# Chapter 12
# DISCUSSION

## 12.1 INTRODUCTION

The aim of this chapter is to synthesize the findings in the preceding chapters and to discuss them in a theoretical framework. The study has, however, been largely exploratory, and the different aspects have not been selected for the purpose of developing or testing some hypothesis or framework. It is therefore natural that the synthesis is partial, since the subject does not lend itself easily to a synthesis. It is also to be recalled that the different chapters in themselves constitute mostly self-contained pieces of research results.

The themes for a discussion integrating and synthesizing the findings have been chosen in retrospect. One theme concerns the management and technology factors and the discussion serves to clarify and emphasize the management factor viewed in parallel with the technology factor. The distinction between managerial and technological innovations is important in this respect.

Another theme concerns the question whether some form of management systems and internal organization is to be preferred to a market organization. The discussion of this theme has been aligned with the work of Williamson (1975).

## 12.2 EMPIRICAL SUMMARY

The empirical investigation presented in the preceding chapters has been concerned with R&D, innovation, management and organization in eight corporations. These corporations are large, diversified and predominantly multinational. They represent different industries and technologies—such as the chemical, electronic, engineering, mining, forestry, pharmaceutical and transportation industry. The data include several hundred interviews with people in R&D, marketing and top management positions.

The primary focus has been on strategic aspects and the relations between R&D and the rest of the corporation rather than solely on internal R&D. The focus of the different empirical chapters has shifted in several respects. First, there has been a shift from viewing the corporations as actors in a larger system of actors to viewing a corporation in itself as a system of actors. Second, there has been a shift in time perspective, in that the early historical development of the corporations has been treated, as well as their more current strategies. Third, aspects of behaviour, often associated with rational behaviour, such as policy making, decision making and organizing have been focused on as well as behaviour less associated with rationality, such as conflicts and the formation of subcultures. Finally, based on perceptions, managerial roles have been focused

on as well as the source/barrier structure pertaining to technological innovations. Thus, the history, strategy, structure and behaviour have been studied in relation to R&D and innovation in large corporations.

Chapters 2, 3, and 4 constitute the historical part of the study. Among the empirical findings are the following:

- Industrialization and the rise of large corporations in Sweden was to a large extent based upon domestic raw materials and domestic inventions, supplemented by foreign capital, technology and managerial influences.
- The 'classical' Swedish innovations were product improvements rather than radically new products. Managerial achievements in connection with invention-based internationalization through direct foreign investment were conspicuous.
- Historical continuity has characterized corporate development. In general, the corporations have grown, diversified and internationalized to different extents, primarily depending upon whether they were based on raw materials or product inventions.
- There has been a mutual interplay and a give-and-take relationship between R&D and corporate development. Particularly, large internationalized R&D operations were associated with large internationalized corporations, while R&D was loosely associated with diversification, at least radical diversification.

Chapters 5, 6, 7 and 8 deal with aspects of strategy and structure. Among the findings are the following:

- Strategies for R&D and innovation were in general vague and loosely coupled to corporate strategies.
- There was a low frequency of strategic decisions made with respect to R&D. However, an assessment of the strategic, tactical or operative nature of R&D decisions was difficult.
- Top management was often evasive in policy making, sometimes in combination with policy-seeking behaviour in the organization regarding R&D. On the other hand, top management was active regarding organizational structure and manning.
- The multidivisional form of organization was adopted by the Swedish corporations in the sample within a period of about five years, regardless of variations in size and degree of diversification and internationalization.

Chapters 9, 10 and 11 deal with specific aspects of behaviour in relation to technological change, R&D and innovation. Among the findings are the following:

- Several corporations have experienced the formation and change of subcultures associated with different professional categories. Typically, such subcultures were established in the corporation for a long period of time and were then opposed and subjected to a transformation.
- There was a high frequency of conflicts of various kinds in connection with R&D and innovation. To some extent certain conflicts were instrumental, but personified conflicts among professionals and managers had severe effects.
- A diversity of sources of ideas and barriers to innovation was found. The most frequent barriers were directly related to human characteristics and organization and management.

## 12.3 TECHNOLOGY AND MANAGEMENT

### 12.3.1 Technological and managerial innovation

In constructing explanatory frameworks it is customary to make conceptual decompositions into causal factors. Throughout this study there has been a focus on management and technology, and it is natural to try to assess the explanatory potential of these factors. In particular, this section aims at recognizing the potentiality of management as an explanatory factor, which ought to be considered in parallel with technology in both practical evaluations and theoretical analyses.

Needless to say, the role of both technology and management in economic development has been recognized, but in widely different ways and with varying emphasis. Consider first the well-known production function approach in economic theory. A measure of output of a collection of firms is related to measures of different input factors considered to be of relevance in the industrial production process. In the last few decades the decomposition into a set of input factors has, to an increasing extent, explicitly taken technological change into consideration. Sometimes aggregates of R&D outlays have been used to represent technology as an input factor. Often, however, the residual factor, besides labour and capital, has simply been labelled technology and has come to reflect changes in the quality rather than the quantity of labour and capital, as well as changes in additional input factors. To the extent that management is a factor of relevance in explaining say, productivity differences between nations, time periods, sectors of industry, or individual firms, it has been subsumed in a statistical residue, sometimes under the heading technology.

The heterogeneity of the residue has, of course, been observed. In addition to the distinction between product and process technology, the technology factor has been further decomposed conceptually into factors reflecting industrial structure, learning and different managerial activities, for example organization and marketing. There have been attempts at quantitative modelling of the management factor, but analytical tractability seems to disfavour the management factor, at least when it comes to incorporating different qualities of management rather than quantities (the latter expressed, for instance, as cumulated salaries to managers).

The following questions may now be asked: 'How can management be distinguished from technology?' 'For what purposes could a distinction between technology and management be a valuable analytical tool?' 'How can the relative importance of technology and management be assessed?'

Several authors include management in technology by using a broad concept

of technology. When talking about innovations, Schumpeter used a broad definition of innovation which he first referred to as 'any "doing things differently" in the realm of economic life', and which then was defined as 'the setting up of a new production function', (see Section 1.3). Moreover, Schumpeter used a narrow concept of management as referring to the organization and administration of running operations, while he reserved the term 'entrepreneur' for an individual who carried out an innovation. (As may be recalled, 'management' in the present study is taken to include entrepreneurship.) Thus, Schumpeter does not specifically distinguish between technological innovations and what is here called managerial innovations, although he recognizes the latter as well. Many authors who first define 'technology' and 'innovation' in a broad sense, in using these terms seem to have industrial products and processes in mind most of the time rather than management and organization. This is in contrast to Nelson and Winter (1974), who define innovation as a change of existing decision rules, thereby tying the concept of innovation directly to managerial behaviour.

It would be wrong to say, however, that Schumpeter does not emphasize what is called the management factor here. On the contrary, he emphasizes the carrying out of innovations and subsequent imitations as the basic events causing economic change, events which are directly associated with entrepreneurial or managerial behaviour.

A slightly different way to decompose industrial production into input factors is to focus on information or knowledge and/or skills in general. Difficulties in finding suitable representations of knowledge make production function modelling harder, and the analysis often becomes qualitative. When a knowledge perspective is used, the problem of conceptual separation also arises: how to distinguish certain skills from labour, certain types of knowledge from capital, etc. To separate managerial knowledge from technological knowledge is difficult both conceptually and quantitatively. Again, there is a tendency to focus on technological knowledge of a non-managerial kind, although different types of knowledge may be explicitly recognized by the authors.

Now the focus may be shifted from aggregate production functions to the level of the firm as described in neo-classical economic theory. At this level of theorizing, the management factor enters only as an assumption about managerial behaviour as maximizing something, usually profit or some more general utility measure. The crucial inadequacy of this assumption is neither that managerial behaviour is equated with a maximizing algorithm, nor that profit or some utility is maximized, but that it fails to consider the uneven distribution of managerial knowledge and skills. In fact, an assumption which associates an extreme trajectory in an abstract space with the behaviour of the management of a firm is flexible enough to deal with a wide range of objections based on notions of satisfying behaviour, limited rationality, imperfect information, multiple goals, sequential attention to goals and the like. But as long as all managers are assumed to be equally skilled in maximization with equal access to information and other factors of production, the theory will fail to explain differences among firms. This may, however, be done by varying the starting conditions of the firms in a dynamic model, by introducing differences in access to information, by varying the values used by management in maximizing or by simply introducing random elements to reflect pure luck. But what reason would there be then for not differentiating the qualities of management? It is to be noted that profit is clearly recognized by Schumpeter as an entrepreneurial motive in capitalist economies but at the heart of his argument is also the view that entrepreneurial talents are skewly distributed in a population.

