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Futures Research, Long-Range Planning and Technology Monitoring

Lucie Deschênes

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In this report, the systematic use of masculine forms is intended only to facilitate reading.

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FOREWORD

Long-range planning and futurology—two terms often used indiscriminately. Long-range planning and technology—two interrelated worlds. It is to throw light on these frequently confused realities, to illuminate the shadowy ground covered by these often interchangeable concepts, that we undertook this contemplative work.

Adopting a historical approach, we trace the development and evolution of futurology and long-range planning, and then examine the advent of long-range technological planning and technology monitoring.

We hope this work succeeds in demonstrating the importance of developing a global vision of—and a strategic approach to—reality as well as the predominant role played by information in a context of increasing market globalization.

It would appear urgent for Canada to follow the example of more advanced countries that have been able to maximize the use of "intelligence" to maintain their positions as world economic leaders and develop institutions for performing future-oriented analysis.

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INTRODUCTION

Futurology, forecasting, long-range planning. These are all terms that describe various human efforts to control the future, to give it a direction or sense.

> Discussions of the future can take many forms: some try to guess at it and predict it; others try to imagine it or dream it; still others try to anticipate it. Each of these verbs has a corresponding noun: fortune-telling and prophecy; science fiction and utopia; futurology, forecasting and long-range planning.[1]

In ancient Greece, oracles made prophecies. "The word oracle means both a **place** where a god or a goddess was thought to reveal the future and the **person** who announced such predictions. Ancient Egyptians and Hebrews consulted oracles, but the most famous oracle was located in Greece on the slopes of Mount Parnassus at a place called **Delphi**."[2] But an oracle's advice was not always useful, for a single prophecy could have more than one meaning. Diviners used a variety of other means to predict the future, including dice, cards, tarot, tea leaves, dominos and palm reading.

From ancient times to the Renaissance, a number of techniques with names ending in *-mancy*—including cartomancy (fortune telling with cards), chiromancy (palmistry) and geomancy (divination by means of geographic features)—found favour among intellectuals. However, the ability to divine, and thus to predict the future, was driven underground until the Second World War, when it reemerged in such contemporary forms as parapsychology. Astrology, once considered a science, formerly influenced decision-makers and remains popular today in many segments of society. "In modern times, the positions of stars and planets, once obtained from reference books and charts, are now programmed into computers so that one need only input a date, time and place of birth to find out how the bodies were or will be positioned."[3] Based on the belief that each planet has a specific influence on peoples' lives, astrology introduced the notion that elements of nature could cause and influence worldly events.

At the same time, ideologies regarding the beginning or end of the world proliferated; these included millenarianism, messianism and eschatology. The influence of Mohammed, Nostradamus—author of *Centuries astrologiques* (1555)—and other prophets can still be felt in modern society. A number of writers describing utopias—fictional, imaginary communities—have also contributed to an ideal vision of society: Thomas More in *Utopia* (1516); Sir Francis Bacon in *The New Organon* (1620) and *The New Atlantis* (1627); Cyrano de Bergerac in *l'Autre Monde, ou les États et Empires de la Lune et du Soleil* (1657); Étienne Cabet in *Voyage en Icarie* (1840); and William Morris in *News from Nowhere* (1890). "Numerous utopian stories appeared in the 1800s when writers were inspired by the idea of progress. One of the best known of these was *Looking Backward: 2000–1887* by Edward Bellamy."[4]

Science fiction also become popular. Among its more famous exponents were Jules Verne with *20,000 Leagues under the Sea* (1870) and *L'éternel Adam* (1910); E. M. Forster with *The Machine Stops* (1920); and H. G. Wells with *The Invisible Man* and *The War of the Worlds* (1898), *A Modern Utopia* (1905) and *The Outline of History* (1929). "But surely Wells's most glorious feat was to predict in 1933, following an incident in Danzig between a young Nazi and a Polish-Jewish businessman, that the Second World War would break out in 1940."[5] More recent contributions have come from B. F. Skinner with *Walden Two* (1948); George Orwell with *1984* (1949); Isaac Asimov with *The Foundation Trilogy* (1942–1949), *The Evitable Conflict* (1950), *I, Robot* (1950), *The Caves of Steel* (1953) and *The Gods Themselves* (1972); Ray Bradbury with *The Martian Chronicles* (1950) and *Fahrenheit 451* (1953); and Aldous Huxley with *Brave New World* (1950). These writers discuss changes in society and the social consequences of change.

Philosophers and scientists have pondered why things are as they are, and what they should be.

> Some philosophers thought about the religious idea that God or Goddess will bring about a grand finale to history, then changed that idea into a belief that history has its own laws of development. About 1807 the German philosopher Georg Friedrich Hegel wrote about a Spirit which realizes itself in history, a Spirit

> that is more like a force, say electric energy, than a god. This Spirit, according to Hegel, drives history from one stage to the next.[6]

Karl Marx took up these ideas and inferred that historical laws would lead to the fall of capitalism and the rise of communism, a system controlled by the workers. The 1917 Russian Revolution did not bring forth this ideal society but rather five-year plans intended to increase production.

Social evolutionism was also influenced by the contributions of Auguste Comte in *Discours sur l'esprit positif* (1844) and Herbert Spencer. "What remains of true social evolutionism appears in a wide variety of sources, including a recent book by B. Stasi in which can be found this Teilhardian sentence: 'The history of the world has a direction, a direction leading eventually to world unity.'"[7] Antecedents to social evolution can be found in Immanuel Kant's works—in *On History* (1784), for example. For Kant, social evolution is motivated by a creative contradiction between men's interests, which drive them to selfish self-affirmation, and the social arrangements necessary to satisfy these interests. "Simply stated, the two key ideas of social evolutionism are these: history (or civilization) advances linearly and history is progress."[8]

In science, the development of the theory of evolution put forward by Charles Darwin, who in *The Origin of the Species by Natural Selection* (1859) explained how nature had evolved from simple cells into the complex life-forms now found on Earth. "Religion, philosophy and science all agreed that the world was going somewhere. People began to believe in progress. Perhaps, eventually, our world would really be perfect."[9]

This proliferation of theories and practices can also be seen in the social sciences, where a wide variety of approaches have been developed and given names such as projection, forecasting, long-range planning and strategy. But since the future is unpredictable, researchers cannot predict events but only suggest what might occur. "Behind modern ways of looking into the future—whether they be called long-range planning, futuristics or futures research—lies a more or less clearly stated conviction that humanity is about to undergo a radical change."[10]

Because these terms are often used indiscriminately, there is some confusion as to the difference between long-range planning and futurology.

By way of providing a background to the debate, we begin with a brief historical overview of the main approaches that have given rise to futurology and long-range planning. Chapter 1 describes the emergence of future-oriented currents in society. Chapter 2 describes the development of the long-range planning approach. Chapter 3 focuses on the importance of long-range technological planning, while Chapter 4 reports on recent progress in the field of technology monitoring.

CHAPTER 1

Futures Research* in the United States

1.1 Institutionalized Futures Research

Modern, scientific forecasting techniques intended not just to predict the future, but to control it, were developed after the Second World War using results from military and paramilitary research. The word "futurology" was coined in 1949 by Ossip K. Flechtheim to refer to a study that dealt with the future. Futurology made great strides in the United States through the work of Herman Kahn and the Hudson Institute. Kahn was one of those who made the world aware of the need to explore the future using indicators.[11] His last book, *The Resourceful Earth: A Response to Global 2000*, appeared in 1967.

In his book *Histoire des Futurs*, Cazes shows that the initial impetus behind institutional futures research in the United States came from national defense. In 1944 General Arnold of the U.S. Army Air Corps asked scientist Theodor von Karman to make a list of technical advances which might be of interest to the military. "The purpose of the forecast was to identify priority research activities that would prevent the Air Corps from falling in military capability in the future."[12] Von Karman's study was the first methodical technological forecast to include a systematic analysis using a predetermined, 15-to-20-year time frame. In his report *Towards New Horizons*, this pioneer of technological forecasting developed a prototype for normative forecasting. "The accent he placed on long-term forecasting and on 'alternative combinations' was characteristic of futurological orientations during the 1960s."[13]

General Arnold's second initiative was to set up a permanent agency responsible for analyzing and comparing defense policy alternatives. This initiative led to the creation of the RAND Corporation in 1948. According to Cazes, RAND became a forecasting methods laboratory during the 1950s and played an important role, as its research staff left to work

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* This term has been widely used to describe the future–oriented research done in the United States.

elsewhere, in the genesis of other American think tanks. Two examples are Herman Kahn and the Hudson Institute (1961) and Olaf Helmer and the Institute for the Future (1968).[14]

"The RAND Corporation, one of the first and best-known think tanks, took its name from R&D: Research and Development—RAND. The RAND Corporation began as the R&D department of Douglas Aircraft Company. Soon after World War II, however, RAND began to study technological inventions in all areas."[15] The Delphi method was developed at the RAND Corporation under Olaf Helmer's direction. This method, first applied in 1953, was extended to scientific and technological forecasting in a major 1963 study of a number of contemporary issues by Helmer and Theodore Gordon.

> The beginning of futures research can be traced to the military planning that followed World War II. To avoid military obsolescence, it was deemed necessary for our nation to be the first to develop key technologies. This goal placed a high premium on technological forecasting (TF), an activity that attempts to predict the future, but with probabilities attached. The success of TF in guiding military planning led to its use by other planners as the pace of change quickened.[16]

Studies of the future became more frequent during the 1960s. Examples of such work are Dennis Gabor's *Inventing the Future* (1964) and Kahn and Wiener's *The Year 2000* (1967). Military research programs in the United States stressed "technological forecasting," or forecasts of technological changes. "The conceptualization of future thinking took place at the same time as the development of forecasting in the USA, but its basis and outcome are both different."[17] Elsewhere, the Hudson Institute devoted a large part of its work to studies of the future, while the American Academy of Arts and Sciences, under its president Daniel Bell, created the Commission of the Year 2000. "In my view, what American society really needed was a systematic effort to detect social problems in advance, determine new solutions, and suggest a choice between alternative programs."[18]

A professional journalist, Edward Cornish, founded the World Future Society in 1966. The Club of Rome, founded in 1968 by Aurelio Peccei, "...took upon itself to rediscover the dangers of industrialization, the race for growth and unbridled demographics"[19] and published the report *The Limits to Growth* by Dennis Meadows *et al.* in the United States in 1972. "The report warned that if every business and every country keeps on trying to become larger and richer, catastrophe will result."[20] According to Cazes, the success of *The Limits to Growth* was due to two factors:

> The first is that the operation had the benefit of the prestigious duo of mathematical and computer modelling, supposed proof of rigour and exactness. The second was that readers were favourably impressed by the "systems" argument underlying the model's architecture. As the name implies, this argument treats the global economy as a system including several highly interdependent subsystems (the five variable blocks); a change in any one of these will induce changes in the other systems with which it is interconnected.[21]

The report's methodology was derived from work on computer-based dynamic modelling ("systems dynamics" or "global modelling") by Jay Forrester of M.I.T. The five variable blocks are: population, industrial production, food production, non-renewable natural resources and pollution. The succeeding report, *Mankind at the Turning Point* (1974), was based on a more sophisticated model—the World Integrated Model developed by M. Mesarovic and E. Pestel—and presented a more optimistic view of the future.

Alvin Toffler's books *Future Shock* (1971), *The Third Wave* (1980) and *Previews and Premises* (1983), as well as works by the Club of Rome, *Reshaping the International Order* (J. Tinnergen, 1976), *L'Énergie : le compte à rebours* (T. De Montrbrial, 1978) and works by Daniel Bell and others were important milestones in the development of the discipline. In Cazes's view, a turning point occurred in 1965, when university researchers became involved in studies of the future. For example, the development of the theory of post-industrial society was critical for futurologists, as it formed the basis for a broad consensus on social and economic organization in the Western world. "By failing to note that the origins of futurology lie in military research, technological futurism and industrial planning, this rhetoric covers up one of its ideological functions, namely, to promote technological progress."[22] In fact, from the 18th century until the middle of the 20th century, the idea of progress was closely linked to societal development. In Daniel Bell's view, this development proceeded from agricultural society to industrial and then post-industrial society. Futures research follows in this vein, and is seen first and foremost as a means for describing and explaining this phenomenon. Daniel Bell's main work, *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, has stressed the importance of forecasting.

Post-industrial theory came into being at the same time as the consumer society. According to E. Philippart, these theories are both based on the proposition that industrial nations are entering a new phase of development, and they both stress the overwhelming importance of service industries and the profound societal consequences of this transformation to a service economy. "The materialistic, mass consumption society gives way to a qualitatively different one, organized around theoretical knowledge—which has become the most important component of everything."[23] Various theories to explain the emergence of an information society were developed later on.

1.2 Futures Research and the Business Environment

Research carried out between 1945 and 1965 was also designed to meet the needs of large corporations. "Descriptive futures research aims at forecasting future contingencies as objectively as possible, based on the regular trends of the past. Typical descriptive forecasting is quantitative. Descriptive futures research is usually carried out in established institutions (research organizations, companies, etc.) by well established methods."[24] Researchers assume that the future is, in principle, predictable. They identify current factors and extrapolate them into the future. Progress is linked to economic growth, seen as the principal indicator of a set of variables.

> The most common ideas of the mode of progress in descriptive futures research have been the concepts of linear and exponential modes of progress. Generally speaking, in the linear model one expects quantitative growth or "more of the same thing" and in the exponential, "much more of the same thing." "The same one thing" can be gross national product, turnover in a company, population, members in an organization, etc. At the same time, growth is regarded as a probable and desirable mode of development. Although there may be some economic and other cycles, the general trend is clear—and predictable—as the cycles to a certain degree of accuracy, depending on the data.[25]

Integrated into long-range industrial planning or corporate planning practices, futurology developed rapidly as a means for business firms to better understand their environment. "In long-range industrial planning, the choice of a method for forecasting growth or product sales depends on a number of criteria such as the product life cycle (birth, growth, maturity, decline)."[26]

It appears that until the Second World War, organizations planned only over the short term. According to B. Scott, this period was critical to the development of formal methods for long-term corporate planning: "The exceptional growth rate of several industries—growth due to arms manufacturing—forced businessmen to reexamine their organizations and, possibly, the logic of their planning practices to meet larger and more far-reaching management challenges."[27] Analyses of trends based on economic growth were more popular during the 1950s and 1960s than during the turbulent 1970s and 1980s. Monitoring of the business environment, the subject of a great deal of research in the early 1970s, gave rise to the "environment scanning" methods of F.-J. Aguilar and I. Ansoff, in which monitoring of a number of areas provides information on forces liable to provoke change. "According to Ansoff, these change-provoking forces should be identified while they are still only sending out weak signals."[28]

Futures research is important for firms, which must often make long-term decisions in a sometimes uncertain environment.

> "A careful, reasonable hypothesis seems to be that firms in fast-growing, high-technology military and aerospace industries were forced to reflect on what their future environment would be, while it took the first oil crisis at the end of 1973 for the remaining firms to get used to the idea that the future may not be a simple extension of past trends."[29]

While the corporate sector views technology as one factor among many, its influence increases as high-technology industries become more important to economic development. "As the nation, the United States among others, becomes more intensively concerned with international competition, and as that competition moves into new dimensions of products, processes and services and acquires a more extensive scientific and technological base, all of these will conspire to create new levels of sophistication in planning and forecasting."[30]

1.3 Government Initiatives and Exploration of the Future

The initial efforts of the American government to explore the future took the form of two initiatives, both dating from the period between the two World Wars. The first of these, the result of a decision by Republican president Herbert Hoover, was the creation in the fall of 1929 of the President's Research Commission on Social Trends, financed by a grant of $560,000 from the Rockefeller Foundation, as well as the publication in 1933 of *Recent Social Trends*, a study which provided a factual basis for planning.

> "Hoover's successor, Franklin Roosevelt, was responsible for the second case of (temporary) institutionalization of long-range planning, in the form of the Commission on National Resources, of which one of the committees, again led by Ogburn, published a report entitled *Technological Trends and Government Policy* that undertook to detect the possible social consequences of technological progress."[31]

Cazes has only found two examples of efforts to create permanent long-range planning structures within the federal government: in 1960, President Eisenhower established a Commission on National Objectives while ten years later in 1969, on the advice of one of his counsellors, President Nixon set up a research group on national objectives. This latter group published a report titled *Toward Balanced Growth* in 1970. However, these two initiatives were never followed up.

The movement toward political institutionalization found more support among legislators. "In 1966, a report of a House of Representatives subcommittee stated that all technological innovations should be subject to assessment before being implemented, to identify the medium- and long-term consequences in advance and to review their positive and negative aspects."[32] This idea was made concrete in a 1972 law creating the congressional Office of Technology Assessment, with ongoing responsibility for studying the social consequences of new technologies and making public its conclusions.

