Technological Innovation Studies Program

Research Report

AUDIT OF CANADIAN ENVIRONMENT AND MANAGEMENT PRACTICES IN PRODUCTION PLANNING AND INVENTORY CONTROL

by

P.R. (Britney) and E.F.P. Newson

School of Business Administration,
University of Western Ontario.
April, 1975.

Rapport de recherche

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The views and opinions expressed in this report are those of the authors and are not necessarily endorsed by the Department of Industry, Trade and Commerce.

THE CANADIAN PRODUCTION OPERATIONS MANAGEMENT ENVIRONMENT

AN AUDIT*

By

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and

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April 1975

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**The authors wish to acknowledge the contribution of G. Edey, principle research assistant. Other assistants included J. Bonny, N. Heeney, K. Hill, and G. Tapley.

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*Under separate cover and available on request.

TABLE OF EXHIBITS

1. INTRODUCTION

Production and Operations Management (POM) plays a key role in the transformation of raw materials into finished goods and services of appropriate time, place and form utility. The prime objective of this audit (POMA) is to clearly identify and generate some insights into various dimensions of the production and operations management force in Canada.

Specifically, through the sampling of Canadian operations, this audit attempts to:

a) Demonstrate clearly that a unique POM audience exists whose prime concern is operations within Canada.

b) Describe in some detail, this audience by documenting;
   i) Their skills, training experiences and expectations,
   ii) The environment within which they function,
   iii) The set of activities and responsibilities undertaken.

c) Identify and begin to address some key issues of Canadian operations management involving continuing education and management training, suitable criteria for success as well as the potential elements of competitive advantage.

The implications for upper management, business educators, and governments are briefly discussed with an eye to strengthening the contribution of Canadian production and operations managers.

The simple research design of this field study clearly reflects its preliminary nature. Approximately 80 participants of the 1973 and 1974 Production Operations Management Course (POMC) of The University of Western Ontario's Business School were interviewed. A personal face-to-face interview provided the vehicle for interviewers to complete a questionnaire interpreting questions and responses as required for 80 respondents.

A copy of the questionnaire is included as Appendix 6.2 and a copy of the 1974 POMC brochure as Appendix 6.3. A computer summary and the master code for this audit is given in Appendix 6.4.

2. THE COMPANY, THE PRODUCT AND THE OPERATIONS MANAGER

2.1 The Company and the Product

The average parent company of the audit had sales of $292M (million) for its entire Canadian operation. The actual distribution of sales is shown in Exhibit 1. The company was usually national in scope. The average number of employees for the entire Canadian operation was 9,615 of which 6,855 were employed in the production function. 40% of the companies were subsidiary operations of foreign-based parents.

The types of industries represented are given in Exhibit 2. The managers described their particular plants or units in the following manner. The units were branch plants or divisions of a single manufacturing company and were located in Ontario. The average number of employees for the branch plant was 734, of which there were 568 production employees. The annual dollar value of goods produced by the plant was $38M. Replacement value for the plant and equipment was $29M. Elimination of the top three companies in this category reduced the mean to $24M. The number of product lines that each plant produced was 5, with the major product accounting for over 60% of the total dollar value of goods and services. The major product was defined by the managers as the one with the highest dollar volume produced or the highest unit volume. The principal product was usually assembled and averaged 5 components. The managers felt that their products were

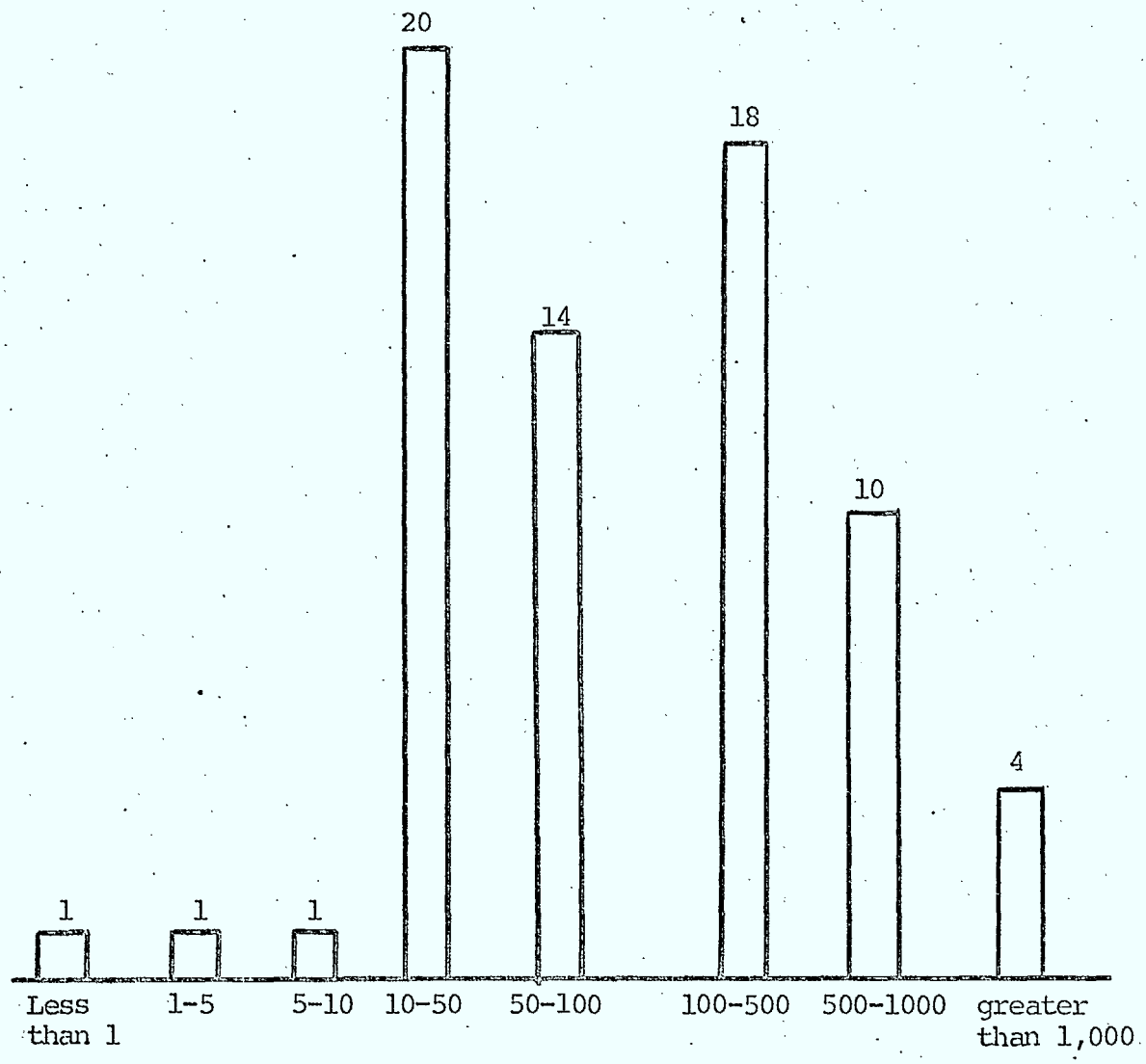


Exhibit 1 - Sales Volume of Goods and Services For The Companies' Canadian Operation (in $000,000)