It may be argued that much of the ignorance about the management factor in economic theory has more to do with a lack of empirical insight and difficulties in incorporating management qualities in quantitative analyses than with the level of analysis. To support the last statement, attention may be drawn to a few examples. In comparing economic performance among different nations, attributions to differing qualities of management in industry are not uncommon. (See Pratten, 1976, for example.) The shift in topics for public discussion during the 1960s from a technology gap to a management gap between the United States and Europe illustrates this point, as does the discussion of Japanese methods of management. In addition to management styles, management education and research may also be compared at an international level (see Singh, 1971). At the sectoral level, the notion of innovation by invasion may illustrate different qualities of management in different sectors of industry. At the level of the firm, there may be a skew distribution of entrepreneurial talent as Schumpeter claims, which could imply a tendency of the same firms to be pioneers through innovating. However, there does not have to be a similar distribution of managerial talent in a wider sense since imitators may be just as economically successful as innovators as may late adopters in relation to early adopters of an innovation.

If quantitative modelling is disregarded rather than the management factor, what could be gained in an analysis? To indicate this, management will be viewed in parallel with technology in a knowledge perspective. That is to say, knowledge (or, interchangeably, information), including intellectual skills, is considered to be at the heart of the matter and technological knowledge will be distinguished from managerial knowledge, in the same way as technologists may be distinguished from managers as knowledge actors (carriers, learners, generators, disseminators etc.). Needless to say, technologists and managers do not have to be different persons but rather refer to different roles.

Now a set of research questions concerning technology and innovation could be transformed into a set of similar research questions concerning management (and vice versa). For example:

- What are the impacts of managerial innovations on economic and social life?
- What are the sources of and barriers to managerial innovations? Do they emanate mainly from management research, from large corporations, from independent inventors, or what?
- What factors govern the processes of diffusion of managerial knowledge?
- What kind of managerial innovations foster technological innovations and vice versa?
- What is the role of significant actors in management and in technology?

Naturally, there are also salient differences between the two types of knowledge. Thus, for example, artifacts from technological knowledge ('hard-

ware') differ from artifacts from managerial knowledge (c.f. the notion of 'orgware' in Dobrov, 1978). The production and distribution of the two types of knowledge differ, for example, with respect to possibilities of experimentation and reproduction, and it is not suggested here that, for instance, new managerial knowledge could or should be made patentable. The point here is rather that the distinction is useful in posing analytical questions.

The economies of managerial knowledge has been widely recognized for a long time, at least since Adam Smith, and associated with questions of the division of labour, co-ordination, resource allocation, competitive behaviour, size and efficiency, etc. Also, a division of management itself into different specialities, functions, roles and so on has long been recognized and notions about the corresponding economies attached to it. Thus Penrose (1959) includes marketing, financial and research economies in managerial economies. Also, there are managerial diseconomies, associated with limits to size, growth and diversification of a firm. This is a common view, and sometimes references are made to 'the law of diminishing returns of managerial control'. Such a 'law' then has implications for questions about market structure and limits of management. However, any implications of that kind would have to be modified when technological and managerial innovations are taken into consideration. Certainly the operations of a multinational corporation of today are more complex than those of a large firm a century ago, but managerial knowledge has increased and so has the stock of available management tools, including technological innovations such as the telephone and the computer. Management, therefore, has not necessarily become more difficult. On the other hand, the cumulation of knowledge and tools for management leaves more room for differences in utilizing available knowledge and tools among different firms. The skewness in the distribution of managerial qualities in industry does not necessarily increase as a result of such a cumulation, but at least the range of possible variation has increased.

Managerial innovations, together with technological innovations, could thus be viewed as dynamic factors in an economy, which not only change optima and limits of production but also change optima and limits of market structure and management itself. A new set of research questions could now be constructed by combining the aspects of management and technology.

Examples of questions in such a set would be:

- What kind of management is the most conducive to technological innovations?
- How will technological innovations facilitate management?
- Is the kind of management which promotes technological innovations also promoting managerial innovations?
- Could managerial innovations be substituted for technological innovations in achieving economic performance?
- Do different types of technology require different types of management and do the latter affect the rate of technological innovations differently?
- What are the differences regarding source/barrier structures of technological and managerial innovations?

Table 12.1 Examples of major managerial innovations

| Managerial innovation | Major characteristics of sources of innovation |
|---|---|
| Scientific management | A cluster of innovations made around the turn of the century in large companies by a well-educated inventor (Taylor) with operative experience. To some extent simultaneity was present in regard to similar innovations by the Gilbreths. |
| Multidivisional structure (M form) | An innovation originating simultaneously in two large companies (Du Pont and General Motors) and carried out by the top managers. |
| Linear programming | A cluster of innovations based on science and originated partially in a military context during and after World War II. The innovations have then diffused into civilian industry and numerous subsequent improvements have been made. |

*Sources:* Taylor (1964), George (1968), Chandler (1962), Dantzig (1963)

- Does the generation of technological and managerial innovations compete for similar kinds of resources?

The knowledge about managerial innovations does not correspond to that about technological innovations. As Williamson puts it:

> The importance of organizational innovation to economic efficiency is poorly understood. . . The diffusion of organizational innovations—within industries, across industries, and across cultures—both in terms of the mechanics of the diffusion process and the economic consequences associated with organizational innovations of various kinds, . . . warrants investigation. (Williamson, 1975, p. 262)

Any textbook on management gives a wide variety of management methods, techniques, concepts, tools and the like. Table 12.1 gives a few examples of major managerial innovations and Table 12.2 a few examples of major technological innovations in order to illustrate the parallelism. One may, for example, note that simultaneity as well as clustering may apply to both technological and managerial innovations. Also, sources and diffusion patterns of both kinds of innovations may be structured in similar ways.

The parallelism may be further illustrated by the different inventive approaches of Frederick Taylor and Charles Babbage (see, for example, Taylor, 1964; Babbage, 1832). The latter has mainly become associated with unsuccessful attempts to develop a mechanical computer, but he was also a brilliant observer and analyst of the economics and industrial organization of his time. It has been claimed that some ideas of Babbage (which by the way had little to do

Table 12.2 Examples of major technological innovations

| Technological innovation | Major characteristics of sources of innovation |
|---|---|
| Detonator and dynamite | Research-based innovations made in the 1860s by a well-educated autonomous inventor (Nobel) with entrepreneurial skills. |
| Diesel-electric railway traction | An innovation with a main impetus from the R&D department of a large company (Kettering at General Motors). Improvement of existing technology for a new application. |
| Electronic digital computer | An innovation in the early 1940s based on science and originated through a United States government supported project at a university as a response to war-time needs. Rapid diffusion into civilian uses and numerous subsequent improvements. |

*Sources:* Lundström (1974), Jewkes *et al.* (1969), Stern (1979)

with his ideas of a computer) preceded those of Taylor and such beliefs are not without foundation. But while Babbage was studying how to make manual operations amenable to automation (i.e., substituting technological innovation for human labour), Taylor was studying manual operations in order to make them more efficient and his managerial innovation was based upon this. Clearly, these innovations may substitute for each other to some extent in achieving economic performance. The illustration may also be carried a little further. According to Peter Drucker, the essence of Taylor's managerial innovation was that planning became distinguished from doing (see Drucker, 1977). The later innovation of multidivisional structure led one step further in that strategic planning became distinguished from operations and assigned as a prime responsibility to top management. The innovation of the computer in turn has provided means to facilitate the management of a complex organization.

### 12.3.2 Management of R&D and technological innovation

While it thus seems clear that technological innovations influence management and may partially be substitutable with managerial innovations, one may ask how management influences technological innovations. Would not, for instance, the computer have been invented and put into operation regardless of any managerial innovations and qualities? The question may be refined to concern how the rate and direction of technological innovation may be influenced by management. This brings in the question of R&D management. It is therefore important in this context that R&D management is interpreted in a wide sense as influencing technological innovation through managerial action at different levels. R&D management is thus not just confined to, say, management at some

Table 12.3 Examples of innovations in R&D management

| Managerial innovation | Major characteristics of sources of innovation |
|---|---|
| PERT (Program Evaluation Review Technique) | An innovation originated in a large company in co-operation with management consultants in connection with a large-scale military R&D project (Polaris). Rapid diffusion into civilian uses. Simultaneity present to some extent with respect to other network techniques. |
| TVO (Technical Ventures Operation) | An innovation originated in 1970 in a large company (General Electric) as an effort to join advantages of large and small companies. Simultaneity present with respect to other forms of venture management. |
| Technological forecasting | A cluster of innovations originated partially in military contexts during and after World War II. Slow diffusion into civilian contexts. |

*Sources:* Finch (1976), Williamson (1975), Sabin (1973), Jantsch (1967), Twiss (1976).

department or laboratory level, and it is certainly not suggested that R&D and technological innovation may be controlled, which sometimes happens to be a connotation of the term 'R&D management'.

