TRANSFORMATION IN TECHNOLOGY, ORGANIZATION AND LOCATION: THE CASE FROM THE CLINICAL LABORATORY SYSTEM OF BRITISH COLUMBIA

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ABSTRACT

Multi-unit, multi-location organization is one of the most salient characteristics of contemporary enterprise. The transformation in the structure of enterprise from the independent, small-scale operation to the complex, multi-unit, multi-location system has been an integral part of wider societal change. Yet the current functioning of these systems and the processes underlying their transformation is not well understood. Particular deficiencies exist in our understanding of the relationship among the technology, organization and location of multi-unit enterprise.

A case study of transformation in the British Columbia laboratory system between 1954 and 1984 shows that the spatial and organizational structure of enterprise is not driven by any single variable and, in particular, technology is not the "prime mover" behind structural change.

The process of structural change is a synergistic one in which external environmental factors and strategic choice have a more dominant influence on transformation than does technology. Thus organizational and location options are not dictated, rather they are perceived and selected as a purposeful response to environmental conditions. This conclusion is reached from a critical evaluation of literature drawn from organization theory, decision-theory, cybernetics and the geography of enterprise; and from the case study.

In particular, it is shown that in the 1950s and early 1960s, strategic decisions were taken that resulted in relative decentralization of laboratory activity, organizationally (down the hospital hierarchy) and geographically (towards the periphery). These decisions were taken

in response to the changing political, social and medical environment. But these decisions clearly predate the availability of technologies that might encourage such dispersion, indicating that technology is not a necessary and sufficient condition for structural change.

Technology can have an impact on the degree of centralization in multi-unit enterprise. In certain circumstances, the development and deployment of specific technologies coincides with a strategic decision to either centralize or decentralize activity. In such circumstances, equipment embodied technology can make a powerful contribution in transforming the relative centralization or decentralization of the system, but it does not determine the choice between centralized or decentralized. Rather, it amplifies the chosen direction.

These findings have policy and research implications for society, for the urban system, for enterprise, in general, and for the future of the clinical laboratory system of B.C., in particular.

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TRANSFORMATION IN TECHNOLOGY, ORGANIZATION AND LOCATION: THE CASE FROM THE CLINICAL LABORATORY SYSTEM OF BRITISH COLUMBIA

CHAPTER 1 - INTRODUCTION

1.1 INTRODUCTION

Multi-unit, multi-location organization is one of the most salient characteristics of contemporary enterprise. The transformation in the structure of many enterprises from independent, simple, small scale operations to complex, multi-unit, multi-location systems has been an integral part of wider societal change (Bell (1976), Reich (1983), Trist (1980)). In recent years, an increasing number of questions have been raised about the role, viability and performance of multi-unit enterprise. First, the complex multi-unit enterprise is facing greater uncertainty because of environmental turbulence associated with recession, deregulation, competition and technological change (Trist 1980). Environmental turbulence requires great adaptability, but it is argued, many multi-unit enterprises have been failing in this regard (Peters and Waterman (1982), Harris (1981)).

A second and related matter is that the current structure of many multi-unit enterprises has become dysfunctional, not only because of a turbulent environment but because of inherent 'design flaws' in organization. In particular, analysts note the poor performance of some enterprises in terms of efficiency, effectiveness, quality of worklife, spatial distribution and lack of innovation (Schumacher (1973), Huber (1984), Harris (1981), Bluestone and Harrison (1982), Reich (1983)).

Thirdly, there are problems in complex enterprises resulting from the explosion in the availability of information technology. Technological change creates uncertainty, through widespread belief that information technology is bringing about a transformation in the way multi-unit systems are structured in organizational and spatial terms (e.g., Toffler (1980), Bjorn-Anderson (1979)). Particularly, it is suggested that information technology has a propensity to change the degree of centralization/decentralization of activities and decision-making within enterprise.

Finally, there are concerns in academic circles that the political, economic, organizational and geographic approaches to the study of contemporary complex, multi-unit enterprise lack both explanatory power and ability to guide policy and management decisions in any meaningful way (e.g., Huber (1984), Goddard (1980), Bell and Kristol (1981), Kuttner (1985)).

This thesis examines, in general terms, the transformation in the relationship among the technology, organization and location of multi-unit enterprise over the past thirty years. It draws together threads from complementary sets of literature on technology, organization and location and concludes about the relationships among these variables that are emerging in contemporary enterprise. These conclusions are then tested in a case study of the clinical laboratory system of British Columbia.

1.2 TRANSFORMATION IN THE STRUCTURE OF ENTERPRISE: A SYNOPSIS

1.2.1. The Pre-Industrial Enterprise

In the pre-industrial mercantile world, the structure of most enterprise was shaped by the prevailing methods of production and distribution and by the philosophies underlying those methods. Thus the size and functioning of enterprise was shaped by trade guilds, local trade cartels and by highly localized market conditions. The most prevalent organizational form was a simple structure with master and artisan working in small, independent units. Spatial structure at this time conformed to the random distribution of resources and site potential and was reinforced by the patterns of spatial interaction that were prevalent in simple agrarian systems (Mumford (1961)).

1.2.2. The Industrial Enterprise

With the advent of the industrial age, there was a discovery of the productivity-inducing potential of the division of labour. This set the stage for the enmeshing of technology and organization, in which the specialization of tasks and the coordination and synchronization of activities (i.e., organization) became closely related to the emerging forms of technology, in particular the machine. Throughout the nineteenth and early twentieth centuries, the theories and underlying values of economics and mechanical engineering prevailed as the principles on which the structure of organization was based (Reich (1983), Bell (1976)). This organizing priniciple was given further embellishment and formalization with Taylor's influential work on Scientific Management, Taylor (1911), in which the engineering philosophy was carried to its logical conclusion. Widespread acceptance of Scientific Management from the 1920s on had a major impact on enterprise in North America and indeed in the Soviet Union (Bell (1976)), that was reflected in the rigid and hierarchical "machine bureaucracy" in large scale public and private enterprise (Mintzberg (1979), (1983)).

From the 1930s on, Mayo and the Human Relations School provided insights about the need for human engineering in large scale enterprise (e.g., Roethlisberger and Dickson (1939) and Mayo (1949)). The applied psychological tradition that followed in organization theory was just as instrumentalist in philosophy as Scientific Management in its intent to improve efficiency, but it did help to raise questions about the complexity of human behavior and interaction in the enterprise.

Despite an interest in the human side of organization, machine bureaucracy continued as a common structure of enterprise. Indeed the principles of economies of scale and bureaucratic organization have been extended in the structure and management of the large divisionalized, multi-national corporation (Taylor and Thrift (1983a), Mintzberg (1983)). In many cases, management has been standardized and formalized to the point where it can be superimposed throughout the diverse businesses and multiple locations of the multi-national conglomerate but with mixed results (Reich (1983).

The influence of economizing principles on industrial organizations is also paralleled in locational patterns of enterprise. Emphasis on economies of scale, minimizing costs of movement and maximizing the economic benefits of agglomeration (i.e., spatial clustering) seems to have developed a spatial calculus that dominated analysis of, and decision-making about, the spatial structure of the industrial organization.

The negative externalities of bureaucratic forms in industrial organizations have been long recognized (even by Max Weber himself in his chapter on the Iron Cage (Weber 1947)) as they relate to questions of stress and alienation. Over the last twenty five years however, a diverse range of observers have questioned the economic and functional virtues of bureaucracy and large scale organization. For example, the early work of Burns and Stalker (1961) in organization theory, argued that 'mechanistic structures' (bureaucracy) were appropriate for repetitive operations in stable environments but that in more complex and dynamic environments, enterprise must adopt an 'organismic' form if it is to be able to innovate and adapt. Similarly the more recent popular management literature has questioned the effectiveness of bureaucratic structures for large corporations operating in turbulent environments, e.g., Peters and Waterman (1982), Naisbitt (1982), Deal and Kennedy (1982), and Huber (1984). Marvin Harris, a cultural anthropologist, in his observations on '<u>America Now</u>', Harris (1981) and Schumacher (1973), an economist, in his thesis that '<u>Small is Beautiful</u>' both, in their own way, question the performance of the large, mechanistic industrial enterprise.

1.2.3. The Post-Industrial Enterprise

Major changes in enterprise have occurred since the Second World War but most significantly in the last two decades. The increasing turbulence and complexity of the environment and the explosion in the capability and availability of information technology since the mid 1960s are critical components in the transformation of enterprise, particularly for those organizations whose principal raw material is information, e.g., banks, business services, education and health. The rapidity of technological change has stimulated interest in its impact on the organizational structure of enterprise, on the well being of employees and on the spatial organization of multi-unit systems, e.g., the collection of essays in Bjorn-Anderson (1979), (1982), Bannon et al (1982), and Marstrand (1984). A number of views have emerged. At one extreme there are those who argue that we are re-creating the factory of the past in the office of the future, Menzies (1981). These authors are determined to turn back the technological tide and forgo any benefits that technology can bring, because they are convinced technology causes unemployment, "deskilling" (a neologism coined by analysts to describe the reduction in skill reouirements brought about by automation) and centralization of decision-making, e.g., Marstrand (1984), Mather (1980). At the other extreme, there are those who argue for blind application of technology, seeing technological change as good in itself. A similarly polarized literature is developing with regard to spatial ouestions, some are arguing that advances in technology liberate remote settlements from the oppression of distance others argue that such technology increases the spatial centralization of power, activity and opportunity (see Bannon et al (1982) and Mandeville (1983) for reviews of these competing positions).

1.3 DETERMINISTIC APPROACHES TO THE STUDY OF TRANSFORMATION

The process of transformation in the technology, organization and location of enterprise is not well understood. Efforts to date have suffered from an undue focus on determinism.

Four broad forms of determinism can be identified:

a) Technological determinism sees the role of technological change as paramount and normally concludes that technological change causes the organizational and spatial structure of enterprise to follow a particular trajectory. Elements of technological determinism can be seen in a wide range of work from Marx, through Woodward (1965) to computer scientists and pundits, e.g., Toffler (1970), (1980).

b) Organizational Determinism is a term that could be applied to the widely held assertion that in any given context, organizations should be structured a particular way if they are to be effective. (See structural contingency theory discussed in Chapter 2 and Mintzberg (1983)). This literature explicitly or implicitly regards specific organizational processes or environmental attributes as the "prime movers" in determining the relationship among the technology, organization and spatial structure of enterprise. This determinism takes a number of forms. Scale of the enterprise, particular environmental characteristics, specific technologies or strategic choices have each had their moment in the sun as prime movers.

c) Geographic Determinism is reflected in the overwhelming emphasis placed on geographic factors as determinants of organizational and spatial structure. Site and situational factors may have had an important influence on location in earlier times, but in an age when the headquarters of many of the largest and most successful enterprises are located in suburbs of medium sized cities, the geographic deterministic models become untenable, Pred (1977).

d) Economic Determinism is the broad term that could be applied to both structuralist explanation and neoclassical economic analysis of the organization, technology and location of enterprise. The patterns that emerge in these models are determined either by the inevitable clockwork of political economy or by the aggregate effects of cost-minimizing and profit maximizing agents.

Despite a host of analyses, there is no coherent body of organizational, economic or location theory that allows us to deal satisfactorily with the relationship among technology, organization and location in multi-unit enterprise (Taylor and Thrift (1983a)). Yet concerns about these relationships continue to be voiced. Indeed they have been brought to a head by the economic turmoil of the early eighties and by the increasing pervasiveness of information technology. These changes create new challenges and choices for the way enterprise is to be organized.

1.4. SYNERGISTIC APPROACHES TO THE STUDY OF TRANSFORMATION

Explaining the transformation in the relationship among technology, organization and location of enterprise is handicapped by the lack of theoretical models linking these variables. Insufficient attention has been paid to the interaction between these variables. Yet enormous investigative efforts have been made in each and in many cases there has been some insight gained by integrating two of the three variables. For example, organizational theory and its subcomponent structural contingency theory, speaks to the links between technology and organization, but completely ignores the spatial dimension, e.g., Mintzberg (1983). Similarly, office location theory has attempted to deal with either the relationship between technology and location, e.g., Goddard and Pye (1977) or the relationship between patterns of monitoring and control and location, e.g., Daniels (1979), but it rarely integrates technology, organization and location. Much of the geographic literature still demonstrates minimal understanding of organization and confines itself to simplistic economic or structuralist-functionalist rationalizations of the locational behavior of the firm. (The precedents in this literature will be reviewed in Chapters 2 and 3).

Technology, organization and location are inter-related phenomena. Each of these variables has undergone transformation and the relationship among these variables has changed as a result, yet the alternative approaches that have been put forward to understand these transformations; have suffered from an undue focus on determinism and causality.

In this thesis it is argued that transformation in organization, technology and location of enterprise is an integral part of wider societal change. The wider societal transformation, the transformation in technology and organization and the transformation in the location of enterprise are synergistic in their relationship. For example, the environment has become more turbulent partly because of changes in the structure and performance of enterprise, which in turn have been partially mitigated by the turbulence in the environment, the increase in scale and spatial complexity of organization and by a shift in the purpose of enterprise. There is no single cause, no prime mover or unidirectional force that is governing the relationships among these variables. The complexity of these relationships does not mean that we abandon any attempt at analysis, rather it requires that a more synergistic and interdisciplinary approach be adopted in the investigation of these relationships.

There is little precedent for such an approach in social science. We have few coherent conceptual approaches for the description of transformation in complex systems, let alone the theoretical basis to explain such phenomena. Marxist lines of analysis can claim to have some elements of holism but they are by no means devoid of determinism and fixed directionality (see Duncan and Ley (1982)). Systems theoretic approaches have made some contribution to the understanding of the structure and processes operating in complex systems, but in their more mechanistic form they have become inflexible attempts at calibrating the behavior of such complex systems (Crosby (1983)). Cybernetics has also provided a useful base for the investigation of complex, synergistic phenomena particularly in its inclusion of the concept of steersmanship as a central variable in the transformation of complex systems (Corning (1983))

Peter Corning's "Synergism Hypothesis" is an impressive attempt to develop a non-deterministic, general theory of socio-cultural evolution, Corning (1983). A theory that identifies a number of synergistic phenomena pertinent to the process of transformation in complex social systems. Corning and other cybernetic views of enterprise, e.g., Beer (1966) can be applied to the process of structural transformation.

When enterprise is transformed, there is a purposeful change in behaviour (and social and technological organization) generated partly by innate survival instincts (what Corning terms teleonomic selection) and partly by the interaction of perceived environmental conditions and the expected utility of transformation. Thus there are elements of causality and choice operating in the same process. There is also an interaction between sub-processes operating internally in the organization and externally in the environment.

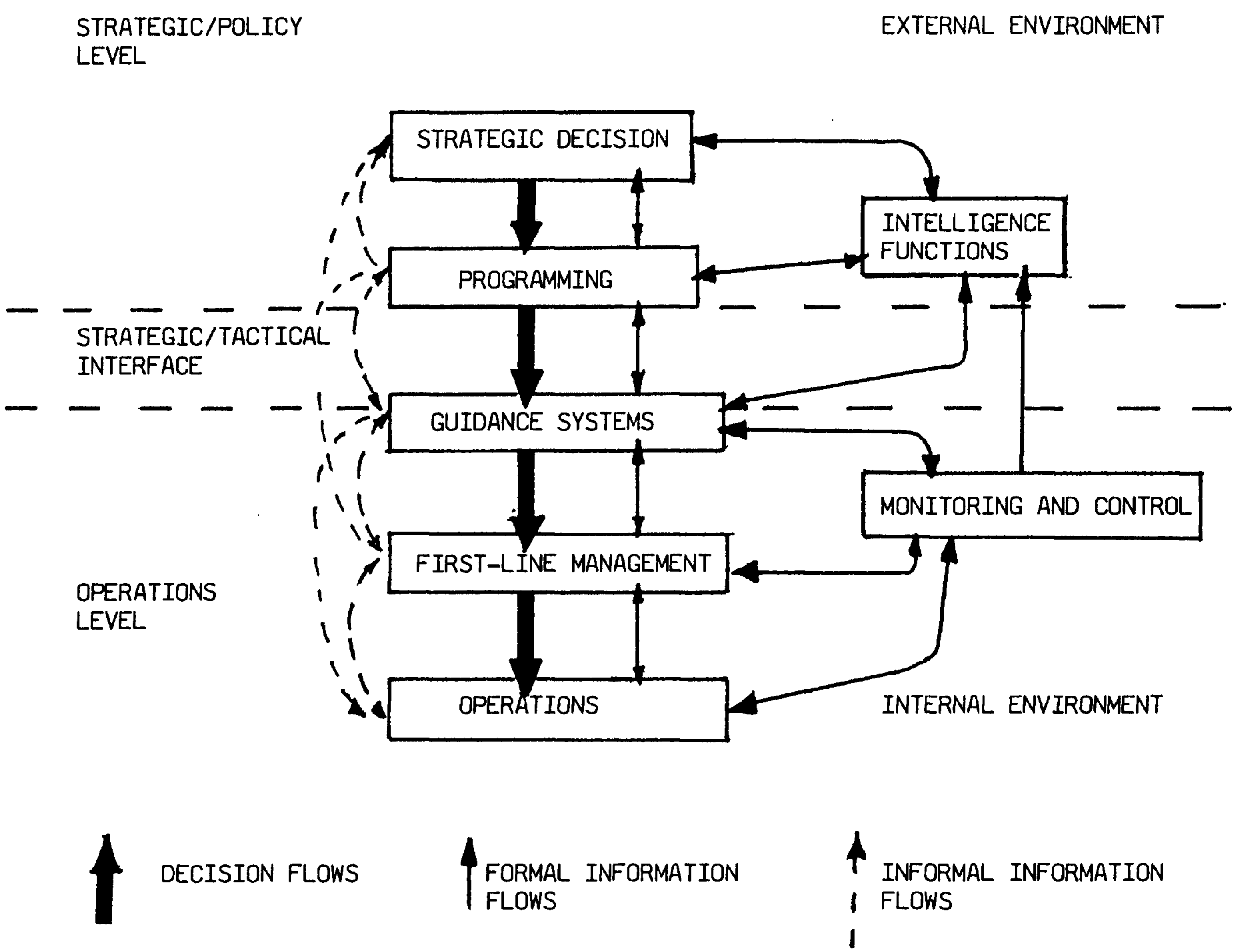
In considering transformation in complex systems then, a number of variables and dimensions must be integrated. None of them can be considered as the necessary and sufficient condition for transformation, although each of them may play a role as a necessary condition in certain circumstances. These factors are not neatly compartmentalized into dependent and independent variables rather they interact in a non-linear, synergistic fashion. Such complexity makes it difficult to operationalize conventional forms of econometric or statistical analysis. In this thesis an alternative form of explanation is sought. A model of multi-unit enterprise will be presented that describes the nature of the hierarchy in complex enterprise. This "prototype" will then be used as a baseline for evaluating structural transformation.

1.5 A MODEL OF MULTI-UNIT ENTERPRISE

Figure 1.1 shows diagrammatically a model of the multi-unit enterprise as a system of decision-levels and information flows. This model is derived from the work of Beer (1966) and Paterson (1981) in management cybernetics and decision hierarchies; from the open systems views in organization theory (see Scott (1981), Mintzberg (1979), (1983)); from the new geography of enterprise (see Taylor and Thrift (1983 a,b)) and from the emerging views of social systems as non-linear decision systems, e.g., Crosby (1983), Prigogine (1977) or evolving cybernetic systems, Corning (1983).

The roots of this model will be described in more detail in Chapter 2, but it is useful here to briefly describe the elements. It is suggested that enterprise operates within the context of a multi-faceted environment. The

FIGURE 1.1 A MODEL OF MULTI-UNIT ENTERPRISE AS A DECISION AND INFORMATION HIERARCHY



enterprise takes strategic decisions based on self-generated goals and on the perception of the environment held by senior decision-makers as it is conditioned by the scanning and probing activities of the organization's intelligence functions, Huber (1984). These decisions are enacted through the programming choices that are made as to the level of activity and funding required by the organization's sub-units to meet the goals of the enterprise. The guidance systems in multi-unit enterprise are defined as the systems involved in "steering" the activities of the sub-units of the enterprise. These may or may not be directly related to the sub-units in a geographic sense or in a direct "line reporting" sense. The activities at each level of enterprise are monitored and controlled to conform to the parameters developed at the strategic and guidance levels. The operations level may or may not require direct first line management depending on the nature of the enterprise under study.

In addition to this decision hierarchy there is a range of information flows both formal and informal that may exist in different forms of enterprise. For example, the much vaunted "management by wandering around" in which strategic managers interact on a casual basis with operations people is an informal information flow. The direct transmission of daily performance reports from sub-units to the strategic decision-level (CEO or Board) is a formal information flow.

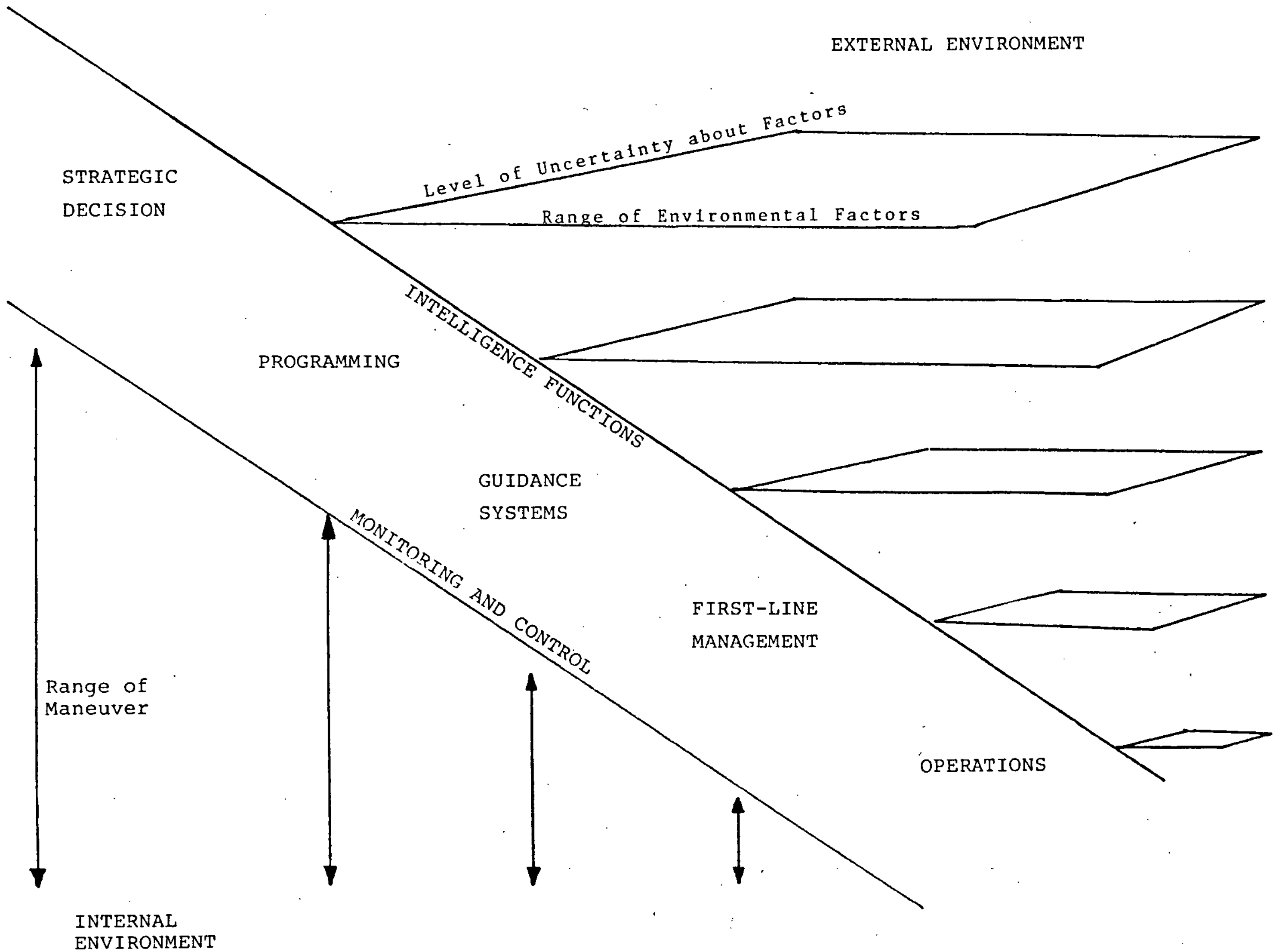
Exchange of information among all the levels can occur in enterprise. Particularly, when the size of the enterprise allows the number of linkages to be manageable and the complexity of tasks involved requires a high degree of formal and informal coordination. However it is more common for a restricted subset of information flows to occur in enterprise, because of the bounded information handling capability of the individuals (March and Simon (1958), Williamson (1975)). Even where perfect and complete information exists, each level will view that information in a selective way.

This basic model can be used as a prototype for examining the relationship between each level of the decision hierarchy. Figure 1.2 shows that at each level, decisions are conditioned by the range and complexity of the environmental field (shown by the surfaces in the diagram) that the decision-maker faces and by the executive constraints imposed from the level above. (The exact model of decisions cascading down a decision hierarchy is drawn from Hardwick's (1982) extension of Paterson's Decision Bands, Paterson (1981) described in more detail in Chapter 2). Each level has some degree of intelligence functions that are involved with probing and scanning the external environment and assimilating these findings within the executive constraints. Similarly each level interacts with the internal environment through monitoring and control functions.

The diagram shows that the environmental surfaces and the organizational options become progressively more prescribed as the hierarchy is descended. This, however, is not a universal truth, rather it depends on the nature of the enterprise under study. Indeed in many cases the environment being faced by the guidance levels or even the operations levels may be more complex than the levels above.

This prototype can be used as a baseline case that can be examined in order to evaluate the transformation in the structure of enterprise. It is hypothesized that the structure of the multi-unit enterprise in spatial,

FIG. 1.2 MULTI-UNIT ENTERPRISE AND THE INTERACTION WITH ITS ENVIRONMENT.



functional and organizational terms is affected by the relationship among:

a) External Environment - Although by no means an independent variable, the external environment in which enterprise operates is one of the critical elements in the synergistic web of factors shaping the structure and performance of organizations. The relationship between environment, structure and performance is neither clear Nor consistent. Just as similar family and educational environments can "produce" junkies and Nobel prize winners, so similar organizational environments can "produce" winners and losers.

b) Strategic Decision - The role of goal setting, of purposeful action is a critical variable recognized in economics, organization theory, cybernetics and political science. Of all the variables considered, strategic decision factors or "purposefulness" seems to be the one necessary, but not sufficient, condition that must exist if complex systems are to survive. It is important to recognize that goals are arrived at through a process of choice, they are not necessarily imposed by some superstructure of society (as the marxists would have us believe) or by some overarching rationality (of economizing, profit-maximizing man as the neo-classical economists infer). The process through which goals are set is a political one (e.g., Corning (1982)). A variety of informational inputs and performance criteria are gathered, analyzed and synthesized by the intelligence function in enterprise. These inputs are incorporated in strategic goal setting and in the critical decisions made by the enterprise. The criteria used by the strategic decision and intelligence functions involve what could be termed the five E's: efficiency, effectiveness, equity, employment and enjoyment (or well being). The resolution of these criteria and interests is achieved through a political process in which the power of interest groups plays a critical role.

c) Internal Organizational Environment - The operating aspects of an organization, i.e., the functions, technology, activities, culture and human factors of organizational behaviour, all contribute to the transformation in the structure of enterprise and affect its performance. Organization theory, organizational behaviour, cybernetics and systems theoretic approaches to organization have in certain cases defined the terms organization and organizational structure to include environment, goals and technology in their definitions. For purposes of analysis here, certain attributes of the internal organizational environment have been separated out and the term organizational structure is used to describe the residual set of factors and related measures.

Table 1.1 shows the dimensions of the internal and external environment. The interaction among these variables is synergistic and it is suggested that there are no causal chains that can be readily drawn out. It is also argued that the interaction between these environmental variables is mediated by strategic choice and by the critical decisions that are made at each level of the decision hierarchy.

In attempting to explore the transformation in the relationship among technology, organization and location these three variables are simultaneously, factors that influence structural transformation and outcomes

TABLE 1.1 - THE STRUCTURE OF THE ENVIRONMENT OF ENTERPRISE

DIMENSION	EXTERNAL ENVIRONMENT	INTERNAL ENVIRONMENT
POLITICAL/ ECONOMIC	Degree of Turbulence Availability of Resources Degree of Competition Degree of Regulation Structural Interests	Size Availability of Resources Relative strength of power elites
SOCIO-CULTURAL	Demographic Factors Social Values Cultural Context	Organizational Style Corporate Culture
TECHNOLOGICAL	Candidate technologies Change Rate R&D efforts	Technologies that are Deployed - Operations Technologies - Co-ordinative technologies
FUNCTIONAL	Candidate Activities Market type	Task environment Size Product diversity
GEOGRAPHIC	Site Situation Markets	Built Environment constraints Physical space requirements

of that structural transformation. For example, if the term organization is thought of as the prevailing pattern of differentiation and communication within the enterprise, then it is both a way of describing the functioning of the enterprise (a dependent variable) and a set of circumstances conditioning change (an independent variable).

Similarly, it seems clear that technology can make a contribution to the process of transformation. However, as Nathan Rosenburg (1982) has pointed out, it is important to distinguish between the mere existence of a technology in the wider environment (invention) and the extent of its diffusion, adoption and use in the enterprise under study. It is technology in operation that can enable system transformation. This requires a synergistic combination of appropriate conditions in environment, organization and strategic decision to be present. Furthermore, it could be argued that the really powerful contributions that technological change has made to the transformation of enterprise and society have been where clusters of technology are involved.

Finally, with regard to location, it seems clear that the limits of the natural environment have lessened their constraints on the behaviour of multi-unit enterprise. Nevertheless, demographic and geographic factors still play an important role where services have to be delivered to people, where goods have to be distributed and where the spatial clustering of activities is a necessity because of the need for face to face contact. To a large degree however, the spatial structure of enterprise can be viewed as an outcome of the interaction of the other factors.

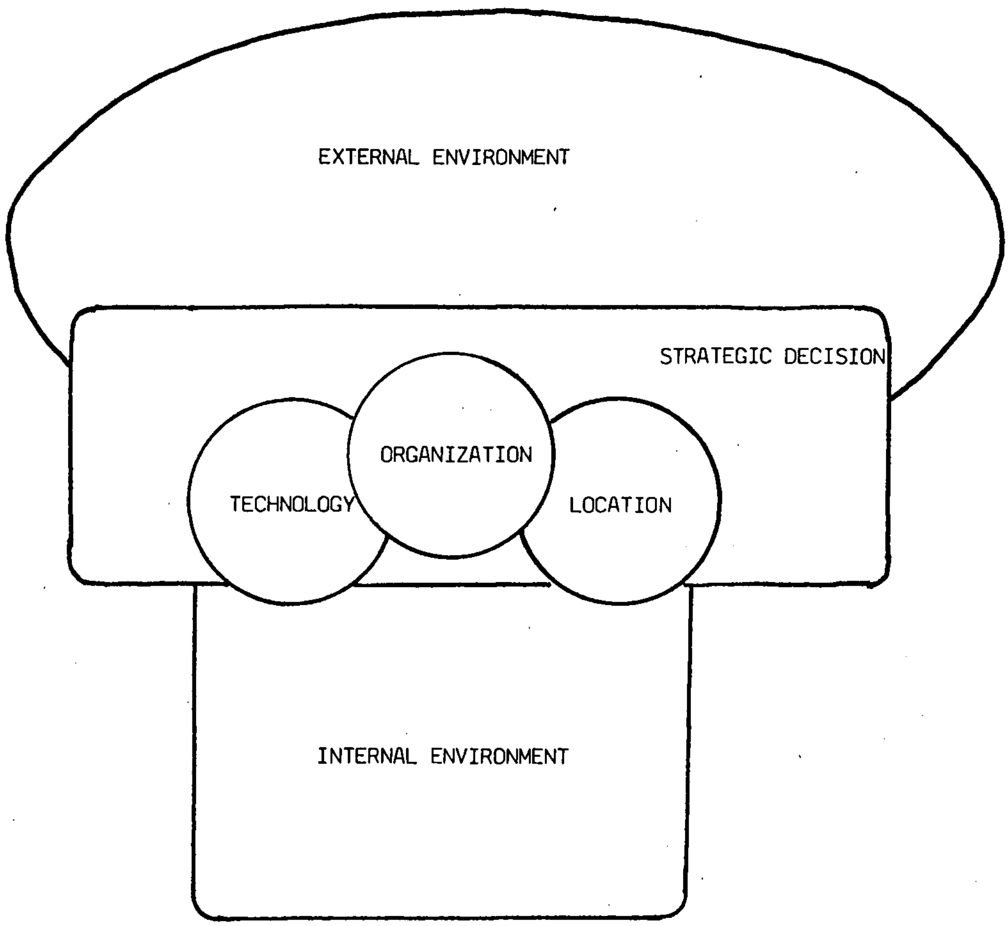
Technology, organization and location operate as both independent and dependent variables in the process of structural change. Transformation in the relationship among these variables can be viewed best by developing an understanding of the wider process that relates external environment, strategic decision and internal environment of enterprise. Figure 1.3 shows the hypothesized relationship among these elements. The organizational structure, technology and location of enterprise are interacting sets of phenomena operating within the wider interaction among the external environment, the internal environment and strategic choice.

1.6 RESEARCH STATEMENT

In the beginning of this chapter some concerns were raised about the structure and performance of multi-unit enterprise and about the academic approaches to analyzing these problems. In the course of this study it will be argued that the transformation that has occurred in multi-unit enterprise is the result of a complex, synergistic process of change. There is no unidirectional force that is shaping this transformation. Rather, there is an interaction among the broad variables of environment (internal and external) and strategic choice, that contributes to the changing relationship of technology, organization and location in the multi-unit enterprise.

The literature in this area is incomplete. Either there has been an overwhelming emphasis placed on simplistic causal modelling, or the analysis fails to include all three components. Technology has been singled out by many observers as the critical contextual variable of the post-war period. Consequently a good deal of geographic, economic and organizational literature has placed an undue focus on technological change as the necessary and

FIGURE 1.3 TECHNOLOGY, ORGANIZATION AND LOCATION IN ITS STRATEGIC AND ENVIRONMENTAL CONTEXT



sufficient condition for structural transformation. It is true that contemporary technology can enable a wide variety of organizational and locational options, but these options are not directly determined by technological capability. It is hypothesized here that emerging technologies can enable both centralization and decentralization within the multi-unit enterprise in spatial and organizational terms. Indeed, it is further argued that processes of centralization and decentralization can occur simultaneously.

The role of environmental change, strategic decision and the political processes underlying the interaction of these variables are suggested here as important contributory factors that condition the relationship among technology, organization and location. Although both contextual factors and operational factors interact to produce structural transformation, the contextual and strategic choice factors are hypothesized as being the variables that condition the direction of structural change towards either centralization or decentralization. Technological and organizational factors on the other hand, are hypothesized to condition the magnitude of these effects.

In the chapters that follow an attempt will be made to describe and evaluate the changing interaction of these variables over the last 30 years and to qualitatively and quantitatively assess the relative contribution these factors have made. Clearly, it would be overly ambitious to attempt a comprehensive explanation of transformation in technology, organization and location for all types of enterprise. Therefore the evidence and analysis necessary to test these hypotheses must be drawn from a specific case study. But it would also be remiss to evaluate transformation in one type of enterprise without placing such an analysis in its wider context. This study is consequently divided into two main parts.

In the following chapter the conceptual framework used in this study will be developed from a critical review of its precedents. In Chapter 3 the literature dealing with transformation in technology, organization and location will be evaluated to test broadly, the hypotheses outlined above and to draw some general conclusions.

In the second part of the study, the conceptual framework will be focused on the transformation of one specific multi-unit system: the clinical laboratory system of British Columbia from 1954 to 1984. The clinical laboratory system exists to provide information. It operates on a multi-site basis, in a technologically complex and dynamic environment in which a wide variety of organizational actors and interests have been involved in decision-making. It is therefore representative of the complexity that is associated with many emerging post-industrial enterprises. Thus in Chapters 4,5 and 6 the general conclusions and criticisms of the literature will be more thoroughly explored in a case study of transformation in the clinical laboratory system of British Columbia between 1954-1984. In Chapter 7 the conclusions from the case study will be presented and the policies and research implications of the two levels of study will be discussed. In Chapter 8 the conclusions that have been reached will be incorporated in the development and evaluation of a set of alternative futures for the clinical laboratory system of British Columbia for 1995.

1.7 RESEARCH OBJECTIVES

The specific research objectives are:

1) To describe the stages and critically evaluate the process of transformation in the relationship among technology, organization and spatial structure of multi-unit enterprise.
2) To assess the relative contribution that environment, strategic decision, technology, organization and geography made in shaping this transformation.
3) To focus specifically on evaluating the apparently ambiguous role that technology has played in shaping the organizational and spatial structure of enterprise.

Thus this thesis is concerned with the two challenges alluded to earlier in this study. The first is to develop a coherent framework for the description of structures and structural transformation, i.e., a typology of different types and stages. The work of Bell (1976), Reich (1983), Trist (1980) and others can assist in developing a typology of transformation. The second challenge is to critically evaluate the process of transformation. Corning's work is a useful starting point in helping to explain the interaction of a number of variables operating at a number of scales.

1.8 CHAPTER SUMMARY

This chapter has introduced the topic of transformation in the relationship among technology, organization and location of multi-unit enterprise. It has been argued that the process of structural transformation is not well understood and that analyses to date have suffered from an undue emphasis on determinism and simplistic causal modelling. An alternative synergistic model has been proposed in which transformation is seen as a result of the interaction of contextual and operational factors. It is hypothesized that technology acts as an enabling factor that can amplify the effects of other contextual variables, but technology does not dictate the choice between centralized and decentralized systems. It has been proposed that the process of structural transformation in technology, organization and location can be evaluated by a critical review of the literature and by the application of the model to a specific case study of the development of the clinical laboratory system of BC from 1955-1985.

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CHAPTER 2 - PRECEDENTS FOR THE CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

The conceptual framework outlined in chapter 1 (in Figures 1.1, 1.2 and 1.3) is derived from the open systems view in organization theory, from cybernetics, from decision/theory, from the emerging geography of enterprise and from the work on socio-cultural evolution by Peter Corning. The approach represented diagrammatically in Figure 1.3 is an attempt to redress the inherent deterministic bias in many lines of inquiry in this area. Before we can justify the selection of this form of model it is necessary to review the evolution of research into the relationship among the variables outlined.

This chapter critically reviews a wide range of literature to demonstrate the precedents of the models outlined in Chapter 1. The chapter is structured into 6 sections.

2.1 Introduction

2.2 The Five Phases of Model Development in Organization Theory

2.3 Critique of the Deterministic and Contingency Approaches

2.4 Refinements of the Contingency Model

2.5 Transformation in Open Systems

2.6 Chapter Summary

This chapter starts with a review of the work in organization theory on the relationship between organizational factors and technology. Criticisms and refinements to the early positions are made and these are then integrated within an open systems framework.

This chapter reviews a wide set of literature. In order to increase the coherence of the review the earlier phases of theory development are represented diagrammatically to reflect the emphasis of each particular phase of the literature. The two basic diagram elements are drawn from Figure 1.2 and Figure 1.3. These diagrams reflect the two critical concepts of synergy and hierarchy within enterprise. Figure 2.1 below reflects the notion of synergy between a number of variables that was discussed in Chapter 1.4 and was shown diagrammatically in Figure 1.3. Figure 2.2 reflects the concept of hierarchy and the interaction between levels of the enterprise. that was discussed in section 1.5 and shown diagrammatically in Figure 1.2.

FIGURE 2.1 SYNERGY

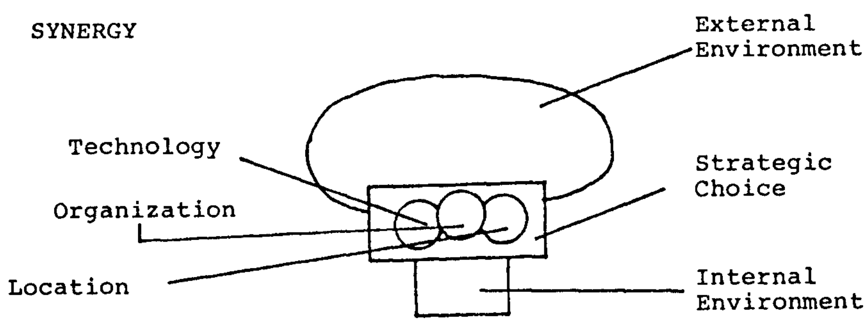
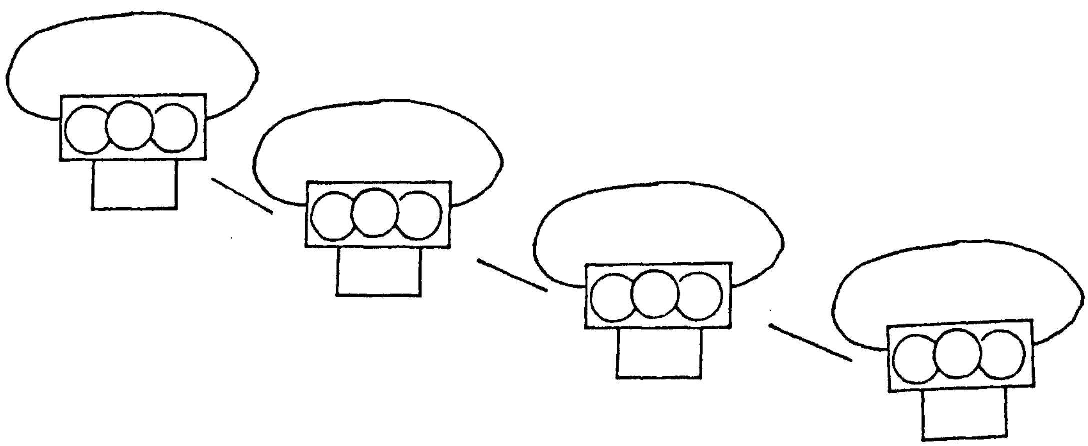


FIGURE 2.2 HIERARCHY



2.2 THE FIVE PHASES OF DEVELOPMENT OF THE MODEL IN ORGANIZATION THEORY

The research conducted in organization theory over the last three decades is a useful starting point in investigating the relationship among technology, organization and location. Inquiry in this area has developed through five identifiable phases. (See Figure 2.3).

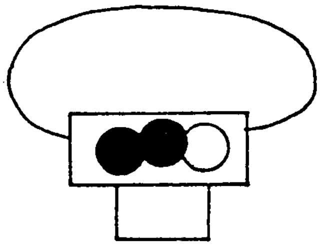
The first phase is that of the technological imperative where technology is theorized to be the primary variable that determines the structure of organization. The second phase identifies organizational size as a determining factor in the structure of organizations (either as a single determining factor or jointly with technology). The third phase identifies environmental or contextual factors as primary determinate variables. These first three phases have been labelled by Jackson and Morgan (1978) as the three imperatives. The fourth phase introduces the idea of strategic choice as a contributory factor in determining organizational structure. The fifth phase is the contingency model approach that recognizes the contribution of a number of different factors.

Each of these phases will be examined in more detail.

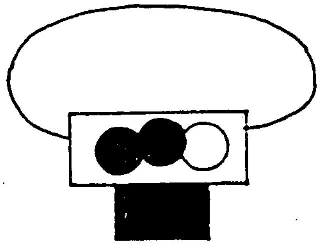
2.2.1 Phase 1 - The Technological Imperative

Most analysts of organizations agree that technology is an important variable. But there has been a considerable debate as to whether technology is the primary determinate or imperative that controls organization structure and performance. Before an alternative framework can be justified, it is important to review briefly the debate on the technological imperative in organizational theory. Gerwin (1979) has argued:

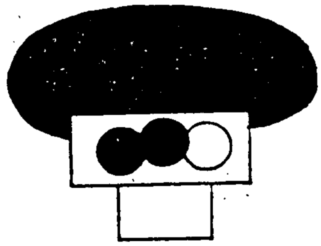
FIGURE 2.3 THE FIVE PHASES OF MODEL DEVELOPMENT IN ORGANIZATION THEORY



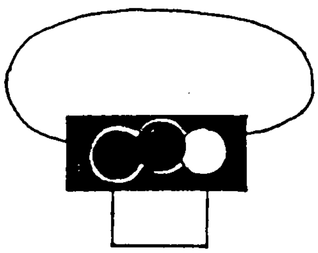
Phase 1 - The Technological Imperative



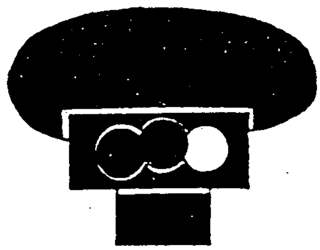
Phase 2 - The Size Imperative



Phase 3 - Technology and the Environmental Imperative



Phase 4 - Technology and Strategic Choice



Phase 5 - Technology and the Contingency Model

> "the mid 1960's was probably the heyday of the technological imperative in organization theory. The works of Galbraith (1967), and Miller and Rice (1967), Perrow (1967), Woodward (1965) appeared to have demonstrated the critical impact of technology upon organization. By the late 1960's the battle with the anti-technologists have been joined and since then the tide seems to have turned in their (the anti-technologists) favour".

Gerwin differentiates between organization level and job level research. Organizational level research starts with the organization as the unit of analysis and considers the major product or service offered. This leads to a focus on the dominant conversion technology (i.e., the principal methodology for producing output) as the characteristic technology of the organization. This technology is then normally measured on a scale such as workflow integration.

Workflow integration is a composite measure of technology, developed by the Aston Group that includes such measures as the extent to which the workflow was automated, interdependent, measurable, and adaptable to other purposes. This scale, like so many others in this school, is really focused on the operations technology (which is defined as the equipping and sequencing of activities in the workflow). It ignores other aspects of the technology such as the materials used or the knowledge required (or technical complexity) of the processes. This type of organizational level approach is exemplified in the work of Blau and Schoenherr (1971), Child and Mansfield (1972), Hickson et al (1969), Pugh et al (1969) and Woodward (1965).

Job level analysis on the other hand starts with the tasks performed by individual employees, which leads it to consider the methods by which these tasks are accomplished. Gerwin goes on to suggest that the weak explanatory power of technological determinism at the organizational level can be attributed to methodological inconsistencies between studies and in particular to a "lack of a common conceptual definition of technology". His analysis of studies at the job level, where there has been greater methodological and definitional consistency, leads him to suggest that technological determininism may still have some validity.

Despite Gerwin's plea for a reappraisal of the technological imperative, it is clear that the mainstream of the technological imperative literature i.e., the organization level studies, has received considerable criticism, which has led to a search for further explanatory variables.

The technological imperative simply stated that technology dictates structure. This view was moderated somewhat by the Aston group's findings which did not replicate earlier results from the technological imperative school. They concluded that,

> "variables of operations technology will be related only to those structural variables that are centred on the workflow. The smaller the organization, the wider the structural effects of technology; the larger the organization, the more such effects are confined to particular variables and size and dependence and similar factors make the greater overall impact." Jackson and Morgan, 1978 p.182.

(For more detailed reviews of the technological imperative see Reimann and Inzerelli (1981) and Scott (1981)).

2.2.2 Phase 2 - The Size Imperative

This leads into the second phase studies where size of the organization is thought to determine structure. Mintzberg (1983) summarizes much of the conventional literature on the structural effects of organizational size:

> "The larger the organization, the more elaborate its structure - that is, the more specialized its tasks, the more differentiated its sub-units and the more developed its administrative component"
> Mintzberg (1983:p 124)

The first element of this hypothesized relationship, (specialization is related to size) was a principal finding of the Aston Group studies (Pugh, Hickson, Hinings (1969)). Second, Blau (1970) argued that increased structural differentiation (i.e., increased number of levels in the organization (vertical) and increased divisions or departments (horizontal)) was affected by size. Blau suggested however that differentiation increases more slowly as size increases. The third aspect of Mintzberg's hypothesis that size leads to a more developed administrative component, is also derived from Blau's work. Paraphrasing both Mintzberg (1983) and Pfeffer (1983), there are two causal arguments behind this finding. First, with increased specialization (division of labour), there is an increasing need for coordination between organizational sub-units - hence more supervisory and coordinating staff. The second argument suggests that with increasing numbers of people to coordinate, direct supervision becomes problematic and impersonal methods of control, such as standardization through rules and procedures have to be used. Creation and maintenance of these rules requires a larger administrative component or techno-structure as Mintzberg terms it.

This latter view is accepted by Corning (1982), but it can be challenged. It seems clear that this shift has occurred in many enterprises as they grow but whether it is necessary for the effective operation of organizations or whether it reflects a broad societal desire to participate in administrative work is not clear. Bertrand Russell foretold of these changes in 1935 when he said:

> "Work is of two kinds,the first kind is involved in altering matter at or near the earth's surface, and the second is involved in telling people to do so. The first is unpleasant and poorly paid the second is

> pleasant and highly paid. The second is capable of indefinite extension, there are not only those who give orders but those who give advice as to what orders should be given"

The next size hypothesis put forward by Mintzberg (1983:125) is that the larger the organization the larger the average size of its units. Finally, Mintzberg suggest that the larger the organization, the more formalized its behaviour. The argument being that in large organizations the standardization of activities and the formalization of roles , allows the organization to decentralize decision-making by prescribing choices very closely.

In terms of any interaction between size and technology, studies by Child and Mansfield concluded that "size has a much closer relationship to the aspects of structure (that were) measured, than does technology" (Jackson and Morgan (1978) p.184). Similarly Blau et al (1976) in reviewing other size-technology studies as well as summarizing their own study of New Jersey factories stated that

> "organizational size rather than production technology appears to exert the more significant influence on the division of labour and the organization of work."

(The size-technology debate is still continuing and a more recent Japanese study (Marsh and Mannari (1981)) suggests there is a revival of support for the technological imperative school of Woodward).

2.2.3 Phase 3 - Technology and the Environmental Imperative

In the the third phase of theory development, the notion of environmental factors or contextual constraints is added to the size and technology imperatives. It is best illustrated in the model developed by Child (1973) shown in Figure 2.4 and described below by Jackson and Morgan (p 185):

> "In Child's model, increased size, workflow integration and contact with outside groups leads to increased complexity in organizations. On the other hand increases in the number of operating sites (i.e., geographical or spatial decentralization) tends to lower complexity. As complexity increases it leads to increases in formalization. Size also leads to pressure on top executives to decentralize authority. Decentralization and formalization are associated with each other in a complementary way, reinforcing each other. Increases in formalization are also encouraged by increases in the size of the owning group. As he himself indicates, Child's model must be treated as hypothetical but it is one of the the first to show how several variables might affect organizational structure."

Other environmental determining factors have been linked to technology by analysts such as Negandhi and Reimann (1979), who identified that the nature of an organization's concern for its consumers, employees, stockholders and government, had an impact on its organizational structure.

Virtually all of the imperative type studies mentioned to date focus on the operations technology of organizations. However alternative views of the role and meaning of technology have been suggested. For example, Thompson (1967) argued that since organizations are rational entities operating in an uncertain environment, they seek to buffer or protect their "technical core" from this uncertainity. The technical core is defined as those parts and processes an organization uses to transform the materials it alters as its primary function. Thompson (1967) identifies three types of technology:

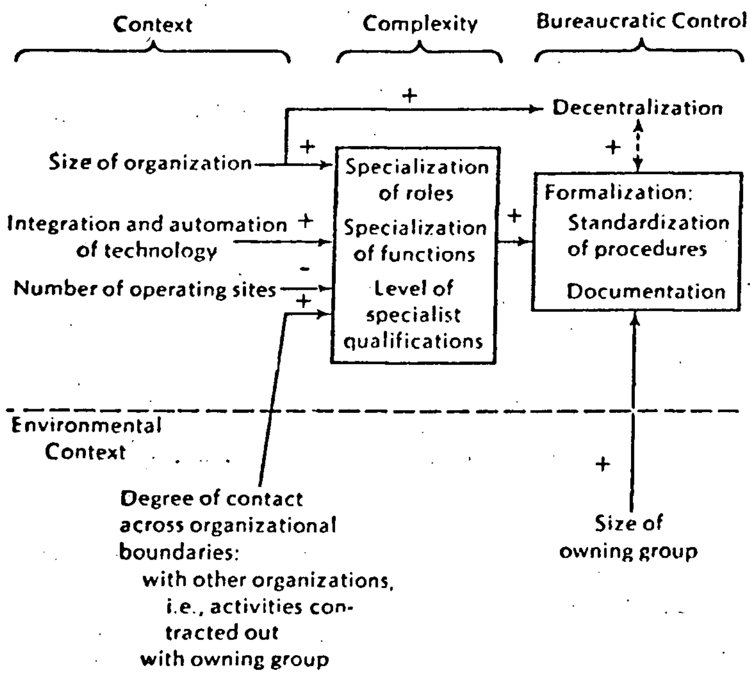
i) mediating (e.g., used by a bank as it mediates between its customers and the services it provides)

ii) intensive (e.g., used by a hospital as it performs all of the necessary functions for the care of its patients) and

iii) long-linked (e.g., used by a factory as various operations are linked in a sequence).

FIGURE 2.4 JOHN CHILD'S MODEL - THE ENVIRONMENTAL IMPERATIVE

CHILD'S MODEL OF RELATIONSHIPS BETWEEN CONTEXTUAL VARIABLES AND ORGANIZATIONAL STRUCTURE. *Source:* John Child, "Predicting and Understanding Organization Structure," *Administrative Science Quarterly* 18 (June 1973):183.



In Thompson's model it is suggested that both environment and technology are important determinants of structure, but their impacts are different. The primary impact of technology is upon efforts to control and coordinate the buffered "technical core". The environment has its primary impact on the organization's structure, in those aspects of structure that are created to respond to uncertainty. For example in order to respond to uncertainty, units are created to monitor and survey what is happening in the environment, plan responses to it, and develop a structure that is appropriate for the degree of uncertainty present in the environment. (The distinction Thomson makes between the strategic level and the technical core may explain why Gerwin asserts that organizational level research does not support determinism and job level research apparently does).

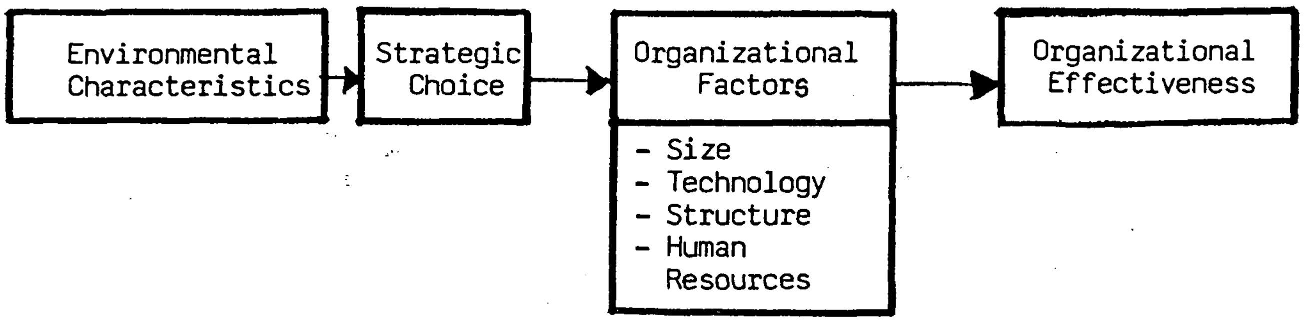
This type of view, represents a departure from pure imperative type models and leads to the fourth phase where technology, size and environmental factors are integrated within a framework of strategic choice.

2.2.4 Phase 4 - Technology and Strategic Choice

Classical management theorists of the scientific management school recognized the critical importance of senior management in determining organizational structure. This view was largely neglected until Chandler's study in 1962 of top US firms, that concluded that an organization's structural configuration is influenced by prior strategic decisions of the top executive team, i.e., structure follows strategy.

John Child (1972) develops this idea further to suggest a concept of strategic choice, i.e., top executives have "freedom of maneuver" (or range of

FIGURE 2.5 JOHN CHILD'S MODEL EXTENDED TO INCORPORATE STRATEGIC CHOICE



discretion) with respect to organizational factors such as scale of operations, technology, structure and human resources. This range of discretion is thought in turn to be defined primarily by conditions present in the firm's environment, as shown in Figure 2.5.

Child's model is somewhat difficult to operationalize as an empirical tool. Anderson and Paine (1975) hypothesized that the response patterns of policy makers is influenced by their perceptions of uncertainty in the environment and their perceived need for change. In reality they found that only when environmental conditions are perceived as problematic do they encourage structural responses by the executive.

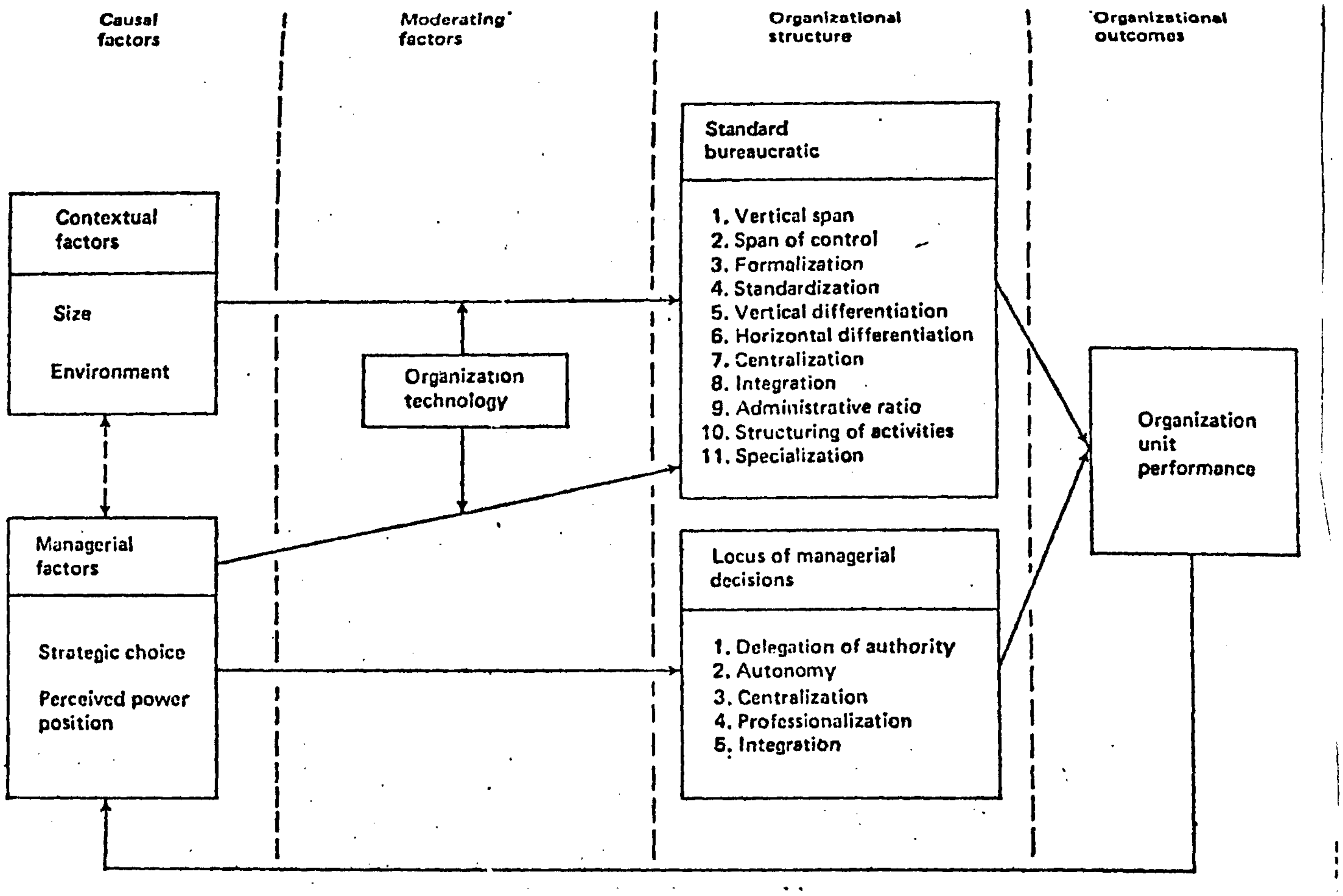
It could be argued that Child's conception is itself a form of imperative. However a study by Montanari (1976) found a codeterminant role for contextual and managerial discretion factors, i.e., for certain structural dimensions, managerial discretion emerged as the dominant predictor, in others it was contextual factors and for others it was technology and size. These findings lead Montanari (1978 and 1979) and Mintzberg (1979, 1983), among others, to the development of the fifth type of model: the contingency model.

2.2.5 Phase 5 - Technology and the Contingency Model

In one form of this model (shown diagrammatically in Figure 2.6) Montanari (1979) extends structural determination theory (phases 1 to 3 above) on three fronts:

1) Incorporating managerial influences into the model
2) Proposing a moderating role for technology
3) Explicitly recognizing the multi dimensionality of organization structure

IGURE 2.6 MONTANARI'S CONTINGENCY MODEL



Montanari integrates the contextual factors of size and environment (phases 2 and 3) with the managerial factors (phase 4) but he extends managerial factors to include perceived power of managers.

In this framework Montanari sees technology as a moderating factor rather than a deterministic one. The dependent factors of organizational structure are those recurring measures in the literature (see Montanari (1979) and Pfeffer (1982)). Montanari's contingency theory hypothesizes that:

> "the causal factor mix and the strength of relationships (between causal and dependent variables) depend on which dimension (of organizational structure) is being analyzed. In addition the moderating effect of technology is present for the standard bureaucratic dimensions but not for the managerial decision aspects of structure. Managerial discretion factors (i.e., strategic choice) are proposed as the primary predictors of the locus of the managerial related dimensions (e.g., delegation of authority, autonomy)."

This approach does have thoeretical appeal and preliminary empirical evidence offered by Montanari (1979), suggests it has some operational validity.

Similarly, Mintzberg (1979 and 1983) tries to integrate the findings from the structural contingency tradition in organizational theory in his book "Structure in Fives". Mintzberg's approach is very much in the "if-then" tradition of Burn and Stalker (1961), Child (1972), Jay Galbraith (1973), Montanari (1979) and others. He asserts basically that organizational structure can be "designed" to best suit the environment of enterprise, the type of tasks it has to accomplish and the type of resources (both human and technological) that is employs. He uses a very interesting organizational "logo" that identifies the five basic components of the organization. (Figure 2.7)

i) Strategic Apex - This is the board level functions of Beer (1979) or the Strategic Decision (F Band) of Paterson (1981).

ii) Middle Line - The hierarchy of middle management that mediates between the goal setting "strategic apex" and the operation of the enterprise.

iii) The Operating Core - Where the principal activities of the enterprise are carried out - the shop floor, the patient care ward, etc.

iv) The Technostructure - Where the rules and operating procedures of the enterprise are designed and monitored.

v) The Support Structure - Where support activities, unrelated to the primary goals of the enterprise, are carried out, e.g. payroll, cafeteria functions, mailroom, etc.

Mintzberg uses these five organizational components and a host of other five dimensional terms, that draw heavily on the Aston parameters outlined earlier, to describe five generic organizational designs (Figure 2.8):

i) The Simple Structure - Is the common form of the small, owner/manager operation where the operating core is supervised directly from the strategic apex with little or no technostructure, support structure or middle line. This structure is preferred for small scale enterprise operating in simple but dynamic environments.

ii) The Machine Bureaucracy - Where the enterprise is broken down into highly specialized but routinized tasks and formalized through written rules and procedures developed by the technostructure.

FIGURE 2.7 MINTZBERG'S FIVE ORGANIZATIONAL COMPONENTS

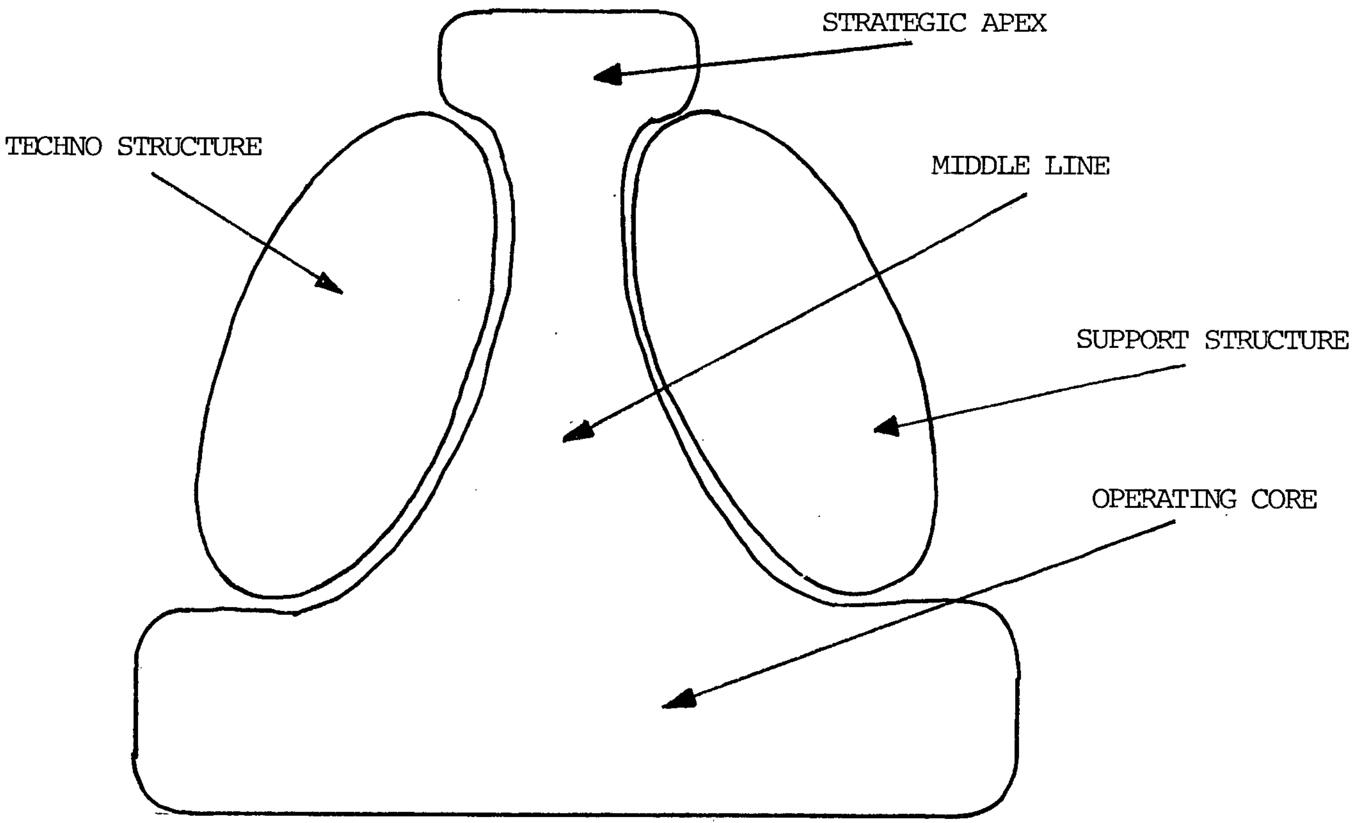
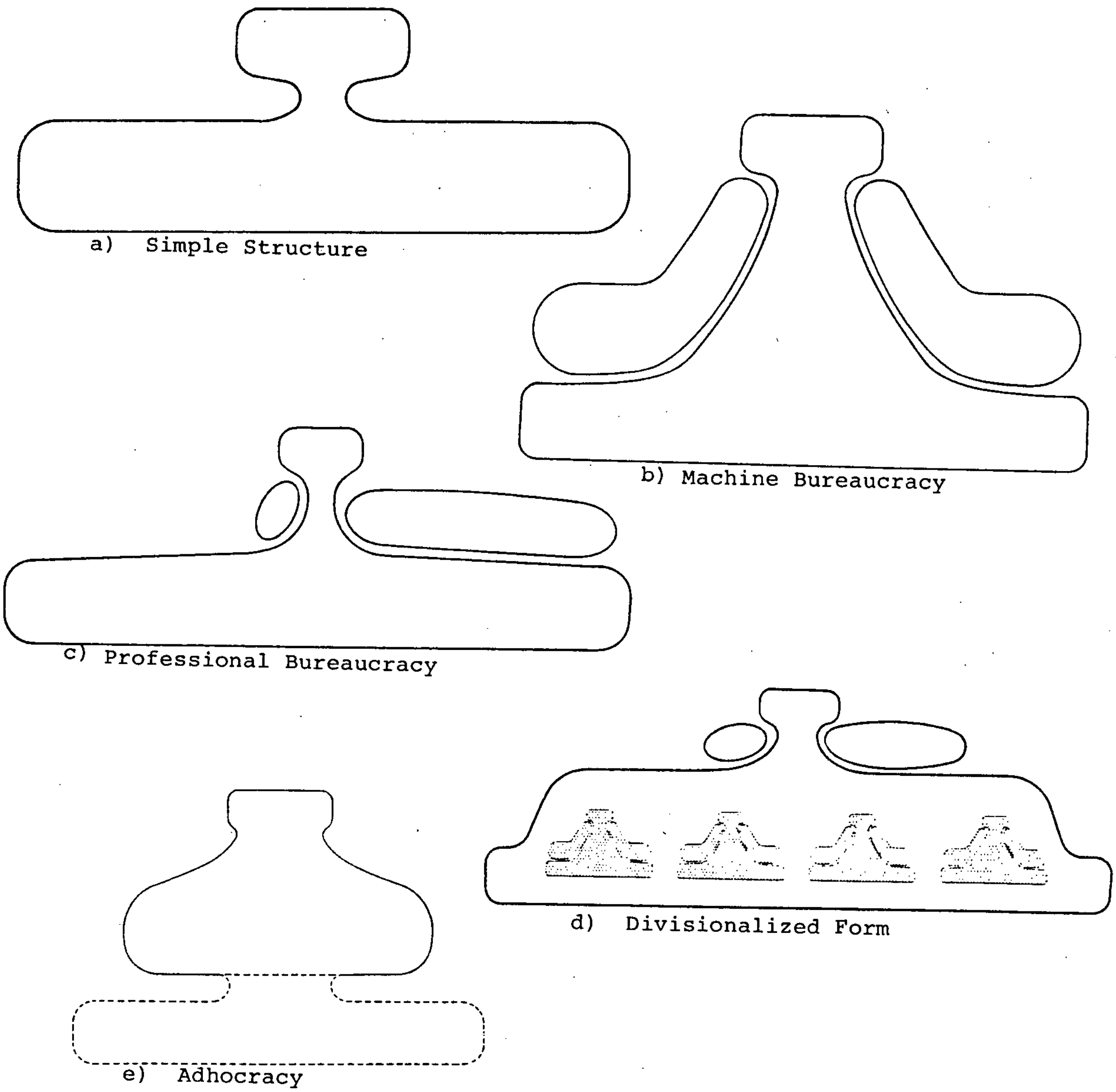


FIGURE 2.8 MINTBERG'S FIVE ORGANIZATIONAL DESIGNS



This form of structure, similar to Weber's (1947) "bureaucracy" or Burn's and Stalker's (1961) "mechanistic structure" is deemed by Mintzberg to be functional for relatively simple, stable and technically uncomplicated environments.

iii) The Professional Bureaucracy - Where highly specialized "operators" are co-ordinated through educational and skill requirements rather than rules. This type of organization is compatible with complex but stable environments such as those in health and education.

iv) The Divisionalized Form - Is the closest Mintzberg comes to addressing the issue of multi-unit enterprise. In this form the co-ordinating mechanism is through standardization of outputs, e.g., profit performance. Mintzberg sees this form as:

"not so much an integrated organization as a set of quasi-autonomous entities coupled together by a central administrative structure."

(Mintzberg (1983:p 215))

The key linkage is between headquarters and the middle line managers in each division. There is a greater degree of formalization and standardization than if each division was completely autonomous. This form is "suited" for large, established, diversified enterprise both public and private working in relatively stable environments.

v) Adhocracy - In this organizational form there is a sophisticated operating core working in loose association, e.g., the think tank, film company or consulting firm. The adhocracy can be an "operating adhocracy" which solves problems on behalf of its clients or an "administrative adhocracy": an organization designed to innovate but one where the operating core is truncated either by contracting out (e.g., developers) or through automation (e.g., certain hi-tech companies). There is a blurring of roles and responsibilities between staff and line in the adhocracy. It is best suited as an organizational form to complex and dynamic environments. This typology will be used in Chapter 3 when we discuss the transformation in the structure of enterprise.

2.3 CRITICISMS OF THE DETERMINISTIC AND CONTINGENCY APPROACHES

Technology, size, environment and strategic choice have been variously regarded as driving variables in the development of research into the determinants of organizational structure. There are a number of flaws in this literature that need attention if we are to apply successfully any of these concepts in this study.