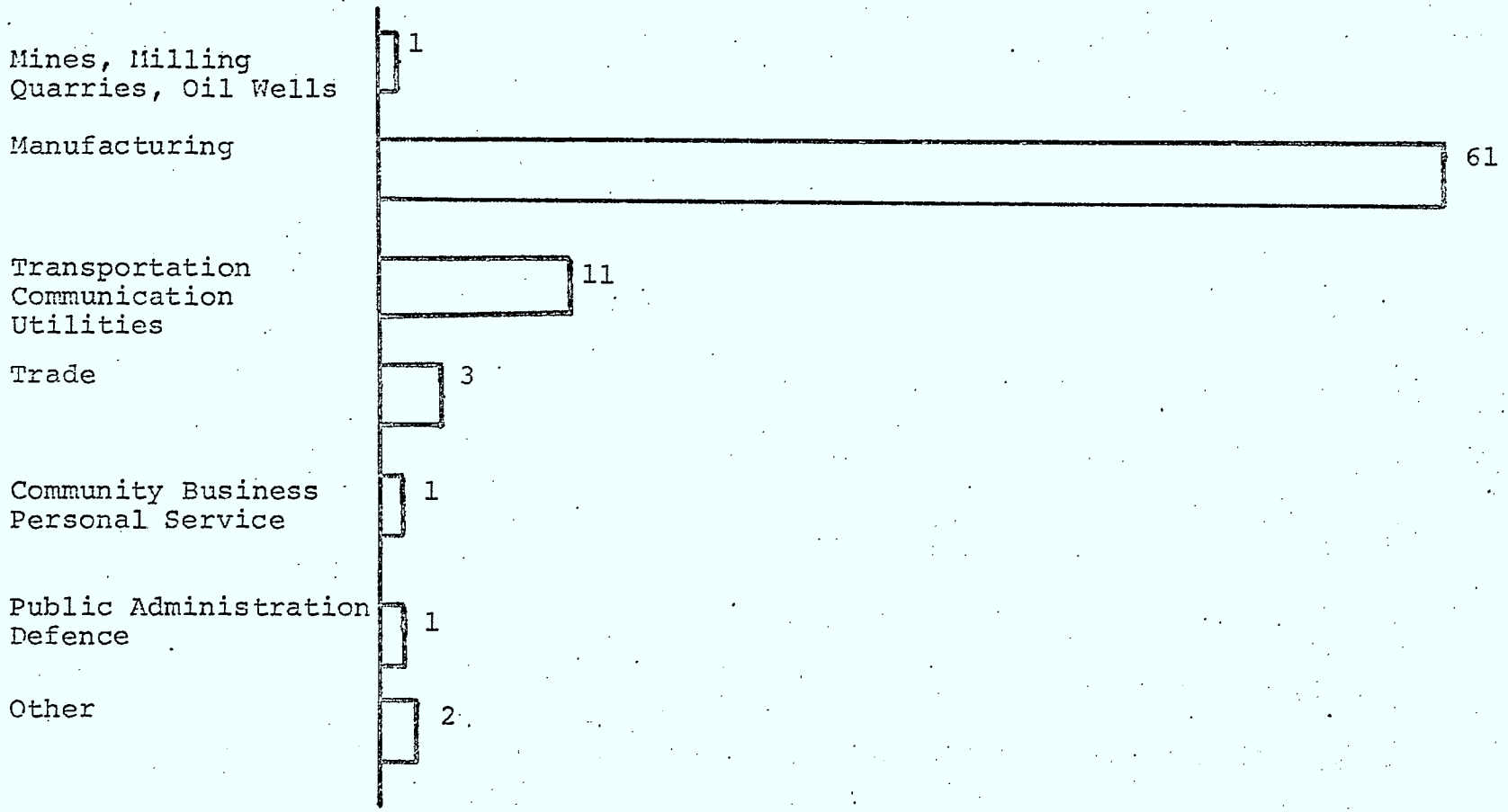


Exhibit 2 - Types Of Industries Represented by the Audit

somewhat technologically difficult to design and to manufacture but surprisingly, technologically easy to use.

2.2 The Production Operations Manager

The production operations managers perceive themselves as predominantly line managers, whose prime task is getting the product out. Production is primarily to order. The distribution of the managers' positions and roles is shown in Exhibit 3.

The average manager was 37 years old with 3 years experience in his present position. Over half the managers had some exposure to university courses, either having a degree or having taken some night classes. The education distribution is also given in Exhibit 4(a), showing exposure to various areas of studies as well as highest level of education attained in Exhibit 4(b). Of those holding bachelors degrees, 95% graduated in science and/or engineering fields. Although several managers had been exposed to M.B.A. studies, only one held the degree. On company sponsored or outside seminar courses, the most common subjects were human relations/industrial relations, followed by planning/scheduling, as shown in Exhibit 5. Invariably the managers felt they benefited greatly from management training courses and felt that others, with whom they worked would benefit also. Surprisingly, in their libraries, they averaged only 3 technical texts, 13 business texts and virtually no production texts.

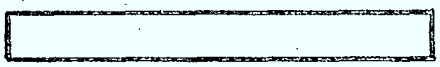
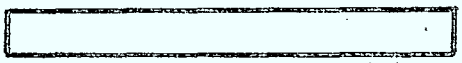
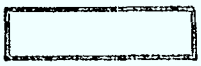
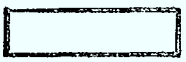
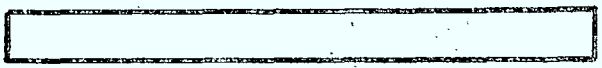
Position/Role	Relative Frequency	%
Vice-President of Operations Director of Manufacturing		3
Plant Superintendent Works Manager		21
Production Manager/Supervisor Manufacturing Manager		23
Ass't Plant Superintendent Ass't Manufacturing Manager		9
Ass't Production Mgr/S'visor Ass't Manufacturing Manager		6
Foreman/Group Leader		8
Others		30

Exhibit 3 - Job Classification Of The Managers

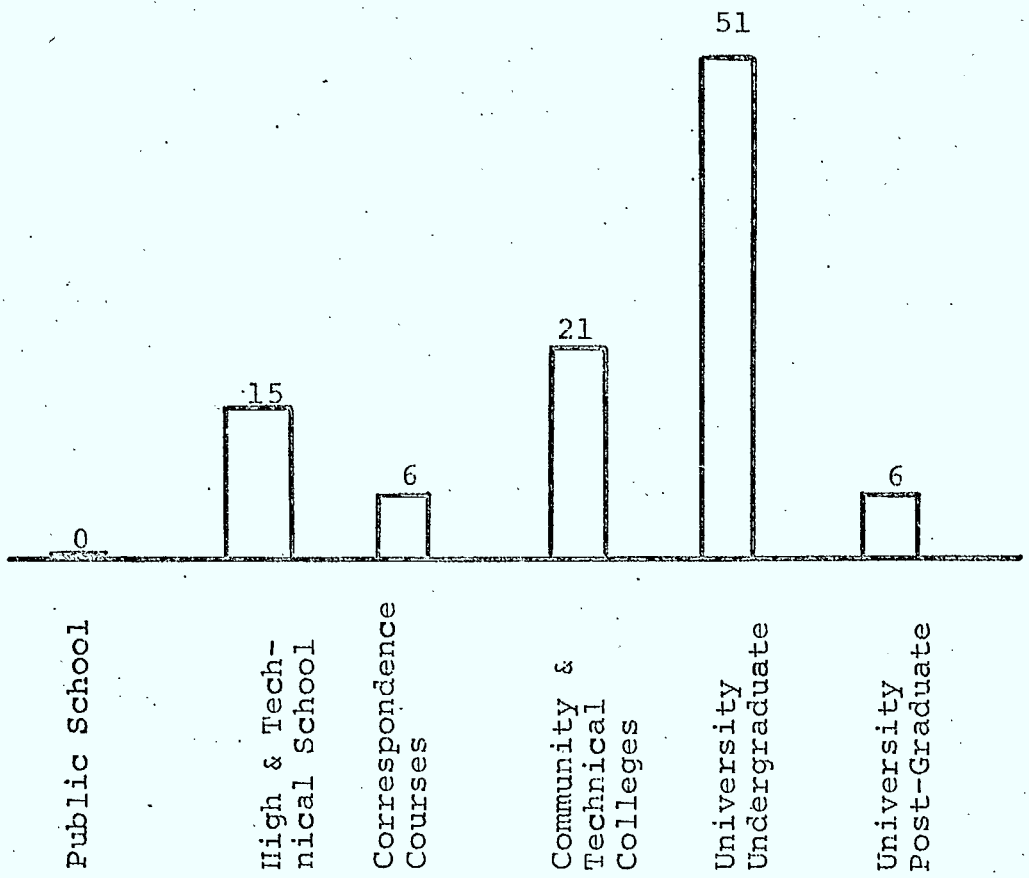


Exhibit 4(a) - Exposure to Various Education Institutions (highest exposure level) (%)

