York: The Free Press.
- Schonberger, R. J. (1986). *World class manufacturing: the lessons of simplicity applied*. New York: The Free Press.
- Senge, P. (1990). *The fifth discipline*. New York: Doubleday Press.
- Sepehri, M. (1986). *Just-in-time, not just in Japan*. Falls Church, VA: American Production and Inventory Control Society.
- Starbuck, W. H., & Dutton, J. M. (1973). Designing adaptive organizations. *Journal of Business Policy*, Summer, 21–28.
- Stata, R. (1989). Organisational learning—the key to management innovation. *Sloan Management Review*, Spring, 63–74.
- Steers, R. M. (1988). *Introduction to organisational behavior* (3rd ed.). Glenview, IL: Scott, Foresman and Company.
- Swenson, D. W., & Cassidy, J. (1993). The effect of JIT on management accounting. *Journal of Cost Management*, Spring, 39–47.
- Thompson, J. (1967). *Organizations in action*. New York: McGraw-Hill.
- Vowles, A. (1993, April). Gaining competitive advantage through organisational learning. *CMA Magazine*, 12–14.
- Wallace, R. S. O., & Cooke, T. E. (1990). Nonresponse bias in mail accounting surveys: a pedagogical extension. *British Accounting Review*, 22, 283–288.
- Wallace, R. S. O., & Mellor, C. J. (1988). Nonresponse bias in mail accounting surveys: a pedagogical note. *British Accounting Review*, 20, 131–139.
- Wilkinson, B., & Oliver, N. (1989). Power, control and the Kanban. *Journal of Management Studies*, 26 (1), 47–58.
- Woodward, J. (1980). *Industrial organization: theory and practice*. 2nd Edn. Oxford: Oxford University Press.
- Yin, R. K., (1989). *Case study research: design and methods* (2nd ed.). Beverly Hills, CA: Sage Publications.
- Zwerman, W. L. (1970). *New perspectives of organisational theory*. Westport, CT: Greenwood Press.