Chapter 9
TECHNOLOGICAL CHANGE AND SUBCULTURES

9.1 INTRODUCTION

In this chapter some underlying patterns of the social context in which technological change takes place in a corporation will be analysed. It is possible to discern some significant social clusters or categories, as distinguished from significant actors and individuals in key positions. The observations will be presented in the framework of subcultures as identified among people engaged in science and technology and marketing in the corporations studied.

The vagueness of a concept and the use of a concept as a kind of residual explanation often go together and the concepts of 'culture' and 'technological change' are frequently used in this way.

Here the term 'culture' will be dealt with in its sociological meaning. In a standard textbook in social psychology, one reads the following definition of culture:

> The pattern of all those arrangements, materials or behavioral, which have been adopted by a society as the traditional ways of solving the problems of its members. Culture includes all the institutionalized ways and the implicit cultural beliefs, norms, values and premises which underline and govern conduct. (Krech *et al.* 1962, p. 380)

As to the 'subculture' concept, simply speaking a subculture is 'a culture within a culture'. It should be noted that the term subculture has some overtones of deviant behaviour and inferiority. These are not intended here. The word will be used in a strictly neutral sense, although it may involve 'deviant behaviour', a term which should also be interpreted in a neutral sense.

Increasing professionalization in industrial society not only accompanies an increasing fragmentation of knowledge and responsibilities, but also tends to create interprofessional barriers to communication and co-operation. A specialized occupational perspective in science and technology may, on one hand, contribute to technological development. On the other hand, 'disciplinarian imperialism' and competition among professions in colonizing areas of inquiry may arise. In particular, conflicts will arise from beliefs in the existence of an indisputable truth or from beliefs in the unification of science through reductionism.

It is natural that each profession characterizes its professional to some extent. However, differences in individual behaviour do not have to be strongly patterned according to different professions, and in some cases it may be exaggerated to talk about cultural differences between professions. Moreover, professions and individuals change and differences may be smoothed out. However, when differences of a cultural nature arise (i.e., differences in basic elements such as beliefs, norms and language) there is often little awareness and understanding of the causes and effects of such differences. Moreover, to use an anthropological

analogy, there does not seem to be any breed (or profession) of investigator who is able to 'travel' among subcultures in the contemporary industrial society, and who can thereby gain and diffuse cross-cultural understanding.

9.2 EMPIRICAL FINDINGS

9.2.1 Subcultures within science and technology

9.2.1.1 Pharmaceutical industry

Within the pharmaceutical industry there has been a transition from chemistry orientation to biology orientation during the last few decades. This transition means that recruitment patterns have changed in favour of biologists, pharmacists, pharmacologists and people from other medical sciences. It has also changed the status and power of chemists. To a large extent they used to be 'generators' in R&D, and their thinking and attitudes about the biological impact of chemical substances dominated in large parts of the pharmaceutical industry. Today, biological concepts and principles have 'taken over', while the chemists' role has been geared towards synthesis. The transition is also said to have brought new ethics and a value orientation to the pharmaceutical industry. The former engineering approach to, and traditional economic value judgement of, new pharmaceuticals have to some extent been superseded by the professional ethics and values among physicians, pharmacists and pharmacologists.

The pace and extent of this transition have not been homogeneous throughout the pharmaceutical industry. Some corporations, such as Astra, re-oriented early, while others still are 'chemistry-oriented'. A partial explanation of why different corporations are in different stages of transition may be that the corporations have had different roots in the chemical industry. Some of the large pharmaceutical corporations diversified on a chemical basis early. Others, like Astra, have been in the pharmaceutical industry throughout.

