

Chapter 13 CONCLUSIONS

13.1 CONCLUSIONS REGARDING R&D AND INNOVATION IN LARGE CORPORATIONS

The presentation in this book has been structured in a way similar to the multidivisional organizational structure, and conclusions have been formulated in each empirical chapter. The major conclusions will be recapitulated here.

In general, large corporations have arisen from a variety of combinations of productive factors and local conditions. According to the dominant element in the original business idea, two slightly overlapping groups of corporations could be discerned—raw-material based ones and product-invention based ones. However, the roles of technology at the time of the establishment of the corporation were many and varied among the different corporations regarding product versus process technology, radical versus incremental technological change, and domestic versus foreign technology. Renowned 'classical' product innovations were significant product improvements rather than radically new products. They came into being through the strenuous work of a small inventive and entrepreneurial elite in a context of contemporary technological and industrial development rather than through flashes of genius in radically new areas. The inventors were often well educated and internationally oriented, both regarding markets and science and technology. There were several links to science in early corporate development, the strongest link being to scientific modes of operation rather than to scientific results. A sweeping generalization would be that Swedish technology in its infant stages had close links to industrial management as well as to foreign technology rather than to science.

The rise of large corporations based on product inventions resulted to a large extent from managerial achievements, especially in international marketing, in which direct foreign investment was an early strategy. Integration of inventive and entrepreneurial skills took place on an individual level in a few cases but mostly on a team level. Features of the significant actors, such as a multiproblem orientation and an international orientation, corresponded to some extent to diversification and internationalization in early corporate development. However, different patterns of corporate development could not be aggregated into a general progression of stages. Corporations based on product inventions initially developed around a single product or product line and then rapidly internationalized, while corporations initially based on raw materials or foreign technology rapidly diversified into at least two different product lines. The level of technology does not discriminate between these patterns but rather the size of input and output markets, the distinction between product and process technology, and proprietary conditions pertaining to technology and raw materials. A lead in product technology in combination with a small domestic market, internationally

oriented entrepreneurship, internationalization, while national sources of raw materials and advanced process technology have been associated with domestication, although the export intensity has generally been high.

There has been a great deal of continuity in corporate development as regards diversification on both sector and product area levels. Recently, diversification has been de-emphasized in several corporations, and there is also a definite trend towards increased internationalization. Late internationalizers have a preference for acquisitions and joint ventures. In general, diversification has been accomplished by the corporations through a mixture of strategies ranging from acquisitions of companies and/or technology to internal R&D over intermediate forms with external cooperation.

As the corporations grow, diversify and internationalize, their R&D operations grow, diversify and internationalize in a give-and-take relationship. There has been an important kind of 'grass-roots R&D', the results of which are not as easily recognized and assessed as indisputable innovations. The connections between R&D and corporate growth consist of both a long, increasing and technology-dependent time lag between R&D and sales and a contemporary coupling through budgeting. The time lag between R&D work and a significant degree of diversification is still longer in a large corporation. Contradictory cases of diversification based on innovations originating internally as well as externally suggest a concept of organizational permeability, pertaining both to the susceptibility of an organization to external ideas and impulses and to the elasticity of an organization in the event that internal ideas and impulses lead to product areas outside the present ones.

In the corporations studied, ratios of R&D to sales in 1975 were positively correlated with internationalization (0.48) and size of sales (0.42) while negatively correlated with diversification (-0.28) as approximated quantitatively. Corporate strategies emphasize growth, internationalization and R&D, while diversification is de-emphasized in half of the corporations. The highly internationalized product-invention-based corporations have entered a stage of multinational co-ordination, which reinforces a strong coupling between R&D, size and multinationality.

Corporations also internationalize their R&D, although there has been a tendency to domesticate the 'R' part. Initial internationalization of R&D was, in general, not part of a corporate strategy but often resulted from acquisitions and local ambitions. There is a current trend towards a break-up of traditional patterns of internationalization and increased emphasis on technological and managerial knowledge. More pluralistic and temporary forms of organizing and managing R&D are being employed, and internal R&D is acquiring additional roles of creating access to, and capabilities for, utilization of external R&D. Models of orderly patterns of internationalization, innovation and diffusion are of limited relevance and apparently increasingly so. The supply versus demand oriented theories behind the growth of technology appear in the context of a corporation to be reconcilable in a dynamic pull-push pattern when seen over an extended period of time. A process of 'first pull, then push' was found in several cases, which means that a period in which a technology is developed as a response

to an originally perceived demand is followed by a period in which the areas of application for the developed products and knowledge are extended beyond the demand initially aimed at.