An immediate example of a managerial innovation with a bearing on technological innovation would be the patent institute. Doubts have been raised about its effectiveness, and it is debatable whether a temporary monopoly is conducive to technological innovation, but it is an example of an R&D management innovation, albeit at the level of an economic system rather than at the level of a firm. More examples are given for illustrative purposes in Table 12.3.

If both the technology factor and the management factor are important for economic development, their joining in the form of management of R&D and innovation should be particularly important. In a similar vein of somewhat simplified deduction, one could develop this idea and say that to the extent that large corporations are important in technological and economic development, R&D management in large corporations would be important. However, in the extreme, one may argue on one hand that R&D cannot be managed at all, and on the other that R&D can be managed just like any other industrial operation (see Bright, 1964; Blake, 1974). Admitting that there are both random processes and universal elements of management involved in processes of innovation, the more interesting question is how to assess qualities and the role of R&D management. There are several studies which deal with this question. Some of these studies have been referred to in the preceding chapters, but as a reminder one can cite the study of Burns and Stalker (1961) and their concept of mechanistic versus organic organizations, the study of Lawrence and Lorsch (1967) and their

concept of differentiation and integration, the many studies of barriers to innovation, and finally the Schumpeterian emphasis on entrepreneurs and innovations in contrast to inventors and inventions.

The empirical material in this study adds to the recognition of qualities as well as limitations of R&D management as reported in the preceding chapters (see the next section for a summary). When it comes to the relative importance of managerial knowledge versus technological knowledge, some of the findings in the preceding chapters will be highlighted here.

In Chapter 2 it was found that the inventions on which a group of companies were based were product improvements rather than radically new products, while the managerial achievements, not the least in international marketing, were remarkable. To the extent that this is true, it emphasizes the role of management for corporate development rather than the role of radical technological inventions and flashes of technological genius. Similarly, the versatility of management in the initial corporate development is important for utilizing the often small competitive advantages offered by R&D under circumstances of initial sensitivity of the corporation to the environment (Chapter 3). This holds true also in the subsequent corporate development in the light of the kind of grassroots R&D mostly undertaken, the cumulative effects of which are of great importance (Chapter 3). However, it should also be noted that more radical innovations have occurred in the subsequent histories of most of the corporations studied, and the management factor has then not always been conspicuous.

Diversification and internationalization as two main features of corporate development offer another illustration of the relative importance of different types of knowledge (Chapters 3 and 4). Most, if not all, successful internationalizations have been based on a technological achievement, while many diversification failures may be attributed to failures on the part of management to appreciate the technological and marketing knowledge needed to enter into new product areas. Thus, it seems that differentials in knowledge about different national markets are less decisive for management than the differentials in knowledge about different product technologies. To some extent also, multinational co-ordination of R&D is possible, although such co-ordination is mostly reduced to intra-continental co-ordination (see Chapter 4). Whether multinational R&D in a single product area is less difficult to co-ordinate than nationally based R&D in multiple areas is likely but is largely an open question. It may also be observed that in market economies, multinational corporations based on a few technologically related products are more common than national conglomerates. That the extent to which this is true in turn depends upon the type of management is illustrated by the difficulties of Japanese multinational corporations in implementing the Japanese way of management in foreign subsidiaries (Yoshino, 1976).

The importance of differentials in technological knowledge is also illustrated by the emphasis in R&D policies on technological synergy, 'natural' or 'organic' extensions of competencies to adjacent fields of science and technology, etc. (Chapter 5). The difficulties in bridging technology differentials through management are further illustrated by the formation of subcultures and conflicts (Chapters 9 and 10). However, subcultures may be conducive to communication and co-ordination, and cultural entrepreneurship is a managerial possibility, so consideration of subcultures actually gives a mixed judgement with respect to the relative importance of management and technology. This can also be said about conflicts since they may be instrumental to some extent in the management of R&D and innovation.

Policy evasiveness on the part of top management, lacking strategic planning of R&D, inadequate top management involvement in R&D management, lacking entrepreneurial R&D management and managerial barriers to innovation (as described in Chapters 5, 7 and 11) may be intepreted as shortcomings or failures in the R&D management factor. With this interpretation one is inclined to believe in a possible up-grading of the management factor in relation to the technology factor. But to the extent that the observed circumstances are interpretable as unremovable limitations of R&D management or just as desirable states of R&D management, such a belief is unjustified. One may also note that both the actual and desirable pattern of decision making regarding R&D may be dependent upon the type of technology (see Chapter 6).

With respect to changes in organization structure, top management is actively exercising a decisive influence, and the structural variable is largely at their disposal, although manning considerations may influence the choice considerably (Chapter 8). To the extent that structure is of importance in managing R&D, the management factor is then up-graded, provided technology does not influence structure. This is, however, likely to be the case. If a market in itself is considered as an organization, its structure is not at the disposal of some central managerial authority (unless it is totally regulated). Managerial decisions in several firms then indirectly influence market structure, which leaves more room for the technology factor. This whole issue, however, is intricate but important, which will be seen when we return to it in the next section.

Finally, it may be observed that in a competitive economy with qualities of technology and management among the means for competition, an increased complexity in the corporate environment and an increased information load on management reinforce the effects of skewly distributed managerial talents. Part of this complexity derives from technological innovation, which thus up-grades the importance of the management factor. Schumpeter's view that the 'creative destruction' in the 'perennial gale' of technological change is the only important form of competition in the long run then places emphasis on R&D management (Schumpeter, 1976, pp. 83–85).

In conclusion it may be added that no significant managerial innovation appears to have originated in Swedish industry, with the possible exception of Alfred Nobel's creation of a multinational R&D organization in the 1880s. While the utilization of foreign technology in Swedish industry has been supplemented by significant domestic technological innovations, there has been an almost total foreign dominance, especially a United States one, regarding managerial innovations. Their diffusion patterns have also differed. For example scientific management diffused into Swedish industry quite differently compared to the diffusion of the multidivisional structure.

In summary, this section has demonstrated the parallelism between technology and management and attempts have been made to assess the relative importance

of these factors. The multinational corporation based on technologically related products is a viable form of organization, while technological differentials appear to make organizational integration less efficient and likely. In the subsequent section the perspective will be shifted and an internal organization versus a market organization as two distinct forms of management in a wide sense, will be compared with respect to their effects on and influences from R&D and technological innovation.

## 12.4 MANAGEMENT AND MARKETS

As a point of departure, the following question may again be asked: 'What kind of management and organization is the most conducive to technological innovations and economic performance?' This question may be directed at different levels of the organization such as the R&D team, the R&D laboratory, the firm, the sector of industry, or the economic system. When discussed at the interfirm level, the concepts of management and organization have to be interpreted in a wider sense in order to include different types of market structure as special cases.

Obviously, the above question has been asked extensively with different levels as the prime focus. At the interfirm level it has been a matter of discussion among economists for a long time (see Kamien and Schwartz, 1975). A most coherent penetration is made by Williamson (1975). This work along with related ones, such as Phillips (1980), will be taken as a central framework in which this study may be viewed when synthesizing it in retrospect. This study is not an empirical comparative study of relative advantages of, say, management systems versus market systems. However, it provides empirical insights into management of R&D and innovation in large corporations, insights which may contribute to assessing the possibilities and limitations of management in relation to the treatment of management versus markets by other authors.

### 12.4.1 Review of Williamson's work on markets and organizations

What is sometimes referred to as 'the Williamson hypothesis' is the statement that an internal organization is superior to a market organization. Although Williamson argues that this is the case in a great number of circumstances, he also carefully points out several modifications, exceptions, limitations, weaknesses of empirical support and so on. Williamson sets out to examine a firm (or a hierarchy) and a market as alternative organizational (or contractual) modes (pp. 5, 253), rather than alternative economic systems (p. 39). He then assumes that 'in the beginning there were markets' and shows how organizational forms develop essentially by referring to the relative advantage accruing from performing transactions in an organization rather than on a market among autonomous parties. This transactional approach is consistently carried through by using such concepts as bounded rationality (referring to Simon), opportunism (that is, self-interest seeking, possibly with guile), uncertainty, information impactedness (that is, the effects of unequal possibilities of information access among the parties in a transaction) and the effects of a small number of parties. Among other things, the cost of information and the difficulty involved in carrying out negotiations and transactions are found to disfavour market-mediated exchanges, while—relatively speaking—an internal organization is found to benefit from such things as learning from transactions. The technology factor, which is often used to explain the rise of certain structures, does not enter into Williamson's framework other than to the extent it affects transactions.