A second, apparently crucial, part of the explanation is the succession of corporate managing directors and their thinking and behaviour. To break the influence of an established professional subculture in a corporation seems to require sustained efforts from the corporate managing director in concordance with changes in the professional power structure and recruitment and promotion patterns. Historical evidence (not only from Astra) support this proposition. At Astra several factors were concurrent, and these can only be briefly accounted for here. Investigations in the 1950s pointed in favour of R&D and internationalization and the location of subsidiaries close to medical schools; communications with external medical expertise paved the way for a transition. The corporate managing director played a role in this stage as well as in later stages, when recruitments and other investments had to be made and the R&D along the new lines had to be protected from established professionals in the rest of Astra. People at Astra-Hässle (where a pharmacist was the R&D manager) were treated as non-professionals and parochialists for a long time. It is interesting to note that the corporate managing director did not influence the choice of R&D lines as long as they were consistent with the new overall orientation. (In fact, these lines

were rather randomly established. If the sequence of initial contacts, advice, minor successes and failures had been slightly different, probably Astra-Hässle would have been working along entirely different lines today.) One may add that the new professional subculture probably also was strengthened by the struggle against established professionals. Although 'the new professionals' received protection and support from the corporate managing director, this was of a non-professional nature, and they had to prove their case to 'the old professionals'.

A third factor in explaining the pace of a transition of this kind is the recruitment situation. In the case of Astra-Hässle, recruitment took place at a recently formed medical school, and it was therefore a new generation of academic researchers with which Astra-Hässle came in touch. They were not strongly influenced by the traditional values among academic medical researchers that research in industry is 'dirty'. In this respect the pharmaceutical industry, as well as many other sectors of industry, had to face the cultural values and beliefs of academic researchers, especially talented ones. Thus, there was both external and internal resistance, and the pace of transition was influenced by the way this resistance was managed. An inadequate supply of talented biologists was lowering the pace of Astra-Hässle. Routes of action employed by corporations in similar situations are to broaden the recruitment base to adjacent disciplines (such as chemistry in this case) or other countries (as with Philips), or alternatively to retrain internally. Thus, the connection to graduate education and university R&D is strong, not only in terms of supply but in terms of subcultural formations, which create barriers to transitions both inside and outside the industry.

In this case it is justified to talk about a transition from dominance of one professional subculture to dominance of another with respect to R&D and technology. Naturally, many internal and external factors of varying generality influence such a subcultural transition in a corporation or an industry. Furthermore, the transition is incomplete in a corporation, and the interpretations of what has happened and where one stands in the corporation in turn are affected by differences in thinking and perspective among people involved.

9.2.1.2 Raw-material based industries

Raw-material based industries constitute large and traditional parts of Swedish industry. Traditionally, at Boliden authority and status have surrounded people engaged in mining and production operations. Recruitment and promotion to leading management positions have favoured mining and production people. People engaged in chemistry related to the marketing side have experienced scepticism from other professionals. The securing of raw-material sources and plant capacity has been perceived as more crucial to business than marketing operations, integration forward and product or environmental R&D. Long-range planning and risk taking traditionally characterized mining people, but selective attention to sources of uncertainty has favoured the opening of mines and investments in new plants rather than new business ideas or concern about technological side effects. The mining and metallurgy professionals identify themselves with the corporation as a mining corporation and beliefs about what business they are in, what customer problems to solve, what parameters to judge product quality on, etc. are affected by their knowledge about mining and metallurgy. In the words of an interviewee, 'There has been an unwritten policy to stop at the pure metal.'

The metals in the ores of Boliden are chemically bound to sulphur. When new technological possibilities to utilize the sulphur content emerged, it took time before attention was paid to this development in influential circles and action initiated. An acquisition in the heavy chemicals and fertilizer industry came about in 1963. Recruitment and promotion to leading management positions have favoured mining and production people. However, the promotion of 'a mining man' to top manager of the acquired company was made partially with the intention that he should learn the chemical side and be able to 'lift it up' in balance with mining and metallurgy.

In this case a professional subculture has been connected to a segment of a refinement chain. Integration forward has required new professionals such as chemists and marketing people and the confrontation with several new subcultures. The main route to forward integration has been acquisition of companies. Thus, the company subculture in acquired companies also is involved in the transition.