2.3.1 Causality

Organizational structure and operations technology are not in some cause and effect relationship to be proved or disproved by technological determinists and their opponents. But rather these two factors are complementary and to some degree substitutable as a means to an end. The selection of organization and technology will be constrained by both strategic choice and by contextual or environmental factors (Aldrich (1979), Mintzberg (1983), Montanari (1979)) such as the economic, socio-political or cultural factors acting for and against the adoption of particular forms of technology and/or organization. Mintzberg's analysis emphasizes the notions of design and fit, which draws on the ecological idea that particular life forms are better suited to certain environments. Although he attempts to avoid deterministic relationships, one is left with the impression that there is certainly a best fit, i.e., tasks and environments virtually "dictate" form if the designer is rational (which is a very major assumption, as Pfeffer (1982), Weick (1979) and others suggest).

2.3.2 Limited Environmental Analysis

The second major criticism that can be made of many of the studies in this body of "structure research" is that the models use a limited range of environmental factors. (The conventional study is in the form of regression analysis using technological and environmental factors as independent variables and measures of organizational structure as dependendent variables). Limitation of environmental factors to one single scale such as the "Lawrence and Lorsch Environmental Uncertainty Subscale" (Lawrence and Lorsch (1967)), may be methodologically convenient but it seems to suppress the range of environmental factors identified by Emery and Trist (1965), Aldrich (1979), Huber (1984) and others.

2.3.3 Limitations in the Concept of Technology

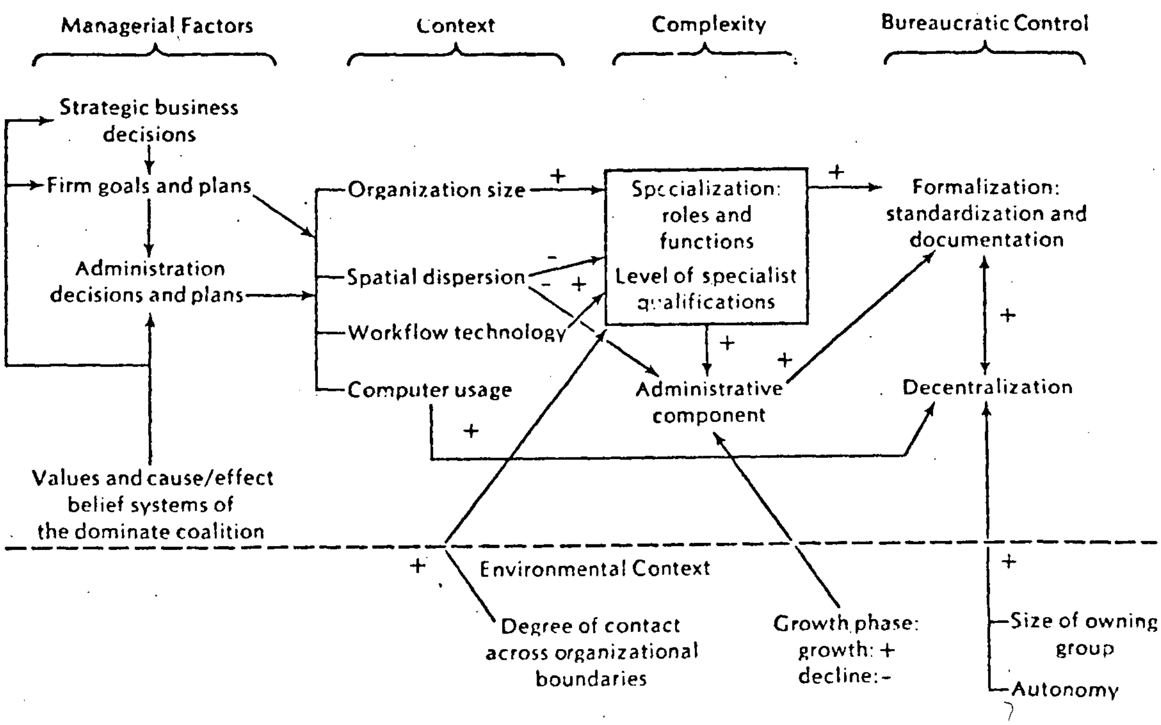
The third major criticism is in terms of the methods used to classify and categorize technology. "Dominant technology" is a phrase often used in the literature, referring to the dominant operations technology the observers could identify in an organization (or in the technical core of an organization). To the analyst of information technology this is an unhelpful focus for two reasons. First, it is unusual for information technology to be the "dominant technology" of an organization. It is much more likely that information technology is used in a secondary role, i.e., for a subset of tasks in the organization. Second, it is unlikely that information technology will always be used as an operations technology in the true sense of the term (although increasingly many industries can be viewed as involved in information processing as a primary function, e.g., financial services, health and education). A more common use of information technology is as a co-ordinative technology, i.e., as a means of enhancing the production and communication of information in an organization. This has led some analysts to add computer usage as a separate contextual factor in models of the relationships affecting organizational structure. (See Figure 2.9 from Jackson and Morgan (1978)).

2.3.4. Inadequate Integration of Geographic Phenomena

The final criticism that can be levelled at the "structural research" is that is does not adequately relate geographical and organizational phenomenon. However there are signs that geographers and others are encroaching on the middle ground between organizational and spatial analysis. For example, in terms of the debate over the impact of information technology on the spatial and organizational structure of enterprise, there has been considerable focus on the centralization/decentralization question. Three broad areas of inquiry are being undertaken.

First, there are those who define centrality primarily in physical space

FIGURE 2.9 JACKSON AND MORGAN'S MODEL OF POSITED RELATIONSHIPS WITH ORGANIZATION STRUCTURE



terms and who have focused on the tele-communications - transport trade-off (T^3 as it is sometimes called), or the convergence of time and space, e.g., De Sola (1977), Abler (1975), Alber and Falk (1981). This inquiry has focused freauently on developing abstract mathematical models of the dynamics of spatial interaction, e.g. Harkness (1973), Isard (1979). The general conclusion here is that communications technology in particular will allow man to overcome the "tyranny of distance" and lead inevitably to decentralization. The evidence that is cited ranges from the increases in relocation of head offices of large corporations from large cities to small cities, to the possibilities of telecommuting, where communications will be substituted for the journey to work (Mitre Corp (1978); Abler (1975)).

The second school examines centrality in functional, organizational and spatial terms. The conclusions from this group are less clear cut. Some argue that face-to-face linkages are of paramount importance in many activities and therefore the decentralizing impact of technology will be limited to a restricted subset of these activities and functions, Gad (1979), Goddard and Pye (1977). Others have argued that it is necessary to recognize the organizational context of locational decisions. These researchers have argued that the structure of decision making within an organization will affect locational decisions, i.e., the structure or organizations is represented in geography, Massey (1979), Pred (1977), Goddard (1980), Edwards (1983), Taylor and Thrift (1983). Pred (1977,1979) in particular has argued that in advanced economies, the spatial hierarchy of many enterprises is conditioned by the structure of decision-making. Theoretical developments in the geography of enterprise will be discussed further in Chapter 3.

The third school of inquiry (which is being conducted by a broader group including economists, organizational theorists and management scholars) focuses primarily on the functional and organizational context and is to some extent aspatial. This group is more concerned with the centralization of decision making and control regardless of location. As such it deals with questions of efficiency, autonomy, equity, and power, e.g., Simon (1979), Beer (1966), Pfeffer (1981). Much of this work is from a value laden position that states that centralization is bad (E.F. Schumacher (1973)). For analysts from this third tradition, the impact of technology on centrality is viewed as a function of the desirability of centralization on the one hand and the feasibility on the other. Simon (1979) has suggested that "any change in technology that makes it cheaper and easier either to centralize or to decentralize decisions will tip the balance in that direction." (These three schools will be reviewed more thoroughly in Chapter 3 when environmental and structural transformation is discussed.

The best conclusion that can be drawn at this stage with regard to technology, organization, location and the degree of centralization is provided by Goddard (1980) discussing the office sector:

> "Technological development is a permissive factor - e.g., facilitating the growth of large enterprises. It is a necessary, though not sufficient, condition for locational change. In consequence the impact of new technology in the office sector needs to be seen in the broader context of the factors influencing organizational structure and strategy in a spatial setting ... In order to avoid naive technological determinism it is necessary to consider the functions of the office and the factors influencing their geographical spread."

2.4 REFINEMENTS OF THE CONTINGENCY MODEL

The first three concerns outlined above (i.e., concerns with causality, environmental analysis and the definition of technology) reflect the more general criticisms being voiced in organization theory. It is useful here to review briefly the change in focus in organizational theory and the contributions that these criticisms have made to refining our model. Chapter 1 described the early roots of organization theory in the work of Weber on bureacracy (Weber (1947)), Taylor (1911) on scientific management and Mayo and the Human Relations School (Mayo (1949)). Over the last three decades a number of conceptual developments have occured drawing from both the primary traditions of organization theory, sociology and psychology, and from secondary or emerging traditions, systems/cybernetics, social-ecology, economics, political science and decision theory.

A number of attempts have been made recently to synthesize, classify and critique what is now an enormous literature. Four useful syntheses are presented in the works of Scott (1981), Hage (1980), Mintzberg (1983) and Pfeffer (1982). The typology of Scott illustrates three competing positions.

2.4.1 Scott's Taxonomy of Rational, Natural and Open Systems in Organization Theory

Scott (1981) attempts a "coherent introduction to the sociological study of organization." He has suggested that organization theory falls into three general theoretical prespectives,

1) A Rational Systems Perspective
2) A Natural Systems Perspective
3) An Open Systems Perspective

From a rational systems perspective:

> "an organization is a collectivity, oriented to the pursuit of relatively specific goals and exhibiting a relatively highly formalized social structure."

Within this tradition fall Scientific Management, Simon's work on Administrative Behaviour and Weber's work on Bureaucracy among others.

From a natural systems perspective:

> "an organization is a collectivity whose participants are little affected by the formal structure of official goals but who share a common interest in the survival of the system and who engage in collective activities informally structured to secure this end."

Within this tradition fall Mayo (1949) and the Human relations school, McGregor of theory X and Y fame (1962), and Parsons (1951).

Scott (1981, p 175) identifies the essential differences between the two schools along a number of dimensions.

1) "Rationalist" analysts were usually practical men, practitioners of management whereas "natural systems" analysts were focused more on academic inquiry.

2) They differ in the case study focus of their inquiries: rational systems views prevail in industrial and bureaucratic environments. Whereas open systems views prevail in not for profit, service and professional organizations, such as schools and hospitals.

3) It has been suggested that the rationalist systems view is more suited to the stable environment whereas the natural system view is suited to dynamic environments.

4) The moral viewpoint of the organizational participant differs in the rational viewpoint where the employee is viewed primarily as one who performs tasks, from the natural systems viewpoint in which the employee's functioning is considered from a holistic perspective.

5) The philosophical traditions underlying these views are different. The rational systems model stems from an instrumentalist, mechanistic perspective. The natural systems perspective stems from an antirational, organic philosophy of social systems.

More recently, Scott points out, we have seen the development of an approach to organizations as open systems. From an open systems perspective:

> "an organization is a coalition of shifting interest groups that develop goals by negotiation; the structure of the coalition, its activities and its outcomes are strongly influenced by environmental factors." (Scott (1981) p: 178)

Within this tradition Scott places cybernetic models or organization, contingency theory, natural selection models of organization, and Karl Weick's theory of organizing (Weick (1979)).

There have, according to Scott, been attempts at integrating these three perspectives on organization. For example, Etzioni's (1958) structuralist model, Lawrence and Lorsch's contingency model (1967) and Thomson's Levels model. The ideas of Thomson (touched on earlier) can be usefully integrated with Mintzberg (1983) and with some of the perspectives on decision-making and organization put forward by TT Paterson (1981) and with the management cybernetics of Stafford Beer (1966, 1979).

Scott (1982, p:127)provides a useful synthesis of Thomson's work:

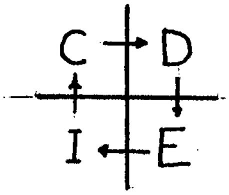
> "Thomson's model in a nutshell is that organizations strive to be rational although they are natural and open systems. It is in the interest of administrators - those who design and manage organizations - that the work of the organization be carried out as effectively and efficiently as possible. Since technical rationality presumes a closed system, Thomson argues that organizations will attempt to seal off their technical level protecting it from external uncertainties to the extent possible. Thus, it is at the level of the core technology - the assembly line in the automobile factory, the patient care wards and treatment rooms in the hospital - that we would expect the rational

> system perspective to apply with most force. At the opposite extreme, the institutional level, if it is to perform its functions must be open to the environment. It is at this level where the environment must be enacted or adapted to, that the open systems perspective is most relevant. In the middle is the managerial levels, which is required to mediate between the relatively open institutional and closed technical levels. To do so effectively requires the flexibility that is associated with the less formalized and more politicized activities depicted by the natural system theorists. It is also the managers - whose power and status are most intimately linked to the fate of the organization - who have the greatest stake in the survival of the organization as a system."

Thomson's work provides a more complex view of the large organization, one in which there is an identifiable hierarchy of behaviour that is both motivated and constrained by the functional needs and the nature of the sub-systems of the enterprise.

2.4.2 T.T. Paterson and the Decision Band Method

T.T. Paterson (1982) has developed a similar hierarchial notion of enterprise that suggests that variation in behaviour, responsibilities (and thus pay) can be distilled down to one critical variable: the decision. Paterson suggests that there are four components of a decision, operating as a "decision making procedure" at 6 hierarchial scales in enterprise. The decision making procedure comprises a four cell matrix in which a linear sequence is followed.



1) The Information Stage (I) - gathers data and recognizes hypotheses or problems.

2) The Conclusion Stage (C) - consists of assessing alternatives for action and rating them on an optimality scale against a particular context or frame.

3) The Decision Stage (D) - consists of examining the alternatives, selecting one and making a committment to achieve a particularly end or objective.

4) The Execution Stage (E) - consists of choosing the correct means of achieving the ends.

Paterson argues that there is "feed forward" from the E stage to the I stage in which the executive implementers communicate the feasability of alternatives.

Paterson asserts that these decision procedures are related through a cascade of decisions down a hierarchy of decision-bands. The hierarchy of Decision Bands is:

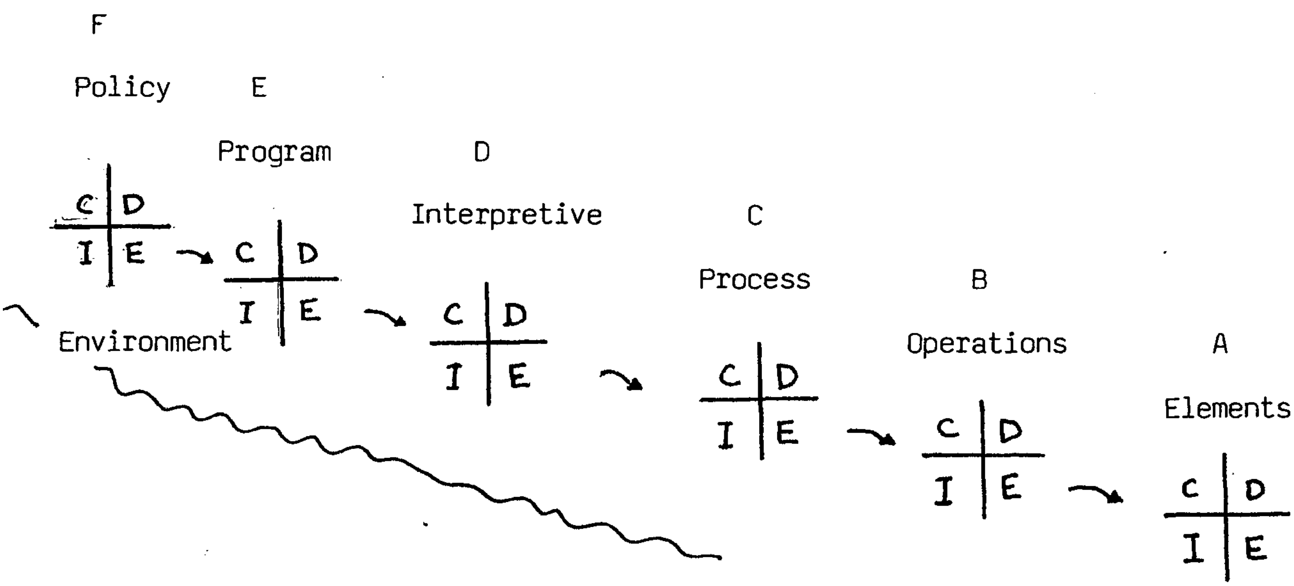
Band	Administrative (Policy and Planning)
F	Policy-making decisions (goal-setting for the enterprise)
E	Programming decisions ("strategic planning")
D	Interpretive decision ("tactical planning")
	Instrumental (Operations)
C	Process decisions (selection of process)
B	Operations decisions (on operations)
A	Element decisions (on elements)

The cascade of decisions refers to the links between the ends set by one level (E Box) as an input into the conclusions (C Box) of the level below.

Fig. 2.10. This concept of a cascade of decisions was developed by Hardwick (1982) in his notion of co-management in education.

At all scales there is interaction with the environment by the I Box, i.e. data is gathered and synthesized in the decision procedure.

FIGURE 2.10 PATERSON AND HARDWICK'S DECISION BANDS IN A DECISION HIERARCHY



2.4.3 Stafford Beer's 5 Systems

Similarly, Stafford Beer, in his physiologically-derived, management cybernetic models, argues that there are only 5 sub-systems in enterprise or in any complex system. The 5 sub-systems in a Beerian model are:

System 1) - Operations

System 2) - Management (direct supervision and organization of operations)

System 3) - Monitoring and Control Functions

System 4) - The Development Directorate (responsible for "corporate planning" or "strategic planning" activities)

System 5) - The Board Function (responsible for steering the enterprise by setting the goals)

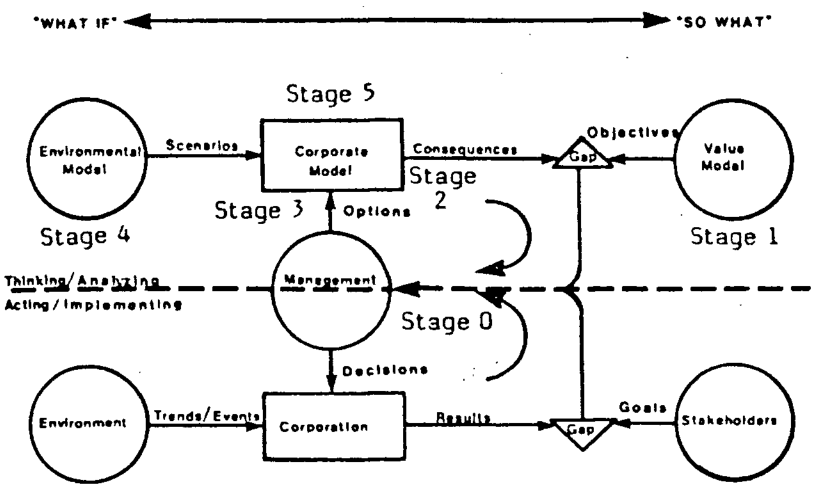
2.4.4 Amara and Lipinski: Strategic Planning Model

Finally, Amara and Lipinski (1983: p 39) offer a useful corporate planning framework that identifies 6 stages in the planning process.

"A number of specific features of this framework should be noted:

1) The upper (analyzing) half of figure 2.11 includes the five principal stages of planning, stages 1 to 5; the lower (implementing) half includes the basically operational loops, stage 0.
2) From left to right, the upper framework reflects the three principal components of any planning framework: the probable (environment), the possible (options), and the preferable (values); or, alternatively, what do we know, what can we do, what do we prefer?
3) The management function is the centerpiece of the framework, straddling the line between the upper "strategic" and lower "tactical" half of the framework. This positioning graphically illustrates the essential unity and inseperability of tactical decision making and strategic planning.
4) The iterative nature of the basic planning process is illustrated by lower tactical and upper strategic feedback loops, joined within the management function.
5) The principal flow between the upper and lower halves of this figure is information: options that inform decisions or resource allocations from

FIGURE 2.11 AMARA AND LIPINSKI'S MODEL OF CORPORATE STRATEGIC PLANNING



top to bottom, results that monitor the outcomes of decisions previously made from bottom to top.

6) Symbolically, the upper strategic loop may be viewed as representing the "left brain" rational component of management while the lower tactical loop represents the "right brain" intuitive component.

7) Financially, the upper half of Figure 2.11 generally deals with choices that are likely to impact the balance sheet, the lower half with decisions more likely to impact the profit-and-loss statement.

8) Any real decision-making situation will be an amalgam of the five stages shown and described eariler."

2.4.5 Summary and Conclusions

Thomson, Beer, Paterson, and Amara and Lipinski all view organization to some extent as open systems. The contribution of Thomson's work for our purposes is in the recognition of the politicization of middle management behaviour and that different levels of the enterprise behave differently. Thomson however underestimates the interaction with the environment that the lower levels of the hierarchy might have in certain types of enterprise, e.g., professional bureaucracy or sales and marketing aspects of organization and his theory (like most of even open systems organization theory) is still somewhat instrumentalist.

The contribution that Paterson makes is in recognizing that hierarchy is (or at least should be) fundamentally related to decision-making, therefore in attempting to understand spatial and organizational hierarchy it is important to "locate" types of decision-making in the multi-unit enterprise.

Stafford Beer's contribution is in providing insight about the interaction of goals, steering and monitoring and control in enterprise. He suggests that bureaucratic forms of enterprise tend to over-develop their monitoring and control system (Systems 3) by duplicating these functions at a number of levels. Beer also argues that the development directorate or intelligence functions (System 4) have tended, historically, to become staff functions, separated from the hierarchy of decision and authority in the large scale enterprise. Beer advocates a form for complex enterprise that conforms more to a flattened, "intelligent" hierarchy than a pyramid-shaped bureaucratic one, a point that will be returned to in Chapter 3.

Finally the Amara and Lipinski model provides us with a framework of how strategic choices can be developed and enacted in a complex environment, and emphasizes the importance (as do both Beer and Paterson) of the need for interaction between strategic planning and operational management activities.

These roots can be seen in the model outlined in Chapter 1 and Figures 1.1, 1.2, and 1.3. The separation of strategic decision, strategic planning (or intelligence), and monitoring and control as critical activities in the structure of enterprise mirror Paterson's F, E, and D bands, Beers Systems 5, 4, and 3 and Amara and Lipinski's Stages 5, 4 and 3. The relationship between strategic decision, organization, environment and technology (shown in Figure 1.3) has roots in the open systems view in organization theory (in particular, cybernetics) and to a lesser extent in structural contingency theory (discussed earlier). However these approaches still do not fully explain the non-deterministic, synergistic phenomena that characterize the relationship among the variables in the conceptual framework outlined in Chapter 1. Indeed it could be argued that the theoretical bases touched upon here are still predominantly either <u>descriptive</u> or <u>prescriptive</u> of the relationship among the variables of concern. Further, it could be argued that much of organizational theory is still somewhat simplistic in its explanation, and has an overwhelming focus on causality even when an open systems view is adopted. Furthermore as Hage (1980) has pointed out there are weaknesses in organization theory in the handling of the concept of structural transformation.

2.5 TRANSFORMATION IN OPEN SYSTEMS

The models described so far adhere essentially to the notion of static equilibrium, an idea that still carries much weight in the minds of neo-classical economists and others. The theories outlined above have developed from linear deterministic approaches to more complex open systems models. However, even the open systems models outlined do not as yet deal with the dynamics of system transformation in any meaningful way. Instead, like neo-classical economic analysis, they tend to view any change as the shift towards the equilibrium state that the contextual conditions dictate. To deal effectively with transformation in open systems it is necessary to have some understanding of how complex social systems transform themselves.

2.5.1 Bouldings' Nine System Types

Before we can deal effectively with transformation in complex open systems it is useful to consider a taxonomy of system complexity. Kenneth Boulding (1968) has identified 9 systems types:

"1) Frameworks - simple structures.

2) Clockworks - simple dynamic structures with predetermined motions.

3) Cybernetic Systems - capable of self-regulation to meet an externally prescribed goal e.g., a thermostat.

4) Open Systems - a self-maintaining system, e.g., a cell.

5) Blue Printed Growth Systems - capable of genetic reproduction, e.g., a plant.

6) Internal Image Systems - capable of perceiving and organizing its perception of environment, e.g., animals.

7) Symbol Processing Systems - possessing self-consciousness and language ability, e.g., humans.

8) Social Systems - "multi-cephalous" systems of actors sharing values or culture, e.g., social organizations.

9) Transcendental Systems - systems comprised of the "absolutes and the inescapable unknowables".

These are arranged in a nested hierarchy of systems within systems. The value of Boulding's insight and the magnum opus of Miller (1978) is not only in demonstrating the complexity and inter relatedness of systems in the world, but in emphasizing the validity of using one lower order level as a model and a means of understanding, higher levels:

> "much valuable information and insights can be obtained by applying low level systems to high-level subject matter"

Boulding is also quick to point out that:

> "most of the theoretical schemes of the social sciences are still at level 2, just rising now to 3, although the subject matter clearly involves level 8"
>
> Boulding (1968:208)

2.5.2 Corning's Synergism Hypothesis

Peter Corning (1983) has made an impressive attempt to develop a theory of socio-cultural transformation (or evolution as he terms it) in his "Synergism Hypothesis" that tries to go beyond simple clockwork in the form of analysis. In his own area, Corning recognizes weaknesses in causal and deterministic models. In reviewing the literature on socio-cultural evolution Corning concludes that:

> "Technoeconomic determinism as a general methodological stance is outdated by the accumulated evidence of a more complex reality. Similar technologies do not necessarily call forth similar social organizations or similar ideologies. They may call forth altneratively, an Athens or a Sparta, a Victorian England or an Imperial Germany, a United States or a Stalinist Russia. Likewise a steel mill can be operated by a laissez faire capitalist, a worker's collective, or a socialist state bureaucracy. The differences are significant. Furthermore the causal arrows do not run in only one direction. The blanket assumption that technoeconomic causes will predominate over political/military causes is an assumption that has become dogma."
>
> Corning (1983:p 224)

Corning also has emphasized that all the "prime movers" of socio-cultural evolution are simplistic. Corning cites Elman Service's critique of cultural evolutionism (terms in parentheses have been added by the author to emphasize the thrust of the argument here):

> "Down with prime-movers! There is no single magical formula that will predict the evolution of every society (enterprise). The actual evolution of the culture (organization) of particular societies (enterprises) is an adaptive process whereby the society (enterprise) solved problems with respect to the natural and the socio-cultural (organizational) environment. These environments are so diverse, the problems so numerous, and the solutions potentially so various that no single determinant can be equally powerful for all cases."
>
> Corning (1983:p 226)

Corning brings together 6 critical concepts in what he terms a Social Triad Scenario of socio cultural evolution. These are:

"1) The Interactional Pardigm which requires a multifaceted view of the basic survival challenge to which our evolving ancestors were exposed.

2) The teleonomic selection model of causation which posits that behavioural changes are likely to have been the pacemaker; that is, the natural selection of morphological changes tracked the process of behavioural and social change (rather than vice versa).

3) The cybernetic model of social organization which makes decision-making, communications and behavioural control processes (political processes) integral parts of organized (purposeful) social behaviour.

4) The Synergism hypothesis which focuses on the functional consequences of various combinational processes, including social cooperation.

5) A bio-economic (benefit-cost) approach to assessing the plausibility of alternative choices and strategies.

6) A revival (with modification) of the Darwinian hypothesis that human social evolution may have been the result of three mutually reinforcing selective processes: a) kin selection for altruistic and group-serving behaviours among closely related individuals; b) individual selection for mutually beneficial forms of co-operative behaviours (egoistic co-operation or enlightened self-interest); and, c) group selection among functionally interdependent groups of co-operators."

Corning (1983:p 275)

The utility of Corning's ideas for our purposes here, lies in his recognition of the complexity of the process of transformation in social organization and in the identification of key variables and sub-processes involved in transformation. Extrapolating Corning's ideas back to the level of the enterprise it is clear that transformation is a process in which survival, adaptation, behavioural change and goal-setting are interacting factors underlying transformation. On the other hand, synergism and bio-economic performance are both criteria in decision-making and attributes of the outcomes of transformation. (Outcomes, as Corning emphasizes, that are not inherently beneficial, i.e., synergism is not a good in itself).

Is this approach an unnecessarily complex "fuzzification" of reality? It would be much easier from a research point of view, to draw the causal model out in Chapter 1, gather the data, load the arrays and spit out regression analyses until we found one with statistical significance. But as Evans (1982a) has suggested:

"For every complex problem there is a simple answer: and it's wrong."

2.5.3 Hage's View on Structural Transformation in Enterprise

Corning provides us with a broad conceptual explanation as to how and why complex systems transform themselves. The question of stages in the structural transformation of enterprise has been examined more closely by organization theorists. Hage (1980:p 208) synthesizes a variety of studies when he describes four stages in the process of change:

1) Evaluation
2) Initiation
3) Implementation
4) Routinization

In the evaluation stage enterprise evaluates how well it is maintaining its relative position against a set of performance criteria, e.g., profit, prestige or market share. If a "performance gap" is identified then a change may be initiated, the search here is for funding to support such a change.

The implementation stage is involved in closing the performance gap by introducing the innovation. Finally as Hage points out:

> "the routinization stage refers to the integration problem. On the one hand dominant coalitions must decide whether to retain or reject the

> innovation. On the other hand special procedures must be routinized. There is a need to reintegrate the organization."
>
> Hage (1980:p 209)

The importance of Hage's work for our purposes is first in the recognition that the enactment of structural change in enterprise involves strategic perception and strategic choice (the C and D boxes of Paterson's decision process) and second in emphasizing the underlying power relations and political nature of strategic decisions about change.

These views tend to suggest that the process of transformation in complex social systems is not a result of clockwork progress towards a prescribed equilibrium, not a trajectory of change determined by technology or environment and not a random process of evolution. Rather structural transformation is a synergistic process of change that is conditioned by environmental circumstances, internal operation and behaviour and strategic decision-making. In social systems, given their "multi-cephalous" nature, the choices made by individuals and groups have a critical role to play in the process of transformation. Thus the analyst of structural transformation must look at interest groups, power and politics as much as technology, economics and environment.

2.5.4 Summary and Conclusions

Investigation of transformation in complex systems involves identification and explanation of both structure and process. A range of precedents for our model have been reviewed in the work of Mintzberg, Beer, Paterson and the structural contingency school. These authors provide us with useful models of enterprise and a vocabulary for the examination of transformation in structure. They also contribute to our understanding of the interaction between environment, decision making, organizational structure and technology.

Recent developments in the theory of organizing (Weick 1979), in the theory of organizational power and politics (Farrell (1982), Culbert and McDonough (1980) and Pfeffer (1981 and 1982); in strategic decision-making under uncertainty (Amara and Lipinski (1983) and Huber (1984)); and in socio-cultural evolution in complex systems (Corning (1983)) provide us with some understanding of how the process of systems change operates.

The conclusion that can be drawn is that any approach to the analysis of transformation in multi-unit enterprise must recognize the complexity of interaction between a wide variety of variables. In particular, it is clear that the nature of the environment facing enterprise is an important factor that helps shape the structure of enterprise. Similarly, strategic decision making, intelligence functions and the inherently political processes underlying these activities are critical to both the structure of enterprise and the process of transformation. Technology, organizational and spatial structure are an interacting web of variables that both influence strategic choice and are influenced by it. In the following chapter transformation in these variables will be critically reviewed and conclusions will be drawn about the relationship among them.

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CHAPTER 3 - CRITICAL PERSPECTIVES ON STRUCTURAL TRANSFORMATION

3.1 INTRODUCTION

There is widespread agreement that advanced nations are undergoing a period of structural transformation, even though analysts disagree about the causes and effects of this transformation. The transformation is thought to occur in a number of dimensions: demographic, political, economic, organizational, socio-cultural and technological; and at a number of levels: societal level, urban systems level and at the level of the enterprise. Some observers have labelled these transformations as the emerging Post-Industrial society, Bell (1976), the Global Economy, and the International Economy, still others have termed them the shift to an Information Society or an Information Economy, Porat (1976). This latter group have focused particularly on the role of information technology, i.e., computer and communications technology, as the driving variable behind structural change in the economy and in enterprise.

In examining a complex synergistic process of transformation it is difficult to develop an organizing principle for such an exposition. If there are no prime movers and no higher order causes then how should such analysis be organized and where should it begin?

The choice made in organizing this literature review of structural transformation is an arbitrary one. This review of structural transformation is divided into 3 levels: the societal level, urban systems level and the level of enterprise. The purpose of differentiating between the societal scale and the urban systems scale is twofold. First, it is clear that the more general societal transformations have been analyzed in a relatively aspatial way. In order to integrate effectively spatial phenomena into the analysis of transformation, the urban systems literature must be considered. Secondly, the urban systems literature provides a useful bridge between the broad societal change and the manifestations of these changes in cities and enterprises.

Structural transformation of the enterprise is both reflected in and affected by those wider environmental transformations found at the societal and urban systems scale. It is also conditioned by some of the specific characteristics of the immediate environment facing enterprise. As pointed out earlier, it is difficult to isolate the three levels because shifts in the behaviour of enterprise are an integral part of broad societal transformation. Thus the organization of this review is for analytical convenience and does not imply that a higher order of importance is to be attached to societal transformation, or that causality flows from higher to lower order.

3.2 PERSPECTIVES ON SOCIETAL TRANSFORMATION

In this section, a range of views on broad scale socio-economic transformation will be critically examined. The intention here is to derive some conclusions about socio-economic transformation that can illuminate both the stages and process of transformation in the relationships among technology, organization and location of the multi-unit enterprise.

Figure 3.1 identifies six basic schools or approaches that are prevalent in the analysis of structural transformation at the macro socio-economic or societal level. These are:

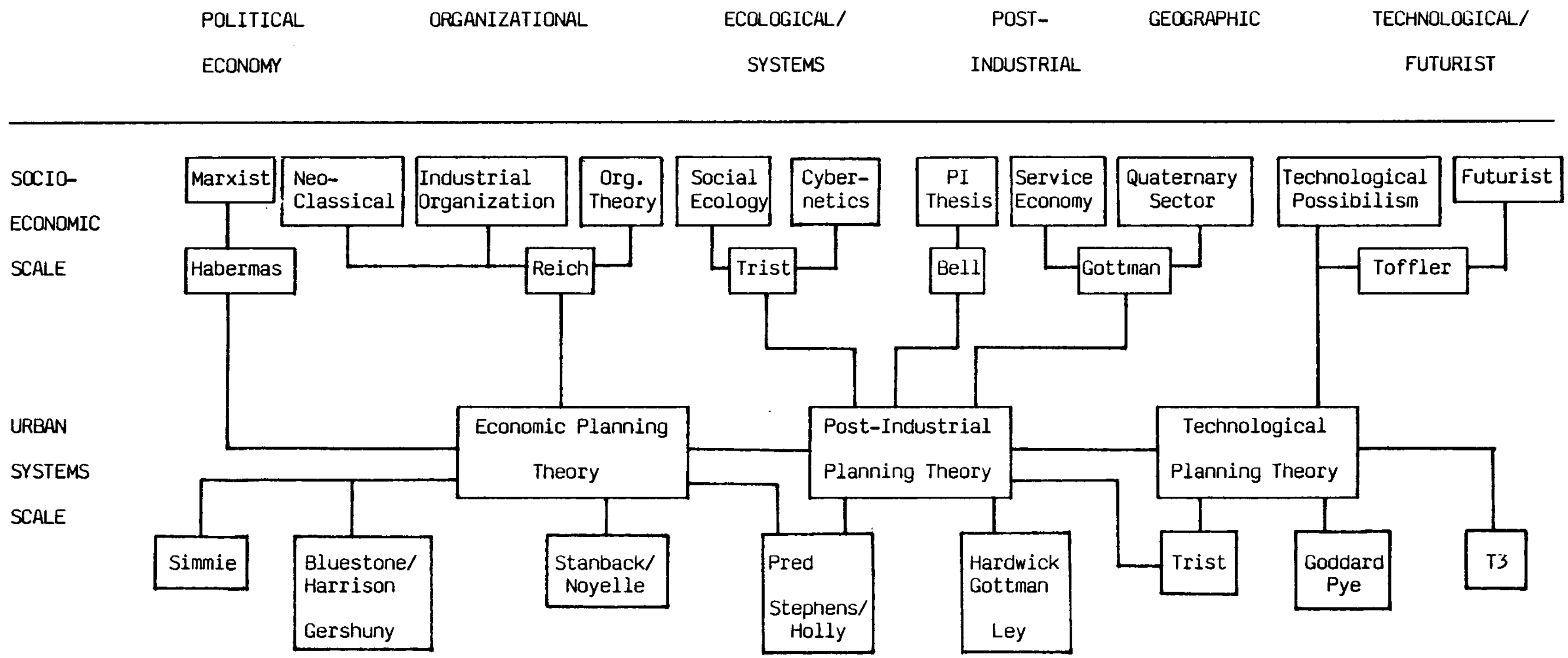
1) Political Economy
2) Organizational
3) Ecological/Systems
4) Post-Industrial
5) Geographic
6) Technological/Futurist

Each of these schools has produced leaders and followers and a good deal of sniping and criticism between the schools has been generated. The intricacies of these debates can be more sharply focused at the urban systems level, because it would be impossible to adequately review here the broad spectrum of views on socio-economic change. However a brief comparison can be made between representative of each of the schools across a number of dimensions. The 6 representatives are Jurgen Habermas, Robert Reich, Daniel Bell, Eric Trist, Jean Gottman and Alvin Toffler. Since Bell's Post-Industrial thesis represents somewhat of a middle ground between these views it can be used as a basis for comparison.

3.2.1. Bell, Habermas and Trist: Post-Industrialism or Advanced Capitalism?

Daniel Bell is the father of the term, "post-industrial society", an extension of the pre-industrial, industrial typology. He states in the very first page of his foreword to the 1976 edition that:

Fig. 3.1 ALTERNATIVE VIEWS OF STRUCTURAL TRANSFORMATION



> "The idea of a post-industrial society is not a point-in-time prediction of the future, but a speculative construct, an as if based on emergent features, against which the sociological reality could be measured decades hence, so that in comparing the two one might seek to determine the operative factors in effecting societal change."

It is then, in Bell's view, a theoretical construct - a benchmark against which we can evaluate societal change. He is not suggesting that post-industrial society displaces all aspects of industrial society, just as industrial society did not displace the agrarian sectors of the economy. This is a point he returns to in his concluding chapters, namely, that social systems take a long time to change:

> "To predict the close demise of capitalism is a risky business and barring the breakdown of the political shell of that system because of war, the social forms of managerial capitalism - the corporate business enterprise, private decision on investment, the differential privileges based on control of property - are likely to remain for a long time." Bell (1976:p 372)

If capitalism is still going to be with us, what are the new dimensions that help differentiate or distinguish post industrial society. Bell emphasizes that he is not advocating the abandonment of existing theoretical dimensions in the analysis of post-industrial society. Instead he suggests that:

> "Like palimpsests the new developments overlie the previous layers, erasing some features and thickening the texture of society as a whole." (Bell 1976 :p.xvi)

What are these new developments? In his foreword, he summarizes eleven basic attributes of post-industrial society that he considers to be indicative of emerging trends. These are:

1) The Centrality of Theoretical Knowledge

Bell has argued that knowledge or human capital in a post-industrial society, will play as central a role as physical capital did in industrial society. He is arguing at a theoretical level for adoption of a knowledge, rather than a labour theory of value. He sees knowledge as a collective good that is much more difficult to privatize than labour and its surplus value. His evidence of the centrality of theoretical knowledge, includes the observation that the emerging and important industries of the late 20th Century are predicated on theoretical developments, rather than the results of empiricism and tinkering as was the case in industrial society. The two salient examples are the chemical industry - requiring a theoretical understanding of the composition and behaviour of macro molecules and the recent developments in silicon chip technology that are based on earlier advances in theoretical physics.

2) <u>The Creation of a New Intellectual Technology</u>

Computer modelling, simulation and systems analysis is being used increasingly to "chart more efficient 'rational' solutions to economic, engineering, if not social, problems" according to Bell. This comment should be viewed in the light of the time. The late 1960s and early 1970s, when Bell was formulating his thesis, saw the height of positivism and quantification in the social sciences, but how pervasive is Markov Chain Analysis in publications today? What Bell correctly forecasted was the growth in extent and importance of information technology and information functions in contemporary society.

3) <u>The Spread of a Knowledge Class</u>

The growth of the technical and professional class has been seen by Bell

(1976) and Gouldner (1979) as an important characteristic of the changes occurring in modern society.

4) <u>The Change from Goods to Services</u>

This point will be discussed extensively in subsequent sections of the chapter, but it is important to recognize here that Bell sees the increasing role of human services (health and education) and professional and technicial services as the hallmark of the post-industrial society. Bell sees these services as "a constraint on economic growth and a source of persistent inflation."

5) <u>Change in the Character of Work</u>

Work has changed from a game against fabricated nature, i.e. machines, to a more playful game between persons. The "rhythm of life" is different and the work environment has changed substantially. (This idea can be compared to Gottman's notion of the quaternary sector in a transactional society - the patterns of social behaviour and the physical environment of work are very different from an industrial world).

6) <u>The Role of Women</u>

Bell recognizes that the changing structure of the labour force (in particular, increased participation by women) and its related effects on households has had considerable impact on patterns of production and consumption.

7) <u>Science as the Imago</u>

Bell suggests that the relationships between science, technology, its clients and society will be central ones in post-industrial society and increasingly these relationships may become a source of problems and concerns.

8) Situses as Political Units

Situses - are defined by Bell as a set of vertical orders. He identifies four functional situses: Scientific, Technological, Administrative, Cultural; and five institutional situses: economic enterprises, government bureaus, universities and research complexes, social complexes (e.g., hospitals, social service centres) and the military. His argument is that societal conflict will be variously organized between these orders and this might prevent the consolidation and organization of a new class.

9) Meritocracy

Education and skill versus inheritance of property are seen as a means of awarding place in society. Bell defines a "just meritocracy" based on achievement and through the respect of peers.

10) The End of Scarcity?

Bell recognizes that scarcity will still be with us but suggests the new scarcities will be of information and time. A point that warrants some criticism.

11) The Economics of Information

Finally, Bell suggests that information is a collective, not a private good and this requires therefore a "co-operative" rather than a "competitive" strategy towards social relations. It is interesting that two Noble Laureates in Economics have addressed the issues of the Economics of Information. Kenneth Arrow (1979) and George Stigler

(1961). The two themes seem to be information as cost e.g., Stigler's work on the costs of search, Stigler (1961) and information as value, e.g., Arrow's work on information as a saleable commodity or as an innovative force, Arrow (1979).

In summary then, the two most important dimensions of change that Bell is emphasizing are first, the centrality of theoretical knowledge and the institutions that produce and recreate it, i.e., the university and the research institute. Second, he is pointing to the change from a manufacturing to a service economy as being a fundamental re-orientation of economic activities.

David Ley (1980) has pointed to the similarity between such diverse scholars as Bell (1976) and Jurgen Habermas (1975) in their conception of post-industrial society. Ley argues that in the realms of economy, politics and culture there is a complementarity in the views of Bell and Habermas in that they both see changes in the nature of work, the role of the state and the growth of aesthetic values and consumption as being indicative of the shift from early to advanced capitalism (in the case of Habermas) or from industrial to post-industrial society (in the case of Bell). A further extension to Ley's melding of disparate academic perspectives is offered by the analysis of Trist (1970). He compared the critical structural differences between U.S. society in the thirties and the sixties and labelled these differences as "comparative saliences". His conclusions are very similar to Ley's synthesis of Bell and Habermas. A number of dimensions were considered and Trist, too, suggested the growing importance of theoretical knowledge, the shift from goods to services, the change in employment structure from blue to white collar, the shift in employment hours towards increased leisure time, changes in family structure and changing attitudes towards the environment.

3.2.2 Robert Reich: The Next American Frontier

Reich argues that there are 2 principal sub-systems in North American society: the business system and the civic system. Each system has alternated as leader through the development of the American economy. Reich suggests that the US has gone through two major phases of economic development and is about to enter a third. The first phase was the mobilization phase where owner/entrepreneurs tinkered with new products and built moderately large and powerful enterprises by mobilizing technology, capital and labour. This phase ended around the first world war. Reich argues that the needs of war, the separation of ownership from control and the potential for social and economic abuses in an owner/operator world led to a focus on scientific management. From 1920 until 1970 scientific management principles were applied not only to the management of large scale production processes, but also to the management of the total economy itself. The same principles that were used to produce cheaper goods in large batch processes were used to police the oligopoly arrangements in most American industries. In the 1970s, Reich argues, this situation reached an impasse. The American economy faltered, not solely because of OPEC or the excesses of monopoly labour, but because of the failure of management to adjust its style and orientation to the concerns of quality of product and quality of worklife. Reich suggests that during this impasse, the American economy embarked on an unproductive binge of paper entrepreneurialism, which created no new real wealth, but provided the multi-nationals with the illusion of growth. In addition, both labour and capital attempted to hold back structural change through protectionism. According to Reich, the U.S. economy has entered a third major stage in which enterprise must recognize the value of human capital in creating new wealth through "flexible system" production and the related need on the part of government, business and labour to bring together the business system and the civic system to work towards a joint economic purpose. A variety of recent texts echo Reich's argument e.g., Harris (1981), Ayres (1984), and Lewis and Allison (1982).

3.2.3 Gottmann and Hardwick: The Quaternary Sector

Just as Daniel Bell has been heavily criticized since coining the term post-industrial so Jean Gottmann has suffered similarly at the hands of critics since coining the term "quaternary sector" in 1961. Gottman (1961, 1983) suggests that modern society is transactional in nature, concerned more with the exchange of information, and with decision-making, rather than with the production of goods. Gottmann proceeds to identify a quaternary sector of the economy that is an extension of Colin Clark's scheme of primary, secondary and tertiary industry. Within this quaternary sector, argues Gottmann, the transactional activities are conducted by the professional, managerial, technical and clerical workers.

This is grossly overstating the quaternary sector. Just as Bell has been criticized for failing to distinguish between different dynamics in the service sector - so Gottmann has been criticized by Bell (ironically) and by Hardwick (1974, 1983) because much of the activity of this sector is really involved with production and distribution of information (See also Stanback (1981)). To lump together all white collar work as quaternary is to fail to recognize, according to Bell (1979):

> "the thrust implicit in the original Colin Clark scheme, with its emphasis on differential productivity as the mechanism for the transition of one society to another."

Hardwick (1983) however has suggested that although greater productivity has indeed been wrested from first agriculture and then manufacturing, this productivity has emerged from activities of the quaternary sector, i.e., the very small sector of the economy that has always existed, which through its innovative and entrepreneurial skill has enabled or "catalyzed" productivity improvement and social change. In the contemporary economy these elements represent a very small share of the labour force (probably less than 5%) compared to 40% - 50% using Gottmann's conception. Yet it is on the viability of this (redefined) quaternary sector that society largely depends for stimulation of the economy. This includes the activities of the entrepreneur, the researcher, the senior government and business policy makers and the merchant banker. Viewed in this light the economy is much less quaternary in nature than Gottmann would have us believe.

3.2.4 Alvin Toffler: The Third Wave

A final view is presented by Toffler (1980) who has argued that the industrial or second wave society is being replaced by a third wave. The second wave according to Toffler was dominated by six principles:

1) Specialization - the division of labour

2) Standardization - of rules and procedures

3) Synchronization - of activities

4) Concentration - of activities and authority

5) Maximization - bigger is better

6) Centralization - spatial concentration

The third wave will bring about decentralized systems producing a more diverse range of customized goods and services and resulting in what Toffler calls a demassification of our institutions.

3.2.5 Criticism of the Alternative Views of Societal Transformation

The term "view" has been used rather than theory because it is not clear whether these various approaches have consituted a body of theory. The marxist and structuralist views have certainly followed a theoretical tradition. Similarly, the ecological/systems views are rooted in the application of general systems theory and social ecology to socio-economic phenomena. The economic views are partially related to conventional neo-classical analysis - although in many cases the arguments are developed more from an empirical than theoretical standpoint. Robert Reich draws more from industrial economics and organization theory than from neo-classical economics (see Kuttner (1985)). The post-industrial thesis is described by Bell as a "theoretical construct" ... a benchmark against which we can compare emerging reality, rather than a theory that explains reality. The information and futurist views are more scenario generations of emerging reality and/or utopia than they are theories that can be tested. The value of each of these approaches is not so much in their academic purity but in the insights they can provide about structural transformation and the powerful effect they can have on policy, planning and action.

Each of these views can be seen as flawed in some way. Recognizing these flaws can assist in synthesizing an overall view of structural transformation.

i) Political Economy

The marxist view is that nothing fundamentally has altered except for a further step on the inevitable historical march of capitalism, i.e., a shift towards advanced or managerial capitalism. This view seems to be incredibly narrow and naive. Everyone recognizes that capitalism is a significant component of the advanced state and many analysts agree that the behaviour of large enterprise can be characterized, to some degree, as self-serving. There is, however, a great deal of evidence to suggest that in modern society the actions of individuals and groups can dramatically alter the structure of our instititions and the behaviour of our corporations. (Thus marxist analysis underestimates the role of politics, interest groups and strategic choice.)

There is a great deal of difficulty in adequately critiquing marxist theory in a paragraph, because it requires a reappraisal of the underlying ideology of marxist thought. The basis of the theory is belief, and so critical exchange about the historical trajectory of capitalism becomes almost as difficult as discussing the inevitability of Armageddon with Jerry Fallwell. However, the mechanistic macro models of structuralist-functionalist thinking do serve a useful role in modelling some of the motivations of some of the players but they do not adequately incorporate the role of individual choice in a democratic society.

ii) Conventional Economic Views

Criticisms of the economic views of structural transformation are as various as the range of economic views themselves. Much of the rigid neo-classical analysis of structural change is very close in vocabulary and style to structuralist-functionalist thinking. Conventional neo-classical analysis has failed to explain adequately the socio-economic changes over the last few years (Bell and Kristol (1981), Kuttner (1985)). This is largely because the fundamental institutional structures of advanced nations - oligopolies, regulated monopolies, professional practices, hospitals, universities, schools and producer services - do not fit well into the established body of economic theory. "New" theory is beginning to emerge in the areas such as the economics of regulation, health and energy but we still suffer under the rhetoric and econometrics of perfectly competititve markets and macro-economic "laws", even though they are difficult to apply directly in the advanced nations or anywhere else (Kuttner (1985)). Perhaps the most significant contribution that the various economic views have made to our understanding of structural transformation is in the empirical evidence that has been provided. Although such empirical analysis rarely comes from "real" economists but from economic geographers and planners, Kuttner (1985). There is however a split between those economists and economic planners who argue that the data show no change e.g., Gershuny (1978), versus those that try to interpret the evidence as part of a broader process of economic transformation, e.g., Reich (1983).

iii) Ecological and Systems Views

The Ecological and Systems views tend to suffer from a similar flaw to that of certain structural marxist and economic views. Whereas structuralism leads to devlopment of macro-mechanical models moving to an inevitable clockwork conclusion (Boulding (1956)) there is a tendency in the ecological view to develop supra-organic process models that suggest that individuals and institutions are reacting/adapting inevitably to changes in habitat and environment. Although this view allows for a wider range of actions, these actions seem to be tightly constrained by ecological or even biological principles. On balance, however, these models provide a useful conceptual framework for generalizations about changing environments and the potential organizational reactions to these changes.

iv) Post-Industrial Views

The Post-Industrial thesis has been heavily criticized by marxist and economic scholars. Three principal criticisms have been made (e.g., Walker and Greenburg (1983) and Lasch (1979)). First, there have been suggestions that the thesis is poorly framed and is imprecise because it does not adequately explain the "causal mechanisms or structural relations which give rise to sensible phenomena". Second, there has been considerable criticism of the notion of an expanding service sector with analysts suggesting instead that the service sector is really diversification and specialization in production (e.g., Gershuny (1978), Walker and Greenburg (1983)). The third principal criticism put forward by this group, is their rejection of Bell's concept that we are witnessing a shift from a labour theory to a knowledge theory of value.

The criticism that Bell's thesis is vague, seems to be an argument in favour of reductionist simplicity, rather than a plea for clarification of

Bell's presentation. However, urging for more care in the taxonomy of the service sector of the economy is a valid criticism. Indeed, others who subscribe to the post-industrial thesis have been more careful in their taxonomy, e.g., Hardwick (1984), Davis and Hutton (1981). As for their final point, there is considerable empirical and theoretical evidence to suggest that knowledge rather than labour is becoming the principal component that adds value, e.g., Reich (1983), Dennison (1975) and the literature on innovation. This point will be returned to in greater depth in the discussion of the transformation of enterprise.

Bell's thesis is not however above criticism. In addition to the taxonomy problems of the goods to services transformation, there are three further criticisms that can be applied to Bell's arguments.

First and perhaps most importantly, Bell does not deal adequately with questions of scarcity. This may be a function of when Bell was writing, i.e., at the end of the post war boom and before oil-crises, stagflation and recession. Bell sees only scarcities of time and information as being important, rather than scarcities of energy, raw materials, capital or jobs. This point has received much criticism by Gershuny (1978) and Simmie (1983) in particular. In his later essays on information technology, Bell (1979) recognizes that the structurally unemployed may be with us for a very long time as automation takes hold in clerical, technical and knowledge occupations, but he offers no substantial integration of these phenomena into his earlier thesis.

A second criticism is that Bell, to a large extent, may have chronicled the recent past, rather than the emerging future. This is not to suggest that his thesis is not useful as a benchmark for assessing societal change - which was his stated purpose - rather it is in the light of changing economic conditions and reactionary shifts in ideology in the late seventies and early eighties, that his thesis must be reappraised, if it is to be relevant for purposes of analysis and policy design.

A third criticism is that the post-industrial thesis is an intellectually elitist and possibly egocentric one. It could be argued that it is a conception of emerging society written by a university professor for university professors. This conception underestimates the role of the entrepreneur and the politician in human affairs.

To some extent these criticisms have been answered in subsequent works. Reich (although no self-proclaimed disciple of Bell's) has addressed some of the economic and institutional inconsistencies of Bell's thesis albeit within a different formulation of economic change in America. The ecological/systems view rearticulated by Trist (1980) follows in the Post-Industrial tradition and resolves some of the concerns about the emerging turbulent environment of the 1980s that were not forseen in Bell's work. On balance, however, the concept of Post-Industrial society still fulfills its stated purpose as a benchmark against which we can plot societal change, in particular, the conception of a knowledge theory of value which runs through much of contemporary thinking on the economy and organization.

v) Technological/Futurist Views

Finally, a brief comment should be made about the contribution of the Informational/Futurist literature. This literature is wide ranging and includes, firstly, useful empirical analyses of the information economy such as Porat's (1976). Second, it encompasses technological determinism from technology "freaks" who fantasize about what technology can do and then attempt to rationalize that "technology's will be done". Third, there is a set of more balanced studies on technological "possibilism" where the potentials of the technology are carefully examined and the possibilities of alternative futures are explored, e.g., Tydeman et al (1982). Fourth, there are a series of synthetic overviews of change (what Bell terms Future Schlock) in the Toffler mode. Finally, there is pure science fiction. One of the criticisms of these strands of literature in this area is that it is sometimes difficult to tell them apart. Opinions that border on science fiction are often given the same legitimacy in the media and popular business press as more careful technology assessment studies. Similarly, the studies that take an overtly deterministic line seem to either be incredibly self-serving on the part of those sponsoring and performing the studies, or incredibly naive in assuming that what can be done, will be done. The value of this literature is in identifying the capabilities of information technology and in formulating alternative visions of the future (scenario generation) that can be assessed in strategic decision making for enterprise, Amara and Lipinski (1983).

3.2.6 Conclusions From the Critical Review on Socio-Economic Transformation

From the literature on societal transformation some general conclusions can be drawn that can be integrated into a coherent pattern, that sets part of the context for the structural transformation of enterprise.

a) From Land Through Labour and Capital to Knowledge

The first theme stems from the transition in what constitutes and creates value. In pre-industrial societies land (or what grazed on it) was both the symbol of and the means of producing wealth. In industrial society wealth was created by the organized application of labour and capital to produce more goods. In a post-industrial society labour and capital continue to play an important role in the creation of wealth but increasingly it is knowledge that adds value. This requires some elaboration. It could be argued that knowedge and organization have always been critical factors in producing new wealth. The neolithic farmers developed new knowledge through research and experimentation. This enabled the creation of sufficient surplus to allow the development of settlements devoted to exchange functions. The innovations in organization of agriculture in Britian in the 17th and 18th centuries greatly facilitated the growth of urban populations. Similarly, the immense increases in productivity in agriculture since the turn of the 20th century have been achieved through improved knowledge and organization. Land has become more productive largely through the application of knowledge.

The productive capacities of the industrial age too have been brought about through the application of knowledge and organization. Adam Smith's pinmakers, initially, had no new tools or new capital, only innovation in the way they were organized. The division of labour facilitated the development of specific equipment-embodied technologies, but it was the organizational innovation that spurred initial improvements in productivity and wealth creation, not solely technological change.

Thus a significant change that has occurred in the transformation to a post-industrial society is the recognition that knowledge and organization are critical factors in creating new wealth. Information is a critical factor of production and in its accumulated form, i.e., as knowledge or human capital, it is as effective in creating value as capital.

b) The Transformation from Goods to Services and Information

The second transformation is that increasingly, products are in the form of information or experiences rather than physical artefacts. Various empirical attempts have been made to measure the shift in the economy from goods to services and information. The proportion of societal effort expended on services, experiences and other intangibles is increasing.

It has been argued that many of these activities are involved in the management, monitoring and control of the production, consumption and distribution of goods (e.g., Gershuny (1978), Reich (1983)). Such activities fall into the category of business services and growth in this sector is perfectly consistent with a knowledge theory of value. Improving productive capacity depends as much on improved education, organization and management as on capital. Improving productivity in this way involves the gathering, processing, dissemination and application of knowledge. Similarly, the corollary of the Gershuny argument is that much of the goods producing sector is involved in the production and distribution of equipment and supplies that generate and transfer information. (Hence Porat's (1976) conclusions that more than 40% of the U.S. economy is in the information sector, the largest compared to agriculture, manufacturing and services). Finally, it is undeniable that there has been growth in the human services such as health and education over the last three decades, e.g., Simmie (1983), Gershuny (1978) and Bell (1976).

A drastic reduction in relative levels of employment in agriculture did not equate to a drop in agricultural output, quite the contrary. Some have suggested it is reasonable to expect that the application of organization and technology to manufacturing and service activities can yield similar results.

c) Transformation in the Nature of Work

There has been a transformation in the occupational structure of the advanced nations. There are a number of dimensions to this change. First, there has been an increasing role for women in the workplace. For example between 1971 and 1981 in Canada, the female labour force grew more than the male labour force. Although much of the change came in so called pink collar work (i.e., sales and clerical occupations) women also made increasing gains in the management, teaching and health occupations. These shifts have significant implications for household structure, consumption patterns and public policy.

The second principal shift was from blue-collar occupations to white collar occupations. This includes two effects: first, the general shift from goods to services, and second within the "goods producing" sectors the shift towards office work, most notably clerical, advisory, systems monitoring and control functions. Interestingly, however, the large relative and absolute growth in white collar work is not paralleled by growth in share of general managers (strategic decision makers) in the workforce (a point that will be returned to below).

The third principal transformation in occupational structure is the relative increase in the number of employees involved in public sector activities (including health and education). Finally, there has been a shift in the number and share of the population who derive income not from work but from transfer payments including unemployment insurance, pension and investment income etc. All these societal trends reflect changes in the way enterprise is organized and in the way wealth is created and distributed.

d) Internationalization of the Economy

A wide range of analysts have recognized that the North American economy has been brought into a more global and a more competitive world economy particularly in the last decade e.g., Harris (1981), Reich (1983), Lewis and Allison (1982) and Ayres (1984). Many economists from both marxist and neo-classical traditions argue that this is a direct result of the restructuring of capital markets to exploit competitive advantages, e.g., accessible raw materials and lower labour rates in the third world, Soja (1982), Hymer (1979). Reich argues that we have exported the technology of large scale production through the investment decisions of multi-nationals and suggests that there is an economic rationale in making these decisions. But it is not solely a flight of capital that has rendered North American manufacturing industries non-competitive, nor is it solely the excesses of organized labour in extracting wage increases or the Arabs in creating oil price increases. America exported organization. In their search for new markets the multi-nationals took high volume production technology and organization to countries where the other factors of production were less expensive. Inevitably these producers became more competitive. The challenge remaining for North American industry was and is to develop the innovative products, organization and technology to create new wealth. Yet there is considerable concern that North American industries have not matched the Japanese or Europeans in their commitment to either education or research and development, Ayres (1984).

e) The Transformation from a Placid to a Turbulent Environment

Trist (1980) has developed a very succinct typology to describe the change in the type of environment faced by enterprise. He sees four phases of development: Placid random, placid clustered, disturbed reactive and turbulent. They have their economic analogies (or "market analogues" as Trist terms them) in perfect competition, imperfect competition, oligopoly and "macroregulation". A turbulent environment is emerging, according to Trist, from three sources. First, "large numbers of large organizations (are) pursuing independent (short-term) goals in societies based on continuous growth and expansion in a finite planet with R & D accelerating the change rate." Second, the communications revolution is reducing the response time and increasing information overload. Third, regulatory mechanisms are unable to cope with unanticipated consequences in interdependent sectors (externalities). Trist argues that in response to such turbulence we must develop organic purposeful systems based on people's capacity to envisage a preferred future and work cooperatively towards that future, i.e., a focus on planning, steering and cooperation.

f) Transformation in Managerial Philosophy

Throughout the various views in the literature at the societal scale there is reference to the development of a two-tiered economy and society. Concern is expressed at the occupational scale, regional scale and the international scale. It is suggested that society is undergoing a process that creates winners and losers (i.e., people, cities and nations) and encourages the separation of command functions from production functions. Reich (1983) and Trist (1980) would characterize these developments as the height of managerialism, Reich (1983) or competitive, technocratic bureaucracy, Trist (1980). They both argue that the managerial philosophy has to change to deal with the other transformations outlined above. The nature of the change that is required is discussed below in the section on the enterprise. It should however, be stated here that there is a considerable body of opinion now emerging in the academic and popular management literature suggesting change will involve the recognition that human capital has to be organized differently and the pattern of decision-making will inevitably have to change, in order to cope with the structural transformations that are occurring in society.

g) Transformation in Technology

Lastly, a theme that is brought out in all the literature on societal scale transformation is the emergence of information technology. If we are entering a new order where knowledge and information play an increasingly important role compared to capital and labour, then tools for the collection, organization and dissemination of information will be very powerful ones indeed. Information has some very peculiar characteristics as a commodity, as Bell and other have pointed out, which render redundant some of our conventional notions of economies of scale, nature of an economic good and the transportation and transmission of information through space. Many analysts are recognizing that these changing characteristics create new potential for organization and location.

3.2.7 Summary and Conclusions on Societal Transformation

The relevance of these societal shifts for this analysis is that they suggest a fundamental transformation in the critical resources and functions of enterprise. If society is moving towards a knowledge theory of value there will be a parallel emphasis on human capital, on education, on innovation and on decision-making in enterprise. This shift from the tangible to the intangible has significant organizational and spatial consequences. In organizational terms the whole notion that, "bigger is better", must be questioned when the critical flows are of ideas and information rather than products. Similarly in spatial terms, a shift towards intangible flows fundamentally alters the friction of distance. Ideas and information as flows of commodities do not necessarily conform to the physical laws inhibiting spatial interaction (Abler and Falk (1981)). Further, increased turbulence and complexity in the environment requires that enterprise must develop methods of coping with uncertainty. Reduction in uncertainty can be mathematically defined as information, consequently uncertain environments require enterprise to be "information-rich" in order the "create the variety" necessary for survival.

3.3. PERSPECTIVES ON STRUCTURAL TRANSFORMATION IN THE URBAN SYSTEM

In this second major section of the chapter we will discuss the demographic, economic, organizational and technological shifts that have occurred over the last several decades and link them to changes in the structure of the urban system. In particular, we will focus on the degree of spatial centralization of the system because this is a useful aggregate measure of spatial structure. This measure is also of particular importance for this study because we are concerned here with the relationships among organization, technology and location of enterprise. Questions about centralization have been critical ones in the literature investigating these relationships. Consequently, we should begin this discussion with a restatement of the definition of centrality and its related measures.

Centrality refers to the state of being central and brings with it notions of the relative degree of concentration of human activities in spatial terms. Centrality however, is not merely a spatial concept, rather it can be defined to include the functional, organizational and political aspects of centrality.

i) Spatial centrality refers to the relative concentration of events or phenomena in geographic space, relative to its surrounding area.

ii) Functional centrality refers to the relative degree of concentration and interconnection of activities in a network. This may or may not involve physical proximity.

iii) Organizational centrality is a measure of the relative degree of concentration of authority and decision-making within enterprise.

iv) Political centrality is a measure of the degree to which political power is concentrated or dispersed among constituencies or participants.

In traditional geographic theory these alternative definitions and measures of centrality have essentially been treated as synonymous or at least coincident with one another, in spatial terms. This is not surprising, because much of the early work on location theory came from Europe where the correlation between these measures was, and still is to some extent, very high (e.g., if your model is London or Paris then you might have a very different view of the linkage between centrality measures than if you are considering the United States). Similarly, at the time of development of early theory such as Christaller (1933), Losch (1954), Alonso (1960), etc. the cities and city systems under consideration demonstrated a marked correlation between the spatial, political, organizational and functional aspects of centrality. Contemporary urban systems, and particularly those of advanced economies, are very different from those agricultural based and early industrial urban systems in which central places displayed centrality in most, if not all, its defined dimensions.

This is, of course, an over-simplification of early location theory. Georgraphers have long recognized that different cities perform different types of functions that are not totally determined by size and catchment area factors. However, this hyperbolic argument raises the crucial point, that the major structural transformations that are occurring in the advanced nations lead us to question the degree of consonance between these alternative forms of centrality in our urban systems. A perfect example of this distinction between attributes of centrality is provided by Gottman (1982) when he analyses the differences between "old" and "new" capital cities. "New" capital cities (i.e. in countries who have elected to change the seat of government) have virtually all been on virgin sites close to the geographic "centre" of the country but away from the existing "centre" of activity, decision-making, and population, e.g., Brazil, Australia and Nigeria.

In this section of the chapter, we critically discuss how structural transformations in the environment of cities and city systems have tended to affect these various attributes of centrality.

Attempts to unravel the effects of these structural transformations on cities and city systems are many and varied. This large and growing literature ranges from casual empirical observations in the business literature and popular press to deep, theoretical fabrications of the underlying processes at work, and the effects they create. Much of the theoretical literature suffers from an ideological constipation, in that it is rooted in mechanistic conceptions of political economy or in simplistic conceptions of economic behaviour, that belong in another time. However, in the course of this discussion we will draw on this wide range of evidence, commenting where appropriate on the assumptions made and the positions taken.

Thus the remainder of this section is structured into four parts:

3.3.1 Structural and spatial transformation in demography.

3.3.2 Social transformation in the urban system.

3.3.3 Economic and technological transformation in the urban system.

3.3.4 Summary and conclusions on urban systems transformation.

3.3.1 Structural and Spatial Transformations in Demography

The census of 1980 in the US and 1981 in Canada, and the analyses derived from it e.g., Hauser (1981), Long and DeAre (1983) and Bradbury and Downs (1982), documents major transformations in the demography of North America. These studies show that in the 1970s the rural population growth rate exceeded the urban growth rate and that relative deconcentration of population resulted in a demographic shift from the North East United States to the South and West of the country. Within urban areas, a decentralization of population was observed shifting from city cores to suburban areas. For example, the Bradbury and Downs (1982) study classified cities into clusters based on whether they had growing, declining or stagnant city populations versus whether they were in growing, declining or stagnant SMSA's. The results provice a fascinating picture of demographic dynamics in the U.S. (and in Canada, if their method is extended to Canadian Census Data). Similar studies have been conducted in Europe e.g., Hall (1984).

Most notably in the United States the group of cities in the cluster - growing city in growing SMSA's - were all in the South and West (i.e., sunbelt cities) with the exception of Springfield, Mass one of the "high-tech" areas outside Boston. At the other extreme, declining cities were predominately in declining SMSA's, though declining cities could be found in either growing of stagnant SMSA's. It is important to note that no city in either Canada or the United States was placed in the category of growing city in declining or even stagnant SMSA's, suggesting at the metropolitan scale that no city core grew without concomitant population growth in its SMSA.

In Canada, cities of the West were all classified as (growing city in growing CMA) as were some of the second order cities of Ontario. At the other end of the scale cities in a declining - declining state were notably Montreal, St. John's, Sudbury and Sydney - Glace Bay.

These changes have profound implications for the present discussion. First it is clear that city growth is related to growth in the SMSA generally, although city core's in declining areas usually fare relatively better than their SMSA's. However, it would seem that absolute growth has not been compatible with declining or stagnant SMSA's. Second, these demographic shifts present a key element of the context of social and economic changes discussed below, namely, there are demographic winners and losers. Third, they have significant implications for political centrality.

The old saying "people vote with their feet" has a corollary in that feet carry votes with them, particularly in the United States, where the census population is the basis for apportioning both representation to the United States House of Representatives and Federal taxation (Houser (1980)). Thus these demographic shifts represent a shift of political power to the growth regions, and consequently a shift in the relative political centrality of the metropolises of these regions. For as Mollenkopf (1983) has pointed out "politics runs on votes as well as money". Indeed, his study provides an interesting analysis of the interplay of demographic shifts and political fortunes and policies of the Democratic Party's "pro-growth coalitions".

The final comment to be made with regard to demography is the impact of the baby boom generation. This bulge carries with it tastes, preferences and beliefs that have been cultivated in an age of relative affluence, and which have significant implications for the factors discussed below and for the political centrality of individual cities. Evans (1984) has suggested that the baby boom will move through the health care system like a pig through an anaconda. This graphic simile can be applied to the other aspects of societal tranformation.

On balance then, demographic changes have increased the dispersion of population in North America, set part of the context for other environmental changes, and affected the political centrality of certain urban locations.

3.3.2 Social Transformation in the Urban System

Daniel Bell (1976) has characterized the transformations in society as a shift from industrial to post-industrial society. Although Bell's thesis was discussed earlier it is important to reiterate here, three related aspects of post-industrial society. First, Bell argues that we are now dealing with a society that is based on knowledge rather than a labour theory of labour. Second, he emphasizes the shift from a goods producing manufacturing society to a service consuming society. Third, he identifies the potential for the emergence of a "new class" who are the knowledge workers of the "new" institutions, hospitals and educational complexes, or the PMTS group (Professional, Managerial, Technical staff), as they are sometimes termed. One can argue as to whether this group has an identifiable class consciousness, or question whether it is indeed a class (see Gouldner (1979) Bell (1976), Ley (1980)).

What seems clear, however, is that these three factors have profoundly affected North American Society. In particular, for this discussion of centrality, it is important to recognize a number of effects.

First, as our transactions become more knowlege and information embodied, rather than embodied in the production and exchange of goods, there is more potential for alternative sets of social and economic relations to exist, than those conventionally described by classical and neo-classical political economists. It is equally possible for these transactions to become aspatial, since information and knowledge can be moved through space more readily than physical objects. The potential for a change in social and economic relations as a result of a shift from physical to knowledge work suggests the potential for decentralization of political power. Bell indeed suggests that many of our social relations have become increasingly democratized. The rise of consumerism and challenges to traditional authority in the 60s and 70s decentralized power to interest groups and networks of coalitions. Although in the 1980s there may be blocks to this process with the reaffirmation of traditional and conservative values in social and economic life.

Second, the emergence of "a new class", that has become an increasing proportion of the population and electorate, has dictated a shift in tastes of the population, in terms of how they spend their disposable income, where they locate and how they choose to organize their enterprises. The shift in consumer preferences from goods to services and experiences has been discussed in the context of Vancouver by Hardwick (1974, 1984) and Ley (1981). This "new class" is a child of affluence, mass media and relative hedonism and this has affected patterns of consumption and location e.g., the role of amenity in determining population movement or location, of the early work of Ullman (1954).

Similarly, their exposure to and understanding of other places through the media and education has encouraged travel as a form of consumption and changed our perceptions and tastes in, for example, gourmet dining (see Ley (1981)). These changes influence the views that people hold about specific cities and the environment they want for their cities. If "status in a large, far flung network of transactional cities" is a variable affecting centrality then to some degree it must be recognized that status is socially constructed in that the image of the city, as held by dominant groups, will influence the way in which locational decisions are made about residence and enterprise. A city that sees itself as post-industrial and acts to reinforce that view is more likely to attract population and enterprise that can enhance its viability. Hence flow the attempts made by the Bostons, Baltimores and Philadelphias of the world to emphasize their aesthetic attributes (slums not withstanding).