Williamson then analyses limits to organization and management and thus avoids predictions of an indefinite evolution towards organizational integration and monopolies. Also, in relation to innovation, he modifies the stand that integration permits transactional economies to be realized. A systems solution is forwarded in which small firms, having a relative advantage at the early stage of innovating, complement large firms having a relative advantage at a later stage. Taking transfer disadvantages into consideration, this system is claimed to be superior to full integration. Finally, Williamson addresses problems of monopoly and oligopoly with anti-trust implications in mind.

Generally, possible and existing organizational forms are only partly integrated. The question is then to what extent will productive units be integrated? For example, a market could be viewed as a completely disintegrated collection of internally integrated firms. But if inter-organizational ownership relations are introduced, an element of integration arises, which may vary along a continuum. Also, the multidivisional structure (i.e., the 'M form in Williamson's terms) could be modified along a continuum of degree of integration. Certainly Williamson thoroughly examines the relative advantages and limitations of different organizational forms, including the market, and he also addresses himself to the question of optimum divisionalization, as well as a total system for efficient innovation. But his emphasis on markets versus hierarchies is recurring. That a vertically integrated firm or an internal organization is superior to the market organization is thus a tempting way to summarize Williamson's findings in a single statement, in spite of the fact that he himself treats the issue in a differentiated manner.

### 12.4.2 Review of Phillips' work on markets, organizations and R&D

Williamson's work pays considerable attention to R&D and innovation. The focus is on questions of size of firm, market concentration, barriers to entry and similar features of market structure, on the one hand, and resources devoted to R&D, productivity of R&D and different barriers to innovation, on the other. A system for innovation, in which large firms limit their integration backwards into R&D and small firms specialize in early-stage invention, is proposed, but in intra-firm terms little is said explicitly about the R&D function. The applicability of Williamson's framework and conclusions when R&D are explicitly introduced as a subsystem in the firm has, however, been treated theoretically by Phillips (1980). This work is summarized below.

Phillips analyses the confluence of internal organizational factors and external market organizational factors in a theoretical framework, with special reference

to the functioning of R&D in different intra- and inter-organizational systems. These systems are composed of selling organizations $S_i$, manufacturing organizations $M_i$, and R&D organizations $R_i$, the latter in turn decomposed into exploratory research ($R_i'$), advanced development ($R_i''$) engineering development ($R_i'''$), and product and marketing development ($R_i''''$). The relationships considered between these organizational elements are whether they are separated, meaning that the market mechanism is used for transactions, or integrated to some extent vertically or horizontally.

By and large Phillips finds support for Williamson's hypothesis that vertical integration is superior to a market organization. In fact, Williamson's arguments, based on concepts such as bounded rationality, informational impactedness, opportunism, goal differences and costs of transactions through contracting, apply with increased strength when $R_i$ is added to the analysis. However, there are several limitations of integration as well, both as understood by Williamson and in other respects such as the appropriability problem, effects arising from interdependencies among different technologies and organizational persistence.

When $R_i' - R_i''''$ are added to the analysis, a set of organizational dilemmas arises regarding the balancing of effects from horizontal integration, for example, through 'horizontal' professional associations, and vertical integration. These effects affect the probabilities for incremental versus radical technological change, which in turn affect the dynamic rather than static efficiency of the organizational structures. Different networks of market/contractual and administrative/integrative relations affect the perception and transmission of technology- and demand-related facts differently, and the framework presented by Phillips permits an analysis of the often obscured issue of technology-push versus demand-pull factors in technological change. Whether or not push or pull factors are effective in some sense, or information about threats or opportunities are transmitted, the efficiency inducing aspects of vertical integration are still largely valid. However, what is exactly the most efficient organizational form is not easily defined. As succinctly expressed by Phillips: 'Bounded rationality applies to the choice of organizational form itself.' (Phillips, 1980, p. 113).

Thus, to put it briefly, Phillips finds that problems of information arising from R&D strengthen Williamson's arguments, although some additional qualifications and limitations to integration have to be recognized. Without going further into Phillips' work here, comments similar to the ones above about Williamson's work also apply to Phillips', with the exception that Phillips does not use the term 'hierarchy'. With respect to R&D and innovation, Phillips' work further clarifies the usefulness of Williamson's framework and also penetrates issues not specifically dealt with by Williamson, such as the technology-push/demand-pull issue. On the other hand, Phillips does not treat Williamson's systems approach to innovation, although both decompose the R&D and innovation process in similar ways.

### 12.4.3 Findings in the present study regarding management and markets

In this section the findings from the present study will be examined to see how they strengthen, weaken or modify the arguments forwarded by Williamson and Phillips in relation to markets and industrial organization. A preliminary note on terminology is in order. While Williamson speaks about markets and hierarchies and Phillips about markets and organizations, essentially the same phenomena will here be referred to as markets and management. Markets and management represent two kinds of systems, sometimes also referred to as inter- and intra-organizational systems. Although recognizable as distinctive stereotypes, their actual differences are a matter of forms and degrees of integration. Integration, in turn, refers to connecting properties of relations among actors, especially contractual relations. Degree of integration then is contingent upon and indicated by several related factors, such as level of interaction, agreements, information flows, stability in transaction patterns, and co-ordinated behaviour.

#### *12.4.3.1 Indications supporting the hypothesis about the superiority of an internal organization*

Table 12.4 summarizes the findings of this study, which offer support for the Williamson hypothesis. Each of the indications in Table 12.4 may be treated quite extensively but will be done only partially here with respect to some of the indications and commentary rather than analysis offered for the rest.

(a) *Early corporate histories*. For expositional purposes Williamson assumes that autonomous contracting is initially ubiquitous. Then he raises the questions why such contracting might be supplanted by a non-market organization and what

Table 12.4 Summary of indications found in the present study that management and internal organization may be superior to market organization with respect to R&D and innovation.

| Type/area of indication | Chapter(s) |
|---|---|
| Inter-individual integration of inventive and entrepreneurial skills | 2 |
| Rise of national invention-based monopolies (bearings, matches, explosives, among others) | 2 |
| Internationalization in product-invention-based corporations | 3,4 |
| Early diversification in corporations based on domestic raw materials and/or foreign technology | 3 |
| Systems orientation | 3 |
| Mixed strategies and structures as response to uncertainties | 3,5,8 |
| Global information processing capacity of multinational corporations | 4 |
| Development of corporate planning | 5 |
| Strategizing in certain technologies | 6 |
| Range of managerial functions and comparative advantages to market functions | 7 |
| The 'M form' as an organizational innovation | 8 |
| Internalization of R&D | 3,8 |
| Structural adjustments and experimentation | 8 |
| Communication and co-ordination structures | 8 |
| Formation of subcultures and cultural entrepreneurship | 9 |
| Regulation of beneficial conflicts (internal competition, for example) | 10 |
| Managing generative and selective processes | 11 |

internal forms of organization will appear first. In short, his answer is that simple hierarchies will appear, possibly preceded by teams or peer groups, since these forms are more efficient in carrying out transactions. Bounded rationality and opportunism are decisive human factors in this progression, and these factors also explain further organizational developments into more complex hierarchies.

Williamson's treatment may be checked with respect to studies of corporate histories. Some qualifications must then be made on empirical grounds. First, Williamson's approach is analytically tempting but the starting condition is never one of full entropy. In the beginning there may be markets, but these are structured, and different resources such as managerial skills, capital, technology, labour and raw material sources are skewly distributed. However, this does not necessarily weaken the argument that simple organizations will arise due to realization of transactional economies when different skewly distributed resources and differentiated skills are pooled. In fact, the common inter-individual rather than intra-individual integration of inventive and entrepreneurial skills, as described in Chapter 2, is an example of a team which emerges in connection with the foundation of a firm. Different contractual forms naturally appear, but uncertainty, bounded rationality and opportunism all limit the possibilities of short-term, contingent claims or sequential spot contracting. It may then be argued, along the lines of Williamson, that teams of actors may realize transactional economies through the special contractual commitments involved in starting a firm, although the team may be bound together in additional socio-psychological respects as well (c.f. family-owned companies). Thus the formation of a small group organization, rather than a collection of autonomous contractors, in connection with the foundation of a company may be explained in the transactional framework development by Williamson. However, Williamson seems to have a worker organization much in mind, and when discussing the role of technology he does not make distinctions between hard and soft technology or between product and process technology. Some qualifications with respect to entrepreneurs, inventors and technology-based companies are therefore to be expected.

The inter-individual joining of technological know how and managerial skill and the build-up of mutual trust and adaptation of behaviour present a case of indivisible information. As Williamson points out, this does not necessarily imply collective organization, but rather that such an organization stems from transactional difficulties with market contracting.