9.2.1.3 Engineering industry

The engineering industry constitutes another large part of Swedish industry. Alfa-Laval provides several examples of subcultural change, although not drastic ones. In the 1960s the new corporate managing director changed recruitment and internal competence in favour of economists, administrators and marketing people. Alfa-Laval earlier had a high proportion of engineers, and clashes occurred between graduate engineers and economists, who—by the way—were and are educated in different types of universities. Perceptions of problem priorities ('what the company really needed', etc.) differed, and gaps in competence were mutually seen as causing mistakes and failures. Agreement could sometimes not be reached that failures actually were failures, at least not that they were 'failures in the long run'. Incidentally, this conflict superseded the social stratification between graduate engineers and technical college engineers. However, the subcultural change did not run as deep through the corporation as the one at Astra.

A simultaneous transition in Alfa-Laval from 'component thinking' to 'systems thinking' took place in the 1960s. On the level of post-rationalization such a transition may sound artificially related to subcultures in the corporation, but in fact, the connections are deep. Massive but selective attention was directed to concrete components such as separators, milking machines and heat exchangers. The traditional competence was centred around these components, and so was the stock of problems and the improvements that were called for. To introduce and base technological development on such abstract concepts as systems and functions took time, and 'systems thinking' diffused slowly and heterogeneously in the corporation. 'At a conference as late as 1966, it was discussed whether or not we sold components or systems'. Moreover, a higher degree of a systems nature in technological development and marketing involves more competence and professionals. Partly for this reason, partly because of trouble with products and pro-

cesses and partly because of general advancements in science and technology, new technologies became relevant for Alfa-Laval during the late 1960s. The mathematics in the corporation was modernized at the same time as computers came into use. Because of this a temporary conflict emerged between, on one hand, empiricists and established mathematicians in the corporation and, on the other hand, mathematicians with a background in operations research and computers. Furthermore, automation technology based on electronic rather than mechanical components rose in relevance to the corporation. Alfa-Laval was slow to embark upon this general line of technological development. The slow pace was due partly to the dominance of mechanical engineers, partly to conflicts. A turning point occurred when a foreign subsidiary 'jumped off the corporate line' and started to buy and develop independently. A re-orientation in the corporation followed, and a competence in electronics was built up. Conflicts between professionals remained, however, and different ways of solving problems in process control and automation persisted. As a response, an independent organizational unit for automation technology was created in 1974, but the new technology has had difficulties in gaining acceptance within older parts of Alfa-Laval.

Generally speaking, the transition from mechanical to electronic solutions for engineering problems is usually well documented. The pace and extent with which this transition has taken place, have largely affected the competitive position. Many factors have been involved in specific cases, but professional subcultures have played a large role. The frames of perception are different in mechanical and electronic engineering and they give rise to different ways of solving technical problems. As a matter of course, people also identify themselves with their solutions, emotions and conflicts are built up, managers involve themselves more and more, anxiety about changes in power based on competence arises, informal coalitions are formed, etc. The traditional influence and status of mechanical design engineers were not voluntarily abandoned or shared, partly since it was not in their own interests but partly also because these engineers did not think it was in the interest of anybody. The latter point is representative of a professional subculture. Its shared values do not just encompass the survival of the profession but also the value of the profession to others (the corporation, industry, society).

Regarding Alfa-Laval, more representative cases are provided. The products and strategy of the corporation have brought it in contact with various other disciplines within chemistry, biology and agriculture. Again, the pace of the use of such competences was slowed down by traditional problem-solving behaviour, although no clashes or deep-running transitions or conflicts occurred. As a traditional manufacturer of machines and components in various processes, including food processing, Alfa-Laval had experienced successes largely based on trial and error methods. When ambitions towards systems technology emerged at the same time as the complexity of customer processes increased, mechanical engineering and problem solving by trial and error became inadequate. Product trouble and customer complaints may aid in pointing out such inadequacies, but the usual response is then to apply or marginally expand the existing competence and to 'search locally' for solutions. A global search, if one is initiated, corresponds to the hiring of a new kind of professional. This has been done gradually by Alfa-Laval, but it still has to amalgamate new values, frames of perception and professional norms. The food and agriculture sector of industry provides a slight parallel to the pharmaceutical industry in this respect, in that veterinarians and agronomists are said to be in the position to bring in new values among engineers and economists, just as medically trained personnel did in the pharmaceutical industry.