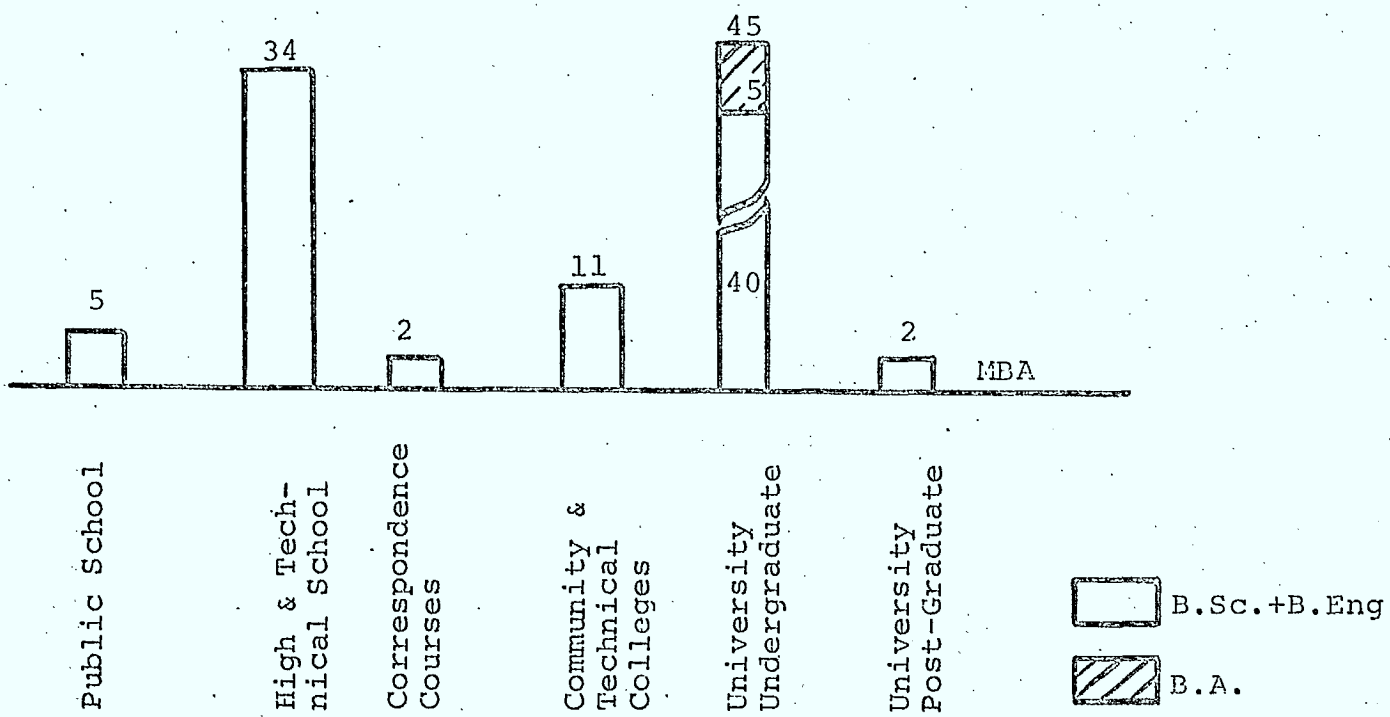


Exhibit 4(b) - Actual Education Attained For 1974
Managers Only
(highest completed level) (%)