> In addition, since 1975, an internal regulation of the House of Representatives (known as the "foresight provision") requires all committees of this body (with the

> exception of the Finance Committee) to carry out ongoing long-range planning and forecasting, so as to facilitate early identification of problems that might call for legislative action.[33]

Futurologists' influence extended to the political and diplomatic arenas as long-range planning methods come to be used there. For example, Kennedy used zero-sum game theory to persuade Khrushchev to remove Soviet missiles from Cuba in 1962.[34] But this influence can also be felt in all areas of society (social, economic, political, military and even philosophical). In the United States, a number of agencies—military departments, NASA, the Federal Power Commission, the Bureau of Labor Statistics—now practice long-range planning. "As Bell has noted, the futurologist's task is to 'determine limits or constraints within which policy decisions can have a real effect.'"[35]

1.4 Methodological Approaches to Futures Research

Futures research studies assume that a vision of the future gives meaning to the past and clarifies the process, or, as Gaston Berger has said, "the future is the reason the present exists." "Thus, the future for all these thinkers does not just happen, but is consciously or unconsciously built. It is the human factor which is crucial to the future—on the one hand, historical memory, and, on the other, socioeconomic and political forces, which are the movers of choice and action. It is again clear that central to the whole process is the human being, and his or her values."[36]

First-generation work in futurology, by emphasizing a future extrapolated from the past and present, has been essentially projective. "In this point of view, the future is always, over the more or less long term, a repetition of the past."[37] Since it appears to see everything as heading in the same direction, such thinking represents a kind of determinism. "When using trend extrapolation, futurists first look for a pattern—called a *trend.* Then they extend—or extrapolate—that trend into the future. In other words, trend extrapolation is a way of looking toward the future by carrying forward an existing pattern."[38] A trend can be represented by a mathematical equation, and different trends raise the possibility of alternative futures.

Two objective methods are trend extrapolation and modelling. According to Cazes, extrapolating a trend over a certain period means calculating the values the trend will take on if current patterns continue. Extrapolation treats each trend as an isolated phenomenon, while modelling groups variables into a coherent set "...in which all relationships, both internal (among the various system elements) and external (between the system and the external environment), are explicit and quantitative; the model is therefore capable of taking simultaneous account of a large number of complex accounting, institutional, structural and logical interdependencies."[39]

Another characteristic of futurology is its use of diverse sources of information, including subjective information, on the future. "This process led to the development and use of such methods as the Delphi technique, scenario writing, brainstorming, cross-impact analysis, and system dynamics for applying informed judgment to the exploration of long-term future change."[40] In the 1960s, Gordon and Helmer developed a method using expert responses that remedies some of the weaknesses in the Delphi method by allowing for interrelations among responses. While experts consulted in Delphi studies had limited their responses to given events/trends, an interaction matrix enables them to indicate if, and to what extent, predictions formulated about variables in each row of the matrix will affect predictions about variables in the columns, by increasing or decreasing the probability that the predictions will in fact come true.[41] K. Wilson has written that in addition to long-term planning, a multidisciplinary approach, an interest for social change, and innovation and formal methods, the discipline of futurology is characterized by a number of functions: (1) selection among future objectives; (2) development of future scenarios using plausible hypotheses; and (3) social intervention.[42]

Economists have developed similar concepts and methods for economic forecasting.

> The most widely used method for long-term economic forecasting falls into two categories. First there are the now well-known extrapolation techniques: regression, correlation, trend analysis. Econometric models are common as well. But intuitive methods—brainstorming, consulting experts, scenarios—are also used. In this case too it is clear that formal intuitive methods (for example, cross-impact analysis) are used very little.[43]

Economic forecasting methods, having developed in stable economic circumstances, led to a deterministic vision of the future.

> In the context of the times and in the particular field of economics, forecasting activities amounted to searching the past for an invariant, supposedly permanent factor. By referring to "yesterday," forecasters were supposed to be able to say what "tomorrow" would be. And to the extent that the structure of the system being studied really was invariant, economic forecasting was an appropriate approach.[44]

This method, which assumes that factors outside the system being studied remain essentially stable, was well suited to the period of economic growth experienced by the United States during the 1960s. However, society soon experience an important structural change.

> Classical analysis and forecasting methods are not sufficient to understand and manage structural changes observed in the development of the contemporary world, which is characterized by the increasing complexity and interdependence of economic and social systems. Moreover, these methods generate very deterministic visions of the future which, in the end, exclude any notion of liberty or free will.[45]

The approach to futures research developed in the United States during the 1960s was based on quantitative data and saw the future as a continuation of the present.

> But why do we classify this effort as a futures research study? Basically, we do this because its findings were almost exclusively based on judgments about the future and because these judgments were used to develop complex scenarios, as opposed to identifying only the next generation of military-related breakthroughs, although the study team members did do an excellent job of anticipating major future developments.[46]

In this regard, the scenario method has increasingly become an integral part of futurology. "According to E. S. Quade, the purpose of a scenario is to describe in advance the assumed conditions under which a system or policy—whether for analysis, design or assessment—will operate."[47]

1.5 Contemporary Futures Research

Between the mid-1970s and early 1980s, a number of factors (including a reexamination of the Welfare State, increased immigration, and political and social movements) affected futures studies, which were viewed as linked to society's ideological objectives. "This exemplifies the change from extrapolations that are as objective as possible, to goal-oriented (normative) future studies. In all cases, the future objectives are stated, and the projections analyzed and examined from the point of view of realizing the objectives, the vision."[48] In this view, reinforced by increasing complexity and interdependence of events during the period, the future becomes more than a continuation of the past through the present. "The 1970s and the beginning of the 1980s were without a doubt a time of discontinuity, producing awareness of the complexity and interconnectedness of events and facts, the consequences of which, according to some writers, are turbulence and uncertainty."[49] Progress continues to be an inspirational theme in the long-range planning literature, which turned away from individual behaviour and toward the global economy. "Today, the nearest equivalent to the tradition of 'Directed Progress' can be found in various international organizations' intentions to reform the world economic order."[50]

In this context, futures research makes a more substantial contribution to public and private sector decision-making—and has a larger influence on public opinion—if the objectives to be pursued are made clear. A new priority for futures research has become to furnish information better suited to strategic decisions faced by public and private organizations.

> Hence our discussion of futurism and forms of corporate strategic planning comes full circle:
>
> - From extrapolation, product-market displacement, contingency planning, and goal displacement;
> - Through futures scenarios, social indicators, quantification of trends, environmental scanning, systematized scanning, and models; and
> - Back to information overload and to dialectic-subjective executive decision making.[51]

Strategic analysis should be combined with alternative futures to stress the importance of change for organizations. "Procedures are needed that not only explore alternative futures but also integrate these alternatives with strategic planning to develop robust, long term corporate plans and monitoring systems."[52]

According to Slaughter,[53] futures research using trend analysis and forecasting should disappear, to be replaced by process analysis and a systemic approach, which recognizes that change and uncertainty are important constants. Users of this approach do not predict the future, but develop different alternative futures*; progress is only one of several variables. A normative approach, using scenario development, is here compared with an approach that generalizes the present by assuming that history repeats itself and that evolution is similar. This active, creative attitude toward the future, in which individual will plays an essential role, is similar to the long-range planning approach, or what the French call *prospective*.

Thomas Jones has noted a fundamental split between two ways of viewing the future among contemporary futures researchers. The first of these, the "developmental futures" school —which includes Daniel Bell, Herman Kahn, Zbigniew Brzezinski (National Security Adviser in the Carter administration) and architect R. Buckminster Fuller (prophet of abundance through technical progress)—sees the future as continuous, gradual evolution. The second, the "turning-point futures" school, sees the future as the result of a choice between several possibilities.

> Starting with the same facts and trends from the contemporary world, this school arrives at conclusions diametrically opposed to those of the preceding school, since it believes that the world is threatened by serious catastrophe, especially by an aggravation of the gap, announced by Malthus in the 19th Century, between the number of people on earth and the amount of available food and mineral resources. Only substantial changes in institutions and value systems can bring about a lasting balance; at the same time, science and technology should be approached with extreme mistrust, since at best they can only relieve symptoms and at worst they may help to aggravate the problems (nuclear energy being clearly a special target here).[54]

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* Appendix 1 describes the tools used for managing change.

Those speaking most prominently for the turning-point futures school are the Club of Rome, the American ecologists Lester Brown, B. Commoner and P. Ehrlich, Michael Marien (author of the *Future Survey*), K. Schumaker (author of *Small is Beautiful*) and the Europeans Jacques Ellul, Robert Jungk, Ivan Illich and Aldous Huxley. Goldthorpe has criticized the futurologists by claiming that their technological and economic determinism is accompanied by lack of doubt as to whether economic growth should be the overriding objective for advanced industrialized nations.

According to Joseph F. Coates, the three classes of expectations raised by futures researchers are: (1) Prediction of events to come. Most trends are now scientific in nature, which complicates their interpretation. It is becoming more appropriate to interpret the implications of these events. (2) The formulation of decision-making advice. "We have methods and techniques for generating and creating those alternative futures. The whole sub-enterprise, elaborated and practised in scores of studies under the title of technology assessment, is increasingly leading to more sophisticated inputs into decision making."[55] This area has experienced great success over the last decade. (3) Provide strategic directions for action and analyze them in terms of complexity.

> "This has been a growing strength of futurism for the last twenty years. Tools of complexity to explain, explore, present and analyze complex situations abound. While no technique is definitive, everything is helpful. The range of tools from Delphi to cross impact, from scenario building to econometrics, is constantly being augmented by improvements and the addition of new tools. Most recently, for example, this journal presented speculations on the application of chaos theory to the study of the future. Tools for complexity are being added to the repertoire on the mechanical and technical side through simulation, imagery, mathematical modelling, and a dozen other areas."[56]

Futures research has therefore become increasingly oriented toward study of alternative futures*. It has developed from a field that predicted future circumstances based on the present to one in which the future is uncertain and complex. Therefore, futurologists develop alternative

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* A summary of the principal factors analyzed by futurists in the United States is given in Appendix 2.

futures and make recommendations to different decision makers, both in government and the private sector, regarding the best strategies to attain these possibilities. "In short, forecasters are concerned with what will happen, while futures researchers are concerned with the process that is capable of creating the alternative futures."[57]

CHAPTER 2

Long-Range Planning* in Europe

2.1 A Long-Term View of the Future

In contrast to the United States, there was virtually no long-range planning in France during the period between the two World Wars.

> To be sure, as A. Drouard has written, there was "a certain amount of research" (discussion would be a better word) by individuals from diverse backgrounds and settings—all convinced, however, that social sciences and humanities were what was needed to cope with the crisis. Among these were J. Coutrot at the Centre Polytechnicien d'Études des Problèmes Humains; R. Aron, G. Friedman, J. Stoetzel and R. Marjolin at the Centre de Documentation of the École Normale Supérieure; and G. Bataille at the Collège de Sociologie.[58]

A fundamental change occurred in the field of long-range planning after 1945, when gazing into the future became both more scientific and more action-oriented.

Toward the mid-1950s, French planners became aware of the importance of taking the long view. In preparing the Second Plan (1958-1961), the Commissariat Général du Plan decided to draw up an economic forecast through 1965 in cooperation with the Service des Études Économiques et Financières of the Ministère des Finances. The Fourth Plan (1962-1965) was also prepared to include a long-term component, to 1975. Prospective 2005 was undertaken jointly in 1984 by the Commissariat Général du Plan and the CNRS (Centre National de Recherche Scientifique). This orientation was strongly influenced by a few individuals, particularly Gaston Berger, Jean Fourastié and Bertrand de Jouvenel, who played a part in drawing the attention of decision-makers and the general public to the future.

> Thus A. Drouard sees in what he calls "the appearance of the long-range view" in the late 1950s one way to satisfy the need, felt in various parts of government

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* This term has been widely used to describe future-oriented research in Europe.

> or business, for "explaining or analyzing social phenomena in specific terms"—where "social" is considered "either as something left over that one must try to master through understanding, or as an additional dimension that must be included in economic forecasts to increase their effectiveness." Similarly, in a sometimes controversial but always intellectually stimulating essay, the sociologist Edgar Morin has suggested that there is a relation between this trend toward the long-range view, the rise of a "new technological and scientific intelligentsia ... and the influence, if not the stranglehold, of this intelligentsia on decision-makers."[59]

Gaston Berger was responsible for coining the French term *prospective**, the meaning of which can be summed up as follows: (1) A strong connection between present action and the future, which implies being conscious of the long-term consequences of one's action. (2) The magnitude of scientific and technological change, suggesting a turbulent future. (3) Discussion of human objectives, taking account of capacity for action. (4) Long-range planning methodology, leading to the creation, in 1957, of the Centre d'Études Prospectives. "After Berger's death, the Centre took on a collegial structure with Pierre Massé as president, and continued its activities for several years before merging with the association Futuribles, founded by Bertrand de Jouvenel in 1960."[60] This latter association attempted to orient social science research towards the exploration of alternative futures.

Bertrand de Jouvenel had pointed out that the distant future required special attention. "In particular, he gave a remarkably clear discussion of the three poles around which long-range planning activities are organized: those who develop images of the future; those professionals—firms, governments, international organizations, local communities—who use them; and finally the 'general public,' in other words, each of us acting individually."[61]

There was lively debate in Europe during the 1960s and 1970s on the nature of long-range planning, which adopts an approach somewhat different from that of trend analysis or forecasting in that it is oriented toward the long term while forecasting is applicable in the short and medium term in a stable environment. In addition, long-range planning studies the relationships between

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* Translator's note: Valaskakis (1988) notes that "the French approach to the scientific investigation of the future is known as 'Prospective,' a concept which has yet to find a satisfactory translation in English." For want of a better translation, "long-range planning" is used here.

different factors and their effect on present circumstances. "It is less interested in a picture or pictures of the future than in the paths that lead to them, the mechanisms that come into being, the problems that develop, and the tensions that may appear and that call for study."[62]

Besides the Centre National de Prospective, founded by Gaston Berger, and the association Futuribles, directed by Bertrand de Jouvenel, a number of other European institutions focus on the area of long-range planning: in England, the Social Science Research Council, which founded the Committee for the Next 30 Years; in Sweden, the Secretariat for Future Studies, to be joined by the Institute for the Future; and in the Netherlands, the Netherlands Scientific Council for Government Policy. "At the time, a fairly broad range of decision-makers and intellectuals in Europe had reached a consensus to promote general study of the future, as clearly distinct from more classical work in economic and demographic forecasting, which was the realm of statisticians, and technological forecasting, which was mainly carried out by the military and private business."[63] Notable among periodicals in this field are *Futuribles*, which appeared in 1961 and has been called *Analyse et Prévision* since 1966; *Analysen und Prognosen*, started in 1968 by the Zentrum für Zukunftsforschung in Berlin; *Futurum* under the direction of Ossip K. Flechtheim; and *Futures* in the United Kingdom.[64] Discussion had become centred on society as a whole.

> The tendency to think on a world scale quickly brought forth two schools of thought: the global modelling school, in large part gradually "taken over" by economists and statisticians, and a more humanistic and ecological school centred on local issues. Another trend—toward long-range planning concentrating on more specific areas of economic activity—has undergone a number of changes in focus; attention has shifted from social and ecological problems (1965) to resource (especially energy) issues (1975) to technology (1980).[65]

2.2 Planning and "Prospective" Thinking

In the early 1960s, what Cazes has called the second phase of long-range planning studies began. This phase was characterized by the public nature of long-range planning reports and by the uses of methods other than forecasting.[66] For example, in 1962, to clarify the general orientations of the Fifth Plan, Pierre Massé brought together a group of a dozen experts to study, using an "indicators" approach, things it would be useful to know about the France of 1985. One of the recommendations from the Groupe 85 report, *Réflexions pour 1985*, published in 1964, was that a long-range planning component should be created, in connection with economic planning, within each major branch of government. "This suggestion was simple but nonetheless effective, since between 1964, when Defense created the Centre de Prospective et d'Évaluation, and 1973, when Foreign Affairs set up the Centre d'Analyse et de Prévision, few government departments did not attempt to develop some capability to explore the long-term future.[67] The events of May and June 1968 contributed to the popularity of this type of research during preparation of the Sixth Plan (1971-1975). On the other hand, the 1973 oil crisis and subsequent recession had the effect of increasing demand for medium-range planning. It appears that in general, the field of long-range planning has become smaller and that more technological approaches have taken the place of more philosophically or politically inspired ones.

There is now consensus among practitioners in futures studies around Gaston Berger's principles: (1) The future is not a given that can be known scientifically in advance, but the product of human action. (2) The future is necessarily open and multifaceted. (3) Exploration of the future should range wide (global view) and reach far (long-term forecasting). (4) The future is best taken into account through the use of analytical, scientific instruments.[68]

In general, the long-range planner attempts to highlight long term evolutionary factors capable of transforming, quantitatively and qualitatively, the structure of the social system under study. "Through imagination, the long-range planner detects uncertainty and attempts to envisage what is hard to predict: the break, the mutation lurking behind the lingering trend, the transformation, the discontinuity, the emergence of indicators."[69] The long-range planner also tries to give meaning to alternative actions, to provide a tool to support decision making*. The purpose of long-range planning is not to predict what the future will be, but

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* For Quebec, see Le groupe québécoise de prospective, *Le futur du Québec au conditionnel* (Montréal: Éditions Gaétan Morin, 1982) and *Perspectives d'évaluation de l'économie québécoise : scénario à l'horizon 2005* (Quebec City: B.S.D., May 1988). See also the work done at the OPDQ and by the Gamma Institute.

