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PREFACE

The growing role of the time factor in problem solving is becoming universally recognized throughout the world. At the same time, this problem remains insufficiently explored particularly in the strategic aspect. This paper describes the general outline of one of the most actual issues connected with the time saving impacts of the modern high technology revolution. The main purpose is to deepen understanding and show the interdependence between techological and managerial capabilities in the time saving aspect. Of course, radical strategic technological changes require the adequate responses from management systems and manager's personal skills. In their turn, technological changes strongly depend on the improved technique of the analytic possibilities, including the improved technique of the analytical approach as a result of international experience, could be considered to maintain the efficient interaction between technological and managerial capability.

TIME SAVING STRATEGIES IN TECHNOLOGY AND MANAGEMENT

A. Kochetkov

Time Saving Impacts of High-Technology Strategic Changes

The 1970s-1980s are "turbulent times" in which most countries have to face the necessity for deep structural changes in their economic structure and therefore in the appropriate social, political, and cultural systems (Drucker, 1980). This necessity emerges from extension of the high technology revolution that is considerably reshaping industrial structures and societal institutions. The direct expression of such a revolution, based on the latest scientific advances, is the widening list of high technologies, with global impacts on economic development: robotics, computers and computer-aided systems, telecommunications, artificial engineering materials, biogenetics, fibre-optics, word processors, nuclear power, lasers, space satellites, etc.

Among many inherent features of the modern high-technology revolution, it is particularly important to emphasize its time saving impact on industrial and nonproduction processes, because the time saving effect is an inherent condition of high productivity and efficiency. At the same time,however, the share of high-technology enterprises in industry in the 1970s-1980s is limited to a comparatively narrow range of manufacturing sectors. As a result, many industries find themselves in the same position as traditional industries, with some negative consequences concerning the level of productivity, quality, employment, etc.

But theoretically, based on fundamental achievements and trends of science and technology, it is impossible to justify the existing uneveness of technological development; there are no constraints for high-technology implementation in any industry. The visable differentiation could be explained by the rather different approach taken by industries to strategic technological changes, as well as by some artificial barriers.

The analysis shows that such constraints and barriers could be overcome by introducing more improved management systems, and the share of the high-technology sphere could be essentially extended, with considerable time-saving problem of improving strategically oriented management capabilities, which can be described in terms of what is required of managers.

The 1970s–1980s bring, in addition, a clear awareness that a new phase of the high-technology revolution has occurred; that is actual competition manifests itself not only in the sphere of science and technology, but is also important in the sphere of new products, process, and markets. For typical business companies the environment dramatically changes: instead of a well-known, long-established technology supported by educational knowledge and technical literature, there are developing innovation systems with unpredictable consequences. Accordingly, uninterrupted evolutionary growth is being replaced by new, discontinuous trends associated with the pulsating nature of technological progress. At last market demand is also transforming from relatively stable to more changeable characteristics (Finkelstein, and Newman, 1984).

No less essential changes are characterized by the internal conditions of company activity, where traditional management functions, such as resources allocation, are losing their priority. Other functions, initially know-how management, are taking their place. There are some dramatic changes at the staff-member level, because educational knowledge and practical experience is rapidly becoming obsolete, requiring managers to develop the ability to regularly learn and develop management skill.

In the management of high-technology structural change it is necessary to account for the pulsating nature of technological changes, according to which periods of accumulative, quantitative, evolutionary changes become periods of qualitative revolutionary leaps. There are three basic phases of technological progress (Yakovecs, 1984).

First, the more widespread choice relates to the change of product/process models in the framework of the same technological generation. Second, the model choice could be made based on the replacement of the technological generation, while remaining at the same time in the framework of the existing technical level of the economy. Third, the choice of product/process models could be linked with the appearance of fundamental new technologies, which qualitatively determine the transition of other model generations. Each of these technological trends adds its particular contribution to the structural changes on the different level of economy. Practically, for the phases before a fundamental technological revolution, it is more efficient to focus resources initially on the modernization of existing product/process models. On the contrary, during the current high-technology revolution, there is the opportunity to resolutely refuse routine choices and to make structural changes based on the transmission to more promising technological models.

