
The Evolution of High Tech Companies over the Years: Some Definitions and Difference between Market-oriented Companies and Innovation-oriented Companies

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Abstract

High Tech companies play a fundamental role in the process of generating variety of technologies, in the development of scientific activities, in the organization of research and development activities and in the links of companies with other research institutions. In sectors High Tech the importance of economies of scale based on the specialized techniques of capital-intensive mass production; the same economies of scale move from the production phase to the research phase and the ability to transform basic research into new productions becomes the barrier to entry for industry. According to an OECD classification, the high-tech sectors include pharmaceutical, aerospace, medical, optical and precision instruments, technologies for information and communication, information technology, biotechnology, nanotechnology. In this paper after the definition of High Tech we will focus on some definitions given by authoritative scholars. Finally, we will focus on another important element to fully understand high tech companies, that is the difference between market-oriented companies and innovation-oriented companies

Keywords: High Tech, companies, history

1. Introduction

Currently, the definition of a high-tech firm has the evocative power in contemporary economic language. It is difficult to define exactly which companies are high tech, many talk about it. These companies are given particular prominence in research and economic policy. Even public opinion and people from various disciplines are attracted to high tech more than any other type of business. This for various reasons:

- ✓ High technology is synonymous with innovation and development and development is synonymous with progress. Knowing and studying the success factors of high technology therefore means laying the foundations for the success of an entire economic system or geographical area or sector of activity. The contribution of the high-tech sectors in the recovery and development phases of the economy is widely recognized. Competitiveness and therefore success on world markets are entrusted to the high tech sectors. A nation's productivity, standard of living and competitiveness in world markets depend heavily on high-tech sectors. The debate is not only between industrially advanced countries and developing countries, but also within the former: between industrial and rural areas, or between metropolitan and extra-metropolitan areas.

- ✓ The management of high-tech companies must constantly respond to difficult challenges, coming from an ever-changing environment. The challenges are difficult for both companies and management. Companies operate in a highly competitive environment. Employees are also at high risk. "For many companies, making an important technology decision is like betting." For this reason "... the challenges that these companies have to face have generated great interest on the part of those involved in contemporary history, economic policies and even management". The OECD (Organization for Economic Co-operation and Development) has repeatedly stated that the main reason for high unemployment is the insufficient capacity of industrialized nations to adapt to change. The research concluded that the slowing pace of employment growth in Europe on the one hand and the high productivity and capacity of the United States on the other create a large number of low-skilled and low-productivity jobs in Europe. the last few decades are two sides of the same problem. No job creation model is desirable. The OECD report confirms that in the coming decades, Europe will have more difficult problems to tackle than those of the United States and Japan. In particular, the report found that most European countries have achieved modest successes in high-tech sectors. Although Germany and Sweden, along with Japan, are seen as leaders in the use of information technology and advanced manufacturing, many European countries have failed to increase their share of manufacturing and exporting high-tech products
- ✓ The professional skills in these enterprises are partly different from the norm. To be successful you need vitality, flexibility, strong specialization of collaborators and the ability to respond to the rapid change in the professional skills required.
- ✓ Speed of technological change and speed of development are two characteristics of the environment in which high tech companies operate. These characteristics give rise to "contradictory behaviors in the face of a single dilemma":
 - 1) how to leave room for creativity that is at the origin of development and change without excessively fragmenting the business activity;
 - 2) how to control the innovation process (avoiding that the costs exceed the benefits) without stiffening the research process. Hence the paradox between a state of perennial chaos and the search for continuity in management. To fully understand the true meaning of high tech companies, we must start with the definition of the word "High Tech". This word identifies anything from the space shuttle to the electric pan.