9.2.1.4 Forestry

As can be seen from the above, there are several examples of how biologists have diffused into different sectors of industry. Iggesund provides another example. Within forestry there has been a period of dominance by mechanical engineers. The selective attention to certain advantages of scale and ignorance of some long-term biological side effects promoted the development of forestry machinery and methods that later on called for biological competence. Mechanical engineers could more easily demonstrate benefits of their way of conducting operations and gained management support. The 'success' of this demonstration hinged not only upon management preferences for short-term corporate economy but also on difficulties to perceive, assess and understand possible side effects of a biological nature. Biological 'thinking' had only penetrated the industry marginally except for certain specific tasks. Contributing factors to the slow pace in the change of frames of perception of managers and engineers were, moreover, the delay in biological effects and the continuous character of technological change: 'Continuous development is not so easily noted'.

Thus, problem solving by a familiar approach appears to involve an underestimation of risks. The opposite also seems to hold, that is problem solving by an unfamiliar approach involves an overestimation of risks. For example, one response by Iggesund to scarcity of timber was to transplant a fast-growing Canadian pine. Top management perceived the experimental procedure by which this type of tree was introduced as a strategic decision involving high risks, while biologists perceived the decision making as a sequence of 'ordinary' decisions.

9.2.1.5 Formation of generations

The formation of generations within a professional discipline should be contrasted with the formation of subcultures. As advances in science and technology proceed and environmental changes occur, professional thinking and behaviour are naturally changed. Sometimes these changes are accommodated within a discipline, sometimes a differentiation of disciplines occurs. A renewal process within a discipline is sometimes not only markedly wave-like but also connected to a new generation. For example, within electrical engineering there have been transitions from vacuum tubes to transistors, from electromechanics to electronics, and from analog to digital technology. Philips has experienced such transitions and difficulties with differences in fundamental thinking between older and younger engineers. Within KemaNobel four epochs of chemical R&D may be discerned. The fourth and present one concerns polymer technology, while earlier there were 'old carbide engineers'.

Transitions between generations take place at different paces and extents in in-

dustry just as in the case of transitions between disciplines. However, changes among professionals in the corporation due to—on the one hand—changes between professional disciplines, and—on the other hand—changes within them, differ in one respect. The latter 'within changes' constitute more of a true transition, while the 'between changes' generally mean just a transformation of the mixture of relationships. However, the conceptual boundaries determining 'within' and 'between' are vague, which is shown by the presence of many names for disciplines and professions.

A word of caution is appropriate here. Changes within a discipline or profession may be so gradual and may not involve value changes deep enough to justify the term 'subcultural change'. Moreover, a subcultural change does not by definition require that new people supersede old people, although such a change is also often involved. Finally, subcultural changes by generation shifts are to be distinguished from a new group of people who just have a cohesive pattern of thinking and behaviour.

9.2.2 Subcultures within marketing

First, one should note that marketing people are not to be identified as non-technical professionals. In fact, several corporations have a high density of technically trained people in their marketing departments. This situation may result from a perceived necessity to have it that way and deliberately strive for it, as for instance at Alfa-Laval and SKF, while in some industries and corporations it seems to result rather from an attitude that marketing may be handled by technologists as well.

Except for the general categories economists and engineers, subcultures among marketing people seem to be more weakly associated with the structure of professional education than was the case among science and technology people. One should note, however, that education in marketing is not so well developed as education within science and technology.

Thinking and behaviour among people involved in marketing are naturally influenced by the thinking and behaviour of customers as well as by the thinking and behaviour within their own corporation around the products sold. This influence from external communication does not seem to breed subcultures to the same extent as does the external communication of corporate science and technology professionals.