Of course, the real choice will depend on many situational factors: economic scale, internalization level, resource availability, management capability, etc., but it is worthwhile to keep the solution range within the framework of the main choices described above (Luard,1983).

An inherent aspect of the pulsating nature of technological development is concerned with the uneven dynamics of aging processes in the basic industries. As a result there are obsolete manufacturing plants and factories eroding the competitive edge of the enterprise. Because of this, it is worthwhile to include in strategic management indicators of the average age of industrial plants. In the 1980s efficient manufacturing plants have an average age of about 7–8.5 years. At the same time, obsolescent plants have an average age significantly higher (in some cases 15–20 years) and as a result they have lost their competitive positions. There is a correspondence between indicators of a company's competitiveness and the average age of industrial plants. Therefore, increasing economical competitiveness in the framework of long-term structural changes presupposes that the corresponding dynamics (diminishing) of average age in the basic industries should be reflected in adequate investments in high technology and modernization of manufacturing plants (Heertje, 1983).

It is very important also to note that there exists a great diversity of competing strategies that could be adopted (Arthur, 1984). In the 1970s and 1980s the scientific work done in anticipation greatly exceeds the possibilities of implementation. In fact, in each company only a limited number of potentially efficient technologies have been implemented. Many others (among the remaining) could be just as promising, but do not have some of the initial adaptation advantages. Thus, it is not necessary to follow advanced competitors and adopt the same technologies. If a given company has a sufficiently high- technology adaptation capability, it could adopt competing technology that is not yet implemented. By technology adaptation capability we understand here the combination of a company's R & D capacity, investment potential, management capability, and the region's infrastructure and labor market capacity.

Information Technology-based Strategic Changes

Different high technologies have different time-saving effects. From this aspect, we note the dominating large-scale time impacts of information technology, which has created, first of all, a basis for the rapid development and application of robots, automated manufacturing, and the automated office. Among other applications of information technology-based systems are undersea and space explorations with robotic devices, mining, construction, and medical and household robots (Jackson and Balthazar, 1984; Masuda, 1980; Pitt and Smith, 1984; US Leadership, 1983). Three key high-technology elements - microelectronics, computers, and telecommunications, taken together, have formed a powerful time-intensive information technology that has become a basis for accelerated shifts in reindustrialization of developed countries, with automation of production and nonproduction processes, as well as deep changes in business, education, health care, researches, and many other forms of human activity on local, national, and global scales (Eurofutures, 1984; Szyperski, 1983).

The contribution of telecommunication technology to the time-saving objective has strongly increased with fibre-optics implementation. New communication technology creates the possibility of handling a great number of messages simultaneously. In combination with computer and satellite opportunities, the telecommunication technology, using fibre optic cables, videotext, teletext, cellular telephones, has increased its productive potential to a considerable degree.

Similar advances are taking place in software technology, including new high-capacity local storage and common operating system (Jackson and Balthazar, 1984).

These advances create a wide spectrum of new opportunities for managers. Apart from the many applications of information technology now known, it is difficult to foresee others. The broad implementation of information technology expresses itself in the fact that not less than half of the total labor force in many developed countries is employed in the information sector (Rubin and Sapp, 1981).

There are technical, economic, and social reasons for such broad applications of information technology-based systems. The combination of a high integration of silicon chips (large scale integration - LSI) with a diminishing of their cost has created favorable conditions for the broad implementation of microprocessors. On the basis of new types of microprocessors the system of "distributed intelligence" is being sussessfully built; that, in its turn, is becoming a basic for deep changes in the division of labor, such as forms of production concentration and cooperation, as well as planning, controlling, management communications, etc.