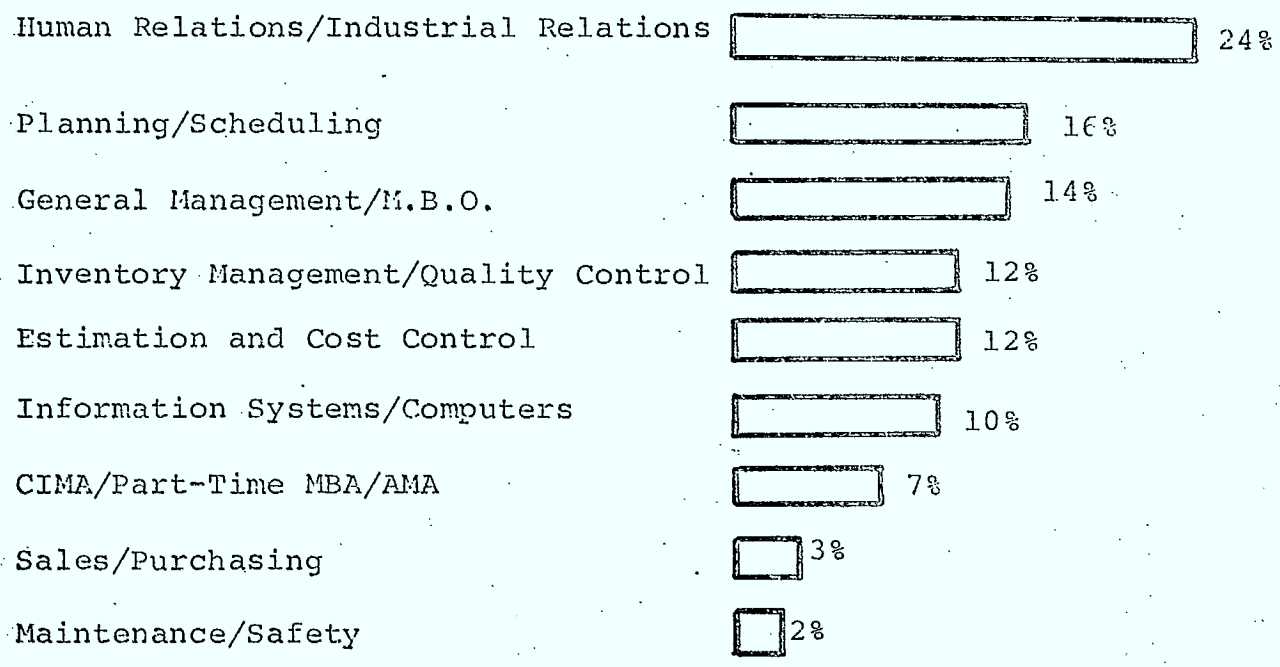


Exhibit 5 - Subject Matter of Continuing Education Courses Attended

2.3 The Production Process

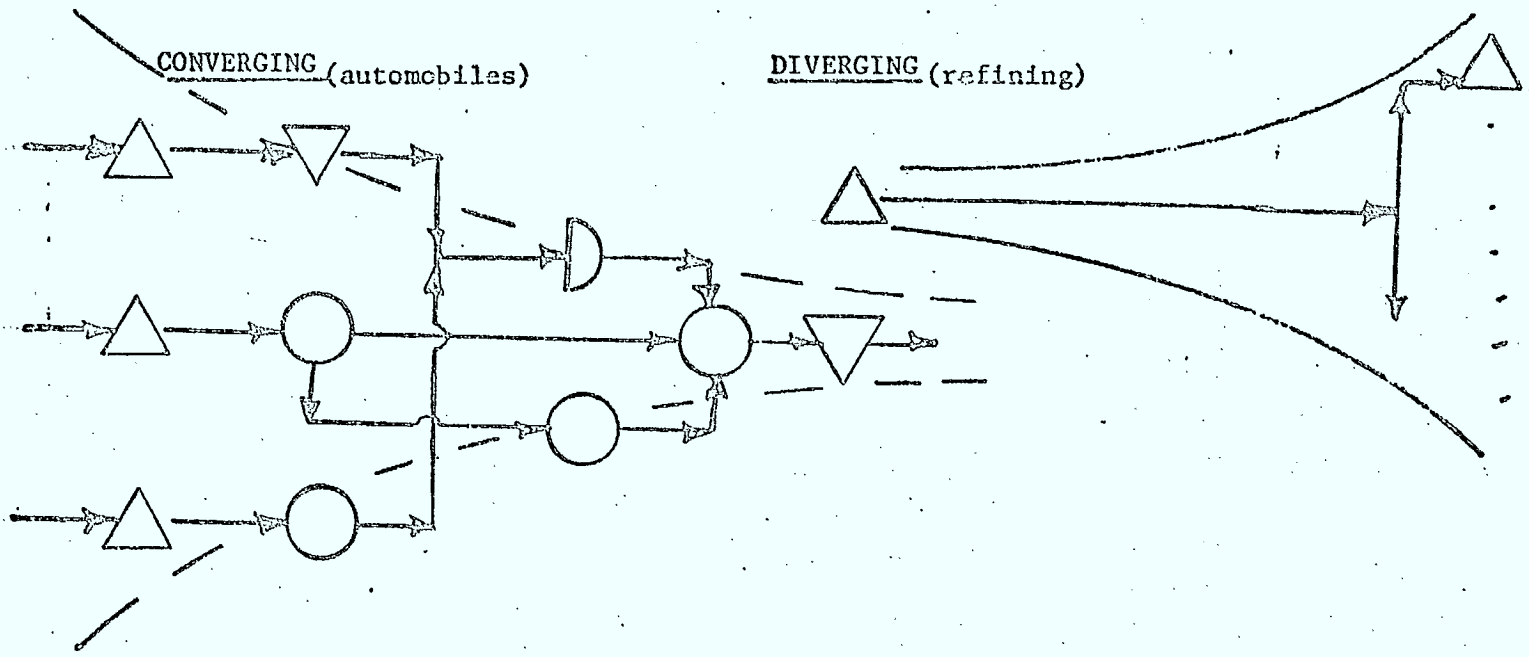
It is difficult to develop a picture of the typical or average production process; however it is useful to review the configurations encountered and to summarize the responses obtained in this audit.

Converging, straight-line, diverging and indeterminant flow patterns were defined as per Exhibit 6. The flow patterns in use are summarized in Exhibit 7.

Several flow patterns usually existed in each operation. However, on the average, 94% of the balance of the product lines followed a similar flow pattern to that of the main product line.

With respect to the determination of the flow of materials the responses were equally split. About 49% of the respondents perceived it as a fixed flow pattern while 51% perceived the flow as discretionary. When discretionary, production planning and control routed all flows.

In summary these observations clearly suggest that production operations managers see themselves in well-defined flow systems in which the major products follow similar flow patterns. These represent relatively homogeneous operating systems with little uncertainty in regards to flow.



STRAIGHT LINE (packaging)

INDETERMINANT (No dominant flow pattern)
(job shop)