> ...to be in a position to detect critical elements; with respect to a particular problem, to identify significant players and their plans; to describe any possible conflict or cooperation that these plans might lead to. Given several alternative futures, long-range planning enables decision makers to think about what they can do to increase the chances that one future, rather than others, will come into being.[70]

According to Cazes, while the long-range planning literature seems to deal with an infinite range of subjects, there are in fact only a small number of key themes. "These eight themes are as follows: (a) natural environment or ecosphere; (b) the geopolitical context; (c) global economic growth; (d) demographic trends; (e) changes in values; (f) technological changes; (g) employment and work; and (h) the Welfare State."[71]

M. Godet has written that long-range planning is based on seven key ideas: (1) Using the future to guide present action. (2) Exploring uncertain alternative futures. (3) Adopting a systematic, global view. (4) Taking qualitative factors and players' strategies into account. (5) Constantly bearing in mind that information and forecasting are not neutral. (6) Using several complementary approaches. (7) Questioning received wisdom.[72]

Long-range planning does not claim to eliminate uncertainty but to reduce it by supporting decisions intended to bring about a desired future. While long-term studies are generally used to solve questions related to uncertainty and change, the idea that the future is linked to human choices and collective action is receiving increasing attention.[73] "The French use the expression 'projet de société' to describe an optimum future scenario towards which the society should strive. At the level of private firms they use the similar idea of a 'projet d'entreprise.' In both cases this 'mission statement' is considered very important."[74]

It appears that, with the recent development of long-range planning, society is increasingly called upon to look to the future, that is, toward essential decisions and the discussions that accompany them.[75] Analysis of future changes in society should be carried out using a dynamic approach. "The development of a society can be described as a process of creative discovery where both stable and chaotic phases play vital roles. Instead of understanding societies in 'equilibrium terms' or as 'mechanisms' we see a world of incomplete information and changing values, a world where we can meet several different futures, development, turbulence and even catastrophes."[76] Such analysis should also be undertaken in the light of the ongoing globalization process.

> There have been only a few rare attempts at long-range planning on a world scale (specific examples are the team assembled in Berlin around the Globus model and work at the IIASA, the European Communities and scenarios established as part of the "Blue Plan"). Agencies that were supposed to promote discussions of society have disappeared (the Policy Review Staff, the National Long-Range Planning Institute in Spain, the Zentrum für Zukunftsforschung in Berlin) or, curiously, are up for review (the French Commissariat Général du Plan).
>
> With a few exceptions (for example, "Orizonte" in Italy and "Portugal 2000"), comprehensive studies are less widespread and have been replaced, notably by *ad hoc* mid-level operations (such as the Rencontres Plan-CNRS "Prospective 2000" and "Eurospective") or even by missions assigned to *ad hoc* groups set up directly by governments (especially in Italy and France).
>
> Most others are industry studies that, backed by business firms and governments, have been appearing more frequently; these are largely inspired by short-term competitiveness concerns.[77]

2.3 The Long-Range Planning Approach

According to M. Godet, long-range planning (*la prospective* in French) is an investigation of alternative futures which is seen as prerequisite to strategy and policy development. "Long-range planning is an original method for understanding the socioeconomic environment and its potential evolution, so that both individual and collective behaviour can be managed more responsibly."[78] This point of view considers long-range planning as inherent in decision making, that is, in taking action with the future in mind. "In the prospective conception the normative and political aspects of futures research are emphasized: the future can be made by human actions; it is the task of futures research to design alternative images of the future and to lead these images into the political arena, where they can be discussed."[79]

Guy Poquet considers that the first stage in long-range planning is understanding the present. A long-range planning strategy can be based on an analytic approach, studying the elements of a system and the relationships between these elements; or it can be based on a systemic approach that views reality as a set of qualitative elements and their interactions and interdependences. The systemic approach analyzes the system in all its complexity, so that "...decisions can be made by evaluating the impact of present action and developing long-term strategies."[80]

This approach was inspired by cybernetics and the General Systems Theory developed by Ludwig von Bertallanfy in 1968. But there are as many definitions of a system as there are points of view. "A system is therefore an intellectual construct. An observer considers a set of elements and organizes them into a system, that is, makes them interact, based on his subjective understanding. In a way, the system is a tool he uses to look at and understand reality."[81] In addition, a system can change (i.e. be dynamic) and can be global and complex; it can include factors of equilibrium and disequilibrium. Long-range study of systems takes place on three levels: perception, in which the boundaries of the system containing the phenomenon under study are traced; comprehension, in which the structure of the system (its variables and relationships) is clarified; and explanation, in which independent and dependent variables are identified.

The second stage in long-range planning is anticipation of changes and implementation of methods such as trend extrapolation or the Delphi method. "To anticipate change, and in so doing round out problem definition and understanding of the current situation, is to identify significant or well-established trends, emerging trends, and indicators"[82] Many kinds of information are used in long-range planning: major trends are characterized by a number of highly influential events that point in the same direction (for example, the spread of communications networks in society); emerging trends are those that appear to be arising from a number of convergent events (for example, telework, which may or may not become common); indicators are the basic elements that make up trends—factors of change, barely perceptible now but possibly a significant trend in the future.

Most methods used in the second stage of long-range planning rely on experts to varying degrees. The most popular of these is the Delphi method, which itself has given rise to a family of analyses based on probabilistic interaction. Starting with divergent expert opinions, the Delphi method attempts to reach a consensus among a group of experts using a series of questionnaires. Analyses based on probabilistic interaction identify events and/or trends regarded as important to a particular field of study; their objective is to determine possible strategies by evaluating statistically coherent probabilities, identifying potential developments, and simulating and testing various decisions in a number of future situations. "This final point brings up the normative dimension to long-range planning and what is, or should be, its fundamental motivation: to act as a decision-support tool."[83] Normative long-range planning, which identifies both a desired future and the means of attaining it, has given rise to strategic planning*.

The third stage in long-range planning is to construct a vision of the future using decision-support studies that attempt to specify means for attaining certain well-defined objectives. Scenario development is the preferred method in this stage.

> Strictly speaking, a scenario is a synthetic means for indicating, plausibly and step by step, a series of events that lead a system to a specific situation, and for describing in detail the situation itself. There are two major types of scenarios: exploratory scenarios, which extrapolate past and present trends to a logical future; and anticipatory scenarios, which begin by defining various desirable future situations and then show how to get there from the present.[84]

A scenario** is based on four ideas: (1) A basis, or organized representation of reality, composed of a system of interrelated dynamic elements. (2) The external environment—economic, social, political, diplomatic, national or international according to the situation being studied—for which external constraints making up the basic environment must be specified in the form of hypotheses. (3) A process or historical simulation which allows the system's

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* For the phases of strategic planning, see Appendix 3.

** For more information on this subject, see Pierre–André Julien, Pierre Lamonde and Daniel Latouche, *La méthode des scénarios* (Paris: Éditions La documentation française, 1975).

coherence to be tested in a variety of ways to check for possible incompatibilities. (4) An examination of the overall system as an organized representation of reality (including forecasts and new trends)—thus an image of the future making it possible to progress toward a new horizon. "In this sense, a scenario does not describe all that is possible or desirable, but attempts to define the conditions for bringing the desirable about by making linkages between it and the possible."[85]

In private sector applications, a scenario is a coherent description of a business firm's environment—its market, clients, competitors and suppliers, as well as the power and pressure groups surrounding it.[86] De Boisanger views the long-range planning process in private firms as including four phases:

> The objective of the first phase is to identify alternative futures that are strategically important to the firm; such ideas for scenarios arise from information gathered through monitoring (by all observers and in a few special studies) but called into question by a few creative and innovative iconoclasts; senior management then selects two or three significant alternatives.
>
> The objective of the second phase is to develop—that is, write and illustrate—a coherent scenario around each significant alternative. Profitable use may be made of expert cross-consultation (such as the Delphi method), cross-impact matrices, analysis and combinatorics (Twicki type), and methods based on creativity.
>
> The third phase develops "in case of..." strategic responses. Presentation of scenarios to various strategy groups at various levels should be provocative, in the sense that they should provoke reactions; all means likely to produce reactions (report, audiovisual presentation, video, film and role playing), including provocative scenario titles such as "When fences fall" (for a rural bank) or "Do inactive accounts consume energy" (for an electricity distributor), should be used. Managers involved are to imagine what decisions they would make, faced with such situations, to act on the environment and on the company itself.
>
> Using the outcome of these activities, the fourth phase makes decisions that best prepare the organization for alternative futures. Alternatives (i.e. environment scenario + strategic response) can be used in three ways: to abandon current strategy in favour of the alternative; to identify major decisions that best (or least poorly) prepare the firm for several currently equally-probable futures; or to set up a process for monitoring key points (indicators and measures of trends, FPA

> alarms and discontinuities) and take preventive action to create favourable situations and keep unfavourable situations from coming about.[87]

According to M. Godet, a scenario is not a specific future situation but a representational mechanism for informing present action in light of desirable alternative futures. "Thus a scenario is only credible and useful if it meets four conditions: relevance, coherence, likelihood and transparency. In other words, one must ask the right questions, formulate key hypotheses giving insight into the future, and appreciate the coherence and likelihood of possible combinations."[88] Given that the scenario method* takes time, it will often be desirable to limit scenarios to a few (from four to six) key hypotheses serving as a background for strategic planning of the "what to do if" or "how to" type. More than ever, using such a shortcut will require prior, explicit reflection on key variables, trends and players.

> In general, long-range planners select three scenarios. One of these, that which appears the most realistic, is central; the two others "set limits" on the range of variation for observed phenomena. Occasionally, the choice is between only two scenarios, based on contrasting hypotheses. The most probable scenario is called the base scenario or reference scenario. To the extent that the other scenarios are based on opposing hypotheses, they are called contrasting scenarios. To develop system evolution scenarios**, three conditions must be met:
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> - the key variables having the most profound impact on the future of the system or industry (in the studied application) must be identified;
> - the objectives of the main players, and the means at their disposal for carrying out their activities, must be understood;
> - possible developments in the variables and players should be determined.[89]

The advantage of scenarios is that they can be used in many ways by the various participants in the planning process; flexibility is one of their chief characteristics. "The clearest winner in the methodological sweepstakes has been the scenario. We now use scenarios more

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* A description of the scenario method is given in Appendix 4.

** The long-range planning process is described in Appendix 5.

frequently than in the past and in a greater variety of situations: both as end products and as 'front ends' for issue generation and for evaluating options."[90]

2.4 From Long-Range Thinking to Strategic Action

The influence of long-range planning is also apparent in organization management, where long-range thinking gives way to strategic action. However, although long-range and strategic planning* employ different practices and frames of reference, there is some synergy between these two complementary approaches.[91] "In the opinion of the director of Euroconsult, a firm should be seen as a tree of skills and cannot be reduced to its products and markets. In a tree, the roots (technical skills and know-how) and the trunk (capacity for industrial production) are as important as the branches (product lines and markets)."[92] This representation of the company as a tree** originated in a strategic analysis of Japanese firms and in the need for long-range planning for the competitive environment.

> For strategic planners, the social environment is the organization's external environment. Information about the external environment is essential at all levels of corporate planning. It is needed to decide on changes in organizational mission, to establish strategic objectives, to explore alternative long-range directions, and to decide what should be done in the short run. With or without futures research, strategic planning must be based on some insight into or assumption about the direction of the external environment.[93]

To take account of uncertainty and be in a position to propose alternatives, organizations should consider the external environment when planning strategically. There are many possibilities:

> One emphasized the benefits of developing and using inexpensive (quick and dirty) procedures for identifying and exploring macro strategic alternatives. The other attempted more detailed analysis of the alternative scenarios in ways that

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* See Appendix 6 regarding integration of long-range and strategic planning approaches.

** The Japanese tree diagram is presented in Appendix 7.

permitted them to be linked to organizational planning models. Typical of the inexpensive approaches are Focused Planning (Boucher, 1972) and Quest (Nanus, 1982); typical of the more detailed approaches are KSIM (Kane, 1972) and INTERFAX (Enzer, 1980).[94]

Michel Godet has drawn up ten recommendations for avoiding errors in strategic diagnosis: (1) Use multiple, uncertain alternative futures to inform present action. (2) Adopt a global, systems approach. (3) Take into account qualitative factors and players' strategies (the limits to modelling). (4) Learn from the past and do not underestimate inertia. (5) Decode information in the light of power games. (6) Mistrust received wisdom. (7) Count on social evolution to bring about technological evolution. (8) Transform structures and behaviour. (9) Put the company's intelligence to use (the Greek Triangle). (10) Consider the methods as tools for discussion and communication.

One fundamental point concerns the Greek Triangle*, or the need to mobilize the firm's intelligence. "Productivity does not guarantee competitiveness; quality and innovation (both technical and marketing), depending above all on the behaviour, initiative and imagination of everyone, at all levels of the firm, are needed as well."[95] To long-range monitoring and willingness to act strategically must be added a third factor: collective mobilization, in response to environmental threats and opportunities and strategic objectives. "This strategic culture, harmoniously combining the three golden rules—Anticipation, Action and Embodiment—is called the Greek Triangle. Long-range monitoring, willingness to act strategically and collective mobilization are the three golden rules in this strategic culture, a tremendous asset to corporations that epitomize competitiveness and excellence."[96] The principal factor underlying competitiveness and excellence, and one of the elements of the Greek Triangle, is the human and organizational dimension, seen in a mobilization of corporate intelligence through an explicit corporate mission that everyone understands.

This situation also implies changes in attitudes regarding personnel, who must accept the corporate mission as their own. "Hence the attention that executives now pay to corporate

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* The Greek Triangle is presented in Appendix 8.

culture—essential to human internalizing of the corporate mission—which determines whether a firm does or does not assimilate certain technologies, accepts or rejects certain procedures, pursues certain strategies easily or with difficulty"[97]

Finally, a distinction must be drawn between firms which conduct highly confidential long-range planning to be used exclusively for strategic decision-making by senior executives—in other words, as a strategic tool—and planning as a tool for motivation and management, enabling the organization to cope with change in a more enlightened environment. In the first case, long-range planning appears as a tool for strategy, while in the second it becomes a tool for motivation and management.[98] "But the preceding discussion also convinces us that management capability must extend far beyond a crisis focus. Vision as well as flexibility is needed. The ancient warning—'Without a vision the people shall perish'—will undoubtedly still be apt in 2000.[99]

2.5 Analysis of Change

Analysis of change is at the heart of any long-range point of view.

> Consider the disruptions that we have seen over the last decade or so: slower growth, intense global competition, burgeoning automation, obsolescence caused by technological change, deregulation, an explosion in information availability, rapid shifts in raw material prices, chaotic money markets, and major changes in macroeconomic and sociopolitical systems. The impact of these discontinuities on industry runs broad and deep. Destabilization and fluidity have become the norm in world business.[100]

In an evolving world where habits and a tendency toward inertia are swept away by forces for change, a firm's strategic flexibility—its ability to react flexibly while maintaining an even keel —depends on intensified long-range technological, economic and social planning.[101] "A strategist attempting to decide how to posture an organization must recognize both the uncertainty of the environment and the potential need to deal with any of the possibilities this environment can produce; it is not sufficient to bank exclusively on the most likely outcome."[102]

B. Cazes has noted that change can follow a regular ascending or descending curve; this type of change—continuous and following a trend, hence predictable—can be anticipated using extrapolation*. Historically, the hypothesis of continuous change has gone hand in hand with belief in uninterrupted progress, an evolutionary process.

> This vision of a one-dimensional future following a logic as implacable as a law of nature, and in which each link in the chain is absolutely necessary, can be found among almost all thinkers who have attempted to construct a theory of the development of modern industrial societies, starting with Turgot and continuing through Condorcet, Saint-Simon, Auguste Comte, Marx and Herbert Spencer, right up to W. W. Rostow.[103]

Under the hypothesis of continuous change, the environment to be explored changes gradually, and long-range planning proceeds by projection, by extrapolation.

A second kind of change, more abrupt, occurs as a discontinuity, qualitative leap or mutation from one state to another. "In such a situation, extrapolating a current trend leads invariably to an incorrect view of the future."[104] Any progress breaks with dominant trends, and follows the path of Directed Progress or Retroprogress.

Current changes therefore bring a good deal of economic, technological and social uncertainty which firms must consider when planning strategically.[105] In addition, long-range planning must be concerned with both quantitative and qualitative changes.

To respond to this situation, the OECD has recently created a program on the long-range future which pays special attention to fundamental changes and possible discontinuities that may affect the socioeconomic environment over the longer term. The program—intended to assist decision makers in meeting the challenges posed, for example, by the global economy, technological progress and environmental problems—includes three closely linked components:

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* For a discussion of the distinction between scanning, monitoring, forecasting and assessment, see Appendix 9.

the OECD long-range planning database, the OECD International Network and the OECD Forum on the Future, an international conference and workshop platform.