A new, large-scale, time saving strategy on the basis of "distributed intelligence" is that of clustered microcomputers building on local area networks (LANs). These provide opportunities for the establishment of a universal standard network that could connect users with different types of hardware. The next step is the combination of LAN with work-stations, batch processors, data base machines, etc., to achieve high-speed information technology. Progress in the development and application of "distributed intelligence" creates favorable conditions for the viability of smaller, high-technology enterprises in which the processes of R & D and engineering can be considerably accelerated. The most striking example of information technology implementation with a large-scale time-saving effect is the CAD/CAM system (computer-aided design and computer-aided manufacturing), which functions to create, display, analyze, and store engineering designs. The outcome is directly transferred into the system via computer programs, resulting in computer control of the production machines by means of NC (numerical control machine tools) in combination with programmable controllers and robots. The CAD/CAM market grew in the early 1980s by about 35% a year. Such systems result in increased productivity and typically pay for themselves in less than two years. The estimated direct time saving effect of CAD/CAM is expressed in the cutting of the manufacturing lead time by 25% and in increasing productivity by as much as four times the current level (Dorf,1983). Such a time-saving contribution of CAD/CAM systems is a result of accelerating the life cycle of many products by shortening the distance from ideas to goods and services. Firms that succeed by duplicating products at low cost will respond to product innovators much more rapidly and accelerate the processes of substitution of older products (Parsons, 1983).

This means economizing the time—design—manufacturing cycle and the practical elimination of the gaps between many existing operations. The next advances with high-technology are the integration of all CAD/CAM functions into a unified system with a common date base, to combine it with robots, FMS, computer material control systems, and other facilities (Pitt and Smith, 1984); that is to set about industrial production of completely automatic factories. The primary economic obstacle to implementing the time saving computer-controlled manufacturing technology is the large initial capital investments needed. In addition, some difficult technical problems must be solved in order to move to fully automated factories. Among these are improvements of the mechanical hardware and its interface with electronics and, to a lesser degree, the development of more advanced electronic hardware and appropriate software. In any case, the automated factory as a product of high-technology implementation will be the most radical contribution to meet time-saving requirements (Survey of Management Issues, 1983).

No less a radical penetration is that of information technology directly into the management sphere (Wynne and Otway, 1982). There are different views as to whether the dominant impact of information technology is to centralize or decentralize. Now it is becoming clearer that considerable opportunities occur in both directions and actual trends will depend, as previously, on the dominant policy. The powerful influence of information technology on administrative productivity, due to the time-saving effect, has also become clear. It is important that information technology firstly mechanizes most routine functions to release work-time for creative labor. No less important are forthcoming opportunities to establish a cooperative network - local, regional, national, and global. In the long term, almost all functions of most business and, to a considerable degree, other firms can be enhanced and economized on the basis of information technology. Thus, information technology has a considerable impact on macro- and micro-economics, and is now becoming a strategic concern for most companies in the 1980s. Information technology is changing the nature of the industry's product and services. In the time aspect, information technology may substantially alter (reduce) the product life cycle and significantly increase the speed of distribution (Parsons, 1983). The time lag between an initial idea for a new product or process and its wide production and utilization is virtually eliminated. Information technology accelerates the division of industrial companies into two types: those that have assimilated appropriate high technology and those that continued to rely on manual operations. Information-technology based companies incur great technical and economical advantages by achieving cost/quality control without the traditional economies of scale. To increase efficiency, information technology-based companies develop new products, services, and processes, new distribution channels, new management systems.

New-Time Saving Requirements for Management and Managers

The high-technology revolution brings with it some strong implications for management and managers, implying strategic changes in practically all managerial systems, processes, structures, and techniques. However, in spite of the spectrum of information-technology opportunities, the ability of most organizations and managers to assimilate new high-technology advances lies far behind the availability. As a result a "strategic technological gap" emerges and strongly impacts on socio-economic development. What response is required from management to cope with forthcoming strategic high-technology changes so as to increase their positive and reduce their negative effects in terms of time saving? The experience accumulated in developed countries (mainly by high technology and well-managed companies) includes the following managerial principles.

Allocating the main business organizations – companies, firms, corporations, enterprises – according to available power and appropriate resources to effective, self-supporting strategic and operating activities (under appropriate control of central industrial and governmental agencies). This is a critical component in the whole of the management system, because only a sufficiently high self-supporting basis creates the possibility of reducing the time needed for problem-solving. Now, most policymakers agree that national policy is only able to contribute, but not to solve, the current microlevel conflicts.

- Accelerated improvement of innovation management techniques, which should be an inherent part of all changes in activity: R & D, engineering, production, marketing, service.

- A rising level of coordination of policymakers' actions that directly influence the duration of decision-making and decision-implementing processes. It is especially important to ensure close interaction in the chain "deliverer–producer–user".