Thus, in summary, changes in demography, in the nature of work and in the education and tastes of society have contributed to the emergence of a "new class" that, because of its increasing size, because of its education and actions, and because of its rise through the decision hierarchy is wresting a greater degree of political control in enterprise and in the community at large. The behaviour of this group increasingly affects the consumption and locational decisions of households and enterprise. The views of this group are to some extent challenged by the actions and ideologies of the Reagan's, Fallwell's and Bennet's of the world, who seem to be articulating and enacting a vision of the past rather than a vision of the future. This phenomenon is consistent with the idea that there are times of multi-parametric change in society when it seems ready to accept simplistic hindsight as its collective vision of the future e.g., the romantic notion of rural life in Britain that was propagated at the beginning of the industrial revolution.

3.3.3 Economic and Technological Transformation in the Urban System

Since the second world war, a variety of academic analyses have tried to explain and/or describe the changes that were taking place in the economic environment and its implications for cities. The only definite agreement that can be found in this literature is a clear recognition that profound changes have occurred. In this section we review the more recent literature dealing with economic and technologic transformations and draw from it some conclusions about the relationship between these changing circumstances and the attributes of centrality.

This section deals with three relevant areas of the literature, Fig. 3.1). First, a review is made of the studies undertaken by economists, economic geographers and planners who attempt to describe, evaluate and understand the structural shifts in the economy in terms of the move from goods to services and the associated spatial reorganization of enterprise. This literature encompasses both theoretical and empirical perspectives on the problem that could be termed the economic planning literature.

Second, we review briefly, the office location literature, which has emerged from the United Kingdom in particular, and which was conceived from a more applied perspective, to deal with the role of offices in regional development.

Third, we will review the literature that evaluates the implications of technological developments - particularly telecommunications - for spatial interaction within organizations, cities and city systems.

Each of these analyses of economic and technological change provides some insights into the measures of centrality, outlined earlier.

3.3.3 a) Economic Restructuring of the Urban System

A number of analysts in the 1970s began to evaluate the economies of advanced nations, in order to understand the observable decline in manufacturing as a share of employment and the apparent relative increase in service activities. Bell's comprehensive concept of post-industrialization and Gottmann's notion of quaternary services or activities were discussed earlier, but it should be recognized that they were early observers of these changes.

A flurry of activity occurred in the mid 1970s much of it from colleagues of Ginzberg at Columbia, who sought to document and explain the shifts in metropolitan economies. Their work provides a useful starting point e.g., Stanback (1981), Noyelle (1983). A current summary of their findings is that through analysis of a number of metropolitan economies in the U.S., it is clear that:

a) There has been a structural transformation of the U.S. economy associated with increasing internationalization of economic activity, the growth of the multi-national firm and a spatial division of labour between nations.

b) Similar structural transformations have occurred in the system of cities in the U.S. featuring a shift from manufacturing to producer services, a shift in location from NE to SW and the development of a new urban hierarchy comprised of:

First tier - nodal or command cities.

Second tier cities - focused on the management of specialized production.

Third tier cities - that are primarily involved in the production i.e. manufacturing and provision of consumer services.

c) These analysis argue that because there has been a parallel restructuring of labour markets, we are witnessing the emergence of a dual economy at a number of levels:

- At the job level - between high paid managers and low paid service workers.
- At the metropolitan scale between executive core and blue collar suburbs.
- At the regional and national scales between centres of decision-making and production.

They predict difficult social and economic circumstances in the U.S. as a result, because the traditional setting of upward economic mobility, i.e., the corporate heirarchy, is being altered, and because high paid, blue-collar jobs are in decline (cf, Bluestone and Harrison (1982)).

Similar analysis has been conducted by Bergman and Golstein (1983) who examined structural changes in the metropolitan economies and attempted to relate the impact of cyclical changes in the national economy to the changing division of labour and pattern of control identified by Noyelle (1983) and Stanback (1981). They identify what they call cyclical or structural ratchet effects; which in simple terms refers to the varying abilities of metropolitan economies to weather national economic storms. Their argument and empirical evidence suggest that about half the urban economies studied were conformant to national business cycles, whereas some such as Chicago were subject to strong negative ratchet effects, and others such as Stamford, Connecticut had powerful positive ratchet effects, i.e., in successive booms, their employment base built up sufficient momentum to counteract any negative effects in national downturns. This is an economic statement of the winners and losers argument seen earlier in demographic terms.

Other investigators such as Philips and Vidal (1983) support the apparent dominance of producer services and FIRE activities (Finance, Insurance and Real Estate) as a key explanatory in predicting economic vitality of urban centres.

What emerges from the analysts considered so far is that there is considerable empirical evidence for a spatial division of labour, in international, national and metropolitan terms. Second, that growth in the size of corporations and the development of the multinational, multilocation enterprise has had a profound effect on the spatial distribution of activities in the urban hierarchy.

In terms of the attributes of centrality defined earlier, the findings so far suggest that there is a split between spatial, functional and organizational centrality. The spatial division of labour (i.e., different functions in different locations) and the tendency for the growth of producer services as a separate entity from corporations, are important factors in explaining changes in the functional centrality of a metropolis. The growth of the multi location enterprise presents a further split between the degree of functional centrality and organization centrality, e.g., Noyelle's differentiation between command, specialized management and consumer or production centres.

It is clearly useful here to dig deeper into the behaviour of these large enterprises to determine what effects their decisions have on the relative spatial, functional and organizational centrality of large cities.

Pred (1977) has argued that cities are enmeshed in networks of multilocational organizations. Similarly, Stephens and Holly (1981) in an excellent analysis of changes in headquater location behaviour of the Fortune

500 companies, conclude that the largest cities, regardless of their location, tend to be steering points in the economic system:

> "although corporate headquarters have been decentralizing to the suburbs, they are able to do so without surrendering their accessibility to specialized contact networks, ancillary business services and inter metropolitan transportation networks".

Their analysis confirms the dominance of major strategic decision centres in the U.S. They also identify a number of additional factors of importance. First, they identify that the apparent redistribution of headquarter activity from the north-east to the south and west of the U.S. can only be partially attributed to actual movement of firms between these regions. Rather they suggest the spectacular growth of industries in the sub-belt (such as aero-space, telecommunications etc.) has pushed many of the native industries already headquartered in the south and west, into the top 500. Thus, these changes reflect the success of post-industrial enterprises rather than a "flight of capital".

Secondly, they find confirmation for Pred's thesis that:

> "City systems in advanced economies have historically maintained stability in the national population rank of their leading metropolitan areas, because according to Pred these metropolitan 'complexes' offer corporate head offices and other high-level administrative activities with specialized information advantages usually not available in smaller urban centres. They are: i) greater propensity for interorganizational face-to-face contacts; ii) availability of specialized business services and iii) high levels of inter-metropolitan accessibility".

In the course of their analysis Stephens and Holly provide a very useful table derived from Warneryd (1968) that unites conceptually, for each level of a three level organizational hierarchy (head office, group head office and plant) the following attributes:

1) Organization - environment interaction - which they label orientation processes, planning processes, programmed processes for the 3 levels above. (There is striking similarity here between this framework and the Beer, Paterson and Amara and Lipinski formulations outlined earlier).

2) Contact Networks - the three levels had progressively less external and progressively more internal communication going down the hierarchy.

3) Functions - ranging from decision-making, planning and product development at headquarters; via control and direction of production at group head office to routine office work and production at plant level, (again the similarities to Paterson are clear).

4) Position in urban hierarchy - headquarters in national metropolis, group headquarters in regional centres, manufacturing plants in local centres.

This formulation brings together the concepts of spatial, functional and organizational centrality in one framework. It is in effect back to a central place theory of the firm!! In that lies its major flaw, because this logical conception does not explain why some cities get plants or regional headquarters and others do not. Pred has found for example that various activities in the corporate structure, while possessing particular locational requirements, are not always found at the same level of the urban hierarchy.

This fact led Stephens and Holly to follow Pred's use of rank-size analysis as a means of deriving the conclusions outlined earlier. The reason for including the Warneryd derived model in the discussion here is that it presents an attempted theoretical model of organizational functioning in the multi-site enterprise and it tries to link internal organizational structure to location. However simplistic this model, it is a useful conceptual base for further research, since it does speak to issues of spatial, functional and organizational centrality.

This model is in sharp contrast to the structuralist analysis of Simmie (1983) and Scott (1982) who try to derive alternative explanations for the phenomena described here using methods of political economy. Simmie follows on from Gershuny (1978) in being critical of the notion of post-industrialism and suggests that we are witnessing in advanced economies - the process of "corporatism" which he defined as:

> "A politico-economic system characterized by the exercise of power through functionally differentiated organizations seeking to achieve compromises in economically and politically approved actions which are as favourable to their particular interests as possible, and which are often legitimized by their incorporation in the objective of the state".
> Simmie (1983:p 61)

Simmie's (1983) empirical analysis of the San Francisco and San Jose SMSA's in the context of the U.S. economy is a rich source of data on employment and organizational changes, that would take too long to comment on here. Suffice it to say that the data generated is interpreted in a way that attempts to argue down the effects of post-industrialism and to cast the metropolitan economies of these two dynamic SMSA's as being rooted in manufacturing of goods by large corporations. He also adopts Gershuny's rationalization that, apart from health and education, there has been no rise in share of services, rather consumers have substituted capital for labour in their households. Perhaps the most serious flaw in his interpretation, is his conclusion that the majority of the workforce is employed in large corporations. The data for 1979 are as follows:

Size of Employment	San Francisco % Units	San Francisco % Emp.	Santa Clara % Units	Santa Clara % Emp
0-9	73	11	72	10
10-99	23	31	25	28
100 or over	3	58	3	63

Because the majority of employment (i.e. just over half) was in firms of 100^+ employees, Simmie feels safe in concluding that:

> "The majority of both the most significant and general employment in both areas is controlled and structured by large corporations".

Such corporations, he argues, are immune to competition because of monopoly and oligopoly. While recognizing that monopoly and oligopoly are critical components of many areas in the American economy, Simmie appears to have his theory and empirical evidence a little muddled. He is kind enough to provide a list of some of these large corporations in the Santa Clara case: they include the "dark satanic mills" of Apple computers, Intel, Measurex, Silconix, Syntex, etc., etc. How many of these <u>large</u> corporations were <u>large</u> corporations 20 years ago or even 5 years ago. Simmie seems to ignore the fact that virtually all employment growth in the last decade has been in small business that grew to be medium sized or even large businesses in competitive environments (see Birch (1981) and the early comment on Stephens and Holy (1981)). As a visitor from London to Berkeley, Simmie can probably be excused for not knowing the basic rule of Silicon Valley, which is that any company whose name ends in -ex is probably:

i) less than five years old

ii) founded, owned and run by 2-ex Stanford engineers who wear running shoes and

iii) going to be sold out to a large multi national when it has 300 employees and proceed slowly but inevitably into bankruptcy e.g., Atari. (Meanwhile the guys in running shoes have started another company with 10 people and a name ending in -tech).

The point of this somewhat facetious attack, is first to identify the lack of appreciation that entrepreneurial skill and the application of human capital in innovative and competitive industries are the major contributory factors to employment growth and the dynamic nature of firms (which is at least recognized by Scott). Second, in terms of our discussion of centrality, Simmie's paper reflects the attitudes of much of the marxist and structural literature in this area in that organizational centrality and political centrality are treated as one and the same process.

Scott's (1982) analysis attempts to explain the regional decentralization as a process of dispersal caused by capital "deepening" (i.e., higher capital/labour ratios), restructuring and reorganization of productive activities. Scott's model is essentially cast in the mould of functionalism but there is a useful logic explaining spatial decentralization of manufacturing processes. He sees four elements in the model.

1) More efficient production techniques let firms grow.

2) Increased use of technology (capital equipment) encourages standardization of processes and linkages within the firm.

3) Increased capital and process 2) above leads to "secular deskilling"

4) Capital deepening and restructuring leads to mergers and international geographic specialization in the internal workings of the firm.

Three comments should be made. First, Scott does not recognize the findings of Dennison's (1975) study that demonstrated the relatively small effect that capital equipment has on productivity improvement in U.S. industry, compared to the contribution of increased worker education and innovation in organization. Second, there are alternative explanations of merger activity that stem from the dominance of accounting professionals and business school management practices employed in organizations in the 1970s (Peters and Waterman (1982) and Reich (1983)). Third, the model is another unidirectional causal chain that leads to simplistic conclusions.

In summary then, there have been substantial economic transformations in the U.S. economy, that have spatial, functional and organizational dimensions and therefore effects on the centrality of the metropolis. Attempts to model these changes have ranged from rank-size conceptions of organizational and functional centrality, to structuralist/functionalist explanations of change as part of an inherent process of capital deepening or corporatism. What is clear is that in the North American and international context we are indeed dealing with a "far-flung network of transactional cities" that are dominated by information processing functions and office work. What is also clear is that this network has certain properties of a complex system - notably the notion of hierarchy albeit an asymmetric one, Pred (1979), and the idea of linkages and flows between elements in this hierarchy.

3.3.3 b) Office Location Literature

The office has been demonstrated to be an important element in a transactional economy, Cohen (1979). It is also an important element in the employment system, and as such a potentially valuable policy instrument, Daniels (1979). Whereas the economic literature discussed above had a predominantly U.S. focus, and in many cases a structuralist theoretical base, the office location literature, in contrast, is U.K. based, and concerned more with empirical description and regional development questions (Daniels 1979, Daniels 1982).

In a recent editorial of an issue of Environment and Planning devoted to the office location literature, Taylor and Thrift (1983b) argue for a more sociological approach to the geography of enterprise as a means of understanding the behavior of firms as active agents of change and not simply as reactive cogs in the machinery of the macro economy.

The office location literature has relevance to the discussion of centrality because it has attempted to identify patterns of communication and linkage within enterprise and between enterprise, e.g., Gad (1979), Goddard and Pye (1977). It has also helped to identify the "industrial office", i.e. those activities involved in the routine processing of information on a relatively large scale, that can be more readily separated both functionally and spatially, to other locations in the urban system. Indeed, relocation of the industrial office in the U.K., e.g., the income tax centres in East Kilbride and Newcastle and the motor vehicle licensing centre in Swansea, Wales, was the principal policy outcome of such insights. (However, senior bureaucrats in the Ministry of Defence could not be induced to flock to

Glasgow from their comfortable Surrey suburbs or from the corridors of power in Whitehall).

Despite such attempts at using office relocation as a policy instrument, office concentration continued in London throughout the 1970s, leading the office location analysts to argue for a more thorough understanding of the internal operations of the organization and for recognition of the processes of dispersion and concentration of decision-making outlined earlier, e.g., Pred (1977,1979), Stephens and Holly (1981).

The literature on office location has provided important insights on the way in which the city system is transformed by the behaviour of enterprise. There is still a fair degree of confusion in the minds of analysts as to whether the inherent processes that influence office location are processes of concentration or dispersion. The argument is analogous to the debate over the changing demographics of cities.

The best conclusion that can be drawn is that higher order decision-making in large multi-national enterprise appears to require access to advanced corporate services that is afforded by only the very largest metropolises, sometimes termed the global cities (e.g., Hymer (1979) and Stephens and Holly (1981)). However, such access can be secured by suburban locations in these global cities (Dunning and Norman (1983)). At the other extreme, there seems to be considerable potential for the dispersion of the "industrial office" activities of the multi-nationals to the lower order cities and to suburban locations in these cities. In between, there are a variety of second-order command centres that sustain headquarter functions for very large firms. Most often these enterprises are indigenous to the region, e.g., the oil companies in Houston or the Hi-Tech firms of Silicon Valley, Birch (1981) and Stephens and Holly (1983). Such firms have grown to be large in that location.

A more infrequent phenomenon, but one that receives much publicity, is the relocation of headquarters from the Rust-Bowl to the Sun-Belt. In this case the senior decision-makers have opted for an alternative location because of access to capital, markets, labour (sometimes specialized, sometimes cheap), intelligence functions or amenity. These firms have overcome the considerable inertia that exists in the built environment and made a wholesale change in their spatial organization. Although little clear evidence exists, an alternative explanation for such moves may be that these enterprises experienced pressure favouring corporate restructuring either through acquisition, merger or through the need for liquidation of real estate assets.

3.3.3 c) Tele-communications and Location

Research on office location has made a major contribution to the question of the impact of tele-communications on the spatial, functional and organizational structure of enterprise. Melvin Webber (1963) suggested, in an early paper, that there was potential for telecommunications to provide both households and enterprise with "community without propinquity". Heady talk of global villages, and time space convergence was common in the early and mid 1970s as technological developments in computers and communication increased exponentially. Everybody, apparently, was going to work at home or in the backwoods. Such technologically determinist positions have not come to pass, which leads Gottman (1983) to conclude that:

> "Despite all the propaganda by the technologists offering dispersal, especially of places of non-manual work, the conclusions reached (by other geographers) are in agreement with mine: there may be decentralization in some aspects but basically transactional activities are not likely to be scattered throughout rural territory just because technology is becoming able to overcome distance".
>
> Gottman (1983:p 24)

What Gottmann does not really emphasize is the way in which telecommunications enables enterprise to consider alternative organizational, functional and spatial patterns. For example, office location analysts such as Pye (1979) identified that approximately 40 percent of meetings in certain types of enterprise studied, could be replaced by telecommunications (mainly by relatively inexpensive voice, data and graphics systems transmission). Abler and Falk (1981) suggest that telecommunications have both organizing and co-ordinating power (i.e. feedback capability), and not just one-way relationships. This enables the conferring (discussion) aspects of organization to be structured in alternative ways. There is some doubt whether these technologies can enable the deal-making aspects of communication to become aspatial.

In summary then, the spatial division of labour described earlier is facilitated by the existence of telecommunications, if not totally predicated on such systems as a basis for co-ordination and control. There is however, considerable empirical and theoretical support for the notion that higher order decision-makers in enterprise require ready access to the support of advanced corporate services (or producer services) that have obvious tendencies to cluster in large nodal centres (see for example Dunning and Norman (1983)). The evidence suggests that certain of these services can be located in metropolitan suburbs particularly if they have attributes of the industrial office, e.g., engineering services (Dunning and Norman 1983).

Although not necessarily determining alternative spatial forms, or functional configurations of enterprise it is clear that new communications technology enables consideration of alternative spatial and organizational structures, e.g., Johansen (1984), Goddard (1980), Mandeville (1983). The major question for research, is what factors influence the selection of which technologies with what spatial, functional and organizational outcomes.

A preliminary set of conclusions with regard to technology and location are that:

i) The choice whether a function is centralized or decentralized is not dictated solely by the technology, however it seems that in an environment that is hostile there is a tendency to centralize higher order decision making in both spatial and organizational terms. Contemporary computer and communication technology can indeed greatly facilitate such detailed central control, but it is questionable whether such a strategic choice is in the long-term interests of the enterprise or its employees.

ii) Technology is enabling the dispersion and simplification of certain production activities that are involved with lower-order decision-making. This can apply to both goods producing and service producing industries. For example, the proliferation of Automated Teller Machines (ATM's) has increased the dispersion of banking services in both time and space. Similarly, the harnessing of telecommunications to emerging CAD/CAM technologies can enable the relocation of production facilities to less expensive sites offshore - such a development in the computer manufacturing industry was cited recently in Business Week

(1985). The emergence of such remote monitoring and control systems will allow enterprise to consider alternative locations that may lead increasingly to what could be termed a "spatially-exploded" organizational structure.

iii) The capabilities of modern computer and telecommunications technologies has enabled the processes of centralization and decentralization, outlined above, to occur simultaneously. For example, many banks are simultaneously centralizing middle-order interpretive (C-Level) functions such as loans administration and decentralizing (as well as automating) certain lower-order operations such as cash dispensing.

3.3.4 Summary and Conclusions on Urban Systems Transformation

As pointed out earlier, it has been argued by Pred that cities are nodes enmeshed in the networks of multi-unit enterprises. As such it is incredibly difficult to isolate transformation in the urban systems environment from either the transformation in enterprise or from wider socio-economic transformation. The stated purpose of including the urban systems scale in this analysis was to identify spatial contextual phenomena that are largely ignored by observers viewing transformation at the level of society or the enterprise. Thus the conclusions here concentrate on those phenomena with a spatial component, recognizing that transformation in the wider socio-economic and enterprise environment are an integral part of urban systems transformation. Five principal conclusions can be derived:

3.3.4 a) Demographic and Economic Shifts: Rust Bowl to Sun Belt and the Process of Deconcentration

There has been a substantial restructuring of the demography of North America from the North East cities (the Rust Bowl) to the South and West (Sun Belt). This is paralleled by changes in the wealth, economic activity and political power of these cities and states. The viability and growth of enterprises in the Sun-Belt is both a cause and effect of these demographic shifts. Similarly, it was noted that there was a series of spatial and demographic shifts towards disperson of population within large metropolitan regions. There is considerable debate whether these reflect processes of concentration (at the inter metropolitan scale) or dispersion (at the intra-metropolitan scale). The most balanced work in this area suggests that both processes are operating but that methodological and measurement problems inhibit accurate assessment of the relative degree to which these phenomena have occurred, e.g., Bourne and Simmons (1984).

b) Increased Competition between Nations, Regions and Cities

The internationalization of the economy has had a profound effect on the urban system. Competition between cities for new development, (e.g., high tech parks) and competition between the enterprise based in different cities has led to greater "pulsation" or turbulence in individual urban economies (Birch (1981) and Bergman and Goldstein (1983)). For example, Detroit may be rooting for the "auto giants" but cities in Tennessee, Ohio and California have interests in attracting and supporting Japanese branch plants. Competition for manufacturing is only one element. There is competition for investment in schools, hospitals and unversities, independent of basic population demand factors. In their attempts to attract such business and social investment, cities are using a wide variety of inducements which include conventional incentives such as tax breaks, and subsidized plants, as well as, more significantly, such factors as amenity, lifestyle and social/cultural facilities aimed at attracting critical decision-makers and their highly educated employees.

c) Increased Spatial Division of Labour

There has been a widely recognized spatial separation of command and production functions. Popular attention is often focused on the international dimension of these changes, but the wave of mergers and acquisitions from the late 1960s to the 1980s and the overall increase in the scale and organizational complexity of enterprise has contributed to the significant spatial restructuring of command functions (F, E & D levels of Paterson or the systems 5 and 4 of Beer) separating them from the operations level. The combination of these three factors: demographic/economic shifts, increased competition and increased spatial division of labour has led to the fourth major trend.

d) The Two-Tiered Economy of the Urban System

It has been suggested that the set of forces outlined above are contributing to the emergence of a two-tiered economy. There are winners and losers in the urban system, and within the metropolis. Some cities and some areas of the metropolis are better placed than others as habitats for enterprise, e.g., Bergman & Goldstein (1983). Thus there is imbalance at all scales: the international, regional, metropolitan and occupational scale. The role of consumer services, transfer payments and public sector activities become more crucial for those cities in the urban system that fall into the "loser" category. These issues are important for our case study in that the economic base of many settlements in British Columbia may depend largely, on the flow of transfer payments and the investment decisions of government with regard to health and educational enterprises.

3.4 PERSPECTIVES ON THE TRANSFORMATION OF ENTERPRISE

The previous sections of this chapter have examined the transformation in the organization of society and the organization of the urban system. It has been argued that these changes are closely related to the transformation in organization of enterprise. In this final section, transformation in the structure of enterprise will be examined and the relationships between the different levels of environment will be drawn together. This section is therefore divided into three main parts. The first considers the transformation in the environment of enterprise, the second deals with transformation in strategic choice and the third deals with the changing organizational and spatial structure of enterprise.

3.4.1 Transformation in the Environment of Enterprise

Organization theory has in the last twenty years focused increasingly on environmental factors in parallel with the increasing prevalence of natural systems and open systems research (Scott (1981)). This has led to a wide range of research efforts aimed at associating environmental attributes with organizational attributes (Pfeffer (1982) and Mintzberg (1983)). An integral part of this research has been the development of typologies of organizational environments that can be employed as a means of assessing environmental transformation.

Mintzberg (1983) and Jurkovich (1974) provide two useful typologies of the nature of the environment facing enterprise. These two perspectives can be used to identify the dimensions in which transformation has occurred. Mintzberg (1983) provides one such typology in his cogent synthesis of the contingency tradition in organizational theory. He concludes that the literature in organization theory focuses on four particular dimensions (or scales) for the measurement of organizational environments.

i) Stability/Dynamic. This dimension refers to the degree of unpredictability in the economy, market, technology, weather, etc, in which the organization operates. The emphasis here is not solely on change, but rather on unpredictable change.

ii) Complexity. This dimension measures the degree of complexity of knowledge required by the enterprise. He confuses the reader somewhat by equating knowledge base with technology. However the essential thrust is that the "comprehensibility" of the environment is an important dimension.

iii) Market Diversity. This dimension ranges from integrated to diversified, from the single product, single location enterprise to the multi-product, multi location enterprise.

iv) Hostility. This dimension ranges from munificient to hostile. Hostility is "influenced by competition, by the organization's relations with unions, government and other outside groups and by the availability of resources to it."

Similarly Jurkovich (1974) develops a "core typology" of environmental characteristics. Drawing on a wide range of organizational literature, Jurkovich identifies four critical dimensions:

i) Complexity

ii) Routineness or non-routineness of a problem-opportunity state.

iii) The presence of organized or unorganized sectors in the environmental field.

iv) The issue of whether such sectors are directly or indirectly related to the organization.

Jurkovich concludes from the literature that environmental transformation operates across these dimensions, at varying change rates.

The work of Burns and Stalker (1961), Lawrence and Lorsch (1967), Thomson (1967) and Hage (1980) provided the original contributions that emphasized these as the important dimensions of environment. The concepts of uncertainty, instability, variation in demand and comprehensibility or complexity of the task environment are central to the analysis of environment. Three criticisms of these kinds of approaches to the classification of the environment can be made. First, despite Mintzberg's relatively broad definition of environment, there is a tendency for measures of environment to be operationalized from too narrow a perspective in organization theory. The wider societal context is of considerable importance to enterprise - yet despite this truism organizational theory, until recently, has focused on the immediate organizational environment (Huber (1984)). An exception of course is the literature dealing with cross-cultural organizational comparisons (for a review see England et al (1983) chapter 7).

The second criticism is that the dimensions for measuring or assessing the environment are neither mutually exclusive or clear. For example Mintzberg's use of the terms complexity and market diversity seem to be attributes of the enterprise, not solely the environment. Similarly, both Burns and Stalker (1961) and Thomson (1967) use technological complexity as an environmental attribute as well as a structural attribute. If these analysts are equating "technology" to the economists notion of a production function, then it is useful to differentiate between the complexity of the envelope of possible technologies (or candidate technologies) and the complexity of the technology actually employed in the enterprise, i.e. the portfolio of techniques used in the organization (see Chapters 1 and 2). The first is indeed an environmental factor - i.e., the range of choices available. The latter is an organizational attribute. (Further, Rattan and Hayami (1971) postulate the existence of a "meta production function." This is :

> "an envelope curve that goes beyond the production possibilities attainable with existing knowledge and described in a neo-classical long-range envelope curve. It describes, rather, a locus of possibility points that can be discovered within the existing state of scientific knowledge. Points on this surface are attainable, but only at a cost in time and resources. They are not presently available in blueprint form."
> Rosenburg (1983:p 17)

Thus, the environmental complexity associated with technology refers to first, the variety of technologies that are known to exist and second, the variety of technologies that can be discovered or developed given existing scientific knowledge. These nuances are not always clearly articulated in conventional organizational analyses and consequently there has been some degree of tautology in the arguments about technology and environment.

The third major criticism is a related one. Because of the considerable confusion over the dimensions of environment, overemphasis has been placed on developing singular dimensional scales, e.g., Lawrence and Lorsch's environmental uncertainty scale. Although uncertainty is indeed a critical environmental variable - unidimensional approaches to complex conditions seem inappropriate.

These criticisms of conventional contingency approaches in organizational theory have been addressed in the more recent work of Huber (1984) and Trist (1980). Both attempt to integrate wider societal transformation with the transformation in the structure of enterprise.

Huber suggests that the Post-Industrial context for enterprise involves three sets of changes:

i) <u>Available Knowledge - More and Increasing</u>

Huber emphasises that both the amount and availability of knowledge is increasing at an accelerating rate.

ii) <u>Complexity - More and Increasing</u>

Huber suggests that complexity can be characterized in 3 ways: a) numerosity b) diversity and c) interdependence. The number, range and variety of different societal states, and components is increasing. In other literature, this has been seen as the development of pluralism in our society (Novak 1983). Huber sees increased interdependence as a consequence of increased specialization and pluralism.

iii) <u>Turbulence - More and Increasing</u>

Huber argues that the increasing rapidity of individual events will be brought about by the application of knowledge and technology. The increased frequency of events and circumstances will increase the level and growth rate of turbulence in the environment.

Similarly Trist (1980) defines the increases in environmental turbulence brought about by shifts in the behaviour of institutions and societal developments (identified earlier).

In conclusion, then there has been a transformation in the environment of enterprise. The shifts identified at the societal and urban systems scale also apply at the immediate environmental level of enterprise. In addition we can incorporate the three conclusions outlined by Huber above as the critical factors in the transformation in the environment of post-industrial enterprise.

In the previous sections the transformation in environmental factors has been explored. These transformations can be synthesized in two ways.

a) From Pre-Industrial through Industrial to Post-Industrial

Table 3.1 shows a typology of transformation using three scales (societal, urban systems and enterprise) and across three developmental stages: pre-industrial, industrial and post-industrial. These terms are most often used to describe transformation over the last 200 years; but they are neither discrete or mutually exclusive phases in history. The argument in this thesis and in the work of Bell and others is that elements of a post-industrial society have emerged over the last forty years and that from certain perspectives these post-industrial elements are becoming the most prevalent in contemporary society. This is not to suggest that attributes of the industrial world have disappeared, rather post-industrial aspects are becoming enmeshed in the industrial world and transforming it to resemble more

TABLE 3.1 A TYPOLOGY OF TRANSFORMATION IN THE ENVIRONMENT OF ENTERPRISE

ENVIRONMENTAL SCALE/FACTOR			
SOCIETAL	PRE-INDUSTRIAL	INDUSTRIAL	POST-INDUSTRIAL
Theory of Value	Land	Labour/Capital	Knowledge
Dominant Economic Activity	Agriculture	Manufacturing	Services
Stability/Complexity of Environment	Simple/Stable	Complex/Stable	Complex/Turbulent
Political Structure	Autocractic/ Hierarchial	Democratic/ Hierarchial	Democratic/ Participative
Fundamental Ethic	Survival/Maintenance	Growth	Pluralism
URBAN SYSTEMS	PRE-INDUSTRIAL	INDUSTIRAL	POST-INDUSTRIAL
Theory of Location	Site Dominated	Resource Dominated	Footloose?
Critical Flows	Agricultural Products	Goods	Information
Spatial Interaction	Local	National	Global
Spatial Division of Labour	Limited	Substantial division by industry or by enterprise	Substantial spatial division within enterprise
Critical Spatial Factor	Access to high quality land	Access to energy resources & markets	Access to information networks
ENTERPRISE	PRE-INDUSTRIAL	INDUSTRIAL	POST-INDUSTRIAL
Organizing Principles	Traditional (simple structure)	Division of labour Formalization, Specialization (Mechanistic/Bureaucratic)	Co-operation (organic)
Available Technologies	Manual	Mechanical	Complex Informational or Cybernetic Systems
Sources of Uncertainty	Weather, War	Demand Shifts, War	Multiple (incl. war)
Sources of Innovation	Exploration and Capture	Tinkering	Organized R & D
Fundamental Motivation	Tradition	Quantity, low cost	Quality, effectiveness

and more the bench-mark state Bell and others have described. Thus the "post-industrial" attributes shown in the table are becoming more prevalent in our environment.

b) 1945-85: Four Stages in Environmental Transformation

The second synthesis focuses more specifically on the post-war period which is the major interest here. Many analysts agree that the shift towards post-industrialism may have begun after the Second World War but there is disagreement as to the extent of its development throughout that period. Four stages of environmental transformation can be defined for the enterprise and technology.

i) Shifts in the Environment of Enterprise

Four different stages can be identified since 1945:

a) The period from 1945-60 in which growth in the economy was predicated on the pent up demand following war and the associated need for investment and development in public enterprises such as health and education.

b) The period from 1960-1970 in which economic growth was associated with increasing affluence, consumerism, and increasing scale and diversification in enterprise. Further, a focus on social development in politics and enterprise took hold.

c) The period from 1970-1980, that Robert Reich (1983) has characterized as the Impasse when stagflation and paper entrepeneuralism dominated in the corporate sector and there was emerging the crisis of cost in public enterprise. Socially, politically and culturally this was the "selfish" decade of hedonism and self-interest.

d) The period from 1980 on, in which North America and the other advanced nations were finally confronted with the underlying need for fundamental restructuring of the economy and of enterprise.

ii) Stages of Transformation in Technology

These periods conform reasonably well to the historical development in information technology set out by Kates (1982) who has identified four phases of development

a) 1945-1955 Massive Million dollar Vacuum Tube Technology - which was only acquired by a very few universities, defense facilities and government agencies.

b) 1955-65 Solid State Technology - large "mainframe" systems that were aquired by most large enterprises.

c) 1965-75 Start of Microelectronics - the development of minicomputer technology helped proliferate information technology applications to most medium sized enterprise and many small scale enterprise.

d) 1975 on - Micro electronic Revolution - the proliferation of chip technology in "smart" appliances and products. Microcomputer applications adopted in small business and the home. Enormous development in computer and communication linkage systems and hybrid (or convergent) technology.

These four phases will be used as approximate time horizons in our subsequent discussions.

3.4.2 Transformation in Strategic Decision

Organization theory, social ecology and cybernetics all emphasize the critical interdependence between environment and goals. It could be argued that there has been a transformation in the predominant goals of enterprise associated with the wider environmental transformation described above.

McDonald has suggested that there are three inter-related sets of interests that have to be accommodated in strategic decision-making these are:

i) Financial or Capital Market Interests that are concerned with issues of profit, cost and return on investment.

ii) Product Interests that are concerned with the choice of what to produce at what level of quality.

iii) Organizational Interests are concerned with the way in which production is organized.

These sets of interests can be usefully employed as a basic classification of policy parameters shaping strategic decision-making. A fourth group of interests not explicitly included in the McDonald model is the public interest.

It is possible to identify transformation in the goals of enterprise across the forty year time horizon using the four sets of interests as the areas in which intelligence is gathered and strategic decisions are taken. It should be emphasized again that there may be considerable inertia operating in various enterprises. Just as society did not become post-industrial overnight in January 1, 1962 so the goals of certain enterprises may not change at all, or they may lag behind other enterprise. The intention here is to try and elucidate some trends in strategic decision-making and policy parameters that have occurred.

In the post-war boom, the financial goals of corporate enterprise were to create growth in sales and profits through increased production in large-scale, standardized production runs. This was facilitated by the product goals of planned obsolescence, a strategy whereby consumers would be induced to speed up their rate of consumption because of annual modifications in styling coupled with poor durability of products, e.g., Reich (1983) and Harris (1981). This focus on high volume production was supported by the goals of the organizational interests who could see higher rewards, status and prestige from controlling larger hierarchies making more profits. This set of goals continued into the sixties.

With market saturation by the early-mid 1960s in many industries, large scale enterprise sought to diversify into other areas of production, seeking out market niches where the same principles of large scale production could be applied. This involved the enterprise in developing itself as a conglomerate of new businesses and in seeking new markets abroad. The product focus was on product differentiation and marketing as a means of preserving market share.

By the seventies the multi-national conglomerate, and the multi-site public enterprise had begun the separation of product goals from financial and organizational goals. Paper entrepreneurialism, (i.e., financial manipulation of accounts, statistics and stock prices to provide the illusion of real growth) became rampant according to Reich (1983). Similarly, in public enterprise there seemed to be a growth in the self-serving nature of the "bureaucracy" driven not by concerns over quality and cost of services but by process goals such as professional autonomy etc.

In the 1980s waves of recession, deregulation, competition and technological change have forced enterprise, both public and private, to reappraise their fundamental strategic goals. The current financial goals are survival and real growth (without benefit of double digit inflation on paper assets). These can only be achieved, according to many analysts, through a rededication of attention to both product and organization (people). Thus in the eighties we see a proliferation of management texts emphasizing, hands-on, market-driven, product-oriented, people-oriented approaches to "excellence". There is an increasingly strong argument being made in the 1980s for the integration of strategic, financial, product and organizational goals, Deal and Kennedy (1982), Peters and Waterman (1983).

Not all organizations conform to these highly generalized transformations. Many enterprises instead seek maintenance of privileged regulated positions in which they can pursue their financial goals and/or organizational goals, e.g., the US steel industry. Others recognize environmental change but take a unidimensional view of how to react to it. The most prevalent uni-directional school of strategic decision-making is the "Lean, mean and tough" school in which organizational and product goals are subsumed under the primacy of cost cutting.

A fundamental conclusion drawn from contemporary organization theory, cybernetics and management literature is that strategic goals are formed in an interactive way with the environment. If enterprise faces a more turbulent, hostile and complex environment dominated by uncertainty and the need for dynamic information flows, then, it is argued, the enterprise's primary strategic goal is survival through adaptation. This in turn involves the integration of financial, product and organizational interests in the goal formulation process. Integration of potentially divergent goals requires, it would seem, a political process of strategic control. One in which the trade-offs between economic, organizational and product parameters can be made through consensus building. This is the underlying process in Theory Z, in "In search of excellence" and even in the pronouncements of the new Canadian Conservative government.

Requirements for concensus building and integration of interests have been met to some degree in many enterprises. In others these requirements have been given lip-service, but the tokenism is flaunted across the pages of the business press. At the other extreme many enterprises have reacted to turbulence by divisiveness, retrenchment and protectionism. The health care system in both the US and Canada faces many of these environmental changes but it is by no means clear as yet what strategic directions will be taken.

3.4.3 Transformation in the Structure of Multi-Unit Enterprise

In this final section we will draw on both the theoretical foundations laid out in Chapter 2 and on some of the more empirical and synthetic observations of transformation in the earlier sections of this chapter, in order to draw some conclusions on the transformation in the structure of multi-unit enterprise.

3.4.3 a) The Relationship between Organization and Control

This sub-section draws on Mintzberg, Beer and Paterson for its vocabulary to investigate the transformation in organizational structure and management and control over the last four decades. It would appear that the emerging forms of enterprise are professional bureaucracy, adhocracy and the so called missionary form (i.e. the organization controlled through corporate culture or religion) and the xerox form (i.e. the franchise operation in which many identical units operate under an umbrella organization that has rights of control without the responsibilities of ownership). Table 3.2 identifies more specifically the dominant organizational structures in each time period across a variety of forms of enterprise. Although this is admittedly a sweeping generalization of a large number of complex and inter related changes. It is consistent with Mintzberg's observations on which organizational forms are fashionable, and with Beer's criticisms of the large multi-unit enterprise.

A number of observations can be made. First, there has been a trend towards organizational forms in which decision-making is decentralized and forms that are professionalized with high levels of skill (professional bureaucracy and adhocracy). Second, there is a counter trend towards organizational designs where operations are controlled centrally through inculturation of employees, i.e. the missionary form, or through formalization and standardization of tasks, e.g., machine bureaucracy, but more particularly, the franchise or "xerox form". For example, McDonald's may be decentralized in the eyes of Peters and Waterman, but there is only one way the corporation allows its franchise holders to make Big Macs or set prices for them.

These kinds of developments in organizational design go a long way to explaining the two-tiered effect in the labour market outlined by Stanback (1981,1982), Noyelle (1983) and others. First, these organizational designs

TABLE 3.2 TRANSFORMATION IN ORGANIZATIONAL DESIGN AND CONTROL

Type of Enterprise	1945-60	1960-70	1970-80	1980-
Goods production and distribution	Predominantly machine bureaucracy	Increasingly divisionalized form	Increasingly divisionalized form/HQ services separated	Multi-unit professionalized bureaucracy or missionary form
Producer services	Predominantly simple structure or internal to the enterprise (eg techno-structure or support)	Increasingly professional bureaucracy internal to the firm	Increasingly prof bureaucracy external to the firm. Operational ahocracy	Xerox form Admin Adhoc and Prof bureaucracy
Health and Education	Professional bureaucracy	Professional bureaucracy	Professional bureaucracy	Xerox form Prof bureaucracy Machine bureaucracy
Consumer Services	Simple structure	Machine bureaucracy	Xerox form or missionary form	Xerox form or missionary form

Source: Adapted from Mintzberg (1983)

employ, on the one hand, higher level "professional staff", e.g., teachers, health care professionals and on the other, unskilled workers, e.g., fast food employees. Second, these forms are consistent with the observed environmental trends and with the "best fit" approach to organizational design and environment described by Mintzberg, in that the relatively complex environment of corporate services or health tends to favour adhocracy and professional bureaucracy and the more stable and simple consumer services or distribution functions favour franchise and missionary forms. Third, the transformation in organizational form relate to the findings of Pred (1979), Stephens and Holly (1981), Stanback (1982), Hardwick (1983) and others who emphasize the critical role played by the "intelligence" functions of enterprise (i.e. culture setting, goal setting, advanced corporate services and the "true" quaternary or strategic planning functions) in the status of cities and the shape of the urban systems hierarchy.

3.4.3 b) Environment, Organization, Control and Technology.

This argument can be extended to include developments in environment and technology. The longstanding debate over the degree to which information technology determines or affects the organizational structure of enterprise is related to synergistic developments in technology, environment and organization.

Robey (1977) in an important review article found that the literature on the relationship between computers and organizational structure fell into four common categories:

1) Computers cause or are strongly associated with centralization of decision making and control.

2) Computers cause or are strongly associated with decentralization of decision-making and control.

3) Computers have no impact.

4) Computer impact is moderated or mediated by other factors.

Robey's conclusion was:

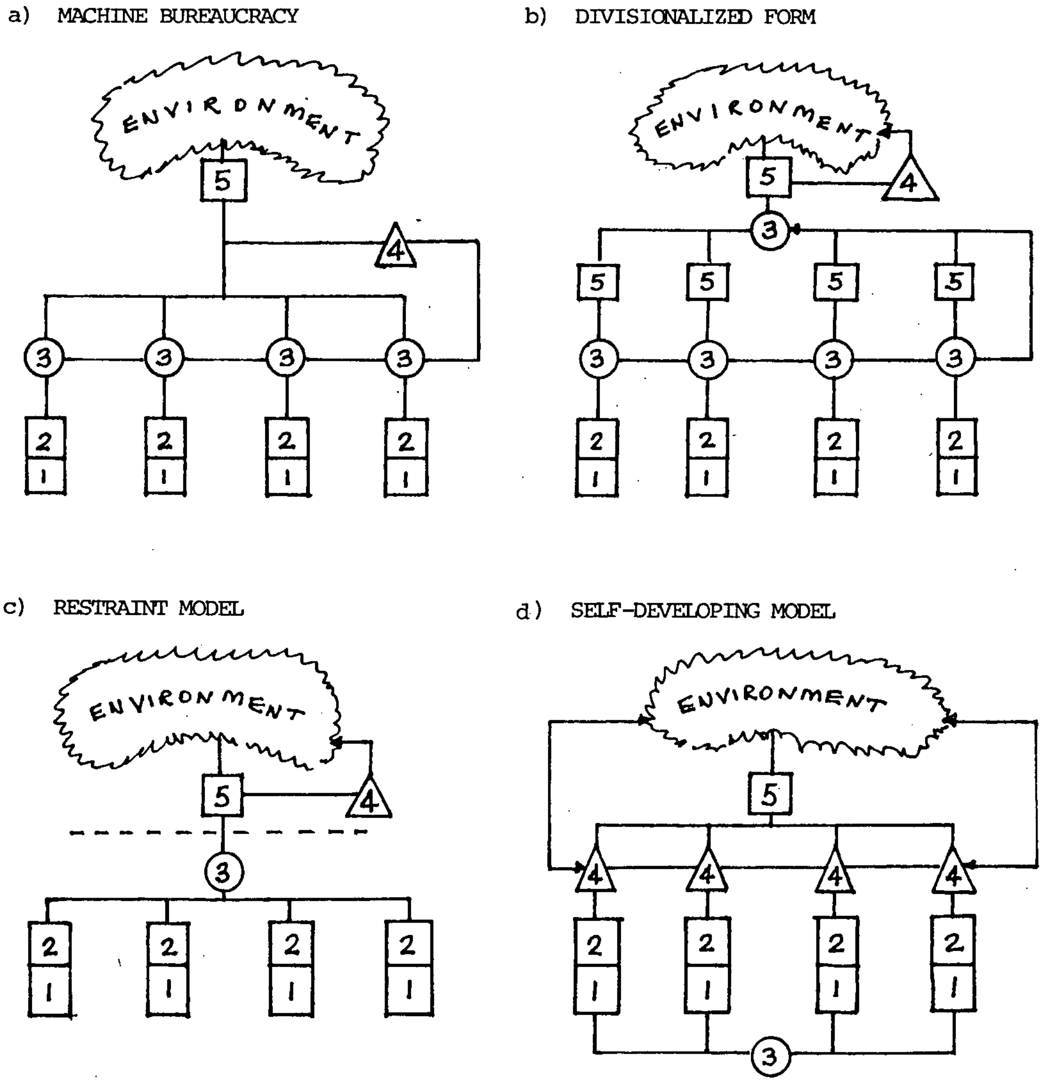
> "that (organizational) structure does not primarily depend on any internal technology for information processing, but rather on the nature of the task environment. Under stable conditions, computers tend to reinforce centralization. Under dynamic conditions, computers reinforce decentralization. Earlier positions (in the literature) are difficult to support because they are locked into the idea that computers "cause" changes. The present review points to the value of looking beyond computers to more theoretically grounded causal variables in the organization's task environment".

Similarly, Herbert Simon (1979) provides a classic quote:

> "whether we employ computers to centralize decision-making or to decentralize it is not determined by any inherent characteristics of the new technology. It is a choice for us to make whenever we design or modify our organizations. The technology does offer us a wide range of alternatives for fitting our decision-making systems to our requirements, whatever they may be".

Changes in environment and technology can be integrated with the transformation in organization and control. The environmental transformations outlined earlier, in particular Huber's work on the post-industrial enterprise and Amara and Lipinski's views on business planning for an uncertain future suggest that more sophisticated scanning and probing systems are required to provide the information base necessary to adapt to environmental change. Information is gathered and synthesized, not only through central data banks, but through continuous and rapid interactions between managers, employees and

FIGURE 3.2 EMERGING FORMS OF MULTI-UNIT ENTERPRISE



KEY: 5 = Board Functions
4 = Strategic Planning
3 = Monitoring and Control
2 = First Line Management
1 = Operations

customers, Huber (1984). In order to make appropriate, adaptational, survival-oriented, responses in turbulent environments, enterprise is adopting forms of monitoring and control, scanning and probing and overall organizational structure that best suits their activities and their goals. The responses are plural, however, depending on the complexity of what the enterprise does, on its goals and ideology, on the corporate culture it espouses and on the resources it has available. The responses made by enterprise are made more plural in that the potential technological solutions to communication, monitoring and control, scanning and probing functions are becoming more varied.

The emerging trend for multi-unit enterprise seems to be towards what could be termed Beerian structures of organization (see Fig 3.2). The first two forms (Figures 3.2 a and b) are analogous to Mintzberg's machine bureaucracy and divisionalized form. The critical difference between these two is in the role of the monitoring and control (system 3) and strategic planning (system 4) components. In machine bureaucracy the system 4 function is involved in rule setting. In the divisionalized form, the system 4 functions do include more scanning probing and corporate planning activities but these functions are generally conducted by staff rather than line positions (senior technostructure). Divisionalized forms are well suited to meeting the goals of paper entrepreneurialism and can survive in complex but relatively stable environments.

The multi-national divisionalized conglomerates live or die dependent on the quality of their "intelligence functions" and their political and economic clout. Some may survive the turbulent eighties if, as Trist suggests they reach some form of "macro-regulation". Their thirst for quality intelligence leads them to spatially congregate around the best intelligence networks and close to the corridors of economic and political power. This helps to explain the prevailing high prices of New York office space sought after by the multinational divisionalized conglomerates and the findings of Pred (1979) and Stephens and Holly (1981).

The machine bureaucracies are dying, particularly in the older more established manufacturing sectors of steel and heavy manufacturing, Bluestone and Harrison (1982). There are so few environmental niches that remain untouched by turbulence and change that it seems unlikely that either public sector or private sector machine bureaucracies can survive long without extraordinary political support.

The "new" or emerging Beerian structures are becoming more prevalent. The first "new" structure is what could be termed the restraint or systems maintenance model (Figure 3.2 c). In this model there is one very large and important goal, which is to maintain the same level of operation with no increase in cost or reduction in profit. The Board function (System 5 in Beer's terms) who are involved in setting the goals for the enterprise is then assumed away rather like a chicken with its head cut off. The enterprise continues to reflex according to the stated goal. There is no scanning or probing because systems maintenance must be continued regardless of environmental fluctuation. Any "steering function" is performed by the monitoring and control functions (system 3 group) who simply turn on and off funding taps if specific criteria are not met. From the perspective of the strategic decision makers this model requires "good soldiers" in the line-management (level 2) functions.

Ironically, this model is increasingly being adopted in the normally complex environment of health and education. The 'crisis' of costs leads to the establishment of the "lean, mean and tough" policy parameters as primary constraints on organizational functioning. The model is inherently unstable if we are to believe open systems theory or structural contingency approaches in that the organizational structure is not suited to its environment and tasks.

The irony is compounded in the fourth Beerian structure (Fig 3.2d) which is somewhat analogous to Mintzberg's Professional Bureaucracy. In this model, it is recognized that complex environments require 'hands on', strategic decision making. This organizational form involves highly-skilled operators interacting with the external environment and with strategic decision-makers. This has been termed simultaneous, "loose-tight coupling" between strategic and operations levels. Each of the sub units is run by a line manager (level 2 function) with a close strategic planning (level 4) adjunct (sometimes in the same cranium). This model has operated in large enterprise in health and education (as Mintzberg describes). Increasingly however, it is advocated for private enterprise involved in production and distribution, e.g., see Peters and Waterman (1982), Huber (1984) and the "atomistic structure" described by Deal and Kennedy (1982).

The predominance of divisionalized and machine bureaucratic structures for much of large scale private enterprise throughout the seventies is borne out by Reich (1983). But the self developing model is certainly being advocated for private enterprise and the proponents of this model cite numerous examples of its emergence. The restraint model on the other hand is prevalent in the private enterprise operating under receivership, in the machine bureauracy in its death throws, and increasingly in the public sector enterprise put under fiscal restraint and tight government control.

The critical point to note is that developments in information technology and automation have enabled all these forms to emerge. Centralized, divisionalized forms needed the kinds of information technology readily available from the mid 1960s on . However, the more recent developments in computerization, automation and telecommunications associated with micro-electronics, have enabled both the restraint model, by facilitating real-time access to information by centralized monitoring and control (system 3) functions, and the self-developing model, through rapid communications with strategic decision makers and intelligence functions.

Technology has caused neither one. Yet both forms of enterprise, divergent as they are in philosophy, in organizational structure and ultimately in performance, are made possible by technological developments.

3.4.3. c) Integration of Location into the Relationship Among the Variables

In this final sub-section, an attempt will be made to integrate the ideas about the structural transformation of enterprise with the spatial phenomenon outlined earler.

Just as Robey (1977) and Simon (1979) synthesized neatly, their conclusions about technology and organizational structure, so Mandeville (1983) provides us with a synthesis from a spatial prespective:

> "The conclusion emerging from comparing many studies is that information technologies can indeed encourage and also substitute for the physical movement of goods and people, with consequences for centralization and decentralization. Which of the two effects will appear in any given case appears to depend more on factors other than the choice of technology".
>
> Mandeville (1983:p 65)

It has been argued in previous sections that the restructuring of enterprise is an integral part of the transformation in the environment, strategic choice, internal organization, and technology of enterprise. These factors are synergistic in their relationship. Spatial structure, it could be argued, is increasingly becoming a product of the interaction of these other variables rather than a contributory factor. It is more an outcome than a co-determinant in many forms of enterprise. There are however some exceptions to this generalization.

As stated in Chapter 1, spatial factors and location still play an important role where services have to be delivered physically to people (especially in those human services such as health and education where the client, or customer is an integral part of the process of service delivery). Similarly, even in an information-oriented society there are still certain aspects of organizational behaviour, e.g., deal-making, that require face-to-face contact, though it has been argued that these aspects are sometimes over-emphasized, e.g., Gad (1979), Goddard (1980).

A limited literature is emerging that deals with the geography of enterprise in a behavioural way. This literature attempts to integrate the relationship between technology, organization and location within the context of environmental factors and strategic choice. The foundations of this literature are in the melding of organization theory and location theory. The contributions made by Pred (1979), Gottman (1983), Hardwick (1983), Stephens and Holly (1981) and others have been described earlier. Two more recent studies bring out the inherent complexity of analysis in this area and provide us with a useful empirical comparison. Both studies are on banking and they shed some light on the critical role of environment, strategic choice and technology in shaping spatial structure of service oriented enterprise.

The first study by Marshall and Bachtler (1984) follows Goddard (1980) in viewing technology as a "permissive factor" rather than a determinstic factor in the process of change. They argue (p 437) that:

> "there is a missing meso-level in studies of technology. National studies have been conducted on industries or techniques and there have been microanalyses of particular applications, but little work has been done to examine the way in which adoption of technology by business organizations is mapped into space".

They therefore examine the effects of adoption of information technology in the banking industry.

> "The introduction of technology is considered in the context of the main trends in the banking environment, and the organizational structure of the main institutions".

They suggest that because of parallel shifts in the environment and organization, it is "impossible to identify an independent technology effect". However, offer the conclusion that a combination of organizational and technological initiatives, though not reducing employment overall, would restructure activities spatially and organizationally, encouraging "both the centralization and decentralization of banking activities".

> "The evidence suggests that in the future the automation of routine branch office functions may be associated with a concentration of administrative work at key local centres. In addition, some banks are focusing labour intensive personal and corporate business at regional office level. Further, although centralized computer systems are likely

> to be retained and updated, computer processing is likely to be more distributed given the centralized structure of banking organizations, this is unlikely to go beyond the regional office level".
>
> Marshall and Bachtler (1984:p 448)

The second study, on the restructuring of the Australian trading banks by Taylor and Hirst (1984) also argues that there is an interaction between environment, organization, technology and location. They are critical of monocausal deterministic approaches to investigation in this research area. Instead in their model:

> "Technology and environment are seen as sets of forces influencing organizational structure, but mitigated by the performance of the organization under study".
>
> Taylor and Hirst (1984:p 1056)

These two studies are informative at a number of levels. First, they take an important step towards less deterministic analysis in their stated intent, although both studies lapse into causal jargon, e.g., "the impact of technology".

The second point to note is that they differ slightly in their conclusion. Indeed, Taylor and Hirst take an academic shot at Marshall and Bachtler's slightly more "decentralist" conclusion. It could be argued that the explanation for the difference lies in the interaction of environment and strategic choice. In relatively "overbanked" Australia (from a consumer banking perspective) rationalization and centralization would be a strategic response consistent with the restraint model described earlier. In the U.K. case, the prospect for some decentralization of autonomy to regional offices may be consistent with the perception of strategic decision makers that because of the U.K.'s relatively low penetration of consumer banking services, there is potential for growth in the customer base. Decentralist approaches to organization (i.e., the self developing model) could be considered as more appropriate forms for a growth environment. It is difficult to tell from the papers whether this is a reasonable explanation of the differences in their findings, even though both studies claim to recognize the relative independence of strategic choice as a variable.

Thirdly, despite their claims of open systems approaches to their analysis both groups seem to attribute changes in organizational structure to changes in technology (albeit in response to environmental pressures). Given the fact that the studies found varying degrees of spatial decentralization associated with similar technological change it seems remarkable that Taylor and Hirst would be critical of their U.K. counterparts. The divergence in the studies' results seems to add further weight to Goddard's (1980) conclusion that technology is a permissive or an enabling factor in location.

These case studies suggest that as multi-unit enterprise has moved into a more turbulent environment, the "performance gap" has increased to a point where action becomes warranted. The organizational and locational outcomes are not dictated by either environment or technology. Rather, they are driven by a synergistic combination of factors, most notably the strategic choices of senior decision makers based on their interpretation of environmental circumstances and the likely outcomes of transformation (cf Corning (1983) in Chapter 2). What seems to be apparent from these banking studies is that even in similar environments and with similar technologies, different structures can emerge. The explanation in this case may lie in the basic environmental perception and goal orientation of senior decision makers in the enterprise. An orientation towards growth leads to self developing structures that are functionally, organizationally and geographically decentralized. An orientation towards tight fiscal control leads towards correspondingly centralized restraint structures.

These generalizations should be modified because technological developments in networking, automated teller systems and distributed processing can enable both decentralized and centralized structure for multi-unit enterprise. They can also amplify the extent of organizational and geographic restructuring in either direction.

A final conclusion from these studies and perhaps one that is unique to current technologies is that they can simultaneously enable both centralization and decentralization in spatial and organizational terms.

3.5 CHAPTER 3 CONCLUSIONS:

This chapter has attempted to review a wide range of literature on the transformation of multi-unit enterprise. An open systems view of structural transformation was adopted in Chapter 1 and the precedents for such an approach were reviewed in Chapter 2. In this Chapter, analyses of transformation using this model leads to both methodological and substantive conclusions.

3.5.1 Methodological Conclusions

a) Synergistic Models of Structural Transformation

In order to investigate properly, the transformation in structure of multi-unit enterprise, it is necessary to develop a synergistic, open systems approach to analysis. Many studies have reached the stage of using multiple variables but there is still an underlying focus on prime movers and uni-directional deterministic links. This can be partly attributed to a lack of conceptual and methodological tools for the investigation of complex systems and partly to the compartmentalization of knowledge and research activity. It is argued here that an interdisciplinary approach is imperative in order to further our understanding of structural transformation in complex systems, in general, and spatial restructuring, in particular.

b) Case Study Approaches

The breadth of understanding required in any inter-disciplinary approach makes analysis tend towards superficiality unless that analysis is bounded in some way. Important contributions can be made where the analyst restricts investigation to a specific case, particularly a case were he/she has considerable working knowledge of the system. Six years of research experience in the clinical laboratory system of B.C. leads the author to select this multi-unit enterprise as a case study.

3.5.2 Substantive Conclusions

The literature reviewed so far has provided four substantive conclusions (although somewhat tentative at this stage) about the relationship among technology, organization and location.

a) Transformation is multi-dimensional and synergistic

There are times of structural change when a number of dynamic factors overlap and interact to create a profound impact on society. A number of variables have interacted in the last decade in the economics, demographics, technology and culture of North America that have crashed like a giant wave on enterprise. Yet the transformation in enterprise that is occurring is not simply a rote response to any one or a combination of these changes, but is to some degree being steered by strategic perceptions and strategic choices. What does seem clear is that the culmulative pressures of multiparametric change is forcing a reappraisal of strategic directions.

b) Technology is Neutral

Information technology is essentially neutral in the direction of its effects on the organization and spatial configuration of multi-unit enterprise. Thus information technology is not the critical driving variable causing centralization or decentralization of decisions or activities in a spatial or organizational sense. Rather it is an enabling factor that can amplify or attenuate the magnitude of the effects of other variables, This is true of all tools - they can increase the range of options and they can increase the leverage of the operator, but they do not dictate what the operator does. However, an important conclusion is that emerging information technology can enable elements of centralization and decentralization to occur simultaneously in the same organization.

c) The Role of Environment and Strategic Choice

The structure of enterprise in general and its spatial structure in particular seems to be conditioned by decisions about how to organize and in turn by the goals of the enterprise and the environmental opportunities and constraints that it faces. Therefore any centralization of decision making or spatial centralization of functions is a result of a synergistic interaction of factors that is guided more by transformation in corporate policy and the interaction with its changing environment, than by technological change.

d) Growth versus Restraint

It appears that the critical variable in determining the degree of spatial dispersion of activities and control is whether the enterprise is interested in growth or in systems maintenance and restraint. Growth is fostered through dispersed or dissapative structures in which sub-units interact freely with a dynamic environment but are guided by an overall philosophy or creed and supported from the centre. Conversely, a common approach to systems maintenance and restraint is through the development of simplistic central control and prescribed limits on the range of action of sub-units. Information technology plays a neutral role in this choice because it can enable both forms of control. The challenge for those designing policy for enterprise is in making the trade-offs between the five E's: efficiency, effectiveness, equity, employment and enjoyment. The danger is that policy impairs all or most of the five E's with technology taking the blame.

PREFACE TO THE CASE STUDY

In the previous chapters it was concluded that structural transformation in enterprise is driven by a synergistic process in which environmental, strategic, technological, organizational and locational factors interact. It was argued that transformation in the environment, changing strategic perception of environment and shifts in the goals of enterprise play a stronger role in the process of structural transformation than do developments in organization and technology of enterprise. It was also argued that technology is essentially neutral, in that it is not the necessary and sufficient condition that determines the choice between centralized and decentralized structures for enterprise. Rather, it can enable a wider range of organizational forms to be considered and can amplify the magnitude of effects in either direction. These conclusions will be tested in this case study by examining structural transformation of the clinical laboratory system of B.C. over the period 1954-1984.

Selection of this case study can be justified for a number of reasons. First, health care in general has become an increasingly important component in the economy of advanced nations. As Bell (1976) has pointed out, the growth in relative importance of health care and other human services such as education is an important hallmark of emerging post-industrial society. The importance of health care as an economic and organizational entity warrants close investigation of its institutional dynamics. Over the last two decades, a variety of research approaches have been forthcoming in economics (e.g., Arrow (1963), Culyer (1971), Feldstein (1971), Evans (1981,1984)) and to a lesser extent in organization theory (e.g., Thomson (1967). However, spatial-oriented analysis of health care services by geographers and health planners have tended to characterize such services as conforming to the classic central place hierarchy models or to other "rational" and mathematically derived location-allocation models, e.g., see Dear (1978) and Teitz (1968). This has led certain geographers to argue that greater understanding is required of:

> "the spatial structure of the systems of supply of hospital facilities, primary medical care and associated pharmaceutical services." (Herbert and Thomas (1982) p247)

This seems to be a plea for closer investigation of the relationship between the organizational and spatial structure of health care delivery. Such analysis seems to be required to explain why health services do not perfectly conform to Christalleran spatial patterns, e.g., Knox (1978).

The second set of reasons for the choice of case study relate specifically to the clinical laboratory system itself. This system has many attributes that are typical of the post-industrial or emerging form of enterprise. Specifically, the clinical laboratory system of B.C. has the following characteristics:

i) The clinical laboratory system in B.C. is a multi-unit system delivering services to physicians through a network of hospital-based laboratories and multi-site chains of private laboratories.

ii) Clinical laboratories are in the information business, in that they exist to generate "answers to questions" (Hardwick D.F. <u>et al</u> (1981)).

iii) Clinical laboratories provide "producer services". Laboratory test information is used by the "producers" of medical services, i.e., physicians. The growth in producer services in the post industrial economy is well documented (Cohen (1979), Stanback (1982), Noyelle (1983)). Analysts have argued for a better understanding of the spatial and organizational dynamics of producer services in general because producer services are critical elements in differentiating levels in the urban systems hierarchy (e.g., Cohen (1979), Dunning and Norman (1983)). Such a view can be extended to advocate analysis of producer services for health and educational enterprises.

iv) The clinical laboratory system in B.C. has elements of both public and private ownership. Although both sectors are ultimately publicly funded, the differences in ownership, control and mission provide a useful basis for comparison and reflect the blurring of boundaries between the civic system and the business system, Reich (1983).

v) Over the last three decades the clinical laboratory has experienced successive waves of change in technology. As such, the laboratory system provides a useful case study of the role of technological change in the structural transformation of enterprise.

vi) The growth in utilization and cost of clinical laboratories in the U.S. and Canada has brought them under closer scrutiny by analysts and policy-makers, (e.g., Conn (1978), Hardwick, D.F. <u>et al</u> (1981, 1985)).

All these attributes make the clinical laboratory system worthy of study for the analyst interested in structural transformation of enterprise. In addition, the author has had considerable research experience in the analysis of policy, organizational, technological and economic issues in the clinical laboratory. It was concluded at the end of the previous chapter that detailed knowledge of any case study was a critical asset when undertaking an interdisciplinary research study of this nature.

Structure of the Case Study

The three chapters in the case study follow the conceptual framework outlined in Chapter 1 where the external environment, strategic decision and internal operational structure were described as the three critical components in structural transformation.

Thus, Chapter 4 analyzes the attributes of the external environment shown in Table 1.1 and reviews the transformation in the wider environment facing clinical laboratories under a number of headings. In particular, the chapter first describes the social/demographic transformations in Canada and B.C. that have relevance for policy-making for laboratories. Second, it reviews the political/economic context of clinical laboratories in Canada and B.C. to show both the relative importance of the laboratory component within health care and how the increasing cost of health care services in general, and laboratories in particular, have become a significant policy issue. Thirdly, Chapter 4 reviews the wider medical context surrounding increased clinical laboratory activity in North America and attempts to demonstrate how changes in the functional focus of medicine may have led to changes in the demand for, and organization of, clinical laboratory services generally. The final section of Chapter 4 focuses on the candidate technologies available in the environment, reviewing the relative rates of penetration of these technologies in North America and their apparent organizational effects. Thus, Chapter 4 is intended to both describe these wider environmental conditions and hypothesize about their possible effects. As such the chapter draws on a range of North American literature and data sources.

In Chapter 5, these broader environmental changes will be integrated into a model of policy-making, in order to demonstrate how and why specific strategic choices have been taken in B.C. over the period. These choices will be set in the broader context of Canadian policies for laboratories.

Chapter 6 has a much more empirical focus and examines in detail the B.C. Clinical Laboratory System from 1954 to 1984 in order to describe the relationship of technology, organization and location in the laboratory system, to evaluate the system's performance against strategic goals and to identify emerging factors, at several critical points in time, that contribute to subsequent structural change.

In Chapter 7, the conclusions that are reached from the case study will be integrated with the general findings from the first three chapters. Finally, in Chapter 8 a series of alternative scenarios for the future of the clinical laboratory system of B.C. are developed and evaluated.

CHAPTER 4 - TRANSFORMATION IN THE ENVIRONMENT OF CLINICAL LABORATORIES 1954 - 1984

4.1 INTRODUCTION

Clearly the clinical laboratory system in B.C. operates within the wider context of socio-economic change described in Chapter 3. This chapter, concentrates on those elements of the environment specific to clinical laboratories and, where appropriate, outlines links to broader trends of social transformation. In particular four areas will be considered:

4.2 The Social/Demographic Environment

4.3 The Political/Economic Environment

4.4 The Medical Environment

4.5 The Technological Environment

These sub-environments conform well to the environmental dimensions identified in organization theory (see Table 1.1 and Chapter 2). In particular, the medical and technological sub-environments encompass the notions of task environment and technological complexity outlined by Thomson (1967), Burns and Stalker (1961) and Mintzberg (1983). Similarly, analysis of the political/economic environment enables identification of the degree of hostility and munificence that the enterprise faces (Mintzberg (1983), Pfeffer (1982)). Finally, the social/demographic aspects of the environment incorporates cultural factors and changes in market demands, Mintzberg (1983).

Each of these sub-environments will be examined in general terms to identify the salient transformations that have occurred during the time period and the potential policy and operational implications of these changes.

It will be argued that the changing social and demographic environment in Canada over the last thirty years is characterized by increasing popular support for: a) federal policy initiatives in health care, b) medical and technological approaches to health care, and c) equity in social, geographic and economic access to health care services. These characteristics provide an important part of the context for laboratory policy-making.

In terms of the political/economic environment in Canada, it will be shown that health care expenditures, in general, and laboratory expenditures, in particular, have grown substantially since the 1950s. This absolute and relative growth in laboratory cost and utilization has been viewed increasingly as a policy problem in Canada and the United States. Further, the observed relative shift in activity from inpatient to ambulatory services and the growth of private laboratories provide the context for, and are the result of, policy initiatives.

The medical environment section of the chapter suggests that a shift in the focus of medicine has occurred over the last four decades. This change in focus from infectious diseases prior to 1950, through diagnosis of disease and sub-set syndromes in the fifties and sixties, toward more aggressive therapeutic intervention in the seventies and eighties, has had considerable impact on the laboratory. In particular, changing medical knowledge and practice have placed different demands on the laboratory and have had implications for the organization and location of laboratory services.

The final sub-environment deals with changes in technology. It is argued that over the last thirty years, North American laboratories have been exposed to a succession of candidate technologies, each of which has had potential implications for laboratory policy, organization and location. In particular, it is suggested that developments in automation and computerization, until the mid seventies, favoured organizational and spatial centralization of laboratory services in large hospital and private laboratories. But it is also argued that more recent technologies have potential to enable a dispersion of laboratory services to smaller hospitals, and indeed to the clinic, the ward and the doctor's office. (The phases of development and the degree of diffusion of these technologies are summarized in section 4.5. A more detailed historical review of technological development is provided in Appendix B).

This critical review identifies the changing environmental characteristics facing strategic decision-makers over the last thirty years. It will be shown in Chapter 5 that environmental transformation and the changing perception of these wider conditions had an important influence in shaping both the goals of the laboratory system in British Columbia and the specific policies that were developed over the period.

4.2 SOCIAL/DEMOGRAPHIC ENVIRONMENT

The organization and direction of any health care system reflects the values and priorities of the wider society in which it operates and is not simply the result of the absolute or relative amount of resources directed to it. In Canada, the health care system has been shaped, to a large degree, by the nature of the society it serves. Thus the health policies that have been developed in Canada in the last thirty years reflect broader societal change.

This section cannot adequately review the links between social change and health policy. The reader is encouraged to look elsewhere for such analysis, e.g., Crichton (1981). It is however important to highlight, in this section, some of the critical social and demographic changes that have influenced the Canadian health system over the last thirty years.

The first major observation is that increasingly Canadian society has considered it legitimate for the federal government to set goals for the health care system. Although nearly all of the important policy initiatives in Canada have been developed and tested by individual provinces (most notably Saskatchewan and Quebec) or by individual professions, it is the federal government which has consolidated a national comprehensive framework for health care delivery. B.C. provides a good example of a province that had developed both its own hospital insurance scheme prior to the federal Hospital Insurance and Diagnostic Services Act of 1957, and had an extensive system of private medical insurers prior to the federal Medicare system (adopted in B.C. in 1968). But federal health initiatives in Canada are important in that once taken, they are jealously guarded by the population at large. "Don't touch health" or at least "Don't appear to touch health" seems to be the pollsters advice to federal and provincial politicians. The reason is that although provinces have the responsibility for administering health care there is a widespread popular belief that Canada's national system must not be fragmented by provincial tinkering.

The second major characteristic that flows from, and is the reason for, popular support for national goal-setting, is a public sense of entitlement or right of access to the health system. The introduction of Medicare "enshrined" the four tenets of universality, comprehensibility, portability and public administration of health insurance. These initiatives and the series of reports and white papers produced through the sixties and seventies, reinforced the Canadian public's sense that they were entitled to access to health care resources (e.g., the Hall Commission (1964) and Lalonde (1975)). Indeed, a recent task force of the Canadian Medical Association (CMA) reports that consumer groups are currently arguing for a "Bill of Rights" for patients (CMA Taskforce (1984) p. 4) thereby "enshrining" patient's rights in a formal sense.

This sense of entitlement seems to be partly the reflection of Canadian acceptance of a version of a welfare state ideology and partly an acceptance of the ideology that access to medical interventions (and related systems) are essential for maintenance and improvement of health status (Crichton (1981: Chapter 5)).

This leads to a third social value that has specific implications for this study, namely the belief in technology. A technologically sophisticated society seems to put its faith in devices and believes that the results achieved through application of such technology are inherently beneficial. Despite advocacy for social rather than medical models of delivery, e.g., community health centres, hospices and para-professional counselling, there remains a strong popular belief in hi-tech for health.

Social values not only reflect broader societal transformation but they are driven largely by the demographics of the population. Two major demographic factors must be considered as part of the environmental context of this study. The first is the baby-boomer's influence on demands for health services and on health policy. The ideas of the "great society" or the "new society" of the late sixties and early seventies were partially driven by demographics. A youth-dominated society was ready for progressive ideas. In Canada, Prime Minister Trudeau gained great influence in the late sixties with a new agenda that reflected the aspirations of progressive baby-boomers. In the late seventies and early eighties the boomers, to a large extent, have put away their placards and granola and taken up more conservative and familistic values. Yuppies are also into hi-tech.

In B.C. the New Democratic Party's short but significant period in government in the mid seventies (1972-1976) gave expression to the wider progressive agenda in Canada. This was demonstrated in their health policy making and the ideas raised in the Foulkes Report (Foulkes (1974)).

The second major demographic factor is the "graying" of the population. The elderly are becoming an increasingly significant proportion of the population that has placed increasing demands on health care services and even greater increases are projected for the future (CMA Task Force (1984)). (The extent to which such demographic phenomena will dominate the demand for health services is open to debate. Analysts argue that its impact on utilization is not likely to be nearly as great as the general levels of service increase in the age-adjusted population).

In Chapters 5 and 6 these themes will be returned to in discussing the policies that were developed and the organization that resulted.