> These three mutually-reinforcing activities will assist the OECD in following emerging social and economic trends, detecting major developments and bringing together the necessary skills, from business, government service and universities, to explore new problems and current events having long-term impacts.[106]

According to H. Guillaume, analysis of the future still depends on two sets of observations: significant trends (*tendances lourdes*) and indicators (*faits porteurs d'avenir*), in the terminology of le Groupe 1985. Significant trends are long-term changes leading to substantial transformations, while indicators are innovations that may change current trends. This approach corresponds to a reorientation of planning within firms, which has moved away from analyzing trends and strategies, and toward managing uncertainty and change and monitoring the environment.

CHAPTER 3

Long-Range Technological Planning

3.1 Technological Forecasting: Key Component of Strategic Decision Making

Technological forecasting first developed in the United States in the 1930s. "The first scholarly study was Technological Trends and National Policy. It was commissioned by the National Research Council, carried out by the National Resources Committee, chaired by sociologist William Ogburn."[107] This study, published in 1937, did not describe the future so much as the past. As discussed in Chapter 1, technological forecasting did not get its real start until the Second World War in the military and until the 1960s in the civilian sector.

> In 1945 the U.S. Army Air Force Scientific Group prepared an originally secret report for President Truman. In this report the question was raised how futures research might be useful for strategic military decision making. The conclusion was that the techniques of technological forecasting especially were very promising: by forecasting technological breakthroughs, changes and threats could be recognized early, and this information could then be used in strategic decision making.[108]

The report *Towards New Horizons* was an early discussion of technological trends in the military.

Between 1947 and 1953 the U.S. Department of Defense, through its Research and Development Board, carried out systematic forecasting of the probability that new arms systems would be developed. These activities were taken up by the RAND corporation, which analyzed trends and devised the Delphi and cross-impact matrix methods. Since the 1950s, many RAND studies have been at the centre of strategic military and foreign policy discussions; it is generally thought that nuclear deterrence theory had its origins at this organization. RAND later broadened its interests to the civilian domain—delinquency, urban management, land use planning, development policy—in both the United States and other countries. "Technological forecasting developed in its actual form in the 1960s with the development of new exploration techniques such as RAND's Delphi method and Honeywell's PATTERN method."[109] At the same time, large corporations have been gradually making technological forecasting part of their strategic planning activities. Erich Jantsch has estimated that between 500 and 600 medium-sized and large American companies had staff specialized in technological forecasting in the mid-1960s, and that 1 percent of their research and development expenses went to this activity.[110]

Since the late 1960s and especially the 1970s, various governments have attempted to identify the technologies most likely to stimulate the overall economy.

> When, after the First and especially the Second World War, governments began to fund research and development activities regularly and to develop science and technology policies, technological forecasting became a systematic, institutionalized practice; before, only visionary scientists or particularly imaginative novelists—like Jules Verne or H. G. Wells—practised it.[111]

The Office of Technology Assessment (OTA) of the U.S. Congress, responsible among other things for assisting the Committee on Science and Technology and the Science, Technology and Long-Range Planning Division of the Congressional Research Service in their long-range planning activities, was created in 1972. Technological forecasting had been recognized as an important instrument in strategic decision making, while impact analysis, or technology assessment, studied the impacts of technology* on society. "Determining in what technology to invest merits and receives considerable attention, and that has bent the field of futures studies toward technological forecasting and technology assessment."[112]

In Papon's view, four major approaches to technological forecasting have been developed: (1) Trend extrapolation, intended to determine future technological evolution "...either by simply extrapolating previous changes in technological variables or by analogy with the behaviour of other known phenomena.[113] (2) Intuitive techniques using scenarios, such as the Delphi method and cross impact analysis. (3) Morphological analysis, which attempts to systematically determine all solutions to a technical problem. (4) Normative techniques intended to determine

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* See Office of Technology Assessment, *Computerized Manufacturing Automation: Employment, Education and the Workplace* (Washington, D.C.: Congress of the U.S., Office of Technology Assessment, 1984).

the process for attaining a given objective using "decision and relevance trees," of which the best known examples are PATTERN (Planning Assistance through Technical Evaluation of Relevant Numbers) and one of its variants, PERT (Program Evaluation and Review Technique).

Jantsch distinguishes between exploratory forecasting, oriented toward possibilities, and normative forecasting, oriented toward functions.

> This voluntarist evolution, combining technological forecasting and programming of technological progress, was based on the conviction that innovation takes place for the most part "on command" and that "demand" (socioeconomic needs and objectives) moulds technological development much more decisively than the technology "supply" resulting from autonomous developments in scientific and technical fields. Or, as economist might put it, the "demand pull" is much more important than the "science push."[114]

In addition, since the subject of technological forecasting should not be changes in technology itself but the pace of this change and its major orientations and areas of application, predictions in the form of lists must be replaced by systemic and historical analyses that reinterpret developments in a certain field in the context of a new technological system.

In this era of a global economy, the strategic importance of new technologies has been widely recognized. Almost fifty years ago, Schumpeter stressed the importance of technological innovation to economic progress. The "long waves" theory invokes waves of innovation to explain successive waves of expansion and recession. "Each phase of the expansion and recession cycles lasts about twenty-five years. After strong growth from 1950 to 1974, there will be a lean period until the beginning of the 1990s. At that time will dawn the age of a fifth Kondratiev cycle, sustained by the technological revolution that has been germinating since the late 1970s."[115] The theory of long technological waves is at the origin of work by Christofer Freeman (1974)*, F. M. Scherer (1981) and the French "régulation" school, who emphasize social and organizational obstacles to the spread of new technology. This fundamentally

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* See C. Freeman, (1986) «Technologies nouvelles, cycles économiques longs et avenir de l'emploi» in *Les enjeux du changement technologique*, Paris, Économica-C.P.E.

scientific and technological capacity for innovation has become one of the key elements of business strategy.[116]

But while technological innovation is an important factor in improving organizational performance, factors influencing the speed and direction of technological progress are little understood. There are also very few critical assessments of past technological forecasts.[117] For example, economists have only been able partially to explain ongoing processes. "Economists have, in Rosenberg's phrase, treated technology as a 'black box.' They have attempted to measure and forecast the effects on output of aggregate changes in labour, capital and/or resource inputs at the macro level, without investing comparable effort in understanding why and how the underlying changes in products and processes occur at the micro-(firm) level."[118] The nature or development of innovations are rarely anticipated correctly.

> As T. Jones has written, these forecasts are generally subject to two criticisms: excessive "techno-optimism" and "socio-optimism." They overestimate the rate both of scientific and technological discovery and of its application. This is regularly apparent in the fields of medicine, meteorology and various computer applications, so that even if some forecasts (e.g. genetic engineering, computer-assisted diagnosis) are prophetic, actual development often comes much later than predicted. In addition, experts' socio-optimism appears in the idea that humanity will be able to solve a number of major problems (e.g. self-sufficiency in food) with essentially technical solutions.[119]

The optimism that characterized the beginnings of technological forecasting has been affected by poor forecasting performance. These forecasting errors can be attributed to the largely unpredictable nature of technological discovery, as well as to unforeseen developments and changes. First, technological forecasting methods and techniques (such as trend extrapolation, morphological analysis and expert consultation) have their limitations; second, scientific and technical systems are interdependent; finally, technology interacts with its political, economic and social environment.

> Better methods of forecasting and planning for the future are needed now as never before. At all levels of government we in the United States badly need—and currently lack—clearer and more quantitative answers to a number of generic

> questions pertaining to technological progress. Equally, the managers of private sector firms, large and small, also often face the need to make decisions for which they lack the necessary knowledge.[120]

But to acknowledge that technological forecasting is uncertain takes away none of its interest. "Attempts to predict future forms of technical progress provide the means to orient this progress and calculate its positive or negative consequences. Technological forecasting is more relevant to the present, to decision-making, than it is to solving the enigma of the future."[121]

In recent years, the American firm Arthur D. Little has developed a set of tools for approaching problems linked to the relation between strategy and technology, using the following definitions:

- Key technologies with a significant impact on product performance and productivity improvements and that help to establish the firm's competitive position;
- Basic technologies available to all firms and generally common to all products within an industry, that have been important to the firm historically;
- Emerging technologies showing early potential for major development, despite a high level of uncertainty.[122]

Arthur D. Little suggests a matrix which relates competitive position to technological position and which shows that technological forecasting, by playing a major role in revealing possible developments in various technologies, determines the firm's strategic position with respect to them. The role of technological forecasting differs according to adopted strategy: (1) A "leader" strategy in which the most promising long-term niches are identified, as quickly as possible (a system for continuous monitoring of indicators is essential here). (2) A "follower" strategy in which technological forecasting provides a calendar for the various phases of new product development (a system providing information on results of ongoing research is called for). (3) A "modifier" strategy to satisfy certain categories of customer in a product's mature phase (forecasting, mostly of the market, attempts to identify possible technological changes). and (4) An "imitator" strategy in which technological forecasting plays almost no part.[123]

3.2 Long-Range Technological Planning

Long-range planning became a key component of the planning process. In the 1960s, the private sector recognized the need to incorporate long-range technological planning into corporate planning. Long-range technological planning originally attempted to predict future technological progress and to evaluate its positive and negative impacts. "Four major concerns are addressed: the time frame for the process of technological innovation; its geographical distribution; its economic and sociocultural consequences; and finally, its threats to humanity."[124]

In France, the Commissariat du Plan, as part of its mission to prepare five-year plans, carried out or sponsored scientific and long-range technological planning activities (in 1962, 1971, 1980 and 1985). "The most notable (and shortest) document, published in 1964 under the title 'Réflexions pour 1985,' attempted to predict major changes over the next twenty years."[125] But Bertrand Gille, in *Histoire des Techniques*, is probably the first to have attempted a systematic discussion of the method. For any particular period, Gille presents a set of interrelated technologies.[126] This approach leads to a division of history into a series of technological systems, in which technological progress is seen as a transition from one system to another.

Jantsch's study *Technological Forecasting in Perspective*, published in 1967 for the OECD, drew up an inventory of long-range planning practices, with emphasis on long-range technological planning. "A survey report sponsored by the OECD identified scores of institutions throughout the world—mostly military or governmental—involved in some kind of technological forecasting activity. This report also created a framework by defining terminology, classifying alternative approaches, and providing an extensive annotated bibliography."[127] Jantsch's document stressed the importance of long-range technological planning and technology assessment (because of technology's influence on society as a whole).*

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* See Pierre-André Julien and Jean-Claude Thibodeau, *Nouvelles technologies et économie* (Montréal: P.U.Q., 1991). See also *The Ontario Task Force on Employment and New Technology* (1987).

Apart from military research applications, scientific and technological long-range planning has flourished in agencies such as BIPE, in specialized directorates of government departments, and in large research organizations such as the CNRS or the CEA. During the 1960s, BIPE conducted a critical assessment of forecasts it had made over the years. "Its conclusions were fairly close to those of D. Sebilo, and in particular show the interdependence between the various advanced fields noted in the early 1960s. BIPE uses an original method known as 'La filière : production-commercialisation-utilisateur final' (the 'production–marketing–final-user connection')."[128] Since 1985, Bipe-Conseil has conducted an ongoing inventory of all strategic information, including technology monitoring, situational follow-up, market evolution and structures of supply. Bipe-Association carries out short- and medium-term forecasting for all industries. Eurostratégies, set up in 1987 as a joint subsidiary of Bipe-Conseil and four other European firms—Roland Berger in Munich, EMC in Madrid, ERA in Brussels and Reseau in Milan—works mainly in the field of information technologies. Ereco (European Economic Research and Advisory Consortium) is a European business consortium established by Bipe-Conseil, IFO in Munich, NEI in Rotterdam and Promethea in Bologna, that has been conducting multi-industry studies in Europe since 1990.

In 1981, the Centre de prospective et d'évaluation (CPE) was established in the French Ministère de la Recherche et de l'Industrie.[129] Since its inception, the CPE has been engaged in international technology monitoring, to which it devotes slightly more than half its resources.[130] It has promoted the concept of technology monitoring in France, especially with French business firms, and has encouraged use of the notion of "technological clusters"*, a multi-product approach based on integration of generic technologies.

It is now widely recognized that new technologies (such as electronics, biotechnologies, new materials) represent a potential for technological renewal.

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* See Christian De Bresson, *Les pôles technologiques du développement : vers un concept opérationnel* (Montréal: CREDIT, 1986), and J. Lemay and C. De Bresson, *Le repérage des grappes technologiques* (Montréal: CREDIT, 1988).

> Measures of technological change are needed for a variety of policy-related purposes. Perhaps the most important need is for a means of monitoring technological progress in relation to prior plans or expectations. This is sometimes done as a function of elapsed time and/or expenditure, or it may be done in relation to the activities of competitors or adversaries. R&D managers, chief executives and political leaders badly need to know "how they are doing."[131]

Among the conceptual models used for long-range technological planning, are the Japanese "bonsai" method and the American "input-output" model. The bonsai method can be used to identify generic technologies used by a particular industry that are converted into specific products.

> It is common in Japan to represent the corporation as a tree, of which the leaves and fruits are products and the roots are technologies. Such technologies are specific, that is, not shared with other firms, and the corporation needs to maintain them to survive and compete. But this in no way prevents the firm from using, at the same time, other technologies needed by all firms and diffused, for example, by service firms or training centres. It is convenient to call technologies in this second group "general" technologies.[132]

Wassily Leontief invented the input-output method. "In technology forecasting, the primary use of an I/O table is to measure the effect that a change in technology will have on the economy."[133] This method is particularly relevant for analyzing macroscopic issues while evaluating a firm's technology strategy.

Systemic long-range planning can be used to assess the economic, political and sociocultural environment. In this view, it is not appropriate to speak of strict technological determinism, but rather of the need to take account of reciprocal interactions between technological and social factors if the present is to be understood and the future forecast. "As a rule, little attention has been paid to three critically important variables: scientific progress, economic factors and the social and institutional environment."[134] Long-range technological planning requires a strict analysis of constraints and possibilities, but also of the economic and social environment.

The goal of exploratory long-range planning is to determine all alternative futures for a given system; these alternatives are often represented in the form of scenarios. These planning methods have been applied to competitive systems by SEMA and Michel Godet in France, and by specialized institutes and consulting firms such as Battelle Laboratories, the Stanford Research Institute and Arthur D. Little. "When they simultaneously include technological, economic and sociological variables, these long-range planning studies are important contributions to understanding the dynamics of competitive systems."[135]

Finally, the FAST (Forecasting and Analysis in Science and Technology) program has supported activities to improve long-range planning capabilities in Europe, where a tendency to analyze the socioeconomic impacts of science and technology at a regional level has been observed.

> One of the results of the 2nd Congress in Milan was the awareness that a "European system" of TA activities has been emerging gradually over the past 5 years in the Community countries around institutions such as the Danish Board of Technology, NOTA, the University of Namur (especially in Information Technology) and the Flemish Foundation in Belgium, CNAM in Paris, BETA in Strasbourg, MERITT in the Netherlands, the Office Parlementaire in France, the BMFT in Germany, PREST, SPRU, UMIST in the UK, FUNDESCO in Spain, ENEA in Italy, EOLAS in Ireland and, at the Community level, around MONITOR-FAST and STOA (European Parliament).[136]

The EURETA network was established by FAST in 1986; the IATIM consortium has been set up in southern Italy, as has the Institut de l'homme et de la technologie in Nantes and the Office de Coordination du Technology Assessment in Wallonie, Belgium. "Proposals for joint action in this area among the Commission of the European Community, the Association internationale FUTURIBLES, OECD and UNESCO have been made."[137]

3.3 Long-Range Social Planning

Developments in long-range social planning were behind much of the impetus (around 1965) driving long-range planning. An initial technology assessment, *La Société et la Maîtrise de la Technologie*, was prepared for the OECD in the early 1970s. The OECD report showed the influence of technological progress in other areas, and therefore how important it was to include social factors in analysis of technology. One of the main thrusts of the report was the need to assess innovation by taking its economic and social ramifications into account. "Everyone agrees on the general objectives of technology assessment, namely to summarize as objectively as possible the positive and negative impacts, benefits and risks associated with technological changes."[138] Buigues has also pointed out the need to view technological changes as intimately tied to social, economic or political trends. The CESTA (Centre d'études des systèmes et des techniques avancées), set up in 1982 by the French Ministère de la Recherche et de l'Industrie, has prepared a discussion of the future of new technologies. "The Swedish Academy of Technical Sciences (IVA) also published, in 1979, a major study on the country's technological future; the Secretariat for the Future regularly publishes studies on problems of economic and social development in Sweden."[139] But the Office of Technology Assessment (OTA), with extensive assessment experience in a variety of fields, is the most important and best-known technology assessment institution in the world.

According to the OECD, the most significant technology assessment program in Europe* has been established in the Netherlands with the creation, in 1968, of NOTA (the Netherlands Organization for Technology Assessment) in the Dutch education and science department.

> NOTA has made the idea of Constructive Technology Assessment one of the central thrusts of its approach, replacing a reactive vision with an active one that encourages early dialogue between various parties (businessmen, scientists, users, politicians), especially dialogue on new technologies (such as biotechnology and

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* See ECC, (November 1990) *State of the Art of Technology Assessment in Europe*, A report to the 2nd European Congress on Technology Assessment.