- Considerable attention to be given to the implementability problem, with the development of specific techniques to closely coordinate decision making and decision implementing.

- Introduction at complex cost–quantity–quality–time criteria for planning and assessing a company's, activity with broad use of negotiation techniques.

- The learning approach: achievement of strategic flexibility, with time-saving effects, through learning actions directed toward an increasing strategic management capability. Among the basic tools of the leaning approach, the key is to build strategic monitoring and control systems.

- Developing strong management techniques for the integration of policy actions in the framework of existing multiheaded institutional structures.

- Developing a new set of management skills (such as network management), which require a clear-thinking, methodical mind.

Taken together these managerial principles are directed to combat existing, basic forms of imbalance, which determine the main time loss in the business sphere:

- Power imbalance: i.e. excessive centralization of decision-making responsibility at the top of the management system.

- Imbalance between different forms of strategic changes: technological, economic, social, organizational.

- Imbalance between decision-making and decision-implementing stages of strategic policy.

- Imbalance between R & D and production/marketing processes.

- Interorganizational imbalance: i.e. unsynchronized actions of different organizations in the framework of unique problems and objectives.

Improving Technological Capability of Strategic Decision-Making Systems

The main contribution to the time-saving objectives can be given by strategic decision making. To a large extent, in business organizations such a system is realized in the long-range planning, but not exactly because some important strategic choices concerning a given organization are made externally. The traditional approach to strategic planning focuses on resource allocation processes. Under the high-technology revolution, there are two major objectives for strategic planning (Printice, 1984; Rhenman, 1983):

(1) To promote high technology innovation.

(2) To integrate technological and other strategic changes - human resource, capital, product, market.

For business companies high technologies have, for the most part, been considered in the context of product/market development. The increasing competition level in the 1980s stimulates, however, a more comprehensive approach. To acquire competitive advantages and achieve cost reduction, high technologies have become important to process management. Apart from this, in the long term it has increased the importance of accounting for not only existing but also emerging technologies. Accordingly, industrial companies face complicated problems concerning knowledge of improved technology-evaluation techniques, because errors incurred in estimating the prospective benefits have become crucial for company viability. Two common errors are underestimation of the time and resources needed to achieve an effective functioning of the innovation technology and overestimation of the average rate of use in calculating expected returns (Gold, 1983).

The general strategic management response to improve the strategic technological capability of business companies lies in a more intensive analytical approach to strategic decision making. Thus, strategic planning is becoming more quantitative and oriented to the use of computer simulation, in addition to traditional expert information. Also, criteria of technology assessment are becoming more comprehensive. Some American companies have successfully used so-called research management techniques in building a matrix that couples R & D plans with business objectives. As a result, the business–high technology portfolio is established as a basis for strategic choice. The other promising analytical technique for strategic planning is the PIMs program(profit impact of market strategy; Albert, K.,1983), some new advances which are being developed at IIASA now, such as ISSMI (Integrated Strategies of Structural and Market Improvement). The mechanism of the ISSMI program involves computerized verification of a range of hypotheses about the strategic behavior of a given regional–company system, taking into account the corresponding behavior of competitive systems (those producing the same products). The strategic behavior of each regional–company system, in turn, is determined by structural change and has a number of alternative forms.

The ISSMI program operates by using information on the structural–economic strategy alternatives for the regions, which are considered as a single multiproduct company or as a set of companies whose strategic behavior depends on interrelations of internal and external factors. The evaluation of technological, investment, employment, and ecological capabilities of a region allows policymakers to examine the factors important to a long-term, sustainable economic growth, in addition to more immediate values of profitability.

Thus, use of computerized techniques such as PIMs or ISSMI programs allows us to make strategic plans more quantitative. This analytical approach simultaineously presents the best remedy to cope with uncertainty. Under the impact of large-scale technological changes the future of company, regional, and national economies could not be considered in the long term as unique and fully determined; the impact possibilities are multiple (Godet, 1982). The basic conceptual idea of how to cope with uncertainty consists of developing and improving strategic planning. As regards time-saving requirements, these could be met by building mechanisms of adaptability into planning and implementation processes. Here, the decisive factor is the analytical approach that is becoming the basis for forming early warning systems. A set of methods used in strategic decisionr-making to cope with uncertainty includes, additionally, a range of forecasted scenarios, sequential decisions, early warning systems, contingency plans, etc.(Kono, 1984).