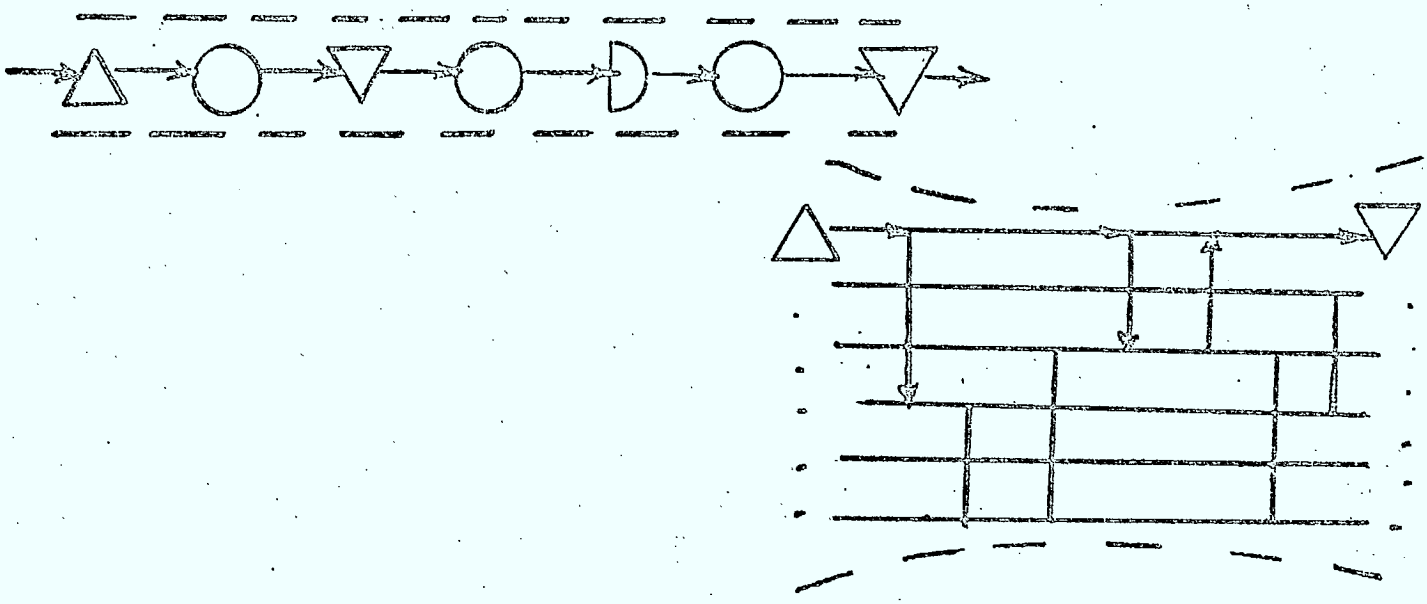


Exhibit 6 - Flow of Materials Configurations

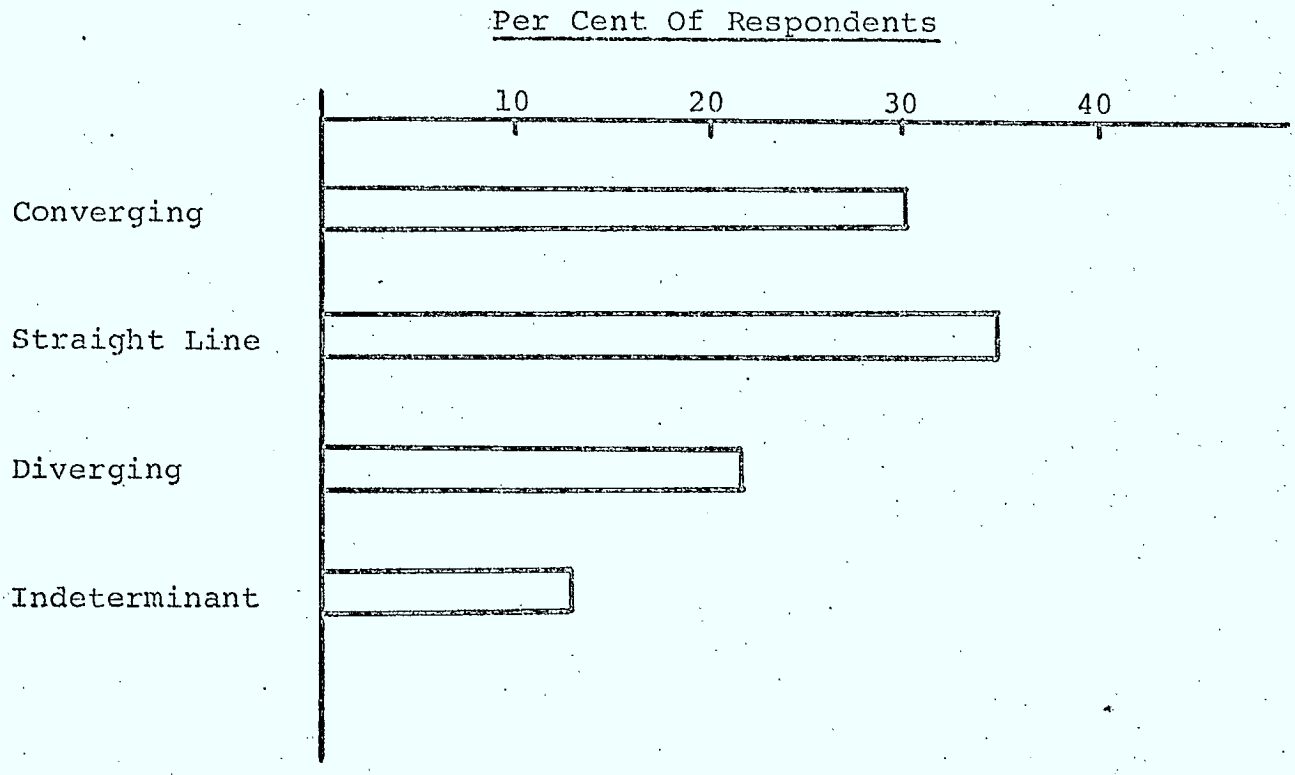


Exhibit 7 - Flow Patterns Exhibited

3. THE JOB AND THE ENVIRONMENT

3.1 Details of the Task

The task of operations management is perceived to be rather complex, involving a variety of activities from cost control to long range planning as outlined in Exhibit 8. It is interesting to note that some of the traditional areas of standards, long range planning (capacity), product design and plant location occupy relatively lower positions than control activities on this scale of activity.

Very little effort is apparently spent on generating reports. The manager typically generates one report each month -- the operating statements. This report is sent to his superiors where the respondent feels the report is used routinely.

A great deal of effort, however, is put forward digesting the many varied reports received. Exhibit 9 shows the variety of reports received by typical managers in terms of the relative frequency of these reports as well as their sources. The manager receives, on average, 38 production efficiency reports per year, 35 scrap/quality control reports and 23 operating statements. His 9 most frequent reports are received from levels of production below him. In total a surprising 88% of the manager's information comes from this source. These reports are used routinely and production efficiency is the one the manager pays most attention to. Rarely does a manager transform a report he receives. Reports are completely written or formal i.e. there is very little verbal and informal reporting.