9.2.2.1 Producer and consumer markets

Concerning marketing on producer and consumer markets, several corporations, such as KemaNobel, Philips and Volvo, are working in both kinds of markets, often with very much the same basic technology. One crucial feature is the competence of customers as professional buyers. With competent customers it is possible to foster a technological development with the aid of mutual communications and similarities in language and value. Under such circumstances marketing people are used to reduce uncertainty and distribute risks in the seller–buyer interface by mutual communications in a professional language concerning values of technical and economic performance. In consumer markets, or rather in markets with non-professional buyers, marketing people tend to place emphasis on the perceptual, cognitive and emotional behaviour of the customer in the buying process rather than on assessment of improvements in customer economy.

Both types of marketing behaviour may be 'need oriented', but for the latter type greater attention is paid to 'irrational' needs and weaknesses in consumer behaviour. Moreover, customers—and sometimes competitors—in consumer markets are often numerous and unstructured. Many factors on this type of markets create thinking and behaviour about technological development and beliefs about consumer behaviour and needs that differ substantially from those of marketing in producer markets. This is reflected in different traditions in doing market research.

There have been many failures in diversifying into consumer markets without previous knowledge about that type of markets. Naturally, economic and other circumstances are important, but also past experience, beliefs, and attitudes, which sometimes prove to be markedly inadequate. Often too high a value is placed on advanced technology to solve customer problems, which is not compatible with customer preferences. Within the corporation one commonly explains it in terms of 'being ahead of time', 'immature markets', or plain stupidity of customers. It is, however, a question of how to compromise between, on one hand, the company's perception of customer problems and 'rational' ways to solve them and, on the other hand, the way customers perceive their situation. At Alfa-Laval 'profitability for the customer' as a basic aim has been questioned on these grounds. To sell barn equipment to farmers involves buyer competence and behaviour that is far from always aligned with customer economy and profitability. For some chemical products it is 'more a matter of selling the can than its content'. Cars, clothes and home appliances sell to a varying extent on appearance in combination with performance. For a science and technology professional with his training in analytic thinking, it is hard to understand customer concern about microwave ovens. 'There has been no proof' is a common statement concerning possible side effects outside the field of a professional. Curiously enough, one sometimes encounters a confusion among science and technology professionals about the difference between unproved and disproved factors. Even if this issue is settled, an attitude often remains that the burden of proof rests mainly on the customer or bodies that are distrustful or frightened about risks.

9.2.2.2 Military markets

Related to marketing on producer markets is marketing of military products. The culture in this seller–buyer interface is well developed and highly important on a global level. The notion of the 'free' world ranged against evil powers has been fostered in the military-industrial complex in Western countries. The people at Volvo Flygmotor engaged in aerospace technology for military purposes point out the remarkable openness in Western countries concerning science and technology. Sweden is officially neutral but is considered to be Western-oriented, which is beneficial for Volvo Flygmotor in the development of United States technology. There are, to a large extent, shared values and beliefs among businessmen, military people, R&D personnel and governments about the

necessity of defending the politico-economical system with a technology-intensive defence. Admittedly, some businessmen do not care—at least not very much—as long as they can sell; some military people entertain the idea of a labour-intensive defence; some R&D personnel may not consider it as part of their responsibility to question the values, or they become reconciled to them, and some people in government circles clearly express different opinions. Moreover, local authority interests and labour union interests often tie themselves to the interests of the military industry, at least in the short run 'until alternate production may be secured'. Despite many variations in ideologies and adaptations to situational logic, military technology is further developed, and this development takes place in a context that encompasses two basic cultural phenomena, namely collective pride and collective anxiety.

To explain some of the cohesiveness of the military culture, one may point to the long tradition, the ties to national culture, the military educational system, the organizational system and the instrumentality of collective anxiety and pride as well as of secrecy. In the interface to industry there is much professional education, many extensive studies and a considerable amount of research concerning military needs and technologies; there is also interface mobility between the military and industry and a regulated economy which consciously fosters a viable domestic defence industry. All this makes the military customer a generally competent buyer with knowledge about the role of technology in defence economy (with offshoots such as war economy and combat economy), a concept which is analogous to customer economy. Moreover, the military subculture diffuses and is reflected in, the corresponding parts in industry. Corporations which have for a long time been doing business with the military, such as Philips-Sweden and Volvo Flygmotor, develop a corresponding corporate subculture. Among its characteristics is that value is placed on advanced science and technology, analytical thinking, and management methods for solving problems. (Incidentally, many management concepts and methods have diffused from the military to the civilian spheres such as strategic planning, logistics, thinking in product life cycles, project planning and operations research.) Being tied to a single, competent customer, members of this subculture solve problems of market uncertainty in quite a different way than is common for civilian industrial customers. Similar traits, although not so pronounced, occur in other instances of a single, competent customer, usually a government body.