The combination of productive factors in founding a company also presents a case of non-separability. Because of the multiplicative nature of this combination, the marginal productivity of each supplier of productive factors such as technological and managerial assets cannot be determined. Team production is involved, just as in manual freight loading, which Williamson cites as an example of worker non-separabilities. In the latter case, an internal organization is presumed to arise in the form of a manager, who:

> monitors the performance of the team and allocates rewards among members on the basis of observed input behavior. Shirking is purportedly attenuated in this way. (Williamson, 1975, p. 50)

Also, non-separability does not mean that collective organization results as a general rule. Technological know-how may be licensed on a long-term basis, patents may be sold, managerial know-how may not be patented but supplied through management agreements (see Chapter 4), raw material sources subjected to various forms of contracting for utilization, etc. Transactional difficulties do not necessarily prevent these contractual forms from supplanting collective organization. Rather, experimental behaviour in these respects occurs together with the emergence of certain standardized options of behaviour (for example, in connection with royalties).

Thus, a variety of combinations of productive factors, human characteristics, and situational conditions create a variety of contractual relationships and quasi-organizational forms. The team of founders in the corporations studied displays this variety of relationships (see Chapter 2). Heterogeneity at the outset is reflected in an initial variety of quasi-integrated forms of founding companies. The role of technology in forms and degrees of integration cannot be reduced to a question of physical indivisibility and non-separability in process technology. Transactional considerations are certainly at the heart of the matter. However, various aspects of technology, management and situation determine the transactional economy, which can be realized through different forms of contracting in the foundation stage of a company, a stage which resembles a venture or a project rather than a collective organization.

The rapid progression into hierarchical forms as a firm develops is a basic and important phenomenon. This may be explained in several ways. Theoretically, a hierarchical structure may be seen as a graph or a system structure with extreme properties arising, for example, from postulates about communication economy, control properties, management principles, or need structures in terms of power and autonomy. But as Williamson points out, a 'leading theoretical need is for additional work on the properties of hierarchy' (p. 261). An analysis of the empirical reasons for the rise of a hierarchy will not be made here other than to point out the importance of skewness in resource distribution, including a skew distribution of managerial talent. Resourceful individuals gathered people around them to assist in company operations, thereby taking advantage of hierarchical forms. As pointed out by Williamson, something of an elite or a group of significant actors in the organization thereby results, who have better access to information, capital and other significant actors in the environment of the firm. This gives the elite a strategic advantage in the organization. Thus, skewness at this point is reinforcing. As also seen from Chapter 2, there appears to be a coupling between the capacities and orientation of the significant actors on the one hand, and features of early corporate development on the other.

A strong case may thus be made that hierarchical forms eventually appear. However, it must be added on the basis of this study that there are imperfections in the rising hierarchy. The rise of an informal organization is well known but the imperfections at the top of the hierarchy are less so. A hierarchy that is imperfect at the top often arises from the initial quasi-organizational team formed at the foundation stage of a company. Sometimes it is obvious that there is one strong man at the top, integrating in himself inventive and entrepreneurial skills (this, for instance, was the case in KemaNobel and SKF) but more often than not there

seems to be a hetereogeneous elite at and around the top, which makes the hierarchy a poor model.

(b) *Diversification and internationalization*. The management and technology factor in integrating a corporation in multinational and multiproduct respects has been dealt with in Section 12.3. Differentials in technological knowledge rather than differentials in knowledge about international markets are crucial for integration through the internal organization of a corporation. The rise of multinational corporations in itself offers support for Williamson's hypothesis in that internalizing operations substitutes for international trade. Similarly, support is offered through the internalization of operations in diverse product fields. This is not necessarily efficiency-inducing in overall respects since some managerial efficiency may have been sacrificed for managerial security in spreading business risks among different product areas. Diversification failures also indicate limitations to the internal management factor due to technology and market differentials.

(c) *Managerial versus market functions*. A market may be conceived of as an overall organization with functions to provide entrepreneurial incentives, to distribute risks, to process information through price formation, and to allocate resources. Similarly, managerial functions, such as motivation, planning, manning, information processing and resource allocation may be discerned, although in different ways and with varying emphasis (see Chapter 7). Relative advantages of markets versus management may be assessed to each of these functions, and a mixed judgement is the likely outcome. For instance, a market is at an advantage in providing entrepreneurial incentives in the form of autonomy and profits, which appeal to some individuals, while the prospects of organizational careers and power have appeal to others.

An internal organization economizes heavily on uncertainty and bounded rationality through sequential decision making and cumulation of managerial experience. Mixed strategies and structures in response to uncertainty, the possibilities of managerial experimentation, recruitment and promotion of individuals on grounds other than their proven economic successes, etc. speak in favour of internal organization. On the other hand, the rise of dynamic conservatism in an organization, managerial conflicts, and conversion of market risks to managerial ego risks disfavour internal organization compared to a market organization. This leads to the question of limits to management, which will be considered next.

### *12.4.3.2 Managerial limits*

Although management and an internal organization may be considered to be superior to a market organization with respect to information processing, planning, co-ordination and learning, several indications of limitations on the part of management may be observed with respect to R&D and innovation (see Table 12.5). This has also been recognized in literature (see Table 12.6).

Williamson derives the limitations from basically human attributes, such as opportunism and bounded rationality, the latter implying limitations with

Table 12.5 Summary of indications of failures and limits to organization and management with respect to R&D and innovation as found in the present study.

| Type/area of indication | Chapter(s) |
|---|---|
| Diversification failures | 3 |
| Acquisition failures | 3 |
| Increasing costs and risks in advanced science and technology | 3 |
| Multinational co-ordination | 4,8 |
| Weak coupling between R&D and corporate strategy | 5 |
| R&D policies for incremental knowledge extension | 5 |
| Policy evasiveness | 5 |
| Impact of business cycles | 5 |
| Non-existing means/ends hierarchies | 5 |
| Policy evolvement in organizations | 5 |
| Incrementalism in decision making | 6 |
| R&D decision-making nature | 6 |
| Politicizing | 6 |
| Lack of entrepreneurial R&D management | 7 |
| Inadequate top management involvement | 7 |
| Non-precedence of strategy to structure | 8 |
| Externalization of R&D | 8,11 |
| Internal transfer problems | 8,10 |
| Persistence of subcultures in the organization | 9 |
| Reorganizational conflicts | 10 |
| Conflicts among managers | 10,11 |
| Conflicts related to R&D people | 10,11 |
| Individual needs for power/autonomy | 10 |
| Barriers to innovation in management, organization and people | 11 |

Table 12.6 Some indications of limits to organization and management with respect to R&D and innovation as reported in literature*

| Type/area of indication | Author(s) |
|---|---|
| Appropriability problems with R&D | Phillips (1979) |
| Range of implementation uncertainties associated with R&D | Phillips (1979) |
| Organizational persistence | Phillips (1979) |
| Bias towards minor innovations | Phillips (1979) |
| Limited adaptive responses to technological threats and opportunities | Phillips (1979) |
| Insufficient incentive system | Williamson (1975) |
| Organizational ageing | Williamson (1975) |
| Inadequate atmosphere for R&D and entrepreneurial elites | Williamson (1975) |
| Decline in R&D spending and productivity in giant organizations | Williamson (1975) |

*Naturally such indications may be found in a wide variety of literature. However, only the literature particularly focused on in this chapter is considered.

respect to computational abilities and language. However, in the course of transactions, the number of parties will be reduced and organizational conservatism will arise. Thus, limitations will be built into the organization and derive from the nature of organizations rather than from solely human attributes. In fact, Williamson's assumption of bounded rationality and opportunism may be discarded and omniscient altruistic management with unlimited rationality assumed as a possibility. Limitations may, however, still be derived from limited channel capacities in processing information in combination with initial information asymmetries. Limited capacities to process information may be derived in turn from considerations of costs in transmitting information. Since unbounded rationality implies non-scarcity and zero opportunity costs of the corresponding managerial resources, such cost considerations will have to rely upon costs of time delays in transmitting information rather than distortion due to opportunism and limitations in node capacities. This serves to illustrate the limitations inherent in organizations in addition to limitations primarily attributable to individuals. Just as it is unimaginably improbable that all molecules in a room will concentrate in a corner and someone in the room will be choked to death through Brownian motion, it is improbable that all human action will be perfectly co-ordinated by random processes. Not even with an altruistic, omniscient manager will this be possible, since processing information for non-trivial co-ordination purposes will be time-consuming. (Limits analogous to Heisenberg's uncertainty relation are also conceivable.) The crucial underlying factors are uncertainty, information asymmetries and limited organizational capacities. Of course, limited human capacities add to this picture in reality, but this strengthens the argument.