> artificial intelligence), and mobilizes skills networks spanning university, government or business organizations.[140]

The activities of the Danish Board of Technology, set up by the Danish Government in 1986, are focuses on organizing debates and disseminating information in various formats (such as reports, cassettes and video). In Austria, the Technology Assessment Unit (TAU), which focused on telecommunications, was set up in 1988 within the Academy of Sciences.

In France, the Office parlementaire d'évaluation des choix scientifiques et technologiques was established in 1984; in the United Kingdom, parliament has endowed itself with a small technology assessment unit; Germany, however, has not yet set up a formal parliamentary technology assessment unit.

> On the other hand, the Bundestag has created, when necessary, temporary commissions of inquiry into sensitive issues (such as energy and genetic engineering) and the government departments concerned, particularly the federal science and technology department (BMFT) had created assessment units or departments to advise them on policy. Finally, and very recently (spring 1990) parliament decided to give ongoing responsibility for study and advice to a specialized agency (AFAS), located at the Karlsruhe nuclear facility, that has been involved in technology assessment activities for a long time.[141]

Technological forecasting has thus given way to technology assessment*, that is, to estimating the potential impact of new technologies on society and on living conditions. A process was thus begun to study and even predict the social and economic impacts of new technologies.[142]

> The various assessment activities therefore converge toward increased awareness of the need to see technology changes as being intimately tied to social, economic or political trends. This multiple interaction process is fundamental. Socio-economic factors influence technological development and the spread of technological innovations, while technological development and the growth of new

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* See Conseil de la science et de la technologie (1991) *Les pratiques de l'évaluation sociale des technologies, Bilan et perspectives*, but also the work undertaken at the CREST.

> technologies, in turn, have socio-political and economic effects that form a part of the impact that must be assessed.[143]

This approach has spawned a good deal of activity within the European Community. "Both FAST I, launched by the European Community in 1979, and FAST II (1984-1987) have addressed issues of this kind, the orientation being that of identifying the changes at the social and individual level brought about by the application of new technologies.[144]

The FAST program is a research instrument intended to identify long-term orientations for pan-European research and development, and to examine economic and social changes that result from the implementation of new technologies. "FAST stands for Forecasting and Assessment in Science and Technology, a research programme of the Commission of the European Community."[145] FAST I established that the Community's research and development policy did not sufficiently anticipate problems that could arise at the end of the century.

> A reorientation and broadening of R&D activity was necessary, based on five major orientations:
>
> - To support and stimulate a broadening and renewal of the European industrial base around two foci: agriculture/chemicals/energy and space/electronics.
> - To assist in designing and developing infrastructures to support new services (especially in telecommunications) over the next thirty years.
> - To follow changes in employment and facilitate establishment of new human-machine relationships.
> - To inspire and stimulate the science and technology necessary to solve major problems in third-world countries and help these countries develop their own scientific and technical potential.
> - To provide community institutions with the skills and knowledged critical to the common mastery of technological changes.[146]

FAST's overall task is to analyze scientific and technological changes with respect to their multiple dimensions—economic, social and political—and to identify new priorities for the

Community's common R&D policy and long-term activities. Another of its objectives is to support discussion on Europe's long-range future by disseminating long-term research work carried out by member nations and by encouraging researchers and potential users to set up *ad hoc* cooperative networks. FAST I highlighted the new technologies' major potential for growth, development and job creation. FAST II supplements these activities with an investigation by major area of technology, that is, by the sector in which the technologies are to be applied.

> Current FAST research is therefore focused on five functions, considered essential for economic growth and social development, each of which is the subject of a high-priority program:
>
> · Technology-employment-work relationships (TET program);
>
> · Service industries and the new technologies (SERV program);
>
> · The new strategic industrial communications system (COMM program);
>
> · The future of nutrition (ALIM program);
>
> · Integrated development of renewable natural resources (RES program).[147]

One aspect of FAST II (1984-1987) that distinguished it from FAST I (1978-1983) was the "10+1 Network": ten national agencies, set up by the governments of the member states, to maintain ongoing interaction between FAST activities and similar work carried out on the initiative of national governments. FAST depends on the creation of a European system of cooperation. Examples of research results now available on trends, problems and perspectives in the five areas studied are: an assessment of the impact of new technologies on total employment; qualitative implications and consequences for work; changes in service industries; and new strategic systems for telecommunications. The following topics were on the FAST work program for 1989-1990:

· Science, technology and economic and social cohesiveness within the Community;

· Advanced production systems;

· The future of European cities: the city as player on the science and technology scene;

- Globalization of technology and the economy;

- Regional scenarios for world society;

- Economy-biosphere relationships;

- Health and technology: toward an improved *local* health care system.

The third phase of the FAST program (1990-1994) consolidates the orientations followed until now. "The priorities for a 4-year period have been established. They are: the development and mastering of generic technologies; the improvement of the management of materials resources; the 'valorisation' of Europe's intellectual resources."[148] The main objective is to improve the international competitiveness of European industry. About 40% of the budget has been allocated to the information technologies and communications section. Among the most important phenomena that European nations and European Community policy must confront during the 1990s are:

- Globalization.*

- A new productive system**: primacy of qualitative, immaterial considerations and human knowledge.

- The rise of financial logic in the allocation of material and immaterial resources.

- Technological development and cohesiveness within the Community: between excellence and diversity.

- Cities (the local level): key players in new social demands for knowledge and technology.[149]

Three new research themes were added for 1991-1992: "The Future of Industry in Europe; Science, Technology and Community Cohesiveness in Broader 'Continental' Europe; and The Global Perspective 2010: Tasks for Science and Technology.[150]

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* The main aspects of globalization are described in Appendix 10.

** Changes in the productive apparatus are described in Appendix 11.

Since 1989, FAST activities have been occurring within the larger framework of the European Community's MONITOR program for strategic analysis, long-range planning and assessment of research and technology which includes, besides FAST, programs for strategic and impact analysis (SAST) and assessment of research and development activities (SPEAR). Among major upcoming events are the third Technology Assessment conference toward the end of 1992 and "Europrospective III" in the spring of 1993.

> Finally, linkages with the "Cellule de Prospective" are of great value and should be reinforced. Cooperation should also be developed with the newly established (by STOA) European Parliamentary Technology Assessment (EPTA) network. Steps should be taken to start cooperation with Eastern European forecasting and assessment organisations, in line with the meeting in Milan on 13 November with representatives of TA activities from Hungary, Czechoslovakia, Poland, Yugoslavia and the USSR.[151]

CHAPTER 4

Technology Monitoring

The OECD recently stressed the importance of scientific and technology monitoring, to anticipate future developments and provide information to support decision-making. "Scientific and technology monitoring refers to all activities to acquire, analyze and assess information required for decisions affecting science and technology."[152] Technology monitoring is above all a process of gathering information—current trends and the strengths and weaknesses of technological systems—for making decisions based on knowledge of present circumstances.

> What has been learned from the evolution from forecasting to technology monitoring can be summed up in three points:
>
> i) Scientific and technological monitoring should not attempt to solve the unsolvable mystery of the future, but should instead clarify, as well as possible, the choices which have an impact on the future but which must be made in the present, under specific circumstances;
>
> ii) These discussions of the future should not be reduced to single, isolated exercises; whatever form they take, they should be ongoing and their conclusions should be necessarily tentative and constantly called into question, especially in the light of changes brought about by scientific and technological progress;
>
> iii) The future that scientific and technological monitoring must deal with is not, however, restricted to changes in science and technology alone. Even if such changes play a major role, which should never be played down, sufficient interaction with the other themes of the long-range planning "archipelago" should be maintained.[153]

A. Y. Portnoff has written that the idea of "monitoring" expresses an organization's concern for maintaining an ongoing vigil of a changing universe and shows, as an organized activity within the firm, its intention to structure, finalize and make permanent this search for information.[154]

The OECD draws a distinction between implicit and explicit monitoring. The first of these is apparent in more or less widely circulated publications and in reports that

> ...imply a crystallizing of information demanding clearer distinctions between the present and the future, between the tactical and the strategic. A number of examples reflect this: reports every four years on research at the BMFT in Japan; five-year plans and master plans from the CNRS in France; "visions" from MITI in Japan; strategic plans of specialized research councils and government departments in the United Kingdom; laws regarding research, and long-range visions, every three years from the STU in Sweden.[155]

Explicit monitoring activities, by taking a broader view, involve gathering information on and discussing the future in a way that is separate from the mechanisms and processes behind day-to-day decisions, but that remains available to support decision-making and priority selection. In late 1988, the Dutch government's economic affairs department began a project for long-range technological planning (technology area foresights) to provide a solid basis for its technology policy.

> Long-range planning undertaken by experts in these fields must deal with three major issues: prospects for innovation and application within the Dutch economy over the next ten years; the international position of the players involved and of the educational and research infrastructure; the degree to which players are prepared and possible obstacles, especially for small and medium-size firms.[156]

In Japan, MITI's ten-year "visions" and the technological forecasting efforts of the STA in 1971, 1976, 1982 and 1986 reflect concern for a long-term view. In France, the *Rapports sur l'état de la technique*, prepared in 1983 and 1985 by the CPE in collaboration with the Société des ingénieurs et scientifiques.

Monitoring also relies on consultation of experts, but is characterized by a philosophy regarding the sense of the evolution of technology. It is also intended to draw the attention of a wide audience to technological development. Dissemination of information is fundamental in this regard.

> Governments in a number of countries have tried to go beyond this phenomenon of "natural" information spinoff towards the operational level, in particular toward corporations, and have undertaken a scientific and technological monitoring effort specifically to support corporate decision-making strategies, with a particular

> concern for small and medium-size firms. These initiatives are not limited to various public and private scientific and technological information systems in a number of countries, but are intended to provide firms with information that has been assessed and put into a form appropriate to their specific needs.[157]

One problem in this respect concerns the explosion in the amount of information and the choice of relevant information. "The way in which decision-makers get information and the way it is actually used in making decisions, are at least as important as its intrinsic quality."[158] Information should be processed in light of its industrial, economic and social relevance.

> The objective of monitoring is to ward off threats and, possibly, seize opportunities by quickly gaining advanced knowledge of changes in the company's environment. As an activity, it seeks to:
>
> - find out what others are doing in areas that are changing and likely to interest the firm, so as to not waste resources reinventing what already exists;
> - detect innovations likely to be integrated into existing mechanisms, or possible substitutions for current mechanisms; these two processes may encourage new competitors to appear, or give existing competitors an added edge;
> - identify, even in distant industry segments, possibilities for the company to do business in a different way;
> - locate expansion zones where the firm enjoys a possible advantage and where competition is weak.[159]

In 1986, the Ministère de l'Industrie established an Observatoire des technologies stratégiques. The OECD stresses the importance of the interactive nature of the scientific and technology monitoring process. "We naturally prefer (preactive and proactive) technology watch, that is, anticipation of threats and opportunities on the horizon, so that adjustments can be made to orientations."[160] This idea forms the basis for the organization and work methods of CEST, created in 1988 in the United Kingdom. In addition, the international dimension of technology monitoring should be integrated into the information system. The CPE instituted the French Technology Survey in 1987 to make the technological capabilities of domestic firms better known outside France.

The profound technological change of recent decades has made technology monitoring essential to corporate growth. Japan has been in the avant-garde of technology monitoring; in the private sector alone, this activity accounts for 1.5 percent of total sales.

> Some authors claim that the percentage of GNP devoted to technology monitoring in Japan is twice that in the United States and three times that in Europe. The government devotes 10 to 15 percent of its R&D budget to line items with titles like "Description of the state of the art in the United States and Europe" or "Study of the current and upcoming technology situation." Another portion, on the order of ten percent, is devoted to dissemination of information collected in this way.[161]

The same author has written that many agencies responsible for technology monitoring in Japan are public. For example, JETRO (Japan External Trade Organization) was established in 1958 to promote trade, collect information and import technologies to Japan. This agency, which reports to MITI, has 77 offices scattered in 57 countries (9 in the United States alone) and employs more than 4,000 agents, a part of whose time is directly taken up collecting and analyzing information on technology. "JETRO has two offices in France—one in Paris, opened in 1965 and employing between 20 and 25 people, and the other in Marseille—that do literature searches and make up price lists for products on the market."[162] The AIST (Agency of Industrial Science and Technology), also part of MITI, appears to be one of the most effective sources of technical information in Japan. Japatic (the Japanese Institute for Industrial Protection) employs 2,300 people. The JICST (Japan Information Centre for Science and Technology), established in 1957 and under the control of the AIST, employs 2,500 permanent staff and 5,000 scientists to analyze journal articles (information on twenty million articles is stored in the JICST data base, compared with 6 million for the CDST and the CNRS).[163] The role of this agency is to gather, use and disseminate scientific information to advance Japanese science and technology.

> JICST analyzes annually about 11,000 journals, of which 7,000 are foreign; about 15,000 technical reports; 500 conference reports; and more than 50,000 patents, of which about 40% are Japanese, 30% American, 7% French and 7% Russian. The result of this analysis is annual publication of 500,000 abstracts. JICST

> information is disseminated in such formats as bibliographies, reproductions, thematic research, on-line computer access using a dedicated network serving ten major cities from Tokyo, magnetic tapes furnished to other networks, etc.[164]

Other organizations engaged in technology monitoring are industry groups (Keidanren and Nekkeiren) and such professional associations as the JIRA (for robotics) and the JAMA (for automobiles). The Science Information Network, managed by NACSIS (the National Centre for Science Information System) is a university network for disseminating all Japanese scientific and technical reports. An information sciences university at Chiba, with responsibility for training between 400 and 800 "technology monitors" annually, was scheduled to be established at the end of 1988.

Finally, private corporations have become engaged in technology monitoring. The Sogo Shosha are large Japanese trade firms that employ staff worldwide, part of whose job is to identify major technological issues. "Persons with responsibility for technology monitoring are found in the 'technology management' function."[165] The major industrial groups devote an average of 1.5 of their total sales to technical and scientific information. In addition, the Technomart was recently established with a mission of giving Japanese firms quick access to new technologies; and the JKTC (Japan Key Technology Centre) was set up to meet the R&D needs of small Japanese firms.

Despite an efficient infrastructure for technology monitoring, the situation in the United States is less impressive, as Americans are above all "suppliers, rather than demanders, of information about technology."[166] However, a number of large corporations—such as the Marriot hotel chain, McDonnell Douglas, Motorola, Xerox and Hewlett-Packard—are very much involved in this activity. Corporations such as Ford Motor, Westinghouse Electric, 3M, General Electric, Kodak, Emerson Electric, Rockwell International, Celanese, Union Carbide, Gillette, Digital Equipment and Wang Laboratories have established in-house teams for monitoring the competition.[167]

In addition, the United States has a particularly efficient infrastructure for technology monitoring built around research institutes often spun off from universities. "Even if close to 70 percent of these institutes are private, they are often subsidized directly or indirectly by the government (for example, SRI, Battelle, Institute for Science Information, Rand Corporation, Hudson Institute, Centre for Futures Research) and are involved in technology monitoring work."[168] In addition, databases are very well developed: for example, Chemical Abstracts analyzes 140,000 journals from 150 countries.

Marcel Bayen has written that interesting developments have been occurring in Europe; for example, Great Britain has set up the CEST (Centre for Exploitation of Science and Technology), a new agency for technology monitoring located in the Manchester scientific park.

Technology monitoring is not very widespread in France, apart from a few large corporations (such as Thomson, Merlin-Gerin, EDF and Atochem); INPI (which conducts an industrial property inventory but does not deal with technological information as such); the CREATI (regional centres for technical support and innovation for small business), the activities of which remain confidential, even though they were set up by large corporations; and finally, a number of banks and consulting firms (such as INNOVATION 128, EGIS, Bertin, Euroequip, BIPE, CEGOS, GC Conseil, Euroconsult, AJOUR). Only a few French corporations—la Régie Renault, Solmer, Thomson, St-Gobain, Bull, Crouzet S.A.—have become involved in this activity.

Among government or similar agencies, the Secrétariat général de la défense nationale (SGDN) seems to be one of the pioneers in technology monitoring. "Using about twenty engineers, the SGDN carries out ongoing monitoring of foreign scientific and technological developments."[169] More recently (late 1986), the Ministère de l'Industrie established an Observatoire des technologies stratégiques (OTS) that works in close collaboration with the CPE. The Bureau de renseignements techniques (BRT) of the CEA has an ongoing monitoring program, with a limited budget.

> Besides these agencies and the CPE, other agencies such as the technical centres, a few forecasting groups in technical ministries—CSTB for buildings, GPES and

> DRET for defense and the Agence d'évaluation technique pour les télécommunications are some examples—do technological monitoring as well. But this activity is limited to a single industry (for example, buildings for the CSTB) or mission (for example, defense for the GPES and DRET) and only rarely look at the problem from a multi-industry point of view.[170]

Bayen has also written that other organizations—such as ANVAR with its Mille IET (technology information for business) and ASI (aids to innovation) programs; CEDOCAR (the army); the CDST of the CNRS; the chambers of commerce and industry; professional associations; and the ARIST (Agence régionale d'information scientifique et technique, with 22 agencies and a staff of 180)—deal mostly with documentation rather than technology monitoring requiring the presence of highly trained engineers (an exception is the Strasbourg ARIST).