In the eyes of other people in the corporations, the military subculture is perceived as 'heavy' and 'very special', which is in contrast to a more 'moderate' self-image within the subculture. This image of 'the military side' in the eyes of others affects organization and management. The pressure upon Swedish military industry to diversify into the civilian sector has raised the need for management to modify the military subculture within the corporations. In the mid-1970s Philips-Sweden chose to locate civilian and military parts of the organization geographically close to each other, aiming at changing the communication pattern. Transfer and turnover of management and personnel could also have changed communication patterns in favour of civilian diversification, and new responsibilities for product work could have been assigned as well. Instead, a 'softer' way was thus chosen. Naturally, there were more reasons behind the move, and the ambition 'to strengthen the civilian leg' arose earlier in the 1960s and has been pursued by other means as well.

9.3 DISCUSSION

9.3.1 Empirical summary

There are several bases for the emergence of subcultures in and around a corporation. Such subcultures may thus be oriented around a product, a profession, a market, or an organizational unit. Here the focus has been on subcultures within science and technology and marketing. Typically, such subcultures are established in the corporation during a long period of time and are then opposed and subjected to a transformation. Table 9.1 summarizes some examples found in the corporations. (The list of factors of primary influence must be considered as a subjective and non-comprehensive summary.)

In addition to the examples in Table 9.1, the diffusion of biological thinking into different sectors of industry has been described, as well as differences in thinking and behaviour in the marketing of consumer and producer products. The culture in the military-industrial complex has been pointed at as a noteworthy example of an established culture in a seller–buyer interface.

9.3.2 Cultural structure

It should be pointed out that the culture associated with science and technology, which is sometimes presumed to be homogeneous, is hetereogeneous with several subcultures that are sometimes in conflict with each other. Scientists and technologists certainly share some basic values and beliefs about the benefits of their work and their methods and what is legitimate in thinking and language. On the other hand, differences in these respects between disciplines, as well as between generations, are marked as described in the preceding section. Such differences within an overall science and technology culture seem to produce intermittent re-orientations rather than smooth, cumulative evolution. Individual scientists and technologists build up conceptions that ossify and obstruct intellectual reorganizations. Science and technology groups are formed on the basis of similarities in educational background and shared conceptions and language. Individuals tend to socialize in at least one group, their social skills improve, they become tied to interests, and they defy fundamentally new conceptions. As a result, disciplines expand and contract, amalgamate and split up, and this is accompanied by generation changes, breakthroughs of new knowledge and, not least, by conflicting interests.

The empirical observations point to science and technology cultures associated with, for example, chemists, biologists, mining engineers, mechanical engineers, and electrical and electronics engineers. These categories correspond to the structure of graduate education, as well as to the structure of industrial branches or sectors. The formation of subcultures also seems to take place to a large extent

Table 9.1 Examples of subcultural transformations

Change involving a subcultural transformation	Factors of primary influence
Astra	
Transition from a chemistry orientation to a biology orientation	Corporate origin Top and R&D management behaviour Recruitment Technological change
Boliden	
Integration of chemistry into the mining orientation	Top management behaviour Recruitment and promotion Corporate strategy Technological change
Alfa-Laval	
(a) Integration of economics into the engineering orientation	Top management behaviour Recruitment
(b) Transition from component orientation to systems orientation	Corporate strategy Internal conceptualizers Technological and market change Product troubles
(c) Integration of electronics into the mechanics orientation	R&D management behaviour Independent subsidiary action Recruitment Technological change
Philips-Sweden	
Reorientation from military markets to civilian markets	Corporate strategy Location Market changes

during graduate education or in the early years of professional life when large parts of an individual's professional '*Weltanschauung*' and language are formed.