In practice, the strategic technological changes emphasized above, are closely connected with other strategic forces implemented by governments and firms, for example cost/price policy, differentiation of product and segmentation of market, etc. The choice of one or a set of these strategies depends on, and in its turn influences, the technological changes. According to product/market strategies the appropriate high technology could be chosen and assimilated. One such technology may contribute to cost leadership and another to reducing waste and improving productivity (Peters, 1982).

The power of information technology is the reason why most firms must efficiently support and reinforce such high technology. This means that strategic planning should include a set of actions as to how, on the basis of information technology, to reduce time and cost, and improve productivity and quality. For example, to support a low cost strategic policy at the level of industrial companies, it is necessary to strategically plan the implementation of computer-aided and process engineering systems, as well as project, process, labor,sale, and cost control systems. To implement these investment-intensive systems, the company will need to deepen its specialization and narrow the product set.

But for many companies the problem of understanding how information technology affects their business under given situations remains difficult. There is no other way to achieve such understanding than to constantly link information technology opportunities with the more traditional set of strategies. The result of such an analysis could be then used to design resource allocation, education, training, etc. To be based on high technology, a strategic decision-making system should be information intensive. First of all, many technological failures are explained by only one reason: that managers are unfamiliar with the technologies to be assimilated (Gold, 1983). In the cases of CAD/CAM and other advanced systems, operating staff usually lack sufficient expertise to evaluate either prospective applications or to compare with alternative, competitive technological systems. Therefore, the organization of special case studies and surveys about technological opportunities is an inherent element of a strategic decision-making system, as is the initiation of appropriate educational efforts on the basis of specialized training programs. Moreover, the most valuable information in many cases is accumulated by people in organizations. As a result, the establishment of an internal information-flow network that ensures intensive contact between members at all organizational levels is necessary. The other side of this problem is the creation of external information networks, which must ensure the possibility of intensive information contacts on a global scale.

Integrating and Implementing Strategic Decision-Making

As experience shows, the considerable losses are due to a timegap between strategic decision making and decision implementation. Accordingly, time saving aims imply close coordination at these stages of integrated strategic policy.

This principle stipulates building implementability into strategic management techniques, traditionally oriented mainly to improvement of the decision-making process (Ansoff, 1982). In accordance with this principle it is necessary to provide a careful preparation of the implementation conditions already present in the policymaking process. Such preparation will ensure the rapid implementation of strategies (King, 1983).

Many researchers and businessmen agree now that reorganization of the human role is the key factor in implementing strategies based on high technology. A simple approach suggests that new computer-aided systems make the human contribution less complex. But a more systematic approach illustrates that the new conditions and innovative and cooperative styles, as well as the uncertainty and dynamics, on the contrary, increase the human role; that is, with respect to management knowledge and skills.

Thus, for management the strategic development of human capability should be correlated with the development of high technology capability. The main tools for meeting these needs are rebuilding the systems of education and training on the basis of the learning approach (Horwitch, 1984; Kozmetsky, 1984; Michael, 1982). Apart from basic knowledge, the education system is required to teach people how to learn on the job. Such learning could be achieved in two ways: by formal training and by self-training, but the best results would be obtained through a combination of these.

Other areas for realization of human potential in management lie in creating innovative, organizational climates and cultures. To reduce the time for adaptation of a new member to the organizational style, there is the promising experience of establishing work contacts between students and organizations during the educational period. In addition, through such contacts, students can accumulate some experience of the high-technology being appropriated by given organizations.

The increasing role of the human factor in management activity is reflected in the substitution of some administrative channels of decision making by negotiations. This could be a promising way to diminish the danger of bureaucratization and increase initiative development.

Reduction of the role of formal administrative decision-making is achieved not only through development of the negotiations technique, but also through the development, without papers, of face-to-face communication, including direct and indirect (using telecommunication) forms. An increasingly less formal organization of problem-solving in its turn requires a diminishing of organizational hierarchy and a reduction of the number of structural levels. The time-saving effect of such a transformation is evident.