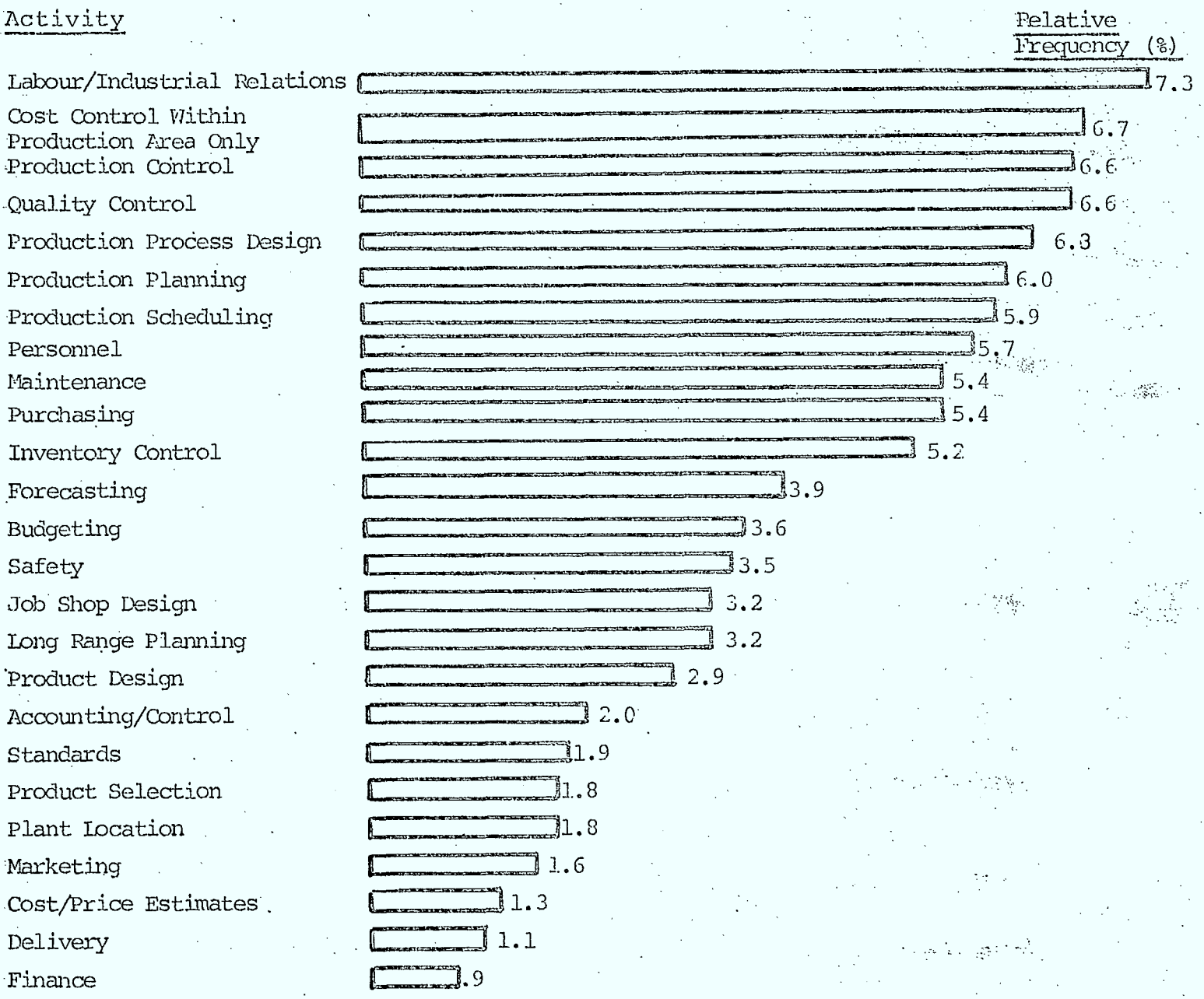


Exhibit 8 - Tasks of the Operations Manager

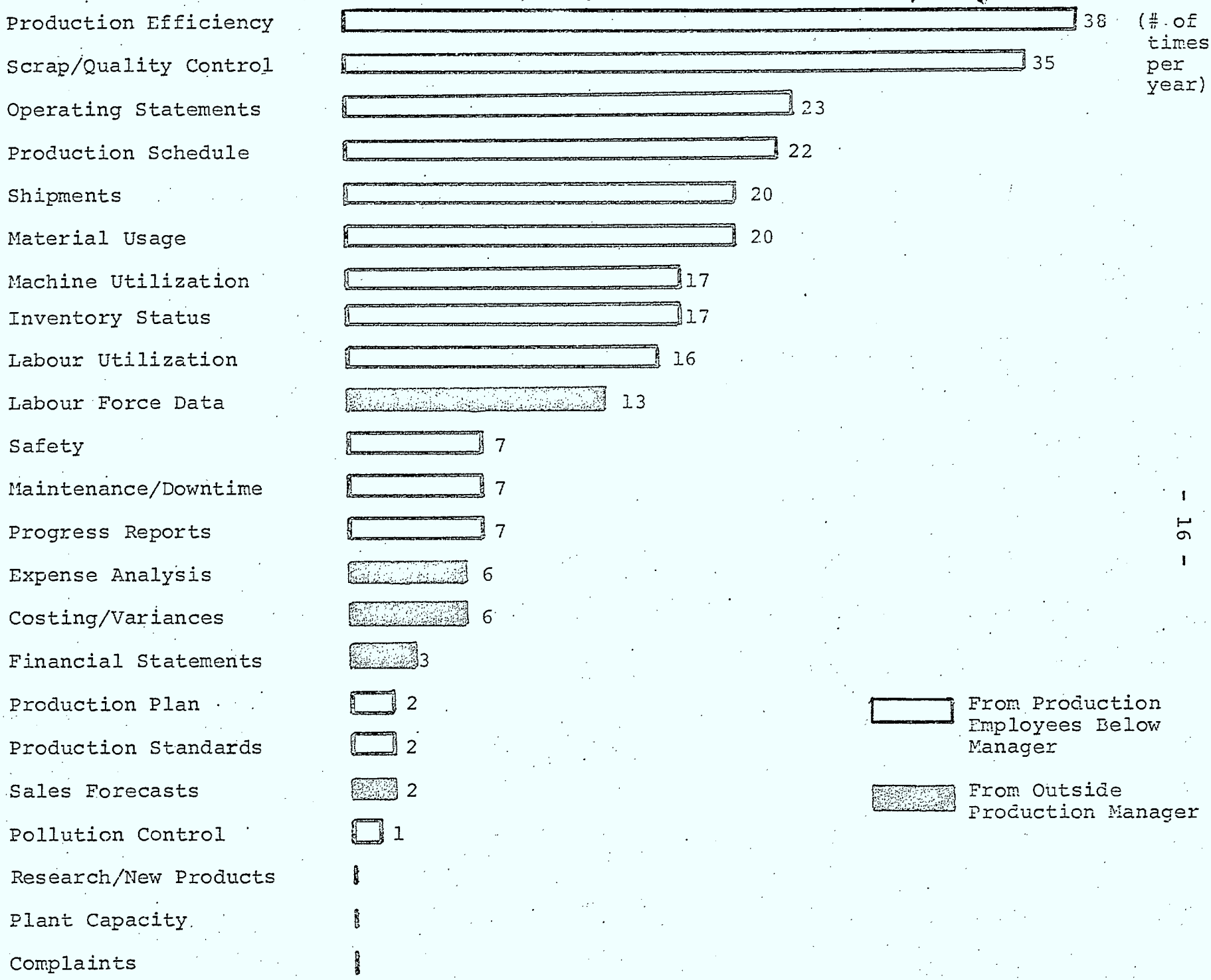


Exhibit 9 - Relative Frequency and Sources of Reports Received

3.2 The Operations Management Environment

Labour force data is received from the personnel department 13 times a year and it is used routinely. Expense analysis and costing/variance reports are received from the finance and accounting departments 6 times a year and are used routinely. Clearly more emphasis is placed on after-the-fact efficiency and utilization reports and less on setting standards, capacity and production planning.

The operating horizon appears to be immediate and very short; whenever a delivery date is to be missed clearly the order of actions are first to allow overtime, second to expedite and only as a third choice, to inform the customer and renegotiate the delivery date. Only 41 of the 80 managers in this sample could give their company service level. The average of the 41 replies was very high being 90%.

The manager typically supervises 10 people directly and 274 people indirectly. He is evaluated mainly on cost minimization and productivity. In addition, delivery and quality are the prime measures of perceived success. Immediate indicators of "when all is well" are developed through reports, and are again quality, cost, and delivery oriented. When questioned on their information needs, operations managers want no additional information. This suggests that they are at home with the "status quo" of production operations management.

Co-operation with the traditional support functions of Purchasing, Quality Control, Finance and Accounting are perceived to be significantly better than that of such dependent functions as Marketing. The poorest relations occurred with the Industrial Engineering and Operations Research groups. It is interesting that the managers feel that this group has only been somewhat useful in their services provided to the production function. Almost 77% of the managers had access to such a group.

Essentially the production manager is responsible for most raw material, work-in-process and finished goods inventories. Clearly the bulk exists in raw materials, acting primarily as safety (buffer) and cycle (lot size) stocks. Work-in-process stocks are next largest, designed to decouple the stages of the production process. Finally finished goods stocks are smallest, accumulated in the form of safety stocks. The control of inventories is established through re-order points and order quantities. Re-order points are usually determined from safety stocks. Order quantities are perceived to be established by user requirements, with some references to the carrying costs of inventory. Only one company had a materials requirements planning system.

The companies have an official sales forecast, generated by the sales or marketing group. It is only a descriptive or non-quantitative model and has a time horizon of one year with

monthly revisions. Planning meetings, however, are held or attended every week; in two thirds of all such meetings only line managers are in attendance.

Computers play an important role in operations. 93% of the companies have access to a computer. The company has had a computer for 8½ years while the manager has had use of it for the past 6 years. The manager uses the computer only somewhat but finds it quite useful when he does. It is used mainly for Accounting/Payroll Billings and Inventory Control and is useful in that it saves time and provides new information with more recency. The managers felt that it would impose some hardship to operate now without a computer.

In summary, this audit suggests that the operations manager must develop a set of skills to read and digest significant amounts of input information on a variety of activities and then must act decisively to meet performance standards on quality, cost and delivery dimensions. Cost minimization is still very important and considerable rivalry still exists between the key line functions of marketing and production operations management.

4. SOME IMPORTANT ISSUES

After reviewing the results of this audit, several key issues are evident. Although each will be dealt with separately they are in summary form:

a) How can Canadians generate a more competitive advantage through effective operations management?

b) What is a suitable criterion for success in Canadian production operations management?

c) What are the essential elements of training Canadian managers in production operations?

Facing issues such as these may be the first essential step in the development of a strong, innovative and competitive Canadian economy.

4.1 How Can Canadians Generate a Competitive Advantage Through Effective Operations Management?

There are four areas where Canada can generate a competitive advantage. They are;

1) With existing products using existing processes and operating efficiently thereby minimizing costs,

2) With existing products using new, innovative processes thereby creating cost reductions,

3) By developing new, marketable products and producing them using existing production processes,

4) By developing new products and new production processes.

Traditionally, Canada's lower labor costs have successfully countered competitor's advantages in economies of scale. This situation may not hold in the future. How can Canada compete without economies of scale? Is there an opportunity to make the product differently through the adoption of innovative production processes? Using the same technology as competitors, can Canada operate systems more efficiently so as to create cost advantages? These options suggest a strong need for superior managerial skills in production operations.

4.2 What Is a Suitable Criterion for Success in Canadian Production Operations Management?

Different operating environments clearly require different criteria for success. Perhaps the two extreme criteria are efficiency on the one hand and flexibility on the other. Although these criteria are not mutually exclusive, i.e. criteria can exist together, however in general, a company must operate predominantly with one criteria only. These criteria and the corresponding environments in which they thrive, are an import- and dimesion of production operations.

Efficiency

Consider an environment where a high volume mature product is relatively undifferentiated, and marketing competition is based mainly on price. Assume also that there is a standard, well-defined process for making the product. This suggests an efficient, low cost production system with a high degree of reliability and utilization of material resources. With less opportunity to improve the physical system, efficiency and productivity become most important.

These situations usually occur where the technology of the environment is well-known and stable; few engineering changes occur and production can be planned with relative ease. Most tasks are relatively standardized and well-defined. There is usually little interface between production and marketing as requirements are known with a fair degree of certainty. The larger volumes generate more opportunities for economies of scale.

Flexibility

An environment quite opposite to that above is one where flexibility is a more suitable operating criterion for success. New products are introduced frequently and there is continual updating and changing of older products. Technologies are changing, continual revision of products and processes introduce a high level of uncertainty. Even when a product design

is relatively stable, there is usually room for innovation, both as a result of manufacturing technology and production system designs. Low volumes necessitate frequent set-ups and generate uncertainty of future runs.