Two factors in particular will be considered here in relation to managerial limits: the nature of R&D and technological change and the role of a heterogeneous elite.

Williamson argues that technology is important only in so far as it affects transactions. The universal nature of transactions gives strength to his argument, but at the same time attention is drawn from the role of technology and R&D. It will be argued that the nature of technology and R&D as well as the nature of a heterogeneous elite involved in the carrying out of innovations are major sources of uncertainty and imbalances in a system of transactional relations.

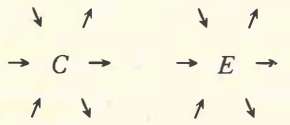
That uncertainty is involved in R&D and technological change hardly needs to be pointed out. In an important way, however, R&D does not reduce but increases the uncertainty. For one thing, it raises the awareness of new and previously inconceivable problems, but technological change also creates uncertainty with respect to other effects on a market (such as side-effects or new demands derived from technological change). It may be noted that basic human needs have remained rather unchanged, while market demands have shifted. It is also questionable whether satisfaction of some human needs have been raised on the whole due to technological change. For example, it could be argued that military technology contributes to the satisfaction of a human need of security, but military R&D may hardly be said to have had this effect globally. That human behaviour is a source of uncertainty also hardly needs to be pointed out. Limitations in disclosure of motives and plans, limitations in organizational transmittance of information and segmentation of communication networks through the formation of subcultures and elites also increase the uncertainty derivable from human behaviour.

Corporations, large and small, collectively account for a large number of technological developments. These developments often move rather continuously and contemporaneously where technological knowledge is concerned, while this pattern is somewhat disrupted where materialized technology is concerned. Technology, moreover, has the intrinsic feature of what will be called here latent economies and dis-economies. First, there is the economy associated with repeated utilization of technological information. In contrast to other productive resources, a piece of information is not being consumed or worn out when it is used. Technological information, therefore, has a non-depletable economic potential. (This does not mean that a piece of information cannot lose its value in a particular situation.)

The other kind of latent economy associated with technology is due to the causality structure of technological developments. If there were single causality chains such as

$$\rightarrow C \rightarrow E \rightarrow$$

each technological advance should have a closed and well-defined economic potential calculable from its single particular effect. However, technology, in general, displays complex causality patterns involving combinations and multiple effects such as the structure below




If $E$ is a desired effect (for example, local anaesthesia or food preservation) achieved by $C$ (for example, a particular pharmaceutical or microwaves), then $C$ and $E$ also tend to give other effects as well. These other effects (side-effects and spin-off but not secondary effects in the normal sense) yield an economic potential (or potential difference more strictly expressed) either by creating possibilities for new advances and applications or by creating a need for new technology. When considering technological development over time rather than considering a set of isolated technological advances, there is a complex push-pull pattern leading to a particular state of technology. In this state of technology there is thus a potential of non-realized fulfillments or applications of technology. Economy is connected to this causality pattern in such a way that economic transactions are carried out for a limited set of steps in the causality pattern. This means that the size of payments related to technological innovations are not adjusted indefinitely according to new side-effects or applications. (Theoretically, such an adjustment would be indeterminable and, in fact, negotiating work would rapidly grow.) Thus, there is a fundamental source of imbalance in the way the economic system is connected to the structure of technological development.

The values, perceptions and behaviour of leading actors have been focused on in several of the empirical chapters. Two main impressions stand out. One is that technological advances and their exploitation are undertaken by an elite, the other is that this elite is heterogeneous. The skew distribution of intellectual output among individuals is well documented as are skew distributions of such things as managerial talent, power and capital. The heterogeneity of the elites, both within and among the corporations, is also conspicuous considering the formation of subcultures and the prevalence of conflicts. Thus, there is a second fundamental source of imbalance, this time of an empirical social nature.

Thus, the point may be made that R&D, technological change and a heterogeneous elite are disruptive to organizational integration and limiting its use. It is conceivable to think of fragmentation of large organizations when certain managerial limits to size and complexity are approached. In a sense then, limits are imposed on the level of interaction needed to achieve a certain degree of organizational integration. In fact, one may hypothesize a certain constancy of the average level of interaction times the size of the organization. The adoption of the M structure is a case in point here. It should also be noted that interaction is a wider concept than transaction. This leads to the next section on the Williamson hypothesis, namely its possible qualifications in the light of what has been said above and support from empirical findings in this study.

*12.4.3.3 Further qualifications and the rise of quasi-integrated forms*

The inclusion of considerations about R&D and innovation in an analysis along the lines of Williamson (1975) qualifies in several respects the hypothesis that management and an internal organization are superior to a market organization. However, there is also supporting evidence for the hypothesis from these considerations. As treated by Phillips (1980), bounded rationality applies particularly strongly to R&D and innovation, as do uncertainties about input/output-measures and information impactedness through increased differentiation in education and experience. In Phillips' view, problems with high transaction costs, appropriability and range of implementation, due to the nature of R&D and technological change are more efficiently coped with through integration than through markets. Thus, integration is seen to give advantages with respect to communication and favour responses to threats and opportunities.

On the other hand, Phillips clearly points out that integration does not solve all problems. Appropriability problems still remain, as do problems about the interactions between different technologies and their applications. Organizational persistence will arise, as well as a bias towards minor innovations, and there will be limits on adaptive responses. In addition, differentiation within R&D units, that is $R'$-$R''''$ in Phillips' terms, will increase information impactedness internally. The latter argument does not, however, necessarily imply that vertical integration of $R'$-$R''''$ is becoming inferior to a corresponding market organization. To the extent that professional specialization increases (for example, because of technological change), information impactedness problems will generally increase, but possibly less so for an internal organization. On the other hand, it should be noted that certain limits to vertical integration (see Table 12.6) have led Williamson to suggest the systems solution that early stage development is

Table 12.7 Summary of indications found in the present study of quasi-integrated forms of organization with respect to R&D and innovation

| Type/area of indication | Chapter(s) |
|---|---|
| Internal R&D competition | 3,10,11 |
| External R&D cooperation (various forms) | 3,5,8,11 |
| Temporalistic/pluralistic structures | 3,4,8 |
| Decentralized divisions with weak centralized strategic control | 5,8 |
| Formation of inter-organizational decision making complexes | 6,9 |
| Reliance upon innovation takeover | 3,5,8 |
| Collective R&D in certain technologies | 3,8 |
| Semi-autonomous innovation companies | 8 |
| Scientific advisory boards | 8 |
| Inter-organizational structures of corporate boards | 7,8 |
| Links to the environment through subcultures | 9 |

carried out by small companies and then transferred to large ones, in spite of some market impediments to transfer.

When findings from this study are taken into account, there is some evidence that an internal organization may be superior to a market organization with respect to R&D and innovation (see Table 12.4). On the other hand, there are also extensive indications of organization and management failures and limits with respect to R&D and innovation (see Table 12.5).

It is not possible to make an overall assessment on the basis of these findings. Besides, such an assessment in terms of an internal organization versus a market organization, as two distinct alternatives, would by-pass possible intermediate organizational forms. In fact, it is not difficult to conceive of such forms theoretically, internal organization being multidimensionally integrated to a matter of degrees. Empirical instances of what would then be called quasi-integrated forms of organization are collected in Table 12.7.

Now some questions naturally arise:

- Are there common factors underlying the different kinds of indications and empirical observations?
- Do optimally quasi-integrated forms exist in some sense?
- Are there any observable trends towards some kind of quasi-integrated forms?

At this stage the empirical and explorative nature of the study does not seem to permit anything more than a few guidelines for further observation and hypothesizing.

First, the characteristics of different stages of an innovative process, together with transfer characteristics, may determine the proper form of integration as already mentioned in connection with Williamson's proposal for a systems solution. However, there are several conceivable variants of such a solution. Small innovative firms may be taken over by large firms, and there are examples of large firms that have this kind of acquisitions as part of their business ideas. Small firms may also be spun off from larger ones as new business development units or

exist as a permanent semi-autonomous innovation company for the purpose of acquisition and early stage development of internal and/or external ideas for transfer or divestment in some form at a later stage. Although its operations are usually more narrowly defined, a central R&D laboratory could also function in this way. Another variant would be an industry-wide co-operative R&D laboratory. What determines the proper form of these variants of specialization by stages is difficult to say. For example, they vary regarding the extent to which the transfer of people takes place in connection with the transfer of results. Moreover, a transfer may involve a mixture of management and technology. One may also note that small management consultancy firms seldom are taken over by large industrial firms and that the latter seldom spin off the former type of firms, although it could be argued that instances of this are increasing.