Differences in emphasis of corporate policies on profit, growth, diversification, internationalization and R&D were found—especially with respect to diversification and R&D, both over time and among the corporations. There is a complex inter-relatedness between matters and people in policy making, which is far from the picture of a stable consensus about a specific hierarchical means-end structure. Evolutionary expansion of corporate technologies into adjacent areas, considered as 'naturally' connected to existing ones, was commonly emphasized. To varying extents, policies confirmed historical corporate development, and to varying extents they resulted from action and reaction at different levels in the corporations. A combination of policy-evasive behaviour at the top management level and policy-seeking behaviour at lower organizational levels was found in several cases regarding R&D and innovation. Four reasons for policy-evasive behaviour were indicated, namely attitude towards specificity of control through policies, stage of maturation in a policy matter, attitude towards especially political risks, and selective and sequential management attention. A general conclusion is that a need exists for a closer coupling between corporate and R&D policies through interaction in the policy-making process and consideration of patterns of technological development and sources of innovation.

Also R&D and corporate strategy were loosely coupled by means of strategic decisions made with respect to R&D. A strategic decision was by definition determined by the size of a concentrated decision-making effort as well as by the size of the effect of a decision. However, due to an increased interdependence in decision making, there was a limited applicability of the subdivision of decisions by three—into strategic, tactical, and operative decisions, based on notions of importance. To design a decision-making process by interspersing concentrated decision-making efforts in the series of decisions (here called 'strategizing') appears to be important in embryonic stages of R&D and innovation as well as in late stages. Diffuse alternatives, lack of deadlines and underestimation of cost/benefit ratios of R&D in combination with rising profitability of costs of completion are among features in R&D decision making, which tend to yield incrementalism and omissions in the decision-making process.

Corporate boards play virtually no direct role in R&D, and the room left for top management to exercise influence on R&D is on an average utilized to a low degree. Top managers differed regarding their behavioural, financial and technological orientations. Rather than have a general manager, who may be good at many things but not very good at anything, different orientations in top management could be balanced through the composition of teams and—as a long-term complementary alternative—through a balanced succession of managers with different orientations.

The working role of R&D managers above the project level fell in the following categories with approximate frequencies. Management of R&D personnel (41 per cent); management of ideas, information, and projects (30 per cent); management of critical relations (15 per cent); Fayol managerial roles (13 per

cent). Roles in the Fayol typology are difficult to separate, but in particular they do not emphasize crucial roles in R&D management, such as the handling of conflicts or deviant behaviour.

The R&D managers did not emphasize the entrepreneurial role, although some of their roles in managing critical relations may be interpreted as having entrepreneurial elements. It is hypothesized here that fear of failure is a barrier to entrepreneurship in large corporations. A climate more benevolent to failure could stimulate corporate entrepreneurship, but at what level is an open question. In general, the problem of managing R&D could to a larger extent be approached with the same philosophy of experimentation that has found application in R&D itself.

The late, but rapid adoption of a divisionalized structure in this sample of corporations was not a consequence of an adopted strategy in the preconceived behaviour sense. Rather, rapid changes in size and diversity of operations paved the way for adopting a newly recognized organizational concept, the diffusion of which was aided by external organizational consultants.

Major structural variations in the outer R&D organization appear to depend especially on the interpretation and implementation of general organizational ideas by top management in addition to manning considerations. R&D intensity was found to correlate significantly neither with a particular structure nor with a diversity of employed organizational means for conducting innovative work.

Some of the organizational ideas in divisionalization are hazardous to R&D when carried to an extreme. The uncertainty associated with sources of, and barriers to, innovation suggests the use of mixed organizational solutions in the form of pluralistic and temporalistic R&D organizations.

Similarly, the idea of top management resorting to strategic considerations (while excluding themselves from operations) is hazardous. 'Diving' in the organization was, however, practised by some corporate managing directors as an information-seeking exercise as well as to motivate behaviour.

With respect to R&D and innovation top management was evasive regarding strategy but active regarding structure and manning. Technical and R&D managers played a minor role in divisionalization. This reorganization into product divisions rearranged interdependencies and relegated the conflict potential arising from sequential dependence of functional managers to lower organizational levels at the expense of a conflict potential arising from a pooled dependence of divisions and tensions between corporate and divisional perspectives.

There was a high frequency of conflicts of various kinds in connection with R&D and innovation. In general, explanations given referred to the characteristics of large corporations, characteristics of R&D and innovation and characteristics of people involved in this kind of work. Typically, significant conflict relations were relations among significant actors, relations associated with a traditional part of the corporation, functional relations, relations between central and local authorities and relations among professionals. While a number of tensions surrounding R&D are natural and may be beneficial to some extent, personal conflicts among significant actors generally have severe effects. The ubiquity, complexity, dynamics and mixed effects of conflicts suggest that conflicts in

connection with innovation in large corporations cannot be resolved but at most regulated, and to some extent they are desirable.

Conflicts among professionals were often associated with the formation and change of subcultures. The tensions between a business culture and a science and technology culture were apparent in many cases. However, the culture associated with science and technology is heterogeneous, and the formation of professional subcultures is strongly connected with the structure of graduate education. The subcultures also tend to produce intermittent re-orientations in corporations and sectors of industry.