> Multi-industry, public sector technology monitoring agencies in this country employ only a few hundred engineers or PhDs; to this can be added about forty advisors and scientific attachés working in embassies. Mention should be made, however, of a recent major effort—initiated by the CPE, which is still involved on an ongoing basis—by the Ministère des Affaires étrangères to collect and disseminate technological information.[171]

In January 1982, the CPE established a monitoring unit to make information and forecasts regarding new technologies available to industry decision-makers and executives. This organization was the first to create—in cooperation with the firms INNOVATION 128, TELESYSTEM/EURODIAL and TRIEL—an electronic newsletter for scientific, technical and industrial information called *VIDEOTECH-CPE.* To make French capabilities for technological innovation better known outside France, CPE has created FTS (French Technology Survey), an international newsletter written in English, French and Chinese and distributed monthly throughout the world. "Finally, recognized as chief coordinator of technology monitoring for industrial use in France, the CPE has been selected as official French correspondent in the European Communities' 'EUROTECHALERT' operation, intended to disseminate technological innovation within EC member countries."[172] Among the CPE's principal means of dissemination are: the bimonthly *Flash*, providing the most relevant scientific and technical information obtained over the past two weeks; a monthly technical bulletin; studies in three collections—*CPE-Études*, *Techtendances*, *CPE-Économica*; an electronic newsletter for scientific, technical and industrial information (*VIDEOTECH-CPE*); and various other newsletters (*Flash-Japan*, *Flash-USA*).

Technology monitoring, rather than forecasting, is therefore the preferred method for tracking and staying abreast of technological change. B. Godin has written that technology monitoring should provide three types of information: (1) technological alternatives in each industrial segment of interest, identifying relevant components and technological generations; (2) identities of major players (companies, universities) as well as an assessment of existing undeveloped domestic technological potential; (3) impacts—to highlight "problems" or issues associated with these technologies, from the point of view of either supply or demand. "Only when these three stages have been completed can long-range planning be used to define a national strategy that takes account of the most promising technologies, domestic potential and impacts be undertaken."[173] There are two stages in this methodology: evaluation of present circumstances using three types of information (technological alternatives, national potential and impacts); and long-range study of the future. Such a long-range approach will identify technologies that drive industry and, because of their subsequent spread, the rest of the economy and society. Many possible scenarios of the future must be sketched, and the evolution of the most probable of these must be followed closely.

Apart from technology monitoring,* in which a company remains constantly up to date on technologies and processes available within its industry, three other types of monitoring are generally discussed: monitoring of competition (products, competitors), used by corporations exposed to world markets; commercial monitoring of customers and suppliers; and environmental monitoring.** "These activities cover wide areas. There is no clear separation between the different kinds of monitoring; rather, there is a monitoring continuum which we call industrial monitoring."[174] According to this approach, there must be a global vision of monitoring within

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* See OECD, *Technologie et compétitivité des petites et moyennes entreprises* (1992), (Short coming).

** See Appendices 12, 13 and 14.

the entire corporation. Industrial monitoring (1) is indivisible and global; (2) requires a methods for efficiently exploiting the various information sources; and (3) requires an organization to bring about synergy between the corporation's different monitoring efforts.

> Because of the increasing importance of information of all kinds and from all sources in corporate decision-making, the firm that can take it all in has an undeniable advantage over the others. More particularly, collection and management of environmental information—that is, about markets, competitors, threats and opportunities—are certainly major corporate issues.[175]

CONCLUSION

In a context characterized by accelerating technological, economic, political and social change and growing uncertainty—and in response to the evolution to an ever more complex society—corporations are increasingly called upon to make a long term vision part of their growth strategies. Many factors help to make the world economy more complex: the globalization of competition; the growing importance of multinational and transnational corporations; the 1992 deadline; problems that take on world significance (such as security and the environment); and political issues such as the rise of nationalism and increasing gaps between nations and between socioeconomic groups within nations.

> Here the problem is how to involve all nations in the global economy, but without exploitation. Determining equitable terms of trade, maximizing technological transfer, encouraging indigenous development in less developed economies, all will be major sources of uncertainty—in short, "world problems." The accompanying cultural readjustment which is implied, without loss of national individualism, may be a major source of friction, if not warfare.[176]

GERD (the General Evolution Research Group), under the direction of Professor Erwin Lazlo, has begun significant work in this area. "In the real world of 'complexity,' the future of the objects is no longer determined. There is no longer the full-time symmetry which was supposed present in the description at the classical or quantum macroscopic level, and it is not present in the world to which we have access"[177] What is now called for is a pluralistic approach, taking into account both deterministic factors and unforeseen elements that may possibly, in what Prigogine calls "bifurcations," lead to a new set of circumstances.

> The role of futures research in this model of social development is on the one hand to identify signs of breaks, social movements, technological innovations, signs of destabilization, etc. On the other, it is to try to outline possible alternatives after the "bifurcation," and in this way to create a kind of map of possibilities for the future. Studying "bifurcations" is where the "emancipatory potential" of futures research can be considered to be at its highest level.[178]

The challenges posed by increasingly rapid technological change and international competition clearly highlight the need for a better grasp on the future from improved understanding of societal change. "This approach must be linked to the complexity of situations, a complexity which will increase along with the interconnectedness of events, and which will require an increasing dialectical capacity and a higher level of critical awareness of the information received."[179]

Another argument in favour of taking the long view, given the trend toward a world economy, is the emergence, described by M. Marien, of a macrosystem in which technology plays a key role by helping to define the terms of exchange in the international environment. "The IT revolution is the most important technological driver of the global economy, and satellites, new fibre optic telephone systems, and computer systems have already helped to link up the world and enable such phenomena as global stock trading,"[180] Companies must be able to adapt rapidly to changes in their scientific, technological, legal, business and financial environment, and therefore detect its characteristics, trends and perspectives as quickly as possible.[181]

Predictions in the form of lists have lost ground to systemic, historical analyses that place developments in a particular field within the context of the new technical system.

> One very seminal role for futures studies will no doubt concern the future transitions of organizations and the formation of new ones, rather then, as over the past 20 years, the mere design of policies or programs for existing organizations. It is organizational, community, and conceptual "technologies" that should concern us, the "heartware," "headware," "orgware" and "teamware," not just hardware and software.[182]

The range of development concerns must be broadened, and qualitative objectives planned for. "Clearly, the attempt should be made to form policy with respect to time frames that take account of more than electoral deadlines, and objectives other than that of balancing a budget."[183] The problem is the capacity of institutions to coherently motivate socioeconomic partners to move toward medium- and long-term objectives. But if these objectives are to be attained, there must be a revolution in mentalities—a radical change in approach by management, who in the future must place more emphasis on human resources and the production of goods with high value added.

This orientation forms part of a "heuristic" approach that emphasizes human factors and the need to plan strategy and innovation. "The heuristic approach has been enormously successful world-wide with the success of *In Search of Excellence* by Peters and Waterman (1982), as well as Hervé Serieyx's first book *Mobiliser l'intelligence de l'entreprise* (1982) and his second, written with Georges Archier, *L'Entreprise du Troisième Type* (1984)."[184] Tom Peters's *Management Chaos* (1989) shares this approach and stresses the importance of flexibility and the need for change. The "rationalist" school, of which Michael Porter is one of the best known representatives, has started a veritable revolution in corporate mentalities—business must now structure its activities using quality circles and operate using corporate mission statements and Japanese-style consensus.

The need to develop a vision that integrates the scientific and technical with the economic, social and cultural has come increasingly to be recognized. "There is an urgent need to recognize the decisive role of men and women, their work, their future activity, their individual and collective potential for taking part in the construction of the country of tomorrow."[185]

In the future, corporations wishing to compete will have to put more intelligence into their products; domestic and international competitiveness requires ever-increasing investments in intelligence. "'Immaterial' or intellectual investments are relative newcomers to the scene; intended to introduce 'intelligence' in all components of the production system—research and development, training, software, communications—they already account for 40% of gross fixed capital formation."[186] This assessment is similar to that of BIPE, which predicts future growth of over 50% in intellectual investments. In 1986, this organization had already stressed that investment in intelligence was a strategic imperative.

Today, information has become the raw material of many companies,[187] and accounts for a growing percentage of intellectual investment by firms that use it to facilitate adjustment to change and solve problems quickly. It is becoming increasingly critical to develop a vision of the future. "Two essential points are raised here: the status of knowledge within our society, and our ability to share a vision of the future."[188] Individual and collective intelligence should be increased to cope with new situations, in which reaction speed itself has strategic importance. These strategic investments affect research (to master the technology), scientific and technical information, information on markets and business structures and training.

Moreover, a more unstable and uncertain environment has made decision-support and information systems for internal and external corporate communication even more important. "Information makes executives more able to receive, absorb and interpret current trends by making them 'wake up,' that is, be as aware as possible of new phenomena."[189] The ability of corporations to remain competitive seems to depend on their commitment to new information-processing technologies and their ability to organize change around the information potential of these technologies. As the recent increase in information networks has shown, these systems give information a special place in strategic decision-making.

Caspar and Afriat have written that companies will need to establish a function that listens, monitors and remains vigilant with respect to three major areas: the economic, monetary and financial environment; the current state of technology and products; and internal information. Intellectual investment must therefore be greater than investment in equipment. Investment in "grey matter" will show up as growing expenditure on artificial intelligence and management of increasingly important expert knowledge. Its concrete result will be increased investment in information networks and systems; in technical, economic and business databases; in the development of systems to monitor technology, competition and the business environment; and in long-range planning activities.

These transformations reveal the fundamental changes that society is now undergoing, and the importance of important human resources, knowledge, information and communication to society's future.[190]

APPENDIX 1

Futures Field: Tools for Managing Change

FUTURES RESEARCH (major knowledge-seeking focus)	*Prediction*	Trend extrapolation
	Economic and technical forecasting	Social indicators Social forecasting Technology assessment
	Systems analysis	Global and societal modelling Long cycle research Simulation of change processes
	Management science	Issues management Decision and risk/benefit analysis Policy analysis
	Scenario writing	Ethnographic futures research Cross-impact analysis Delphi surveys
FUTURE STUDIES (synthesis, criticism and communication)	*Comparative surveys and critique of futures issues*	Digests, indexes, overviews of problems and dimensions of change
	Futures in education	Professional training and development Curriculum innovation and course development Interdisciplinarity
	Speculative writing	Social imaging processes Creation and falsification of images Exploration of the trans-rational
	Networking	Global communication Social innovations Green politics
	Theory and practice of alternative lifestyles	Alternative technology Reconstruction of community New age cultures and values
FUTURES MOVEMENTS (stimulating, reconceptualizing and possibly leading change)	*Humanistic and transpersonal psychology*	Future imaging worksops Despair and empowerment work Psychodrama Psychosynthesis

Source: SLAUGHTER, Richard A. (October 1989) "Probing Beneath the Surface, Review of a Decades's Futures Work", *Futures*, p. 447.

APPENDIX 2

Structural Elements Important to the Future*

A. THE U.S. ECONOMY AND SOCIETY (relative health, strenght, etc.)	**Amara**, Ayres, Bell, Boulding, Drucker, Hughes, Lamm, Ogilvy
• Political structure and direction, role of decision making and policy	Amara, Ayres, Bell, Boulding, Drucker, Ferkiss, **Lamm**, Meadows, Marien, Ogilvy, Theobald
• Societal structure, its institutions and changing balance, including a shift to an aging population	Amara, Bell, Boulding, Drucker, Ferkiss, Lamm, Theobald
• Work, jobs	Amara, Ayres, Bell, Drucker, Ferkiss, Lamm, Theobald
• Defense: outlook for spending	Amara, Boulding, Clarke, Hughes, Lamm, Marien, Meadows, Ogilvy
• Education, negative and pessimistic views of the educational system	Amara, Ayres, Bell, Clarke, Drucker, Lamm, **Marien**, Meadows, Ogilvy, **Pierce**, Schwartz, Theobald
• Health	Amara, Ayres, Clarke, Lamm, Meadows, Ogilvy, O'Neill, Theobald
• Resources, including capital and knowledge	Ayres, Boulding, Drucker, Ferkiss, Lamm
• Energy policy and potential for future shocks	Amara, Ayres, Boulding, Drucker, **Hughes**, Lamm, Marien, O'Neill, **Schwartz**
• Cities	Amara, Ayres, Lamm, Meadows, O'Neill, Pierce
• Infrastructure	Ayres, Bell
• Transportation	Bell, Clarke, Ogilvy, O'Neill, Schwartz
• Immigration	**Lamm**
B. THE GLOBAL ECONOMY	Amara, Ayres, Boulding, Drucker, **Ferkiss**, Hughes, King, Ogilvy
• Political structure	Ayres, Bell, King, Meadows, Schwartz
• Societal structure	Ayres, Bell, Drucker, Ferkiss, King, Meadows, Pierce, Schwartz
• Shifting power/trade balance	**Ayres**, Bell, Boulding, Drucker, **Ferkiss**, **Hughes**, **King**, Lamm, Ogilvy, Schwartz

APPENDIX 2
(continued)
Structural Elements Important to the Future*

B. THE GLOBAL ECONOMY (continued)	
• Capital, sources/availability, financial flows/international debt	**Ayres**, Boulding, Drucker, Hughes, **King**, Lamm, Meadows, Schwartz, Theobald
• Trade in weapons/disarmament	Ayres, Boulding, Ferkiss, King, O'Neill, Theobald
• Food and agriculture	Ayres, Drucker, Hughes, King, Ogilvy, O'Neill
• Industrialization/development	Bell, Boulding, Drucker, Hughes, Schwartz
• Population and cities	Boulding, Ferkiss, Hughes, King, Lamm, O'Neill, Theobald
• Energy	Amara, **Ayres**, Hughes, King, Meadows, Schwartz
C. ENVIRONMENTAL (U.S. AND GLOBAL)	Amara, Ayres, Boulding, Ferkiss, Hughes, King, Lamm, Marien, **Meadows**, Theobald
D. SCIENCE (responsibility, accountability, influence on industry)	Bell, Boulding, Clarke, Hughes, King, O'Neill, **Pierce**
• Ideas/images of the future, intellectual technologies	Amara, **Bell**, **Boulding**, Drucker, Clarke, King, **Marien**, Ogilvy, O'Neill, Theobald
E. TECHNOLOGY	**Amara**, Ayres, Bell, Clarke, Drucker, Ferkiss, Meadows, O'Neill, Schwartz
• Social innovation technologies 'peace research, for example'	Boulding, Drucker, King, O'Neill
• Biotechnologies	Amara, Ayres, Drucker, Hughes, Marien, Ogilvy, O'Neill, Pierce, Schwartz
• Military technologies	Ayres, Marien
• Telecommunications	Amara, Ayres, Bell, Drucker, O'Neill, **Pierce**
• Materials	Amara, Bell, Marien, O'Neill, Schwartz
• Computers/AI/microelectronics	Amara, Ayres, Bell, Clarke, King, Lamm, Meadows

APPENDIX 2
(continued)
Structural Elements Important to the Future*

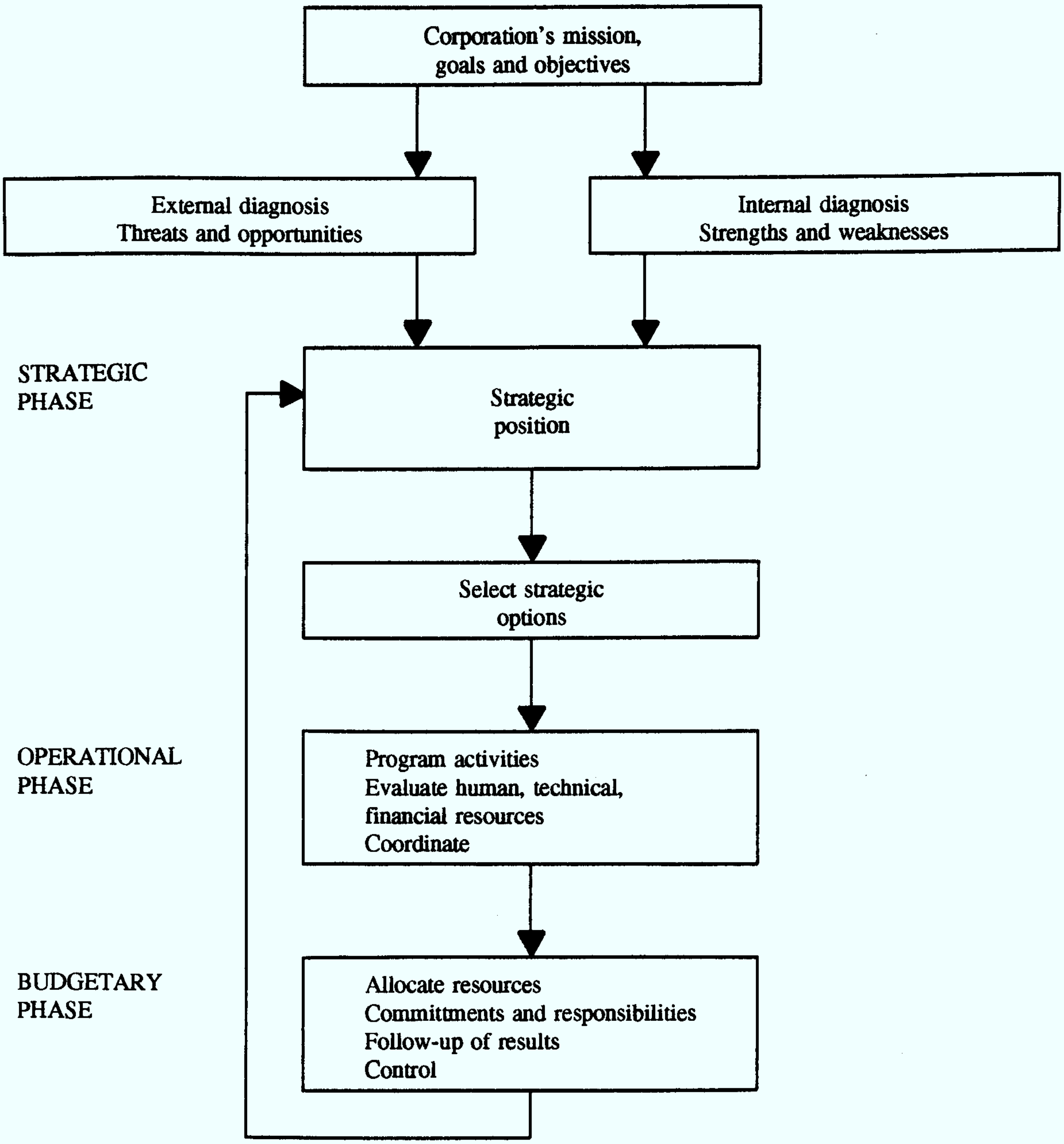
E. TECHNOLOGY (continued)	
• Entertainment, video, recorded interactive, etc.	Clarke, Marien, Schwartz
• Information technologies	**Amara**, Bell, Clarke, Drucker, King, Lamm, Marien, Meadows, **Ogilvy**, **Pierce**, Schwartz
• Energy technologies	Amara, Clarke, Hughes, King, O'Neill, Pierce
• Automation/robotics	Ayres, Clarke, Drucker, King, O'Neill
• Space technologies and technology transfer (e.g. biosphere research)	Clarke, O'Neill, Pierce

* Names in boldface type reflect greater emphasis given to this topic.