In this environment, opportunities for innovation at all levels within the production system abound. For example, scheduling becomes an important problem; uncertainty of product, process and future demands on the production system are common. Clearly operating costs are less important, and adaptability to change and innovation are a most important ingredient for success.

Whatever the appropriate criteria for success, efficiency or flexibility, an important issue becomes one of how to develop and train production operations managers. Exhibit 10 summarizes the criteria suggested above.

CERTAINTY OF
PRODUCT SPECIFICATION
(VARIETY)

PRODUCT VOLUME	UNCERTAIN	CERTAIN
LOW (INTERMITTENT)	JOB SHOP FLEXIBILITY	
HIGH (CONTINUOUS)		LINE FLOW EFFICIENCY

Exhibit 10 - Criteria For Success and Some Key Dimensions of Production Operations

4.3 What Are the Essential Elements of Training Canadian Managers in Production Operations?

Managers may adopt one of several contemporary management styles including theory X, theory Y, management by objectives (MBO) and so forth. Another system, however, tends to appear in the field of production operations; managers often try to engineer operations rather than manage them under the guise of technology.

This distinction can best be seen by example; first as technologists and operations researchers who try to solve key problems once and for all in the one best way through the applications of specific tools and/or techniques. Another situation may be industrial engineers who try to eliminate behavioural problems through automation. It is typified by the so-called optimal plant layout configurations guaranteed to minimize costs. These approaches are in themselves most commendable and quite appropriate. However it is an attitude of finality that characterizes the engineered solution.

Environment dynamics tend to cast shadows on the appropriateness of concepts such as equilibrium, steady-state and optimization conditions, dramatically decreasing the returns and benefits from engineered operations. Management becomes a very important contributor of effective operations, requiring management skills which lie beyond technology.

5. SURVEY RESULTS AND IMPLICATIONS FOR THE FUTURE

5:1 The Situation

The results of this audit describe the operations environment within which our sample of Canadian managers work. Our managers are evaluated on cost minimization and efficiency. Their major activities include cost control, production control, labor and industrial relations, and quality control. The reports most frequently received are production efficiency, scrap and quality control and operating statements. They in turn generate summary statements for others.

Many Canadian companies seem to be operating in apparent equilibrium situations where there is little or no perceived incentive for change. Rewards encourage managers to operate at peak efficiency; flexibility and development become secondary issues. Canadian production operations appear to have chosen a criterion for success most compatible with relatively high continuous product volumes and more certain product specifications.

The reasons for this situation are probably many and varied. As foreign companies expand into Canada, their products may be mature and standardized, the processes may be fully engineered and standardized. Canadian-owned companies in secondary manufacturing fields often produce derivatives

of foreign designed products. As product technology is licensed, so too are processes. Thus a prime production criterion for such companies become stable, minimum, and predictable costs.

In addition to this operating environment, there appears to exist an inadequate exposure to a broad range of management activities such as marketing and policy, a noticeable lack of business and, in particular, production management reference materials on the job and a general tendency to design and engineer rather than manage systems and situations. When coupled with the prevalent task of digesting reports and planning through others, we see some strong implications for future directions in developing effective Canadian operations through managerial training and an effective competitive advantage.

5.2 Developing a Potential Competitive Advantage

This inquiry has considered how increased productivity in the manufacture of goods and in the rendering of services in Canada might improve our international competitive posture. Our tentative findings indicate that it would be premature to expect managers directly responsible for our production resources to generate this increased productivity.

This is not to be critical of Canadian production and operations managers. On the whole, they operate in systems of moderate technical sophistication, in primary or secondary industry;

they quite rightly are expected to provide stable, dependable, efficient, minimum-cost performance. When we examine the characteristics of these managers--their age, temperment, focus of education--in the context of the imperatives of the organization they serve, it is not difficult to understand why there is a reluctance to suggest entrepreneurial and risk-taking modifications to their systems. By nature they are conservative, and they have chosen to operate in systems where stability and predictability are considered absolutely necessary.

Under the circumstances, it would be unrealistic to ask managers to participate in any general way in the design and modification of their production systems to routinely include high risk and high payoff innovative production processes. This, it appears, is not their job!

We should address the question then: if competitive advantage is to be achieved through increased productivity, what can we ask of the operations manager in this regard? You may recall that we are suggesting increased productivity as an alternative strategy to new and better products. Let's examine some of the current activities of universities, government, and business on the issue of competitive strategy in general.

New product development has historically been the focus; much government funding has been applied to the generation and encouragement of new and better products. In addition, both the

Office of Science and Technology and the Department of Industry, Trade and Commerce have expressed interest over a period of years in research and development "follow through"--getting new products out of laboratories and into the market place successfully. In the private sector, corroborating conversations with senior managers of large corporations reveal their need for managerial entrepreneurs who can escort new products from the laboratory, through development, and out to the marketplace. Contrary to usual corporate practice, these managers are often hired rather than trained and developed.

In marketing new industrial products, Professor B. Little[1] of Western's Business School has spent considerable time researching management practices in the introduction of new products--but from the marketing point of view. Ph.D. theses by Cooper and More have extended this work.

In addition to the activities of finding, developing, and marketing new products, there may be a need for another skill, introducing new processes. Recent studies by Professor M. Leenders and P. Richardson document the evolution of new process technology in Canada in the mining industry.

Again, Professor A.R. Wood and R. Elgie are currently studying early and late adapters of new technology with government

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[1] References to published literature and research in this section are listed in Appendix 6.1.

sponsorship. Professors Crookell, Wrigley, and Killing (all of Western's Business School) are completing research on the transfer of technology and issues of sovereignty.

In summary, if it is true that Canada may forge a competitive advantage through innovative operations management, and if it is true that managers of change at all levels may be required to execute this strategy effectively, our findings suggest that a cadre of qualified production operations managers may not be available. What are the implications for continuing education to ensure that our production operations managers provide this leadership? What further studies might be appropriate to define his role and expected impact on Canada's competitive posture?

5.3 Continuing Education in Operations Management

Production operations management is closely tied to production, systems analysis, industrial relations and industrial engineering disciplines. The problems, basic tools, models and philosophies are tightly interwoven. Manufacturing has traditionally provided an exciting and data-rich environment in which to define, develop and apply them. Recently the term operations has been broadened in definition to include service and other non-manufacturing activities, and the basic tools of production operations management are being liberally applied outside manufacturing. Many of the courses offered by universities,

associations and consultants tend to be short, periodic and directed towards the more pragmatic areas such as scheduling, inventory control and human relations. Due to time limitations, short courses of one week or less usually emphasize content, and the details of implementation are left for post-program, on-the-job training. Yet the single most distinguishing feature of production operations management clearly lies in its central focus on the management process of which an essential ingredient is implementation. One common skill participants do bring to the classroom and are usually willing to share are their experiences in somehow getting things done.

A real opportunity exists for continuing education in production operations management to meet the needs of managers today. The remainder of this paper discusses our approach and the Production/Operations Management Course (POMC) at the School of Business Administration, The University of Western Ontario, Canada. Exhibit 11 summarizes the contents of this program of study; for more detail see Appendix 6.3. Implications regarding continuing education for operations managers are presented below.

Our experiences indicate that the Canadian production operations managers attending POMC are quite adept at getting things done, sometimes at extreme personal costs. They view implementation as a very important aspect of their decision making, and an area in which they can and do contribute readily.

They enthusiastically devour the Management Accounting portion of the course, while still remaining uncertain as to how much time and study they should devote to Marketing. Quantitative methods and the traditional Operations Management sections are religiously accepted as review and in-depth study in their area of expertise. A lot of it is not review, but in fact new concepts and approaches to their problems. Industrial Relations are studied with requests for more on Organizational Behaviour and Interpersonal Skills. The computer-related areas are still viewed with some suspicion, and although fully accepting computers, our managers still feel little need to study the area in any depth.