The subcultural features formed during graduate education are then often reinforced when the young professional goes into a corporation, due to the structural correspondence between universities and different sectors of industry. The inertia of the educational system in universities then produces a strong and enduring sectoral barrier to change in industry. This circumstance may partially explain the phenomenon of innovation by invasion as described by Schon (1967), that is, how whole sectors of industry are invaded by new technologies outside their traditional fields.

9.3.3 Cultural change

Social differentiation into different cultures is neither hierarchical nor permanent, and an individual or a corporation may be associated with several cultures with multiple and temporary connections of various strength. An individual may belong to a subculture in science and technology but also to a corporate culture and to a regional culture. His cultural memberships may change as well. Individuals are also carriers of culture, and a corporate culture may be altered as the result of changes within individuals and among corporate personnel.

In considering cultural change, three connected processes are of relevance here:

(a) the formation of change of cultures;
(b) the association of an individual with a culture;
(c) the association of a culture with a corporation.

To discuss each of these processes in depth would be beyond the scope of this study. The role of graduate education has been noted above. In a second-order analysis, one may take as a starting point the observation that social differentiation is clustered (i.e., social differences are not evenly distributed but patterned). The clustering of social differences in language, beliefs and values in problem solving among professionals is influenced by the individual's need to reduce uncertainty in connection with his pattern of communication, which he can only partially influence. Interpersonal variations are a great source of uncertainty and this may be reduced by conforming to a certain language and to certain standards and norms of behaviour. Consider, for instance, the use of mathematical logic standards of reasoning among science and technology professionals or the standard way of assigning the burden of proof to the one who makes a statement or proposes a change. Individuals, however, differ in their capacities to process information and handle uncertainty associated with interpersonal variations. Their needs to reduce uncertainty differ, as well as the manners in which uncertainty is reduced. Moreover, different needs of different individuals become dependent upon each other, which may mutually reinforce a social clustering.

Thus, there are several determinants behind the formation of cultures and the association of an individual with different cultures pertaining to different segments of his life situation. The strength of this association differs between individuals and also changes with time. A high learning capacity makes a professional less dependent upon his discipline-oriented knowledge as acquired by formal education, and may therefore permit him to be more problem oriented and less inclined to associate with a certain professional culture. A university researcher may feel associated with science and technology in general but with academic research in particular and even more with academic research within his field. Problems in connection with too weak an association of university researchers with the culture of industrial R&D are often witnessed. Although not so frequently mentioned, the opposite may also occur, that is, an individual leaves the university and in a way overassimilates into the industrial culture, thereby distinguishing himself from his university colleagues.

The third process, the association of a culture with a corporation is of main concern here. The focus is especially on change associated with professional subcultures, as encountered in the corporations studied. On one hand, a corporation is associated with different cultures through its personnel. On the other hand, a specific corporate culture is often formed, a culture which may retain its basic characteristics even if turnover of personnel is high. Since a culture reduces variations and uncertainty for its members, it may be instrumental in coordination and communication. A culture may also be instrumental in preserving a power structure. Management has possibilities to influence language,

ideology, beliefs and myths in the corporation and thereby influence the corporate culture to the benefit and convenience of themselves. Thus, there are several motives behind the formation of a corporate culture. However, a culture may also act as a barrier to change, as can be seen from the cases studied.

Focusing on changes of professional subcultures in the corporation as summarized in Table 9.1, one may discern twelve factors of primary influence behind such changes. Although it is extremely difficult to separate such factors and assess their influence, certain indications are worthwhile considering. The most frequently encountered factors are, on one hand, technological and market changes and, on the other hand, top management behaviour, corporate strategy, recruitment and promotion. The latter group of factors directly involves top management. This indicates that top management plays a primary role in cultural change in the corporation and that strategy formation, recruitment and promotion are important instruments in bringing about that change. In this sense a top manager in a large corporation may act in an important manner as a cultural entrepreneur. This does not always have to be the case, though. In some cases a corporate managing director has hindered or slowed down a cultural change initiated internally or externally.