Source: COATES, Joseph F. and Jennifer JARRALT (1989) "*What Futurists believe*", Ed. Lomond.

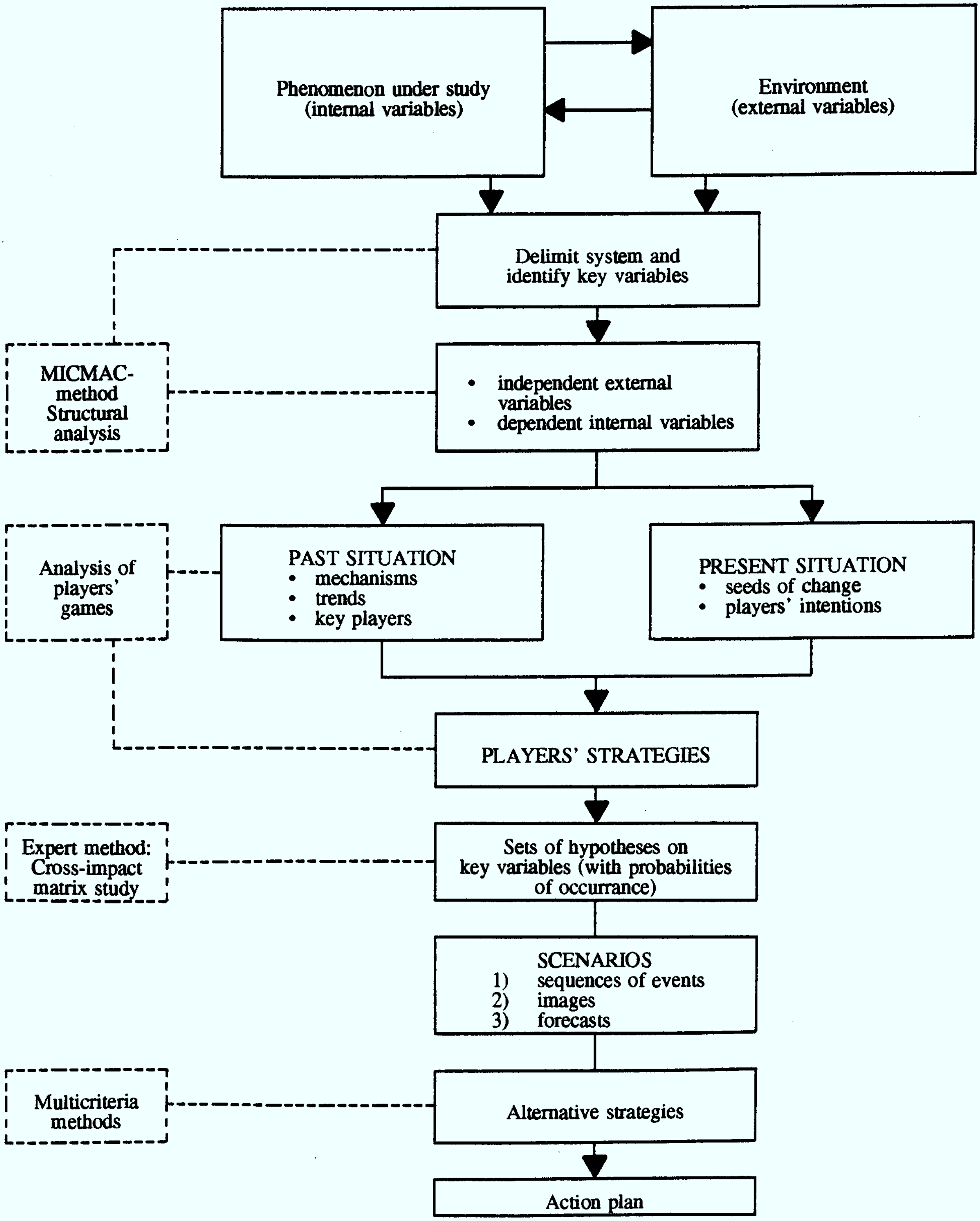
APPENDIX 3

Phases of Strategic Planning



Source: GODET, Michel (1985) "*Prospective et planification stratégique*", Paris, CPE-Economica.

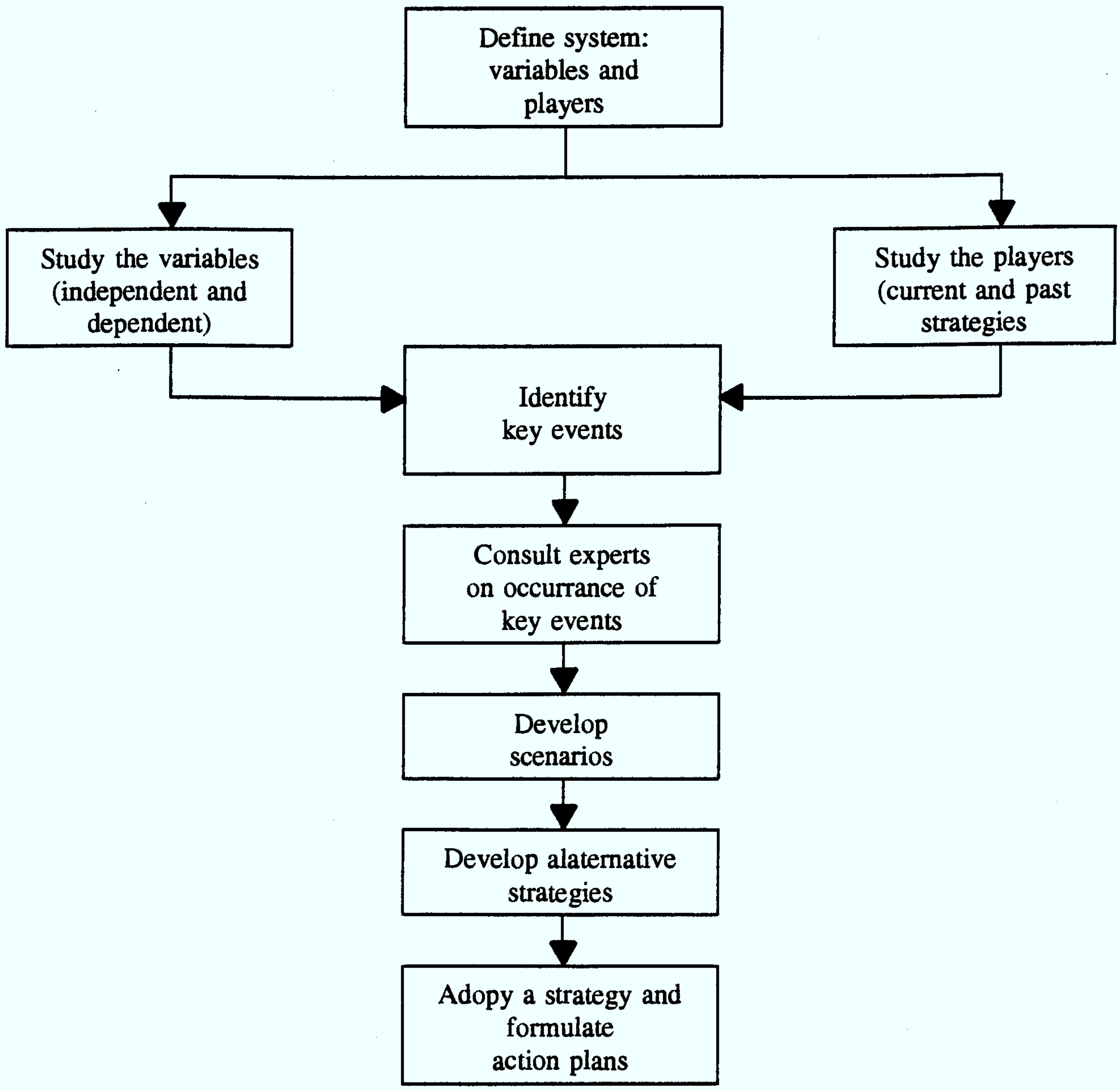
APPENDIX 4
Scenario Method



Source: GODET, Michel (November 1989) "Prospective et stratégie : approches intégrées", Futuribles, p. 14.

APPENDIX 5

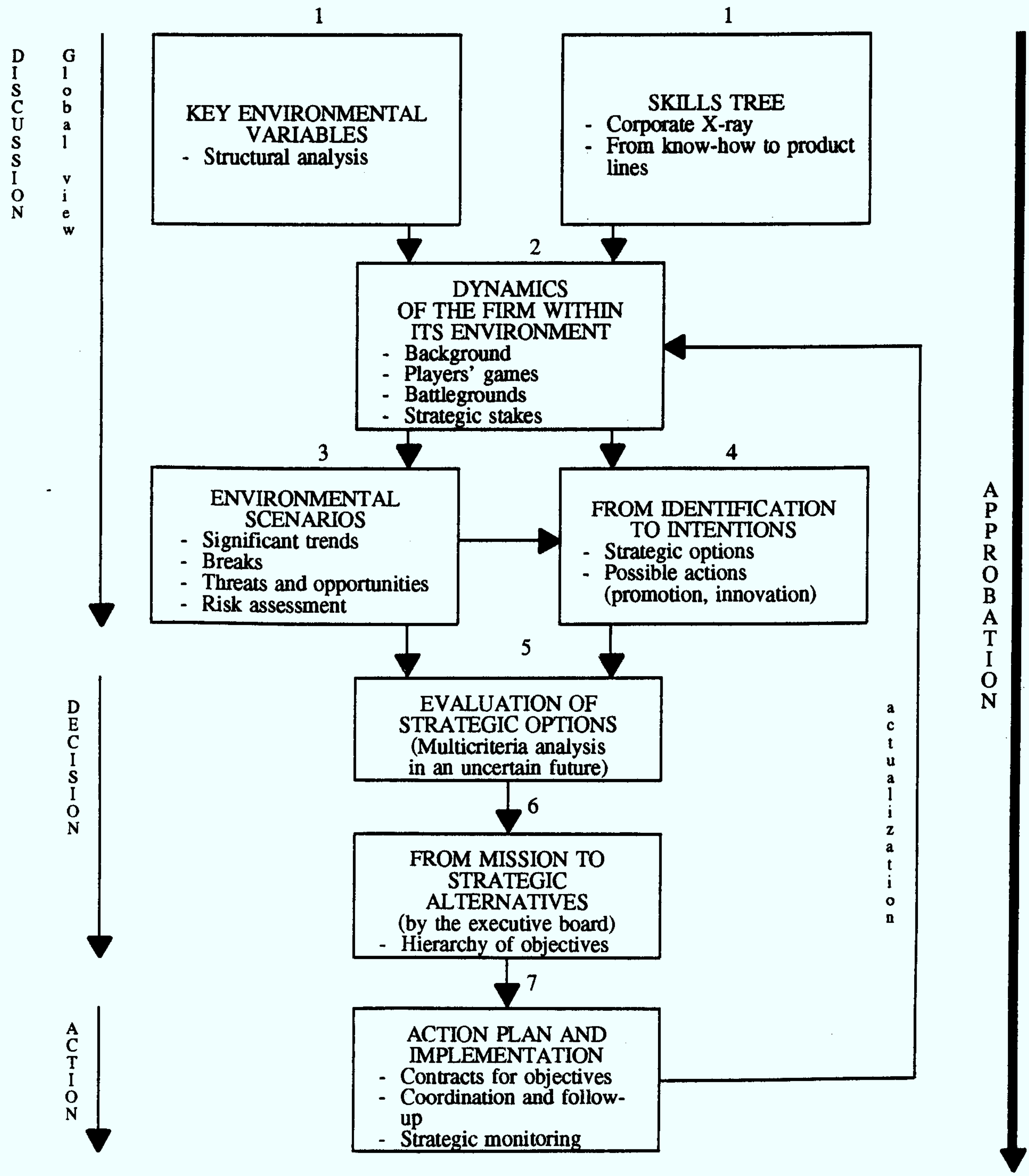
General Framework for Long-Range Planning



Source: GODET, Michel (1985) "*Prospective et planification stratégique*", Paris, CPE-Economica, p. 228.

APPENDIX 6

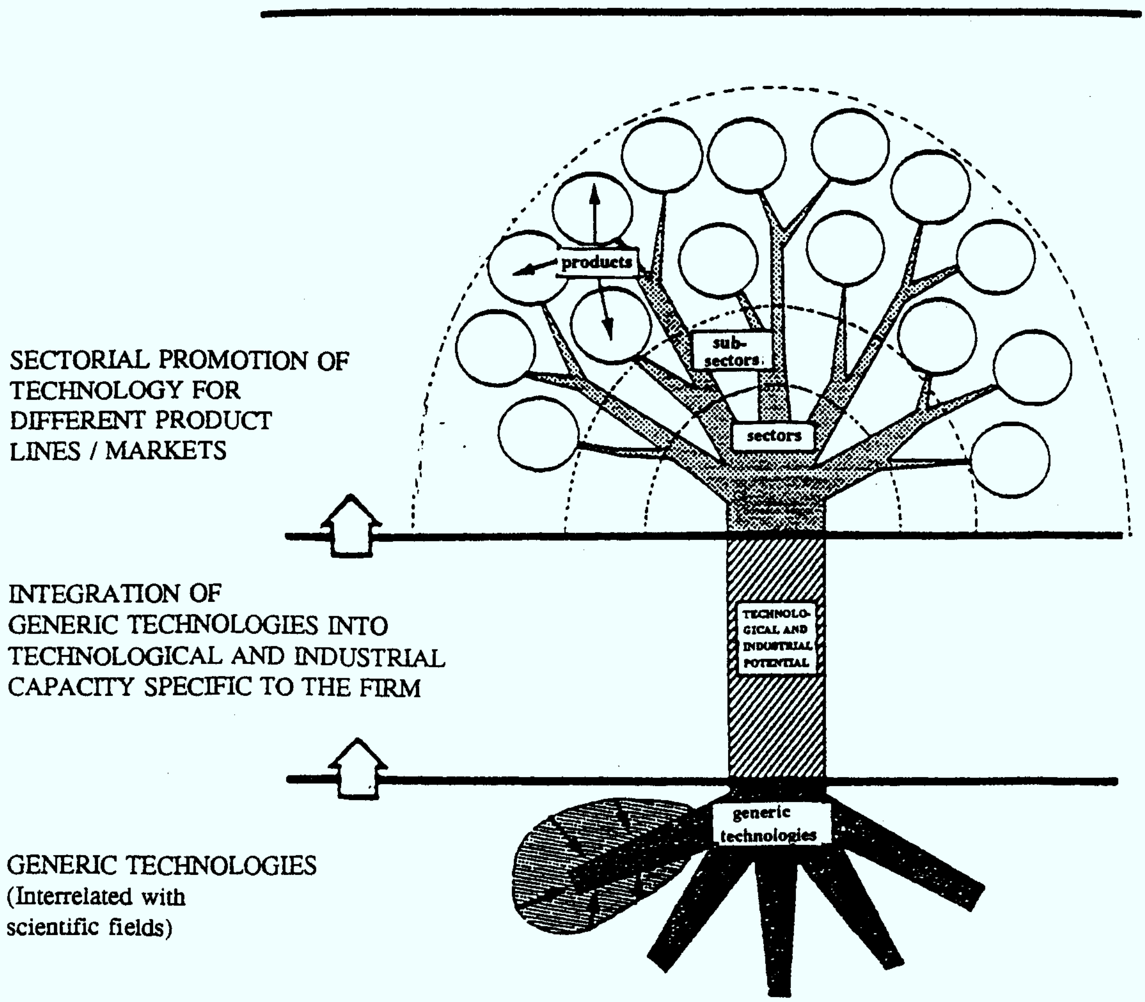
Integration of Long-Range and Strategic Planning Approaches



Source: GODET, Michel. (November 1989) "Prospective et stratégie : approches intégrées", Futuribles, p. 12.