Several observations must be dealt with head-on by management education. First, the task of operations management is perceived as complex; techniques alone, however complex, do not work! Implementation is a very large part of all activities and indeed they clearly see their job as one of getting things done. The case study method offers a rich background for developing experiences in action planning.

Second, a process of staffing-off some or most of the traditional activities of production is apparent. Our managers get involved less with the design activities such as product design, plant location, product selection, long range planning and standards. Their tasks are heavily laden with more control-oriented activities such as cost control, production control, industrial relations, quality control, inventory control, and

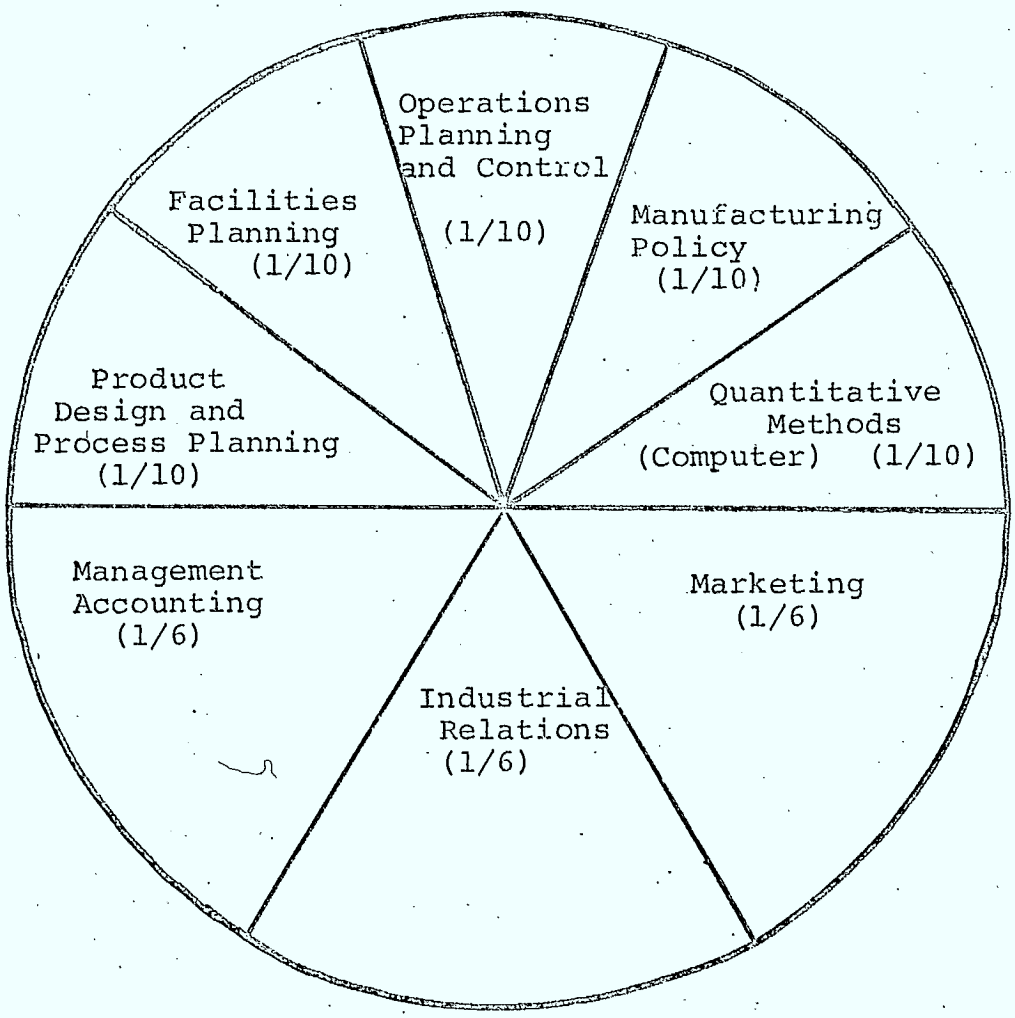

Exhibit 11 - POMC 74
Program Make-Up

scheduling. Clearly more educational effort must be devoted to the design and utilization of reports to rapidly digest the information contained there-in and support their control-oriented task of getting things done. Obviously, a user orientation must be the target in such areas as quality, inventory and cost control as well as management information and control systems.

A third area evolved around a narrow perceived attitude towards measures of performance. Very few participants looked beyond a quality, cost, or delivery measure against some historical norm or derived standard for measures of success. Flexibility in meeting rapidly changing demands and coping with a rapidly changing environment is not perceived as an acceptable performance criterion. In Canada, this may be the only dimension upon which one can compete with large multi-national operations.

A fourth concept concerns the cost minimization attitude "that you must pay for everything". Managers use full costs in all decisions, allocating fixed costs with reckless abandon. Their abilities to distinguish between relevant costs for purposes of decision making and full costs for profit assessment are non-existent. In attempting to pay for everything, such things as overhead and depreciation get in the way and lead to poorer decisions. Few operations are in fact profit-centres so that relevant costs rather than profits are of critical importance. When given the opportunity, these managers devour information on cost behaviour; the implications are obvious.

Finally, there exists a very real dependency on the computer without understanding what it can do. Since most design activities are staffed-off, systems designs are generated elsewhere. Computers have been in use for an average of seven years, and yet very few can talk about them to any depth. They feel that they cannot operate without them. When asked what they would like from the computer, our operations managers wanted more of the same information, but in a different form. Again the implications are for an urgent user orientation program towards the computer.

As a result of our experiences with Canadian managers, several key dimensions of the continuing education task emerge.

1. Since production operations managers perceive their role as definitely "line", our programs should continue to draw upon and develop the expertise our managers have in implementation and getting things done.

2. Since we cannot rely on managers to see the full implications of models to their operating tasks, our programs should continue to stress a balanced presentation of tools, techniques and concepts as well as the implications of these methodologies.

3. The managers we see are quite narrow in background and exhibit deficiencies in dealing with the rest of the organization. Many current systems are designed

to take away many of the traditional areas through specialist staff functions, termed earlier as staffing-off. Therefore we must continue to offer a broadening experience rather than an in-depth narrow program, one that facilitates the interchange of ideas across all phases of operations.

4. Since continuing education courses often represent our managers' first formal study in management, we should clearly build on the things they do well and not deny their experiences. This suggests that we should carefully develop and reinforce operations management skills spanning some of their favourite areas including engineering and the behavioural sciences.

The case study total immersion approach provides an excellent vehicle for involving managers in interesting and relevant issues, and carrying these studies through to action oriented implementation stages. Rather than studying the decision-making process per se, taking an active role in the process is far superior. More research obviously needs to be done on the basic set of skills needed by operations managers.

5.4 Conclusion

This inquiry has surveyed existing operations in Canada, and considered how the management of production operations could influence Canada's international competitive posture.

Our tentative finds suggest that there is an exciting opportunity to increase the effectiveness of the managers who direct our production facilities and the resources throughout Canada.

Examining their characteristics and the organizations they serve, it is not difficult to understand an apparent reluctance to innovation. By temperment, the managers seem to be conservative. They have been trained and developed to operate systems where stability and predictability are considered absolutely necessary. These systems are of moderate technical sophistication and require stable, reliable, efficient, minimum cost performance.

In summary our audit suggest that Canadian production operations managers require additional learning experiences, specifically in the area of improved managerial rather than technological skills. Further, the development of our managers should be undertaken with knowledge of their potential contribution to Canada's competitive position in international trade. This knowledge is well beyond the scope of this research, however continued research at this and other Schools may provide some insights soon.

6. APPENDICES

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