2. High Tech companies: some definitions

A wide variety of definitions emerges from an examination of the literature on high-tech companies. It may be useful to summarize some of the most significant:

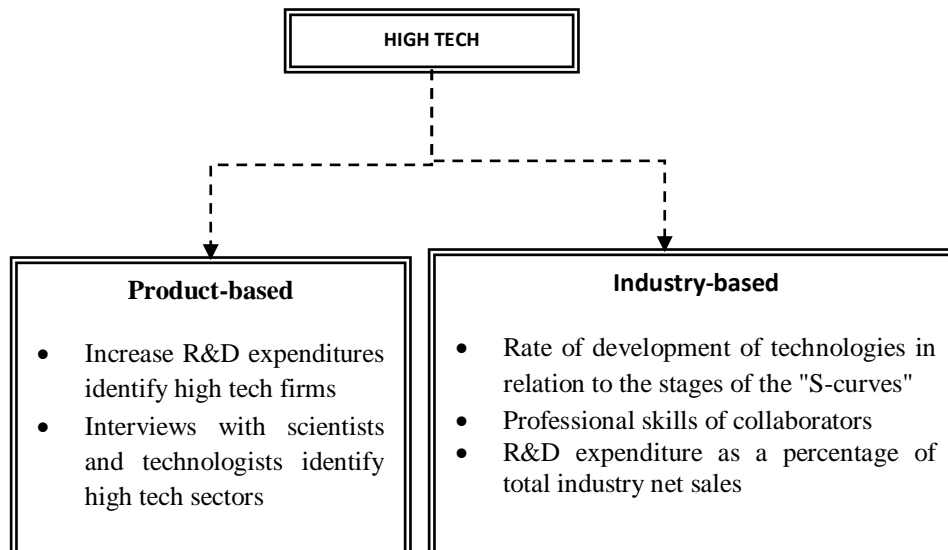
- ✓ According to Kleingartner and Anderson (1987), high tech companies have the primary objective of transferring new ideas to the market (commercializing). To achieve this goal:
 - allocate significant resources to research and development, with an R & D / sales ratio at least double the average of the other sectors;
 - they hire collaborators and develop professionalism (in the collaborators themselves) strongly oriented towards technology; the weight of these professionals on the total number of employees is at least three times higher than the national average.

These characteristics give a strong scientific / technical content to the sector which translate into thrusts that make the competition different from that of other sectors.

- ✓ Milkovich's definition is along the same lines. "Firms that prioritize invention and innovation in their strategies, that devote a significant percentage of their financial resources to R&D, that employ a relatively high proportion of scientists and engineers among their collaborators who compete in world markets where life average of the product is short ». Milkovich (1987).
- ✓ According to Diwan «... A new“ techno-economic paradigm ”has emerged based on new technologies that have international production processes and global markets. They are mainly represented by microelectronics. These high-tech companies have a strong R&D intensity and realize strong economies of scope - instead of economies of scale - in order to make it convenient to “customize” the production to the customer's needs. They are the technologies of the future, radically different from the old technologies based on standardization and mass production techniques. The implications for high tech are fundamentally different. . . ”.
- ✓ Thore gives an even broader interpretation to the concept of high tech. Let's follow his thought. Technological progress before 1880 was linked to the steam engine, the railway, and steel. Another wave of innovations came at the end of the century with the chemical industry, electricity and the automobile. Later it was the turn of aviation, oil, the film and radio industries. Many of these "conventional" technologies involved economies of scale. As a result, there were strong incentives for businesses to grow and large.

During the 20th century, a new form of capitalism emerged which Thore refers to as high-tech capitalism. Starting from this definition, Thore gives a broader interpretation of high tech. «High tech is the technology articulated in a pyramidal, complex chain of products and services with various characteristics». "A car engine is assembled with thousands of individual parts. Each component part has its own history of production and assembly ». "The architecture of the final product is hierarchical, it is a network of various individual links". In Schumpeter's thinking, innovation was made up of "leaps", discontinuities, in technology as happened for the car, the plane, the telephone, the synthetic rubber. These "bursts of creativity" are still there (fax, telephone, cell phone, satellite communications, open heart surgery), but most changes in technology are the accumulation of a large number of small changes in products rather than the result. of "technological leaps". "Many innovations are no longer the product of an inspired genius (such as Edison or Nobel) or of a particularly enlightened entrepreneur, but are the result of actions planned and controlled by management" "In the climate of intense competition of the nineties, a company it must bring a steady stream of new products to the market; each generation must be superior to the previous ". In high tech capitalism, capital and profits change their nature. The various definitions can be mainly traced back to two:

- product-based definitions
- industry-based definitions



PRODUCT-BASED: In the United States, the drive to define high-tech sectors originated from the analyzes concerning the structure of the trade balance ordered by the economic authorities in the late 1970s. Faced with a growing deficit, the need arose to establish how much was determined by high-tech products and how much by low-tech products. The ultimate aim was to establish whether American companies had lost the technological supremacy they had gained after World War II. In 1977 a National Science Foundation (NSF) study used R&D expenditures as a criterion for identifying high-tech products. The assumption was (and is) that R&D expenditures reflect complex technological solutions and therefore that high R&D expenditures identify high tech. This analysis was subsequently refined by classifying product groups with above-average R&D intensity as "technology intensive" products. Two years later another research, also promoted by a US government agency, identified twenty groups of industrial products as high tech based on the "technological complexity" of the products. The list included sectors such as inorganic chemistry, synthetic resins and pharmaceuticals. The classification, however, lent the side to criticisms concerning the subjective evaluations of the "degree of complexity". Subsequent research adopted broader criteria to define high-tech companies and sectors. They defined high-tech companies committed to designing, developing and introducing new products and new production processes on the markets "through the systematic application of scientific and technological knowledge". These companies used cutting-edge techniques. They had a high share of R&D costs; a high share of technical and scientific personnel; they initially served small and specialized markets. The problem of giving weight to the various factors soon emerged. "At what level does a particular factor become relevant? ". Another approach made use of input-output analysis. R&D expenditure on one side of the matrix and exports classified by product groups on the other side in order to build a technological intensity index. Products were classified according to the ratio of R&D expenditure to export value. Products with significant intensity were called high-tech products. Also from this research emerged a certain degree of

subjectivity related to the concept of "significant level" and "intensity of R&D". A breakthrough in research methods came with a study by the Bureau of the Census Center of Economic Studies. Also in this case the need was dictated by the observation that the trade balance of the American high tech sectors was in deficit. While there was a general belief that these sectors had a surplus balance, the data said otherwise. Fearing that the contradiction originated from measurement errors, a completely different path was chosen than in the past. A large sample of scientists and technologists were asked to define what they considered high tech products. On the basis of the interviews the following were identified as high tech sectors: biotechnology, some segments of pharmaceuticals, optoelectronics, computers and telecommunications, computer-integrated manufacturing, materials design, aerospace, nuclear technology. The other criterion, identifying high tech companies is represented by the industry based.

INDUSTRY-BASED: With a second approach, the definition of high tech encompasses an entire industry rather than a product or group of products. It is a simpler method than the previous one and is less sensitive to variations concerning individual products. On the other hand, however, given that all products in a sector are considered high tech (while in reality they are not), this approach tends to overestimate the size of the high tech sectors. The criteria adopted to identify the high tech sectors are mainly three:

1. Rate of development of technologies in relation to the stages of the S-curves. The choice of this criterion is based on the following assumption. While in traditional sectors, the rate of growth of the S-curve, which measures the development of technology over time, begins to decline after the evolution phase, in high-tech sectors investment in R&D and the consequent expansion of scientific knowledge lead to the creation of a new «S-curve».
2. In more recent times, recourse has been made to the profile of the professional skills of collaborators. High tech sectors are defined as those in which the share of engineers, technicians, experts in the use of computers, "life scientists" and mathematicians exceed the average of the other manufacturing sectors. The assumption is that the professionalism of employment reflects the ability of a sector to accumulate the knowledge and technological experience necessary to develop new products and new processes
3. R&D expenditure as a percentage of total industry net sales is another widely used criterion for identifying high tech sectors. The 'R' in R&D consists of two components: basic research and applied research.
 - Basic research is carried out by scientists within universities and research institutes; only a small portion of the research done within the company falls into this category.
 - On the contrary, applied research is mainly done within companies. Applied research is defined (unclearly) as the application of scientific and technical principles in the creation of products and services in order to obtain an economic result. It is not easy to distinguish the two parts that make up the 'R' in R&D, but the differences between applied research and basic research are well known. The 'D' in R&D refers to product and process development.