Second, the characteristics or specific nature of different technologies may determine the proper form of integration. For example, rapid advances combining different technologies put a strain on integration, while engineering improvements in a stable set of parameters (or natural trajectories in the language of Nelson and Winter, 1977) may build up a potential for integration in a producer–user interface. It may be noted that the empirical findings in the present study show neither a significant correlation between R&D intensity and a certain form of outer R&D organization, nor a significant correlation between R&D intensity and an employed variety of organizational forms. Although the sample is small a variety of forms of outer R&D organizations within the same sectors of industry may also be observed. This, in fact, is in contrast to the intersectoral adoption of the M form.

By viewing management in parallel with technology, the specific nature of different management areas could be taken into account as well. The separability of managerial functions may be low, and one may ask why there exists general management in technologically specialized industries when the reverse situation is hardly to be found. On the other hand, managerial functions such as budgeting, planning and legislation may be carried out on a higher level of aggregation. In comparison with technological development, managerial development has so far not been characterized, measured and subjected to forecasting or assessment similar to technological forecasting or assessment.

There is an important interplay between managerial and technological innovations. (Take, for example, the computer or the principle of division of labour.) There is also an important interplay between the growth of managerial and technological knowledge and its manifestations as artefacts. (Managerial artefacts would include, for example, formal organizations, contracts and adopted policies or laws.) There are effects from learning by doing both regarding technological innovations (see Sahal, 1980) and managerial innovations. (See Section 12.3.1 for examples of managerial innovations that have originated in practice and in large firms, rather than from managerial research.) It is thus conceivable that experimentation and innovation lead to incremental adoption of quasi-integrated forms, the efficiency of which will change over time depending upon the state of management and technology. For example, contractual forms may be an area of future managerial innovations which could signify important changes in organizational forms.

Third, the concept of strategy might be complementary to transactional considerations in judging the rise of different organizational forms. For a concept of strategy to be valuable in this respect, it ought to include an element of preconceived behaviour, although admittedly at the expense of analytical as well as empirical tractability. Strategy formation relates to managerial behaviour, which does not have to be guided invariably by transactional calculations determining structure any more than it has to be guided invariably by profit maximization. The impact of cultures and values on structure is also important to consider—for example, with regard to the use of co-operative or competitive strategies.

Fourth, it is important to take randomness specifically into account. In fact, it is remarkable how much could be explained by models of random processes (see, for example, Price, 1963; Steindl, 1965; Williamson, 1975; Sahal, 1978). Stochastic models of technological developments, the development of firms and the development of structure may be used. Thus, it is conceiveable that a stochastic graph model of relations, whose degrees of integration are governed by, say, a Markov process, could be designed to describe and explain (in the language of the model) the appearance of quasi-integrated forms.

In summary, the presence of quasi-integrated forms in between pure forms of internal organization and market organization may be interpreted in different ways. Assuming a degree of managerial rationality influencing the emergence of quasi-integrated forms, their presence could be interpreted as an intermediate stage in a progression from one pure form to another. However, they could also be seen as resulting from managerial experimentation with organizational forms as well as resulting from technological innovation or from random processes.

Here an empirically based regression argument will be forwarded to indicate that quasi-integrated forms are responses to inadequacies of internal organization as well as market organization. The adoption of the M form in itself could be seen as a regression from an internal organization to a quasi-integrated form to the extent that decentralization is achieved and centralized strategic planning is diminished. Similarly, there are other cases such as the reliance upon innovation take-over and the creation of semi-autonomous innovation companies, which could be interpreted as regressions from organizational forms with a higher degree of integration. Reasons for such regressions are found in difficulties experienced in managing R&D and innovation in large, highly integrated organizations.

Whether there is a general tendency to employ quasi-integrated forms to an increasing extent is difficult to say (see Osers, 1972, for indications in socialist countries regarding R&D). Essentially, both managerial and technological innovations could promote such a tendency as well as its countertendency.

In addition, bounded rationality and opportunism in the choice of organizational form, which—when it comes to internal structure is a choice fairly open to management—will induce managerial experimentation with a variety of organizational forms. (It should be noted that managerial opportunism—that is, self-interest seeking, possibly with guile—is an extra factor, which in addition to bounded rationality, contributes to re-organization.) Certainly, evidence of the limitations to innovation set by large corporations is accumulating as is the evidence of limitations on market organizations that promote technological in-

novations that contribute to welfare. Thus, it might be hypothesized, albeit on speculative grounds, that organizational forms of extreme purity of the market or the internal organization type will decrease. The range of employed intermediate forms will, however, remain in a flux due to uncertainty, bounded rationality, opportunism and innovations.

In summary the entire study has explored various aspects of R&D and innovation in large corporations. These aspects refer to corporate histories, strategies, structures and behaviour. The findings have been synthesized and related on a higher level of aggregation to the hypothesis that organizational integration in a firm is superior to a market organization. This is described as the pure form of the Williamson hypothesis, since a leading work on this theme was published by Williamson in 1975. The findings which emerge from this study with respect to the hypothesis treated by Williamson are then:

(a) The inclusion of considerations about the organization of R&D in the context of a firm and a market qualifies the Williamson hypothesis as follows: there are intermediate quasi-integrated forms, and these are the most conducive to technological innovation.
(b) Experimentation with organizational forms, due to uncertainty, bounded rationality, opportunism and managerial innovation will create an ever-changing state of organization, which makes an arrival at stable, optimally quasi-integrated forms unlikely.

In addition, one may hypothesize (although on weak grounds) that:

- The quasi-integrated forms that are the most conducive to technological innovation are dependent upon the specific nature of different technologies and, moreover, change over time due to technological and managerial innovation.
- There is a movement towards employing quasi-integrated forms of organization, and convergence from market structures and totally integrated structures to quasi-integrated structures takes place in the sense that variety at the extremes is reduced. This movement is due to market and organization failures and is enforced by managerial and technological innovation.

## 12.5 MANAGERIAL IMPLICATIONS

The purpose of this study has been to provide insight into the varieties and subtleties surrounding innovation and to provide a sense of the contingencies involved in managing innovation and theoretizing about innovation. Managerial implications have been formulated in different chapters. These implications must be weakly formulated and interpreted with much caution. However, for the sake of clarity some of the normative findings of this study will be outlined below. They include the following:

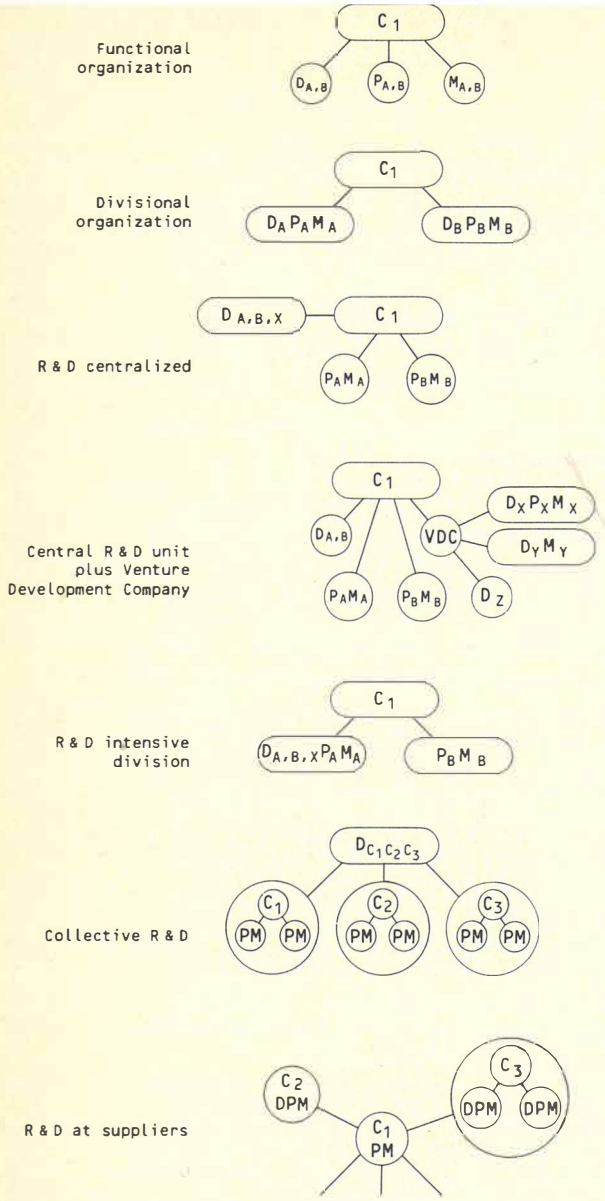
(a) Internationalize through R&D-based specialization.
(b) Do not centralize all R&D for technology transfer to product divisions.
(c) Profit centres for R&D and innovation should be noted as dangerous.
(d) Embryonic radical innovations should be separated into innovation companies, venture development companies, and the like. Premature transfer of technology should be avoided.
(e) Internal R&D competition as well as external R&D cooperation may favour technological innnovation.
(f) Integrate R&D into corporate strategies through interaction in the strategy formulation process.
(g) Perform collective or co-operative R&D in certain technologies.
(h) Vertical integration does not necessarily favour technological innovation in the long run.
(i) Integration of R&D and marketing is important.
(j) Apply pluralistic and temporalistic forms for the outer R&D organization.