Thus, there is the need to develop informal networks of management (human) relationships as an alternative, to some degree, to develop formal organizational structures. In practice, in business relationships there is such a latent structure, very frequently more effective than administrative channels. But in other cases the solution taken within the framework of this latent structure contradicts societal criteria. The problem-solving approach here is to develop organizations with open-system attitudes, recognizing the power of network relationships and managing such networks consciously.

It is quite obvious that the human factor is not only an area of unlimited time-saving opportunities, but is at the same time, the sphere of most difficulties and constraints. The actual resistance to the implementation of new high technology emerges not from obsolete machines, but from "obsolete" people and from organizational resistance. Such resistance can lead to time-extensive management, which make old any new technology during its assimilation. International experience shows that to overcome human and organizational resistance to forthcoming high technology it is necessary, first of all, to rebuild existing reward systems, to replace key people, and to pass staff members through special training courses. The resistance to high technology is not lost automatically; to overcome it requires planning.

In many cases, the process of strategy implemention faces some difficulties due to the multilevel, multisectoral, and multiorganizational nature of society. As a result it is increasingly necessary for a superior coordination of strategic action in time and space. As high technology affects products and processes, considerable changes occur in the relationships between an industry and its suppliers and users. For example, the use of sophisticated quality control systems by the autoindustry is forcing steel producers to become much more quality conscious (Parsons, 1983). And, of course, the high technology supplier will become an important force for a firm that depends on such facilities.

As a result a new cooperation of networks is being created. At the same time, the substitution of paper-based communications by electronic mail and the introduction of more sophisticated telecommunication systems establish more favorable conditions for the intensification of cooperative links. To improve policy coordination is very important because the considerable and ineffective time lag between decision making and implemention, as well as between policy stages, often occurs in situations where strategies of organizations are chosen without agreement with other existing governmental, regional, and other guiding criteria

(Rothwell, 1982). To achieve time-saving on the basis of a higher level of policy coordination are such well-tested technological remedies as standardization of product and management technologies, development of telecommunication networks, matrix organizational structures, and some other updated formal systems.

There are considerably fewer proposals for improving management coordination and cooperation in the area of human factors, although the coordination of human interests is potentially a more promising remedy for cooperative activity. In this area, there is also a rich international experience about the technique of negotiations and contracts. Under the conditions of a high-technology revolution, a "front end" in cooperation management work is formed by the know-how of innovative activity. The development of cooperation in this field could, to a large extent, become a time-saving management strategy realized in regional, national, and international frameworks (Kochetkov, 1981).

In conditions of relatively more decentralized economics cooperation in know-how, production, marketing, and other forms of business activity could be more effectively achieved by negotiations and contracts. That is, there is an urgent necessity to substitute many existing administrative forms of decision making with channels of negotiations. There are many areas of negotiations techniques that must now be rapidly learned and implemented (Albert, 1983). Negotiations as a means for cooperative effort tends to spread at the level of a group or in personal activity. In many cases with a small team as the basic unit of human organization in the business activity, it is worthwhile to set the goals on the basis of negotiations about the team's task in terms of quantity and quality of work, conditions, time of implementation, and payment. Moreover, negotiations could be the basis also for team optimization as to team membership (for example minimizing the number who chose personnel, etc.). As international experience shows, delegating to a team total responsibility (cutting across all operating functions) for work performance gives the most effective results and, as a rule, contributes to a diminishing of the time span from the initial idea to user utilization of a product (Finkelstein, 1984).

It is very important for strategy implemention that a considerable mass of capital funds be accumulated, but resources constraints make inevitable the typical situation for managers in which obsolete and new technologies coexist with each other during long periods. Introduction of our thinking creates similar situations in management principles, organizational forms, and methods. In addition, many new principles are not well understood due to the complexity, uncertainty, and dynamics of technological development. Under these conditions, the role of investigation using model experiments could increasingly become an inherent part of strategic change management. Such specially organized strategic management experiences could take the function of discovering opportunities and the means of their implementation.

There is no well-known way of how to manage high-technology development for the purposes of society. There is time to search for ways through experimentation and generation of the results (Goldberg, 1984).

High Technology Venture Management

One of the main time-saving strategies of the 1970s–1980s has been the broad development of new high-technology ventures, of which there are two types.