A subculture may constitute a means of co-ordination as well as a barrier to change. Through a period of conflicts and disordered co-existence, a state of a dominant culture in a corporation may be transformed into one of the following:

- (a) a state of amalgamation of cultures;
- (b) a state of dominance of a new culture;
- (c) regression to the old culture; and
- (d) a state of ordered cultural coexistence.

Several factors account for the transformation of different cultures in a corporation. The role of top management as a kind of cultural entrepreneur is important, although cultural change cannot be managed at will. Instruments are, among other things, corporate strategy, recruitment and promotion. A general conclusion is that treating technological change as an autonomous or exogenous variable in relation to cultural change is incorrect.

A diversity of sources of and barriers to both radical and incremental innovation were found both internally and externally. Sources of ideas among people were generally skewly distributed. Moreover, top management, as well as higher R&D management, was more selective than generative. Among a wide variety of perceived barriers to innovation, the most frequently indicated ones were related to management and organizational and human attributes rather than to, for example, the resource situation or the business environment. This emphasizes behavioural skills as an additional dimension of entrepreneurship in large corporations. Internal competition among individuals on both operative and managerial levels appears as a barrier in innovative work, while internal competition on a project or R&D unit level as well as external co-operation appears to have a positive effect on the rate of innovation. A general conclusion would be that the age and ageing of organizations rather than the size of an organization, create barriers to innovation—size being primarily a matter of a chosen form of management and organization.

13.2 CONCLUSIONS REGARDING TECHNOLOGY, MANAGEMENT AND MARKETS

The synthesizing discussion in Chapter 12 has proceeded along two inter-related themes:

- (a) technology and management;
- (b) management and markets.

economic change, so far the management factor has not. Lack of empirical insight and lack of analytical tractability appear to disfavour the recognition of the management factor. Neo-classical economic theory disregards, in particular, a skew distribution of managerial talent, a skewness possibly contributed to by managerial innovations and their varying rates of diffusion.

Viewing the state and change of technological and managerial knowledge in parallel produces a set of analytical questions, which highlight the possible interdependencies. Managerial innovations, such as scientific management, multidivisional structure and linear programming, show similarities to technological innovations regarding patterns of innovation and diffusion. Among dissimilarities we may mention the impossibility of patenting managerial innovations, which makes such innovations comparable to unpatentable but diffusible process innovations.

To the extent that both technology and management matter in economic development, a case could be made that the management of R&D and technological innovation in particular ought to matter. Examples of managerial innovations in these areas can be found, although they are not frequently conspicuous, possibly due to the intangible nature and degree of professionalization of management of R&D and innovation. Concerning the relative importance of technological and managerial knowledge and skills in corporate development, the empirical findings call for an up-grading of managerial achievements relative to technological ones. At the same time several failures and limitations of management of R&D and innovation were indicated. The presence of multinational corporations rather than national conglomerates, and the connections between R&D and internationalization rather than between R&D and diversification, show that technology differentials rather than regional market differentials limit the economizing of managerial capacity. A general conclusion would be that the management factor deserves increased recognition, empirically as well as analytically, relative to the technology factor.

By taking R&D and innovation into account, two kinds of qualifications of the hypothesis that internal organization is superior to a market organization result. Aspects of R&D and innovation modify the arguments pertaining to superiority in general, but also the general arguments behind a claimed superiority apply to a modified extent to superiority with respect to innovativeness, in particular. The present study partially supports Williamson's hypothesis in several respects, such as the realization of transactional economies through inter-individual joining of inventive and entrepreneurial skills, the rise of hierarchies—their imperfections at the top notwithstanding—internalizing of R&D, comparative advantages of a range of managerial functions relative to market functions, and the rise of product-invention-based multinational corporations. To a limited extent diversification may be explained by transactional considerations since managerial efficiency may have been sacrificed for managerial security in spreading business risks among different product areas, which is not necessarily efficiency inducing in overall respects.

The present study also offers indications of management failures and limitations regarding R&D and innovation, such as failures in radical diversification,

incremental R&D decision making, commits and barriers to innovation in large corporations. Limitations derive from human and organizational attributes as well as from the recombinant and non-consumable nature of technology, yielding latent economies to be realized. The heterogeneity of an inventive and managerial elite, moreover, implies limitations of internal organization relative to a market organization.

Empirical as well as analytical evidence indicates the emergence of quasi-integrated forms in connection with R&D and innovation, such as external R&D co-operation, reliance upon innovation takeover and semi-autonomous innovation companies. Regressions to organizational forms intermediate to internal organization and market organization indicate the existence of quasi-integrated forms, which are the most conducive to technological innovation. Experimentation with organizational forms and managerial as well as technological innovation will make an arrival at stable, optimally quasi-integrated forms unlikely.