| Criterion | Prerequisite | Weaknesses |
|---|--|--|
| <ul style="list-style-type: none"> • "5-curve" stage • Professional skills • R&D expenditure | <ul style="list-style-type: none"> • While in the low-tech sectors when the S-curve reaches maturity, technology and often also the company) starts to decline, in the high tech sector maturity is preceded by the start of another "5-curve" • The greater the proportion of skilled personnel, the higher the ability to create knowledge the experiences needed to develop new products and production processes. • High R&D expenditures reflect complex technological solutions therefore they divide high tech sectors | <ul style="list-style-type: none"> • It is difficult to build a true "S-curve" in real time. • Not all high-tech activities are carried out by scientists, engineers or skilled technicians. • If these activities are broken down into simple operations, they can also be carried out by people with low or modest specialization. • It is a significant index when a sector is in the early stages of development of the life cycle. It fails to distinguish between high tech and low tech in stable, "mature" sectors. • R&D expenses depend on the phase of the economic cycle and on fiscal incentive or disincentive policies, on public subsidies. |

Different ways of interpreting the concept of a high-tech enterprise lead to different opinions. A criterion can be identified the common characteristics. From the various definitions emerge some elements of high tech companies on which there is broad consensus:

- **Uncertainty:** a rapidly changing environment of markets and technologies creates "ambiguities and uncertainties" within companies. To be successful, management must be able to manage "periodic shifts between chaos and continuity".
- **Contraposition:** the high-tech environment seems to create a fundamental dilemma for organizations and management as it simultaneously imposes the need for both stable and flexible structures." A different "managerial style" from the traditional ones is needed because the "challenges" are specific to these sectors; They are different; they are somehow unique.
- **National flag:** the success of a nation or a company is identified with development. High tech is synonymous with the development of new products, the creation of new jobs, greater productivity, greater ability to compete. Public opinion entrusts economic and social progress to these companies, but this has not always been the case. Maidique and Hayes (1984) recall how in the period 1969-1984 there was a general belief that American companies had lost their superiority in the technological field, but had managed to replace it with supremacy in management.

- **They are not the only ones:** high technology is not alone in having development as its goal. They are not the only ones innovating. Their goals and problems are common to other companies as well. It is widely believed that high-tech companies are exclusive to the electronics, information technology and pharmaceutical sectors. If the criterion is to have a significant share of technicians and scientists, the title of high tech must be attributed to all companies strongly engaged in the research of new technologies, therefore also to some segments of the food industry and to other sectors in which innovation has a high priority.
- **Push for development:** it has rightly been observed that development is also the result of management's propensity to change. So "development is a controllable factor". At the origin the push and the psychological propensity of entrepreneurs and management to development and secondly in their ability to manage development itself. There are often opposing forces within companies. "Some want development, others reject it."
- **Synonym for knowledge:** scientific research, innovation and the development of new ideas are of vital importance. We speak of "knowledge industries" as a synonym for high tech.
- **Hyper-competitive environment:** the strong innovation content in the economies of these companies gives rise to a competitive environment different from that of other sectors. The constant search for innovation quickly makes existing technologies obsolete. Their commercialization can rapidly change the supply and demand of the markets. It is an environment of "creative destruction" in which one or more companies, having the imperative to surpass their competitors, can destroy what they have recently created and from which they still derive profits.

Under these conditions "the only constant is continuous change". External change affects the strategies, the management of the various functions, the organizational structures, the forms of control. "As these companies continually have to come up with new responses to the many changes they face, internal boundaries are shifting. The identity of the various operating units, their names and their roles change to follow technological developments, changes in markets and products, new competitors, company development ".The characteristics of high-tech enterprises are:

| | |
|----------------------------------|--|
| Aims | Innovation is their "creed". Transforming inventions into innovations |
| Competitive area | They compete in sectors where the average product life is short. They sell products that are relatively new to the market. |
| Resources | Higher than average share of personnel with technical training. Ratio between R&D expenses and net sales higher than average. They invest a significant portion of their budget in the R&D of new technologies. |
| Complexity | High degree of complexity of the sector's products and relations with other sectors. |
| Organizational structures | They frequently change structure, often with incremental progress. Uncertainty and instability are the causes. The ability to manage multiple operational units with multiple time horizons is needed. They have to be flexible, but at the same time they have to strictly control the innovation processes. When the formal structure is rigid, they resort to the informal one to create flexibility. The concept of formal organization as opposed to informal organization must therefore be revised. |
| Check | It cannot simply be understood as a guide to the goals set by management. It is done through culture rather than through formalized systems. Control is synonymous with staff participation in decisions. |
| Strategies | They anticipate change in conditions of great uncertainty. They do not have only top management as their source. The sources are varied, both internal and external. Innovation is much more than the simple launch of new products. They largely concern the creation and development of processes, structures and systems aimed at facilitating innovation. |

3. When a business to be defined as high tech

We can certainly say that a business to be defined as high tech must satisfy the following three criteria:

- the business needs a strong technical-scientific base
- New technology can quickly make current technology obsolete
- As new technologies develop, their application wreaks havoc in markets and demand.