Most occur in small and medium-sized, new innovative firms oriented to the rapid achievement of high-technology results. Such venture firms have successfully proved their competitive advantage in comparison with large firms: they have generated, grown, and given market life to more than half of the high technology-innovations in the 1970s–1980s. Therefore, large companies have initiated new high technology-ventures by developing them in special centers within the framework of their structures. The viability of such innovations will be tested during the 1980s. It is also necessary to explain the nature of the time-saving efficiencies of small, high-technology based firms because there is much evidence that the scope for smaller producers is reduced due to increased cost of research and development, product standardization, capital intensive requirements, machinery introduction, etc.

The major reason for the viability of small venture firms is their ability to give life to many new high technologies two or three times more quickly than can large firms: that is, small venture firms are thus able to gain time and to win the competition.

The reasons for the considerable time-saving efficiency of small venture firms are in the innovative nature of high-technology development processes and in the special features of research, development, and engineering. Owing to these peculiarities, high- technology ventures can escape the sad fate of traditional small firms.

The time-saving effect of smaller venture companies arises from their flexible and easily changed structures and their readiness to take a high business risk. Small firms who can rapidly adopt new high technology and reduce, on this basis, the product development cycle, gain a competitive advantage over large companies. Large companies, on the contrary, due to the complexity of organizational rebuilding are, in many cases, limited in new technological initiatives. Thus, the development of innovation-oriented small-to-medium venture business enterprises should be considered as a considerable contribution to accelerating technological development as a whole. This is proved by innovation management practice, initially in the US (Oakey, 1984, Bullock, 1983), especially in the San Francisco Bay area of California, including Silicon Valley.

At the same time, the separate functioning of such companies is, as a rule not competitive, although we can see the happy emergence of new firms (Texas Instrument Corporation, as a typical example). But, in most cases, small, high technology venture firms engage in direct subcontracting with large companies. Apart from this, there is a propensity in small, high-technology firms for products to enjoy relatively short life cycles, frequently as little as five years (Oakey, 1983). Small venture firms are able also to successfully arrange part-time research and development. The considerable time-saving effect obtained by small high-technology venture firms in the engineering stages occurs because in many well-managed high-technology companies the investment proportions between research, development, and engineering stages are 1:3:10. In a more broad sense, engineering management is the management of intensive know-how of product, process, and people, as a basis for productivity growth. As experience shows, the time length of strategic technological changes depends on the engineering contribution. In well-managed companies the time of the transition to new product/process models is not more than one to two years.

The experience accumulated by high-technology venture firms allows us to formulate a set of guiding principles for well-managed, time-saving strategies (Ansoff, 1982; Bullock, 1983; Kozmetsky, 1984). These principles give concrete expression to the basic axioms of the dynamic synchronization of structural changes considered above.

- The critical role of the basic product/market business idea of a venture for choosing the appropriate direction of high-technology development. Such a choice includes testing of the technical and manufacturing feasibilities, taking into account resources, R & D, organizational and market limits.

- The necessity to integrate all organizational pieces - objectives, structure, reward, decision making, people and others - into interdependent systems, so that it will be impossible to change one organizational dimension without changing all the others.
- Strategically planned change in the forms and techniques of organizational support at each stage of venture development: formulating the basic business idea - creating a prototype of the new technologies - production and market, testing of a number of initial models - natural growth - volume of production - strategic maneuvering to achieve the purposes of basic business idea.

The main difficulty of such an approach is to predict the changes from one stage to another and the transition from research to engineering functions, and then to manufacturing and marketing. If such changes are reasonably predictable it is possible to plan the organizational changes, including the transition of the mainly informal venture organization of the first stages to multifunctional organization, that coordinates and controls, at other stages. If in the growth stage the problem of managing product diversity arises, the venture must decentralize some product management. If the necessity to develop a second generation product-line arises it is worthwhile to set up a separate group for this purpose. If the problem of diversification arises (at the strategic maneuvering stage) it is important to follow the steps to decentralization with development of the product, market, or region profit center network (Ansoff, 1982).

Thus, planned, integrated technological–organizational strategic changes are the source of time-saving effects and thus the elimination of waste in the long term.

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