4.3 POLITICAL/ECONOMIC ENVIRONMENT

In the post-war period health care has played an increasing role in the economies of advanced nations, Bell (1976). Health care in Canada has been both a national priority and a symbol of national unity, Crichton (1981: p 216). In this section, growth in health care services will be reviewed generally (4.3.1) and clinical laboratories will be discussed in particular (4.3.2) to emphasize the growing prominence of these activities. The policy and operational implications of such growth will be assessed in Chapter 5 and 6.

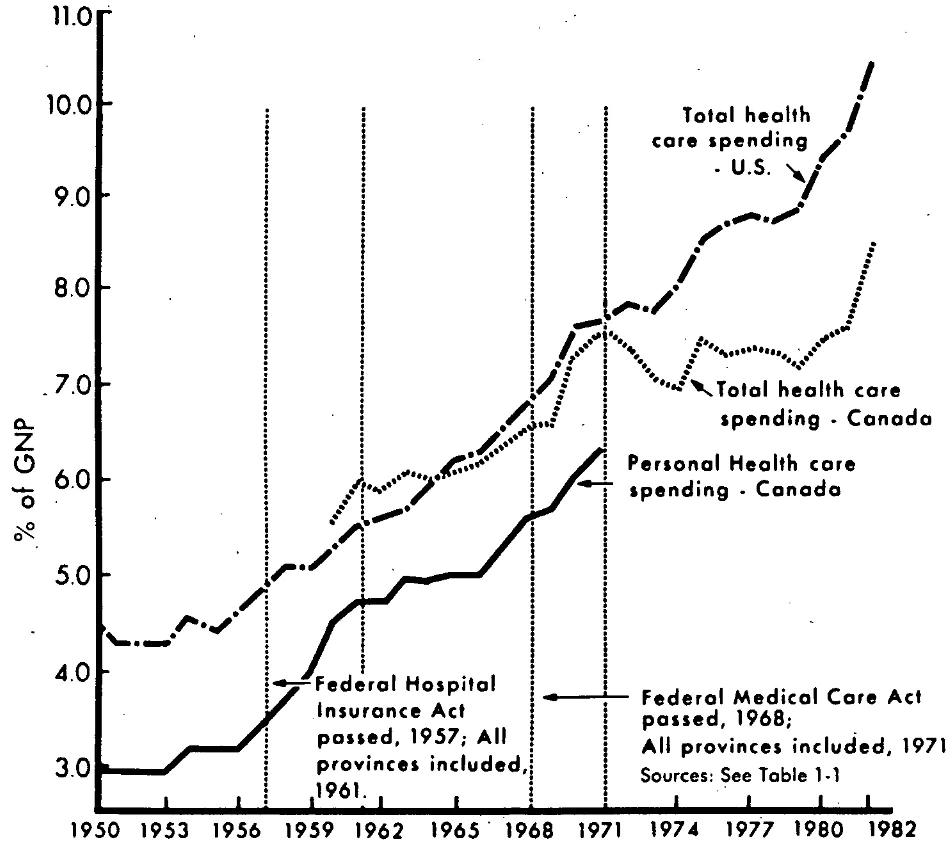
4.3.1 Health Care and the Economy

Since the 1950s there has been a substantial increase in the role and share of economic activity devoted to health care services in Canada and in B.C. Figure 4.1 shows health care expenditures as a share of GNP for the U.S. and Canada over the period 1950-82. Although health services in Canada have grown substantially over the period, in both relative and absolute terms, this growth has not been consistent. In particular, it is important to note the "step" changes in expenditure that followed the enactment of federal hospital insurance in the late 1950s and then federal medical insurance in the late 1960s. It is also useful to note the apparent stabilization of relative expenditures in Canada in the 1970s.

This latter trend is of particular interest to health economists because it is in too sharp a contrast to the experience in the U.S. (Evans (1984) p. 10). Whereas growth in the health care services share of GNP in the U.S. paralleled the Canadian experience up until the late 1960s, there was a significant divergence between the two nations in the 1970s. Canada maintained a relatively constant share of GNP until the recession of the 1980s

Fig. 4.1

Health Care Spending as a Percentage of National Income, Canada and the U.S., 1950-1982



(when Canadian GNP dropped suddenly and health costs upturned suddenly). The U.S., on the other hand, continued to increase throughout the 1970s and early 1980s leading two widespread concern about uncontrollable cost escalation (The 1983 U.S. share of GNP devoted to health is 10.8%, a continued increase).

At the provincial level, health expenditures by the provincial government have continued to escalate in absolute and relative terms throughout the sixties and seventies (Figure 4.2). The figure shows the rapid increase in the provincial government's expenditures on medical services following the implementation of the medical insurance scheme in 1968. It also demonstrates the relatively high priority given to health care funding by the NDP in the period 1972-76. More recent data for all three time series were not available, but a picture of the early eighties experience is given by Figure 4.3. This figure demonstrates per capita expenditures on hospital and medical care for Canada and B.C. It can be seen that B.C. hospital expenditures per capita have lagged behind the Canadian average over the period, conversely medical expenditures have exceeded the Canadian average. The trend lines would indicate that the "gap" between the two is widening; a point that will be returned to in our discussion of clinical laboratory funding below and in Chapter 5 and 6. (In subsequent analyses in this case study expenditures will be expressed in constant dollars. This refers to the nominal (current) dollar expenditures adjusted by the Gross National Expenditure (GNE) deflator for that year. The author recognizes that in the absence of industry specific price deflators such adjusted expenditures are not a true measure of real output for the sector. However, these measures reflect real cost to society relative to other sectors of the economy).

Fig. 4.2 HEALTH COSTS AS SHARE OF GPP

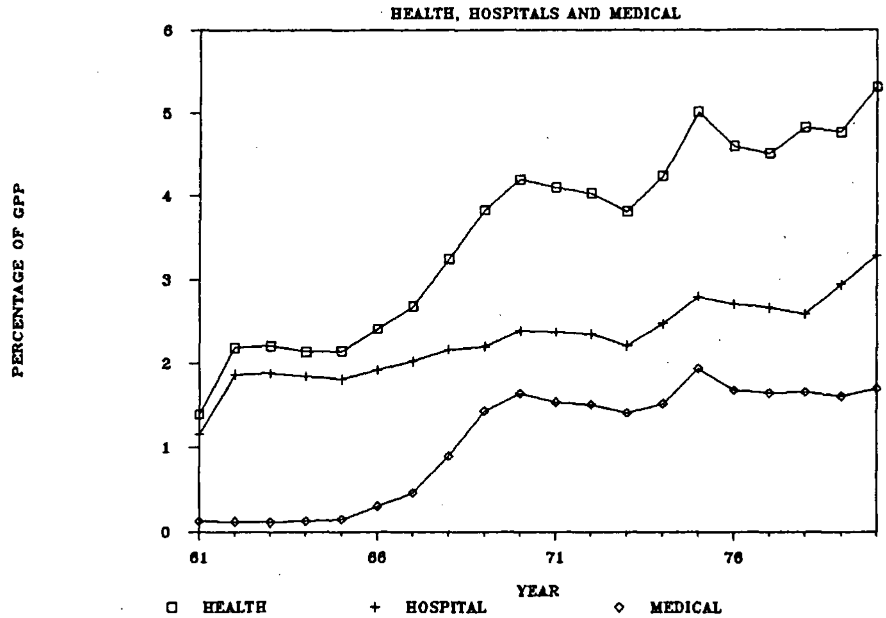
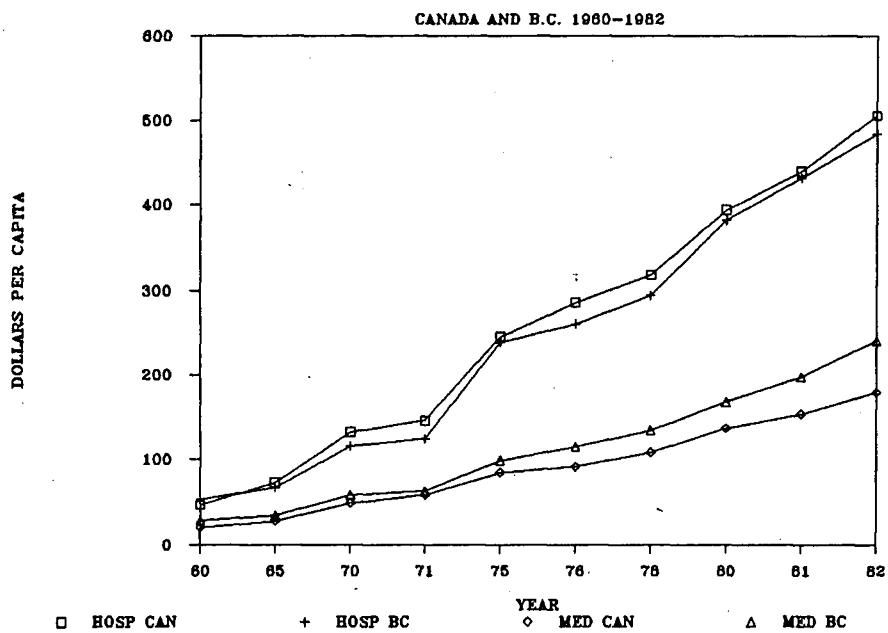


Fig. 4.3 HOSPITAL AND PHYSICIAN EXPENDITURES



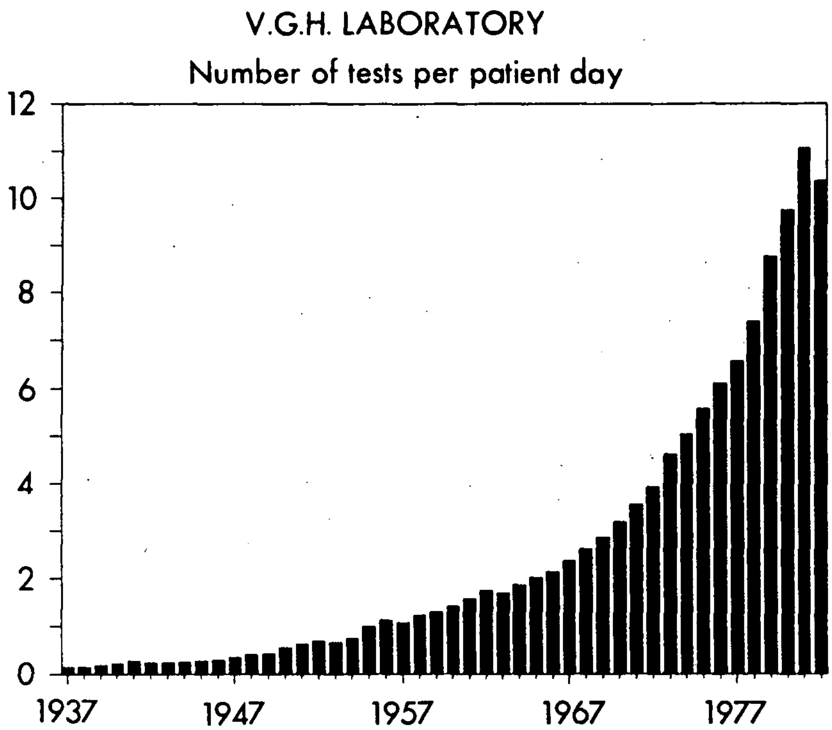
These changes in absolute and relative costs reflect a wide variety of factors; shifts in manpower, technology, patterns of practice and utilization, availability and accessibility of health services as well as the effects of policy aimed at all these variables (see Evans (1984) and Barer and Evans (1984) for further analysis and discussion of the relative contribution of these factors to total health care spending). But significantly in the 1980s, cost is being viewed not simply as an outcome of policy initiatives and changes in delivery, but also as a primary contextual variable in policy-making. Thus cost itself has become an environmental issue. Its importance has been amplified by the international recession, by the declining resource revenues in B.C. and an unwillingness on the part of Provincial Government to consider large-scale deficit financing.

Health care costs were not always such a political issue. It is clear that in the 1950s and 1960s the primary political focus was on issues of service upgrading and improvement in accessibility of services (both socially and geographically). The changing policy focus as it relates to the laboratory will be discussed in Chapter 5.

4.3.2 Growth in Laboratory Services and Costs

The clinical laboratory has grown continuously over the last 100 years, but very rapid growth has occurred in the last three decades. Accurate, long-term, time-series data are difficult to obtain. However, Figure 4.4 shows the exponential growth in the use of laboratory procedures since the 1930s at British Columbia's largest hospital, Vancouver General. The pattern of exponential growth in the use and cost of laboratories is an international

Fig. 4.4


V.G.H. LABORATORY
Number of tests per patient day
12
10
8
6
4
2
0
1937
1947
1957
1967
1977

phenomenon (Hardwick D.F. et al (1981), Benson and Rubin (1978), Altman and Blendon (1977), Banta and Kemp (1982)). Increasingly, this growth has been viewed as a policy problem because there appear to be few mechanisms to assess adequately the value of these services relative to their costs (Hardwick et al (1985), Schroeder (1985), Statland (1985)).

In Canada, the magnitude of this growth can be measured in a number of ways, although none of the measures is perfect because of the inadequacy of the data bases. (A point encountered by other analysts in the area, e.g., Labonte (1983) and IFTF (1985)). For example, Figure 4.5 shows the growth in a laboratory use index (workload units per Patient Day) for Canada and three selected provinces (B.C., Saskatchewan and Ontario). This index is imperfect for a number of reasons:

i) The workload unit on which it is based has gone through three recalibrations (in 1954, 1969 and 1981) and it is not clear how these time series can be adjusted to reflect a continuous pattern. (However the data prior to 1969 have been multiplied by a factor of 4.3 to reflect observed annual changes in other variables).

ii) The data are partial in that they do not include private laboratory activity.

iii) There is a widely held concern that the workload unit has been applied inconsistently by individual institutions making both longitudinal and cross-sectional comparisons somewhat tentative.

iv) The final and perhaps most important criticism of the workload unit as a measure of laboratory utilization is that it is not really a measure of output at all. Workload units are values assigned to laboratory procedures to reflect the expected labour input to that procedure (since 1969 1 unit = 1 minute). The unit values for a specific test are also reduced if done on automated equipment. Thus the workload unit is perhaps a better labour productivity measure (expected labour input/actual labour input) than it is a utilization measure.

The data do suggest, however, that B.C. hospitals "utilization" index is below the Canadian average, falling somewhere between Ontario and Saskatchewan.

A second measure of growth is laboratory cost per patient day expressed in constant 1971 dollars. Statistics Canada data for Canada and the three provinces are shown in Figure 4.6 for the period 1962-1981/82. These data are for all Public, General and Allied Special Hospitals (PGAS) and do not include private laboratory activity. Again B.C. falls between Saskatchewan and Ontario in terms of its average cost per patient day, but B.C. costs per patient day have surpassed the national average in the period 1979-1981/82 reflecting perhaps higher factor prices for hospital laboratories in those years.

A third alternative measure of growth, and one that has considerable appeal, is real per capita laboratory expenditures, i.e., adjusted for both population increases and general levels of inflation. This measure overcomes some of the difficulties with the workload data in terms of comparability and completeness, however a number of problems persist:

First, the data are derived from three different sources:

a) Hospital statistical returns filed with Statistics Canada (HS1 and HS2) for the period 1966-1981/82.

Fig. 4.5

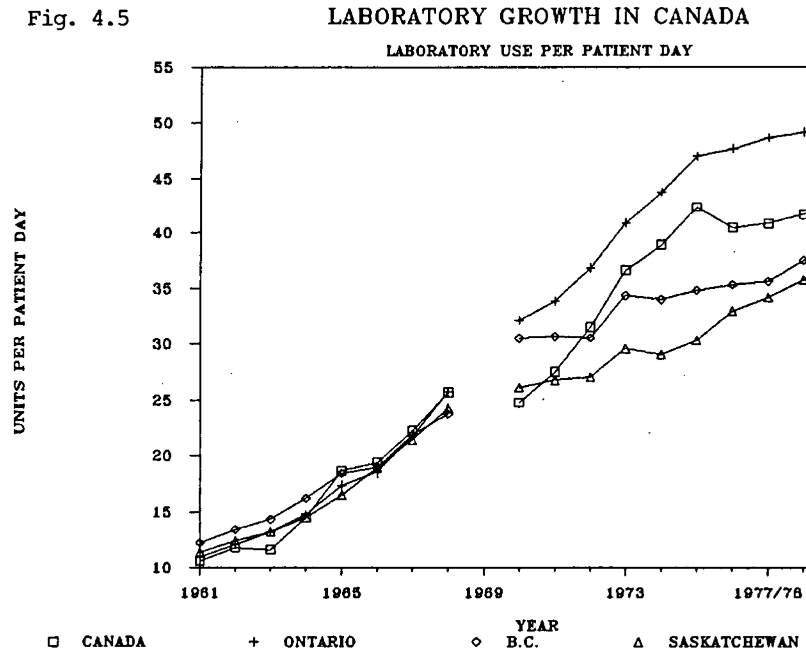
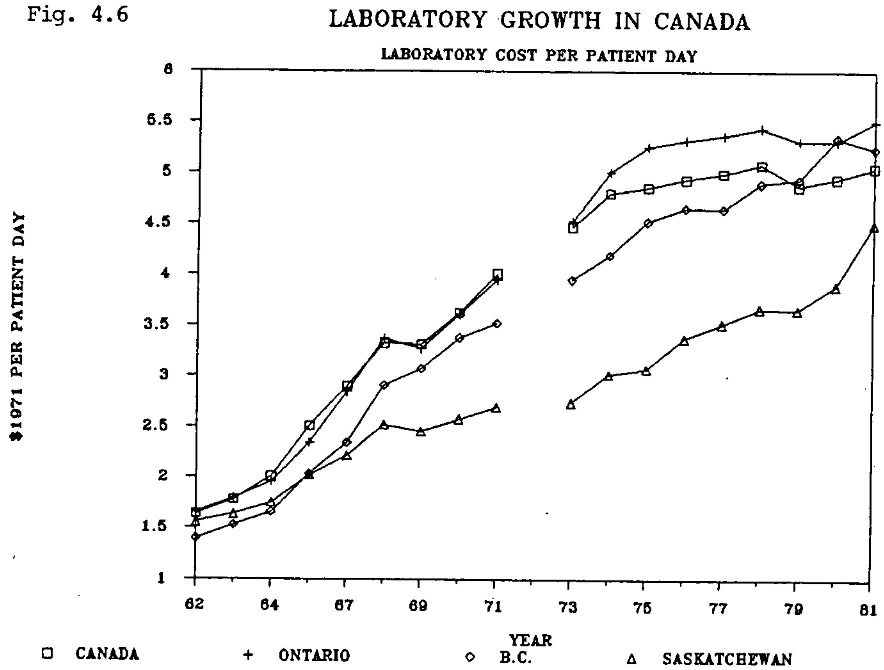

LABORATORY GROWTH IN CANADA
LABORATORY USE PER PATIENT DAY
UNITS PER PATIENT DAY
55
50
45
40
35
30
25
20
15
10
1961
1965
1969
1973
1977/78
YEAR
□ CANADA
+ ONTARIO
◇ B.C.
△ SASKATCHEWAN

Fig. 4.6


LABORATORY GROWTH IN CANADA
LABORATORY COST PER PATIENT DAY
$1971 PER PATIENT DAY
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
62
64
67
69
71
73
75
77
79
81
YEAR
□ CANADA
+ ONTARIO
◇ B.C.
△ SASKATCHEWAN

b) Provincial Medical Services Commission (MSC) data for the period 1970 to 1983/84. (Since 1968 MSC as the province's sole medical insurer has reimbursed hospitals, private laboratories and physicians for outpatient testing on a fee for service basis).

c) The two principal private insurers MSA and CU and C that operated fee-for-service medical insurance plans prior to the enactment of Medicare in 1968.

The second problem is in the meaning of the term expenditures. In the case of the hospital statistics (HS1 and HS2) the data include only the cost of salaries, wages and operating expenses and do not include fixed costs such as hospital administrative overhead, heat, light, rent or capital equipment. These expenditures are analogous to direct variable costs. Fee for service payments on the other hand, include a professional component to recompense pathologists and a technical component that covers the entire cost of operation including overhead, building costs, capital equipment and profit. They are thus analogous to gross sales. Because of these differences there is a question over how directly comparable these data sources are.

A third and final wrinkle is added to the analysis when one considers the case of the outpatient component of hospital laboratories. Although hospitals receive fee-for-service payments from the Medical Services Commission, the "revenue" received by the hospital for these tests is simply offset against the hospital's expenditures. Consequently, the hospital laboratory receives no "income" over and above the expenditure already declared in the hospital statistical returns. Various factions in the provincial laboratory scene have interpreted MSC payments to hospitals as double payment, this does not seem to reflect the reality of hospital funding. What is clear is that this offset revenue policy is becoming an increasingly critical issue, as will be discussed further below.

With these caveats in mind, Figure 4.7 and 4.8 and Table 4.1 attempt to evaluate real growth in cost of laboratory (pathology) services in B.C. In particular, Figure 4.7 shows two measures for selected years from 1954 to 1983/84. Unadjusted real cost per capita was derived by adding total hospital laboratory costs to total MSC laboratory payments (including fee-for-service payments to hospitals) thus giving the "double-billing school" the benefit of the doubt. Adjusted costs simply removes the MSC payments made to hospital laboratories and leaves hospital expenditure to include those costs that were actually incurred in producing all laboratory services in those hospitals (including outpatients).

Figure 4.8 breaks these adjusted costs down further into hospital laboratory costs (including outpatient), private outpatient laboratory fees and other fees (paid to doctors offices) for the period 1970-1983/84.

Finally, Table 4.1 analyzes growth in the adjusted per capita cost for inpatients and outpatients by type of provider.

Despite the difficulties in measurement stated above a number of significant patterns emerge. First, total adjusted expenditure on laboratory services has increased in real terms more than 13 fold over the thirty year period. For the period 1970/71-1983/84 for which the data are more reliable, it can be seen that the outpatient share of adjusted laboratory expenditures has increased from 44.1% to 53.3% and the private laboratory share of adjusted total per capita expenditures increased from 26.6% to 35.9%. Conversely the

Fig. 4.7

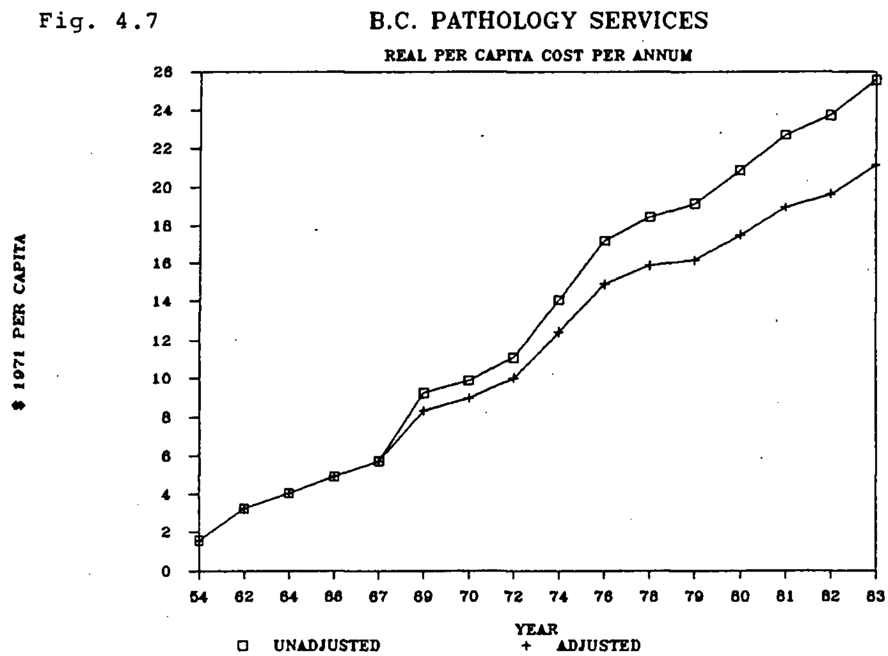

B.C. PATHOLOGY SERVICES
REAL PER CAPITA COST PER ANNUM
$ 1971 PER CAPITA
0
2
4
6
8
10
12
14
16
18
20
22
24
26
54
62
64
66
67
69
70
72
74
76
78
79
80
81
82
83
YEAR
UNADJUSTED
+ ADJUSTED

Fig. 4.8

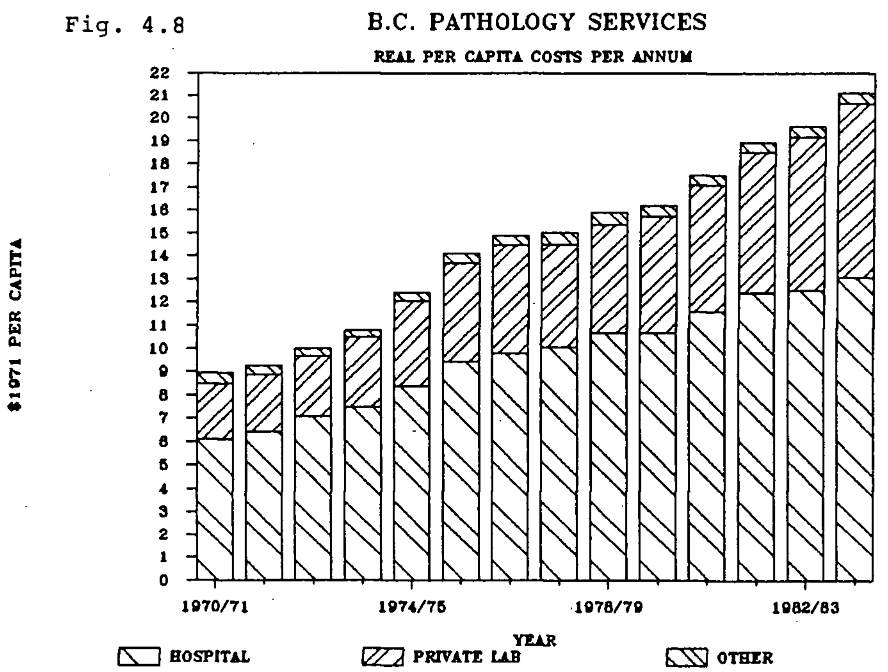

B.C. PATHOLOGY SERVICES
REAL PER CAPITA COSTS PER ANNUM
$1971 PER CAPITA
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
1970/71
1974/75
1978/79
1982/83
YEAR
HOSPITAL
PRIVATE LAB
OTHER

Table 4.1 GROWTH IN LABORATORY EXPENDITURES IN BRITISH COLUMBIA 1970-1983 OUTPATIENT VERSUS INPATIENT BY TYPE OF PROVIDER IN CONSTANT (1971) DOLLARS PER CAPITA

	1970/71		1983/84		% Growth in Expenditure 1970-1983
	$1971 Per Capita	% Share	$1971 Per Capita	% Share	
Total Laboratory Expenditures (Adjusted)	8.96	100	21.12	100	136
Hospital Sector (Total)	6.12	68.3	13.08	61.9	114
(Inpatients)	(5.01)	(55.9)	(9.85)	(46.7)	97
(Outpatients)	(1.11	(12.4)	(3.23)	(15.2)	190
Fee-for-Service Medical Sector (Total)	2.84	31.7	8.04	38.1	183
(Private Laboratory)	2.38	26.6	7.58	35.9	218
(Doctor's Office)	(0.45)	(5.1)	(0.46)	(2.2)	2
Outpatient Total	3.95	44.1	11.26	53.3	185
(Hospital Outpatient)	(1.11)	(12.4)	(3.23)	(15.2)	190
(Private Laboratory)	(2.38)	(26.6)	(7.58)	(35.9)	218
(Doctor's Office)	(0.45)	(5.1)	(0.46)	(2.2)	2

Sources: See Data Appendix and Text.

hospitals' share of total real expenditures has dropped from 68.3% to 61.9%, and in particular the inpatient sector has dropped from 55.9% to 46.7%. Finally, there has been very little real growth in testing in doctors offices (2%).

These shifts are both the result of and have produced the context for policy-making for the laboratory system of B.C. as will be discussed further in Chapters 5 and 6. The respective functional and organizational structure of the public and private sectors must be viewed within the context of growth in expenditure, fee-for-service versus cost reimbursement and the strategic choices that paralleled cost escalation.

In the sections that follow the wider medical and technological environment surrounding this growth will be discussed. In particular, emphasis will be placed on changes in the prevailing functional focus of North American medicine and on the changing availablity of candidate technologies for the laboratory.

4.4 MEDICAL ENVIRONMENT

For the last hundred years the medical laboratory has been an identifiable "place" that provides physicians with information about patients and populations. It has been described as a physician's "workshop of science", Reiser (1978) and as a "system that answers questions", Hardwick, D.F. et al. (1981). The purpose of this section is to describe how the functional focus of North American laboratories has changed in response to wider changes in medicine (from a focus an infectious diseases to a focus on therapeutic intervention), and to identify the policy and operational implications of that changing medical environment.

4.4.1 Changing Focus in Medicine

Throughout the 19th century and until 1950 the major killer diseases were the infectious diseases. Continuous progress had been made in treating infectious diseases since 1875 when enactment and implementation of the British Public Health Act began to demonstrate that improved town planning and sophisticated sanitary engineering, coupled with improved nutrition, could help reduce the awful toll that infectious disease took in rapidly growing industrial cities. In 1885, Robert Koch, a bacteriologist was appointed to the newly created chair of hygiene at the University of Berlin:

> "At the time of Koch's arrival in Berlin, tuberculosis was the predominant endemic disease in Europe, responsible for approximately one death in seven. ... Koch applied his ingenuity and techniques to search for a bacterial cause for tuberculosis. In 1882, he triumphantly announced success: For the first time, the parasitic nature of a human infective disease, and indeed, of the most important of all diseases, had been completely demonstrated."
>
> Reiser (1978:84,85)

Progress in diagnosing and treating infectious diseases continued with the development of sulfonamides in the nineteen thirties, penicillin and streptomycin a few years later, and the advances in the control and cure of other infectious diseases through inoculation and public health programs that occurred in the 1940s. These developments have almost eradicated many of the infectious diseases and represent what Lewis Thomas has termed "decisive medical technologies."

Lewis Thomas has argued that almost all of the increased resources allocated to health care since 1950 has been directed to what he terms "half-way technologies". Half-way technology represents the best available treatment, but treatment that has been unable to eradicate or reduce substantially the incidence of disease to which it is targeted, despite the large and growing resources allocated to these activities. As Thomas wrote in the mid-70s:

> "We are left with approximately the same roster of common, major diseases which confronted the country in 1950, and, although we have accumulated a formidable body of information about some of them in the intervening time, the accumulation is not yet sufficient to permit either the prevention or the outright cure of any of them. This is not to suggest that progress has not been made, or has been made more slowly than should reasonably have been expected. On the contrary, the research activity since 1950 has provided the beginnings of insight into the underlying processes in several of our most important diseases, and there is every reason for optimism regarding the future. But it is the present that is the problem."
>
> Thomas (1977:37)

An increasing focus on diagnosis and documentation of specific disease states paralleled this research activity. For example:

> "So many diseases and syndromes had been described by 1960, numbering in the thousands, that physicians could not recall all their names much less the symptoms that identified them. For example, over 1000 illnesses and about 200 symptoms were associated with the cornea of the

eye alone. By 1960, more than 15,000 papers pertinent to medicine appeared each year, any one of which might shed light on the illness of a patient."

Reiser (1978:204)

Similarly, Fletcher et al. (1981) conducted a survey of the contents of original articles appearing in three major medical journals (Lancet, New England Journal of Medicine and JAMA) over the period 1946-76 and found trends in the kinds of clinical questions addressed over the thirty year period.

> "The most common question throughout related to treatment (30 percent in 1976 and 44 percent in 1946). Most of these therapeutic studies were evaluations of the effectiveness of treatments. The second most common question in 1976 was the study of causation of disease, a question that was a relatively infrequent focus of investigation in 1946. The pathogenic, mechanistic approach to causation became relatively more common throughout the thirty years."
>
> Fletcher <u>et al</u> (1981:290)

The increasing number of subset syndromes and the requirement to understand more fully the pathogenesis of the disease is associated with a shifting focus from microbial diseases to chronic diseases. McDermott suggests that:

> "If periods of months or years customarily elapse between the start of the disease process and the "outcome" in terms of death or permanent disability, a range of outcomes is possible. The outer reaches of the range can be very different: for example, survivals of fifteen or twenty years for some people are to be contrasted with survivals of one or two years for others. Yet all have the same disease. To be sure the disease manifestations form patterns that can be refined into subsets. With chronic disease, the question then arises whether and how many of them are sufficiently different to be diagnosed in the living patient. Then the rather common situation of a complicating factor such as hypertension or diabetes can greatly expand the total number of possible outcomes, thus producing a still larger number of subsets each with certain characteristics all their own."
>
> McDermott (1977:217)

The picture that is being painted here is one in which medicine is focusing increasingly on taxonomy, i.e., sub classifying disease syndromes and on elucidating disease mechanisms. This diagnostic and research achievement through the fifties and sixties coupled with the developments in chemotherapeutic agents and techniques for control of the patient during surgery in the sixties and seventies has enabled an increasing number of more specifically targeted medical and surgical interventions. They may not totally fulfill the promise that Thomas had for them in the mid 1970s in terms of their cost-effectiveness; but these interventions such as coronary bypass surgery, management of adult leukemia and other cancer patients were being used increasingly in the seventies and eighties, Banta and Kemp (1982). These halfway technologies require fine grain taxonomic work (i.e. diagnosis) followed by real time physiologic monitoring and therapeutic adjustment.

McDermott (1977:214) asserts that:

> "Roughly three quarters of the non-surgical physician's care today (both general and specialist) is not curative but supportive. This fact is known but is frequently misunderstood by the non-physician student of medical care. To say that the principal contribution is "supportive" is not to say that it is unimportant, nor that it does not require mastery of the technology. On the contrary the pattern of disease that has been shaped by our economy and our public health measures has created a situation in which supportive therapy that is largely, though not exclusively, technological becomes the physician's major function. Involved here is quite sophisticated management of the deranged physiology of ultimately fatal disease."

The changes in the functional focus of medicine may from an economic point of view reflect the law of diminishing returns i.e. proportionately less pay-off for more resources added, Evans (1984), Schroeder (1985). However, medicine and the public perceives the highly expensive interventions as highest quality care and seems unwilling to forego these types of interventions even with a lack of evidence "validating" their effectiveness. What are the implications of these changes for the laboratory?

4.4.2 Changing Functional Focus of the Laboratory

Medicine's increased understanding of the pathogenesis of disease and of associated subset syndromes in the last 30 years has substantially increased the complexity of the diagnostic process and therefore increased the amount of information required for both diagnosis and treatment.

> "With most microbial diseases, individual cases all tend to be alike, and the period from onset to full clinical illness is only a matter of days or hours. Under those circumstances the data supplied in the disease descriptions in textbooks is quite satisfactory. But the United States pattern of illness faced by the practitioner today is no longer mainly a matter of obvious microbial disease among the young, but of highly diverse hidden structural disease, frequently with several decades between actual (undetected) onset and outcome .... Although a chronic disease may be common, its individual expressions may be so diverse as to afford a single physician encounters with only one or two examples of each expression in his professional lifetime."
>
> McDermott (1977:278)

This increasing complexity and lack of predictability in medicine had its implications for the laboratory. For example, in the era of infectious diseases, the public health laboratory was the principal diagnostic resource. In the era of taxonomy and sub-typing of disease the powerful diagnostic test is the prime tool. With increasing emphasis on surgical and medical interventions for chronic disease, then in addition to sophisicated diagnostic tools, medicine has reached for real-time physiological monitoring as a support.

This synoptic description suggests that causality flows from medical need to laboratory function. This is perhaps overly simplistic and even optimistic, for it is clear that the development of the laboratory's technological capability and research in laboratory medicine enabled the sub-typing of disease and the monitoring of therapy to occur. What is important for this analysis is not so much establishing cause and effect but to show how the overall goals of medicine in general and laboratory medicine in particular have changed, over the last forty years, from classification and description of disease to therapeutic intervention and monitoring.

In particular, the expansion of halfway technologies that Thomas described was associated with changes in the laboratory, where, throughout the fifties and sixties, laboratories became much more precise and thorough in their technology (as well as increasing substantially in scale and mechanization as will be discussed in the next section). In the seventies and eighties, with the proliferation of halfway technologies, such as chemotherapy for common cancers, to most hospitals and with the development of targeted therapies for more subset diseases and syndromes, more and more diagnostic and monitoring facilities have been "required" in smaller and smaller institutions, closer to the real time physiological management of the patient.

The impact of more complex therapeutic interventions on laboratory cost and utilization can be substantial (Schroeder (1985), and Morrison et al (1985)). For example Table 4.2 shows the average laboratory costs per patient day (expressed in constant 1973 dollars) for all acute care admissions and for adult patients with acute leukemia at VGH. It can be seen that during the period 1973-1979 the average laboratory cost per day increased by 67% but costs for leukemia patients increased by 193%. The more rapid rise in leukemia costs is associated with both utilization and complexity (or price) effects. More aggressive therapeutic regimens (particularly new chemotherapeutic agents) have a very powerful impact on the patients overall physiology and consequently there is greater need to monitor the patients organ system, and immune system functions (one might term this iatrogenic testing - testing induced because of the intervention selected).

Table 4.2 REAL LABORATORY COST PER PATIENT ADMISSION (IN CONSTANT 1973 DOLLARS FOR ALL ACUTE CARE ADMISSIONS (ACA) AND ACUTE ADULT LEUKEMIA PATIENTS (LEUK) AT VANCOUVER GENERAL HOSPITAL 1973 and 1979

Type of Test	1973 Cost/ACA	1973 Cost/LEUK	1979 Cost/ACA	1979 Cost/LEUK	% Growth in Cost/ACA 1973-1979	% Growth in Cost/LEUK 1973-1979
Chemistry	1.30	0.87	2.29	2.51	76	189
Hematology	0.66	2.39	0.90	5.93	36	148
Microbiology	0.66	1.62	1.30	5.88	97	263
Blood Bank	0.76	3.10	1.42	6.89	87	122
Other	1.31	1.31	1.92	1.92	47	47
Total	4.69	7.89	7.83	23.13	67	193

Source: Unpublished data, Department of Pathology
Vancouver General Hospital

1) Constant dollars were calculated using general CPI series.

2) Other includes anatomical pathology and nuclear medicine only. Detailed data are not available for leukemic patients consequently average acute care admissions data are used.

The increasing importance of laboratory information in diagnosis and treatment is also reflected in the research focus found in Fletcher _et al's_ (1981) review of journal articles from 1946-76. The frequency with which clinical phenomena of signs and symptoms were described in articles dropped from 90% to 68% (clinical signs) and from 88% to 63% (symptoms) over the period. Frequency of description of laboratory tests increased, on the other hand, from 70% to 90% of articles sampled. The process of substituting laboratory data for clinical data is described most thoroughly and somewhat ruefully by Reiser (1978: Chapters 8 and 9).

Medicine in general and laboratory medicine in particular have shifted their functional focus. These shifts can be summarized in tabular form (Table 4.3). Three broad phases in modern medicine are identified: infectious diseases, diagnosis and surgery, therapy and monitoring. For each of these phases it is possible to describe the primary purpose of the tests being used, the type of test methodology involved and the important attributes that the testing methodology must have.

Table 4.3 SUMMARY OF DEVELOPMENTS IN FUNCTIONAL FOCUS OF MEDICINE AND THE LABORATORY 1940-1980.

Laboratory Focus	Medical Focus		
	Infectious Diseases	Diagnosis and Surgery	Therapy and Monitoring
Primary purpose of tests	Screening	Diagnosis	Monitoring
Type of tests	Microbiological	Chemical, hematological, histological	All types
Important Attributes of tests	Sensitivity, Focus on epidemiology	Accuracy, precision, specificity	Turnaround time, reproduceability, consistency of results

In the thirties and forties, and in B.C. even on into the 1950s, the focus was on infectious diseases, and the Provincial Health Laboratory was perhaps the most important element in laboratory medicine of the time. With diagnosis becoming the principal focus, it was necessary to develop more sophisticated tests with better discriminatory power. Finally, in an age of complex therapeutic interventions it becomes critical to measure a wide range of patho-physiological parameters on an ongoing, real time basis in the acute care setting, and also to have reliable screening and diagnostic tests to identify those ambulatory patients who do not need acute care intervention.

4.4.3 Policy and Operational Implications of the Changing Medical Environment

The changes in the functional focus in medicine have a number of important implications for policy and operations of the clinical laboratory.

4.4.3 a) Growth, Specialization and Centralization Until the 1980s

Two of the most salient developments in the postwar period that are related to a changing functional focus in medicine have been first, the absolute and relative growth in the number of medical and allied health professionals and secondly, the increasing specialization of that manpower. It could be argued that specialization and growth in numbers follow the requirements of halfway technologies in that such interventions are complex and labour-intensive. The cynical interpretation might be that with infectious disease essentially cured, there was a surplus capacity of health care workers seeking out new functions - an argument that has intuitive appeal and some enthusiastic support certainly in the analysis of developments in dentistry. Whatever the underlying mechanism it is clear that medicine and the allied professions have both grown and specialized in the last thirty years.

Mechanic (1977) argues that:

> "The most salient aspect of medical organization in modern countries is the enormous growth of specialization and subspecialization that has occurred. While much of this development is due to the growth of biomedical science and technology, specialization is also a political process bringing economic advantages and greater control over one's work and responsibilities. Specialization moreover allows physicians to dominate a specified domain and to restrict competition."
>
> Mechanic (1977:69)

The development of specialization in medicine has unfolded over the last century, according to Reiser (1978: Chapter 7), driven by the difficulties that expanding knowledge presents to any one individual and by the status, prestige and income derived by the specialist. One of the effects of this process, argues Reiser and others, is the need for geographic centralization around the hospital. This is because most of the emerging specialites were defined around specific diseases, specific ages of patients and specific technologically based activities rather than around the underlying medical sciences of pathology, physiology and anatomy. Thus diagnosis and treatment of many diseases and patients involves a complex mosaic of referrals.

These changes in degree of specialization both functionally and geographically were recognized long ago by Fyodor Dostoyevsky:

> ".... The whole of my right side is numb and I'm moaning and groaning. I've consulted all sorts of doctors: they can diagnose excellently, they will tell you all your symptoms, they have your illness at their fingertips, but they've no idea how to cure you. I happened to come across a very enthusiastic little medical student. "You may die," he told me, "but at least you'll have a very good idea of what illness you're dying of!" And, then again, the way they have of sending you to

> specialists. "We can only diagnose your disease," they tell you. "You'd better go to such and such a specialist and he'll be sure to cure you." I tell you the old-fashioned doctor who used to cure you of all illnesses has quite disappeared. Now there are only specialists .... If there's something wrong with your nose, they will send you to Paris: there's a European specialist there who cures noses. You go to Paris, he examines your nose. "I'm sorry," he tells you "I can only cure your right nostril, for I don't cure left nostrils, it's not my specialty. You'd better go to Vienna. There you'll find a special specialist who will cure your left nostril." What are you to do?"
>
> Dostoyevsky: The Brothers Karamazov

Centralized, hospital-based facilities have become the essential components of modern, high quality medicine. However, the question of economies of scale and the need for a referral threshold to sustain subspecialty physicians has tended to set up (at least in the minds of analysts) the classic Christalleran central place system, in which, inevitably, the population has a differential spatial access to the services of certain specialists. These spatial imbalances were perhaps at their height in the early seventies in the U.S. where specialism was in full reign and rural practice deemed relatively unattractive. Recent evidence (Williams et al. (1983)) suggests that this process may be ameliorating in the U.S., partly, it could be argued, as a result of the apparent deconcentration of population identified in the last census (Chapter 3) and partly because of the oversupply of physicians.

Up until the mid 1970s there appears then, to be an important link between specialization, concentration and integration of functions and centralization of facilities into a hierarchial, central place network. This seems to apply to both medical services and laboratories. This pattern of increasing scale of operation, increasing division of labour and specialization of function that occured up until the late seventies is consistent with contingency approaches in organization theory (see Mintzberg (1983)and Chapter 2).

4.4.3 b) Forces of Dispersion

Conventional organizational theory suggests that growth in scale, specialization and the development of a bureaucratic hierarchy are inter-related phenomena. The historical record in laboratories seems to reflect these trends up until the late seventies. Recent futurist and popularist management texts have begun to challenge whether these trends will continue.

Toffler's work in particular has been applied specifically to the clinical laboratory in a paper by Benjamin (1981), which describes the transition from the "second wave" to the "third wave" laboratory. Benjamin suggests that the "second wave" laboratory of today epitomizes the "industrial age form" of the large, centralized data factory. He describes how modern laboratories reflect the six second wave criteria defined by Toffler:

1) Specialization - laboratories have become divided into highly specialized sub-sections with very narrowly trained operators.
2) Standardization - laboratory output has not only become standardized (a useful development Benjamin feels) but also all the processes have become rigid and impersonal.
3) Synchronization - the laboratory has come to synchronize its component tasks eg. blood drawing, test batching.
4) Concentration - laboratory work has become concentrated into relatively few places.

5) <u>Maximization</u> - is reflected in the bigger is better, more tests produced at assumed lower per unit cost.

6) <u>Centralization</u> - in the laboratory has meant:

> "centralizing all equipment and personnel in one area, funnelling all specimens and requests through a central processing area and distributing the data through a similar centralized mechanism."
> Benjamin (1981:325)

Benjamin suggests that a "third wave" laboratory is likely to be decentralized, diverse and customized, predicting increased satellite laboratories, nearer the patient testing, and home testing. In summary he states:

> "I view the laboratory of the next decade requiring not more space but different space. As decentralization progresses we will offer a greater diversity of tests and services. We will customize our approach to respond to the needs of each individual patient. Technologists will evolve from mere technicians to interpreters and educators. Long established work habits and relationships will change. Much of this will be achieved through a widely distributed information network mediated by the computer. These changes will, in turn produce significant changes in the economy of operating the laboratory, which is, perhaps, the reason why so may laboratory directors and hospital administrators view this type of evolution with nervousness."

This view is consistent with the "atomized structure" described by Deal and Kennedy, and with the decentralized, image of enterprise seen in <u>Megatrends</u> (Naisbitt, 1982), <u>In Search of Excellence</u> (Peters and Waterman, 1982) and Huber (1984).

This section has suggested that shifts have occurred in medical practice and laboratory support towards real-time, physiological monitoring. Some argue that these trends will lead to dispersed, decentralized laboratory operations (e.g. Benjamin (1981)). Although these authors have articulated one possible future state for enterprise in general and the laboratory in particular, it is by no means clear that decentralization follows centralization as night follows day. It depends critically on the goals of the system, the functions and manpower involved, the available technology and its relative desirability and feasibility of implementation. Perhaps it is shaped most importantly by the goals of strategic decision-makers and the relative power that they have to enact those goals.

4.4.3 c) Changing Functions and Emerging Structures

This final sub-section on the medical environment will focus on the emerging functional and manpower factors and attempt to link them to changes in organizational and spatial structure of laboratories. Conventional organization, geographic and economic theory and medical practice are all consistent with the observed development of a centralized, specialized and hierarchial laboratory system until the late 1970s and early 1980s. The structures that are emerging may require a different form of explanation. This can be done at a number of levels. First, it is possible to describe how the changing functional focus of the laboratory is related to the changing task elements in the laboratory and the types of tests involved. At the second level, changes in the structure of the organization as a whole can be described. Third, the potential geographic changes related to the emerging functional focus will be discussed.

The predominant tasks of the laboratory are changing from the production of test data towards the management of test information (Tydeman (1984), Morrison (1984), Hardwick *et al*. (1985)). Whereas the efforts of the laboratory up until the mid 1970s were focused on producing a series of high quality individual answers, the focus in an age of therapeutic intervention is on the integration of these data so that physicians can more readily track patient progress. For example, changes in the management of diabetic patients, epileptic patients and those on total parenteral nutrition (TPN) requires more frequent read-out of physiological parameters and collation of those data into legible, accurate and consistent sets of information. Such "fine tuning" of patient state, through the adjustment of drug levels, TPN intake, etc., presents the need for more timely data to allow appropriate action to be taken. An organizational response is to disperse the testing technology nearer the patient (as will be discussed in the following section) but equally it is conceivable that the central laboratory will continue to dominate by concentrating, not so much on performing tests, but on the collation, communication and quality control of test results in the variety of settings.

The second related aspect is the impact of these practice changes on the organizational structure of laboratories. If the functional focus of the laboratory is increasingly on information management rather than test production, this changes the form of the "operating core" of the laboratory organization and the manpower needed to staff it. The "technostructure" of the laboratory is likely to become more highly developed as the tasks of process workers become distributed. Similarly, a focus on collation of data for specific patients may lead to a more "market-oriented" structure, rather than a "functional-oriented" structure. Up until recently large clinical laboratories have adopted a divisionalized form where each sub-discipline (e.g., chemistry, hematology, microbiology) performed a specialized set of functions. If the principal focus of the laboratory changes towards the monitoring of patient therapy, then it is conceivable that the boundaries between the existing sub-disciplines will begin to blur and that organizational sub units begin either to coalesce around a new set of functions e.g., specimen collection, quality control, information collation, information reporting etc. or restructure along "market" lines eg. diabetic patients, cardio-thoracic patients, etc. The former has begun to occur in large laboratories where high-volume areas of chemistry and hematology have been integrated and structured on the basis of sub units such as specimen collection, sample preparation, test production and reporting. The latter trend is seen more where the medical and surgical subspecialties have developed separate laboratory facilities, or have successfully negotiated for the establishment of dedicated satellite laboratories for a particular sub-set of patients, e.g., Intensive Care Unit and Emergency rooms. The factors underlying this restructuring are partly associated with the changing pattern of demands for laboratory information (outlined earlier) that reflect changing goals of the medical enterprise, and partly the changing equipment embodied technologies on the supply side of the equation (discussed in the following section). Both supply and demand factors seem to be reinforcing the dispersion of activity suggested by Benjamin, but considerable question remains as to how all the economic, medico-political and quality of service concerns will be resolved.

Finally, this section will examine the potential implications of the shifts in medical and laboratory practice for the spatial configuration of the laboratory system. It has been argued that the increased emphasis on therapeutic interventions and real time physiological monitoring of patients might encourage the geographic dispersion of laboratory services within and between institutions, i.e., from central laboratory to bedside, and from hospital laboratory or referral laboratory to doctor's offices and to the home. At the other extreme, it has been argued that many of the therapeutic advances that have occured in recent years have been for relatively rare diseases. As Thomas suggests:

> "There have been a few other examples of technology improvement, comparable in decisive effectiveness, since 1950, but the best of these have been for relatively uncommon illnesses. Childhood leukemia and certain solid tumors in children, for example, can now be cured by chemotherapy in a substantial proportion of cases, but there are only a few thousand of these per year in the country ..."
>
> Thomas (1977:39)

Thus, there remains a strong argument for centralization of certain types of therapeutic interventions and the laboratory services that support them, in those cases where the incidence of disease is very low. This seems to suggest that screening, diagnosis and monitoring tests for commonly occurring illnesses will clearly be more likely to disperse than the more complex technologies. If medicine continues to make advances at the esoteric end of the scale, i.e., developing therapeutic interventions for rare disease, it is likely that this will encourage a change in the shape of the medical laboratory hierarchy. It is plausible to expect a network of facilities in which a very few have esoteric facilities and virtually all others institutions (hospitals and clinics) have identical "baseline" facilities. In particular, the "menu" of tests available would be similar in a wide variety of institutions and locations.

Chapter 6 of the case study with its more empirical focus will assess changes in the functional and spatial hierarchy of laboratories in B.C. to determine if the hierarchy is demonstrating signs of development in this direction.

4.4.4 Section Summary

This section has attempted to describe the changing functional focus of medicine and the laboratory in general terms and has tried to link these changes to the organization and spatial structure of the laboratory system. The shift in medicine from infection diseases prior to 1950, through diagnosis of disease and sub-set syndromes, to active intervention in the disease process through specifically targeted therapies, has had considerable impact on the functional focus of the laboratory.

The changes in focus towards more complex and intensive activities have resulted in, or been associated with, growth in the size of the system and the degree of specialization. Specialization in turn is thought to encourage geographic concentration of activities in the hospital setting. It has also been argued that processes of concentration will continue to play a role in shaping the structure of the system. However the more recent changes in the functional focus of medicine and the laboratory may have some substantial implications for the organizational and spatial structure of the system. In particular, the increased demand for real-time physiological monitoring may be best served by a decentralized laboratory system. The degree to which this occurs will depend on the goals of the system, the relative power of competing groups of interests, the technology employed and the economics of alternative configurations. Technology can play an important enabling role in the final system design. For, as the functional configuration of the laboratory has shifted, so has its technology. It is to changes in the technological environment that we now turn.

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4.5 TECHNOLOGICAL ENVIRONMENT

The preceding section discussed how the clinical laboratory has changed, over the last 100 years, in form, function and capability in response to changes in medicine. However, the system was and still is a system to answer questions from physicians. The volume and type of questions answered has changed considerably over the last century, but in particular the dramatic developments in scale and function have occurred in the last thirty years. Many of these changes have been associated with rapid developments in the technological environment of the clinical laboratory.

This final component of the environment will focus on the changing technology of the clinical laboratory and will develop some possible relationships between the candidate technologies and the structure of laboratories. In particular, a model of the development of technology in the clinical laboratory will be defined (4.5.1). Second, this model will be applied to the post-war record of technological innovation in North American clinical laboratories in both laboratory automation and information technology (4.5.2). Third the relative rates of diffusion of these technologies (4.5.3) will be assessed. Finally, some potential relationships between changes in the technologies and changes in the organization, spatial structure and performance of laboratories will be discussed (4.5.4).

This section argues that automation and computerization can modify the tasks of the laboratory, the decision-making levels inherent within these tasks and the potential organizational and spatial structures that emerge. Up until the mid 1970s, a variety of technologies enabled centralization and specialization in the laboratory hierarchy. Since that time a more diverse range of technologies present a wider set of organizational and locational alternatives. It must be re-emphasized that this discussion concentrates on the potential capabilities of the candidate technologies and not on the actual effects they have had in the B.C. case. The actual experience of the B.C. system is discussed in Chapter 6.

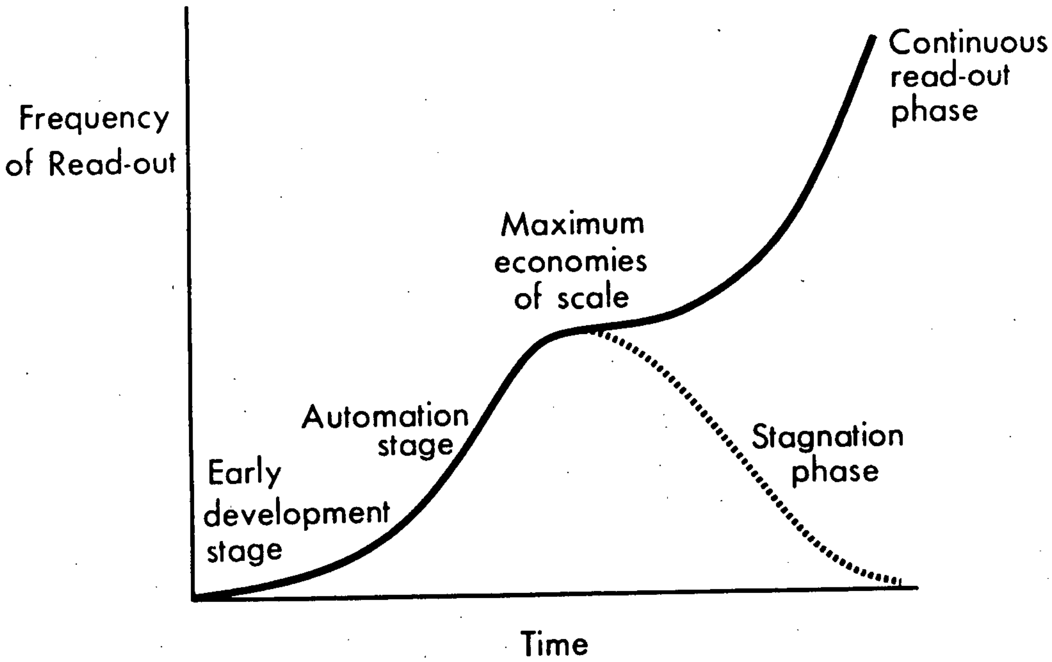
4.5.1 A Model of Technological Development

A model of technological development in clinical laboratories has been derived from analysis of the historical record, e.g., Reiser (1978), Mitchell *et al* (1981), and Elin (1980); from personal observations and research on the development of laboratory technology, e.g., Morrison *et al* (1985), Tydeman *et al* (1982); and from a basic understanding of diffusion models, e.g., Baruch (1978), Gordon and Fisher (1975). The model describes stages in the development of equipment-embodied technologies designed to produce specific types of answers, e.g., measures of oxygen, or of liver function. The development path is bounded by a double sigmoidal curve in which the X axis is time and the Y axis is frequency of read-out (Figure 4.9), Hardwick *et al*. (1985), Morrison *et al*. (1985). Like many development or diffusion models it is hypothesized that there are a number of identifiable stages through which each technology moves. The model is partial in the sense that it is a model representing only the development and diffusion stages of a specific technology, the invention and innovation stages extend beyond the origin of the diagram and include the synergistic combination of theoretical knowledge and applied science. Discussion of the role of these aspects is well documented in the literature of biomedical innovation, e.g., Roberts et al (1981), Gordon and Fisher (1975) and technology assessment, e.g., Banta and Kemp (1982). The focus here is on the application and diffusion of laboratory technology because the clinical laboratory has been primarily a "receptor" rather than an "originator" of new equipment embodied technologies.

The figure suggests that there are four principal stages in the development of laboratory technology:

1) Early development stage - where a new equipment-embodied technology is capable of relatively small increments in output over traditional methods, i.e., the marginal cost per unit is relatively high and constant and the technology, normally, is characterized by relatively limited mechanization of certain elements in the operations of the laboratory.
2) Automation stage - the refinement of early technologies and the mass production of equipment leads to an exponential growth in the output capacity of laboratory instruments.
3) Integration and Concentration stage - at the third stage technologies are configured to provide maximum economies of scale by integrating a number of functions and concentrating them in one area under the control of a very small number of operators. This is perceived to be the high "productivity" phase.
4) Pluralization and Disperson stage - at the fourth stage technologies can evolve along any one of a family of curves. At one extreme the same

Fig. 4.9 TECHNOLOGICAL DEVELOPMENT IN THE LABORATORY



type of answer can be produced using an alternative technological approach. The tests that were previously produced by a large centralized system, become available as continuous read-out, i.e., in effect on-line testing. At the other extreme, the technology may be superceded by alternatives and gradually wither away. In between there are a whole series of development trajectories which are affected by the receptivity of users, i.e., physicians, to new technology, resistance to change on the part of laboratory providers, degree of duplication acceptable in the system and the functional and economic constraints under which the system operates.

This development curve can be used, not only as a description of the stages that laboratories have moved through over the last few decades, but it can also be thought of as a model of the inherent dynamics of the laboratory system at a point in time. The phases of development, automation, integration and pluralization happen to different testing technologies at different times. In the technological environment at the current time there are representative examples on each stage of the curve. For example, DNA probes are at a very early phase of development, many microbiology susceptibility tests have entered a very rapid automation phase, hematology blood counting procedures have probably reached their maximum economies of scale and finally the patho-physiological parameters (answers) that have been measured traditionally by biochemical techniques have entered a phase of pluralism and dispersion. In particular, oxygen monitoring has become feasible as a continuous read-out procedure using skin electrodes. At the other extreme, the Basal Metabolic Rate test has long since disappeared. In between, there is a proliferation of equipment capable of performing a wide selection and combination of test procedures at different scales of operation and at different costs. Sub-sets of this technology are being termed "nearer the patient" testing. These include those relatively inexpensive and "easy to use", microprocessor based technologies that allow testing to be conducted in physicians offices (deskside technology), or in dispersed locations within hospitals and clinics (bedside technology). These technologies represent the laboratory analogy of the personal computer (Belsey (1984), Hardwick (1984), Morrison (1984)) and can be extended to include even "self-testing" or "home testing" technologies e.g., dipstick testing by the controlled diabetic, Free and Free (1984).

The model then is not just a static description of historical developments in laboratory technology - although it is insightful to apply it to the development of "cutting edge" candidate technologies over the last 30 years - but it can also be usefully employed as a tool for analyzing the technological diffusion dynamics of the clinical laboratory at any one point in time.

This model is first applied to the historical record.

4.5.2 Development of Laboratory Technology 1954-1984

This section summarizes the developments in both laboratory automation and computerization over the last thirty years. A more detailed review is provided in Appendix B.

Table 4.4 lists the emergence of candidate technologies in the clinical laboratory environment (in particular automation and computerization).

The equipment embodied technologies of the 1950s were very much at the early development stage of the model. The introduction of the Technicon autoanalyzer for chemistry analysis and the Coulter counter represented the first steps towards true automation. In the sixties, new systems were introduced with greater through put capacity, broader repertoire and increased analytical precision. By the mid 1970s, the gargantuan automated chemistry analyzers (e.g., SMAC) had reached their maximum economies of scale. Since that time technology providers have marketed discrete analyzers that produce tests in combination on both a batch and stat (i.e., statim - when necessary) basis. Similarily, by the late seventies hematology analyzers had reached their maximum output. In the last 5 years, an increasing number of smaller and more flexible systems have emerged. Film based technologies in particular present an interesting set of alternatives.

Table 4.4 A SUMMARY OF TECHNOLOGICAL DEVELOPMENTS IN THE CLINICAL LABORATORY 1950-1985

Year	Laboratory Automation	Laboratory Computerization
1956	Introduction of Technicon Auto-Analyzer	-
1958	Introduction of Coulter Counter	-
1964	Introduction of SMA series 12/30, 12/60 and 6/60	Experimental Laboratory Computer Systems
1969	Introduction of Centrifugal Analyzer and Dupont ACA	"
1970s	Proliferation of "Smart" Automated Analyzers	Proliferation of Laboratory Computer Systems
1978 on	Development of Second Generation Centrifugals	Development of Micro-Computer Based Systems
1980 on	Development of Thin Layer Dry Reagent Film Chemistry Analyzers	Application of Networking & Communications Technology in Clinical Laboratories

Source: See Appendix B.

Similarly, the model of development of clinical laboratory technology described above can also be applied to clinical laboratory computer technology. At the first stage a few functions are mechanized, e.g., results reporting. At the second stage there is a very rapid automation phase where output increases and the number of functions included is expanded, e.g., the laboratory computer systems of the early seventies. At the third phase the functions are integrated and concentrated to reach maximum economies of scale. This phase is seen in the powerful dedicated laboratory mini-computers of the mid to late seventies, which had analytical instruments on-line and incorporated sophisticated reporting and workflow management systems in their software. Finally, the fourth phase is one of pluralization and dispersion. Microcomputer systems and networking technology can facilitate links to other, formerly incompatible, systems and data bases and can enable customized and diverse research, monitoring and analytical functions to be carried out within the laboratory's and hospital's information network.

4.5.3 Technological Diffusion at Each Time Horizon

This section examines how these waves of technological development in laboratory automation and computer technology have been diffused throughout the North American laboratory system. Baruch (1979) summarized the factors underlying diffusion of medical technology in the U.S., as follows:

> "The diffusion of medical technology is a complex process dependent upon the character of the industry, cost of investment and adoption, sophistication of users and their environments, general-use standards, user prestige, patient distribution, government regulations and scale of operation. The one positive influence with the greatest impact on the rate of adoption of a new technology is the third party payment system."
> Baruch (1979 p 11)

How widely diffused were these technologies throughout North America in the four time horizons under study? How many laboratories, large or small, brought these technologies into their portfolio of technologies in each time horizon? The literature is very sketchy on the precise rates of penetration to sub-types of hospitals and institutions because few national surveys or data bases have been compiled (either in the U.S. or Canada) and those that have been conducted are thought to be of questionable validity (Banta and Kemp (1982)). However, from generalized descriptions (e.g., Reiser (1978)) and interpretations of private companies market surveys (e.g., Finkelstein (1980)) it is possible to estimate the relative penetration of selected technologies in North America across the time horizons (Table 4.5). This type of analysis will be a major focus in chapter 6 in an attempt to calibrate the diffusion dynamics of the system in B.C. and to assess the portfolio of technologies held by various types of institution at each time horizon.

Table 4.5 ESTIMATED RELATIVE DIFFUSION OF SELECTED LABORATORY TECHNOLOGIES THROUGHOUT NORTH AMERICA BY TYPE OF INSTITUTION

	1954	1964	1974	1984	1994
Automated Chemistry Analyzers 1					
Clinic	zero	zero	low	low	high?
100 Bed	zero	low	medium	high	high
100-200 Bed	zero	medium	high	high	high
200-300 Bed	zero	high	high	high	high
300+ Bed	zero	high	high	high	high
Teaching	zero	high	high	high	high
Automated Hematology 2 Systems					
Clinic	zero	zero	low	low	medium?
100 Bed	zero	low	medium	high	high
100-200 Bed	zero	medium	high	high	high
200-300 Bed	zero	high	high	high	high
300+ Bed	zero	high	high	high	high
Teaching	zero	high	high	high	high
Lab Computers					
Clinic	zero	zero	zero	low	medium?
100 Bed	zero	zero	low	low	high?
100-200 Bed	zero	low	medium	high	high
200-300 Bed	zero	low	medium	high	high
300+ Bed	zero	low	medium	high	high
Teaching	zero	low	high	high	high

1) Major "state of the art" automated instruments e.g., SMA series Dupont ACA and centrifugal analyzers.
2) Coulter Counters or equivalents.

4.5.4 Policy and Operational Implications of the Changing Technological Environment

From this review of the developments in laboratory technology and data processing over the last 30 years and the processes underlying the diffusion of these technologies, a number of policy and operational implications can be derived:

4.5.4 a) Policy Implications

First, there has been an exponential increase in both the productive capacity and the diffusion of automated equipment throughout the 1960s and 1970s. By the mid-late 1970s both routine chemistry and routine hematology appeared to have reached the height of integration and concentration in terms of the output of the instruments, the penetration in the market place and in the concentration in the industry. These technologies have facilitated greater geographic centralization of laboratory test production. The emerging technologies in the 1980s, however, can enable a wider variety of geographic and organizational patterns.

Second, there has been a demonstrable convergence between automation, computerization and communications technologies. This parallels the developments in other industries where robotics, CAD/CAM, electronic mail, teleconferencing, videotext and word processing are technologies that blur the lines between automation, communications and computing. The convergence of these technologies contributes to the range of options open to the laboratory. For example, there exists a choice between "smart instruments" or "dumb" instruments coupled to dedicated computers.

The third salient conclusion that can be drawn relates to the issue of cost. The capital cost of automation, computer and communication technologies all declined over the period albeit at different rates. Table 4.6 demonstrates selected indices of the decline in capital cost per unit of service for these technologies. Although the cost issue became an increasingly important one in the seventies, the operating costs per unit of service do not appear to have decreased substantially for automated instruments in the seventies. Indeed there is evidence that "seventies automation" may have increased the real per unit cost - the benefits of flexibility gained were offset by increasing reagent and supply costs. (Morrison et al 1984(a) and (b) Morrison et al (1985)). Similarly with computerization, although the costs per unit of service has declined, a "state-of-the-art" laboratory computer for a 200 bed hospital for example, is still as expensive, probably more so, than in the early seventies. (A situation that is analogous to the personal computer industry, where the customer gets more for their money, but tends to spend more of it on "state-of-the-art" equipment.)

Table 4.6 COSTS OF COMPUTERIZATION AND AUTOMATION FOR THE CLINICAL LABORATORY

COMPUTERS

Year	System	Capital Cost (Hardware/ Software	Core Memory K	Current Dollar Capital Cost per K	Const Dollar Capital Cost per K (in 1980)
1967	CLAS 300 (B-D Spear)	$ 70,000	4	$17,500	$39,400
1971	BSL Clin-Data[2]	$125,000	8	15,600	33,100
1973	CLAS 800 (B-D Spear)[1]	$146,651	16	9,200	17,100
1973	Automated Health Sys.[3]	$ n/a	28	-	-
1975	LCI[4]	$310,000	64	4,800	7,450
1977	CDC (Medlab)[5]	$438,000	97	4,500	5,050
1980	Meditech (UBC)	$400,000	1000	400	190

AUTOMATION IN CLINICAL CHEMISTRY[6,7]

		Capital Cost in Current Dollars	Approx. Output Capacity (tests per hr)	Current Dollar Capital Cost per Output Unit	Constant Dollar Capital Cost per Test[8]
1965	SMA 6/60	$75,000	360	0.042	0.052
1969	Dupont ACA	75,000	75	0.200	0.185
1969	Centrifugal Analyzer	65,000	300	0.043	0.046
1976	SMAC	200,000	3,000	0.013	0.009
1979	American Monitor KDA	120,000	250	0.096	0.050
1984	Kodak Ektachem 700	170,000	500	0.068	0.023

Sources:

1 McLendon (1974)
2 Ball (1970)
3 Nussbaum (1977)
4 Wycoff/Wagner (1976)
5 Scalafani (1981)
6 Berkeley Scientific Laboratories (1976)
7 Hardwick et al (1982)
8 Based on 5 year straight-line amortization and 1000 hours of capacity operation per annum

4.5.4 b) Operational Implications of Change in the Technological Environment of the Laboratory

The operational implications of the changing technological environment can be described at three levels. First, following the approach used by Tydeman et al (AAMC, 1982), the capabilities of candidate technologies can be compared to the tasks of the organization in order to assess the potential impact of technology on those tasks. Second, it is possible to examine the magnitude and direction of change in the level of decision making associated with each of those tasks or functions, that might be associated with technological change. Third, at the level of the enterprise, the relationship between technology and organizational structure can be examined. The well established descriptive measures of organizational structure, e.g., degree of specialization, formalization, and centralization of decision-making, provide analytical framework for linking changes in the technological environment with possible changes in organization.

4.5.4 b) i) Automation, Computerization and Laboratory Tasks

At the level of the task or function automation and/or computerization has enabled changes in the component tasks of the testing process (see Tables 4.7 and 4.8).

Table 4.7 A MODEL OF LABORATORY FUNCTIONS - INPUT, PROCESS, OUTPUT AND CONTROL

Input

- Test Selection
- Test Order
- Test Requisition
- Transport/Mail (Information)
- Specimen Collection
- Transport/Mail (Information & Specimen)

Process

- Accessioning
- Specimen Preparation
- Sample Distribution
- Test Analysis
- Data Verification

Control

- Test Selection
- Specimen Collection
- Work Flow
- Quality Control
- Utlization Review
- Education

Output

- Report Preparation
- Analysis and Interpretation (Lab)
- Transport/Mail (Information)
- Interpretation and Behaviour Modification (Physician)

Table 4.8 LABORATORY FUNCTIONS - POTENTIAL IMPACT OF TECHNOLOGY ON TASKS

	Function	1950s Tech	1950s Type	1960s Tech	1960s Type	1970s Tech	1970s Type	1980s Tech	1980s Type
Input	Test selection	-		*	I	**	I	*	I
	Test order	-		-		*	I	**	I
	Test requistion	-		-		*	I	**	I
	Transport/Mail(I)	-		-		*	I	**	I
	Spec. collection	-		*	I	**	I	**	I
	Transport/Mail (IP)	-		-		*	I	*	I
Process	Accessioning	-		-		**	I	**	I
	Spec. preparation	-		-		-		*	A
	Sample distribution	-		-		*	I	*	I
	Test analysis	-		**	A	**	A	**	A
	Data verification	-		-		**	IA	**	IA
Output	Report prep.	-		-		**	IA	**	IA
	Anal. p. interp.	-		-		*	IA	*	IA
	Transport/Mail (I)	-		-		**	I	**	I
	Int. & behav. mod.	-		-		-		-	-
Control	Test selection	-		*	I	**	I	*	I
	Spec. collection	-		*	I	**	I	**	I
	Work flow	-		*	I	**	IA	**	IA
	Quality control	-		*	IA	**	IA	**	IA
	Utiliz. review	-		-		*	I	*	I
	Education	-		-		*	I	*	I

\- Technologies have not been widely adopted
* Technologies have been adopted to a small degree
** Technologies have been widely adopted and have had a major effect on tasks

I = Information technologies
A = Automated equipment

In summary, automation has principally affected the tasks associated with processing of tests i.e., the analysis itself. Although automation has been thought to have had brought about a substantial improvement in the quality of output and induced even greater demand for tests (input) the tasks associated with these components of testing to date have remained relatively unaffected (with the exception perhaps of test selection where panel-ordering, i.e. ordering all tests on an instrument, has become normal in certain hospitals, whether advocated by laboratories or not).

Computerization has facilitated the management of the input, output and process phases by providing informational support for test requisitioning (input), specimen collection (input), accessioning (process), test analysis (process), data verification and quality control (process) and report preparation and distribution (output).

In the fifties, laboratories were experiencing rapidly increasing workloads with little or no mechanization. In the sixties and early seventies, automation relieved much of the burden for routine tests and the task focus shifted to quality control and data handling. Certain case studies show that the ratio of clerical to technical workers rose steadily in laboratories without computers during this period (e.g., Hendricks et al (1982)). Following computerization many of the data handling problems are resolved and so the clerical/technical ratio declined.