The last point deserves to be elaborated upon.

### 12.5.1 A pluralistic R&D organization

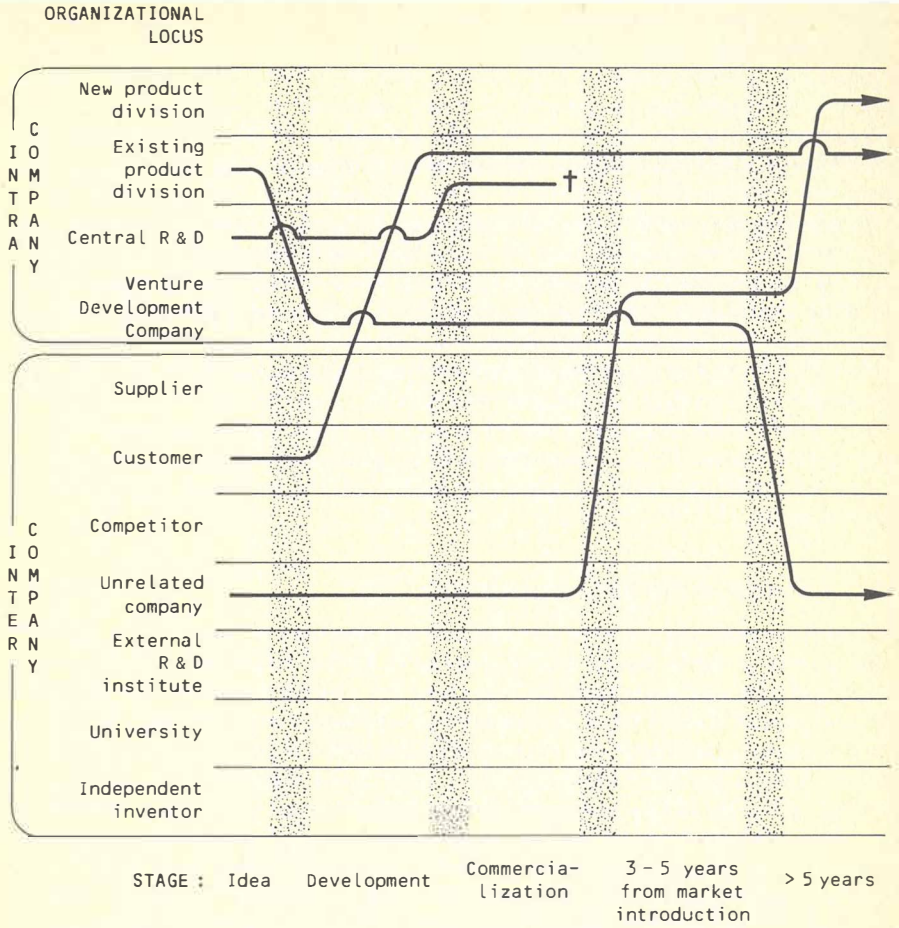
Figure 12.1 depicts different possible organizational structures and Figure 12.2 shows different possible processes in innovation. What could possibly be said in a normative way about the best organization of R&D and innovation in a corporation in the light of the variety of solutions available and employed? Under what circumstances should one rely upon suppliers, co-operate externally, have an innovation company, centralize R&D, etc.? Internal and external uncertainty cannot be sufficiently reduced to advocate a certain choice between different solutions. Another approach is then to allow for multiple solutions, or what will here be called a pluralistic R&D organization. This approach is analogous to portfolio (or diversified) solutions in uncertain investment situations, as reported by Markowitz (1952) and others. A pluralistic R&D organization would then mean using mixed solutions such as having a satellite organization, performing co-operative R&D, having one or more innovation companies, having central as well as divisional and regional R&D, having multiple channels of communication, having dual ladders of promotion etc. The multitude of uncertain sources of, and barriers to, innovation speak in favour of such a pluralism, and so do general arguments about diversified solutions as a response to uncertainty. The effects of a poorly functioning R&D organization do not show up immediately, and the risks in relying upon one particular form of R&D organization, carried to the extreme, have also been described in Chapter 8.

Organizational features such as diffuse and/or multiple rather than single clear goals, fuzzy rather than sharp divisions of responsibilities, and loose rather than rigid structuring of work sometimes are advocated for R&D organizations. Although such features may be instrumental in certain situations, they may or may not be present in a pluralistic R&D organization and certainly do not characterize it. It is a question of having overlapping rather than unclear responsibilities and goals. If, for instance, a marketing department has the responsibility for doing market research in product R&D, it is quite feasible that the R&D department has a responsibility to make sure that the work is done in case the marketing department does not fulfill its responsibility. The overlapping respon-




*Notation:*
$C_1$, $C_2$ . . . denote companies. A, B denote existing product areas and X, Y, Z new product areas. Functions are D for R&D, P for production, M for marketing.

**Figure 12.1** Organizational structures for R&D and innovation




*Note:* Simplified venture paths are shown. Multiple sources and paths are common in practice. Vertical movements denote a transfer, eg through licensing or acquisition.

**Figure 12.2** Innovation and business development paths

sibilities do not, however, have to be vaguely outlined but may very well be clearly defined in terms of primary and secondary responsibilities, the secondary ones being in effect when the primary ones are not fulfilled.

One may argue against a pluralistic organization for at least two reasons:

(a) that such an organization would be too costly; and
(b) that it would create conflicts.

That a pluralistic organization is not suited to take certain advantages of scale is natural. Although there are scale advantages in certain types of R&D, regarding equipment, communication and personnel, they are often diffuse and may vanish when a threshold size is passed. It could therefore be argued that a large organization would be less sensitive to the advantages of scale than a small one, other things being equal and thus could better afford a pluralistic R&D organization.

Regarding the creation of conflicts through a pluralistic R&D organization, it is likely that role conflicts, territorial conflicts and internal competition will develop in a pluralistic structure. On the other hand, conflicts are prevalent in innovative work, and some of them are fruitful. Conflicts tend to have negative effects when they become personified, but not necessarily when they are issue oriented. It is, in fact, conceivable that institutionalized pluralism would weaken the tendency of conflicts to become personified. Nevertheless, internal competition in R&D is seldom fully exploited as a means of increasing innovativeness in large corporations. Thus, a pluralistic R&D organization places requirements on corporate R&D management, regarding both effects of scale and synergy and effects of conflicts.

### 12.5.2 Temporalistic R&D organization

When the organizational structure is discussed, the time dimension is sometimes collapsed in a static model and disregarded in the sense that a sequence of employed structures over time and the processes which take place in the structure are not primarily considered. It is conceivable to have a succession of solutions—for instance, to let a period of decentralization follow a period of centralization, rather than to seek a compromise as a permanent solution. The question of whether R&D should be integrated mainly with external science and technology or mainly with marketing could be resolved in this temporalistic manner. Admittedly, this is somewhat speculative but little attention has been paid to the possibilities of what may be called temporalism in organizing for innovation. It is not primarily a matter of adapting the organization to environmental changes or working with temporary assignments. Rather, it is a matter of creating long-term 'swings' in the organization, which may create positive effects from the change in itself and provide for a kind of dynamic compromise along conflicting dimensions such as degree of integration and degree of decentralization. It is true that continual reorganizations have negative effects and that innovative work requires a certain social order as Merton (1957) expresses it. But this speaks in favour of carrying out major reorganizations with long intervals of organizational stability in between. Besides, changes in the outer R&D organization may affect the social order to a lesser degree than changes in the inner R&D organization. There may certainly be a tendency to overestimate the positive effects of a change in itself, possibly leading to irresponsible reorganizing. On the other hand, an R&D organization is indeed ageing or ossifying. On the whole, an increased circulation and mobility of people involved in R&D are desirable in many large corporations in order to transfer know how and experience as well as stimulate the generation of ideas. This does not, [illegible] changes, nor does it have to be accomplished through structural changes.

### 12.5.3 A final comment

Knowledge about managing R&D and innovation has increased considerably during recent decades. It has largely been true that management theory has been lagging behind management practice, at least the best practice. It is also true that research in management seldom is a source of radical managerial innovations. Systematic, scientifically oriented empirical studies appear to be able to contribute more to the gradual improvements in management. By analogy with the increasing role of science in technological innovation, one may hypothesize an increasing role of management science (in a broad sense) in managerial innovation in the future.