Concerning the instruments for bringing about a cultural change, strategy formation, recruitment and promotion certainly are important. These instruments may, or course, be used in different ways. Thus, for example, Boliden promoted a mining man as head of the new chemical part of the corporation to be able 'to lift it up', while SKF, instead, promoted a steel man as manager of the corporate R&D laboratory, to be able to up-grade the steel side of R&D in traditional areas. Astra heavily relied on recruitment of new competence, which was natural considering the total dominance of chemists. (It is a fundamental fact that a specialized professional in one field cannot be converted into a specialized professional in a different field overnight or even over some years.)

A cultural entrepreneur may use other instruments as well. To restructure communications through organization and location is a tangible way of acting. He may also act in a more intangible way on the level of fundamental elements in a culture, such as influencing language and values, creating symbols and rituals, strengthening ideologies and nurturing myths.

However, the dynamics of cultural change as discussed here, involves more factors than just a cultural entrepreneur, which is often used as a handy explanation. Although there are instruments for management which influence a culture, it would be naïve to consider a culture as something which could be created and managed totally at will. Cultural change has, for instance, a pre-history in which external changes and internal conflicts are influential. The whole process of change, which may last over some decades, is characterized by disorder and uncertainty and the outcomes may vary. Starting from the situation of a dominant culture in a corporation, with a new culture emerging, four types of outcome may be discerned:

- amalgamation of cultures;
- transition to new dominance;
- ordered co-existence;
- rejection of emerging culture and regression to old culture.

Of the above, amalgamation (for instance, at Alfa-Laval), transition (for instance, at Astra) and the role of new generations of professionals are important. A new generation may change and amalgamate values and beliefs previously associated with two subcultures or disciplines, and a new generation may be needed to subdue an old subculture. Ordered co-existence of two subcultures (for example, at Boliden) may be accomplished both by hiring new professionals with weaker subcultural association and by structuring organization and management.

Finally, some comments may be made about the general trend to incorporate biological competence in industry. It is a response partly to threats from technological side effects and partly to opportunities in the advancing life sciences. Neglecting, for the moment, the many confluences of scientific disciplines in advanced natural sciences, one may make the following rough description. Chemists and others have been engaged in designing resistant compounds, they have been utilizing 'aggressive' methods and have applied rude measures to achieve certain effects and suppress others. To a different extent biologists utilize processes in nature (for example, by enzyme technology, microbiological extraction, biological control in agriculture and genetic engineering) and by these means it is possible to tailor outcomes, although in most cases industrial use is barely economically feasible so far. A naïve but illustrative simplification would be to view the change as turning from fighting with, to manipulative co-operation with, nature. This change may lead to the establishment of a new subculture of biologists in parts of industry. Likewise the transition to electronics has led to the dominance of electronics people in parts of industry. If there were to be a confluence of biology and electronics (c.f. bio-chips) in the decades to come, it would probably cause resistance to change among these new subcultures. The reasoning behind such a forecast has been presented here in the form of similar historic cases and a body of supporting evidence in psychology and sociology concerning individual and group behaviour in information processing, problem solving and socialization.

9.4 CONCLUSIONS

This chapter has focused on the relationship between technology change and subcultures in eight corporations representing different sectors of industry. The general conclusion is that treating technological change as an autonomous or exogenous variable in relation to cultural change is incorrect.

There are several bases for the emergence of subcultures in and around a corporation, for instance, a product, a profession, a market or an organizational unit. Formation of different cultures is neither hierarchical nor permanent, and an individual or a corporation may be associated with several cultures with multiple and temporary connections of various strength.

The tensions between a business culture and a science and technology culture are apparent in many cases. The culture associated with science and technology is, however, heterogeneous with several subcultures not infrequently in conflict with each other. Examples are subcultures associated with chemistry, biology, mining, mechanical engineering and electrical engineering. The formation of these professional subcultures is strongly connected with the structure of graduate education. The subcultures, moreover, 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 with 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 co-existence.

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. Such instruments include corporate strategy, recruitment and promotion.