The purpose of automation and computerization has been not only to improve "efficiency" (i.e. reduce labour time per test) but also to improve the quality of laboratory service as measured by quality of result, menu range and turnaround time. Automation improved the efficiency and quality of the process, computerization contributed to the efficiency and effectiveness of elements in the input, process, output, and control functions of the laboratory.

However, there are still a number of steps in the testing process that have not as yet been greatly enhanced by automation or computerization. These are concerned with the collection, transportation and physical handling of specimens and samples (in both the input and process phases). It would seem that as far as can be determined from the literature, the "efficiency" and "quality" of the laboratory in performing routine tests has reached its maximum in terms of the specific tasks that automated technology has modified. Further developments will require that these materials handling and transportation functions be given consideration. This may involve spatial, functional and organizational restructuring of the clinical laboratories and these potential changes will be discussed in the third section.

4.5.5 b) ii) Automation, Computerization and the Impact on Decision-Making Levels

In an effort to develop a better approach to employee remuneration Paterson (1981) developed a system of classification of tasks called the Decision Band Method (see section 2.4.2). In essence, the system classifies jobs or tasks in terms of the level of decision making necessary. From a review of the literature on the impact of automation and computerization on the clinical laboratory, it is possible to estimate the general shifts in decision level for each component task. (Shown in Table 4.9). This analysis seems to demonstrate that with automation many activities in the laboratory

TABLE 4.9 LABORATORY FUNCTIONS - ESTIMATED DECISION BAND OF LABORATORY TASKS

	Function	1950s Decision Band	1960s Decision Band	1970s Decision Band	1980s Decision Band
Input	Test selection	D	D	D/C	D/C
	Test order	B	B	B/A	B/A
	Test requisition	A	A	A	A
	Transport/Mail (I)	A	A	A	A
	Spec. collection	C	B	A	A
	Transport/Mail (IP)	B	B	A	A
Process	Accessioning	B	B	A	A
	Spec. preparation	B	B	A	A
	Sample distribution	B	B	A	A
	Test analysis	C	C	C	B
	Data verification	D/C	D/C	C	C/B
Output	Report prep.	D	C	B	A
	Anal. p. interp.	D	D	C	C
	Transport/Mail (I)	A	A	A	A
	Int. & behav. mod.	D	D	D	D
Control	Test selecton	D	D	D/C	D/C
	Spec. collection	B	B	A	A
	Work flow	B	B	A	A
	Quality control	D	D/C	C	C/B
	Utiliz. review	D	D	D/C	C
	Education	D	D	D	D

Note: Decision Bands
F - Policy making decisions
E - Programming decisions
D - Interpretive decisions
C - Process decisions (selection of process)
B - Operation decisions
A - Element decisions

have been reduced to simpler operations. (As pointed out earlier, laboratory automation can release staff to undertake more specialized procedures that are manual and complex requiring interpretive decisions on the part of technologists. However, the analysis in Table 4.9 is directed principally at the cutting edge of automation, i.e., high volume tests).

The activities that have remained at higher decision bands are the activities of the physician, i.e., test selection, interpretation and behaviour modification, and the interpretive, education and quality control functions that are carried out by pathologists and technologists. Automation and computerization have to some degree made possible a reduction in the level of decision making associated with test analysis itself but much of the reduction came with the increasing size of operation, division of labour and routinization of activities in the laboratory, rather than through the introduction of capital equipment (e.g., see McLendon (1974) and Nussbaum (1977)).

The implications of these changes are seen at a number of levels. First, there is a potential impact of increased automation and reduced decision level requirements on the skill mix of staff. For example, as suggested earlier, some studies report changes in the mix of clerical and technical staff before and after computerization. Second, simplifying the decision-making requirements can increase the diffusion of the technology. If expertise is a limiting factor on the diffusion of technology, as Baruch (1979) suggests, the reduction of laboratory functions to the level of routinized operations could provide a stimulus for the wider diffusion of these technologies. For example, the Kodak DT 60 system is claimed to be, (for the reasons outlined in Appendix B) an "idiot proof" technology that requires little or no interpretive decision making on the part of the user, Whitlow (1985). The third sets of implications are for the pay scales of technologists and laboratory workers. Recent analysis using Paterson's Decision Band Method indicates that grade I technologists do not perform at the same decision-band as grade I RN's, even though the technologist groups have consistently argued for parity in remuneration. In order to preserve "professional status" technologist may try to concentrate on the interpretive aspects such as quality control - even though these tasks too are becoming automated.

On balance, the analysis of changes in decision-making level suggests a reduction in the decision-level of routine testing that may first encourage the dispersion of these technologies to less specialized, non-qualified users; second, reduce the rate of increase in manpower requirements for technologists; and third, have implications for the skill mix of staff. These hypothesized effects are consistent with predictions of a "two-tier economy" where at the level of the region, the city and the workplace there will be a separation of levels in which most jobs will be at the A level (basic procedural tasks), with a very few positions involved at the D level (interpretive functions). The interests of collective bargaining units and "professional associations" will clearly be in resisting such changes but the "deskilling" of the skilled positions is a possible outcome with emerging candidate technologies. The responses on the part of laboratory workers to date has been to either focus on those information management tasks that can provide them with more "professionalized" work or shift to more esoteric testing areas. In the future workers may have to relocate their activities to produce laboratory test data on the wards and in the clinics.

4.5.4 b) iii) Automation, Computerization and Organizational Structure

As discussed in the previous chapter, the growth in the size of the laboratory, the increasing specialization of medicine in general, and the increased specialization of laboratory medicine in particular, have tended to encourage the geographic centralization of hospital and laboratory facilities. This was found to be consistent with organization, geographic, economic theory and in the medical practice of the time. This section reviews ways in which automation and computerization fit into the model and examines the degree to which technology is allowing processes of concentration and dispersion to occur.

In the 1960s and early 1970s laboratories experienced very substantial annual increments in use of procedures. The growth in use, cost and technology are inextricably linked and many efforts have been made to unravel the causal factors, e.g., Finkelstein (1980), Tydeman et al (1983), Morrison et al (1985). Whatever the cause, the reality by the 1970s was that laboratories were facing large and increasing workloads and costs, and wider availability of equipment embodied technology.

One organizational response was geographic centralization. In an article entitled "Centralization answer to volume explosion", Scardino and Deppisch suggested in 1973:

> "Increased workloads and specialization engender rising costs for laboratory space, reagents and equipment, and the like and also for skilled personnel necessary to perform the more difficult procedures.

> To solve them, significant organizational modifications on the part of the clinical laboratory are required. One possible approach involves geographic centralization - pooling of the resources of several small laboratories into one centralized area." (Scardino (1973) p 50)

The centralized system they describe is one where a large central laboratory that is automated and computerized provides services to a wide range of locations (each of which has its own small emergency laboratory). The rationale behind the scheme was that first, costs of processing tests could be reduced through the economies of scale that the batch automation systems and computerized information systems offered. Second, the quality of service could be controlled through centralization. Third, centralization created the critical mass of cases to sustain laboratory sub-specialists.

In the same year, a debate was published in "Human Pathology" (Benson (1973)) in which proponents of laboratory centralization and decentralization argued the case. The arguments on the centralist side focused on cost, quality control through standardization and centralization, and the perceived scarcity of professional and technical staff. The arguments on the decentralist side pointed out that test processing was only about 50 percent of the cost of testing and that quality service meant close face to face communication between laboratory and other medical professionals. Put very simply, the debate is about whether the laboratory is a production facility or a subset medical information system.

By the mid 1970s some important changes were beginning to occur in technology that would shed a slightly different light on the centralization debate. First, the development of the Dupont analyzer provided a large test menu to a medium sized laboratory. It was a system with high supply costs, but it was relatively easy to operate and provided very reliable quality. This was the beginning of a trend towards flexible and user friendly instruments. The second major trend in technology was the developments in computers and networking. As early as 1974, Chapelle et al had recognized for hospitals that there was:

> "... the possibility of networking multiple mini-computers into a "distributed" data processing system, which provides both a high level of intradepartmental processing power and an extensive automated interdepartmental communications capability." Chapelle (1974) p281)

The development of such systems in the hospital environment would, they argued, have a number of important advantages:

> "From a management viewpoint, the modularity of a distributed network permits a degree of responsiveness not advisable under other traditional approaches ... Possibly the most important result is that the distribution of systems will bring the capabilities of modern computer technology under the direct control of the people who have the processing needs." Chapelle (1974:p283)

The impact of networking was not felt in the laboratory for several years, until the development and proliferation of micro-computers and local area network (LAN) technology. Indeed, such technologies are only now beginning to be implemented in laboratories in North America. For example, Duke University has a series of satellite laboratories, each with a micro-computer networked to a host computer, for data collation and quality control purposes. Similarly in B.C., a multi-site long haul network linking the teaching hospitals and several local area networks are currently being established. This integrated system will allow the transmission of information among five hospital sites, and within certain sites, enabling "satellite" laboratories, doctor's offices and bedside instruments to be interfaced into a co-ordinated laboratory quality control and data communications system (Cassidy et al (1985)).

These current developments in technology can enable horizontal decentralization of functions (i.e., transfer of functions across the organization) and geographic dispersion of the test production activities of the laboratory (operational level activities). But they are simultaneously enabling a centralization and geographic concentration of quality control and information interpretation activities (the higher order decision activities).

Finally in this discussion, a comment should be made on the links between the development of equipment-embodied technology and specialization, formalization and standardization. In the clinical laboratory, automation can have two effects on these aspects. First, it can allow the simplification of routine work enabling it to be standardized and formalized. Second, it can provide the improvement in productivity to release resources to do other more specialized tasks.

An important caveat should be made here. As outlined earlier, technology and organization are on the same continuum. The degree to which work is standardized or formalized is not always because of equipment-embodied technology, but it is often associated with the process of implementation of that technology. Two perceptive sets of commentators on computers in the laboratory expressed the difficulties in separating the concepts. McLendon (1974) reflecting on his experiences with computerization in the laboratory suggested:

> "I would however pass on the advice of one wise person, who stated several years ago that one should do a systems analysis of the laboratory operation, design a good manual back up system and then not computerize his laboratory!" (McLendon (1974) p 179)

Similarly Nussbaum et al (1977), reflecting on their experience with computerization of laboratories stated:

> "It is not possible to distinguish between the impact of the computer-based information systems per se and that of the laboratory organization necessary to make optimal use of these systems."
> (Nussbaum et al (1977) p 149)

Standardization, specialization and formalization are "soft" technologies that can be employed in laboratories regardless of the equipment embodied technologies involved. Frequently the implementation of such equipment embodied technologies enforces a discipline on the enterprise to modify some of these structural attributes.

4.5.5 Section Summary

This section has attempted to model the development of laboratory technology in North America and describe the possible implications of this technology for the functional, organizational and spatial structure of laboratories.

It has been argued that the developments in automation and computerization can modify the tasks of the laboratory, the decision making levels inherent within these tasks, and the potential organizational and spatial structures that can emerge under alternative technological scenarios. The conclusion that can be drawn, as in the previous section on the medical environment, is that up until the mid 1970s, there have been a variety of technological factors reinforcing the formation of centralized, hierarchial structures for laboratory systems. Since that time, the technologies that have been developed, particularly, smaller scale analyzers, micro-computer based and network technologies, present a plural set of opportunities for the organization. Just as in Section 4.4, it was suggested that the changes in medical demand were simultaneously creating processes of geographic concentration and dispersion among a network of testing facilities, so the developments in equipment embodied technology can enable these processes and amplify their effects. Whether function and technology will dictate organization and spatial form is by no means clear cut. This will depend on the relative costs and benefits of these organizational and spatial structures i.e., on their relative performance, and the perceptions and relative power of the interested groups who select and guide these choices.

4.6 CHAPTER SUMMARY

This chapter has described the salient characteristics of the changing environment faced by clinical laboratories. It has been argued that since the 1950s, social and political pressure have favoured increased access to health care in general, and laboratories in particular. Similarly, the increasing economic burden of enabling such access has become an important environmental issue in recent years.

However, demand for laboratory services has not been driven solely by social priorities or by increased resource allocation. Rather, the transformation in medical practice towards more specific diagnosis and more aggressive therapy has placed greater demands on laboratories. Such demand has been further stimulated by the availablity of candidate technologies that can expand the range and intensity of test utilization. The interaction of technology and medical demand provide a powerful stimulus to growth. But again such growth has been given legitimacy by a societal context in which access to medical services is considered an appropriate objective.

There are certain specific organizational and locational outcomes that might be expected given such an environment. It has been suggested that both medical practice and laboratory technology have favoured increased concentration of activity in hospitals and large private laboratories until the mid 1970s. The combination of a more therapeutic focus in medicine and increased capability, versatility and variety of technologies, might lead to the prediction that a more dispersed spatial and organizational pattern of laboratory activity would be observed over the last decade. However, this is a naive prediction. It assumes that environmental conditions dictate locational and organizational responses. Yet considerable debate exists over whether centralized or decentralized laboratory organizational hierarchies are the more effective and efficient alternative. Similarily, it is by no means clear what is an "appropriate" level of laboratory activity or how such an activity should be organized and distributed.

In themselves, environmental conditions are insufficient to explain spatial and organizational outcomes. They provide a critical context for structural transformation but they do not determine it. In the following chapter, the perceptions of the environment held by various interests and the strategic decisions and policies that flow from these perceptions will be evaluated. It will be argued that although environmental conditions play a critical role in systems change, they do not determine the choices made by strategic decision makers.

CHAPTER 5 CHANGING STRATEGIC PERCEPTION AND POLICY-MAKING FOR THE CLINICAL LABORATORY SYSTEM OF BRITISH COLUMBIA 1954-1984

5.1 INTRODUCTION

In the previous chapter, transformation in the wider environment facing clinical laboratories was discussed in general terms. The possible policy and operational implications of these changes were also reviewed. This chapter analyzes more specifically the policies made in B.C. in response to these wider environmental circumstances and focuses not only on what policy was made but on how policy was made for clinical laboratories.

In particular, this chapter shows how policy for laboratories in B.C. has emerged from the changing strategic perception and goals of a number of "structural interests" (or policy actors). It is argued that the goals and perception of these groups are conditioned by their ideology and that the changing relative power of these structural interests has to a large degree shaped the policies that emerged. (Throughout this chapter, the term ideology is used to include conventional notions of political ideology and the set of "ideas" or philosophy held by the various groups).

By developing a general model of policy making it is demonstrated that the goals of all the structural interests favoured growth in laboratory services until the mid 1970s. Since that time there have been changes in perception of this growth by certain groups (particularly government) and this has lead to increasing confrontation among the structural interests.

By placing B.C.'s experience in a wider Canadian context, this chapter argues that growth in laboratory services has occurred in many jurisdictions and under various institutional frameworks. However, it is also suggested that there is considerable variation in the way such growth is structured, in economic, organizational and geographic terms.

The variation that occurs among different provinces and within B.C. over time is explained partly by environmental shifts. But, it is explained as much by changes in the perception of environment by strategic decision-makers (or structural interests), by changes in the power of these interests and by the policies that flow from power and perceptions, as it is by transformation in the environment. Therefore, it is argued that the relationship between environment and policy is interactive and synergistic, not linear and causal.

The chapter is structured into four major sections.

5.2 A model of policy-making for clinical laboratories.

5.3 Policy development in Canada and British Columbia for the period 1954-84.

5.4 Comparison of the B.C. experience with other provinces (in particular Ontario and Saskatchewan).

5.5 Trends in clinical laboratory policy and the implications for structure.

5.2 A MODEL OF POLICY-MAKING FOR CLINICAL LABORATORIES

As a framework for the analysis of the B.C. experience, this section develops a general theoretical model of policy-making for clinical laboratories that is based on an inherently structuralist-functionalist view of health policy-making. Although the author expressed some concerns with structural-functionalist explanation at the societal scale (see Chapter 3), such an approach can be utilized as a baseline for the analysis of the roles and motivations of groups at the level of the enterprise or the industry. But it should be emphasized that the strategic perceptions and choices made by individuals may have had as much influence on policy as did the behaviour of groups of interest.

Three elements are involved in this model:

5.2.1 Identification of structural interests.

5.2.2 Evaluation of the ideology, goals and contraints of the various structural interests with regard to medical technology in general and clinical laboratories in particular.

5.2.3 Assessment of the interaction of these interests.

5.2.1 Identification of Structural Interests

Robert Alford's (Alford 1975) study of "Health Care Politics" identifies three groups of "structural interests" in health care:-

a) Dominant structural interests are those served by the structure of social, economic and political institutions as they exist at any given time in the health care field. The professional monopoly is deemed the major "dominant structural interest".

In considering the dominant structural interests or "policy actors" in the clinical laboratory policy arena it is necessary to distinguish between different medical professionals and technology providers (see Fig. 5.1 and Table 5.1).

i) Clinical professionals - the principal users of clinical laboratories.

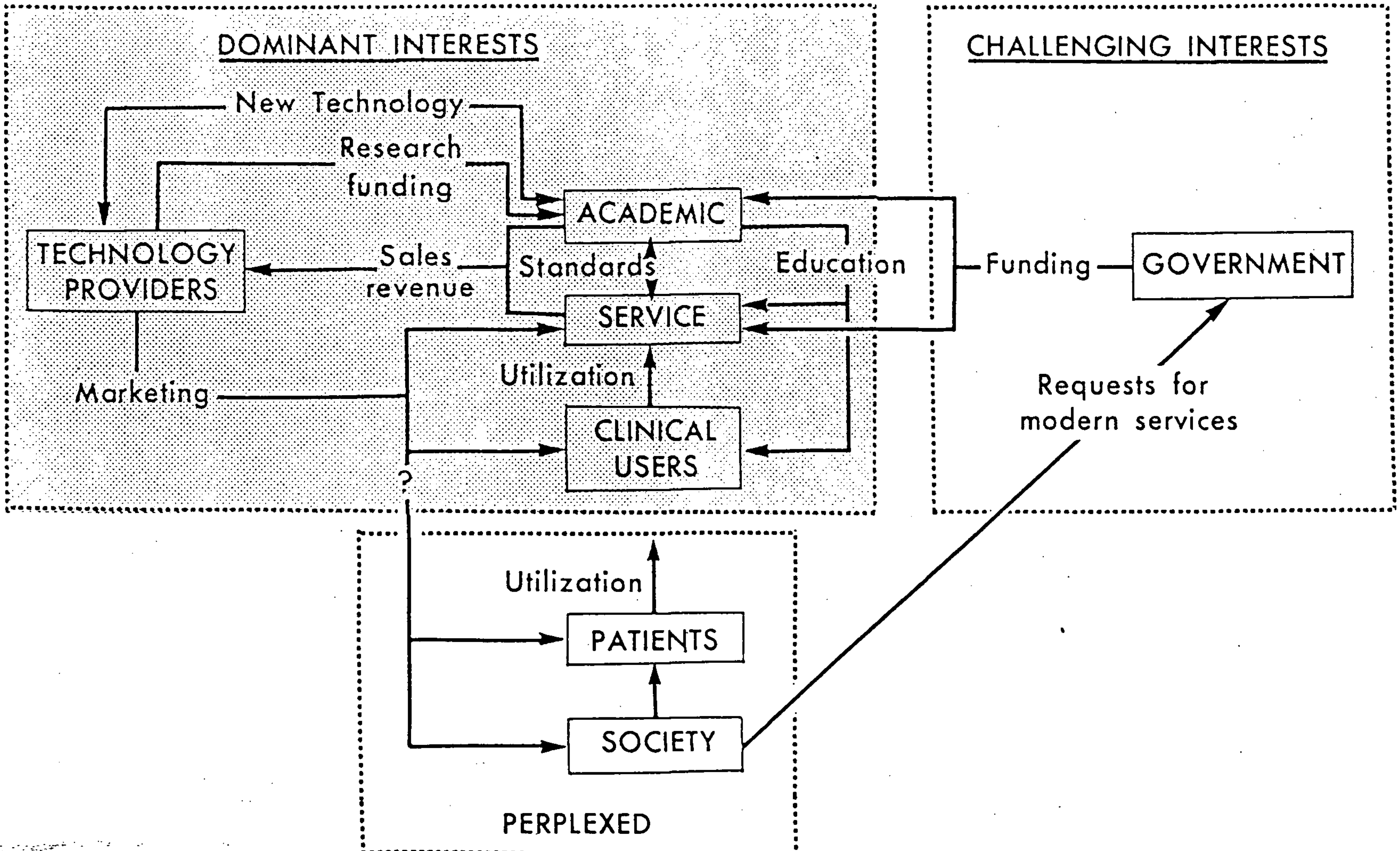
ii) Diagnostic professionals providing services i.e., pathologists who are involved in delivery of professional services in hospitals and those who own and manage for-profit private laboratories.

iii) Academic Diagnostic Professionals - those pathologists and laboratory scientists involved principally in teaching, research and development and provision of tertiary referral services in teaching hospitals. Diagnostic Professional and Academic Diagnostic Professionals are involved in policy-making through their inputs to professional associations and advisory groups. Within hospitals they perform the "guidance system" function described in Chapter 1. Finally, in private laboratories, they can be involved in guidance functions and strategic decisions.

iv) Corporate technology providers - the private corporations that develop and market laboratory technology (both hardware and supplies), and who in various other jurisdictions have also owned and operated "for profit" clinical laboratories.

This last group do not perhaps fit Alford's conception of a "dominant structural interest" in health, since it is not a professional group. (Although Weller (1977), in modifying Alford's conception recognizes them as such). However, in the area of laboratory policy technology providers must be treated as a dominant structural interest since they have such a considerable

FIGURE 5.1 A MODEL OF DOMINANT CHALLENGING AND PERPLEXED STRUCTURAL INTERESTS IN POLICY-MAKING FOR CLINICAL LABORATORIES.



effect in shaping policy outcomes, and in influencing attitudes of both the physician providers and the public, Leavitt (1984).

b) <u>Challenging structural interests</u> are those being created by the changing structure of society. The complexity of health care organization has lead to a challenging movement that Alford describes as "corporate rationalization" that includes hospital administrators, medical schools, government planners, and researchers and public health agencies. Alford sees this group as "developing their structural interest in breaking the professional monopoly of physicians over the production and distribution of health care". (Alford (1975); p.14) Alford suggests that challenges made by this group to the dominant group will be a major source of conflict.

c) <u>Repressed structural interests</u> are those for whom "the nature of institutions guarantees that they will not be served unless extraordinary political energies are mobilized." Alford describes this group as including the white rural and urban poor, ghetto blacks, and the medically indigent. The term repressed is perhaps more applicable to the U.S. health care system, and to access to health care services generally, rather than to Canada and clinical laboratory services in particular. It is more useful to describe this group as the Perplexed. The general public and the interested subset of those, i.e., patients, are not so much <u>repressed</u> in Canada with regard to clinical laboratories or health care, as they are <u>perplexed</u>, insofar as they have demonstrated interest in having access to laboratory tests, but no real understanding of what they want access to, or more specifically what it does

TABLE 5.1 STRUCTURAL INTERESTS IN CLINICAL LABORATORY POLICY-MAKING - IDEOLOGY OF MEDICAL TECHNOLOGY, OBJECTIVES AND CONSTRAINTS

Structural Interest	Ideology of Medical Technology	Objectives of Laboratories	Constraints on Laboratories	Primary Structural Objective
Dominant Clinical Physicians	Clinical Objectivity	Security, objectivity Action orientation Pursuit of the obscure Ease of access Timeliness of access	Regulatory	Accessibility Utilization
Diagnostic Service Professionals	Diagnostic Objectivity	Security, Standards, Markets/income	Regulatory	Service Standards Use, Prices
Academic Diagnostic Professionals	Scientific Objectivity	Progress, Standards, Funding	Scientific, Funding	Research/Teaching Standards, Status
Corporate Technology Providers	"Can-do-ism"	Profits, Growth Market Share	Regulatory, Scientific	Profit, Growth
Challenging Government and more recently Hospital Administrators	Technology is progress Technology should be controlled	Bronze plaque syndrome Visible but rational committment	Fiscal, Informational (state vs professional agency), geographic	Control, Image
Perplexed Patients	Hardware = care	Access to local "Service Stations"	Informational (agency)	Access to 'good' services
Society	Sense of entitlement that "modern" services should be available (option demand)	Availability of a modern but "inexpensive" system	Informational Geographic	'Modern' system

for them. (See the asymmetry of information problem raised in the health economics literature, Evans (1984: Chapter 4) and Wildavsky's (1977) work on excess caring). It is recognized however that lack of knowledge on the part of patients and society, can lead to a sense of powerlessness, which may be seen by some as a form of repression.

5.2.2 Ideology of Medical Technology and the Objectives of the Structural Interests

Over the last forty years equipment-embodied technology (i.e., hardware) has become increasingly important in medicine, if not in health care generally. Each of the structural interests defined above has some underlying idea about technology in medicine, i.e., an ideology of medical technology, and some specific objectives concerning clinical laboratories (Table 5.1). The overwhelming ideology seems to be that of the "technological imperative", Altman *et al*. (1977).

5.2.2 a) Dominant Interests

In particular, the dominant structural interest in North America, i.e., the medical profession, has been increasingly impressed with the capabilities of hardware, and science in general, because it recognizes the potential to increase objectivity in medicine, Reiser (1978). This is important to the medical profession because it helps alleviate the responsibilities of making important decisions under uncertainty, a theme that pervades much of medical thinking and teaching, e.g., Nolen (1978) and Fox (1978). However, the different medical groups defined earlier, do not view science and technology in quite the same light.

i) Clinical Physicians

The objectivity provided by scientifically based, equipment-embodied laboratory technology gives clinicians greater security in the face of uncertainty and complexity of practice. Faced with more options (in terms of number of disease states and possible therapeutic interventions) it would seem logical that physicians would ask more questions and more complex questions of the laboratory, Hardwick D.F. et al (1985). The use of laboratory tests does not necessarily lead to "better" decisions or health outcomes, but it is clear that use of tests can lead to "more rational" decisions, at least in the minds of physicians and in the eyes of the courts. The clinical physicians' interpretation of the objectivity that technology may bring, is perhaps overemphasized - tests and technologies are not as powerful, objective and decisive, as most clinical physicians believe or suggest by their patterns of practice (e.g., see Reiser (1978: Chapter 9)).

The quest for objectivity has become particularly important because of the changing focus in medicine outlined in Chapter 4. It was argued that since 1950, medicine has increasingly focused on "halfway technologies", unlike the "decisive clinical technologies" such as antibiotics that helped eradicate infectious diseases. Halfway technology such as by-pass surgery, renal dialysis and chemotherapy for cancer, represents the best available treatment, but treatment that has been unable to eradicate or substantially reduce the incidence of disease to which it is targeted, despite the large and growing amount of resources allocated to these activities. These medical technologies carry with them increasing dependence on clinical laboratories and other diagnostic services and act as one of the prinicipal driving variables behind demand for laboratory services (Morrison et al. (1985); Schroeder (1985)).

"Halfway technology" also reflects a trend in medicine towards action (or intervention) rather than inaction. Access to laboratories and other diagnostic services present an opportunity for clinical physicians to "do" something with minimal risk of it harming the patient. (Indeed it could be argued that the test becomes a substitute for care). Finally, commentators suggest that with the development of "halfway technology", clinical medicine becomes oriented towards the pursuit of the obscure disease (or zebra-chasing as it has been referred to) McIntosh (1981), Williams (1983). In summary, the specific policy objectives held by clinical physicians as a structural interest over the last 30 years, are that laboratories should be accessible spatially, economically and bureacratically for use by all physicians. Therefore, even without a direct pay-off for performing tests (such as described by Bailey (1979) and Schroeder (1979) in the U.S.), clinical physicians have an interest in utilization.

ii) Diagnostic Service Professionals

The role of diagnostic service professionals leads them in search of security, in that they need to be assured that the answers they provide are of reasonable quality, hence a focus on standards of service (McIntosh (1981); p.56). A secondary objective is the desire for markets or income; diagnostic service professionals do not normally derive income from patient encounters, therefore they have a strong structural interest in seeing growth in utilization and prices, in order to survive and prosper. Third, diagnostic service professionals are interested in developing new and better services (not only for reasons of income or market share, but also because progress in service delivery represents 'better' diagnostic medicine). Thus the specific policy objectives of the diagnostic service professionals has consistently been that laboratory demands from clinical physicians should be met, prices should not drop and that services should be expanded and upgraded to keep laboratory services at a "state of the art" level, McIntosh (1981). Thus they embody the values of "not-only-for-profit" (NOFP) medical practice that has been identified for physicians in general, Evans (1984: Chapter 7).

iii) Academic Diagnostic Professionals

Academic diagnostic professionals have somewhat differing objectives. Their principal objective is "progress" and in particular the advancement of standards in service, teaching and research. A related structural objective held by the academic group is to acquire the physical and human resources to allow them to continue and expand their research and development efforts. This group conforms more to the "not for profit" (NFP) economic model.

iv) Corporate Technology Providers

The final "dominant" actors are the technology providers. This group especially since the space race era of the 50s and 60s is imbued with a profound sense of "can-do-ism", i.e., given sufficient dollars (and/or profit incentive) technology can achieve anything, Leavitt (1984). Their objectives are oriented towards profit and growth. They constantly seek new markets but they seek, simultaneously, to encourage brand loyalty (e.g., preserve market share), and go to great lengths in their marketing and research and education funding, to promote this. In summary then, the specific policy objectives of corporate technology providers are to ensure a growing and profitable share of the market for laboratory equipment, supplies and services.

b) Challenging Interests

i) Government

The so-called challenging actors - the government, the planners, etc. are somewhat schizophrenic in their attitudes to technology in health. On the one hand they see technology as being equivalent to progress, on the other hand, (and this other hand does not always emerge simultaneously), there is a sense that technology should be rationalized and controlled. The schizophrenia being "more technology is good but unhindered proliferation is bad". In particular, Banta and Russell (1981), have suggested that government's policy objectives towards technology and medicine can be best described in terms of a four level hierarchy:

"At the first level of the hierarchy the government actively promotes the development and adoption of new technology with little or no regard for cost. At the second level without making judgements about the benefits of technologies, the government intervenes to encourage greater efficiency in their production and use - for example, by encouraging the regionalization of facilities. At the third level the government begins to question and test the benefits of medical technologies and may act to restrain the use of any found not be beneficial. At the fourth level the government accepts that it may not be realistic to provide every kind of care that is beneficial - because some benefits are too small or too costly - and acts to limit the diffusion of technologies to a level that strikes a balance between the benefits gained and the costs of achieving them".

Banta and Russell (1981;p 649)

To add to the conflict between development and control, there has often been the additional objective of government to provide visible and tangible artefacts for specific communities. This is referred to here, as the "bronze plaque syndrome". Diagnostic services are particularly popular areas for political tokenism and charitable endowment because the end result is visible, tangible and can indeed have a bronze plaque attached to it. One of the problems with this situation is that the annual operating cost of most diagnostic technology far exceeds its capital cost, Altman & Blendon (1977); Tydeman et al. (1983).

ii) Hospital Administrators

A comment should be made at this stage on the role of hospital administrators in this model. Until very recently in Canada, their role in growth, and challenges to growth, has been more passive than active. In fact, because of lack of information and direct routes of communication between other interests, they have been by-passed in the policy-making process, i.e., to some degree they fall into the category of the perplexed. When they have been involved in the policy-making process their position falls between the government and the diagnostic service professionals, incorporating elements of the "bronze plaque syndrome" and the (limited) promotion of outpatient testing as a source of revenue (because, despite the offset revenue policies described earlier, relatively low marginal costs of clinical laboratory tests provide an opportunity for creating some financial surplus). This is in sharp contrast to the pre-DRG funding model in the U.S., where hospital administrators had an enormous incentive to promote and facilitate more testing and clearly did so, Conn (1978). The changes in funding and increasing climate of restraint in both Canada and the U.S. is leading to some convergence in policy-making and hospital administrators are currently being moved to present increasing challenges to growth in clinical laboratory costs, Statland (1985). Indeed the hospital administrator's office in the U.S. and Canada is fast becoming the venue for conflict over growth of laboratory services. Thus, in summary, the policy objectives of the challenging interests have been to provide a visible but limited commitment of resources to clinical laboratories in order to best meet perceived needs and local political pressures.

c) Perplexed Interests

Finally, the "perplexed" want access to laboratory services but they do not know what specific facilities or services they require. At the level of the patient there is, and has been since the witch doctor, an equation that seems to state that hardware = care. If a medical professional brings to bear a physically-embodied technology on a problem, the patient is more likely to accept that curing, or at least treatment, has occurred (e.g., the placebo effect). At the level of society there is a concern that because there is always the risk of illness striking an individual or his family these hard technologies should be available "just in case". With increasing societal affluence this "option demand" seems to be manifest in a sense of entitlement - a right to access to medical technology, a point made earlier in Chapter 4. Thus, the perplexed interests of society and patients are concerned with accessibility to services and with modernism. To the lay public, state of the art hardware conveys a sense of the best available treatment; an idea that is promoted by the media and, it has been argued, by the other dominant interests.

5.2.3 Interaction of the Structural Interests: Coalitions and Constraints

It is clear that in this model there is considerable potential for the interlocking of interests, particularly the dominant interests, in seeing growth in the laboratories. Figure 5.1 shows diagramatically the interaction of these interests and how they lead to growth, particularly the relationships between diagnostic professionals and technology providers. There is therefore the potential for the formation of formal and informal, conscious and sub-conscious, "coalitions" that are mutually reinforcing.

A variety of possible constraints may be faced by the different policy actors (Table 5.1). To date these constraints have not been sufficiently strong to curb growth in laboratory services as shown in Figure 4.5 - 4.7 and Table 4.1. Indeed the foregoing analysis identifies that each of the groups has an interest in growth in laboratories. Challenges to that growth will be dependent on the specific incentives and constraints faced by each of the groups and on the ideologies and structures that underly them; in particular, the economic incentives and constraints provided by funding developments.

Although it appears that the interlocking of these structural interests leads towards growth, a number of anomalies require explanation. The principal policy-making questions involve private, for-profit laboratories, that in Canada provide outpatient services and derive income from a fee-schedule negotiated by organized medicine. Are these "firms" purely for profit or are they a form of "not only for profit" (NOFP) organizaton, like other medical practices, in which the profit objective is accommodated in a utility function that includes professional quality concerns, practice style and an income vs leisure trade-off, (Evans (1985):Chapter 7)?

For example, B.C. laboratory physicians have maintained a very powerful lobby within organized medicine that has successfully restricted any para-professional or non-medical professionals from owning and operating clinical laboratories, BCMA Task Force on Private Laboratory Accreditation, (1969) (1972). (The situation in other jurisdictions will be compared later in this chapter).

In terms of the process of policy-making for laboratories, it is interesting to observe that medically owned fee-for-service clinical pathology practices have managed to remain virtually unchallenged over the last 25 years, even though they appear to violate the normal "rules" of medical economics. In particular, they violate the "rule" that practices should not employ a large number of auxiliaries to substitute for professional time, yet the professional time component of private clinical laboratory practice is widely recognized as being minimal. (See Bailey 1979 (p.68)). For example, a recent court decision in the U.S. ruled that ownership and control of a clinical laboratory in itself did not constitute the practice of medicine, because no direct professional involvement was required. (Interestingly, the profession themselves recognized this to some extent in 1969 in the BCMA's Final Report of the Special Committee on Accreditation of Private Laboratories (1969) which stated:

> "This (clinical laboratories) is one of the few situations in medicine where data vital to the patient's welfare may go directly to the ordering physician without having been perused by another physician".

The theory of economic behaviour in the professions predicts that practitioners in law, medicine and accountancy will avoid the use of auxiliaries (Evans (1984)). Two alternative theoretical explanations are advanced. First, such effort may be aimed at maintaining prices by keeping supply restricted or second, it may reflect the fact that a medical practitioner derives income from expending her "own time" and not simply from the profit from her practice (i.e., billings minus expenses (Evans (1984)). Thus it is in the group's and the individual's interest not to employ auxiliaries, e.g., nurse clinicians, who might increase supply, drive down prices and "squeeze out" professional time. Yet clinical laboratory professionals in B.C. and elsewhere continue to employ auxiliaries on a large scale in their private practices, apparently unrestrained by their medical colleagues. Part of the explanation for this seems to lie in the demonstrated ability of the professional group to legitimate their objectives in the eyes of the wider profession. But is also a function of the monopoly power of medicine in that private laboratory practice in B.C. is an activity only open to physicians and consequently the use of auxiliaries is a rational response in a "closed shop".

A second and related issue involving private medical laboratories and the wider medical profession is cost. Escalating laboratory cost has become an issue for organized medicine and they see themselves as:

> "having responsibility to the public to assure that medical dollars are being spent conservatively in the best interests of the patient's clinical needs". (Paul (1974))

Yet organized medicine has tended to regard the laboratory cost problem solely as an issue of utilization (demand side) and not an issue associated with "fees" or the structure of the supply side.

Currently in B.C., the profession has agreed to a form of cap on the total billings of the Medical Services Plan. Under these circumstances, it is conceivable that clinical professionals will begin to scrutinize total laboratory fees more closely. For example, Table 5.2 shows total laboratory billings (including total laboratory "fees" paid to hospitals) and private laboratory billings as a share of all MSC billings for the period 1970/71 to 1983/84. It can be seen that outpatient laboratory services in general, and private laboratories in particular, have taken a substantially larger share of Medical Services expenditures over the period (almost exactly doubling their share). Future challenges by government may involve methods of communicating the "zero-sum game" nature of this expenditure, i.e., what physicians spend on laboratory tests they must forego in income. (When one considers that total fees paid to laboratories in 1983/84 at $102 million was just 16% less than the total fees paid to other medical specialists ($119 million) the situation seems unstable. Why does this group of diagnostic professionals remain

TABLE 5.2

TOTAL MSC EXPENDITURE, TOTAL LABORATORY

AND PRIVATE LABORATORY SHARE 1970-1983

(Millions of Current Dollars)

YEAR	TOTAL MSC[1] EXPENDITURES ($millions)	TOTAL LAB INCLUDING "FEES" TO HOSPITALS ($millions)	% of total	TOTAL PRIVATE LAB ($millions)	% of total
1970/71	121.9	7.73	6.3	4.90	4.0
1971/72	132.5	8.31	6.3	5.36	4.0
1972/73	142.8	9.47	6.6	6.12	4.3
1973/74	162.8	12.37	7.6	7.90	4.9
1974/75	199.4	16.86	8.4	10.81	5.4
1975/76	256.9	23.88	9.3	15.25	5.9
1976/77	283.4	29.39	10.4	18.50	6.5
1977/78	316.7	31.60	10.0	19.12	6.0
1978/79	356.9	36.77	10.3	22.22	6.2
1979/80	407.9	44.90	11.0	26.72	6.6
1980/81	474.1	55.89	11.8	33.20	7.0
1981/82	597.7	70.30	11.8	41.79	7.0
1982/83	707.9	85.76	12.1	51.10	7.2
1983/84	793.8	102.02	12.9	61.96	7.8
Percentage Growth	+551	+1219	+104	+1164	+95

Source: MSC Financial Statements

1) Medical Care fee for service expenditures excluding additional benefits or para-medical care (i.e. chiropractors, naturopaths, physiotherapists, optometrists, massage specialists, Red Cross or public health).

unchallenged by their peers? This situation can only become more acute as governments and paying agents attempt to transform health care reimbursement from "open-ended" to "closed-off" systems (Crichton (1984)). Again, the answer seems to lie partly in the professional cohesion of the medical community and partly in the bargaining power of this interest group.

A number of possible "bargaining" strategies can be suggested as an explanation for the private laboratories apparent power. First, because of the "incomplete vertical integration" of the health care delivery system in Canada, Evans (1981), the clinical laboratory professionals can make a very strong case for being the "thin end of the wedge". They could argue to their physician colleagues that if fee-for-service reimbursement was eliminated for laboratories in the ambulatory setting, replacing it with budgets or per capita allowances for their private laboratories, then this would open the door for the rest of medicine to become "socialized" or undergo similar provider upheaval (i.e., government vertically integrating into medical service provision).

Evidence from the U.S. seems to confirm the validity of this "thin edge of the wedge" argument as a threat to practitioner autonomy and to the "normal" structure for health service delivery of incomplete vertical integration. However, in the U.S. case, the clinical laboratories were the first wave of what is now an enormous tide of "corporatism" not "socialism". In particular, Bailey (1979) describes how private corporate laboratories began to get involved in kickbacks to physicians and other more direct vertical integration by technology providers in California in the 60s and 70s. The processes of corporate vertical integration that were prevalent initially in U.S. laboratories have gained increasing momentum in health care under the control of Humana, AMI and HCA in the U.S. The process of vertical integration seems inevitably to lead these companies to the direct provision of medical services and to the doctor as corporate employee.

From a theoretical standpoint the "thin end of the wedge" approach does appear to allow a "few" dominant interests to gather political support from the "many" clinical users, for maintenance of fee-for-service, non-competitive, professionalized laboratories that employ auxiliaries to generate a profit.

A second possible explanation, but one that is again difficult to document in the B.C. case, is what could be termed the "merge into the background" approach. The essential argument being that a small number of clinical pathologists want to maintain high prices for tests. A possible strategy is to dilute their interests in the overall professional interests - e.g., argue strongly for across-the-board fee increases, rather than negotiating specifically on the basis of costs of production of laboratory tests. A related strategy is the "spear carrier" approach, This is essentially the converse of the previous approach. In order to gain the support of all physicians for fee increases for laboratory fee items, laboratory physicians could advocate proportionately higher increases for doctor office tests (a very restricted menu range, restricted it should be added by laboratory physicians). In this scenario instead of arguing that "50 (1%) of us want higher prices for laboratories" the argument comes from a broader base because most physicians can gain. However, the evidence shown in Table 4.1 is that doctors' office billings have declined in their share of total laboratory billings to MSC over the period. Thus, even if such a "spear carrier" effect existed it has not benefited ordinary physicians.

These policy-making processes are purely conjectural. What is very clear is that the real activity per capita for private laboratories, their share of total adjusted laboratory expenditures and their share of medical expenditures in B.C. has increased substantially. (See Chapter 4.2 and Tables 4.1 and 5.2 in particular).

Evidence of the selective nature of private laboratory activity is shown by data for the top 10 billing items for 1973-1983/84 (Table 5.3). This demonstrates the large share of high volume and largely automated tests performed by private laboratories in B.C. However it is interesting to note that the private lab revenues from these top ten tests in each year represented a declining share of all expenditures. Even though the private laboratories share of revenues from these tests remained constant at around 60-65 percent. (However, since 1978, the top 30 fee items account consistently for 68 percent of private laboratory billings but only 53 percent of hospital outpatient billings). These data suggest the private laboratories continue to derive a large proportion of income from high volume tests. But, they also appear to be expanding activity into virology, parasitology and other more esoteric testing areas.

The inverse story is told in Table 5.4 in which the range of billed tests (number of different fee items billed) is given for the years 1979-1983/84 by type of laboratory in the metropolitan regions. These data suggest a process of "adverse selection" in which the hospital based laboratories carry responsibility for a wide (and in the case of Vancouver, rapidly widening) menu of tests whereas private laboratories

TABLE 5.3

MSC EXPENDITURES ON TOP TEN LABORATORY FEE ITEMS BY SECTOR IN CONSTANT DOLLARS AND AS A SHARE OF ALL LABORATORY BILLINGS TO MSC 1972-1983/84

	Private		Public		Other		Total	
	$1971 millions	% of all lab	$1971 millions	% of all lab	$1971 millions	% of all lab	$1971 millions	% of all lab
YEAR								
1971	3.09	37	1.07	13	0.63	8	4.79	58
1973	3.46	32	1.21	11	0.19	2	4.86	45
1975	5.04	31	1.72	11	0.29	2	7.05	44
1977	4.91	27	1.78	10	0.54	3	7.23	40
1979	6.62	30	2.24	10	0.67	3	9.53	43
1981	8.04	28	2.65	9	1.33	5	12.02	42
1983	8.14	23	3.73	11	1.46	4	13.33	43
Real % Growth 1971-1983	+163		+248		+132		+178	

Source: Medical Services Commission, Unpublished data.

Table 5.4 MSC NUMBER OF DIFFERENT TEST TYPES BILLED

BY LABORATORY SECTOR IN METROPOLITAN REGION
1979/80 - 1983/84

YEAR	Private		Public		Other (Doctor's Offices)	
	Van	Vic	Van	Vic	Van	Vic
1979/80	256	214	350	299	41	22
1980/81	287	208	373	279	37	21
1981/82	273	208	382	289	44	23
1982/83	266	210	386	285	40	23
1983/84	259	212	390	281	36	22
% Change 1979-83	+1.2	-1.4	+11.4	-6.0	-12.0	0

Source: Medical Services Commission, Unpublished data.

derive the majority of their income from the more common tests particularly those that are automated. Clearly this is not simply an adverse selection (cream-skimming) story because these high-volume automated tests are also the tests most commonly requested by physicians in the community. However, even if private laboratories are motivated solely by patterns of medical demand, they also enjoy the positive externality of immense economies of scale in production, since it is widely recognized that such laboratory practices concentrate data production of this limited range of tests in a very small number of central facilities using automated equipment (Foulkes (1974), Bailey (1979) and Labonte (1983)).

Why is there not more vigorous opposition from the public laboratory sector concerning such adverse selection? The answer seems to be that it is to some extent in their interests not to complain. Hospital laboratories can be divided into two distinct groups: teaching hospitals and community hospitals. Virtually all laboratory specialist physicians in B.C. teaching hospitals are salaried staff with no financial interest in private laboratories, whereas a number of community hospital laboratory physicians also own and control private laboratory practices.

This structural arrangement helps to explain the relative organizational concentration of high volume tests in private laboratories and wide menu facilities in hospitals. If it is assumed that pathologists operate as NOFP entitites, it is plausible to argue that those whose academic objectives dominante their utility function will forego fee for service earnings for practice preferences, e.g., complex case work, research and educational duties. Conversely, those pathologists who have stronger "for profit" motivations are likely to gravitate to private laboratory practice on a full time basis. In between however, are the true NOFP group who combine professional objectives and financial objectives. Thus they will accept salaried or sessional payments for hospital work (thereby fulfilling professional objectives) and simultaneously own and run fee-for-service laboratories. (This is not to suggest that full-time private laboratory practice is devoid of professional satisfaction, rather, the proportion of "interesting cases" is lower by definition in the totally ambulatory setting).

Table 5.5 shows current MSC data on the number of laboratory physicians by practice style (comparable data are not available for previous years). Almost exactly half of the province's 179 pathologists are working in hospital laboratories exclusively. A large proportion of these laboratory physicians are associated on a full-time, salaried basis with the teaching hospitals and/or the University of British Columbia. What is also interesting is the relatively small number of solely "private" laboratory physicians (12) and the concentration of public/private physicians in the Central Fraser Valley and the Okanagan. These distributions help explain the lack of private-public confrontation in the non-teaching hospitals. However they do not explain it all.

Although hospital laboratories lost a considerable amount of market share over the seventies and early eighties, Figures 4.5 and 4.6 showed that both the public and private sectors have grown substantially in real terms during the period 1970-1983/84 for which data are available. Real growth in all sectors may explain why friction and confrontation between the dominant interests has been minimized. Indeed as we shall review in Chapter 6 the

TABLE 5.5 NUMBER OF LABORATORY PHYSICIANS BY PRACTICE STYLE BY REGION

	Public	Public & Private	Private	Priv. Lab. & Priv. Prac.	Full Time Hospital/ Private	Total
A. Vancouver Island	14	1	4	1	1	21
B. Northern B.C.	7	0	0	0	0	7
C. Central Interior	4	2	0	0	0	6
D. Okanagan	3	5	0	0	0	8
E. Kootenay	0	1	0	0	0	1
F. Fraser Valley	0	28	1	0	0	29
G. Vancouver	91	0	7	1	8	107
TOTAL	119	37	12	2	9	179

Definition of Laboratory Physician

All Laboratory Physicians identified are listed in the College Medical Directory under the following specialities unless noted otherwise.

Pathology
Pathology - Anatomical
Pathology - General
Pathology - Haematological
Nuclear Medicine
Medical Biochemistry
Bacteriology
Neuropathology
Medical Microbiology
Haematology

Source: Special table from Medical Services Plan imbalances in equipment and physical plant that existed in 1974 between public and private laboratory facilities (Foulkes 1974) to a large degree have been redressed, particularly in the teaching hospitals, where new facilities have been built for four out of five teaching hospitals in the last 5 years. The estimated data for 1982-83/84 indicate that gaps between the public and private sectors may be widening again under "restraint" suggesting renewed potential for confrontation between public and private sectors.

5.2.4 Section Summary

In this section a general model of policy-making for laboratories has been described. The model hypothesizes that the structural interests and interaction of a number of different dominant actors contributed to the growth in laboratory services, and the structure and performance of the system that resulted. Growth has been generated because of the shift toward a more scientific focus in medicine (i.e., a shift in the "exogenous" demand curve) but it is also clear that the interest groups involved have the ability to "steer" the structure of the supply side and allow their particular objectives to shape the spatial, functional and organizational pattern of service provision and thus the costs of the system. Growth in laboratory services may well be an inevitable phenomenon given a growing societal acceptance of, and an increasing medical focus on, the scientific application of technology to health. How that growth is manifest in organizational, economic and geographic terms seems to be influenced by policy-making and in particular by the power and interests of the groups involved in that process. The changing policy initiatives that have resulted from this policy-making process are discussed in the following section.

5.3 POLICY DEVELOPMENT IN CANADA AND BRITISH COLUMBIA

5.3.1 Canadian Policies For Laboratories

The policies developed for B.C. can be set in the context of the broader Canadian policy-making experience. These policies reflect shifts at both the national and provincial scales, in the relative power of the structural interests and the changing objectives, incentives and constraints they have faced.

Since 1950, in both Canada and B.C., policy development for laboratories has involved 6 principal sets of issues:

a) Funding and Reimbursement, e.g., the issues of upgrading and the conflict between fee-for-service private laboratories vs publicly owned, cost reimbursed hospital facilities.

b) Upgrading Standards - in terms of quality and accessibility of services.

c) Training and Manpower - both pathologists and technologists.

d) Rationalization of Services in particular the concept of regionalization.

e) Management of Technology - in particular capital equipment planning for laboratories.

f) Cost and Utilization - as pointed out in Chapter 4, cost has latterly become a primary contextual issue in policy making.

Table 5.6 shows five general phases in the development of these issues across Canada.

Table 5.6 DEVELOPMENT OF DIAGNOSTIC SERVICES POLICY IN CANADA

PHASES	YEARS	ACTORS	DESCRIPTION
1) Initiation	1950s - mid 1960s	Federal and Provinicial Governments, Professional Users	- Federal grants in early 1950s for equipment and training of laboratory and other diagnostic professionals - HIDS act - funding of inpatient testing - Medicare - funding of outpatient testing
2) Automation	Late 1950s on to present	Technology Providors, Scientific Professionals	- Introduction of Autoanalyzers (late 50s) - Screening became more feasible - Private laboratories became more profitable - Utilization increased substantially
3) Accreditation	1960s to 1970s	Governments, Professionals	- Concern over quality and growth - Leads to forms of licensing and control - Post secondary education grants for training of technologists etc.
4) Rationalization	1970 on	Government, Diagnostic Service Professionals	- Attempts at regionalization - Fee schedule challenges to private labs - Attempts to inhibit use and cost of inpatient and outpatient services
5) Pluralization & Confrontation	1982 on	Dominant <u>vs</u> Challenging Actors	- Corporate labs <u>vs</u> medical & government - Public <u>vs</u> private sector service facilities - Government <u>vs</u> hospital facilities and professionals - Health <u>vs</u> education (manpower) - Medical profession <u>vs</u> allied health profession

These phases of policy development parallel very closely the structure of the Banta and Russell (1981) model outlined earlier. However, there is an interesting irony in that the first three phases of policy development: initiation, automation and accreditation have sown the seeds of the policy problems (utilization and cost) faced 20-30 years later. The initial investment in manpower and facilities and the incentives built into the system decades before, outweigh the constraints that are currently being faced. This point has been made elsewhere with regard to health policy generally, Evans (1984), and it cautions policy-makers to "look before they leap" or at least think before they leap.

For laboratories in particular, the federal and provincial government's initiatives in training of staff, funding of testing and provision of facilities were the economic foundations of growth on the "supply side". Equally, increased automation and marketing of automated equipment has contributed in a major fashion to the utilization of laboratories, Tydeman _et al._ (1983). Finally, medical associations responsible for accreditation of private and public facilites in B.C. and Ontario (and indeed in the U.S.) have become the vehicle for fee-schedule negotiation and licence granting, and some have argued that these bodies operate very much as price makers rather than price takers, Labonte (1983). In Canada, it is only in Saskatchewan that the ideologies running behind the challenging interests have been integrated and embodied in the structure of the clinical laboratory system since its inception. Hence the different type of structure in the Saskatchewan case, that is discussed below.

5.3.2 British Columbian Laboratory Policy

Although the B.C. case is similar in many ways to the broad Canadian experience shown in Table 5.6, a number of significant differences emerge. Specific data for this section were derived from published sources and from a detailed review and content analysis of the minutes of the meetings of the Provincial Ministry of Health's Laboratory Advisory Council (LAC), which operated from the early 1950s to 1980. The LAC was founded in 1955 to advise the Ministry of Health on matters pertaining to clinical laboratories. (A similar committee was struck for Radiology). The committee contained representation of pathologists from both community hospitals, (some of whom also had private lab interests) and teaching hospitals (where in very few cases did pathologists have private laboratory interests). The committee also had formal representation from the B.C. Association of Laboratory Physicians (BCALP).

As the title "advisory" suggests, the LAC had no decision-making power to commit government resources, but it did make recommendations (particularly in later years on the approval of new eauipment) which were accepted normally by the provincial government.

The LAC minutes are a useful source because they provide a window on the issues of the day and the perceptions and concerns of the "dominant" structural interests. The positions taken in camera in the various committees and subcommittees of the BCMA and the BCALP would provide some very interesting colour and depth to the review, but they are not reflected here, except where they have been raised in the LAC forum or in other published sources such as the B.C. Medical Journal: the official voice of the BCMA.

With these limitations in mind, Figure 5.2 demonstrates the changing policy agenda for labs in B.C.

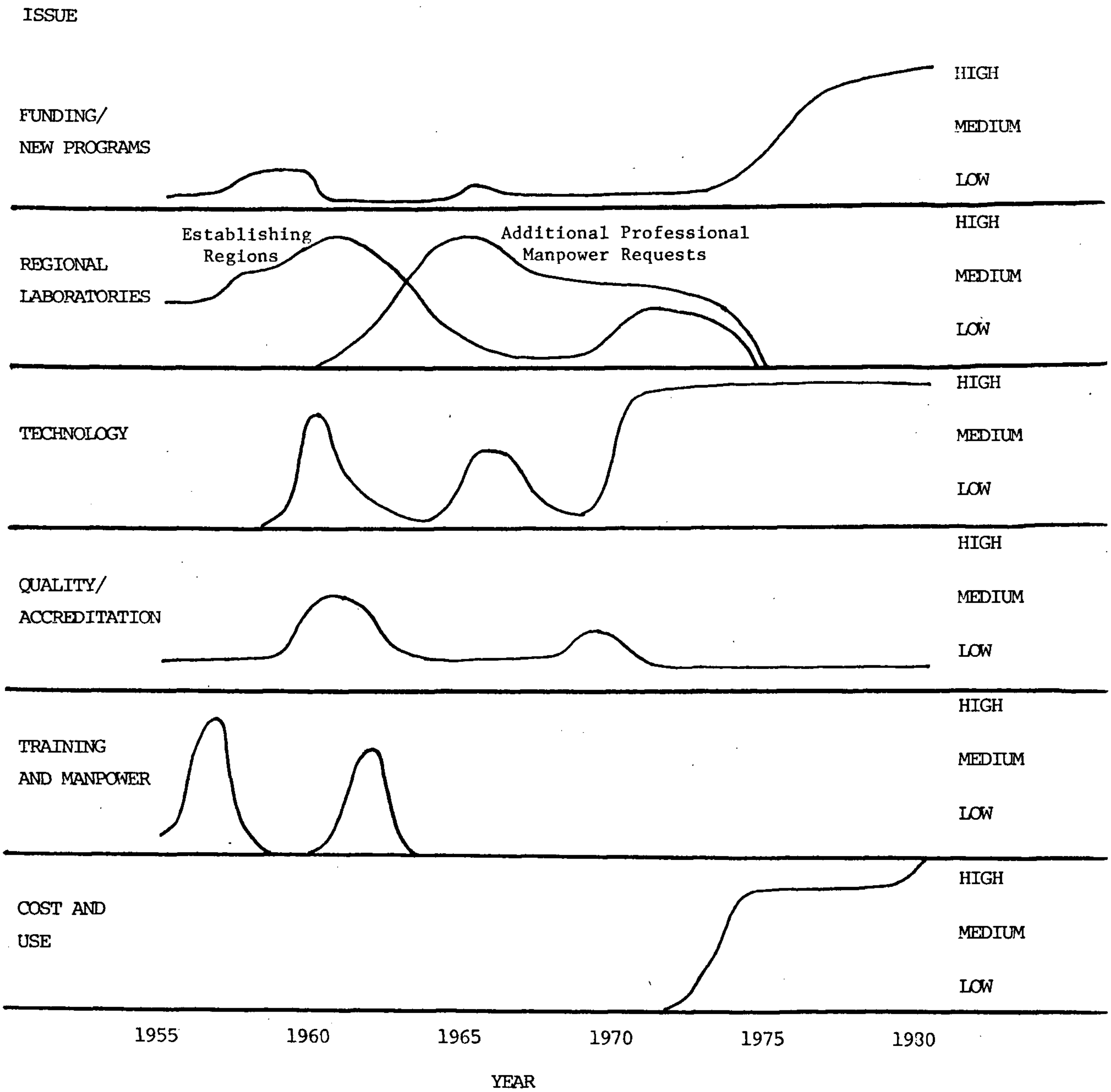
a) Upgrading

In the mid-late 1950s, the policy debate was centered around upgrading the standards of laboratory facilities and increasing the availability of manpower (both pathologists and technologists). Interest in these issues was stimulated partly as a result of the Federal Grants for diagnostic services - the Laboratory and Radiological Services Grants which operated from 1953 until 1956 - but also because of the accumulating pressure that a more sophisticated physician clientele was placing on the diagnostic services system. The point has been made earlier that an increasing sophistication and specialization of medical manpower was an integral part of the changing functional focus of medicine. It was also associated with the return of physicians following military service (and/or post graduate training in the U.S. and Britain) where physicians began to acquire the knowledge in emerging techniques of medicine and surgery. There was then, both a demand-pull and a supply-push for upgrading. (Although B.C. had established a hospital insurance program in the late 1940s, the enactment of the national Hospital Insurance and Diagnostic Services Act (HIDS) in 1957 provided further fiscal and regulatory stimulus for upgrading diagnostic facilities). Manpower planning issues in the mid-50s centered around the establishment of a medical technologist training program at Vancouver General Hospital.

b) Regional Laboratory Service

The remarkably early policy development in B.C. in the 1950s, and one

FIG. 5.2 THE CHANGING POLICY AGENDA FOR LABORATORIES - FREQUENCY OF ISSUES RAISED IN LAC MINUTES.



that apparently had been raised as early as the 1940s by both government and medical profession, was the issue of regional laboratory services. From the start of LAC records in 1955 the predominant LAC issue was establishment of regional laboratory centres, i.e., regional community hospitals acting as both referral centres and as a laboratory management resource for smaller hospitals in the region. In 1955 two principal regional centres were being established for the province (in addition to the Victoria and Vancouver tertiary referral centres). The first was the Lower Fraser Valley Region centred at Royal Columbian Hospital and the second was established for the Kootenays at Trail.

The precise seauencing of regional centres coming on stream is discussed in detail in Chapter 6, however, by the late 60s, nine regional centres were established or were in the process of being established in the Lower Fraser Valley, Kootenays (East and West), Okanagan, Prince George, Prince Rupert, Nanaimo and Kamloops (Royal Inland).

It is interesting to observe (or at least, read second hand) the process of selection of these regional centres that would provide services to smaller hospitals in the regions. The LAC attempted to use rational criteria in the selection of such centres - including population size and density, current and proposed laboratory workloads and the reauired medical diagnostic sophistication of the centre. This type of regional planning process was fairly far advanced compared to many other Canadian provinces and other countries (Banta and Kemp (1982)). Indeed on several occasions through the 60s, members of the LAC report that B.C.'s regional laboratory service was widely regarded as a pioneering endeavour.

Despite this "model" planning process - a credit to the government, the LAC members and the professionals involved - it is striking how many B.C.

communities demonstrate an almost fanatical, frontier independence that substantially altered the number and distribution of the regional centres. The competition between these sub-regional centres was quite evident in LAC discussion. For example, the Kootenays eventually had to be split into three regions more because of competition for supremacy between the communities of Nelson, Trail and Cranbrook than because of geographic, medical or demographic pressures. Similarly, the Okanagan (a linear "valley region" with an obvious geographic centre at Kelowna), was divided, over time, into three sub-regions, reflecting the fierce competition for status between Vernon, Penticton and Kelowna. Such sub-regional rivalries exist in many countries, for example, in the Borders Region of Scotland, however there, the rivalries between Galashiels, Hawick, Kelso and Langholm are given expression on the Rugby field, in B.C. such rivalries are given expression in their diagnostic status.

Once these regions were established, the principal policy focus of the 1960s was what could be termed "feeding the regions". LAC business was dominated by requests for additional professional manpower for the established regions and to a lesser extent creating new second-order regional centres such as Skeena and Peace River.

c) Technology

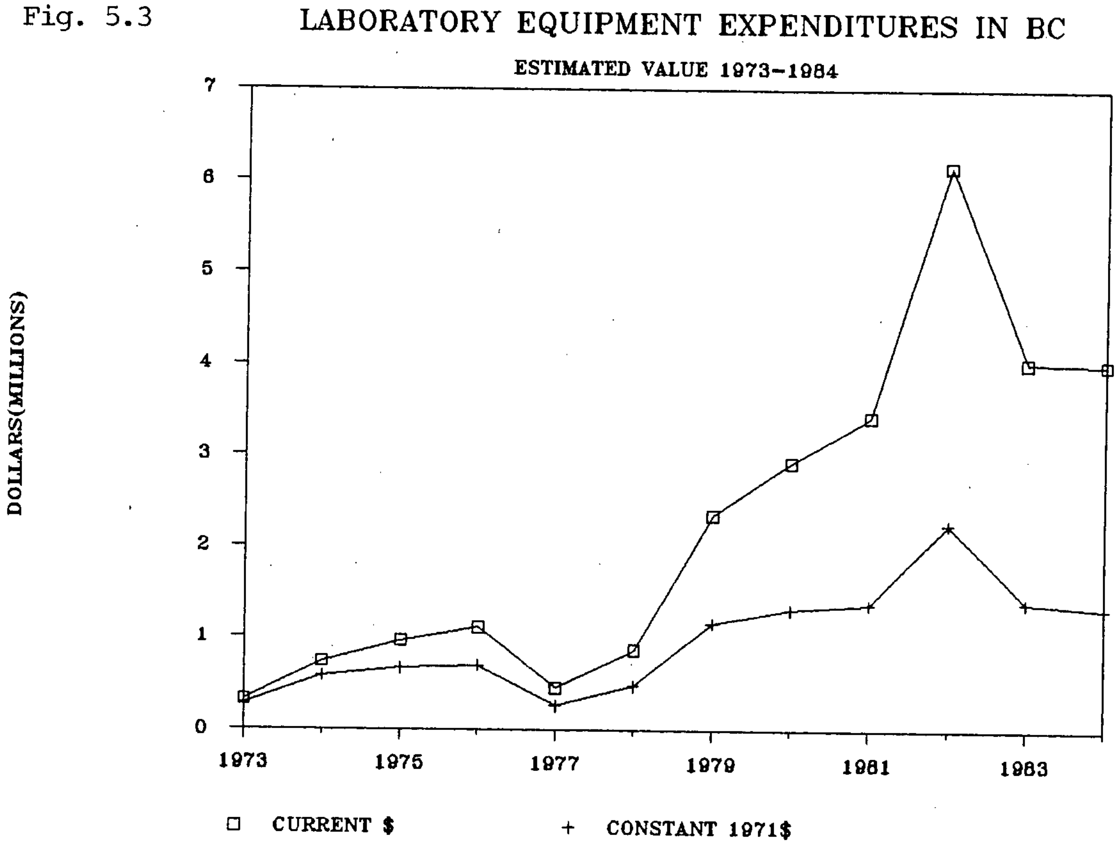
Requests for technology came in three distinct waves. The first around 1959/1960 when cell counters and auto analyzers were approved for only the largest 3 or 4 hospitals. Secondly in the mid-60s when the earliest SMA equipment was being requested for larger hospitals (although apparently very few major purchases were made in this period).

Third, by the early 1970s technology and capital equipment planning became more dominant. The extent of this third wave is demonstrated by Figure 5.3 which shows the total value of laboratory equipment obtained from 1973-1984 in both current and constant dollars. The ebb and flow of capital funding levels and their organizational implications will be discussed in more detail in Chapter 6. What is evident from a policy perspective is that equipment and facilities planning became two of the dominant issues by the late seventies.

d) <u>Funding and Reimbursement - Private Labs</u>

Data are very sketchy about private laboratory activity throughout the 1960s. Two sources can be used however. First it is possible to extrapolate back from the stated size and role of these "actors" at the time of the Foulkes Report in 1974. Second, some empirical evidence is available from the two principal medical insurance companies (MSA and CU&C) operating in B.C., which describes the growth in outpatient (medically insured) services throughout the sixties. This evidence will be reviewed in more detail in Chapter 6 but it seems clear that the mid-late sixties was the initial take-off period for private laboratory services in B.C. Although such establishments had been in operation in the late 1950s, the mid-late 1960s saw the parallel emergence of both multi-test automation, e.g., the SMA 12 chemistry analyzer (see Chapter 4) and the adoption of the national medical insurance plan by B.C. in 1968. These factors improved greatly, the feasibility of ambulatory testing and apparently increased signficantly the profitability of testing (Foulkes (1974)).

Fig. 5.3


LABORATORY EQUIPMENT EXPENDITURES IN BC
ESTIMATED VALUE 1973-1984
DOLLARS(MILLIONS)
0
1
2
3
4
5
6
7
1973
1975
1977
1979
1981
1983
CURRENT $
CONSTANT 1971$

e) Quality and Accreditation Issues

The LAC played an important role in setting standards for hospital laboratories through the planning of facilities, the development of regional services and initiatives to help train and fund an increasing number of pathologists and technologists in the province. It was however, through the actions of the predominantly "private lab" group of physicians following the enactment of Medicare, that a system of accreditation and licensure for private and public laboratories was developed. According to a "Background and Status Report on Laboratory Accreditation" produced for the B.C.M.A.:

> "The accreditation program for pathology laboratories in British Columbia began in 1968 through the appointment by the B.C.M.A. of a committee whose responsibility was to establish a program for the inspection and surveillance of private laboratories in the province, this to lead to a form of accreditation. In 1969 the program was expanded to include small hospitals and in 1971 through provincial government regulations, a mandatory program for accreditation was established for all private and all public laboratories in the province".
>
> Gofton (1980:p383)

The essence of the system is that it designates laboratories into 3 principal groups or categories with a specific range of tests assigned to each type.

- Category 1 Laboratories have a very limited number of tests (19) that can be done by any licenced physician.
- Category 2 Laboratories are accredited to perform all category 1 tests plus additional tests in hematology, microbiology and chemistry (a total of 73 different tests type can be done but such laboratories must have a registered medical technologist perform the work).

- Category 3 Laboratories can perform any test and the category includes "regional" category 3 accreditation for the regional hospital laboratories and category 3 facilities in the private laboratory sector. (Apparently, in some private lab organizations in B.C. even small "bleeding stations" have category three status, McArthur (1983)).

This accreditation program is monitored and contolled by inspection and proficiency testing systems for all but category 1 labs, (organized and run by the BCMA):

> "Thirty percent of laboratory payments in B.C. now (1980) are for the performance of category 1 tests. Of this 30 percent of payments, 22 percent are made to category 2 and 3 laboratories for category 1 tests. The remaining 8 percent of all laboratory payments in B.C. go to category 1 or category 1+ facilities including private physicians".

In reviewing the more than 10 years of experience with the program, Gofton (1980) suggests that it made a major contribution in upgrading the quality of both public and private facilities but also:

> "Since the onset of the program the expansion of laboratory services by the opening of new laboratories unrelated to existing major private networks has been relatively small".
>
> Gofton (1980:p. 388)

Thus as suggested at the national scale the quality assurance, accreditation and licensing activities of the profession also serve to maintain barriers to entry for prospective "competitors".

f) <u>Cost and Utilization</u>

In the early 1970s cost and utilization issues began to emerge as dominant issues in the LAC discussions and elsewhere. Differing emphasis was placed on the question by various interests. The LAC's mandate was primarily oriented towards hospital laboratories and its concerns were largely voiced in response to workload growth in hospital laboratories and the perceived inability of the funding system (i.e. hospital budgeting) to keep up with demands on the laboratory. Therefore, "eliminating unnecessary utilization" became a clarion cry, even though no one was very precise about how unnecessary utilization could be defined, much less how it could be eliminated. The LAC did not seem particularly concerned with the management practices of individual laboratories, e.g., LAC did not see the cost issue as an inefficiency issue, concentrating instead on monitoring and controlling the flow of new technology to the hospital laboratories.

The BCMA's official position seemed to be that laboratory cost escalation was caused by the unnecessary ordering of esoterica by an ill advised minority (Paul (1974)). This is in constrast to the low-cost, high volume problem that was defined by analysts elsewhere, e.g., Moloney and Rogers (1979). A brief on the subject by the Economics Committee of the BCMA did not include any concerns about prices of either high volume or low volume laboratory fee items, Paul (1974).

A third perspective on the broad issue of costs came from the Foulkes Report (1974), which saw cost escalation as problematic more in terms of the structure of the supply side:

> "Diagnostic laboratories (pathology and radiology) are under both public and private ownership. Private laboratories , generally, are superior to public laboratories (i.e., in hospitals) with regard to space and equipment owing to neglect of the public laboratories over the years. Recent trends towards automation of tests reduced costs, but in the absence of revised fee schedules has resulted in increased profits for the private operations rather than saving to the purchaser of the services."

The report advocated that eventually all diagnostic services should come under public ownership and control integrated on a regional basis. The report further recommended the establishment of a Diagnostic Services Authority (DSA) that would plan an integrated regional system of unified public and private facilities. (The report also recognized some major economic and political difficulties in implementing such a scheme).

These competing views of the cost and utilization issues have continued over the last decade. At various times the provincial government (or at least the bureaucracy) have attempted challenges to the fee schedule, which were either stoutly defended by the profession, or smothered in fuzzy accounting studies, depending on one's perspective. Organized medicine continues to decry the "over-use" of esoterica, but efforts to harness this outrage into a meaningful program of demand management have not been very successful (e.g., see Hardwick et al. (1982) and (1985) and Morrison et al. (1985)). Analyses conducted in the teaching hospitals have attempted to demonstrate that supply side management, particularly the management of technology, can inhibit cost, if not utilization increases. The Ministry of Health has acted on those research findings with apparent success. (Hardwick et al. (1981); Hardwick et al. (1985); Morrison et al. (1983); Morrison et al. (1985)).

In summary then, the policies that have emerged in B.C. have been formed from a close interaction between "needs" and "interests". Different policy issues have dominated at various times over the period. The ongoing goal of the system is to meet "legitimate needs" within a budget constraint. But the precise interpretation of what "legititmate needs" are, who should meet them and under what organizational framework is open to debate. It is useful here then to briefly compare the B.C. experience to two other provinces - Ontario and Saskatchewan - that represent polar extremes surrounding B.C.'s policies for laboratories and health generally, Crichton (1984).

5.4 COMPARING THE SIMILARITIES AND DIFFERENCES IN THREE PROVINCES: ONTARIO, B.C. AND SASKATCHEWAN

5.4.1 General Patterns of Growth

The three provinces have been selected as three representative points on a continum of ideology and structure between state ownership and control (Saskatchewan) to the more laissez faire approach in Ontario, with B.C. settling somewhere in between. Figures 4.5 and 4.6 showed absolute and relative growth in the use and cost of laboratory services per patient day for Canada and each of the 3 provinces for the period 1962-1981/82.

These data demonstrate that a consistent pattern of growth has occurred in all three provinces over the period. Table 5.7 summarizes the growth experiences of the provinces. The growth rate in the sixties appears to be substantially greater than in the seventies, although this may partly be a function of the change in measurement system for the laboratory (see table footnotes). The relative position of the provinces in absolute terms, with Ontario the highest and Saskatchewan the lowest user, is not reflected in relative rates of growth in the utilization index (Table 5.7). B.C. appears from this analysis, to have lower growth rates than Saskatchewan. This may however be a function of the data base not including private laboratory based activity.