To present the theme of the link between marketing and R&D, the most important distinction to be made is between the two situations: that of market-oriented high technology and that of innovation-oriented high technology. Market-oriented high-tech companies attribute to R&D the task of making innovations that meet specific market objectives. High-tech, innovation-oriented companies, on the other hand, do not attach great importance to what customers want or need.

The needs or wishes of customers are taken into consideration after there has been a result at the R&D level. Aspartame, the low-calorie sweetener from G.D. Searle, was discovered, for example, by chance by a researcher working on an entirely different research project. The commercial launch took place only later. Let's see what other differentiating elements there may be between market-oriented and innovation-oriented companies.

4. Market-oriented companies

A first group is made up of companies "state-of-the-art plus". R&D becomes more dynamic when competing companies on the market seek to develop, for competitive purposes, modifications and improvements to existing technologies. In the robotics sector, for example, it was often the same suggestions from customers that made progress possible. Timothy Bublick, director of marketing at DeVilbiss Company, a robotics company, says: If you develop a robot gun that sprays paint for a given customer, this new technology application will become a new product that will enrich the state of the art. " This approach, if followed one hundred percent, can risk delaying technological advances. In the semiconductor industry, for example, the industry's ability to find ways to pack more transistors into a single chip may slow progress in the development of optical technologies. A second group is made up of companies known as "problem solving". These companies are not limited to the "state of the art" of technologies however, as Thomas Edison, the first "high-tech" marketing expert, recommended, they made sure their new products met real wants and needs before starting development. of technology. Edward W. Ungar, director of the Battelle Memorial Institute (one of the most prestigious R&D firms in the world) expressed a similar view: 'In R&D work, most new ideas for new products must be evaluated on the basis of the probabilities that the product is accepted in a competitive market ". Putting this problem-solving orientation into practice, Schering-Plow seeks to combine its innovative skills and marketing techniques to find the delicate balance between R&D initiatives and the need to place every scientific success within of the long-term strategic objectives of the company.

5. Innovation-oriented companies

Many high-tech companies, or laboratories, divisions or branches of large corporations, are actually research firms. Companies of various types and sizes, for example, are now dealing with biotechnology. Those involved in basic genetic engineering research include companies such as Biogen and Genentech along with more market-oriented pharmaceutical and chemical companies. The possible applications of biotechnology are so numerous that basic patents were at stake in the initial phase of the commercial battles (Lewin, 1982). While developments ranging from disease-immune grains to microorganisms that devour oil spills are predicted, the potential for commercial development of the technologies is so vast that some companies risk falling behind or even completely ignoring important possible commercial applications. In addition, US military and space research has made it possible to develop several new products for consumer and industrial markets. The non-military by-products that have been obtained often bear little resemblance to the original applications. For example, electronic games using laser technology are already running in the Pizza Time Theaters; the fruits of Singer Aerospace's research can be found in its sewing machines and portable electrical tools. In fact, the research that is born oriented towards the market for military and space programs can then become aimed

at innovation when it generates products for the consumer and industrial market. In planning market outlets, it is very useful to obtain better business results to take into account the strategic distinction between market-oriented research and innovation. In fact, if clear and realistic objectives are established from the outset, the disputes that often arise between R&D and marketing when a project does not give rise to easily salable products can be avoided. Furthermore, this has the advantage of offering precise guidance to market research workers who need to identify the best commercial applications or technological achievements.

6. Conclusion

In light of what has been highlighted in the previous pages we can conclude that, there is no consensus on the boundaries between high tech sectors and other sectors. However, from the elements common to several definitions it is possible to reach a conclusion. Relationship between R&D and sales and the ratio between specialized personnel and total number of employees are two commonly accepted indices for identifying high-tech companies and it is difficult to give a definition that keeps its boundaries stable for a long time. The cause is known. Technological change is very intense.

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