TABLE 5.7 GROWTH IN LABORATORY SERVICES AVERAGE ANNUAL PERCENTAGE CHANGE IN USE AND COST OF SERVICES, CANADA, ONTARIO, B.C. AND SASKATCHEWAN, 1961-1981.

	Canada		Ontario		B.C.		Saskatchewan	
Years	Lab Use	Lab Cost	Lab Use	Lab Cost	Lab Use	Lab Cost	Lab Use	Lab Cost
1961-68	9.5	17.4	19.5	17.4	13.5	18.2	16.3	10.3
1971-1981/82	7.3	2.6	6.1	3.9	3.5	4.9	5.1	6.8

1 The Laboratory use Index was derived from annual hospital statistics by dividing total laboratory workload units by total patient days for public hospitals (general, teaching and allied).

2 The laboratory workload unit system was recalibrated in 1969/70 making longitudinal comparison difficult.

3 The laboratory workload unit is a weighted measure of the amount of labour normally required to produce a particular test using a particular method. With automation the number of workload units assigned to a particular procedure can be reduced as much as five fold. Thus this index may be substantially underestimate the growth in the number of laboratory tests (see text).

4 Laboratory Cost refers to constant 1971 collar cost per patient day.

In comparing policy development in the three provinces (Table 5.8) it can be seen that in all three cases, continued growth appears to have been given legitimacy because of the technological imperative in medicine and a sense of entitlement held by physicians and the public that access to diagnostic services is symbolic of a modern and humane society. Such continued growth is made feasible and is encouraged by the increasing availability of new and more powerful hardware, and a system of third party reimbursement (whether cost or fee) for the use of this hardware.

Table 5.8 LEGITIMACY AND FEASIBILITY: SIMILARITIES AND DIFFERENCES BETWEEN PROVINCES

	Legitimacy	Feasibility	
	Ideology	Funding	Structure
Similarities Between Provinces	- Technological imperative	- Third party reimbursement for procedures	- Complex services are hospital based
	- Sense of entitlement by physicians & patients	- Availability of hardware	
Differences Between Provinces	- Entrepreneurial attitudes towards clinical laboratories in Ont & BC	- Higher relative prices in BC & Ont	- Size of public vs private laboratory sector (BC, Ont)
	- State ownership in Sask	- Investment Public vs private	- Structure of private laboratory sector in 3 provinces
	- 'System wide' view in Sask vs institutional view (BC & Ont)	- 'Marketing' of tests in Ont	- Role of provincial laboratory (Sask)
		- No cross-institutional billing in Sask.	
		- Offset revenue policy in BC & Ont	- Limited regionalization in BC and Ont.

5.4.2 Structural Differences

There are however some important structural differences among the three provinces, in particular with regard to the role and importance of privately owned, "fee for service" clinical laboratories (see Table 5.8). The size of the private laboratory sector in B.C. and Ontario is substantial, whereas in Saskatchewan it is virtually non-existent (Labonte (1983), Committee for the Healing Arts (1969) and Personal Communication Saskatchewan Department of Health (1983)). Indeed, estimates for Ontario suggest that the growth rates of the private laboratory sector are approximately 50% higher than hospital based facilities (Globe and Mail (1984)). In B.C. the private laboratory industry is a medically controlled oligopoly (with three "practices" dominating the market) , whereas in Ontario the industry primarily, is a corporately controlled oligopoly, Labonte (1983), Globe and Mail (1984).

These structural differences reflect the ideological bent of the provinces. The Saskatchewan laboratory facilities have a more "system-wide" focus and conform to a belief in state control, i.e., providing a service to a population via a network of public institutions. This is reinforced and made feasible for example, in the way in which the Saskatchewan Provincial Health Laboratory acts as a spillover or buffer facility that provides testing capacity for outpatient services including biochemical testing. This is in contrast to B.C. and Ontario, where Provincial Health Laboratories have a narrower more specialized mandate (principally microbiological and public health functions) and additional testing capacity (over and above hospitals) are provided in the fee for service private laboratories. Similarly, Saskatchewan has no system of cross institutional billing for tests performed, again reinforcing the notion of a system wide view of services. In contrast, Ontario and (as we have seen) B.C. have an active system of private laboratories that are entrepreneurial in nature and that embody values of private rather than public ownership.

Although bureacratic rationalization of the Saskatchewan type has not occurred to the same extent in Ontario and B.C. there are a number of emerging trends in laboratory policy that are likely to have an impact on the organization and performance of the three provincial laboratory systems.

5.5 TRENDS IN CLINICAL LABORATORY POLICY AND THE IMPLICATIONS FOR STRUCTURE

5.5.1 Reimbursement and Regulation

The primary trends to be considered are changes in attitude towards reimbursement and regulation. First, governments are still faced with expanding use and cost of diagnostic services at a time of severe fiscal constraint (UBC Health Policy Study Group (1982), Hardwick *et al*. (1985). This is leading all provincial governments to put increasing pressure on the hospital based diagnostic facilities through hospital budgetary constraints. (As noted earlier, a parallel situation is occurring in the U.S. where DRG finding mechanisms creates significant incentives to curtail or relocate hospital based laboratory activity). Second, there is a growing, and seemingly politically acceptable, trend towards "for-profit" approaches in selected aspects of health care in the U.S. and to a lesser extent in Canada, e.g., hospital management. Third, the provincial governments of both B.C. and Ontario appear to have accepted the status quo with regard to traditional attitudes toward private laboratories, i.e., they seem unlikely at this stage, to alter unilaterally the structure of the industry through regulation. Attempts have been made to encourage competition between the public (hospital based) laboratories and the private laboratory sector. For example, McKintosh (1981:p.157) identifies that "physicians in British Columbia are required to give priority to public (hospital) diagnostic services when these operate in competition with private facilities". This is by virtue of a 1971 'Order in Council' in B.C. (B.C. Ministry of Health (1981) p. 191). However, there appear to be few mechanisms or incentives to enforce this order.

Similarly in Ontario, the recently announced BOND program, an attempt to encourage independent revenue generation on the part of hospitals, is reflected in the laboratory sector where hospitals have been encouraged to compete with private laboratories for outpatient work. Although governments may have an interest in having hospital based facilities compete with private laboratories, they have difficulty in designing incentive systems to achieve this. More importantly, they have difficulty in maintaining these incentives in the medium term. This is part of the more general problem of designing incentive reimbursement systems for hospitals, in that any surplus achieved by an institution is perceived, in the medium term, as a signal of "over-funding".

The interaction of these three reimbursement and regulatory factors leads to interesting dynamics between the policy actors in each of the provinces.

a) Ontario: The For-Profit Commercial Model

First, Ontario already has a much more profit oriented, commercial model for its private laboratory sector with publicly traded companies operating in multi-site chains: the trend towards corporate oligopoly described in the U.S. by Bailey (1979). It is understood that these arrangements must lead these institutions to pursue growth actively for the benefit of their share-holders. To this end they have a sales force that solicits new business. Even with some form of fee schedule competition bewtween private and public laboratories it is likely that a "competitive" private sector will lead overall to higher government expenditures on diagnostic services (because "gross sales" eauals "gross expenditures"). This eventually puts even greater pressure on governments to act in the direction of restraint in public institutions, or to act through increased regulation of the industry. Either way, this leads to increased confrontation between the private sector and both government and public laboratories.

Secondly, this scenario puts pressure on the diagnostic service professionals who are "reduced" apparently, in this model to the level of corporate employee.

Thirdly, it puts pressure on academic diagnostic service professionals to challenge the corporate laboratories since public restraint and private expansion translates into a direct transfer of testing, funding and income from the public medical sector to the private corporate, non-medical sector. (The corporate technology providers who in the U.S. environment have vertically integrated into the provision of clinical laboratory services, might counter this scenario by generous endowments to the academic professionals but this seems unlikely to offset the potential revenue distribution effect). This situation seems inherently unstable since corporate profits are dependent on professionally negotiated fee schedules and continued government funding.

Fourthly, it is possible that one of the "logical" policy responses to continued growth in laboratories might be an increased amount and proportion of user fees. Anecdotal evidence in the U.S. suggests that this is a likely consequence of the combined effects of DRG's and the ambulatory provisions for Medicare in the 1984 Deficit Reduction Act. In Canada and in particular in Ontario, increasing application of laboratory user fees is possible, given the ongoing extra-billing controversy and the beginnings of user-fee "nibbles" into the "sacrosanct" social welfare programs under the new Mulroney government. The basic flaw in this approach being applied to clinical laboratories over and above the well-established criticisms of user fees in health, is that the patient is not the consumer of the laboratory test it is the physician (Hardwick et al. (1985)). Will any government impose user fees on physicians' use of resources, and live to tell the tale?

b) B.C.: Professionally Dominated Diagnostic Services

In British Columbia, a professional rather than a corporate oligopoly exists in the private laboratory sector. As discussed earlier, similar, though less advanced trends, seem to be unfolding there too. The question now in B.C. is to what extent the apparent transfer between public (cost reimbursed) and private (fee-reimbursed) institutions will go unchallenged. B.C. has been described as a pragmatic province with regard to health services, in that the provincial government's interests are driven by the bottom-line rather than by ideology (Crichton (1984)). (This notion helps explain the ideologically inconsistent moves made by the B.C. government in the health area.) If this is true for laboratories, it would seem that the public/private debate might be resolved on cost effectiveness grounds. This is only likely to happen for laboratories in B.C. when more sophisticated policy/management tools are available and if there is a political will to use them.

c) Saskatchewan: A Public System View

In Saskatchewan the challenging actors i.e., government, have had more power because of the underlying ideology of health policy in that province. The power of this structural interest has been embodied in the structure of diagnostic services in that province since inception. Thus, even with a conservative government in Saskatchewan it is inconceivable that the province will develop a large private laboratory industry.

A related issue that results from the reimbursement and regulation trends outlined above, is the potential confrontation between corporations and the process of privatization on the one hand, and regulation and technology assessment on the other. Banta and Russell (1981) argued that technology assessment, cost-effectiveness and cost-benefit analyses are the logical fourth stage in policy development for medical technology generally. However, privatization, for example in the laboratory sector, takes the decision-making about new eouipment embodied technology out of the hands of the regulators and places it in the hands of the corporate actors. This situation is particularly advanced in the U.S. case where the corporate technology providers have vertically integrated into the provision of laboratory services. The policy question is whether central planning activities such as technology assessment are compatible with privatization. Again confrontation seems inevitable.

5.5.2 Laboratory Technology: The Trends and Implications

The second broad trend in laboratory policy is in the functional focus of medical technology in general and the prevalent technologies of laboratories in particular. As outlined in Chapter 4.4 a focus that places greater emphasis on complex "half-way technologies" that require detailed therapeutic monitoring and fine grain diagnosis, will create two effects on the organization of diagnostic services. First, the perceived requirement for greater and greater concentration of complex diagnostic facilities (e.g., PET and NMR imaging and complex cytogenetic investigation) in the tertiary referral teaching environments will place even greater fiscal burden on these institutions. Second, the requirement to provide real time physiological monitoring "nearer the patient" will increase pressure for the diffusion of routine laboratory facilities, not only to small hospital laboratories, but to clinics, wards and physicians' offices. This latter trend towards "nearer the patient testing" has important structural implications. First, it creates even greater difficulties for control of the system, not only in terms of the likelihood of increased utilization and thus cost of laboratories, but also in terms of the quality of the services provided. Second, it has the potential to undermine the roles of pathologists and technologists as more laboratory procedures fall under the responsibility of clinical physicians, nurses and other ancillary professionals. These issues are rapidly emerging in the U.K., the U.S. and Canada. (Browning (1982); Belsey (1984) and Hardwick (1985)). Initial reactions suggests that the debates over the deployment and control of these technologies may be bitter and protracted.

5.5.3 Manpower and Management: Trends and Implications

A final and related trend is in the manpower structure and competition for control within the laboratory industry itself. Two issues are of importance. First, is the recent push by medical technolgists in Ontario and Manitoba for self-regulatory status. This comes in response to the growth in size, specialization and professionalization of diagnostic services in Canada over the last 30 years. Pursuit of this issue is likely to lead to confrontation between pathologists and technologists and between commercial laboratories and employees. The second issue is the increasing role of the hospital administrator in challenging the diagnostic service professionals. The changes in reimbursement and the increasing trend towards "closed off" rather than "open-ended" patterns of funding, Crichton (1984), places the administrator in the position of being accountable for "trading off" quality/accreditation concerns against cost. Laboratories will thus be viewed as an arena for confrontation over these issues. In smaller hospitals, where laboratory professionals may have less power (for example, because they are not geographically full-time) it is possible that hospital administrators will move to bring laboratory services under direct management control. (The spectacular growth of the Clinical Laboratory Management Association (CLMA) in the U.S. over the last five years is evidence of power shifting from pathologists to professional management). The trend toward management rather than medical control of laboratories may or may not improve cost-effectiveness but it seems that it will inevitably increase confrontation (particularly between the dominant and the challenging interests). It also reflects the renaissance of scientific management in the service sector - or perhaps attempts at the industrialization of the service sector.

5.5.4 Prospects for Control

A combination of intertial factors and dynamic factors operate in the three provinces. In Saskatchewan the historical hold that government has had on the laboratry sector and its integration into a systems view of health seems to have sufficient inertia to withstand any attempts by the dominant actors to reassert themselves. Thus in Saskatchwan there may well be continued growth fuelled by the pervasive scientific focus in medical care, but that growth will not be viewed so much as a policy problem, because it will occur within the framework of overall health systems development.

In B.C. it is likely that the medical dominance of laboratories will continue until such times as the policy and management tools are sophisticated enough, the costs are large enough and the political will is strong enough, to promote intervention. In the interim laboratories in B.C. will continue to grow albeit in an increasingly tense and confrontative environment. (The future of the B.C. laboratory system will be explored in more detail in the final chapter).

It is in Ontario that the pressures will be greatest because of the economics and the structure of the laboratory sector. If the commercial system fails to produce more cost-effective laboratory services will there be sufficient pressure to change the system? Will Ontario be forced to choose between a return to medically controlled oligopoly or an assault on the Canada Health Act by allowing extra-billing for laboratory services? Whatever course is taken it seems that conflict is inevitable.

In summary then, emerging trends in laboratory policy in Canada appear to be leading towards a destabilization of the "coalitions" that have historically driven policy in this area. These informal coalitions have reinforced growth of laboratory services in Canada over the past three decades. Ironically, the destabilizing of these coalitions does not offer a prospect for improved control or management of growth. Instead, the process of pluralization, confrontation and structural differentiation may create even greater difficulty in managing laboratory growth.

In order to resolve the inherent instabilities in the structures that are emerging, greater emphasis must be placed on developing a new set of coalitions that are capable of managing growth. This will involve much closer co-operation between dominant and challenging interests, in the policy-making process. Unless there is a focus on concensus building and open negotiation in policy-making it is possible that confrontation will lead to deterioration in quality and cost effectiveness in the laboratory sector.

5.6 CHAPTER SUMMARY

This chapter has described what policies have been made and how these policies have been made for B.C. It has also set the B.C. experience in the context of other Canadian policy-making.

The conclusion that can be drawn is that growth in use of laboratory services is a common phenomenon that is found throughout Canada. Such growth is fuelled primarily by the increased demands from technologically oriented physicians for laboratory-generated "answers to questions". However, it is also evident that the structure of this growth in an economic, organizational and geographic sense is shaped very much by the policy-making process which in turn is steered by the ideology, perceptions and decisions of a number of structural interests. This is not to suggest that policies made are wrong or illegitimate; rather, they reflect a political process of decision-making, one in which certain groups have historically had more power than others. The engine of growth may be medical science, but the growth is being channelled by policy.

For example, the differential growth of private laboratories observed in B.C., Ontario and Saskatchewan suggests that environmental factors (such as the availability of suitable candidate technologies and the existence of third party medical insurance) do not provide the necessary and sufficient conditions for systems change. They may greatly enable such change but they do not dictate it. Rather the process of structural transformation is shaped by environmental change, perception of that change by groups and individuals, and by the policies that flow from those perceptions.

It is also evident that policies have a tendency to backfire on the policy makers in later years. In particular, the federal government's actions in the 1950s in initiating upgrading of manpower and facilities across Canada, rebounded decades later as problems of cost, utilization and lack of control on growth. Similarly, the role played by organized medicine in B.C. in assuring quality of services in the late sixties, has given that group power to control the organization of service delivery. The provincial government and the hospitals are left with a large snowball - started by the federal government and pushed along through the years by the dominant structural interests.

CHAPTER 6 TRANSFORMATION IN THE STRUCTURE AND PERFORMANCE OF THE CLINICAL LABORATORY SYSTEM OF BRITISH COLUMBIA 1954 - 1984

6.1 INTRODUCTION

The previous chapter concluded that the interaction of environmental change, strategic perception and policy-making have had an important influence on the structure and performance of the laboratory system. The purpose of this chapter is to provide specific empirical evidence of the changing organizational and spatial structure of the B.C. system from 1954 to 1984. A chronological approach will be used to reconstruct the stages and the process of structural transformation. The chapter is divided into six main sections.

6.2 The Fifties - the need for upgrading

6.3 The Sixties - the needs of equity and accessibility

6.4 The Seventies - pressures for growth and the needs for control and rationalization

6.5 The Eighties - restraint and systems' maintenance

6.6 Synthesis - transformation in spatial structure

6.7 Chapter Summary

For each of these time periods:

a) The environmental and policy context facing laboratories will be described.

b) The structure of the system in terms of its technology, organization and location will be analyzed.

c) The performance of the system will be evaluated against strategic goals.

The data for this chapter are drawn from a number of primary sources used already in chapters 4 and 5. In this chapter more specific analyses of Statistics Canada hospital data and Medical Services Commission data will be conducted.

It will be shown that the B.C. system has gone through a number of identifiable stages of development and that the process of transformation between these stages is influenced more by shifts in environment and strategic choice than by the adoption of specific technologies by sub-units in the system.

In particular, it is argued that the widespread perception of inadequacies in the B.C. laboratory system in the 1950s and the initiatives taken by the federal and provincial governments, the profession and certain institutions, created substantial pressures for upgrading. The policies that emerged led to a relative dispersion of laboratory activity (organizationally down the hospital hierarchy and geographically throughout the province). Similarly, a strategic focus on improving social, economic and geographic accessibility to services in the sixties and early seventies produced continued spatial and organizational decentralization of laboratory activity from larger hospitals to smaller hospitals and to the ambulatory setting (including private laboratories).

Technology played an important role in amplifying the effect of these strategic choices but it did not initiate them. Indeed, it will be shown that the strategic decision to disperse services to smaller regional centres predates the availability of candidate technologies that might encourage such dispersion.

Finally, it will be argued that current problems with the performance of the system in terms of persisting regional imbalances in availability of services and lack of control on growth are compounded by the institutional frameworks that were developed in the 1950s and 1960s. Again, technology may have amplified the magnitude of these problems, but it is argued that the current spatial and organizational structure of service delivery is a result primarily of previous strategic choices.

6.2 B.C. CLINICAL LABORATORIES IN THE 1950s: THE NEED FOR UPGRADING

6.2.1 Environmental and Policy Context

The B.C. government established a system of provincial hospital insurance in June 1948 that reimbursed hospitals on a fixed budget basis (including coverage for "pathologists' services" on an inpatient basis)(Pearson 1948). Such a system of insurance reflects the adoption of the values of a government run hospital insurance scheme pioneered originally in Saskatchewan, LeClair (1975).

Despite an established hospital insurance plan there were significant pressures for upgrading of the hospital system in general, and hospital laboratories in particular. This was a result of demand presures from an increasingly sophisticated medical profession (discussed in Chapters 4 and 5) but was also reflected in the findings of the government sponsored Hospital Insurance Inquiry Board of B.C. (1952) that:

> "Due to the rapid growth of population and industry, the Province is in urgent need of some new and additional construction of both acute and general hospitals and chronic or convalescent institutions".
>
> Hospital Insurance Inquiry Board (1952)

This is not to suggest that the government accepted cost increases uncritically. Indeed, in the same report, a comparison of similar sized institutions in Saskatchewan and B.C. yielded the conclusion that:

> "the very considerable excess of costs in British Columbia over those in Saskatchewan arises chiefly from the difference in the amount of net wages and salaries paid in the comparable institutions".
>
> op. cit. (P FF 67)

The federal government also played an important role in the process of upgrading with a series of grants for particular demonstration or pilot programs. The Laboratory and Radiological Services Grant ran from 1953 to 1957 and provided funding for upgrading laboratory services.

> "The Laboratory and Radiological Services Grant was designated to assist provinces in establishing and improving diagnostic services through the training of radiologists, pathologists and other personnel; extension of diagnostic facilities; provision of diagnostic equipment and maintenance of laboratory and radiological services".
>
> McIntosh (1982:14)

Table 6.1 shows the amounts of the grant for B.C. for the fiscal years 1953/54 to 1956/57 and the relatively small share that was expended on laboratory equipment. Sources do not show precisely how the remainder of these grants were spent, but B.C. Ministry of Health and Welfare annual reports imply that these funds provided the necessary fiscal stimulus for both the establishment of the medical technologist training program in 1956 at V.G.H. and the regional laboratory services at Trail, New Westminster and Kamloops.

TABLE 6.1 FEDERAL LABORATORY AND RADIOLOGICAL SERVICES GRANT TO B.C. 1953/54 - 1955/56

YEAR	TOTAL GRANT IN CURRENT DOLLARS	EQUIPMENT SHARE LAB %	RADIOLOGY %	TOTAL EQUIPMENT %
1953/54	339,400	3.4	6.2	9.6
1954/55	400,500	7.5	19.6	27.4
1955/56	506,400	n/a	13.6	n/a
1956/57	743,500	n/a	38.0	n/a

Sources: 1) Laboratory Advisory Council Minutes
2) B.C. Ministry of Health and Welfare, Annual Report 1958 pp J32, 33.

These grants also acted as a spur to the creation of the laboratory Advisory Council:

> "the plan for the development of improved clinical laboratory services in this province was approved by the Department of National Health and Welfare, but the implementation of the plan has been delayed pending the appointment of the Advisory Council".
> (B.C. Department of Health and Welfare, (1954:p L106))

Three items dominated the policy agenda of the LAC in the mid 1950s. First, the need to improve the physical plant of laboratory facilities was recognized. For example, a new provincial health laboratory was built in Vancouver in 1955 and V.G.H.'s Pathology Department moved into 30,000 square feet of new space in 1957.

The second important component in the upgrading agenda of the 1950s was the creation of the initial regional laboratory services. Table 6.2

reconstructs the establishment of regional laboratory services based on the LAC minutes and B.C. Department of Health and Welfare Annual Reports. As was shown in Figure 5.1 and discussed in general terms in Chapter 5, during the period from 1955 until 1962 the LAC agenda focused on the establishment of regional centres for:

1) Lower Fraser Valley - based at Royal Columbian Hospital and serving initially four (and by 1958 a total of nine) hospitals throughout the Lower Fraser Valley.
2) Trail/Tadanac - based at Trail Hospital this centre was the first to be funded directly from National Health Grants and was designed to provide regional laboratory services for all the Kootenays.
3) South-Cariboo (Currently Thompson-Nicola) centred at Royal Inland Hospital in Kamloops, this facility was to provide regional services to hospitals of the Thompson and Cariboo regions.
4) Okanagan - Centred originally in Kelowna, this region was split subsequently into 3 sub-regional centres at Kelowna, Vernon and Penticton.
5) Upper Vancouver Island - Nanaimo was designated a regional centre serving the north and central areas of Vancouver Island in 1960.

The third and final major agenda item was the need for upgrading the quality and quantity of laboratory manpower, in particular, medical technologists. A program run by the University of British Columbia was established at Vancouver General Hospital in 1956. By 1958, the B.C.

TABLE 6.2 DEVELOPMENT OF BRITISH COLUMBIA'S REGIONAL LABORATORY SYSTEM 1955 - 1975

Year	Number of Regional Centres Added	Cummulative Regional Centres	Number of Professional Manpower Additions to Existing Regions	New Regional Centres Established
1955	1	1	-	Lower Fraser Valley (RCH)
1956	2	3	-	Trail-Tadanac (Kootenay) Thompson-Nicola (Kamloops)
1957	1	4	-	Central Okanagon (Kelowna)
1958	-	4	-	
1959	-	4	-	
1960	1	5		Nanaimo
1961	-	5	-	
1962	-	5	-	
1963	1	6		Prince Rupert-Kitimat-Terrace
1964	1	7	3	Prince George
1965	-	7		
1966	1	8	2	St. Paul's (Vancouver)
1967	-	8	3	
1968	-	8	4	
1969	1	9	3	Cranbrook (E. Kootenay)
1970	-	9	2	
1971	1	10		
1972	-	10	1	Dawson Creek (Peace River)
1973	-	10	1	
1974	1	11		Cowichan (Royal Jubilee)
1975	1	12		Nelson (W. Kootenay), Trail splits to become centre for Kootenay Boundary

Department of Health and Welfare could report that:

> "The shortage of fully qualified medical technologists was not as acute this year due mainly to an increased number of graduates from the training school".
>
> B.C. Dept. of Health and Welfare (1958, p. J33)

Emphasis was also placed on refresher courses for technologists, particularly those in hospitals without the full-time services of a pathologist.

These three policy initiatives aimed at upgrading physical facilities, regional services and manpower were the primary focus of policy-making for laboratories in the late 1950s. The legitimacy of upgrading was seen by virtually all the policy actors and was made feasible by federal initiatives (the Grants system prior to 1957 and the Hospital Insurance and Diagnostic Services Act after 1957) that provided financial support, in particular capital funding, over and above the existing provincial hospital insurance system.

6.2.2 Technology, Organization and Location of Laboratories in the 1950s

Statistics Canada data on individual hospitals does not extend back before 1966 in a machine-readable form. However, published hospital statistics provide a useful snapshot of the general pattern of laboratory service provision in the 1950s.

Data for 1954 indicates that B.C. was below the national average in the percentage of hospitals that had laboratory facilities, 77.2 percent as opposed to 85.4 percent for Canada as a whole (DBS, 1954 p. 41).

Similarly, the proportion of work referred in from other hospitals as a provincial average (a surrogate measure of overall lab referrals), was less than 1 percent in B.C. compared to almost 5 percent nationally. These two factors suggest relative inadequacy and insularity of laboratory service provision, and they stress further the legitimacy of the need for upgrading regional laboratory services.

In terms of manpower, the distribution between occupations is compared with Canada, in relative and absolute terms in Table 6.3. B.C. lags behind the Canadian average in terms of numbers of qualified professional staff, i.e., pathologists, bacteriologists and biochemists. But, it is interesting to note the difference in the certification level of pathologists. At the national level 131 (68 percent) of pathologists (and/or bacteriologists) had certification whereas in B.C., 13 (87 percent) had certification. Similarly, B.C. has a much higher ratio of interns in the laboratory. These differences may be associated with the attraction of more recently qualified graduates to B.C., with the establishment of the UBC medical school in the early 1950s and with the more widespread upgrading process outlined above.

The candidate laboratory technologies available in the 1950s were limited to complex manual procedures, except for flame photometry introduced to V.G.H. and perhaps other large hospitals in 1950.

As shown earlier, growth in use of tests at V.G.H. and elsewhere proceeded rapidly through the 1950s. The overall growth in laboratory services for B.C. and Canada is represented by data between 1954 and 1962 (Table 6.4). Two principal points should be made. First, real growth over the period in Canada was much higher than for B.C. This reflects the impact of the national Hospital Insurance and Diagnostic Services Act in 1957 on the provinces that did not already have some form of comprehensive hospital insurance. But this differential growth is also a function of the fact that B.C. started with a level of laboratory activity that was 25 percent higher than the national average.

TABLE 6.3 B.C. AND CANADA LABORATORY MANPOWER BY CATEGORY FOR 1954 (FULL-TIME PERSONNEL ONLY)

Category	Canada Number	Number per Million Patient Days	B.C. Number	Number per Million Patient Days
PROFESSIONAL				
Bacteriologist/ Pathologist	72	3.07	7	3.00
Bacteriologists	34	1.45	2	0.86
Pathologists	88	3.76	6	2.58
Biochemists	51	2.18	4	1.72
Interns	114	4.87	15	6.43
TOTAL PROFESSIONAL	365	15.58	36	15.44
Technicians	1687	15.58	171	78.32
Others	583	24.88	96	41.16
TOTAL	2629	112.20	301	129.06

Source: Canadian Hospital Statistics Annual Report
Dominion Bureau of Statistics, Ottawa, 1954

TABLE 6.4 HOSPITAL LABORATORY COSTS FOR CANADA AND B.C. 1954 - 1962 BY SIZE OF HOSPITAL*

	1954				1962				% Real Growth**	
	Canada		B.C.		Canada		B.C.		Canada	B.C.
BED SIZE	$'000	% Share	$'000	% Share	$'000	% share	$'000	% share		
1 - 49 50 - 99	407	5.30	48	5.06	1468 1902	3.88 5.03	201 194	7.08 6.84	629	624
100 - 199	1258	16.53	122	12.86	6497	17.19	625	22.03	355	351
200 - 299	859	11.29	42	4.43	4839	12.80	152	5.36	396	218
300+	5175	68.00	738	77.77	23094	61.09	1664	58.65	293	98
TOTAL COST	7610	100	949	100	37803	100	2837	100	315	144
COST PER PATIENT DAY										
Current $	0.325		0.406		1.182		1.020			
Constant $	0.503		0.628		1.610		1.390		220	121

Source: 1) Dominion Bureau of Statistics, Hospital Statistics Annual Report 1954.
2) Statistics Canada, Special Tables produced at the request of the author, 1985.

* Includes all PGAS Hospitals (Children's and CCABC included).

** % Real growth refers to the percentage increase in the total (constant 1971 dollar) cost of laboratories in the class. The GNE deflator was used to calculate constant dollar costs.

The second point to note is the remarkable relative deconcentration of laboratory activity over the period in B.C. (and to a lesser extent in Canada as a whole) from the very largest facilities to the smaller and medium sized hospitals (particularly 100-199 beds). This reflects the impact of policies aimed at upgrading regional services.

It is difficult to provide any accurate estimate of private laboratory activity in the period 1954 to 64. (The first private laboratory operation in B.C. was begun in 1959, McArthur (1984)). But an estimate of the total outpatient laboratory activity can be derived using private medical insurers' data. Table 6.5 shows outpatient laboratory expenditures per capita by type of medical insurer from 1954 to 1983, both in current and in constant (1971) dollars, shown in parentheses. The private insurance data are for only two companies (who had most of the market) and are thought to be somewhat inaccurate (Personal Communication, D. Schreck 1985). This is largely because they were derived from annual reports of these agencies, (corroborated by periodic surveys of the voluntary medical insurance market) and the accuracy of management information systems on which such reports were based is suspect. Nevertheless, the data show steady absolute and relative growth in expenditures on outpatient pathology services through the fifties and early sixties, although the absolute amount of real per capita cost was still low compared to the seventies. The dramatic discontinuity shown after 1968 and the continued escalation of pathology services as a share of all medical services will be discussed in more detail in sections 6.3 and 6.5).

TABLE 6.5 PATHOLOGY AS AN INSURED MEDICAL SERVICE - OUTPATIENT LABORATORY COSTS BY TYPE OF INSURER
1957 - 1983 (SELECTED YEARS)

Year	Number of Persons Insured (including dependents)			Pathology Cost per Person			Total Pathology Cost in Thousands			Pathology as a Share of All Expenses		
	$MSA_{2,4}$	$CU\&C_3$	MSC Total B.C. Population	$MSA_{2,4}$ $	$CU\&C_3$ $	MSC_1 $	$MSA_{2,4}$ ($000)	$CU\&C_3$ ($000)	MSC_1 ($000)	$MSA_{2,4}$	$CU\&C_3$	MSC_1
1957	381,058	106,642*	1,482,000	0.54 (0.78)	0.38* (0.55)	-	206 (299)	40 (58)	-	2.3%	2.7%*	-
1961	480,528	106,906*	1,631,226	0.86 (1.19)	0.94 (1.30)	-	413 (570)	100 (138)	-	3.0%	3.4%	-
1967	707,995	166,871*	1,935,863	1.68 (1.96)	2.00* (2.33)	- -	1,189 (1,385)	334 (389)	-	4.7%	5.0%*	-
1970			2,122,430			3.64 (3.76)			7,733 (7,989)			6.3%
1975			2,404,102			9.93 (6.78)			23,880 (16,300)			9.3%
1979			2,633,323			17.05 (8.47)			44,059 (22,304)			11.0%
1983			2,819,979			36.18 (12.47)			102,020 (35,167)			12.9%

See Table Notes

TABLE NOTES

SOURCES:

1) Medical Services Commission, Annual Financial Statements.
2) Shillington (1957,1961,1967) Trans-Canada Medical Plans Annual Enrolment Experience and Annual Financial and Statistical Experience Report
3) Personal Communication - D. Schreck General Manager of CU&C Insurance
4) Annual Reports of the Medical Services Association, Vancouver

NB

Items marked with an asterisk are estimated because CU&C data counted number of enrolees as opposed to number of persons covered for the years shown. MSA data for persons per enrolee were therefore used for those years. Laboratory expenditures for CU&C are pure estimates based on one year of accurate percentage share and total laboratory cost. Other years estimates were generated by estimating a trend line (using MSA growth as an indicator) through the known point.

Figures in brackets are in constant 1971 dollars.

6.2.3 Performance of the System

The B.C. experience in the fifties suggests that a major structural shift had begun in the organization and location of service delivery, this occurred even though routine operational reimbursement systems for hospitals remained constant and there was no major diffusion of equipment-embodied technology in the period, to any but the very largest of hospitals. Yet a very substantial relative deconcentration of activity began to occur. It must be re-emphasized that the period 1955-62 saw a major push by policy-makers to establish upgraded regional laboratory services in the province. If this was the primary goal in a process of upgrading, then it appears that significant progress towards that goal was made. However, as we shall see below, major regional imbalances still remained in the sixties in terms of the spatial distribution of laboratory activity, and in the access to services and expertise.

In summary, it appears that the observable relative upgrading of the clinical laboratory system in B.C. was achieved primarily through a combination of federal and provincial policy initiatives aimed specifically at upgrading physical facilities, manpower and regional laboratory services.

6.3 THE SIXTIES - THE NEED FOR EQUITY AND ACCESSIBILITY

6.3.1 Policy and Environmental Context

The sixties was a decade of major social transformation in North American society. In health the Saskatchewan Doctors' Strike of 1962 and the provincial government controlled medical insurance system that resulted, laid the foundation for Canada's Medicare system (implemented nationally between 1967 and 1969). The period from 1962 to 1972 is a very important one for clinical laboratories in B.C. Not only was it a period of sustained growth, but it also saw the consolidation of a structure for laboratory service delivery that has carried on throughout the last two decades - sometimes challenged, but never changed.

In the 1960s, British Columbia went through a period of rapid growth generally and health care was no exception. Similarly, the medical and technological environment of the mid-60s to the early seventies was relatively dynamic. Candidate technologies - such as the developments in laboratory automation described in Chapter 4 and Appendix B - became available for purchase by private laboratories by the mid-60s. It is not clear whether private laboratories in B.C. acquired these technologies on introduction to the market in 1965, but they were certainly in place by 1969, because by that time a 12 channel chemistry profile was given a fee schedule number (B.C.M.J. July 69). The early versions of this automated technology (the Technicon Auto Analyzer I series and Coulter Counters) had been obtained for very large hospitals (the top 5), immediately they were introduced in Canada in 1959 and 1960. Similarly, the second wave of profiling analyzers (SMA 12 and SMA 6) were introduced into selected hospitals in the mid-60s. Wider diffusion of these technologies was not actively encouraged by the LAC despite requests from the regions. However, it appears from discussions in the LAC minutes that less expensive, semi-automated systems were provided for the regions, although no specific data are available from this source.

The relationship between technology diffusion and the regions in the 1960s is an interesting one. The LAC received a report from consultants in 1965 that stated:

> "the trend of medical practice is changing due to automated equipment. In some larger centres multiple tests are considered cheaper than individual tests and advances in cybernetics and telecommunications could make results available immediately. These trends must be taken into account when considering the future of regional laboratory services."
>
> (Quote from a personal Communication to LAC 1965)

LAC reaffirmed their belief in a regional laboratory system and throughout the 1960s continued to "feed the regions" in terms of their growing requirements for professional and technical manpower. However, on several occasions in the late 60s, regional centres began to report that their satellite hospitals were referring proportionately less work to the regional centres. This was partly because of improvements in the number and quality of staff in the satellites, but also because of the impact of automated and semi-automated technology. (No data are available for years prior to 1976 to determine whether any testing formerly done by regional hospital laboratories was captured by private laboratories in the sixties. Data from the private insurers does indicate that from 1964 to 1967 there was a substantial growth in outpatient laboratory billings in British Columbia. For example, the principal private insurer (MSA) noted in its annual report of 1967 that outpatient laboratory billings increased by 27% over the previous year (1967)).

If physicians were reluctant to order tests on uninsured outpatients in the early sixties, the reasons for that reluctance were removed in 1968 with universal medical insurance. Although rapid increases in outpatient testing seem to predate universal medical insurance in B.C., such a policy clearly removed any barriers and substantial increases in both use and cost are evident (see Table 6.5).

6.3.2 Technology, Organization and Location in the Sixties

The 1960s is the decade in which there is hiatus in the data series, consequently consistent empirical evidence for all sectors of the system is difficult to obtain. However, a number of patterns can be sketched out.

First, it has been demonstrated that the sixties was a period of expansion in the number of regional laboratory centres and in the professional manpower for these centres. Although time series data on regional equipment allocations were not available for the sixties, a number of pieces of evidence point to this as a period in which laboratory facilities were greatly improved, even though they may not have become highly automated. Both the B.C. Ministry of Health's annual reports for the late sixties and the LAC minutes indicate increased diffusion of capital equipment. For example, the Ministry's annual report of 1968 stated that because of increasing demands for new tests and greater availability of candidate technologies:

> "Assessment of new equipment required to perform many of the recently developed tests considered essential to good patient care has become more difficult. To illustrate the growing demand, equipment totalling $250,000 was purchased by laboratories in British Columbia in 1967, whereas this amount was spent in the first six months of 1968."

Similarly the Ministry's annual reports of 1962 and 1970 indicate that a program of new laboratory construction paralleled the establishment of regional centres so that by 1970, the Ministry could report that "plans for 20 laboratories were either under review or at the working drawing stage."

In parallel to this increased provision of physical plant, the reports in the 1960s continued to stress increased workloads and consequent need for additional manpower. In 1964, the newly opened British Columbia Institute of Technology (BCIT) took over the medical technologists' training program with an initial class size of 80 students per year. By 1967 the Ministry reports:

> "A shortage of trained laboratory technologists existed, and the smaller hospitals in the suburban areas had difficulty in obtaining adequate staff. Facilities at the British Columbia Institute of Technology were increased to accommodate more trainees, and a new programme was initiated .... 80 students enrolled in the one year programme and 82 in the two year programme."
>
> Ministry of Health (1967, p M31)

The results of increasing provision of both capital and human resources are shown in the growth in use and cost in B.C. during the sixties that was reviewed in Chapters 4 and 5. More particularly Table 6.6 shows laboratory costs as a share of all hospital costs, by size of hospital for B.C. On average, the laboratory's share of hospital costs increased by 58 percent for all sizes of hospitals in the period 1962-70, from a 4.1 percent share to a 6.5 percent share. This share levelled off - or in the case of larger hospitals actually declined - throughout the seventies. The sixties was clearly a period of absolute and relative expansion in hospital based laboratory services.

The extent to which upgrading was distributed among the hierarchy of hospitals is difficult to unravel, but Table 6.7 shows two effects: one of

TABLE 6.6 LABORATORY COSTS AS A SHARE OF ALL HOSPITAL COSTS 1962-1981/82 FOR ALL PGAS HOSPITALS IN B.C.

BED SIZE YEAR	1-49	50-99	100-199	200-299	300+	TOTAL
1962	2.5	2.1	4.2	4.1	5.0	4.1
1963	2.9	2.4	4.4	4.2	5.3	4.4
1964	3.0	2.5	4.5	4.8	5.6	4.6
1965			NOT AVAILABLE			
1966	3.6	3.3	4.8	5.3	6.5	5.3
1967	4.1	3.3	5.1	5.1	7.0	5.7
1968	4.7	3.6	5.4	5.4	7.9	6.3
1969	5.2	3.9	5.6	5.9	7.5	6.2
1970	5.4	5.3	5.4	6.1	7.5	6.5
1971	5.6	6.1	5.4	6.3	7.0	6.4
1972	6.9	4.4	7.6	n/a	7.2	6.5
1973	5.9	6.5	5.4	5.8	7.6	6.9
1974	5.9	6.2	5.2	5.4	7.1	6.5
1975	6.3	6.7	5.5	5.5	7.3	6.7
1976	6.9	8.0	5.0	5.9	7.3	7.0
1977/78	7.3	8.9	5.8	5.8	7.0	7.0
1978/79	7.3	9.4	6.0	6.0	7.2	7.1
1979/80	7.2	9.1	5.8	5.9	7.3	7.1
1980/81	7.3	8.8	5.4	5.7	7.0	6.8
1981/82	7.7	8.8	5.7	5.9	6.7	6.7
Growth in Share %						
1962-82	185	314	34	45	34	62
1962-70	113	149	27	48	50	58
1970-81/82	33	67	6	-2	-11	3

Source: Special Tables produced for the author by Statistics Canada, Health Division for all PGAS Hospitals in B.C. based on HS1 and HS2 returns.

concentration and one of dispersion. The concentration effect is seen in the increasing share of patient days in the 200-299 bed facilities throughout the sixties - a phenomenon perhaps associated with a general upward size drift of regional hospitals during a wave of new facilities construction. The dispersion effect is seen in the more rapid increases in laboratory cost per patient day for the smaller hospitals (less than 100 beds) suggesting relatively higher level of laboratory activities and/or lack of economies of scale in laboratory test production for this size of hospital.

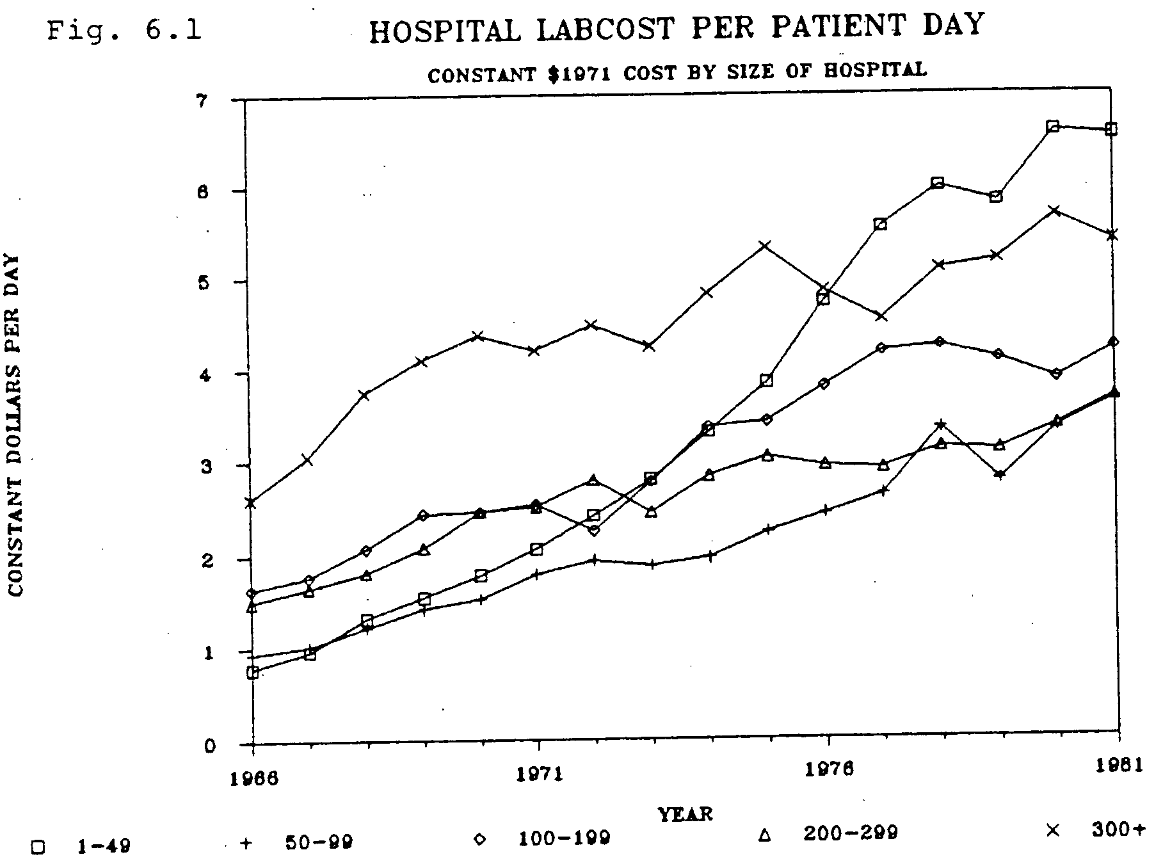
These data refer to all PGAS hospitals and are expressed in current dollars. The effect of two special hospitals, i.e., Children's Hospital and the Cancer Control Agency of B.C. (CCABC), should be removed from this analysis because these facilities provide diagnostic services of a tertiary referral nature from a very small approved bed complement. Thus, Figure 6.1 shows the constant dollar laboratory cost per patient day by size of hospital excluding these facilities. The basic point remains that there appears to be a relative deconcentration of activity to the smaller centres as measured by real laboratory cost per patient day.

Another measure of the changing organization of the system is the relative concentration of activities in teaching hospitals. Vancouver's teaching hospitals play a critical role in the clinical laboratory system of British Columbia. They provide tertiary referral services to in-patients in their facilities and perform tests on specimens referred in from around the province. They also act (in conjunction with the university) as the training facilities for laboratory medicine specialists in B.C. and are thus the "custodians of knowledge" in the system.

TABLE 6.7 LABORATORY COSTS PER PATIENT DAY (IN CURRENT DOLLARS) AND SHARE OF ALL HOSPITAL PATIENT DAYS BY SIZE OF HOSPITAL 1962-1982 (INCLUDING ALL PGAS HOSPITALS IN BRITISH COLUMBIA)

YEAR	1-49		50-99		100-199		200-299		300+	
	Lab Cost	% Days	Lab Cost	% Days	Lab Cost	% Days	Lab Cost	% Days	Lab Cost	% Days
1962	0.53	13.6	0.46	15.4	0.97	23.3	0.92	5.9	1.43	41.8
1964	0.69	11.7	0.60	16.6	1.14	24.8	1.25	5.7	1.78	41.1
1966	1.05	11.2	0.85	18.5	1.30	23.5	1.62	6.8	2.46	40.0
1968	1.86	9.4	1.15	15.07	1.92	22.1	1.89	14.9	3.97	38.5
1970	2.38	8.3	2.22	14.7	2.26	20.8	2.63	16.8	4.65	39.3
1972	3.78	n/a	2.49	n/a	5.68	n/a	0		6.48	n/a
1974	4.74	6.0	4.32	12.6	3.65	13.3	3.59	15.3	6.39	52.8
1976	7.92	4.7	8.41	9.9	5.74	11.3	4.99	17.5	8.38	56.7
1978/79	10.33	3.0	12.94	8.3	6.34	13.0	6.02	16.8	9.70	58.1
1980/81	14.59	3.8	17.10	8.0	7.96	13.0	7.92	16.8	13.14	58.5
1981/82	15.80	3.5	20.86	7.4	9.64	11.2	9.59	16.1	13.47	61.7
Percent Change 1962 1981/82	2280	-75	4434	-52	893	-52	942	172	842	48

Fig. 6.1


HOSPITAL LABCOST PER PATIENT DAY
CONSTANT $1971 COST BY SIZE OF HOSPITAL
CONSTANT DOLLARS PER DAY
0
1
2
3
4
5
6
7
1966
1971
1976
1981
YEAR
1-49
50-99
100-199
200-299
300+

The relative share of resources allocated to these facilities is shown in Table 6.8. Teaching hospital laboratories have been allocated a relatively constant share of resources (or at least laboratory expenditures) over the period 1966-1981/82. However, a number of minor fluctuations occurred that deserve comment.

Using the teaching hospital share of all hospital laboratory expenditures (which for the reasons outlined in Chapter 4.3 is the more reliable time series) it can be seen that there was a relative drop in the share of resources to the teaching hospitals in the period 1966-1971 but specifically after the enactment of medical insurance in 1968. This seems to reflect two factors discussed earlier a) the emphasis placed on upgrading community hospital laboratories, in general, and regional laboratories in particular throughout the sixties and b) the increased availablity of private laboratory facilities in Vancouver in the period 1969-72.

The second observation that will be returned to in the next section is the small relative increase in teaching hospital expenditures in the period 1975-1979/80. This is partly due to the inclusion of Shaughnessy Hospital in the statistics from 1974 on, but such a change, in isolation, would be reflected in a one year "step" change, rather than the five year "rate" change that appeared to occur.

On balance then in the late sixties, the organization of the laboratory hierarchy was affected by a policy focus on upgrading regional and community hospital based facilities, and by the increased accessibility to private laboratory services brought about by the enactment of Medicare. The specific evidence concerning the changing regional dynamics of the system will be

TABLE 6.8 TOTAL ADJUSTED* LABORATORY EXPENDITURES, HOSPITAL LABORATORY EXPENDITURES (TOTAL AND TEACHING) AND TEACHING HOSPITAL'S SHARE OF BOTH TOTAL ADJUSTED LABORATORY EXPENDITURES AND TOTAL HOSPITAL LABORATORY EXPENDITURES, B.C., 1966-1981/82.

YEAR	TOTAL ADJUSTED LAB EXPENDITURE CURRENT $	TOTAL HOSPITAL LAB EXPENDITURE CURRENT $	TEACHING* HOSPITALS LAB EXPENDITURE	% OF TOTAL ADJUSTED LAB $	% OF TOTAL HOSPITAL LAB $
1966	7.61	5.44	1.95	25.6	35.8
1967	9.51	6.77	2.38	25.0	35.2
1968	n/a	9.19	3.40	n/a	37.0
1969	16.68	10.66	3.53	21.2	33.1
1970	18.39	12.56	4.24	23.1	33.8
1971	20.27	14.00	4.51	22.2	32.2
1972	23.51	16.65	5.71	24.3	34.3
1973	28.28	19.60	6.74	23.8	34.4
1974**	36.88	24.95	8.51	23.1	34.1
1975	50.62	33.84	11.52	22.8	34.0
1976	58.96	38.76	13.36	22.7	34.5
1977/78	65.05	43.68	15.20	23.4	34.8
1978/79	74.87	50.15	17.59	23.5	35.1
1979/80	85.73	56.61	20.31	23.7	35.9
1980/81	105.40	69.63	24.77	23.5	35.6
1981/82	129.55	84.82	29.24	22.6	34.5

* See section 4.3 for definition of total adjusted laboratory expenditure
** Teaching Hospitals are CCABC, Children's Shaughnessy, St. Paul's, UBC HSC and VGH
** Shaughnessy becomes listed in Stats Canada data formerly a Veterans Hospital
UBC HSC refers to UBC Extended Care and Psychiatric Unit for years 1966-1979/80 and it is a very small component.

reviewed in the penultimate section of this chapter. This is done to increase the clarity of exposition and to help synthesize the historical analysis of locational, organizational and technological change.

6.3.3 Performance of the System

The goals of the health system, in general, and the laboratory system in particular, in the mid-late 60s and early seventies, were to improve access to services through regional initiatives, through upgrading of community hospitals, and through provision of universal and comprehensive medical insurance coverage. The latter goal was completely realized through federal rather than provincial initiatives with Canada's Medicare program. The goal of improving access to laboratory facilities in specific regions appears to have been realized. However, the goals of upgrading and regional development that were set for the system in the fifties and sixties, and the success of policy initiatives in realizing those goals, created the policy and organizational problems experienced in the seventies and eighties.

6.4 THE SEVENTIES - GROWTH, CONTROL AND RATIONALIZATION

6.4.1 Environmental and Policy Context

The end of the sixties had seen the implementation of comprehensive medical insurance in B.C. The regional laboratory system was well established and the professional manpower requirements of the regions appeared to have been met.

When the New Democratic Party came to power in B.C. in 1972, the policy agenda changed and the bureaucracy became more sophisticated, Crichton (1984). There was a relative shift in power from the institutions and the professions to the provincial government and the bureaucracy, although ministry officials still came from health care rather than management backgrounds. The transformation in the bureaucracy at this time is mirrored in the terminology used by the LAC - "functional programming" became the jargon of the day.

The Foulkes Report of 1974 was a wide-ranging planning document that reflected an ideology of state ownership and control (in the planning sense) of health care services. The decentralist philosophy of preventive services, community health and a more social and community based model of health care delivery that underlay Foulkes ideas was in contrast to the centralized planning agenda that emerged from the document. (This seems to mirror a common contradiction in social democratic policy-making that decentralized "grass-roots" structures always seem to require "central planning" interventions).

Chapter 5 indicated that the Foulkes Report's perception of the policy agenda for diagnostic services was that the private laboratory facilities in the early seventies were well equipped and well run. The Foulkes report also alleged that the private laboratories were highly profitable, because of higher fee schedules than other provinces that did not return savings brought about by automation to the consumer. In contrast, public hospital laboratories were ill-equipped in terms of space and automated equipment.

The view that public facilities had been neglected seems at odds with the evidence for the sixties that has been reviewed in the previous section, therefore clarification is required. The Foulkes report was really concerned with the standard of facilities in the major metropolitan areas (Foulkes (1974)), Tome Four:104-113), where there was an evident disparity between the modern facilities of the large private laboratories and the inadequate space and obsolete equipment of the major referral and teaching centres of Vancouver and Victoria. For example, VGH between 1957 and 1974 had gone through a five fold increase in test procedures per patient day (Figure 4.4) without any increase in its 30,000 square feet of space. (The laboratory will move into 70,000 square feet of space in July 1985, after a 10 fold increase in tests per patient day since the 1957 laboratory facilities were opened). Similarly, by 1974 Children's Hosital had undergone almost 15 years of continuous growth in test use without any increase in space.

The inadequacy of most of these metropolitan facilities (Royal Jubilee Hospital was a notable exception according to Foulkes) was of particular concern because of the relatively low proportion of outpatient services provided by these institutions (less than 15 percent in most major metropolitan hospitals). Outpatient services were limited as a direct result of inadequate equipment and space, but, according to Foulkes, this need not necessarily be so:

> "These figures (on outpatient laboratory activity in hospitals) confirm ..... that the major urban hospitals play a relatively minor role in providing laboratory services to ambulatory patients. They also establish the fact that, with proper support and community orientation, this role can be enlarged in terms of the total role of the hospital until, as is the case in Victoria, the hospitals direct a substantial percentage of their services to the out-patient needs of the community. Indeed, it is possible for an urban institution to equal the service percentage levels of smaller and more remote hospitals which, in some cases, represent a primary source of all laboratory services in the area."
>
> (Foulkes (1974); Tome Four:103)

As was noted in Chapter 5 the Foulkes Report recommended a provincial Diagnostic Services Authority (DSA) be established to take over, co-ordinate and control all laboratory (and indeed radiology) services. However, the feasibility of this scheme soon began to be questioned by the government itself.

For example, a brief prepared for an Ad-Hoc government committee to survey diagnostic services in one region of the province identifies the inherent difficulty in "buying out" a private laboratory (Personal Communication, Evans 1985). What was for sale, in this case, was not just the assets of the laboratory, but also its expected profit stream. Thus the owner-vendor could take his expected future profits in a capital sum - somewhat analogous to milk producers selling their quota, or taxi-cab owners selling their licenses. The policy problem is that the capital exchanged is "lost" permanently to the system if competitive pricing returns to the "market". The owner/vendor retains the capitalized profit stream.

These factors and other more direct defences from the dominant interests (see Chapter 5) held off any immediate implementation of such a scheme. Nevertheless, the government's perception was that the private laboratories were a "problem" brought about by technology (automation) and previous inadequacy in policy making, planning and funding. This reflects an apparent shift in the goals of the provincial government from the sixties. The government now presents itself as a challenging agent to growth (or at least one growth area) rather than as an active agent in encouraging development.

At the same time as this shift in strategic perception and goals occurred, there was a marked increase in the availability of candidate technologies in the technological environment. Chapter 4 and Appendix B describe how by the end of the sixties, high volume automation (e.g., the 12 channel chemistry profile systems and multi-parameter blood counters) had greatly increased the profitability of private laboratories and made screening more feasible. Similarly, these technologies had been introduced in large hospitals and had begun to greatly facilitate routine monitoring procedures (e.g., see Morrison et al (1984)). By the early 1970s, manufacturers of technology also began to market smaller and less expensive chemistry analyzers (e.g., Abbott ABA-100 and Gilford 3500) and reconditioned, second generation blood counters were available to the B.C. market. These products were aimed at the 100-300 bed hospitals - many of which acted as regional centres. Similarly, other manufacturers were producing a range of sophisticated chemistry instruments, e.g. the Gemsaec, and Dupont ACA, that could greatly expand the automated menu of larger institutions. Consequently the agenda of the LAC shifted markedly in the early and mid seventies towards scrutinizing applications for equipment for small and large hospitals.

The final policy question that began to dominate in the 1974-75 period was the issue of cost and utilization of laboratories. The growth in use and cost (operational budgets) and the simultaneous pressures for upgrading physical facilities and equipment (capital budgets) represents the kind of policy-making schizophrenia that was alluded to in Chapter 5. Resolution of these apparently divergent goals required a process of planning and rationalization. The LAC were continually being requested by the Ministry to develop guidelines for equipment allocation, space requirements, etc. There were several attempts made to do this, e.g., LAC suggested that Gemsaec centrifugal analyzers should only be placed in those laboratories with more than 1 million workload units, ABA-100s in hospitals between 1/2 million and 1 million units and ABA 50s in hospitals under 1/2 million units. It seems that these standards were reasonably well adhered to although relatively complete data for equipment allocation are only available for 1975 to 1980. Specific structural changes between 1972 and 1979/80 will be reviewed below.

6.4.2 Technology, Organization and Location in the Seventies

Real growth in the laboratory services system by sector is shown in Table 6.9. In line with the spirit of the Foulkes report, the hospital sector did witness steady real growth in the period 1972-75/76, but it lagged considerably behind the spectacular real growth in private laboratory expenditures for the same period!

As discussed earlier in Chapter 5 these shifts reflect the increasing share of laboratory activity in the ambulatory environment, although private laboratories share of outpatient laboratory services has not increased over

TABLE 6.9 LABORATORY COST PER CAPITA AND ANNUAL GROWTH RATES IN CONSTANT 1971 DOLLARS BY SECTOR, BRITISH COLUMBIA, 1970-1983/84

	[1]Hospital Laboratory Cost		[2]Private Laboratory Cost		[3]Other Laboratory Cost		[4]Total Adjusted Laboratory Cost	
	$	% inc	$	% inc	$	% inc	$	% inc
1970/71	6.12		2.38		0.45		8.95	
1971/72	6.41	4.7	2.46	3.4	0.42	-6.7	9.29	3.8
1972/73	7.08	10.5	2.60	5.7	0.32	-23.8	10.00	7.6
1973/74	7.47	5.5	3.01	15.8	0.30	-6.2	10.78	7.8
1974/75	8.40	12.4	3.64	20.9	0.38	+26	12.42	15.2
1975/76	9.43	12.3	4.25	16.8	0.43	13.2	14.11	13.6
1976/77	9.80	3.9	4.67	9.9	0.43	0	14.90	5.6
1977/78	10.09	2.9	4.42	-5.4	0.52	20.9	15.03	0.9
1978/79	10.65	5.6	4.72	6.8	0.53	1.9	15.90	5.8
1979/80	10.68	0.3	5.04	6.8	0.45	-15.1	16.17	1.7
1980/81	11.58	8.4	5.52	19.8	0.43	-4.5	17.53	8.4
1981/82	12.41	7.2	6.11	10.7	0.43	0	18.95	8.1
1982/83	12.49*	6.4	6.70	9.7	0.46	7.0	19.65	3.7
1983/84	13.08*	4.7	7.58	13.1	0.46	0	21.12	7.5

* Estimates (see Data Appendix)

Sources: Statistics Canada Hospital Data and MSC unpublished data (see Data Appendix)

1) Hospital laboratory cost includes total expenditures made by hospitals on laboratory services (including outpatients) but doe not include MSC payments.
2) Private laboratory cost refers to total MSC fees paid to private laboratories.
3) Other laboratory cost refers to total MSC fees paid to doctor's offices.
4) See section 4.3 and Data Appendix for definitions.

the period. More specifically the private laboratories' increasing share of all laboratory costs reflect a fee effect and a utilization effect.

Similarly, in the hospital sector there are both wage and utilization effects (no accurate data are available that reflect real utilization). However, B.C. hospital workers wages, like all those across Canada, increased over and above general wage inflation from 1966 on through the 1970s by about 2% per annum (Evans 1984:163).

In terms of the allocation of technology, Table 6.10 shows annual equipment allocations to the regions. (1973 was the first year any regional data were available, however the data are thought to be accurate for the period 1974 on). These data show the effect of the Foulkes report in the dominance of allocations to the metropolitan regions (Capital and Greater Vancouver) in the period 1974-1975. Conversely, they show a significant retreat from that position with the return of a Social Credit government in 1976. (It would be inaccurate to suggest that equipment allocation is purely politically motivated. However these data reflect the changing policy agenda of government and bureaucracy, partly in response to requests for equipment from institutions, partly because of internally generated priorities (i.e., needs vs choices)).

The distribution of equipment allocations by type of major item by size and type of hospital are shown in Tables 6.11, 6.12 and 6.13. Table 6.11 shows approvals for major chemistry analyzers. These were defined for the mid 70s as items over $50,000 which represents a clear threshold that divides highly automated state-of-the-art technology, e.g., Gemsaec, SMA 6/60, Dupont ACA, KDA etc. from the medium-small analyzers such as ABA-100's and ABA-50's,

TABLE 6.10 ESTIMATED LABORATORY EQUIPMENT ALLOCATIONS TO HOSPITALS BY REGION IN B.C. IN CONSTANT 1971 DOLLARS, 1973-1980.

YEAR	GVRHD[1] $'000	%	CAPITAL[2] $'000	%	NON-METRO[3] $'000	%	TOTAL $'000	%
1973	87.95	31	0	0	193.49	69	281.44	100
1974	520.00	79	28.00	4	112.00	17	660.00	100
1975	326.96	52	60.75	10	243.00	38	630.72	100
1976	433.92	67	45.51	7	171.45	26	650.87	100
1977	87.36	35	63.48	25	100.17	40	251.02	100
1978	108.92	23	87.58	19	272.03	58	468.53	100
1979	348.24	57	21.86	4	241.43	40	611.53	100
1980	686.63	61	141.71	13	301.30	27	1129.64	100
TOTAL	2599.98	56	448.89	10	1634.87	35	4683.74	100

Source: LAC minutes

1) Greater Vancouver Regional Hospital District
2) Capital Regional Hospital District (i.e. Greater Victoria)
3) Non-Metropolitan Regions (i.e. all other B.C.)

TABLE 6.11 NUMBER OF CHEMISTRY INSTRUMENTS APPROVED FOR B.C. HOSPITALS, BY SIZE OF HOSPITAL - TYPE I INSTRUMENTS (MAJOR ANALYZERS $50,000 AND ABOVE), 1973-1980

		HOSPITAL BED SIZE					
Year	Total	1-49	50-99	100-199	200-299	300+	Teaching
1973	1	0	0	0	0	1	0
1974	5	0	0	0	0	1	4
1975	6	0	0	0	1	3	2
1976	1	0	0	0	0	0	1
1977	1	0	0	0	0	0	1
1978	2	0	0	0	0	1	1
1979	7	0	0	0	1	5	1
1980	10	0	0	2	3	0	5
TOTAL	33	0	0	2	5	11	15

TABLE 6.12 NUMBER OF CHEMISTRY INSTRUMENTS APPROVED FOR B.C. HOSPITALS, BY SIZE OF HOSPITAL - TYPE II INSTRUMENTS (ANALYZERS $20-50,000), 1973-1980

		HOSPITAL BED SIZE					
Year	Total	1-49	50-99	100-199	200-299	300+	Teaching
1973	0	0	0	0	0	0	0
1974	5	0	0	2	1	2	0
1975	9	0	0	3	1	3	2
1976	12	0	1	7	1	3	0
1977	3	0	0	1	0	1	1
1978	6	0	1	2	0	1	2
1979	5	1	1	1	0	0	2
1980	7	1	0	2	1	1	2
TOTAL	47	2	3	18	4	11	9

Source: LAC Minutes

TABLE 6.13 NUMBER OF HEMATOLOGY INSTRUMENT APPROVED FOR B.C. HOSPITALS, BY SIZE OF HOSPITAL - AUTOMATED CELL COUNTERS (COULTER-S OR EQUIVALENT), 1973-1980

		HOSPITAL BED SIZE					
Year	Total	1-49	50-99	100-199	200-299	300+	Teaching
1973	2	0	0	0	0	1	1
1974	2	0	0	0	1	1	0
1975	5	0	0	4	0	1	0
1976	7	0	1	1	2	1	2
1977	2	0	0	0	0	2	0
1978	3	0	1	2	0	0	0
1979	1	0	0	0	0	0	1
1980	12	0	2	6	0	2	2
TOTAL	34	0	4	13	3	8	6

Source: LAC Minutes

Gilford 3500s, etc. (Table 6.11) An instrument comparison definition was used rather than dollars for subsequent years. Again the data show the committment made to re-equip the teaching hospitals in 1974 and 1975. (The large number of approvals in 1980 for teaching hospitals are for new hospitals - Children's and the UBCHSC). They also demonstrate the relatively restrained capital budgets of the 1977-78 period and the continued growth in capital funding from 1978 to 1980. Table 6.12 shows a more consistent pattern. The diffusion of second-order chemistry analyzers still fluctuates with the availability of capital funding, but there is an observable trend towards diffusion to smaller and smaller hospitals through the decade. Apparently the growth in workloads in these institutions brought them to a threshold where they meet the criteria for automated equipment, e.g., from 1974-76 a large number of ABA-100s and ABA-50s were approved for 100-199 bed hospitals on the basis of "rational planning criteria".

Similarly, Table 6.13 shows the diffusion of automated blood cell counters for hematology. The data are for Coulter S (or equivalent) instruments and include reconditioned systems which were marketed at about 1/3 of the original purchase price. The data again show diffusion of these technologies down the hospital hierarchy.

This pattern of technology provision helps explain the data shown earlier on the changing hospital hierarchy. In particular, Table 6.6 demonstrates that laboratory costs continued to increase as a share of all hospital costs in hospitals less than 100 beds throughout the seventies, whereas medium sized hospitals (100-300) stabilized their share and the share in large hospitals (over 300 beds) actually declined, especially in the period

1979-1981/82. Similarly, the pattern of provision of automated technology is consistent with the increasing real cost per patient day in very large and very small hospitals. In particular, previous research has indicated that automation can simultaneously induce latent demands for testing and increase the consumables cost of the laboratory thus leading to an overall increase in real cost per patient day (Tydeman et al. (1983), Morrison et al. (1984)). Finally, a comment should be made about the teaching hospial component of the system. Despite the limited approvals of technology in the 1974-76 period, the upgrading sought by the Foulkes report took until the early eighties to become a reality. The reason may be that the NDP government's masterplan for the teaching hospitals involved the creation of a British Columbia Medical Centre on the Shaughnessy Hospital site. This vision of a totally integrated single site facility was rejected under Social Credit in 1976 (with the tacit approval of institutions such as VGH and Children's that did not support amalgamation). Consequently, the planning for upgrade of the teaching hospitals took much longer.

The second major point concerning the teaching hospitals laboratories is their relative cohesion and strength from 1976 on. Other analysts have found that management within the teaching hospital laboratories have demonstrated an ability to influence substantive outcomes for their departments, Pickard (1983). This strength of leadership exercised by the "guidance systems" in teaching hospital laboratories has contributed substantially to the upgrading of standards and physical facilities found so inadequate by Foulkes (1974).

6.4.3 Performance of the Systems in the Seventies

The goals of the system in the seventies were more conflicting than in the previous decades. The goals of the "dominant actors" still favoured growth in utilization and cost, particularly in the ambulatory environment. The government on the other hand, while supportive of a shift towards ambulatory services, wanted to divert the growth in this activity away from the private laboratory sector towards "upgraded" metropolitan hospitals. Similarly, government sought to "rationalize" the allocation of technology and services with the adoption of a central planning philosophy. The performance of the systems suggests that these goals have been only partially fulfilled. Ambulatory testing has increased, and metropolitan hospital facilities have been upgraded. However, the central planning dilemma still persisted in the late 1970s for hospitals in general, with the Hospital Role Studies (an attempt to plan an "appropriate" and "rational" hospital hierarchy) having mixed success as an instrument of rationalization. For laboratories, the planning agenda of the late seventies was much more heavily focused on monitoring and control of the equipment allocation and hospital laboratory construction program, than on questions of regional development. However, the increasing sophistication of the equipment planning process is readily apparent in the mid-late seventies.

Absolutely no progress was made in challenging the private laboratory sector's growth. In fact, as shown earlier, private laboratories took an increasing share of both medical fees and adjusted laboratory costs and they generated even greater "apparent" profits. Ironically, the rapid real growth in these variables took place under the NDP government, which seems to underline once more the consistent potential for health policies to backfire on policy-makers. One might facetiously suggest that the appropriate guiding principle for health planners is not Roemer's Law (a built bed is a filled bed) but Murphy's Law (if anything can go wrong, it will go wrong).

The final section reviews the more recent experience in the system to evaluate how the laboratory system might cope with an age of restraint.

6.5 THE EIGHTIES - RESTRAINT AND SYSTEMS MAINTENANCE

6.5.1 Environmental and Policy Context

The period 1979/80 to 1983/84 saw remarkable changes in the economy of British Columbia. From the dizzy heights of 1981, where a booming economy seemed somehow immune from the early effects of Reaganomics, B.C. plummeted into a recession in 1982 from which it shows little sign of recovering. The Bennett government initiated a series of public sector "restraint" budgets from 1982 to 1984. However, the counter-Keynesian philosophy was not applied so rigidly to health as to other sectors - largely, it is suspected, because of the popular support for the health system (both nationally and provincially) described in Chapter 4.1. However, health in general and hospitals, in particular, were not immune from restraint, but restraint had to be coupled with systems' maintenance.

Spectacular growth in hospital wage settlements and physician fees in B.C. had occurred in the period 1980-1981 (Barer and Evans (1985)). Such growth in factor prices placed the system under greater pressure in the recession. An environment of restraint was paralleled by a shift in the government bureaucracy's senior levels; from those with health planning to those with public administration or general management backgrounds.

In terms of specific laboratory policies, the LAC was disbanded in 1980 and therefore there is less empirical evidence of the policy-making process for laboratories. Similarly, the detailed hospital statistical data are not yet available for years since 1981/82, consequently this analysis will be less complete than previous decades.

The laboratory system did have to cope with restraint, however as we shall see, there is a major difference between the estimated experience of hospitals and the actual experience of private laboratories. Restraint in 1983 came after two years in which considerable technological diffusion took place in terms of the next generation of chemistry and hematology analyzers. Similarly, it occurred after a period in which there were major pushes for computerization from hospitals and laboratories, because of a host of candidate technologies in the wider environment. The juxtaposition of a dynamic technological environment and a lean economic environment presents an interesting context for the 1980s.

6.5.2 Technology, Organization and Location in the Eighties

Annual real growth in hospital laboratory cost average 8.4 percent and 7.1 percent for the years 1980/81 and 1981/82. But private laboratories grew by 19.8 and 10.7 percent in the respective years (Table 6.9). Detailed data for hospitals are not available for later years, but estimates were generated using the increased current dollar per capita figure for all hospitals in B.C. (Barer and Evans 1984) and extrapolating the current dollar increase to

1983/84. It would seem, therefore, that estimated hospital laboratory costs are relatively accurate for 1982/83. The estimate for 1983/84 is likely to be high given restraint policy on hospitals and even higher if the slide continued in laboratory costs as a share of all hospital costs (Table 6.5). Even with the relatively generous growth estimates for hospital laboratories they continued to be outpaced by the real cost of the private laboratory sector.

In order to identify the magnitude of the expanding gulf between the two sectors Table 6.14 shows outpatient laboratory cost data for 1970/71 to 1983/84 in constant dollars. The table shows four sets of time series:actual billings (fees) for outpatient services by hospitals (public), private laboratories and doctors' offices (other). In addition an estimate was made of the hospital's actual costs in generating the hospital's outpatient services (remembering that MSC fees paid to hospitals are offset against expenditures). The difference between costs and fees gives an estimate of the residual "profit" that would have to be used to pay for fixed costs such as buildings, capital equipment and hospital overhead. The percentage difference can be used as a surrogate measure of relative changes in profitability of private laboratories. (The data used to generate this series and the procedure for estimating outpatient costs are shown in Appendix A). It should be pointed out that the cost estimates do not account for the fact that outpatient laboratory facilities in hospitals can be added to existing inpatient facilities at relatively low marginal cost. Nor do these estimates adjust for the relatively more "esoteric" and "low-volume" nature of the public lab outpatient workload documented in Chapter 5. Thus these hospital outpatient costs over estimate substantially true variable costs of production, which may offset the exclusion of fixed costs.)

The data show relatively similar growth in billings for both private laboratory based and public laboratory based oupatient testing over the late seventies and early 1980s. The actual billing data for 1983/84 indicate a slight divergence between the two.

What is more striking is growth in the "apparent profit" share for hospital data, i.e., fees minus costs. In the period 1979/80 - 1983/84 this "apparent profit" share has grown from 19.15% of revenues to 27.28% of revenues (which equates to an increase in "mark-up" on costs from 27 to 37 percent). Interestingly, these data for hospitals also show that the laboratories suffered apparent "losses" on their outpatient services until 1972/73.

This analysis seems to suggest that even if private laboratories were unprofitable in the early to mid 70s (and not even the private laboratories suggested they were) they have become increasingly profitable in the last five years and/or hospitals have become increasingly efficient. The real per capita growth in services, the dominance of a few tests in the private laboratory menu, the fact that private laboratories operate normally only 6 days per week between the hours of nine to five, and the limitation on the expansion of the number of private lab facilities throughout the province, leads one to conclude that the two or three major laboratory "practices" in the metropolitan areas enjoy enormous and increasing economies of scale. (As will be demonstrated in the regional analysis that follows, the geographic

TABLE 6.14 OUTPATIENT LABORATORY COSTS - COSTS VERSUS FEES AND THE "APPARENT" PROFIT MARGIN 1970 - 1983/84 (ALL IN THOUSANDS OF 1971 CONSTANT DOLLARS).

YEAR	OUTPATIENT LABORATORY FEES PAID BY SECTOR: PRIVATE	OTHER	HOSPITAL	OUTPATIENT HOSPITAL COST	"APPARENT" PROFIT % FOR HOSPITALS
1970/71	5,060	964	1,964	2,353	-19.8
1971/72	5,364	911	2,030	2,862	-40.9
1972/73	5,831	713	2,480	2,392	3.5
1973/74	6,945	694	3,236	3,236	11.2
1974/75	8,645	896	3,950	3,636	8.1
1975/76	10,406	1,052	4,842	4,487	7.3
1976/77	11,549	1,070	5,729	4,905	14.4
1977/78	11,137	1,306	5,960	5,385	9.6
1978/79	12,163	1,367	6,597	5,909	10.3
1979/80	13,293	1,190	7,840	6,176	21.2
1980/81	14,840	1,151	8,996	7,273	19.1
1981/82	16,778	1,178	10,267	8,118	20.9
1982/83	18,637	1,282	11,356	8,429	25.8
1983/84	21,357	1,306	12,503	9,092	27.3

concentration of laboratory activity in selected areas is very marked, thus reinforcing these economies of scale.)

Turning now to technology, a number of important developments occurred in the portfolios of individual hospitals even through the period of restraint. This is a function of increased utilization on the demand side, a substantial increase in the candidate technologies available in the wider environment, and a perception by government that outdated equipment had to be replaced.

Tables 6.15 shows major chemistry analyzers approved by size of hospital (data are based on interviews with Ministry of Health officials and are not derived from LAC sources). The trend toward increased relative penetration of automation to smaller centres that had appeared at the end of the seventies continued on through the eighties even under restraint. (Although it should be noted that certain hospitals did not receive full grants for the equipment because government believed the price tag exceeded requirements).

The pattern of equipment allocation indicates two effects. One is the need for replacement of the many analyzers inserted in the larger hospitals in the period 1973-77 which were by the period 1981-84, reaching the end of their mechanical life as well as becoming obsolete in terms of their scientific capabilities (e.g., more accurate methods were now available). The second effect is the growing number of requests from smaller hospitals to upgrade analyzers from medium to large size. This was a result of both replacement needs and increased test volumes bringing them close to a threshold that might warrant a major analyzer. In addition to these chemistry analyzers, the "state of the art" hematology analyzers (e.g., Coulter S Plus V) were approved

TABLE 6.15 NUMBER OF CHEMISTRY INSTRUMENTS APPROVED FOR B.C. HOSPITALS, BY SIZE OF HOSPITAL - TYPE I INSTRUMENTS (MAJOR ANALYZERS), 1981/82 - 1984/85

	HOSPITAL BED SIZE						
Year/ Bed Size	1-49	50-99	100-199	200-299	300+	Teaching	Total
1981/82	0	0	1	1	0	2	4
1982/83	0	1	3	1	2	2	9
1983/84	0	2	4*	0	2	0	8
1984/85	1*	2*	4*	0	0	0	7
TOTAL	1	5	12	2	4	4	28

Source: Personal Communication, Ministry of Health, 1985

* Certain instruments in these years were acquired without approval or without full grant.

for the five largest hospitals. Thus there is a continued commitment to "state-of-the-art" technology in the large centres and a "trickle-down" effect in subsequent years to the smaller institutions (increasing their capacity and likely in years to come their cost per patient day) Tydeman et al (1983), Morrison et al (1984).

Finally, this discussion of technology reviews the changing information technology for hospital laboratories. Little has been said in the historical analysis so far about computerization in hospital laboratories, because very little computerization was undertaken in the province until recently.

The first initiative was taken by a group of researchers and laboratory professionals at St. Paul's Hospital and U.B.C. In 1966, the group started a laboratory computer research project as part of a wider interest in automation in the laboratory. The group surveyed the market for hardware and software and by 1968 had acquired a PDP 9 mini-computer. Over the next three years a combination of in-house software development and acquisition of the MUMPS system from Massachusetts General, led to the implementation of the laboratory computer system in 1972. The system was used for chemistry only and included on-line connection of auto analyzers.

Apparently some observers felt that this evaluation project hindered the wider diffusion of laboratory computers in the province in the late 1960s and early 1970s. However, in retrospect, delaying wider diffusion was fortuitous given the financial instability of many of the eariliest computer vendors and the rapidly developing capabilities of mini-computer technology in the period 1968-1974 (Ball (1970), Siemansko (1978)).

By the mid 1970s, wider diffusion of laboratory computer technology occurred. For example, two laboratory computer systems were implemented in 1974 one in Vancouver General (LCI system), the other in Royal Jubilee Hospital in Victoria (Cybermed). In the next year, some data processing capability was provided on the PDP/11 machines that were an integral part of the Gemsaec chemistry analyzer configurations: a further three hospitals were added on this basis. Very little real progress occurred in laboratory computerization from 1976 until 1980. The Ministry of Health had difficulty in implementing satisfactorily, a series of financial computer systems in hospitals. The lack of performance from these systems, and the consequent frustration and economic costs, tainted government's (and to some extent hospitals') perception of computerization until the mid 1980s.

However, a number of institutions were active in acquiring computer resources. For example, in 1980 the new UBCHSC hospital acquired a Data General/Meditech configuration with grant support. Similarly, Children's Hospital acquired a Data General/Meditech system again using grant support. (In both cases the computers provided data processing for more areas than the laboratory.) Finally, in the last three years the VGH Department of Pathology, with academic and network support has acquired a series of Data General mini computers running both Meditech and custom-designed software. This network of systems provides data processing and data communication capability for laboratories and a wide variety of other hospital applications. The specific technological advance described earlier in chapter 4.5 is the use of long-haul and local area network technologies, that now link all the teaching hospitals and the university campus for interactive full-motion video as well as data communications (Cassidy et al (1985)). Similarly, Lion's Gate Hospital in Vancouver have acquired IBM based systems and CCABC has implemented Honeywell technology.

Apart from these innovative institutions who have built an alternative computer and communications infrastructure, the other major protagonist involved in hospital and laboratory computers in B.C. at the current time, is the B.C. Hospital Shared Systems Society (BCHS[3] or "the Cube" as it is known colloquially). This group is charged with the responsibility of developing a set of applications programs that can be run on DEC mini and microcomputers and will eventually be used by all participating hospitals. These two groups represent the major thrusts of computerization in hospital laboratories in the province.

No published information is available on the growth and proliferation of personal computers in the province's hospitals and/or laboratories. (A phenomenon common to many enterprises where P.C.'s came in the back door as petty cash items, bosses toys or as typewriters, Business Week 1985, March). However, it should be noted that the increasing diffusion of automated laboratory equipment - "smart analyzers" - has dispersed data processing within and among laboratories (see Appendix B). These technological developments present the starting point for certain future scenarios identified in the final chapter.

No detailed hospital data are available beyond 1981/82, consequently the analyses conducted for previous decades cannot be updated beyond the tables and discussion already shown.

6.5.3 Performance of the System in the Eighties

Apparently, the goals of systems maintenance and restraint have had more effect the hospital sector than on the private laboratory sector. By direct influence on incomes and budgets, government can enable a steady state, or at least a slow-down in growth of hospital based activities, even without any efforts to inhibit utilization.

Conversely, the lack of utilization reduction strategies in the outpatient fee-for-service environment and the difficulty in capping a fee for service reimbursement system has apparently transferred laboratory activity from public to private sectors. There are two basic observations on this situation. First, there is some evidence to suggest that the "apparent" profit margin on this activity is increasing, hence in the absence of competitive pricing this can lead to an increased transfer of resources out of health care (to private income and investment). Secondly, as will be discussed below, the increasing relative share of activity going to private laboratory services concentrates this activity further in the metropolitan areas and selected regional centres.

6.6 SYNTHESIS - TRANSFORMATION IN SPATIAL STRUCTURE OF THE B.C. LABORATORY SYSTEM

6.6.1 Approach

It has been argued throughout this study that the changing spatial structure of enterprise is largely an outcome of the wider synergistic interaction among environmental factors, strategic choice and organization. Therefore, in this section, the evidence concerning changing spatial structure of the B.C. Clinical Laboratory system is reviewed as a means of synthesizing structural change in the system.

It will be argued that processes of spatial concentration and dispersion have occurred throughout the period. In certain time periods, in certain regions and in certain sectors of the system, processes of spatial concentration are stronger than processes of dispersion (and vice-versa). These changes are linked to wider transformation in environment, policy, technology and organization.

In particular, it will be shown that the observed relative dispersion of laboratory activity to specific regions until the mid 1970s is consistent with a continuing commitment to regionalized laboratory services. Similarly, the processes of relative regional concentration that have occurred since that time are consistent with policy initiatives to upgrade metropolitan hospital and enhance services in certain centres. However, on balance, the most striking empirical funding is the enduring relative stability of the regional hierarchy. Individual regions have changed their relative status, but there has been a remarkable stability in the relative distribution of activity among ranks in the regional hierarchy.

Finally, it is concluded that laboratory services are not distributed evenly per capita throughout the regions of the province. Rather, like other producer services, they continue to be concentrated in higher-order settlements. In particular there is a discrepancy between the distribution of population and the distribution of private laboratories.

This section is divided into three parts:

6.6.2 - General description of changes in regional distribution of population and laboratory activity over the period 1966-1971 for which regional data are available.

6.6.3 - More specific analysis of changing regional distribution of hospital laboratory activity.

6.6.4 - Changing regional distribution of private laboratory activity.

6.6.2 Regional Distribution of Population and Laboratory Activity 1961-84

B.C. experienced the same relative deconcentration of population that has has been observed at the national scale (see Chapter 3). Table 6.16 shows the share of population in 5 categories of Regional Hospital District for selected years from 1961-1983/84 (The definitions used in classifying the regions is described in Appendix A). The metropolitan share of population has declined consistently across the time period. Conversely, major regions (e.g., Kelowna, Kamloops, Nanaimo and Prince George) and third order (more remote) regions have accounted for an increasing share of population. Second-order regions dipped sharply in the period 1966-1971 but have grown in relative share since that time.

TABLE 6.16 DISTRIBUTION OF B.C. POPULATION BY TYPE OF REGIONAL HOSPITAL DISTRICT, FOR SELECTED YEARS, 1961-1983.

	1961	1966	1971	1974	1979	1981	1983
Metropolitan	58.4	57.4	56.4	54.6	52.1	51.7	51.2
Suburban	4.2	3.9	4.5	5.1	6.3	6.4	6.6
Major Regions	10.4	11.4	12.3	13.2	14.0	14.1	14.2
Second-Order	18.3	18.4	17.8	17.9	18.0	18.1	18.2
Third-Order	8.7	8.8	8.9	9.2	9.6	9.7	9.8
All-B.C.	100	100	100	100	100	100	100
Total Population (Millions	1.631	1.874	2.185	2.354	2.633	2.744	2.820

Source: Health Services Research and Development, Manpower Planning Unit, UBC

The regional distribution of population is in contrast to the distribution of laboratory activity. Table 6.17 shows the changing distribution of hospital laboratory activity and private laboratory activity. Although the relative share of hospital laboratory activity differs from the distribution of population among regions, the trends in the changing share of activity are consistent with population. (It can be shown using chi-squared analysis that the 1981 distribution of hospital laboratory activity is significantly different at the 10% level - however it is not significant at the 5% level).

Data for private laboratory activity were not available for years prior to 1979. However, the 5 year time period indicates substantial relative geographic concentration of private laboratory activity. (For example, chi square analysis shows the distribution to be significantly different from the population distribution at the 0.1% level. Even when sensitivity analysis is used to generate distributions excluding inter regional referrals the distribution of private laboratory activity is still significantly different from population at the 0.1% level.)

The pattern of inter regional referrals is of particular value in describing the relative status of centres in the regional hierarchy. Referral data are available for 1983/84. (These data do not conform exactly to the regional data produced by the Medical Services Plan - see appendix A).

However, Appendix C reproduces an input/output matrix of referred outpatient laboratory services paid to hospitals and private laboratories by location of laboratory over location of patient. Table 6.18 abstracts those regions that had any laboratory fees paid to hospitals or private laboratories

TABLE 6.17 DISTRIBUTION OF HOSPITAL AND PRIVATE LABORATORY ACTIVITY IN B.C. BY TYPE OF REGIONAL HOSPITAL DISTRICT, SELECTED YEARS, 1966 - 1981.

REGION	1966 $ 1971 Thousands	1966 %	1971 $ 1971 thousands	1971 %	1974 $ 1971 thousands	1974 %	1979 $ 1971 thousands	1979 %	1981 $ 1971 thousands	1981 %	1983 $ 1971 thousands	1983 %
METROPOLITAN												
Hospital	4,485	68.8	8,885	64.7	12,517	63.9	17,952	64.9	20,807	64.1		
Private Lab							11,216	83.8	14,091	82.0	18,019	84.4
TOTAL							29,168	71.1	34,898	70.6		
SUBURBAN												
Hospital	143	2.2	337	2.5	448	2.5	854	3.1	1,084	3.3		
Privcate Lab							9	0.1	9	0.1	9	
TOTAL							863	2.1	1,093	2.2		
MAJOR REGIONS												
Hospital	826	12.7	1,991	14.5	2,968	15.1	4,048	14.6	4,846	14.9		
Private							1,411	10.5	1,781	10.5	2,104	9.9
TOTAL								13.3		13.4		
SECOND-ORDER												
Hospital	744	11.4	1,763	12.8	2,559	13.1	3,351	12.1	4,094	12.6		
Private							692	5.2	1,018	6.0	1,075	5.0
TOTAL							4,043	9.9	5,112	10.3		
THIRD-ORDER												
Hospital	317	4.9	763	5.6	1,071	5.5	1,440	5.2	1,612	5.0		
Private							63	0.5	100	0.6	150	0.7
ALL B.C.												
Hospital	6,515	100	13,739	100	19,603	100	27,645	100	32,443	100		
Private							13,390	100	17,000	100	21,357	100
TOTAL							41,035	100	49,443	100		

in those regions (according to this source). The "final output minus initial input" column is one measure that demonstrates the higher referral status of the metropolitan regions, Central Okanagan and Thomson-Nicola regions. The percentage of billed services originating within each region shows the relative amount of flow-through of referred outpatient laboratory work. In five regions viz. Central Okanagan, Dewdney-Alouette, Fraser-Ft. George, Nanaimo and Thomson-Nicola, the proportion of billed services originating within the region was less than 60 percent, indicating these regions act as referral laboratory centres for the surrounding regional hospital districts. (The private laboratory component in these data must be viewed with some caution because the location from which the service was billed may not necessarily correspond to the location where the test was performed). However, on balance the pattern of referral activity shows the dominance of metropolitan and major regional centres in the laboratory hierarchy.

Finally, the hierarchy of laboratory services can be defined in terms of the range of laboratory services available in different regions. Table 6.20 shows the average menu of outpatient tests available in each of the groups of regional hospital districts. These data reinforce two earlier observations. First, they demonstrate an obvious regional hierarchy in the range of services available in both the public and private sectors. Second, they demonstrate that for the regions in which private laboratories operate, the menu of tests available is between a quarter and a third of that of the hospital sector (with the exception of the metropolitan regions). These data provide further support for the conclusion that a process of spatial adverse selection is in operation in the private sector. (A perfectly rational reponse by an enterprise with a for-profit mission).

TABLE 6.18 TOTAL PRIVATE LABORATORY AND HOSPITAL OUTPATIENT LABORATORY FEES BY REGIONAL HOSPITAL DISTRICT. LOCATION OF PHYSICIAN OVER LOCATION OF PATIENT FOR 1983/84 IN CURRENT DOLLARS.

Region	Lab Expenditure Generated within the RHD	Lab Expenditure Paid to Labs in RHD	Final Output Minus Initial Input	% of Billed Services Generated in in Region
Capital	11,855	14,764	+ 2,909	70.1
GVRHD	44,385	56,464	+12,079	77.5
Metropolitan Total	56,240	71,228	+14,988	
Dewdney-Alouette	1,802	1,093	- 709	54.9
Suburban Total	1,802	1,093	- 709	54.9
Central Okanagan	3,319	5,517	+ 2,198	54.9
Fraser - Ft. George	2,656	2,544	- 112	50.9
Kootenay Boundary	1,138	1,085	- 53	96.5
Nanaimo	3,130	1,626	- 1,504	33.1
Thomson-Nicola	2,181	3,719	1,538	57.5
Major Region Total	12,424	14,491	- 2,067	
Central Kootenay	1,327	1,037	- 290	97.4
Comox-Strathcona	1,897	852	- 1,045	74.5
Fraser Cheam	1,897	553	- 1,344	85.4
Kitimat-Stikine	474	144	- 330	77.5
N. Okanagan	1,517	95	- 1,422	99.7
Okanagan-Similkameen	2,466	1,627	- 839	98.2
Peace River	1,233	1,103	- 130	95.1
Skeena-Queen Charlottes	569	542	- 27	89.8
Second Order Total	11,380	5,953	- 5,427	
Central Coast	95	39	- 56	97.9
East Kootenay	1,707	1,739	+ 32	90.0
Third Order Total	1,802	1,778	- 24	
Non-Metro Total	27,408	23,315	- 4,093	
Unknown		289		
TOTAL	83,640	94,841	+10,895	

Source: See Appendix E

The specific regional dynamics of the hospital and private laboratory sector are reviewed in more detail below.

TABLE 6.19 AVERAGE MENU OF TESTS AVAILABLE ON AN OUTPATIENT BASIS BY TYPE OF REGION IN BRITISH COLUMBIA, 1979-83.

Regional Type	Public (Hospital)			Private Lab (Non-Zero Regions Only)		
	1979	1981	1983	1979	1981	1983
Metro politan Regions	325	336	336	236	241	236
Suburban Regions	116	178	181	12	14	13
Major Regions	184	199	201	62	62	66
Second-Order Regions	126	139	137	45	41	43
Third-Order Regions	87	91	95	21	23	21

Source: Medical Services Commission, Unpublished Data

6.6.3 Regional Dynamics of Hospital Laboratory Services

The regional dynamics of hospital laboratory provision can be investigated using five forms of analysis. The first approach is to examine the cumulative share of laboratory activity in regions, ranked by level of laboratory activity. Figure 6.2 shows cumulative percentage curves for selected years, from 1966-1981. Although there is an apparent reduction in the concentration of laboratory activity in the top 10 regions from 1966 to

1971 (Figure 6.2) no significant difference could be found between the years using chi-squared analysis.

The second form of analysis reinforces this finding. Figure 6.3 shows rank-size curves for the same years. Rank-size analysis was originally conceived as "rule" that described the perfect linear relationship between the log of a city's population and the log of its rank. Thus a convex curve represents a greater degree of dispersion of population than the "rule"; a concave curve represents higher relative concentration than the rule suggests. (The author recognizes Harvey's (1969:12) criticism that there is no theoretical basis to expect city systems to conform to this rule. However, the author follows on from Stephens and Holly's (1981) use of rank size analysis as a measure of relative change in the hierarchy over time).

The rank-size evidence from the B.C. case suggests that a small number of centres continue to dominate throughout the period 1966 - 1981, but that the system has grown steadily across its rank-size hierarchy. These findings are not surprising given the concentration of population in metropolitan areas and major regional centres. In order to derive an estimate of the changing centrality of specific regions a third form of analysis is used. In this case laboratory cost per capita is used as a measure.

Figure 6.4 shows the average laboratory cost per capita for groups of regions for selected years and Figure 6.5 shows average annual growth rates for the intervening periods. These data suggest that real per capita growth in laboratory activity was highest in the lower ends of the regional hierarchy in the period 1966-71 reflecting a continued commitment to regional services.

Fig. 6.2

CUMULATIVE SHARE ANALYSIS

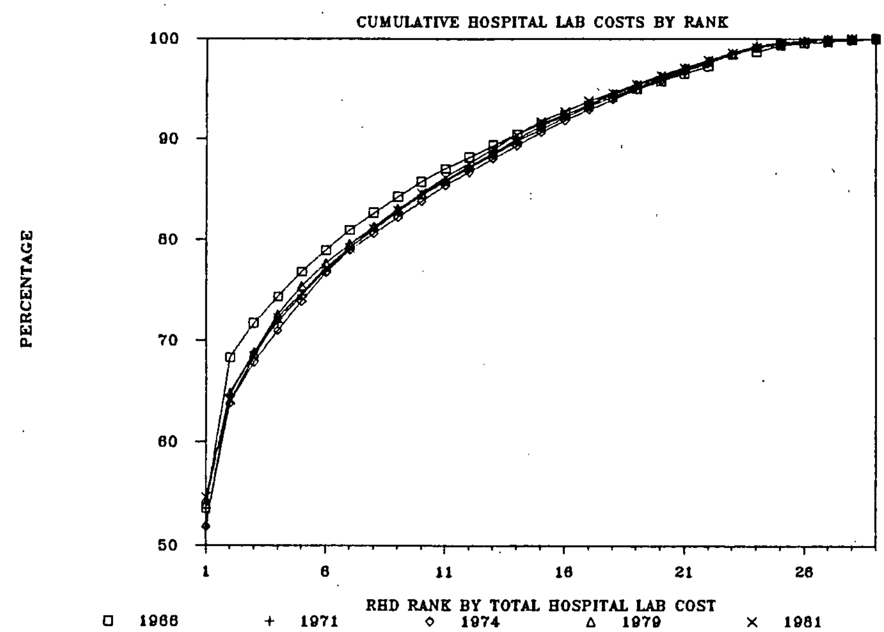


Fig. 6.3

RANK SIZE ANALYSIS: 1966-81

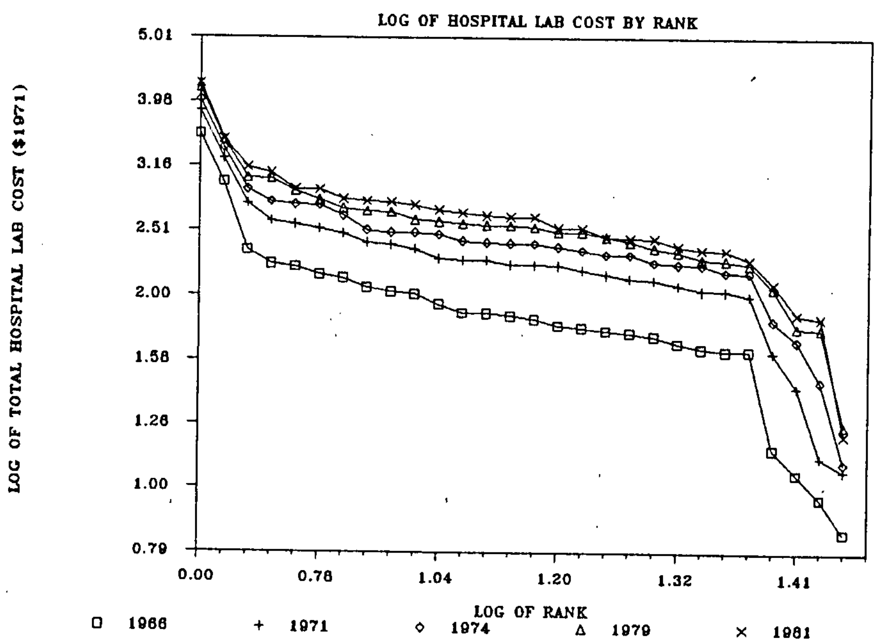


Fig. 6.4

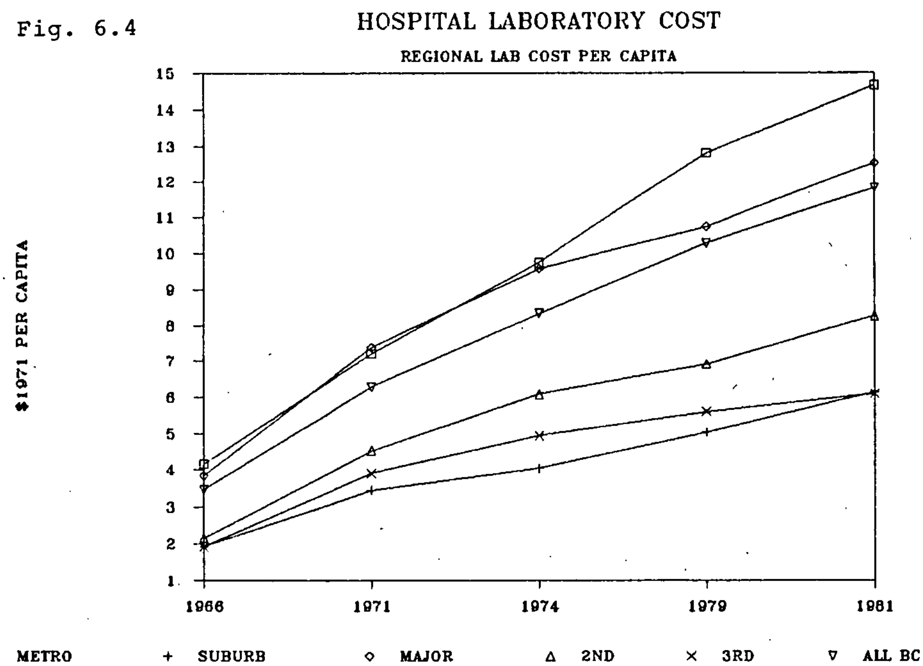
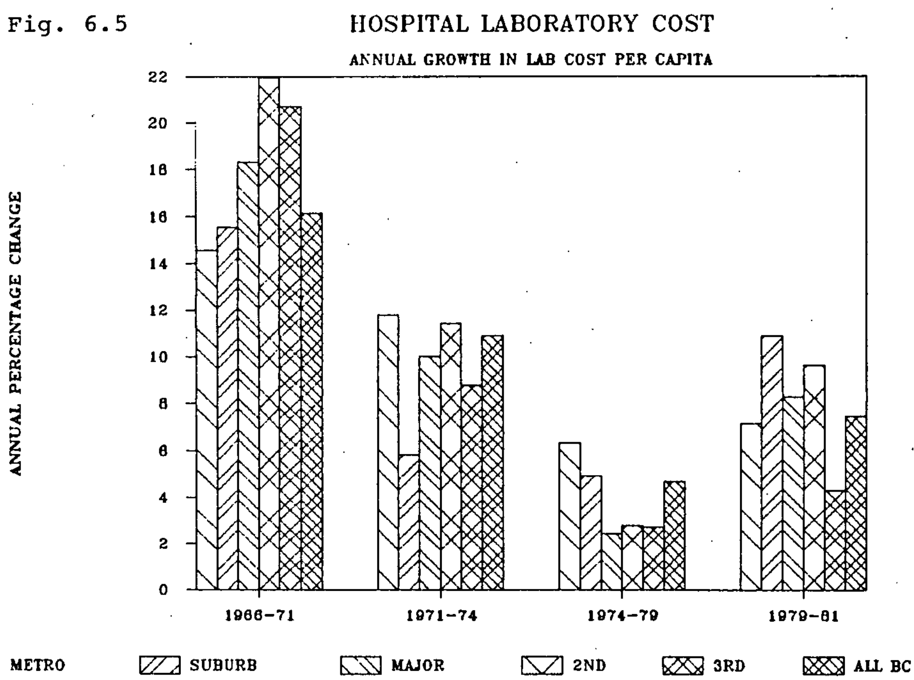

HOSPITAL LABORATORY COST
REGIONAL LAB COST PER CAPITA
$1971 PER CAPITA
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1966
1971
1974
1979
1981
METRO
+ SUBURB
◇ MAJOR
△ 2ND
× 3RD
▽ ALL BC

Fig. 6.5


HOSPITAL LABORATORY COST
ANNUAL GROWTH IN LAB COST PER CAPITA
ANNUAL PERCENTAGE CHANGE
22
20
18
16
14
12
10
8
6
4
2
0
1966-71
1971-74
1974-79
1979-81
METRO
SUBURB
MAJOR
2ND
3RD
ALL BC

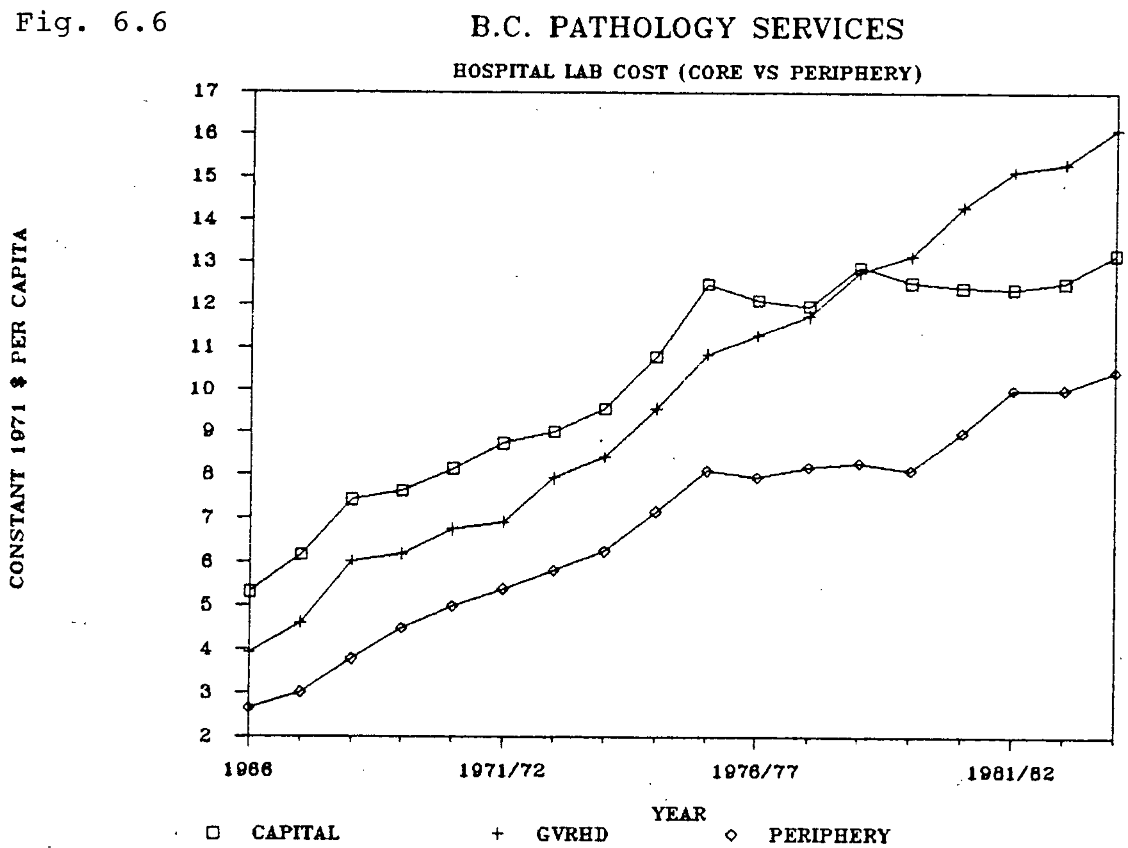
Annual growth rates declined in the period 1971-74 but there was a relatively even rate of growth across the regional hierarchy. In the period 1974-79 growth declined further to a provincial average of 4 percent, but rates of growth were higher in the metropolitan and suburban regions reflecting a commitment to upgrade metropolitan facilities. Finally, in the period 1979-81, annual growth rates have increased in all regions.

These data suggest an obvious hierarchy has persisted throughout the period in the level of laboratory activity found in the various types of regional setting. Higher order metropolitan centres and major regional centres have higher costs per capita (unadjusted for referrals). There are indications that the gap between metropolitan regions and third order regions has widened since 1974.

Further evidence for the metropolitan regions is given in Figure 6.6 which shows hospital laboratory activity (in constant 1971 dollars per capita) for 1966-1981/82 for Greater Vancouver (GVRHD), Greater Victoria (Capital) and the Periphery (all other regions and non acute care hospitals). The results indicate continuous and parallel growth in real per capita activity for all three groups until 1975-76 and the relative dominance of GVRHD after that period. It is also important to note the marked levelling off of hospital-based laboratory activity in the Capital Region (Victoria) since 1975. A point that is returned to below in the discussion on private laboratories.

The regional analyses so far have shown the relative allocation of activity across types of regions but they have not demonstrated the changing relative status of individual regions over the period. Thus a fourth form of analysis summarizes changes in a laboratory cost index (LCI) for specific

Fig. 6.6


B.C. PATHOLOGY SERVICES
HOSPITAL LAB COST (CORE VS PERIPHERY)
CONSTANT 1971 $ PER CAPITA
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1966
1971/72
1976/77
1981/82
YEAR
CAPITAL
GVRHD
PERIPHERY

regions between the selected years. The LCI was derived by expressing real hospital laboratory cost per capita relative to the provincial average:

$$LCI = \frac{\text{Hospital Lab Cost per Capita in Region}}{\text{Hospital Lab Cost per Capita all B.C.}} \times 100$$

Appendix D classifies regions into four cells according to the magnitude of the LCI (high is greater than 100, low is less than 100) and the direction of change (increasing or decreasing) between the selected years.

These data are summarized in Table 6.20 by showing the number of regional hospital districts in each of the four categories.

The table format demonstrates the changing relative concentration and dispersion within the regional hierarchy over the years selected. The axis from top-left to bottom-right ("high but declining" to "low but increasing") is the axis of dispersion. In particular the "high but declining" category refers to those regions that had an LCI greater than 100 but whose LCI declined over the time period. Conversely the "low but increasing" category refers to regions with LCI's of less than 100, but whose LCI increased over the period. Similar logic can be applied to the "high and increasing" to "low and declining" axis as an indicator of relative concentration.

The data reinforce the earlier conclusion that in the period 1966-71 processes of regional dispersion of laboratory activity were more dominant. The processes of concentration and dispersion seem to have levelled off in the early seventies, and by the late seventies the axis of concentration seems more dominant. These findings are consistent with both the commitment by policy-makers to improve regional laboratory services until the mid 1970s, and with subsequent shift in emphasis towards upgrading of metropolitan facilities

TABLE 6.20 SUMMARY OF RELATIVE CHANGES IN REGIONAL LABORATORY COST INDEX FOR THE PERIODS 1966-71, 1971-74, AND 1974-81.

Period		
1966-1971	High but Declining 4	High and Increasing 3
	Low and Declining 3	Low but Increasing 18
1971-1974	High but Declining 5	High and Increasing 2
	Low and Declining 10	Low but Increasing 11
1974-1981	High but Declining 4	High and Increasing 3
	Low and Declining 14	Low but Increasing 7

Source: See Appendix D

Note: Numbers in each cell represents the number of regional hospital districts falling into each of the four categories in the time period selected.

and to maintaining standards fo service and technology in the major regional centres.

Part of the explanation for this changing regional pattern stems from the variation in the geographic distribution of physicians per capita. Thus the fifth measure of the regional dynamics of hospital laboratory activity is the change in laboratory activity per physician.

Appendix E shows data for years 1974 and 1981. The data demonstrate that in the province as a whole, hospital activity per physician has increased by 24 percent in constant dollar terms over the period (from $5000 to $6200 per physician). However, this pattern of growth is not consistent throughout the regions. In particular six regions had decreases in total real hospital laboratory activity per physician (viz., Capital, Cariboo, Central Coast, Central Okanagan, Cowichan Valley and Kitimate-Stikine).

The considerable variation in hospital laboratory activity per physician in 1981 (from a low of $2,340 ($1971) in the Cariboo Region to a high of $11,550 ($1971) in Kootenay Boundary) reflects partly the pattern of inter regional referrals, partly the regional distribution of private laboratories and partly the variation in hospital laboratory utilization among the regions.

It is not possible to isolate these effects satisfactorily. However, it is possible to estimate the relative contribution that variations in lab cost per physician and physician/population ratios have made in explaining changes in lab cost per capita for each of the regions. Appendix F shows a first-order difference model in which the change in hospital laboratory activity per capita between 1974 and 1981 is the sum of two effects. The first is a laboratory utilization effect in which the doctor/population ratio is held at the 1974 level but the laboratory cost per doctor is allowed to increase to its actual 1981 level. Conversely, the second effect is a doctor/population effect in which laboratory cost per physician is held constant and the doctor/population ratio is allowed to increase to its actual 1981 level. The results indicate that for the province as a whole the laboratory use effect is stronger, explaining 58 percent of the change between the years, whereas the doctor/population effect explains 34 percent of the difference. Again, there are substantial variations among the regions with certain regions experiencing changes explained almost entirely by doctor/population effects, e.g., Capital, Cariboo, Central Coast, Cowichan Valley, Dewdney-Alouette, Fraser-Cheam, Powell River and Skeena/Queen Charlotte, while all the other regions are explained by a combination of the two.

The lack of a consistent pattern throughout all the regions of the province suggests that the spatial distribution of hospital laboratory activity is a complex phenomenon driven by the differences in beds per capita, physicians per bed and laboratory use per patient day as well as the patterns of regional referral and regional distribution of subspeciality medical practices. Attempts to use any of these criteria as predictors of regional variations either singly or in combination, might be a focus of subsequent research. However, the complex interaction among these variables and the inherent methodological difficulties with longitudinal research leads one to conclude that such causal modelling would be difficult to operationalize. Rather, the analysis conducted to date indicates that the strongest predictor of current relative levels of laboratory activity in individual regions is the designation of specific places as regional centres in the 1950s and 1960s and the subsequent commitment to maintain and expand pathology services in those settings.

6.6.4 Regional Dynamics of Private Laboratory Services

A similar pattern emerges from analysis of regional variation in private laboratory activity. Table 6.21 shows changes in private laboratory activity per capita for years 1979/80 and 1983/84 for those regions with private laboratory billings. Two significant points emerge. First, there is a concentration of private laboratory activity in the major population areas. Second, the largest increments in private lab cost per capita have occurred in major population areas. Thus a spatial process of adverse selection is occurring and apparently this process is leading to further concentration of activity in a small number of regional centres, i.e., the metropolitan areas, the Okanagan, the Kootenays, the Fraser-Ft. George and the Thomson-Nicola regions.

This process of increasing relative concentration is especially marked in the case of Greater Victoria (Capital) where between 1979/80 and 1981/82, the private laboratory share of total adjusted laboratory expenditures increased from 44 to 50 percent in the two year period. This explains the relative flattening of the growth of hospital laboratory activity that was observed earlier (Figure 6.4).

On balance this regional analysis of private laboratory activity per capita shows a marked concentration in the more densely populated areas. It also suggests that growth in private laboratory activity is leading to further spatial concentration in those areas. Finally, it reinforces the earlier argument that the distribution of pathologists and their choice of practice styles has an important effect on the pattern of services provided.

In particular, it appears from this historical review that the designation of primary regional hospital laboratory centres in the late 1950s and early 1960s initiated the deployment of pathologists to these centres. In subsequent years, it seems that certain individuals (or their successors) have gravitated to NOFP practice (the public/private group of laboratory specialists shown in Table 5.5). Thus, the spatial distribution of private laboratory activity is not only a function of population or physician density, but of previous strategic decisions taken by the provincial government to support pathologists in those locations. The spatial structure of health service delivery is inextricably linked to manpower policy and provider behaviour.

TABLE 6.21 REGIONS WITH PRIVATE LABORATORY ACTIVITY IN CONSTANT 1971 DOLLARS PER CAPITA AND AS A SHARE OF ALL ADJUSTED LABORATORY COSTS IN THE REGION, 1979-1983

REGION	1979		1981		1983	
	$71 per Capita	% of All Lab	$71 per Capita	$ of All Lab	$71 per Capita	% Inc 79-83
Metropolitan						
GVRHD	7.89	36.0	9.31	37.1	11.79	49.4
Capital	9.99	43.9	12.85	50.2	15.63	56.5
Major Regional						
Central Okanagan	5.33	39.3	6.97	41.5	9.12	71.1
Fraser-Ft. George	3.60	22.6	4.60	25.0	5.10	41.7
Kootenay Boundary	2.68	13.9	3.16	14.5	3.64	35.8
Nanaimo	0.99	7.8	0.96	8.3	1.12	13.1
Thomson-Nicola	5.26	32.3	5.85	29.4	5.82	10.6
Second Order						
Alberni-Clayoquot	4.20	41.6	1.34	16.4	1.45	34.5
Central Kootenay	0.60	6.9	0.71	7.8	0.68	13.3
Fraser-Cheam	5.35	42.7	6.04	42.6	7.50	40.2
Kitimat-Stikine	3.33	28.7	4.08	37.3	4.74	43.4
N. Okanagan	0.10	1.2	1.09	10.7	1.25	1150
Okanagan-Similkameen	0	-	0.82	6.9	2.53	-
Peace River-Laird	1.87	19.1	1.66	15.4	2.11	12.8
Skeena-Queen Charlottes	0.82		0.50		0.03	-64.4
Third Order						
Bulkley-Nechako	0.30	3.6	0.29	3.7	0.29	-3.4
E. Kootenay	1.04	16.5	1.60	22.7	2.39	129.8
Powell River	0.07	0.8	1.10	1.0	0.23	228.6
		% share		% share		% share
ALL B.C.	5.04	31.2	6.11	32.2	7.58	35.9

Source: Medical Services Commission, unpublished data.

Note: No Regional Hospital Data were available for 1983. Consequently, the right column shows percentage growth in private laboratory per capita from 1979 - 83. The figure for all B.C. does show private lab as a share of all lab for that year.

6.7 A SUMMARY OF TRANSFORMATION IN THE CLINICAL LABORATORY SYSTEM 1954-84

This empirical review has documented the changing technology, organization and location of the clinical laboratory system in B.C. and critically evaluated both the stages and process of structural transformation.

Table 6.22 summarizes the changing environmental context, the shifts in policy over the time period and the structure and performance of the system that was apparent in each decade. These represent the stages in structural transformation.

6.7.1 Summary of the Stages in Transformation

The British Columbia laboratory system has gone through four stages of transformation between 1954 and 1984. The first stage, in the 1950s, could be termed the "pre-conditions for take-off" in which a variety of policy actors operating at the strategic decision level (federal and provincial governments), and the guidance systems level (laboratory professionals) "sensed" that the system was in need of upgrading. They perceived that a "performance gap" existed between needs and resources (based on both B.C.'s position relative to all of Canada and relative to the expanding set of "candidate" laboratory functions that could be undertaken). Environmental pressures for upgrading were strong and widely recognized and strategic policy initiatives were taken to improve the feasibility of upgrading. In particular, the provision of grants by the federal government and the commitment of the provincial government to upgrading facilities, manpower and regional laboratory services provided the infrastructure for growth.

TABLE 6.2 2 A HISTORICAL SYNTHESIS OF THE DEVELOPMENT OF THE B.C. CLINICAL LABORATORY SYSTEM 1954-1984

	1950s	1960s	1970s	1980s
ENVIRONMENT				
Social/Demographic	Demographic pressures on facilities	Access and equity a societal focus	Early 70s - "new society" agenda	Conservative backlash
Political/Economic	Development focus	Growth in the economy and in health	NDP government focus on health	Restraint and systems maintenance
Medical	Emerging diagnostic focus	Increasing sophistication of halfway technologies	Pressure on utilization	Continued expansion and increase in utilization
Technological	Static	Automation/dynamic	Number of candidate technologies increase both automation & computers	Dynamic change in technological environment particularly information technology & hybrids
POLICY				
Medical	Need for improved facilities	Rapid increase in demand	Continued increase in demand and access (TAT)	Preserve and enhance access to services, maintain facilities
Federal Gov't	Grants/HIDS Act	Medicare 1968	Preventive (Lalonde)	Restatement of "no tinkering" with Medicare
Provincial Gov't	Commitment to upgrade - facilities - manpower - regional services	Commitment to feeding the regions in: - manpower - construction	Commitment to: - preventive/community - upgrade metro hospitals - control private labs	Restrain expenditures but maintain services - control prices but manage technology replacement
ORGANIZATION				
Growth	Pre-conditions for take-off	Take-off in growth, lab increasing share of hospital costs	Continued growth but levelling off in share in large hospitals	Enforced "steady state" in hospitals is growth in private labs
Hierarchy	Very asymmetric - few large, many small	Relative dispersion of activity down hierarchy	Increasing concentration in large hospitals	Concentration of beds and services
Private/Public	All public	Rapid growth in private lab in the late 60s	Continued growth of private labs under NDP	Hopital labs levelling off, private labs increasing
TECHNOLOGY				
Automation	Minimal	Increasing penetration in major hospitals and private labs	Technology diffusion in 70s	Replacement and diffusion to smaller centres
Computerization	Zero	Zero	Large hospitals only their moratorium	Standard systems vs net-working of plural systems
LOCATION				
Regional Dynamics	Insular	More dispersion than concentration	More concentration than dispersion	Elements of a two-tiered system (v high - v low)
Rank Size	Total dominance	Hierarchy move up in parallel	Hierarchy moves up in parallel	All move up but less quickly
Cumulative Share	of large centres	Unchanged	Unchanged	Unchanged
PERFORMANCE				
Goal Achievement	Success in initiating upgrade	Substantial absolute and relative growth evidence of regional dispersion and improvement in access	Metro hospital labs are eventually upgraded Technology allocation is managed	Steady state is closer to being achieved in hospitals
Emerging Issues	Regional and social access needs improving	Pressures of growth on cost - need for rationalization	Failure to control private labs. Utilization, cost and technology major emerging issues	"Boxing" in all lab expenditures (especially private) Managing utilization growth with similar real resources

In the second stage in the 1960s, a continued commitment to upgrading by both government and the profession was coupled with a desire to improve accessibility and equity of service provision. Again, the federal government played a critical catalytic role with Medicare in 1968, but equally the provincial government subscribed to the developmental ideology. In particular, they continued the development of facilities and manpower for the regional laboratories. The combined philosophical and financial commitments of government to development policies enabled the growth and dispersion of laboratory services that medical practice of the day demanded. The availability of automated technology amplified the growth of certain sectors (in particular private laboratories) and certain tests (in particular routine patient monitoring) but it certainly was not the necessary and sufficient condition for systems change.

In the third stage of development of the system during the 1970s, policy makers sensed that continued growth needed to be managed and controlled to meet rational goals of efficiency. Attempts were made to centralize and rationalize activity and to direct development to certain sectors of the overall system. The policy efforts to direct that growth through central control seem to backfire on provincial policy-makers.

In the fourth stage in the 1980s, the continued expansion in demand in the medical (functional) and technological environment, the inability of the "centralist" model to direct activity to specific sectors and the lean economic environment lead to the imposition of an enforced "steady-state" on the sector that seems more controllable (i.e., the hospital sector). The result is a further transfer of activity to the private laboratory sector.

The system in this fourth stage displays increasing potential for conflict between the structural interests who historically had reinforced growth.

6.7.2 Summary of the Process of Transformation

The process of structural transformation observed in the B.C. case is a synergistic one. The wider environment, the perception of strategic decision makers and the policies that resulted are inter-related phenomena. On balance, the critical variables in the process of transformation are the changing environmental context of the system, the perception of this context by the structural interests and the policies that resulted. Internal organizational factors such as the portfolio of technologies adopted do appear to have a "multiplier effect" on policy directions taken. For example, automated technologies increased the profitability of the private laboratory sector and technologies diffused to smaller institutions helped increase the relative status of these facilities. However, these technologies did not cause the increasing scale of private laboratory operation or the upgrading of smaller institutions. Rather, it was the policy initiatives taken in the fifties and sixties that established the institutional framework within which subsequent growth has occurred.

Similar candidate technologies are available across North America but differences in policy making have produced very different effects in the diffusion and application of these technologies. An emerging example of this is the so-called nearer the patient testing systems. In the United States, doctor's office testing is currently undergoing a period of considerable growth, Belsey (1984). Such growth is being given legitimacy by the need for real-time monitoring, but primarily, it is being driven because of the potential for revenue generation on the part of physicians; by a policy and regulatory environment (particularly reimbursement system) which provides a "window of opportunity" for profitable doctor-office testing; and by a major marketing push from the technology providers, who are facing tighter competition and "cost-cutting" philosophy in other hospital and commercial laboratory settings.

In Canada, such technologies are being controlled because of the existing regulatory framework and the recognition by the technology providers that the cost of marketing these technologies aggressively in Canada does not warrant the likely returns. Thus two jurisdictions with similar levels of medical sophistication, and similar belief in the technological imperative are making different policy choices creating differences in the resulting structure and performance of the system. (A similar story was told for private laboratories in Saskatchewan versus B.C. and Ontario, in Chapter 5.)

In the chapter that follows, the findings from the case study will be integrated with the findings from the general literature in order to draw some conclusions and to identify wider policy implications. In Chapter 8, the specific policy implications for the B.C. clinical laboratory system will be discussed in a series of future scenarios for the system in 1994.

CHAPTER 7 TRANSFORMATION IN TECHNOLOGY, ORGANIZATION AND LOCATION: CHOICE OR CONSEQUENCE?

7.1 INTRODUCTION

This study has critically examined the relationship of technology, organization and location in multi-unit enterprises.

In particular, the study's goals were to assess the relative contribution that environment, policy and operational factors made in shaping structural change in multi-unit enterprise, and to evaluate the apparently ambiguous role that technology has played in the process of transformation.

In this chapter, the conclusions from the case study of structural transformation in the B.C. clinical laboratory system are integrated with the findings from the general, literature-based analyses. The policy and research implications of these conclusions are also discussed.

7.2 GENERAL CONCLUSIONS

7.2.1 The Process of Structural Transformation

The principal conclusion is that the process through which the technology, organization and location of multi-unit enterprise is transformed is a relatively enduring one. It is a process of transformation in which technology plays a secondary "enabling" and "amplifying" role to the principal synergistic interaction between external environmental factors and strategic choice. Specifically, the spatial and organizational structure of enterprise is transformed when strategic decision makers "sense" a significant change in the wider environment of enterprise and perceive a "performance gap" exists between the existing structure and functioning of the enterprise and some independently derived (although not necessarily consistent) set of performance criteria.

The case study demonstrated that the goals of the B.C. clinical laboratory system changed because of both environmental pressures and inadequacies in the internal operations of the system. But the more dominant factors conditioning the direction of systems change were the perceptions of these external and internal conditions held by strategic decision-makers and the policies that flowed from these perceptions. This conclusion was reached from an historical examination of decision-making in the B.C. system and from a comparison of the sequence of environmental shifts and policy changes with the changes in organizational and spatial structure.

At varying times throughout the last thirty years, strategic decision makers have been more open to the development of "change policies", (Crichton (1984)) because of dynamics in the socio-cultural or political environment (e.g., progressive liberal views vs conservative views) or because of a dominant set of new candidate technologies or candidate functions in the wider environment. But the policies that resulted were not dictated solely by such environmental factors. Rather, there is considerable support in the case study for Corning's view that structural change in complex social systems is brought about through a synergistic relationship between strategic choice and conditioned response to environment. Further, the process of strategic choice (or policy-making) in complex social systems is a political process that involves both self-interested action and co-operative altruistic action.

An illustration of the synergistic nature of structural transformation occurred in the late 1960s. The availability of high-volume chemistry profiling instruments coincided with the federal government's commitment to improving access to medical services through universal medical insurance; with an increasingly well organized and powerful private laboratory community and with a rapidly increasing supply of physicians (Evans 1984 p.157). The synergistic combination of environment, technology, power and policy amplified the growth of the private laboratory sector.

7.2.2 Supply Versus Demand

The second principal conclusion is a related one: neither a simple demand-side (medical needs) model nor a simple supply side (structuralist-functionalist) model is sufficiently robust to explain the changing structure of the clinical laboratory system of B.C. over the period. On the one hand, it seems clear that the scientific focus in medicine has had a powerful influence on growth and diffusion of laboratory services under different institutional frameworks. For example, it was observed that Saskatchewan, B.C. and Ontario had experienced similar growth in utilization of hospital laboratories. On the other hand, the structural differences between these provinces (and indeed between Canada and the U.S.) suggests that the dominant interests can "steer" the system in a particular direction that is compatible with their goals. The policy-making process is made more complex by inertia, lags and downstream externalities that were observed in Chapters 5 and 6. Indeed, the findings of the case study add further weight to the argument that today's policy solutions create tomorrow's policy problems.

7.2.3 Centralization Versus Decentralization

The third set of conclusions relates to the processes underlying the degree of spatial, functional and organizational centralization in the system. In spatial terms, four effects were observed. First, the hierarchy of hospital laboratory services is characterized by an enduring stability in terms of the relative allocation of activity between different ranks in the regional hierarchy. Second, over the period studied, the regional hierarchy of hospital laboratory services has grown steadily across its rank-size distribution. Thirdly, a large number of individual centres have undergone relative change in status over the period reflecting the differential impact of policy interventions, organizational change and technology. These three findings parallel Stephens and Holly's (1981) conclusions on the changing spatial structure of large U.S. corporations and their headquarters' location. A fourth locational effect is the high and increasing level of concentration of private laboratory activity in urbanized areas. (The policy implications of this are discussed below).

In functional and organizational terms, the case study shows that forces of concentration and dispersion occurred simultaneously throughout the time period. Concentration is reflected in the increasing share of patient days (and thus overall laboratory activity) in medium and large hospitals, since the mid 60s. Dispersion is reflected in the continuous relative increase in laboratory activity per patient day in smaller hospitals. The processes of concentration and dispersion offset one another to a large degree, leading to relative stability in the organizational and spatial hierarchy. For example, the teaching hospitals have retained a remarkably constant share of hospital laboratory activity.

Technology played a critical enabling role in many of these changes but it did not determine them. Specifically, in the laboratory case, the strategic commitment to disperse laboratory services to specific regions of the province and to specific types of hospital clearly predates the availability of candidate technologies that might encourage such dispersion. Similarly, the observed processes of increased spatial and functional concentration of laboratory activity in private laboratories that occurred in the late seventies was driven more by policy (or lack of it) than by technology.

In certain time periods, in certain sectors, there is considerable consonance between the availability of candidate technologies in the environment, the deployment of these technologies in the "portfolio" of the sub-units of enterprise and most importantly a strategic choice to drive the system in a particular direction. In such circumstances equipment-embodied technology can make a very powerful contribution to changing the relative centralization or decentralization of the system, but it does not determine the choice between centralized and decentralized. Rather, it amplifies the chosen direction.

Technological change presents new organizational and locational options for strategic decision-makers. Thus greater technological variety provides a wider set of strategic choices. In particular, the emerging hybrid technologies of automation, computerization and communication present a new set of alternatives for enterprise. These technologies are unique in that they allow the simultaneous dispersion and concentration of functions and decisions in both spatial and organizational terms. But ultimately the final systems design will be selected from, and not dictated by, the availability of these technologies.

7.2.4 The Role of Technology in Structural Change

A fourth principal conclusion relates to the general role of technology in systems transformation. Equipment-embodied technology is too often regarded as the "prime-mover" behind structural change (by both academics and the media). Consequently, in times of positive societal development it is given too much credit and in times of difficult structural upheaval it takes too much blame. In the clinical laboratory case, a number of factors interact, in a synergistic fashion, to produce structural transformation in enterprise. But, the more dominant factors are the growth in medical knowledge (on the demand side) and strategic decisions taken on how to organize (on the supply-side). Thus the clinical laboratory system, like many other emerging enterprises, is both knowledge-driven and policy-driven. Technology is indeed an important factor, because it plays a role in the external environment (i.e., as candidate technologies) and in the internal organizational environment (i.e., within the portfolio of technologies adopted by the organization). However, technology is not the "prime mover" of structural change.

7.2.5 Central Control Versus Institutional Autonomy

Throughout this study is has been argued that strategic decision making is a critical variable shaping structural transformation. However, it is doubtful whether the complex multi-unit enterprise can be "steered" effectively through a system of detailed central control. In particular, the provincial government was unsuccessful in directing activity from private to public laboratories under the New Democratic Party in the early 1970s (indeed, their policies may have had the reverse effect). Similar failure to contain medical services in general, and private laboratory billings in particular, supports the conclusion that detailed central control of a complex enterprise will meet with mixed success, at best, and has the potential to "backfire" on the central authority. Conversely, the experience in the 1950s and 1960s suggests that the central agencies created an environment of growth and encouraged the deployment of professionals to "guide" the development of sub-units. This model of dispersed control contributed greatly to the growth in the system, but it also led to the policy problems of cost escalation faced in the following decades.

On balance then, in a complex, largely public sector system, neither detailed central control nor complete institutional autonomy seems capable of producing "managed development". A different institutional framework must be developed if the system is to fulfill the apparently conflicting goals of service development and restraint. In Chapter 8 specific future policy options for the B.C. laboratory system will be examined.

7.3 GENERAL POLICY IMPLICATIONS

This study has implications for policy at three levels: the societal scale, the urban systems scale and the scale of enterprise.

7.3.1 Policy Implications at the Societal Scale

Equipment-embodied technologies are not uncontrollable monsters ravaging our society and institutions, nor are they simple benevolent slaves that enhance our well being. Rather they are instruments of human action. We have the choice to create them, deploy them and organize them to meet our goals - they are means not ends. Technologies in themselves are not inherently good or bad; they have to be managed. It should be pointed out that the ability to develop policy and organize activity is itself a powerful and necessary "technology" whose equipment is knowledge of a wide variety of human, scientific and technical phenomena.

The second and related implication at the societal scale is the critical role that knowledge plays in structural transformation. Expanding medical knowledge and changing patterns of practice played a more dominant role than did specific equipment-embodied technologies in stimulating growth in laboratory services. Technology enabled and sustained the growth but it was not the necessary and sufficient condition that caused it. Conversely, lack of knowledge about how to direct and manage complex social systems has hampered our ability to steer the system in a preferred direction. This suggests that an advanced society should continue to place a very high priority on applying knowledge, not only to what we do, but to how we do it. Thus, there is a need for research and education in post-industrial society, not only as a means to create new products and services, but also to provide the research and the educated labour force to better organize the production and delivery of products and services. The management of complex social systems requires more than calculus. Thus, to neglect the social sciences and humanities in our research and educational policies is to perpetuate our inability to manage complex social systems. Health care is an example of this deficiency. The enormous financial and intellectual resources dedicated to the development of techniques and technologies in medicine is in sharp contrast to the resources dedicated to evaluative and management research.

7.3.2 Policy Implications at the Urban Systems Scale

This study raises more specific policy implications of the urban systems scale. The enduring stability of the urban hierarchy is in contrast to the change in status of individual cities. In common with other researchers (e.g. Pred (1979) and Stephens and Holly (1981)) this study demonstrates that the changing status of centres (and the emergence of "winners and losers") is an aggregate reflection of the individual behaviour of a number of multi-unit, multi-location enterprises (both public and private). Further, this work suggests that the changing status of the various sub-units of enterprise is a result of strategic decisions taken by policy-makers and by individual decision-makers in these sub-units.

These decisions are not dictated by some super-organic force favouring concentration or dispersion, nor are they being determined by technology, rather they are being steered by strategic decision making and the behavioural and political processes underlying this decision-making.

This argument, that strategic choice governs location, has important policy implications. In particular, the case study suggest that health care services delivered through privately owned "firms" are subject to a process of "spatial adverse selection". For example, the spatial distribution of private laboratories does not conform to the spatial distribution of population. This is in contrast to public sector facilities in which no significant difference was detected between relative spatial distribution of population and hospital laboratories.

Increasing privatization of health services in Canada might be expected to increase the degree of spatial adverse selection and lead to a deterioration in the level of service available for specific communities. In the U.S., the increasing dominance of multi-unit for profit hospital chains coupled with the squeezing of Medicare and Medicaid seems likely to restrict geographic accessibility to health services (in particular, inner city areas and remote rural areas). Corporations with a "branch plant mentality" owe allegiance to their shareholders not to specific communities.

This process of spatial adverse selection could be extended to raise doubt about the private/public mix in education and other human services. Indeed, it was geographic as well as social imbalances that led to public control of human services throughout the last century. However, this is one area in which emerging communications technologies can play an important role. For example, the potential for satellite based television to enable "distance learning" is well documented, Hardwick (1984). Judicious application of such technologies can alleviate regional imbalances in accessibility to informational services. But what is "judicious" in the eyes of private corporations may not be so judicious in the eyes of the public.

A related but more general policy implication of this study is in demonstrating the important role played by multi-unit service-oriented enterprises (both public and private) in preserving employment and vitality in smaller urban centres. Formalized "urban policy" died in the seventies and eighties in North America, leaving in its wake a residual interest in the impact of all public and corporate policies on urban settlements. (First Annual Report of the Commission on National Urban Policy 1982:p. 1-12). In seeking to alleviate the multiple stresses of "loser" settlements, service-oriented enterprises can play an important sustaining role in these urban economies. Conversely, cutbacks in government operated health, education and systems maintenance enterprises (e.g., forestry enhancement, highway maintenance, law enforcement, legal aid, social services, etc.) can only serve to further depress those settlements that have already received considerable blows to their traditional economic base. In B.C. such actions have been commonplace; motivated by declining revenues and the need to "rationalize" the apparent duplication of services. For example, the closure of the David Thomson University was a final hardship to the struggling resource settlement of Nelson. Similarly, the closure of the mental health rehabilitation centre in Kamloops eroded further an already depressed urban economy. If urban policy can make a revival, it must focus almost exclusively on understanding and modifying the behaviour of multi-unit, multi-location enterprises in both the private and public sectors.

Perhaps the most significant urban policy implication raised by this study is in identifying the critical catalytic role played by the quaternary elite. The strategic decision makers in the B.C. laboratory case conditioned the spatial and organizational structure of activity. The size of this quaternary elite in the laboratory case is relatively small: between 5 and 10 key actors (government officials and medical professionals) made the strategic decisions that changed the system.

If we are to understand the dynamics of the urban system we must look much more closely at how and why the quaternary sector makes decisions. The basic purpose of this group is to steer enterprises. They select a direction for the system based on the intelligence they have gathered and on their own vision of the future of the enterprise. Unfortunately, most forms of analysis in geography, economics and planning tends to assume that strategic decision-makers make decisons based on some simple profit-maximizing, or service-maximizing formula. In this case strategic decision makers are satisficing under environmental constraints rather than optimizing. They do not have total discretion in their choices, neither are they totally constrained by environment or performance criteria. Thus, the ability of the quaternary elite to select appropriate courses of action is critical to the survival and well-being of the enterprise and the cities in which the enterprise is enmeshed.

More sophisticated analysis and monitoring of the size, location and perceptions of the quaternary elite is necessary if we are to further our understanding of the dynamics of the urban system. In analyses to date many analysts have failed to recognize fully the pivotal role of these decision-makers as the control points in urban change.

7.3.3 Policy Implications at the Level of the Enterprise

The study has policy implications at the level of the enterprise. There is evidence to suggest that a system in which autonomous, self-directed sub-units operate under the umbrella of widely-shared goals, is a spatial, functional and organizational structure that is compatible with growth and accelerates growth. However, such "dissapative" structures consume a high level of resources (energy) and consequently in less munificent environments they present a threat to overall systems stability (Prigogine (1977)). Conversely, detailed central control in spatial and organizational terms seems incapable of steering a complex multi-unit enterprise towards predetermined goals. (Developments in information technology have enabled both forms of control but the technology is neutral in determining the selection of either extreme).

Specifically, in the B.C. laboratory case, the multi-unit enterprise operating in an environment of "development" can reinforce that growth by creating the kind of "self-developing" structure that was derived theoretically in Chapter 3 and seen empirically in the B.C. laboratory system of the 50s and 60s. Conversely, the "goal-less" restraint model of detailed central control may not be the most effective solution for an enterprise facing the combination of a lean environment and a need to preserve services. Such a model stifles the spirit of co-operation, ignores the "intelligence" contribution that can be made by the sub-units, reduces the morale of employees and degrades the public's perception of the enterprise and its strategic decision makers.

An alternative restraint model is one where the policy level clearly articulates the goals of the system, increases autonomy given to sub-units (in terms of their routine operations), and imposes an overall budget constraint on the system. This is the basic model that was used successfully by the total Canadian health care system during the seventies, combining "top down" constraints with institutional freedom. The model breaks down, however, when the goals of the system are not widely held, or where certain groups of workers, institutions or provinces are perceived as having escaped from the overall net (hence the challenges to extra-billing and the leap-frogging in wage settlements that occurred in the early 1980s).

The final policy implication at the level of the enterprise is the potential offered by emerging technologies for a "spatially-exploded" organizational structure. A greater range of choices is now available for the structure of enterprise. The preferred alternatives should involve not only concerns of efficiency, but also the quality of worklife and the need for intelligence functions in the sub-units of the enterprise. Such organizational structures might increase further the spatial separation of command and production actvities, creating further imbalances in the urban system. It was argued earlier that cities are "enmeshed in networks of multi-unit enterprises". This study emphasizes that the geographic location of senior decision makers in the multi-unit, multi-location enterprise is a critical variable in predicting growth of the enterprise and subsequently in determining the vitality of individual cities. These relationships have implications for urban policy and corporate strategy.

In particular, the very largest cities continue to retain senior strategic decision-makers and maintain their high-order status. Second-order regional centres are likely to maintain and enhance their viability if they can retain or attract the self-developing sub-units of growing enterprises. It was argued earlier in chapter 3 that such sub-units are likely to be staffed by better educated and more upwardly mobile individuals than would be found in the sub-units of the machine bureaucracy, e.g., the "industrial office". Consequently, these self-developing sub-units are likely to be created or to relocate in those areas where a suitable pool of labour is available and/or where the city offers particular social, cultural or environmental amenities that appeal to these groups. Attracting self-developing growth will therefore involve a commitment to educational infrastructure, development of natural amenity and enhancement of social and cultural facilities. Regional development policy has frequently ignored strategies that might spawn "home grown enterprise" or attract self developing sub-units. Instead, fierce competition between cities is set up where very large subsidies are offered to "attract" the "industrial offices" and the centrally controlled plants of distant, static conglomerates - jobs at any price.

7.4 FUTURE RESEARCH IMPLICATIONS

This study has adopted an interdisciplinary approach to the analysis of structural transformation in the multi-unit enterprise. Such a wide ranging study raises more research questions than it answers. Therefore, in this final section a number of theoretical, empirical and applied research implications will be discussed.

7.4.1 Implications for Future Theoretical Research

From a theoretical perspective, the study has argued that a behavioural approach aimed at the level of the enterprise has more explanatory power in the analysis of structural transformation than does either a societal level structuralist approach or a neo-classical economic approach to analysis. This is consistent with the plea made by Taylor and Thrift (1983b) for a more behavioural focus in industrial geography - a new geography of enterprise. However, this study follows on from others, e.g., Marshall and Bachtler (1984) and Edwards (1983) in its attempt to integrate more closely, the considerable body of knowledge in organization theory and cybernetics with this new geography of enterprise. If geographers are to be successful in developing, greater understanding of the spatial dynamics of the enterprise, then they must incorporate this body of knowledge in their teaching and research and they must forge collaborative research links with organizational specialists.

Conversely, organization theorists could make a very useful contribution to research in urban planning and urban geography if they were to begin to integrate spatial phenomena into their research and teaching. The business disciplines of organizational behaviour, urban land economics and marketing could be excellent foundations for such research bridges. Equally, at the graduate level, the training of urban land economists, urban planners and urban geographers might usefully include joint courses on the geography of enterprise. A final useful bridge between the two fields can be built on research and teaching of urban studies as a formal interdisciplinary program.

The second principal research implication relates more specifically to the case study and to health policy and health planning research. If nothing else, the case study has demonstrated the considerable downstream negative externalities created by certain health policy and health planning initiatives. It was suggested earlier that the best advice to health policy-makers might be "look before you leap", but this is inadequate in itself. Considerable future research is required in developing health planning models that improve policy-makers ability to assess the medium and long-term implications of policy changes. Such research should not be limited to linear econometric forecasting or computer simulation. Rather, it will require the ability to integrate possible structural shifts in environment, demands, operations and technology with the goals of the health system, in order to evaluate the utility of proposed options under alternative future scenarios. Such methodologies have begun to emerge (e.g., Tydeman and Mitchell (1978) and IFTF (1985)) and in the final chapter of this study a "futures epilogue" will be attempted.

7.4.2 Implications for Future Empirical Research

This study has research implications and raises questions for empirical work in a number of areas. First, it would be very useful to have available a larger number of case studies on structural change in specific multi-unit enterprises. In particular, investigators might select a series of specific enterprises that had undergone change in spatial and organizational terms. By examining the pattern of change in the organization and location of activities and decision-making in each of these enterprises, it should be possible to draw some more general conclusions about prevailing trends in restructuring. Using a cross-sectional, rather than a longitudinal form of analysis it would then be possible to measure, more precisely, the relative contribution of:

- impact of different environments on changes
- role of strategic choice
- conventional land economic considerations
- real estate inertial factors
- locational preferences of senior executives
- corporate image considerations
- role of telecommunications and technological change.

By comparing enterprises that had undergone structural change to a control group of more static enterprises, it would be possible to produce experimental results that would better validate the hypotheses tested here in a longitudinal study.

A second and related empirical focus which could be conducted as part of the previous study, or with a similar experimental design, is a more detailed investigation of the factors that "triggered" change in technology, organization and location. Was change a result of a synergistic combination of factors or were there specific conditions that tipped the balance? Again, the results of the laboratory case study indicate that shifts in policy and environment played a stronger role than technology and operations in the process of structural transformation. These conclusions may be generally applicable, but they require further empirical validation.

7.4.3 Implications for Future Applied Research

The final set of research implications relate to possible applied analyses. The results from the proposed theoretical and empirical work outlined above could be applied to a number of public policy and business planning areas. For example, the application of this research to the office development industry is an obvious one. In particular, the relationship between corporate restructuring and office building would be a useful focus of research. Similarly, the links between "spatially exploded organizational structures" and the use of telecommunications in creating "smart buildings" in both downtown and more peripheral locations, is a subject requiring organization level research.

Similarly, the theoretical and empirical research at the level of enterprise could help develop more specific urban policy and urban planning programs. To date, most of the North American research has been conducted using structuralist-functionalist analysis at the societal scale or using more conventional economic analysis at the urban systems scale. Theoretical and empirical research at the level of the enterprise would produce a better understanding and hopefully some specific interventions that might alleviate the externalities of the "winners and losers" phenomenon discussed earlier.

Further, applied research initiatives might also come in the health planning area where a closer melding of health policy analysis and spatial analysis could be developed. Particular attention should be paid to the link between privatization of health services and the process of spatial adverse selection, discussed earlier.

Finally, applied research could be developed to provide a more geographic focus in corporate planning for the multi-unit enterprise. Such research might transform the corporate planning mentality from one where "places" are simply seen as "sub-units" of the enterprise in a relatively aspatial way. Applied research in this area could lead to a better integration of "places" and "sub-units" from both a corporate and a public policy perspective.

This study has attempted to develop understanding of structural transformation in multi-unit enterprise from theoretical, empirical and applied research perspectives. Much remains to be done. The research challenge in the future is to provide the knowledge base to guide policy and action in the best interests of the individual, the enterprise and society.

CHAPTER 8 THE FUTURE OF THE CLINICAL LABORATORY SYSTEM OF BRITISH COLUMBIA

8.1 INTRODUCTION

This final chapter is as an epilogue to the study. It describes briefly, a series of environmental conditions that the clinical laboratory system of B.C. might face in 1995 and reviews a range of alternative policy options. It should be recognized that these attempts at forecasting are highly speculative and are intended as an input to more detailed planning and policy-making exercises that should be conducted.

The basic model for this review is one that draws on the conclusions of the body of this study. The previous chapters have argued that the critical variables in systems transformation are the changing nature of environment and strategic choice. Consequently this chapter is divided into three main parts:

8.2 Future Environmental Conditions

8.3 Future Policy Options

8.4 Conclusions

8.2 FUTURE ENVIRONMENTAL CONDITIONS

It is possible to differentiate two types of change in the future environment of a system. The first is a rate change. In this case a particular trend can be extrapolated to forecast a future environment for clinical laboratories by examining the likelihood of increased, decreased or constant rates of growth in a particular phenomenon. The second type of change is a step change or structural shift in which existing trends are dramatically altered (in both magnitude and direction) and new elements are added. The review of the last 30 years of experience of the B.C. Clinical laboratory system suggests it is likely that both types of environmental change will occur.

Table 8.1 summarizes a series of possible trends and structural shifts in the environment of the B.C. laboratory system. (These have been based broadly on a report on the future diagnostic services market (IFTF, 1985) and on presentations on the future of laboratories, in particular, Goodman (1984) and Burtis (1985)).

These environmental changes are purely speculative but they suggest that it is probable that the environment that will be faced by policy-makers in the 1990s is one in which there will be:

- continuing pressures within medicine for increased use of patho-physiological "read-out" because of advances in knowledge
- continuing pressure on the government to maintain state-of-the-art health services with limited revenues.

It is also conceivable that the research currently being conducted in immunology and genetics will increase the number of different questions that can be asked of laboratories, e.g., Goodman (1984). It is also likely that these "new questions" will be an additional load on the laboratory system, particularly for screening and diagnostic purposes. Improved diagnosis and improved understanding of the pathogenesis of disease has historically led medicine to develop interventions. If history repeats itself, it is likely that such interventions will follow the law of diminishing returns in that they will involve the increased use of clinical laboratory services (as well as other resources) in order to make a relatively small improvement in

TABLE 8.1 THE ENVIRONMENT OF B.C. CLINICAL LABORATORIES IN 1995 - POSSIBLE TRENDS AND STRUCTURAL SHIFTS.

ENVIRONMENT	TRENDS	STRUCTURAL SHIFTS
Social/Demographic	- Health care continues to be a dominant policy issue. - Continued popular support for Medicare. - Institutions dominate in care for the elderly.	- Major reorientation of social values towards family centred care and away from high technology.
Political - Economic	- Health care costs take an increasing share of GNP and GPP through the 1980s and early 1990s - "Economic Renewal" in BC has still not restored the relative prosperity of the late 1970s.	- BC economy is no longer dominated by resource industries but by "struggling" high-tech firms and service industries creating a lean but stable government resource base.
Medical	- Modest improvement in patient outcome can be assured with early detection of virtually all diseases of the immune system - All diseases of the immune system (including all cancers) are now treated very aggressively - Palliative care is still relatively unacceptable to medicine and the public - Coronary bypass surgery has been largely replaced by medical interventions that require continous drug monitoring	- The AIDS epidemic reached its peak in 1992 with the discovery of a vaccine However it is estimated that 10,000 British Columbians may still be carrying the disease and are immune to the vaccine. - Major advances in immunology and genetics have made it possible to screen for a vast number of diseases at an early stage in their development - Natural childbirth is considered barbaric

TABLE 8.1 Continued

ENVIRONMENT	TRENDS	STRUCTURAL SHIFTS
Technology	- A wide variety of DNA probes and Monoclonal Antibody procedures are now commercially available and they are capable of diagnosing and typing all cancers at an early stage of development - Desk top chemistry and hematology instruments are capable of the same menu of tests available on centralized automated instruments in the mid 1980s. They cost $10,000 (1985 $) - Desk-top micro-mainframe computers are available commercially at a cost per system of $10,000 (in 1985 $) but with the power of the large micro-computer of the early 1980s. - Satellite based communications systems are available in most buildings. - General Purpose Local Area Network technologies and translater packages are available for all makes of computers.	- Chemotronic sensors (based on chemically sensitized semi-conductors) can be used to measure any bio-chemical constituent using either samples of body fluids or by direct attachment to the patients' skin. These technologies are commercially available. but they are still relatively expensive for use in all areas of the hospital. - Voice interactive soft-ware technologies were perfected in the late 80s allowing direct dictation to micro-computer and the digitizing of voice commands.

patient outcome. Similarly, the development in laboratory technology and in computer and communications technology, will enable even more questions to be answered in even more geographic and organizational settings.

The IFTF report cited earlier draws a different conclusion from polling a panel of experts in the U.S., who suggested that utilization of laboratory tests would decline in the early 1990s as a direct result of reimbursement initiatives in that country and the consequent substitution of new technologies for old. This indicates the very close interaction between environment and policy in shaping outcomes. The policy options for the BC system will be reviewed below.

8.3 POLICY OPTIONS FOR THE B.C. CLINICAL LABORATORY SYSTEM

It has been concluded that the likely environment facing B.C. policy makers over the next 10 years is one in which medicine will be capable of asking more questions of clinical laboratories and government will have fiscal pressures to restrain the cost of these activities. What kind of policy responses can be made?

In this analysis a range of possible responses are described and evaluated. At one ideological extreme is a "free enterprise" model for the laboratory system, at the other is a "centrally-directed system". Each of the options in between will be described, and evaluated to determine the likely outcomes they would have in terms of cost, quality and distributional effects. Table 8.2 summarizes the attributes of each alternative response. (For a more thorough analysis at the level of the entire health care system see Evans (1985; Chapter 14). It should be re-emphasized that policy for laboratories has not been made solely by government. Rather, as discussed in Chapter 5, a number of different structural interests are involved in the policy-making process.

8.3.1 <u>The Free Enterprise Model</u>

Analysts have observed that clinical laboratory services, in certain jurisdictions, have been delivered within a "free enterprise" system of competitive firms operating in a market framework (e.g. Bailey (1979), Evans (1984:230). However, it is well recognized that there are problems with such a situation, because of the absence of a sovereign consumer. For example, lower per test costs are often counterbalanced by increased utilization, Bailey (1979)(Consumer sovereignty is one of the basic assumptions (and requirements) of a competitive market. The consumer is the best judge of his tastes and preferences and this is backed up by his willingness to pay. In health, patients are not "sovereign consumers" because of the asymmetry of information problem, Evans (1984, Chapter 4). However it can be argued that in the case of laboratories, the physician is the consumer of the service and he meets the essential criteria of being able to evaluate what he is buying and what it does for him).

The free enterprise model discussed here reflects the "privatization" thrust in U.S. health care, where the consumer is considered to be the patient and his insurance company. Thus the "free" refers to unrestricted competition on the provider side: not really a true market.

The introduction of a "free enterprise" model in B.C. would necessitate the dissolution of existing regulations regarding licensing of laboratories.

It is likely that the size of the present market for outpatient tests (in excess of $100 million) would encourage the entry of new firms (e.g., medical technologists, chemists and corporate technology providers). It is equally likely these firms would follow other private laboratories in their choice of location. In particular, they have an incentive to select those areas where there was a sufficient concentration of physicians to create economies in specimen collection and results' distribution and to develop economies of scale in test production. These firms would then have to build up their market share by offering a better level of service than the existing facilities. (It is unlikely that price competition would bring new firms any increased business given that the consumer of the test (the physician) does not pay for the service).

The net result of such a policy would be to increase the availability of laboratory services in the major metropolitan areas, increase the overall cost of testing through higher levels of utilization with no parallel reduction in prices. Further, it would require the co-operation of laboratory professionals in developing and maintaining an appropriate program of quality assurance. Such co-operation might not be forthcoming in view of the attack on the professional monopoly. In short, the free enterprise model has potential to create considerable political and economic confrontation.

8.3.2 Medical Sub-Market Approaches

A modified set of market approaches can, however, be developed. For example, physicians could be given an incentive to behave as fully-informed consumers of laboratory services. Under such a scheme, the physician's visit fee would be increased to cover all diagnostic expenses for laboratory and imaging procedures. The physician would then be responsible for paying for laboratory services as part of his costs of operation. Under such a scheme, price competition would become meaningful to the consumer/physician. There would be an incentive for the physician to limit utilization of tests, to "shop around" for better prices, or to perform the tests in his office if results of appropriate quality could be produced at lower cost. In a competitive market, prices would be bid down and costs to the physician (and in the long run to the third party paying agent) would be reduced by a combination of price effects and utilization effects resulting in an "allocatively efficient" use of resources.

This alternative has a good deal of theoretical appeal, but a number of implementation and operating problems would have to be overcome. First, it is very likely that the profession would view such a scheme as the "government bribing doctors to practice sloppy medicine" or that by bringing their use of diagnostic resources into the fee for a patient episode this was "government interfering in the practice of medicine." (There are no real theoretical grounds for such assertions but the rhetoric sounds familiar. Doctors would likely make these assertions based on the realization that it will limit them in the long term). Despite such protest, it is rumoured that the U.S. is considering such a scheme for outpatient reimbursement under Medicare. The scheme, which might be termed "Son of DRG", would involve a flat fee for a particular type of outpatient visit (or illness) from which the physician has to pay for any diagnostic services used (Statland (1985)).

The second principal problem is in designing appropriate sub-markets for inpatient and ambulatory environments. The administrative problems of charging doctors for use of tests in the hospital environment are considerable. For example, tracking who actually ordered the test (the intern, resident or staff physician), might pose some problems. Similarly, the same tests ordered under different circumstances can have wide variation in resource costs, e.g., stat tests can cost four or five times as much as tests ordered on a routine basis. The data processing and accounting problems are considerable but they are not impossible to resolve. However, on balance, efforts to ration tests or to provide financial incentives to limit utilization in the hospital setting have not been particularly successful to date. Equally, even if reduction in use can be achieved it does not necessarily lead to a proportionate reduction in cost, Morrison et al (1985). It has been argued that test utilization reduction can lead to perfectly elastic cost reduction in the ambulatory environment, Morrison et al 1985. Thus implementation of a "medical sub-market" might be logically aimed at high volume routine tests in the ambulatory "fee for service" environment. (The continued emergence of improved nearer the patient testing technologies is likely to enable the transfer of testing to the doctor's office in the medium term. The current wave of instruments do not appear to have sufficient menu range of low enough operating costs to warrant adoption by physicians. But, developments in medical practice and laboratory technology suggest that pressures will continue to perform more sophisticated diagnostic work in the doctor's office).

TABLE 8.2 POLICY OPTIONS FOR THE B.C. CLINICAL LABORATORY SYSTEM OF 1995

Policy Option	Free Enterprise Model	Medical Sub-Market	Adjusting the Public/Private Mix	Restrained Autonomy	Centrally-Directed System
Underlying Ideology	No professional control. Follows "free market" principles	Professional control, market principles including fully informed consumer (ie physician)	Some professional control but indirect government control and quasi-market	Professional control but more direct government control of funding	Government ownership and control of facilities and operation
Allocative Efficiency	Impaired because of the absence of a sovereign consumer	Strong incentives to be allocatively efficient in test selection and use	Indirect incentives to be allocatively efficient	Incentives to be allocatively efficient within budgets	Would contain costs but no guarantee of allocative efficiency
Technical Efficiency	Likely would reduce the resource cost per test	Incentives to reduce per test costs in hospitals & private labs	Indirect incentives to reduce prices of tests	Incentives to reduce costs of production	Would reduce "prices" and may reduce costs of production
Distributional Effects	Pathologists would lose control Ancillary professions might gain	Possiblity of wealth transfer from private labs to other physicians	Probable wealth transfer from private lab to hospitals and government	Transfer of resources from private to public is possible	Transfer of wealth from private lab to government
Issues of Implementation	Presents a strong challenge to the medical monopoly	Difficulties in calibrating the allocation of doctors budgets	Difficulty in communicating incentives to individual physicians	Requires a high level of co-operation negotiation & analytical support	Presents an enormous challenge to organized medicine. "Buy-out" costs are high
Negative Externalities	Utilization would increase through marketing. Services would concentrate in metropolitan areas	Possibility of reduction in standards of quality control (although medico-legal trade-off exists)	"Competition" between sectors may lead to higher utilization	Budgeting process could become overly politicized leading to loss of allocative efficiency	Scientific standards may decline if profession are not responsible for management of sub-units

The third principal problem in implementing such a scheme in either the inpatient or outpatient environment is in calibrating the initial allowance per episode. Internists order more tests than surgeons because of the types of diseases they treat and the way that they treat them. Should internists be "punished" more than surgeons? Who is going to decide what the initial endowment should be, using which criteria? For the outpatient sector, the Medical Services Commission has data necessary to calibrate the current size of the initial endownment (by individual physician, by specialty and by region). However, there is no clear evidence to determine whether the current level of utilization by a group or an individual is necessarily appropriate (or inappropriate). Similarly, in order to ensure "fair" competition for outpatient testing, hospital laboratories would have to be responsible for the same costs of operation as private laboratories (i.e., overheads, buildings etc). However, a policy objective might be to retain this "subsidy" for public laboratories in order to encourage hospitals to play a more dominant role in the market. (This would make them a form of Preferred Provider Organization (PPO).

The final set of concerns surround the ongoing operation of the system once implemented. Would physicians actually "shop around" or would they maintain their existing practice style and pressure for higher fees overall? It should be re-emphasized that previous research shows little success in using financial incentives to create reduction in test use. (See Grossman (1983), McIntosh (1981) and Hardwick et al (1985) for reviews of the research experience).

The final problem with implementation is with regard to the billing procedures. One of the advantages of universal medical insurance is the economies of scale in administering the plan. A scheme in which 5000 doctors got bills from a 100 different laboratories transfers central financial administrative functions to doctors' offices, private laboratories and hospitals thus reducing the overall allocative efficiency of the system. This could be alleviated by the use of the Medical Services Plan as the central clearing house for such financial transactions. MSP could issue each physician a "diagnostic credit card" that could be used to purchase laboratory and other diagnostic services. The Medical Services Plan would simply deduct the physician's diagnostic "purchases" from his other revenue and his income (credits) and expenses (debits) would be itemized on his monthly or quarterly statement.

This scheme like most health policies that have been discussed, has some potential to backfire. It might encourage certain physicians to "cut corners" in their test ordering behaviour (although a very obvious medico-legal trade-off exists). Similarly, with the advances in desk-top technology, such a scheme might encourage the use of such laboratory technology without appropriate quality assurance (but again a medico-legal trade-off exists). In a true medical sub-market overuse or misuse would be impossible by definition because the consumer (physician) is backing up his preferences with his willingness to pay.

On balance, the scheme has considerable theoretical appeal. Its primary weaknesses lie in the lack of empirical research evidence that financial incentives restrain test use. Analysts have argued that more sophisticated behavioural controls are required.

8.3.3 Adjusting the Public/Private Mix of Laboratories

Over the last decade, certain policy-makers have viewed the size and growing share of all medical activity that is directed to the private laboratories as a major problem. An option for government would be to attempt to change the structure of the reimbursement system to alter the public/private mix of laboratories. For example, government could eliminate fee for service testing done in hospitals from the Medical Services Plan, replacing it with direct funding through Hospital Programs. (In effect, this is how the current system operates). In addition, an outpatient bonus of 3-5% of the prevailing fee would be provided to hospitals as an incentive to compete in the outpatient market. As pointed out before, any incentive for hospital based laboratories to compete must circumvent the offset revenue policy that has persisted over the last 15 years. (Direct payment to a laboratory controlled account would provide a real incentive).

Government could then remove the hospital laboratories from the Medical Services Plan, and negotiate or impose a cap on entire MSC billings. This framework would provide an incentive for physicians, in aggregate, to recognize that what they expended in laboratory tests (as a group) they would have to forego in income (as a group). Theoretically, physicans would minimize testing done in private laboratories in order to maximize income. However, it is very doubtful whether simply recognizing that one group is getting a bigger share is sufficient incentive to modify the individual's behaviour.

Another less dramatic variant of this scheme is to provide more information on laboratories in the "Blue Book" - The Annual Statement of

Physicians gross billings to the Medical Services Plan. Many journalistic and research efforts have been made to identify the gross and net incomes of individual laboratory physicians. The existing data presented in B.C. do not provide any clear indication of individual billings. It is even difficult to determine total fees paid to specific "firms" because both group practices and individuals have billing numbers and as private companies, they are not required to produce public financial statements.

The increasing share of resources taken by private laboratories from the Medical Services Plan includes the costs of operation of the facilities (wages for technologists, equipment, supplies and other overhead) and the income to the medical professionals (in the form of professional fees and "profits" on technical fees). It seems inequitable to require laboratory specialists to declare total net income as individuals (because no other specialist or general practitioners are required to do so). But it does seem reasonable to identify the individuals responsible for generating at least the professional component of those billings.

However, it is very questionable whether more open disclosure of gross incomes would have any real effect on the test-ordering of individual physicians or on the laboratory fee schedule. Under these circumstances, it would be in the best interests of all physicians to use less tests from private laboratories in the aggregate - but it is not clear whether individual physicians would make that choice without a more direct incentive to do so. (Habitual behaviour is difficult to change. One should not lecture buyers of lottery tickets or cigarette smokers on the economics of their habit and expect to get a rational response). A "free information" scenario might set up some very heated debate in committees of the BCMA with regard to fees, but we have already observed the apparently powerful role that laboratory physicians have played on such committees.

The final problem with quasi-market scenarios which give incentives for hospitals to compete is that such competition may induce increased demand overall, rather than simply transferring market share to the public sector. On balance, market oriented approaches to behaviour modification have some theoretical appeal, but they also carry considerable difficulties. Research indicates that laboratory test utilization is a complex behavioural phenomenon. Sophisticated behavioural, regulatory and market incentives can encourage modification in utilization and thus cost. However, a preferred design for such a framework is not yet clear.

8.3.4 Restrained Autonomy

A fourth major policy option is a less radical deviation from the status quo. This option is termed "restrained autonomy" and it is suited to a multi-unit enterprise that has both dynamic demands and scarce resources. Essentially, the entire laboratory system would be divided organizationally into a series of autonomous "managed boxes" - a "box" being a large subsystem of laboratory activity such as the private laboratory sub-system, the teaching hospital sub-system and the non-metropolitan regional hospital districts as a single sub-system. In this model, central government authorities are responsible for establishing the overall goals of the system in terms of access and equity and in determining, through negotiation, the initial resource allocation to each sub-system. The guidance systems in each box would be comprised of medically directed management teams responsible for the internal allocation of resources and the operation of the systems. Performance criteria (e.g., quality assurance and utilization patterns) would be monitored by a number of existing agencies.

The funding system would be "closed-off" rather than "open-ended". Annual resource allocation to the boxes would be negotiated, based on per capita growth rates. The internal allocation of funds within the boxes would be determined using existing planning and budgeting mechanisms. However, the principal differences would be that the budgeting process would determine the "relative" share of resources allocated to any sub-unit within a box rather than determining the actual dollars allocated to that sub-unit. Thus in the hospital environment, the network of hospital laboratories would have an incentive to co-ordinate the allocation of roles among the various hospital laboratories. In the private laboratory sub-system, fee schedule "billings" would be used to determine the "share" of total expenditures that would go to individual laboratory practices, rather than the absolute dollars. Thus, if one private laboratory operation sought to aggressively market its services, it would do so at the expense of another operation's total income.

Again, this option has some theoretical appeal, because it allows government to negotiate "blocks" of funding. Block funding for outpatient work is in contrast to the current practice of negotiating "prices" of individual items (virtually in the dark) which leaves government with an "open-ended" bill to pay, depending on the relative richness of the fee schedule and the pattern of utilization.

In the hospital sector, such a scheme would provide an incentive to rationalize service among institutions, reducing duplication and improving the economies of scale in management and purchasing, as well as in test production. The likely information and automated laboratory technologies of the 1990s could enable a spatially exploded laboratory structure. These structures can be more sophisticated in the metropolitan areas because, despite advances in telecommunications, specimens still have to be moved from place to place. But, as remote sensing technologies become available, and as deskside and bedside systems become more reliable and less expensive, it is possible to envisage a "spatially exploded" network of production and control. Test production would be conducted in peripheral sites (in doctors offices, clinics and wards) and quality control and data synthesis functions would be centralized. All these activities would be mediated through computer networks and data communication systems. The computer and communications infrastructure for such a system is currently being implemented in the teaching hospitals of Vancouver (Cassidy _et_ _al_ (1985)).

A number of problems exist with the "restrained autonomy" option. First, it requires a tremendous amount of co-operation between individual actors, not only among hospital laboratories, but also among the administrators of these hospitals. It would therefore be necessary to separate the laboratory funding "box" from the hospital funding system. The second issue is that this scheme does not provide any real incentive for hospital laboratories to pursue outpatient business, unless the annual negotiations establishing the size of the hospital box were to include incentive allowances for outpatient work.

The third problem is the level of management expertise required in each sub-system. It would seem that teaching hospitals, private laboratories and certain regional centres have a demonstrated ability to manage multi-site sub-systems. However, the availability of such expertise must be balanced against the insularity of certain institutions. Inevitably, the implementation of such a scheme would involve considerable power-struggles between sub-systems and within sub-systems.

On balance, however, this option has considerable merit; it preserves professional autonomy in the direction of laboratory sub-systems, which is important consideration when the medical and technological environments are likely to be dynamic. It can also create incentives to transfer activity from private to public sector laboratories - if that is considered a policy goal. Finally, it encourages limits on total private laboratory billings and rationalization of hospital laboratory facilities. It transfers decisions about the organization of services to the professionals who are best placed to make those decisions. But it also makes those professionals accountable for making cost and quality of service trade-offs, among and within institutions.

8.3.5 Centrally Directed Systems

The final "extreme" option is total government owernship and central control of all laboratory activity in the province. As suggested in the Foulkes Report (1974), this would involve the creation of a Diagnostic Services Authority, responsible for administering the take over of all private laboratory activity and co-ordinating a "new system" of hospital and community health centre diagnostic facilities.

Such a scheme carries with it considerable political and economic costs in its implementation. It is inconceivable that the current Social Credit government could "de-privatize" an enterprise without severely compromising its ideology. That in itself would not be a first, because the government has taken several ideologically inconsistent policy initiatives in health (Crichton (1984)). The economic costs of implementation are considerably higher, now, in real terms, than they were at the time of the Foulkes report, a decade or more ago. If private laboratories were to capitalize their future profit stream in the selling price - the total buy-out figure could conceivably be in excess of a hundred million dollars. (Such a figure might be acceptable from an economic perspective because future "profits" would flow back to government. But the political fallout of such a move is predictable).

There are also problems in terms of replacing the standards of service provided by private laboratories using existing hospital resources, in particular, the specimen collection and distribution networks from medical buildings to private laboratories. Consequently an additional injection of capital and manpower would be required in the hospital sector to deal with these problems.

A variant of this option would be to "nationalize" private laboratories (buying only the physical assets of the firms) and offer an annual management contract to those practitioners who currently own and operate those practices, or indeed to other qualified bidders. This, in effect, would involve the abolition of fee-for service laboratory medicine and present a very obvious threat to organized medicine as a whole (see the "thin end of the wedge" argument in Chapter 5).

On balance, direct government intervention and control of all sectors of the laboratory community involves a very bold challenge to organized medicine, a challenge that carries with it considerable cost of implementation. It is very unlikely such an option would be pursued in the short term without some transitional arrangement such as "restrained autonomy".

8.4 CONCLUSION

It seems very probable that the conflict between growing demands and scarce resources will continue to dominate the clinical laboratory environment for the next decade. Consequently, policy-makers in both government and medicine are faced with the pressing need to re-examine the institutional framework of service delivery in order to identify alternatives that can lead to managed growth.

A general rule of reimbursement in health care is that the closer a scheme gets to reimbursement per capita and the further it gets from reimbursement per procedure, the less expensive is the system. (Hence the much lower rates of use and cost experienced in the Health Maintenance Organizations (HMOs) in the U.S., or in the British National Health Service, without any adverse effects on health status). Fee-for-service reimbursement for laboratories is obviously an inherently "expensive" proposition, especially when the enterprises enjoy internal economies of scale and employ auxiliaries. As medical knowledge expands and as clinical practice develops, the demands placed on diagnostic services can only increase. Thus the problems of laboratory costs in general and private laboratory billings in particular, are unlikely to ameliorate without policy intervention.

This analysis of alternative policy options has suggested that considerable political, economic and quality of service risks may exist if radical market or centrally controlled alternatives are pursued. A series of intermediate policy interventions have been presented that to varying degrees provide incentives to manage growth in utilization and/or cost. None of these alternatives is perfect in the sense that each of them carries costs in implementation and operation with as yet unmeasurable benefits.

In particular, the creation of a medical sub-market is very appealing from a theoretical standpoint particularly in its potential to reduce utilization and prices. But it carries considerable political and administrative costs of implementation and has some potential to backfire.

"Restrained autonomy" in which sectors of the system are identified and provided an annual budget, can create incentives to rationalize the supply side of the system. Such a scheme could "close-off" the "open-ended" nature of funding to private laboratories and could provide a transitional organizational framework that would allow future implementation of either a medical sub-market or a system of direct government ownership. But, it too carries problems and costs in implementation.

A final comment should be made about preserving the status quo. The biggest single factor favouring the status quo as a policy option is that it is easy to implement! However, as discussed in previous chapters, the current laboratory system faces a number of internal and external pressures that seem to lead inevitably, to greater confrontation between the structural interests and to increased instability of the current institutional framework. The other principal reason favouring restructuring is the absolute size and cost of the system and its rate of growth. The increasing economic burden of this activity seems to warrant attention. What is likely to happen?

It seems clear that extreme policy options of "free enterprise" or "detailed central control" should be avoided, because they do not appear to promise marked improvements in allocative efficiency and they will increase confrontation in the system. The options in between all have merit but no "quick fix" solution stands out. What is most likely is that government and the profession will tiptoe into the future, responding to the "crises of funding" and the "challenges of technology" in an incremental fashion.

However, the organization of the B.C. laboratory system will not be carried blindly into the future by medical knowledge and technology alone. It will be steered there by strategic choice. If government takes an initiative in developing an open dialogue with other structural interests by exploring these (and other) options it is possible to maintain a high quality, cost-effective future for the system and minimize confrontation. If government does not initiate such an open discussion, then other participants will pursue their interests and the results may not be as beneficial to the people of British Columbia.

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APPENDIX A - DATA SOURCES APPENDIX

HOSPITAL DATA

The hospital data were derived principally from Hospital Statistical returns filed with Statistics Canada. These data from HS1 and HS2 returns for B.C. were available from Statistics Canada via the Division of Health Services Research and Development, Department of Health Care and Epidemiology, UBC and with the permission of Hospital Programs, B.C. Ministry of Health. The Statistics Canada tapes of HS1 and HS2 data were available for the years 1966 to 1981/82. However, a number of additional sources were used for years prior to 1966 and as the basic for producing provincial estimates for fiscal years 1982/83 and 1983/84. In particular, the author commissioned a series of tables from Statistics Canada that included the years 1962, 1964 and 1966 to 1981/82. These were for all Public, General and Allied Special Hospitals in the provinces of B.C., Saskatchewan and Ontario, and for Canada as a whole.

The estimates of hospital laboratory cost for the years 1982/83 and 1983/84 were derived using growth figures based on published hospital statistics 1982/83 (Statistics Canada #83-X-202) that were analyzed by Barer and Evans (1984).

The hospital data prior to 1962 were derived from Dominion Bureau of Statistics, Annual Hospital Statistical Reports for the years 1954 and 1962. Analyses of these data also included data derived from Lefebvrés (1976) report to Statistics Canada (Public General and Allied Special Hospitals in Canada Historical Summary of Inputs and Utilization of Facilities 1953 to 1973, Statistics Canada Health Division, July 1976).

The Outpatient Hospital Cost data shown in Table 6.14 were derived by calculating the outpatient workload units as a share of all patient workload units and multiplying this ratio by total hospital laboratory expenditures. This procedure allocates quality control etc. evenly to all patient tests. Thus the outpatient hospital cost figure includes an estimate of quality control.

REGIONAL HOSPITAL DATA

Data for the period 1966 to 1981/82 were aggregated into Regional Hospital Districts. Only hospitals with an acute care bed component were considered. These hospitals accounted for almost all hospital laboratory activity in the years selected. The membership of the Regional Hospital Districts was defined consistently throughout the period.

Regions were further aggregated into five groups based on the following criteria:

a) Metropolitan Regions were defined as Greater Vancouver RHD and Capital (Victoria) RHD.

b) Suburban Regions were defined as the 2 regions containing dormitory settlements of Vancouver, i.e., Dewdney-Alouette and Central Fraser Valley.

c) Major Regions were defined as RHD's with a hospital having greater than 200 acute care beds in 1981. The only exception to this rule was Kootenay Boundary, which was assigned to this group based on the exceptional referral status of the Trail/Tadanac Hospital relative to its approved bed complement. A total of five RHD's fell into this category:

Central Okanagan,

Fraser Ft. George

Kootenay Boundary

Nanaimo

Thomson - Nicola

c) Second - Order Regions were defined as those RHDs with a hospital having between 100 and 200 Acute Care Beds in 1981. This category includes:

Alberni - Clayoquot

Central Kootenay

Comox - Strathcona

Cowichan Valley

Fraser - Cheam

Kitimat - Stikine

North Okanagan

Okanagan - Similkameen

Peace River - Liard

Skeena - Queen Charlottes

d) Third - Order Regions were defined as the remaining that had no hospital with greater than 100 Acute Care Beds. This category includes:

Bulkley - Nechako

Cariboo

Central Coast

Columbia Shuswap

East Kootenay

Mount Waddington

Powell-River

Squamish - Lilloet

Stikine

Sunshine Coast

(The Stikine region has no acute care bed capacity and consequently it is eliminated from most regional analyses).

Regional data on outpatient testing for the years 1979/80 - 1983/84 were prepared by the Medical Services Commission on the request of the author (see below).

MEDICAL SERVICES COMMISSION - OUTPATIENT LABORATORY

The Medical Services Commission produces an annual financial statement that itemizes gross payments to individual practitioners and group practices. This source was used for total MSC expenditure data.

The data for laboratories was provided by the Medical Services Plan and is not routinely published. The data base for 1979/80 - 1983/84 has been "cleaned" by M.S.P. to allocate correctly patterns of activity between public, private and other (doctor's office) categories. The category of "vested" laboratories used by M.S.P. has been included in the private laboratory component.

LABORATORY ADVISORY COUNCIL DATA

The author was given access to the historical minutes of the LAC under the condition that individuals were not quoted directly. The minutes were analyzed by recording the relative frequency of agenda items and discussion on particular topics (see Chapters 5 and 6). The LAC minutes were also used to estimate the number, type and value of capital equipment approvals for new technology. These data were thought to be complete for the years 1975 - 1980. But it should be emphasized that these data reflect LAC approvals and do not necessarily correspond to actual government expenditures. However, Ministry officials were confident that the LAC data would be a useful estimate of the magnitude and direction of trends in equipment allocation.

REFERRAL DATA AND MANPOWER DATA

The data shown in Appendix C and the regional physician data used in Appendices E and F were obtained from the Health Manpower Research Unit at UBC. Specifically, Appendix E is table 109 from "Fee Practice Medical Services Expenditures Per Capita, 1983-84 and Full-Time Equivalent Physicians in British Columbia, 1979-80 to 1983-84," HMRV Report 85:1, U.B.C., Division of Health Services Research and Development, 1985. Further, the 1974 and 1981 Manpower Data used in Appendices E and F were derived from the "Rollcall Reports" from those years.

Others sources are cited in the text and identified in the Bibliography.

APPENDIX B

1) Development of Laboratory Automation 1954-1984

Stanley Reiser, in his excellent review of "Medicine and the Reign of Technology", describes the emergence of the clinical laboratory as a "workshop of science". The laboratory is seen as serving the physicians increasing demands for objective information about their patients both as a means to differentiate between disease or patient states and as a means of guiding therapy and evaluating progress - the laboratorians holy trinity of diagnosis, screening and monitoring (see section 4.3). The growth of clinical laboratories has continued since the 1880s and 90s but it is in the last 30 years that the laboratory has seen its most visible and rapid development of hardware, utilization and cost. The discussion that follows traces the development of equipment-embodied technology for the laboratory from 1954 to the present. For a thorough discussion of earlier clinical laboratory developments the reader is referred to Reiser (1978: Chapter 6).

a) 1954 - A Technological Base Line

Although there were equipment-embodied technologies in the clinical laboratories of the early 1950s, they were neither highly mechanized or automated (if automation includes the notion of autonomous feedback, Wiener (1947). Rather, descriptions by observers of the period, suggest that "new technology" was a label given to rather complex laboratory apparatus that assisted laboratorians in producing test results (or answers) at a very low frequency. For example Elin (1980) in a review of developments in instrumentation for clinical chemistry suggested:

> "The past 20 years have been an era of dramatic technological development of instrumentation in clinical chemistry. Prior to this

time, the tools of the clinical chemist were the test tube, the flask, the burette, the pipette, the cuvette, and the photometer. Laboratory determinations were essentially manual and a significant amount of time was required for each analysis."

Changes from this baseline are reflected in data from Vancouver General Hospital where in 1950 a total laboratory staff of 53 FTE (5 pathologists, 30 technicians, 10 clerical and 8 auxilliary staff) performed some 200,000 examinations. Thirty years later, in 1980, 348 FTE's produced some 3.67 million procedures, a per capita increase from 3773 to 10,566 procedures/FTE (180 percent) - a substantial gain in productivity.

In the early 1950s only the largest institutions appeared to have had access to the more sophisticated equipment. For example in B.C., the Vancouver General Hospital had a flame spectrophotometer in 1950 - this instrument was so "high-tech" it warranted a photograph in the hospital's annual report. This instrument is now a fundamental building block of any small laboratory and is often incorporated as a module in both large and small automated analyzers.

It was in the late 1950's that laboratory technology moved towards automation. In 1956 Dr. Skeggs developed the "automated analyzer", a rather cumbersome series of testing modules that had serum specimens flow between them by means of an airflow. This development was the foundation of automation in the laboratory and rapid growth by the Technicon Corporation. The Auto Analyzer I (AAI) was to become the pioneer in the "automation" of ten common clinical chemistry tests (Reiser (1978), Mitchell et al (1980)).

In 1958, Dr. Wallace Coulter gave an address to the National Electronics Council on the design of an automated instrument that could reproduce counts of red cells and white cells in patients whole blood. These two developments founded the clinical laboratory automation industry and marked the beginning of a decade or more of market dominance by Technicon and by Coulter Electronics in their respective market niches. By 1960 most large teaching hospitals had acquired both instruments. VGH for example, had acquired a pair of Technicon auto-analyzers and a Coulter model A by that year.

b) <u>1964 - Entering the Age of Automation</u>

By the mid 1960s some important developments in laboratory automation were beginning to gain momentum. (Although as we will discuss in chapter 6, B.C. in 1964 was still equipped with 1958-62 technology, developments were occurring rapidly elsewhere.) Technicon introduced their SMA 12/30 in 1964, an instrument that produced 12 different analyte measurements on each specimen at a rate of 30 specimens per hour. Two years later the SMA 12/60 and SMA 6/60 models were announced. The SMA 12/60 simply doubled the throughput of the SMA 12/30, thereby effectively doubling the capacity of routine clinical chemistry laboratories. The SMA 6/60 provided for the first time the capacity to produce the electrolyte tests (sodium, potassium, chlorides and CO_2) as well as BUN and/or creatinine, and glucose at a rate of 60 specimens an hour. These tests are of particular use in measuring the patient's acid/base balance, renal function and glucose metabolism and were thus fundamental diagnostic tools. But perhaps more importantly this development allowed the clinician to monitor, patient progress more readily, e.g., reaction to intravenous therapy. (The subsequent increase in the use of these tests throughout the seventies has been documented recently for VGH, Morrison <u>et al</u> (1984)).

1964 was also an important year in the world of clinical chemistry testing because it represented the inauguration of a project in the Dupont Corporation, where a team of scientists were called upon to develop an automated analyzer that would allow the laboratory to be more selective in the tests performed on each specimen (Perry et al (1970)). The Technicon systems performed all 6 or all 12 tests on each specimen - whether they were requested or not. The scientific goal of the Dupont ACA, was to provide selectivity of testing as well as to allow the use of, what was by then considered the superior, kinetic rather than end point reaction techniques (Perry et al (1970)). The commercial goal was to develop a "unique" instrument using patented chemicals, plastics, packaging and technology. The instrument was finally unveiled in 1969 and evaluated at the University of Alabama and elsewhere (Perry et al (1970), Britten and Werner (1970)). After relatively minor alterations the Dupont ACA was receiving "rave reviews" for its accuracy and precision and its ease of use compared to the Technicon equipment. Also in the mid 1960's:

> "A private consulting firm completed a study projecting commercial possibilities for clinical laboratory equipment. Many corporations bought that study, and partly as a result, about 30 different automatic or semi-automatic systems were developed world wide in the next five years. Over $1 billion was spent with some individual companies spending as much as $20 million. By the early 1970's, the field of automated blood analyzers began to look like a competitive industry: although Technicon still held 80 percent of the market from 1969-1972 (for clinical chemistry) the field itself was growing, creating intense competition for a growing share of the market among the several large companies (e.g. Dupont) who had diversified into this area, and a number of small firms specializing in particular products." Leavitt (1984:733)

Leavitt (1984) goes on to describe another major development in clinical chemistry testing that was funded initially from National Institute of Health grants. The "centrifugal flow analyzer" was developed at the Oak Ridge National Laboratory by Dr. Norman Anderson. The instrument named GeMSAEC (General Medical Science - Atomic Energy Commission) after its joint sponsors the NIH and the AEC, eventually was brought to market in the early 1970s by Union Carbide under the brand name of Centrifichem. As we will discuss later, the rapidly increasing number of candidate technologies in the 1960s were not brought into the portfolio of most B.C. hospitals until the mid 1970s. For example, by 1974 VGH had acquired an SMA 6/60, a Dupont ACA and 2 of the pioneering GeMSAEC instruments, the first hospital in the province to do so.

c) <u>1974 - Age of Growth and Proliferation of Centralized Testing Facilities</u>

This is the era of maximum economies of scale, integration and concentration at a number of levels. First, at the level of the laboratory test, Technicon had produced their SMAC instrument, a goliath, computer-driven testing facility that produced 20 different test results on each specimen at unheard of rates or production: 3000 tests per hour! Similar instruments emerged from a number of suppliers at this time, Grams (1976). These instruments in operation however may have been demonstrating signs of diseconomies of scale because most laboratories adopted relatively simple quality control rules that involved repeating abnormal test to verify the answer. Because statistically, 1 test in 20 will be an abnormal normal (i.e. a false positive result) these instruments were used to "double test" almost every specimen (Grams 1976).

Several other important developments occurred in the area of equipment-embodied technology in the clinical chemistry laboratory of the seventies. In particular three different immunoassay techniques were developed and to some extent automated, throughout the 1970s (Benson (1985), Elin (1980)). These techniques are used in the measurement of important biochemical constituents such as hormones, drugs and enzymes. First, radio-immuno assay (RIA) uses radioactive labelling to assist in the measurement of hormones such as thyroxin. By the late 1970s totally automated systems became available (Elin (1980)). Second, enzyme immunoassay (EIA) techniques were developed as an alternative to RIA because of the inherent scientific problems and licensing difficulties encountered with the use of radioactive material. EIA methods have been developed for use on continuous flow systems, biochromatic analyzers and centrifugal analyzers. Third, fluorescent immunoassay (FIA) was developed using a fluorescent molecule as a label rather than a radioactive label. Although analytically superior such systems are not as yet highly automated (Elin (1980)). In addition to immunoassay techniques, automated developments occured in clinical chemistry in electrophoresis (bringing a small degree of mechanization to the otherwise very complex analysis of protein), in chromatography where both the combined technologies of gas chromatography/mass spectrometry (GC/MS), and automated high performance liquid chromatography (HPLC) have enabled quantitative measurement of drug levels for both toxicological and therapeutic monitoring purposes, and in the measurement of trace metals (e.g. x-ray fluorescent spectrometry) and anodic stripping voltammetry (ASV)).

Similarly, in the area of hematology testing the Coulter Company was producing, throughout the late sixties and seventies, a progression of larger and more elaborate cell counters that embodied data processing functions and that performed even more hematologic measurements. However, in hematology, not only were there refinements in cell counting technology, but automated instruments were developed to perform platelet counts, leukocyte counts and differential counts and certain coagulation procedures. The reliability, accuracy and precision of certain instruments has been called into question and thus the rate of penetration in the marketplace has been less than in clinical chemistry (Morrison (1984)).

In microbiology there has been little automation of the routine culturing procedures except for the automated urine culture and sensitivity systems developed in the mid-late 1970's (Abbott Laboratories). Blood-banking too has seen limited automation apart from refinements of the early blood typing instrumentation (Mitchell et al, (1981) Wagstaff (1981)).

The integration and concentration of technologies at the test level was reflected at the level of the firm and of the industry. Leavitt points out that:

> "By the end of the 1970's, each of the three major technologies for automated blood chemical analysis was dominated by a corporate giant for whom medical technology was a mere sideline. Technicon, having grown from a small family business to a multi-million-dollar corporation on the strength of its "continuous flow" Auto Analyzer, was taken over by Revlon, Inc. - an even larger corporation - as part of a diversification scheme. The largest share of the "discrete chemistry" segment of the market was held by DuPont, the second largest chemical company in the U.S. And the newest "comer" in the field, the technology of "centrifugal flow" was dominated by Union Carbide "the nation's largest producer of petrochemicals." (Leavitt, p.734)

d) 1984 - The Age of Pluralism

F.L. Mitchell wrote, in 1981, about future trends in clinical chemistry:

> "The biggest changes for the future as it concerns people, however, could be in the organization of the laboratory itself. Clinical Chemistry with its recent dramatic escalation in size might be

considered unstable compared with its cospeciality, histopathology. Such an expansion as the chemists have experienced might equally be followed by a contraction on a similar scale: if this occurs it will again be due to technology, but this time operating to allow the clinician or his clinical or ward staff to carry out a large number of chemical tests without referral to the laboratory. Instruments for operation near the patient have been in use for some years, particularly for glucose, blood gas and pH measurements but these have not been fool proof and do have disadvantages. However, recent developments particularly in layer chemistry and aided by the application of microprocessors will allow the design and manufacture of reliable machines capable of being operated to acceptable standards by non-laboratory staff. There are many self-evident advantages to this approach for obtaining pathological measurements and future developments along these lines will be interesting to follow". (Mitchell 1981, p. 15)

Mitchell's prophesy has come to the market place in a variety of ways. There is emerging a continuum of laboratory instruments ranging from the very inexpensive film based or dip stick technologies to the goliath, multiple testing, high capacity instruments. These systems can be classified into four distinct groups:

1) Small, nearer the patient test systems.
2) Down sized laboratory systems.
3) Central laboratory systems.
4) Goliath automated systems.

This classification is analogous to micro, mini, supermini and main frame classification system used for computer hardware. The economic and organizational implications of the central laboratory systems and the goliath automated systems have been well discussed in the literature over the last two decades because of the increasing diffusion of these systems in North American hospitals. Although no absolute concensus exists on how these systems should be selected and managed, the issues in the debate have been thoroughly articulated, for example, Maloney and Rogers (1979), Tydeman et al (1983), Reiser (1978), Grams (1976), Hardwick et al (1985). it is, however, only in the last few years that down sized systems with high capacity and broad menu range, and nearer the patient testing facilities, which can be reliably operated, have both begun to emerge.

By the late seventies and early eighties, a number of imitator technologies emerged in the centrifugal flow market - Rotochem, Cobas-Bio, etc. Similarly, new manufacturers entered the large systems market in both hematology and chemistry. Perhaps more importantly the Kodak Ektachem system came to market - a dry reagent, film-slide based technology borrowed obviously from photographic processes that allowed the development of fast, flexible, easy to use and relatively inexpensive testing systems. These could be used in the conventional centralized laboratory settings i.e., Kodak Ektachem 400 and 700, and more recently the micro systems, i.e., the DT 60 which may well become the foundation for nearer the patient testing facilities (Belsey (1985), Hardwick et al. (1985)).

The film-based technologies are of particular interest from an organizational and spatial point of view for a number of reasons. First, nearer the patient testing systems have been advocated from some time in both the highly acute care setting, e.g. emergency room or cardiothoracic surgical suite and the outpatient clinic or doctors' office. In the former case the stat lab or hot lab has been the response (Weil et al (1980)), in the latter the notion of the satellite or clinic lab has been advocated, e.g., Free and Free (1984), both have been thought to contribute positively to patient management and outcome and to improved use of hospital or clinic facilities in terms of length of stay. Second, until the development of film based technologies there have been grave concerns over the economics and the quality of "nearer the patient" facilities. In particular, instrument systems for stat labs are often similar in capital costs to those for large central laboratories. Similarly ward·based or clinic based testing systems, e.g., glucometers, will be duplicated over and over in an institution, raising concerns about costs (e.g. Browning et al (1984)). The major concerns, however, have been over quality of results (Farr, (1983) Browning, (1984) etc). This has been particularly true of glucometers and manual or semi-automated dipstick chemistry technologies and the debate over their development seems to be most advanced in the U.K. rather than the U.S. This is somewhat ironic given the greater technological focus of American health care.

The potential of these emerging wave of film-based systems to resolve economic and quality concerns has not as yet been adquately evaluated. In terms of quality, film-based technology may present a solution, as Elin suggested:

> "The several layers of the film based system (spreading, reagent, semipermeable, indicator and transparent support) for processing and chemically reacting with the sample are mounted between two slides. The spreading layer is an isotropically porous nonfibrous layer with an 80 percent void volume. The spreading and metering action of this layer compensates for minor differences in the usual sample volume of 10 microliters and serum viscosity. Thus a constant volume per unit area is naturally applied to subsequent layers of the slide. This obviates the accuracy and precision problems inherent in pipetting small sample volumes." (Elin 1980, p. 288)

An additional benefit aiding high quality test results with such a system is that the porous layer effectively removes the protein in the sample, thus removing one of the principal difficulties of performing accurate analytical chemistry on blood (personal communication, DJ Campbell). Resolution of these difficulties could have substantial downstream effect as will be discussed below.

2) Development of Information Technology in the Laboratory 1954-84

Computers are often considered as the quintessential "new" technology. People talk about computers as being fundamentally different from other forms of mechanization. One might facetiously suggest that this is because computers have very few moving parts. To those of us raised in a world with an industrial, mechanical conception of machines that is re-emphasized in our metaphors - "the wheels of industry", "the engine of the economy", we are perhaps uncomfortable and somewhat incredulous at machines that don't appear to do anything. This is most clearly seen in the media who invariably use pictures of whirling tape drives as their visual metaphor of computerization (although tape technology is the oldest, and slowest of the current data storage technologies). This is changing however because coloured bar graphs and pie charts exploding on the screen of microcomputers have become the new visual metaphor for computerization in the 1980s. A significant societal adjustment!

Is computer technology any different from the types of laboratory technology already described? Certainly in the laboratory, and more generally in society, computers are not fundamentally dissimilar to steam engines, machine tools or internal combustion engines in that they are machines that perform a function. The essential difference is that their basic raw material for processing is information, rather than coal or pig iron, and information has indeed some peculiar characteristics as a commodity and as a resource as discussed in Chapter 3. However, at a fundamental level computers simply process information by reducing names, signals, numbers and concepts to a series of zeros and ones on which simple operations are performed albeit at speeds unknown to an industrial world of Newtonian physics (for revs per minute read revs per nanosecond).

Are computers different because they process information? What is different about the computer age is not the computers themselves, it is the overwhelming dominance of their raw material (information) in most of current human activity. Porat's study, alluded to earlier, identifies the information based activities in the US economy as by far the largest component of economic activity. The clinical laboratory is an excellent example of how the computer came to be a useful tool because of the overwhelming dominance of information as the predominant input and output of the laboratory system. From the 1930s on, laboratory output (number of results or answers) has been consistently doubling every 5-10 years (Reiser (1978: Chapter 8), Morrison et al. (1985)). For example each increment in volume of test production creates a parallel change in the order of magnitude of the data points that have to be generated, collated and reported. When, as in the 1960s, the doubling involved hundreds of thousands of test answers in five years, the data processing problems became substantial. Thus there emerged three identifiable phases in the development of laboratory computer technology.

a) Timesharing

First, there was a relatively short lived phase where laboratory data processing was operated as a time sharing system based on a large centralized hospital mainframe computer. Mainframe computers were and are still too expensive for any one laboratory to justify. More importantly, comprehensive, mainframe-based, hospital information systems that include laboratory functions have never been totally viable because of the inherent complexity and variety of data processing problems in the hospital environment. (IBM would perhaps dispute that statement but there is clearly no continent wide standard acceptance of any comprehensive, mainframe based, totally integrated, hospital information system.)

b) <u>The Laboratory Minicomputer in the Mid 1960s</u>

In the second phase, developments of high capacity rapid analyzers throughout the 1960s and 1970s was paralleled by the interest in applying emerging mini-computer technology to the data processing functions of the laboratory. Thus labs looked to minicomputers, the smaller brother of the "big brother" mainframe, for a computerized data processing solution. A plethora of books and journal articles appeared from the mid-1960s on - in the area of laboratory computing. These described what computers could do for laboratories, Ball (1970), Siemansko (1978), or how hospital laboratories could justify one, Scalfani (1981). Often the articles were no more than claims by the particular author that he/she was the first individual to get one in a geographic area. For above all else the laboratory computer became the new status symbol of laboratory medicine.

Stand-alone laboratory computer systems were widely adopted in large clinical laboratories in North America both hospital based and commercial in the 1970s. Just as with automation, computerized laboratories information systems came and went and a few systems dominated the market, paralleling the mini-computer dominance of the OEM based manufacturers: Control Data, Data General and DEC.

c) Mid 1970s On - Pluralization and Dispersion

A third phase developed by the mid to late 1970s. Manufacturers of laboratory eauipment were beginning to recognize two things. First, they saw that there was a market for laboratory instruments that included some data processing functions. This would give a smaller laboratory (e.g., in a 100-200 bed hospital) a means of automating some of their data processing functions without recourse to the mini-computer based laboratory solution - which was still in the hundreds of thousands of dollars price range. The second factor recognized by manufacturers of lab equipment (and indeed manufacturers of toasters, microwave ovens, vacuum cleaners, etc., etc.) was that the microprocessor allowed them to develop a "smart" machine that was "user friendly" (Pritty (1980)). Later, in this third phase (1979 on) developments in microprocessor technology led to a wider availability of small powerful stand-alone microcomputers for laboratory use. Finally in the 1980s there has been a rapid and increasing availability of both microcomputing hardware and software as well as the development of network technology to increase the "connectivity" and compatibility of systems (Bourne (1980), Cechner (1982), Vorus (1982), Tydeman et al (1982), Herman (1983), Cassidy et al (1985)).

Table 109

Distribution of Fee-for-Service Payments, 1983-84
by Location of Physician over Location of Patient
for MSC Type of Practice PATHOLOGY AND BACTERIOLOGY

Regional Hospital District of Physician	Total[1]	Estimated Regional Hospital District of Patient[2]: Alberni Clay'ot	Bulkley Nechako	Capital	Cariboo	Central Coast	Central Fraser Valley	Central Koot'ay	Central Okan'an	Col'bia Shusvap	Comox Strath-cona	Covi'an Valley	Dewdney Alou'te	East Koot'ay	Fraser Cheam
Non-Metro - Subtotal	**23,315**	**0.017**	**0.031**	**0.002**	**0.040**	**0.002**	**0.018**	**0.051**	**0.141**	**0.033**	**0.045**	**0.007**	**0.026**	**0.068**	**0.020**
1 Alberni-Clayoquot	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Bulkley-Nechako	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 Cariboo	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 Central Coast	39	0.0	0.0	0.0	0.000	0.979	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 Central Fr. Valley	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Central Kootenay	1,037	0.0	0.000	0.000	0.000	0.0	0.000	0.974	0.000	0.0	0.0	0.0	0.000	0.005	0.000
8 Central Okanagan	5,517	0.000	0.000	0.001	0.000	0.0	0.000	0.001	0.594	0.000	0.000	0.0	0.000	0.000	0.0
9 Columbia-Shuswap	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 Comox-Strathcona	852	0.000	0.000	0.003	0.001	0.0	0.000	0.000	0.0	0.000	0.745	0.000	0.000	0.000	0.000
11 Cowichan Valley	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12 Dewdney-Alouette	1,093	0.0	0.000	0.000	0.0	0.0	0.369	0.0	0.0	0.0	0.000	0.000	0.549	0.000	0.001
13 East Kootenay	1,739	0.000	0.000	0.000	0.000	0.0	0.000	0.086	0.000	0.001	0.000	0.000	0.0	0.900	0.000
14 Fraser-Cheam	553	0.0	0.006	0.000	0.0	0.0	0.001	0.000	0.000	0.0	0.003	0.000	0.007	0.000	0.854
15 Fraser-Fort George	2,544	0.000	0.281	0.006	0.104	0.000	0.001	0.0	0.003	0.000	0.000	0.002	0.003	0.000	0.000
17 Kitimat-Stikine	144	0.0	0.000	0.0	0.0	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0
18 Kootenay Boundary	1,085	0.0	0.0	0.000	0.0	0.0	0.000	0.012	0.000	0.0	0.0	0.002	0.0	0.003	0.0
19 Mount Waddington	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20 Nanaimo	1,626	0.239	0.000	0.013	0.000	0.0	0.001	0.000	0.0	0.0	0.250	0.090	0.000	0.000	0.001
21 North Okanagan	95	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000	0.0	0.0	0.0	0.001	0.0
22 Okanagan-Similkameen	1,627	0.000	0.0	0.000	0.0	0.0	0.000	0.003	0.001	0.0	0.000	0.000	0.0	0.000	0.000
23 Peace River-Liard	1,103	0.0	0.002	0.002	0.0	0.0	0.000	0.0	0.000	0.000	0.000	0.000	0.000	0.0	0.0
24 Powell River	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25 Skeena-Q. Charlotte	542	0.002	0.000	0.004	0.000	0.0	0.002	0.0	0.000	0.0	0.006	0.0	0.0	0.001	0.000
26 Squamish-Lillooet	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27 Stikine	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28 Sunshine Coast	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29 Thompson-Nicola	3,719	0.001	0.000	0.001	0.178	0.000	0.000	0.000	0.001	0.204	0.001	0.000	0.000	0.000	0.000
Metropolitan - Subtotal	**71,228**	**0.002**	**0.000**	**0.168**	**0.005**	**0.000**	**0.045**	**0.002**	**0.001**	**0.000**	**0.011**	**0.021**	**0.017**	**0.002**	**0.020**
3 Capital	14,764	0.003	0.000	0.701	0.000	0.0	0.000	0.000	0.000	0.000	0.039	0.080	0.001	0.000	0.000
16 Greater Vancouver	56,464	0.002	0.000	0.026	0.006	0.000	0.057	0.002	0.001	0.000	0.004	0.006	0.021	0.003	0.025
Unknown	298	0.535	0.000	0.010	0.001	0.0	0.002	0.0	0.0	0.0	0.006	0.000	0.002	0.000	0.000
TOTAL	**94,841**	**0.007**	**0.008**	**0.125**	**0.013**	**0.001**	**0.038**	**0.014**	**0.035**	**0.008**	**0.020**	**0.018**	**0.019**	**0.018**	**0.020**

[1] Fee-for-service payments in thousands of dollars.
[2] For each medical service, the patient's RHD has been assigned as the RHD of the physician making the referral for service (where relevant) or, where there was no referral, as the RHD of the physician rendering the service.

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... continued

Table 109
(Continued)

Distribution of Fee-for-Service Payments, 1983-84

by Location of Physician over Location of Patient

for MSC Type of Practice PATHOLOGY AND BACTERIOLOGY

Regional Hospital District of Physician	Estimated Regional Hospital District of Patient[1] Fraser Fraser George	Greater Van-couver	Kitimat Stikine	Koot'ay Boun'ry	Mount Wadd-ington	Nanaimo	North Okan'an	Okan'an Simil-kameen	Peace River Liard	Powell River	Skeena Queen Char'tte	Squa'sh Lill'et	Stikine	Sunshine Coast	Thompson Nicola	Unknown
Non-Metro - Subtotal	**0.058**	**0.016**	**0.011**	**0.046**	**0.009**	**0.024**	**0.065**	**0.103**	**0.045**	**0.001**	**0.021**	**0.004**	**0.0**	**0.000**	**0.092**	**0.007**
1 Alberni-Clayoquot	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Bulkley-Nechako	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 Cariboo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 Central Coast	0.000	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.018
6 Central Fr. Valley	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Central Kootenay	0.001	0.007	0.0	0.010	0.0	0.000	0.0	0.002	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.000
8 Central Okanagan	0.000	0.002	0.0	0.001	0.0	0.000	0.254	0.143	0.000	0.002	0.000	0.000	0.0	0.000	0.000	0.002
9 Columbia-Shuswap	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 Comox-Strathcona	0.000	0.027	0.000	0.000	0.190	0.014	0.005	0.001	0.000	0.0	0.013	0.0	0.0	0.000	0.000	0.001
11 Cowichan Valley	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12 Dewdney-Alouette	0.000	0.072	0.000	0.000	0.0	0.000	0.0	0.000	0.000	0.0	0.001	0.0	0.0	0.0	0.001	0.006
13 East Kootenay	0.000	0.006	0.000	0.001	0.0	0.0	0.000	0.000	0.000	0.000	0.0	0.005	0.0	0.000	0.000	0.000
14 Fraser-Cheam	0.0	0.023	0.000	0.000	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.099	0.0	0.000	0.000	0.006
15 Fraser-Fort George	0.509	0.020	0.037	0.000	0.000	0.001	0.000	0.000	0.004	0.000	0.000	0.005	0.0	0.002	0.000	0.021
17 Kitimat-Stikine	0.001	0.004	0.976	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.019
18 Kootenay Boundary	0.0	0.006	0.0	0.965	0.0	0.0	0.0	0.000	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.010
19 Mount Waddington	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20 Nanaimo	0.000	0.025	0.000	0.000	0.029	0.331	0.0	0.000	0.000	0.001	0.0	0.0	0.0	0.000	0.000	0.019
21 North Okanagan	0.0	0.001	0.0	0.0	0.0	0.0	0.997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000
22 Okanagan-Similkameen	0.000	0.009	0.0	0.002	0.0	0.0	0.000	0.982	0.0	0.0	0.000	0.0	0.0	0.000	0.000	0.002
23 Peace River-Liard	0.006	0.026	0.000	0.006	0.0	0.0	0.001	0.0	0.951	0.000	0.0	0.000	0.0	0.002	0.000	0.004
24 Powell River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25 Skeena-Q. Charlotte	0.001	0.056	0.019	0.0	0.0	0.000	0.000	0.000	0.0	0.008	0.898	0.0	0.0	0.001	0.000	0.002
26 Squamish-Lillooet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27 Stikine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28 Sunshine Coast	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29 Thompson-Nicola	0.000	0.018	0.000	0.001	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.003	0.0	0.000	0.575	0.011
Metropolitan - Subtotal	**0.019**	**0.816**	**0.004**	**0.001**	**0.001**	**0.036**	**0.000**	**0.001**	**0.002**	**0.008**	**0.001**	**0.006**	**0.000**	**0.006**	**0.001**	**0.005**
3 Capital	0.000	0.006	0.000	0.000	0.000	0.158	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.009
16 Greater Vancouver	0.024	0.775	0.005	0.001	0.001	0.004	0.000	0.001	0.003	0.010	0.001	0.008	0.000	0.007	0.001	0.005
Unknown	0.0	0.399	0.0	0.0	0.000	0.025	0.0	0.000	0.000	0.001	0.0	0.018	0.0	0.000	0.000	0.001
TOTAL •	**0.028**	**0.468**	**0.005**	**0.012**	**0.003**	**0.033**	**0.016**	**0.026**	**0.013**	**0.006**	**0.006**	**0.005**	**0.000**	**0.004**	**0.023**	**0.006**

[1] For each medical service, the patient's RHD has been assigned as the RHD of the physician making the referral for service (where relevant) or, where there was no referral, as the RHD of the physician rendering the service.

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APPENDIX D

APPENDIX D.1 RELATIVE CHANGE IN LABORATORY COST INDEX OF REAL HOSPITAL LAB COST PER CAPITA FOR REGIONAL HOSPITAL DISTRICTS BETWEEN 1966-1971

High But Declining N = 4	High and Increasing N = 3
3 Capital *8 Central Okanagan 16 Greater Vancouver	*18 Kootenay Boundary *20 Nanaimo *29 Thomson-Nicola

Low and Declining N = 3	Low but Increasing N = 18
*6 Central Fraser Valley **13 East Kootenay 14 Fraser-Cheam	1 Alberni-Clayoquot 2 Bulkley-Nechako 4 Cariboo 5 Central Coast 7 Central Kootenay 9 Columbia-Shuswap 10 Comox-Strathcona 11 Cowichan-Valley 12 Dewdney-Alouette *15 Fraser Ft. George 19 Mount Waddington 21 North Okanagan 22 Okanagan-Similkameen 23 Peace River 24 Powell River 25 Skeena 26 Squamish 28 Sunshine Coast

* Regional centre established before 1966
** Regional centre established 66-71

APPENDIX D.2 RELATIVE CHANGE IN LABORATORY COST INDEX OF REAL HOSPITAL LAB COST PER CAPITA FOR REGIONAL HOSPITAL DISTRICTS BETWEEN 1966-1971

High But Declining N = 5	High and Increasing N = 2
3 Capital	16 Greater Vancouver
8 Central Okanagan	18 Kootenay Boundary
17 Kitimat-Stikine	
20 Nanaimo	
29 Thomson-Nicola	
Low and Declining N = 10	**Low but Increasing N = 11**
2 Bulkley-Nechako	1 Alberni-Clayquot
4 Cariboo	10 Comox-Strathcona
5 Central Coast	13 East Kootenay
6 Central Fraser Valley	14 Fraser-Cheam
7 Central Kootenay	15 Fraser Ft. George
9 Colubmia-Shuswap	19 Mt. Waddington
11 Cowichan Valley	21 North Okanagan
12 Dewdney-Alouette	23 Peace River
22 Okanagan-Similkameen	25 Skeena
24 Powell River	28 Sunshine Coast

APPENDIX D.3 RELATIVE CHANGE IN LABORATORY COST INDEX OF REAL HOSPITAL LAB COST PER CAPITA FOR REGIONAL HOSPITAL DISTRICTS BETWEEN 1966-1971

High But Declining N = 4

3 Capital
8 Central Okanagan
18 Kootenay Boundary
20 Nanaimo

High and Increasing N = 3

15 Fraser Ft. George
18 Greater Vancouver
29 Thomson-Nicola

Low and Declining N = 14

2 Bulkley-Nechako
4 Cariboo
7 Central Kootenay
9 Columbia-Shuswap
11 Cowichan-Valley
12 Dewdney-Alouette
13 East Kootenay
14 Fraser-Cheam
17 Kitimat-Stikine
21 North Okanagan
24 Powell River
25 Skeena
26 Squamish
28 Sunshine Coast

Low but Increasing N = 7

1 Alberni-Clayquot
5 Central Coast
6 Central Fraser Valley
10 Comox-Strathcona
19 Mt. Waddington
22 Okanagan-Similkameen
23 Peace River

APPENDIX E HOSPITAL LABORATORY COST PER PHYSICIAN BY REGIONAL HOSPITAL DISTRICT FOR B.C. 1974 AND 1981

REGIONAL HOSPITAL DISTRICT	HOSPITAL LAB COST IN THOUSANDS OF 1971 $		
	1974	1981	% CHANGE
Alberni-Clayoquot	5.06	7.33	44.82
Bulkley-Nechako	7.27	8.28	13.90
Capital	4.85	4.82	-0.72
Cariboo	6.29	6.19	-1.52
Central Coast	2.50	2.34	-6.38
Central Fr. Valley	3.40	4.70	38.07
Central Kootenay	6.38	7.20	12.81
Central Okanagan	6.11	5.64	-7.70
Columbia-Shuswap	5.18	5.86	13.14
Comox-Strathcona	3.09	5.86	89.83
Cowichan Valley	6.26	5.00	-20.17
Dewdney-Alouette	5.76	6.14	6.59
East Kootenay	3.12	4.02	28.62
Fraser-Cheam	5.40	5.87	8.71
Fraser-Fort George	7.60	10.60	39.48
Greater Vancouver	4.65	6.20	33.40
Kitimat-Stikine	6.78	5.67	-16.34
Kootenay Boundary	7.95	11.55	45.27
Mount Waddington	2.70	5.35	98.07
Nanaimo	6.35	6.49	2.26
North Okanagan	5.21	6.06	16.24
Okanagan-Similkameen	4.70	6.73	43.14
Peace River-Liard	6.44	9.67	50.15
Powell River	5.27	5.64	6.92
Skeena-Q. Charlotte	6.12	6.39	4.53
Squamish-Lillooet	5.16	6.07	17.64
Stikine	0.00	0.00	0.00
Sunshine Coast	3.32	3.51	5.47
Thompson-Nicola	6.52	8.71	33.56
TOTAL B.C.	5.00	6.20	24.00

APPENDIX F - FIRST-ORDER DIFFERENCE MODEL

A first-order difference model was used to investigate the relative contribution of changes in physician/population ratios and changes in laboratory cost per physician to changes in laboratory cost per capita. The basic form of the model is as follows:

Let C_t = Laboratory cost per capita at time t

D_t = Doctors per capita at time t

L_t = Laboratory cost per doctor at time t

By definition

$$C_t = D_t \cdot L_t$$

The first order difference model suggests that

$$\Delta C_{t+1} = \Delta D_{t+1} \cdot L_t + \Delta L_{t+1} \cdot D_t$$

In particular, the change in hospital laboratory cost per capita between 1974 and 1981, approximates to the sum of two effects:

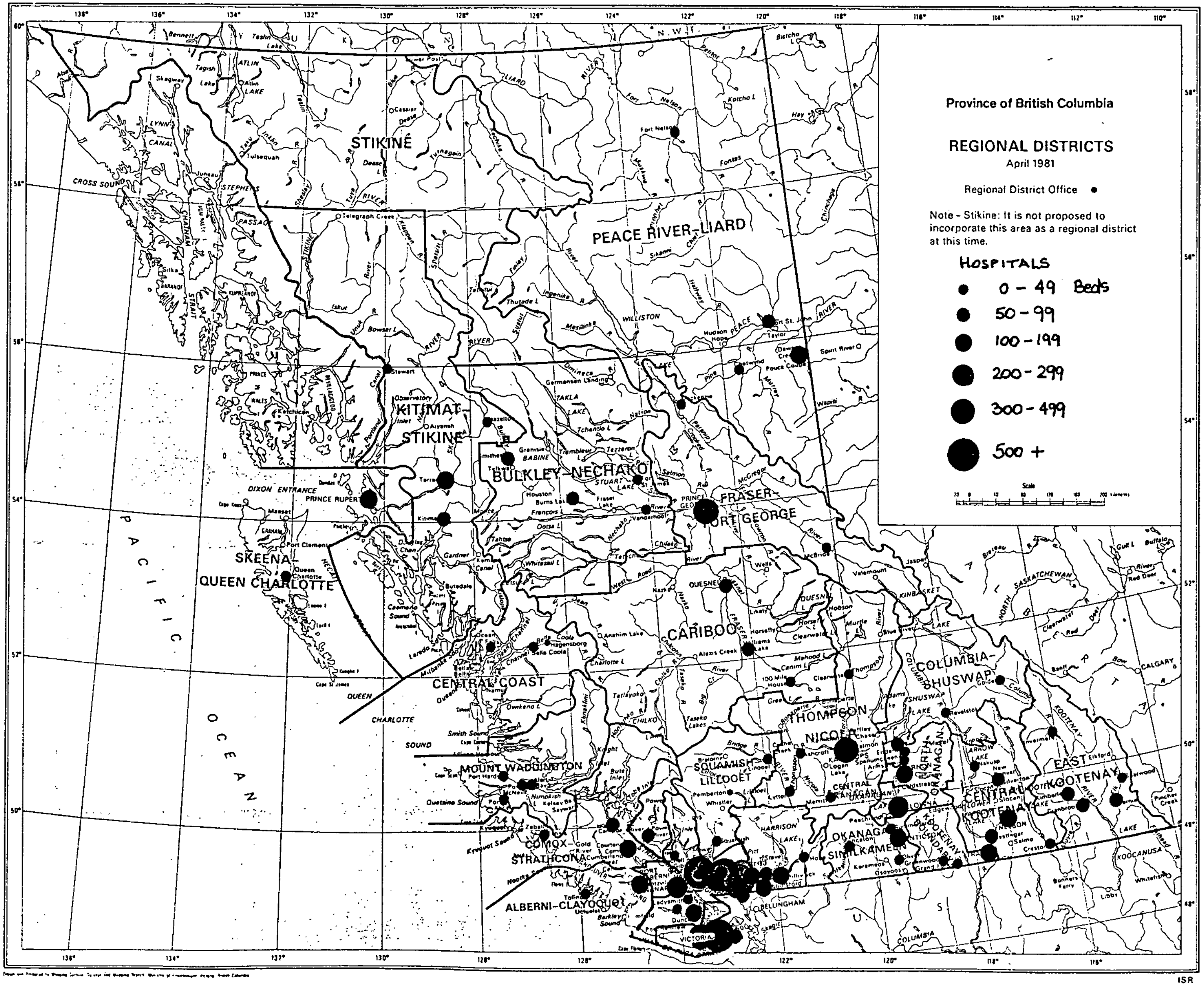
- The first is due to changes in doctors per population (i.e. $\Delta D_{t+1} \cdot L_t$) while holding laboratory cost per doctor constant.
- The second is due to changes in laboratory cost per doctor (i.e. ΔL_{t+1} D_t).

The two effects do not precisely eoual the net change between years because of the higher order effect ($\Delta D_{t+1} \cdot \Delta L_{t+1}$).

The attached table E.1 shows the actual change in hospital laboratory cost per capita between 1974 and 1981 (in constant 1971 dollars). The labe use effect refers to the factor $\Delta L_{t+1} \cdot \Delta D_t$. The doctor effect refers to $\Delta D_{t+1} \cdot L_t$. These factors are then expressed at a percentage of the overall change in laboratory cost per capita from 1974 to 1981.

TABLE F.1 FIRST ORDER DIFFERENCE MODEL

Regional Hospital District	Difference in Lab Cost per Capita 1974-1981	Effect of:		% Effect of:	
		Lab Use Change	Doctor Density	Lab Use Change	Doctor Density
Alberni-Clayoquot	2.16	2.06	0.07	95	3
Bulkley-Nechako	0.65	0.93	-0.24	142	-37
Capital	1.60	-0.08	1.69	-5	106
Cariboo	1.09	-0.07	1.18	-7	108
Central Coast	2.48	-0.19	2.86	-8	115
Central Fraser Valley	2.33	1.26	0.77	54	33
Central Kootenay	1.68	0.85	0.74	50	44
Central Okanagan	0.52	-0.69	1.30	-134	253
Columbia-Shuswap	0.87	0.67	0.18	77	20
Comox-Strathcona	4.38	3.43	0.50	78	12
Cowichan-Valley	0.67	-1.18	2.32	-177	347
Dewdney-Alouette	1.74	0.35	1.30	20	75
East Kootenay	1.29	1.11	0.14	86	11
Fraser-Cheam	1.71	0.53	1.08	31	63
Fraser-Ft. George	5.47	3.22	1.61	59	29
Greater Vancouver	5.60	3.19	1.81	57	32
Kitimat-Stikine	-1.48	-1.33	-0.17	90	11
Kootenay-Boundary	4.30	6.40	-1.44	149	-34
Mount Waddington	2.17	2.51	-0.17	116	-8
Nanaimo	0.39	0.23	0.16	59	40
North Okanagan	2.31	1.04	1.10	45	48
Okanagan-Similkameen	3.73	2.96	0.54	79	15
Peace River-Liard	3.40	2.84	0.38	83	11
Powell River	1.86	0.53	1.24	29	67
Skeena-Q. Charlotte	1.44	0.36	1.04	25	72
Squamish-Lilloet	1.86	0.81	0.90	43	48
Stikine	0	0	0	0	0
Sunshine Coast	0.34	0.24	0.09	72	27
Thomson-Nicola	4.46	3.12	1.00	70	22
TOTAL B.C.	3.49	2.01	1.19	58	34


Province of British Columbia
REGIONAL DISTRICTS
April 1981
Regional District Office
Note - Stikine: It is not proposed to incorporate this area as a regional district at this time.
HOSPITALS
0 - 49 Beds
50 - 99
100 - 199
200 - 299
300 - 499
500 +
STIKINE
PEACE RIVER-LIARD
KITIMAT-STIKINE
BULKLEY-NECHAKO
FRASER-FORT GEORGE
SKEENA-QUEEN CHARLOTTE
CARIBOO
CENTRAL COAST
COLUMBIA-SHUSWAP
THOMPSON-NICOLA
MOUNT WADDINGTON
SQUAMISH-LILLOOET
CENTRAL OKANAGAN
NORTH OKANAGAN
CENTRAL KOOTENAY
EAST KOOTENAY
KOOTENAY BOUNDARY
OKANAGAN-SIMILKAMEEN
COMOX-STRATHCONA
ALBERNI-CLAYOQUOT
PACIFIC OCEAN
PRINCE RUPERT
VICTORIA
ISR

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