APPENDIX 7

Synthetic Tree Representation of the Technology Function in a Japanese Corporation

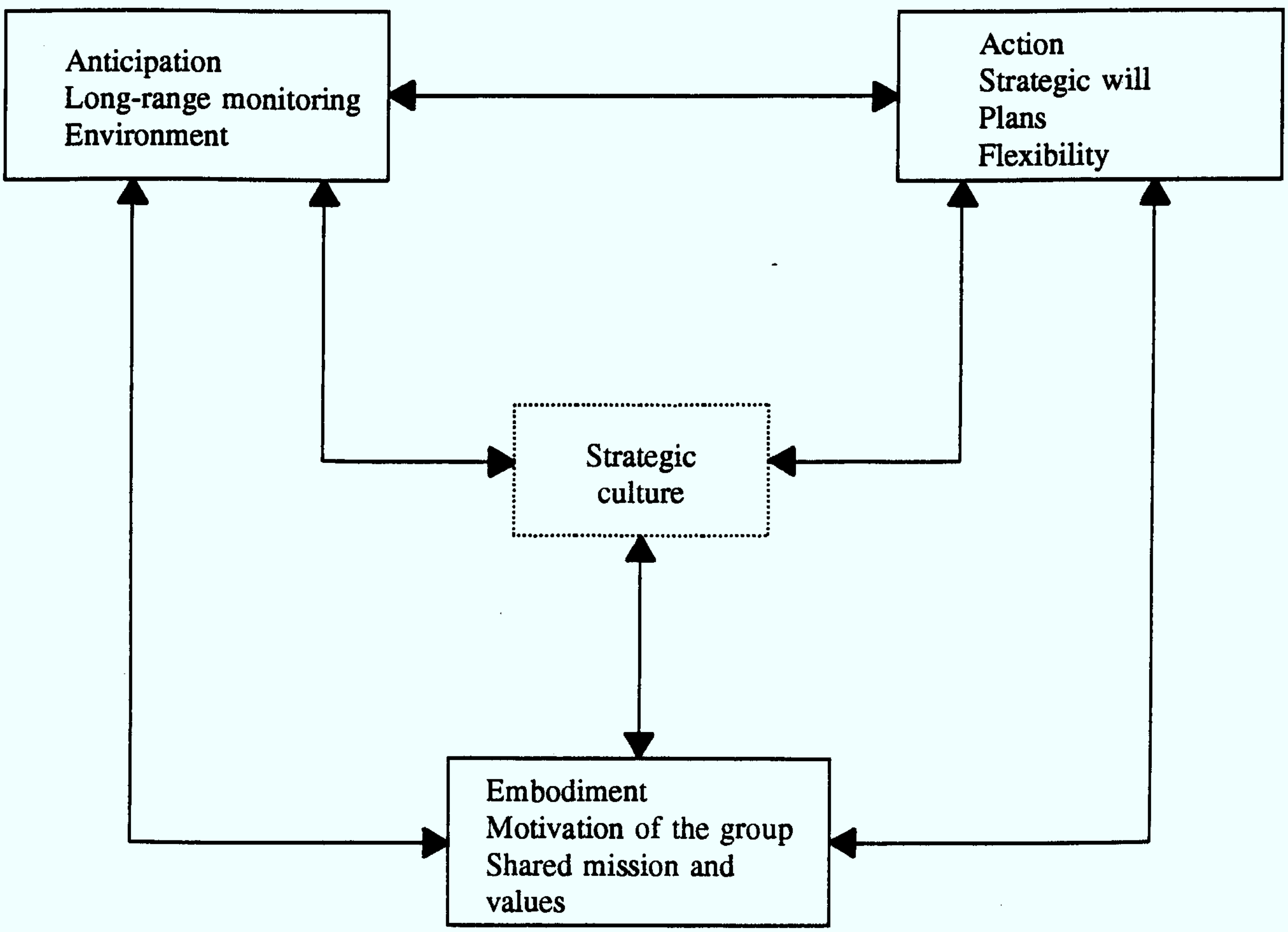


Source: GODET, Michel, (1985) "*Prospective et planification stratégique*", Paris, CPE-Economica, p. 239.

APPENDIX 8

Strategic Culture: The Greek Triangle

- Long-range monitoring
- Strategic will
- Motivation of the group



Source: GODET, Michel (1985) "*Prospective et planification stratégique*", Paris, CPE-Economica, p. 18.

APPENDIX 9

Distinctions Among Scanning, Monitoring, Forecasting, and Assessment

	SCANNING	MONITORING	FORECASTING	ASSESSMENT
Focus	• Open-end viewing of environment • Identify early signals	• Track specific trends and events	• Project future patterns and events	• Derive implications for organization
Goal	• Detect change already under way	• Confirm/disconfirm trends	• Develop plausible projections of future	• Derive implications for organization
Scope	• Broad, general environment	• Specific trends, patterns, events	• Limited to trends, patterns, and issues deemed worthy of forecasting	• Critical implications for organization
Time Horizon	• Retrospective and current	• Real time	• Prospective	• Prospective and current
Approach	• Unconditioned viewing • Heterogeneity of stimuli	• Conditioned viewing • Selective stimuli	• Systematic and structured	• Systematic, structured, and detailed
Data Characteristics	• Unboundable and imprecise • Vague and ambiguous	• Relatively boundable • Gains in precision	• Quite specific	• Very specific
Data Interpretation	• Acts of perception • Intuitive reasoning	• Weighing evidence • Detailing patterns	• Judgments about inferences	• Judgments about inferences/implications
Data Sources	• Broad reading • Consulting many types of experts inside and outside of the organization	• Focused reading • Selective use of individuals • Focus groups	• Outputs of monitoring • Collected via forecasting techniques	• Forecasts, internal strategies, competitive context, etc.
Outputs	• Signals of potential change • Detection of change under way	• Specification of trends • Identification of scanning needs	• Alternate forecasts • Identification of scanning and monitoring needs	• Specific organizational implications
Transition	• Hunches regarding salience and importance	• Judgments regarding relevance to specific organization	• Inputs to decisions and decision processes	• Action plans
Organizational Outcomes	• Awareness of general environment	• Consideration and detailing of specific developments • Time for developing flexibility	• Understanding of plausible futures	• Specific actions

Source: MILLET, Stephen M. and Edward J. HONTON, (1991) A Manager's Guide to Technology Forecasting and Strategy Analysis Methods, Columbus, Battelle Press. p. 89.

APPENDIX 10
Major Breakthroughs on a World Scale

PROBLEMS; ACTIONS; TIME FRAME Examples	1 ENVIRONMENTAL PROBLEMS	2 USA/J/EUR TECHNO/ECONOMIC *WAR* FOR WORLD LEADERSHIP	3 WORLD INFORMATION/ COMMUNICATION/ TRANSPORT NETWORKS	4 WORLDWIDE GAP BETWEEN *RICH* AND *POOR*
SHORT TERM 2-3 YEARS	• Standards • Environmentally conscious taxation	• World rules against private monopolies	• Standards • Promotion of applications of existing technologies	• Design of world programs • Development of local science and technology capability
MEDIUM TERM 5-10 YEARS	• New processes and products • Renewable resources	• Changes in public financing of industrial R&D • Expansion of basic and socially conscious R&D	• Restrictive measures on computer crime and copyright pirating	• Redifinition of technology transfer • Reform of GATT and world financial institutions
LONG TERM 20-30 YEARS	• New biotechnologies • Design of new products; different energy system	• Change from "cooperate to compete" to "compete to cooperate"	• Design of new systems, products and services (in addition to business services) • Lifestyle changes	
OVER GENERATIONS *EPOCHAL*	• 100% solar energy? • Transformation of cities • End of mercantile and consumer economy • *Eco-development*	• End of the technology war between USA/J/EUR • New economic values	• Redefinition of information and communication	• Towards a new planetary consciousness and society based on local/world identity

TECHNOLOGICAL R&D POLICY:
- DEFINITION OF A STRATEGIC WORLD TRADE POLICY VISION
- COHERENCE BETWEEN REQUIREMENTS UNDER 1 AND 2, BETWEEN 2 AND 4, ETC.
- REDEFINITION OF PROGRAM PORTFOLIO
- RESTRUCTURING OF FINANCIAL RESOURCES

Source: FAST/MONITOR, (October 1991) *Les recherches FAST 1989-1990, Conclusions majeures et recommandations pour la politique communautaire de la RDT*, Commission of the European Communities, p. 18.

APPENDIX 11

Changes in Productive and Political Apparatus for TRD — Priority to APS (*Anthropocentric Production Systems*)

	FACTORS IN CHANGES IN THE PRODUCTIVE APPARATUS: TOWARD *ANTHROPOCENTRIC PRODUCTION SYSTEMS*					
PROBLEMS AND ACTIONS TIMEFRAME Examples	1 INCREASED KNOWLEDGE	2 GROWING DESIRE FOR QUALITY AND SECURITY	3 DESIRE FOR -AUTONOMY -PARTICIPATION	4 NEW GENERATIONS OF TECHNOLOGY	5 "DEMATER-IALIZED" PRODUCTION	6 GLOBAL MARKETS AND ECONOMY
SHORT TERM	• Support for cooperation between universities, public research centres and small businesses • Up to date assessment of European *strategic* knowledge	• Reinforce standards • Support cooperative research between firms	• Promote exchange of information on innovative experiences	• Standards	• New methods for financing R&D (beyond risk capital)	See Appendix 10
MEDIUM TERM	• Measures to encourage mobility of qualified workers within the Community • Increased training for non-qualified workers	• Use of open bidding • RD activity in poorly covered areas	• R&D activity concerning self-management and self-assessment in decentralized production units • European social charter setting high standards for participation and codetermination	• Reinforcement of technological research (new optomatronic components)	• New indicators for firm's technological, economic and social balance sheet	See Appendix 10
LONG TERM	• New *human resources* concepts • Development of new concepts and practices regarding business ethics	• Stimulation of new products for target social categories	• Program for inter-disciplinary training on the firm of tomorrow for designers, businessmen, advertising executives, politicians	• Exploration of emerging *intelligence* technologies • What technological megasystems in Europe and in the world?		See Appendix 10
OVER GENERATIONS *EPOCHAL*	• What curricula for 21st Century vocational training systems? • Start thinking about the university and firm of the year 2020		• What firms / networks based on world knowledge?			See Appendix 10

GENERAL PROPOSALS FOR TRD POLICY:

- ESTABLISH A EUROPEAN FORUM ON ADVANCED MANUFACTURING
- BEGIN A TECHNOLOGICAL R&D PROGRAM CENTRED ON APS
- PROPOSE A WORLD TRD INITIATIVE FOR COOPERATION WITH POORER NATIONS

Source: FAST/MONITOR, (October 1991) *Les recherches FAST 1989-1990, Conclusions majeures et recommandations pour la politique communautaire de la RDT*, Commission of the European Communities, p. 19.

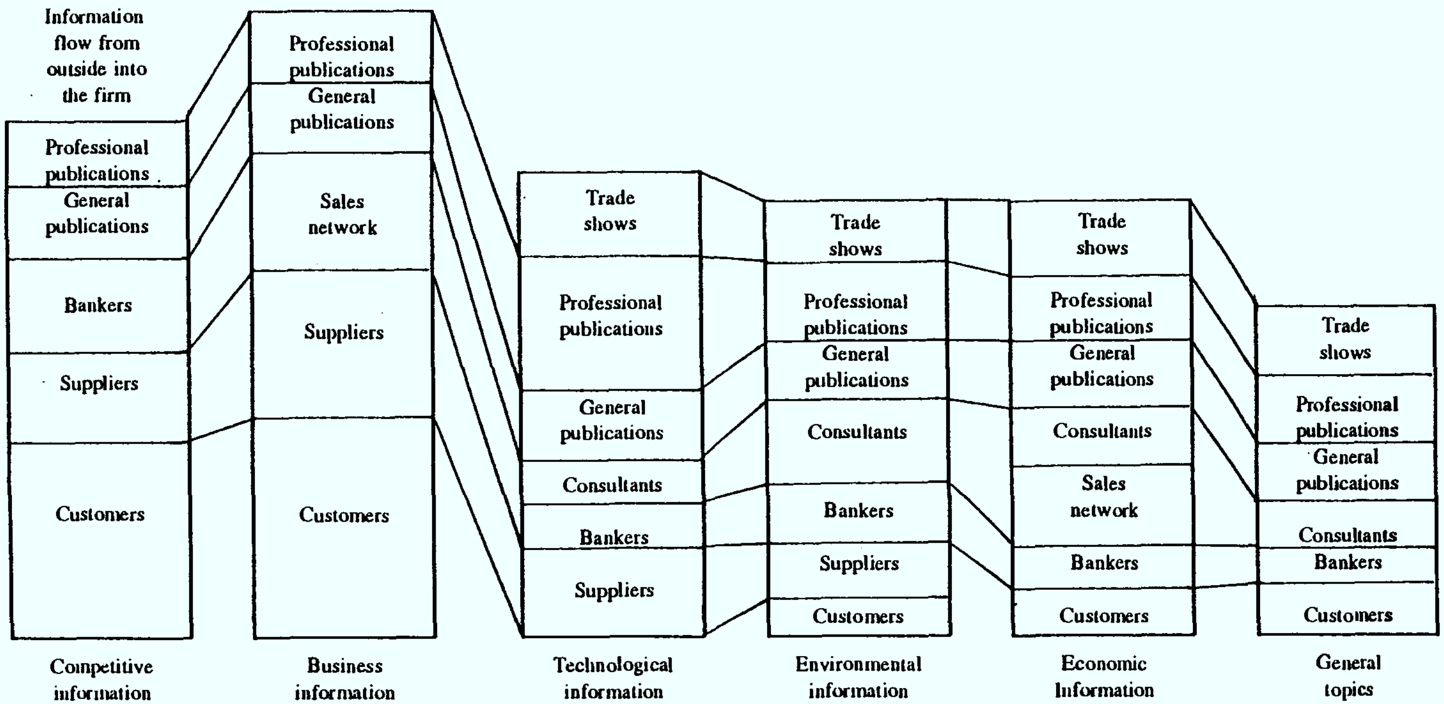
APPENDIX 12
Types of Monitoring, with Their Parameters

TYPE OF MONITORING	MEANS OF SURVEILLANCE	PRINCIPAL PARAMETER
TECHNOLOGICAL MONITORING	SCIENTIFIC FACTS	
	MATERIALS	
	INFORMATION SYSTEMS	
	TECHNOLOGY	
	PRODUCTS	Main service functions
		Supplementary service functions
		Appraisal functions
		Performance
		Resistance to constraints
	PROCESSES	
MONITORING OF COMPETITION	ECONOMY STRATEGY	Investment policy/strategy
		Economic well-being
		Obstacles to leaving field of activity
		Obstacles to entering field of activity
		Industry reaction to newcomers
		Business, pricing policies followed
	COMMON CUSTOMERS	Industry growth
		Changes in respective market shares
BUSINESS MONITORING	CUSTOMERS MARKETS	Long-term changes in customer requirements
		Customer/firm relationship
		Client solvency
	SUPPLIERS	New products
		Firm/supplier relationship
		Ability to supply, at lowest cost
	LABOUR FORCE	Changes in supply of new skills
		Labour market organization
		Labour costs
ENVIRONMENTAL MONITORING	Sociological Political Cultural General economic environment etc.	

Source: MARTINET, Bruno and Jean-Michel RIBAULT, (1988) *La veille technologique, concurrentielle et commerciale, Sources, méthodologie, organisation*, Paris, Éditions d'organisation, p. 69.

APPENDIX 13

Relative Importance of Sources for Different Types of Monitoring



Source: MARTINET, Bruno and Jean-Michel RIBAULT, (1988) *La veille technologique, concurrentielle et commerciale, Sources, méthodologie, organisation*, Paris, Éditions d'organisation, p. 74.

APPENDIX 14

Formal Information Sources

	PRESS	SERVICES (S) DATABASES (B)	S S C	GOVERNMENT	OTHER
DIRECTORIES	GUIDE LAVOISIER (15,000 JOURNALS)	ANRT DATABASE DIRECTORY (1,100 DBS)		GUIDE DES GUIDES	
TECHNOLOGICAL MONITORING	• TECHNICAL PRESS • PATENTS • STANDARDS	• QUESTEL (S) • INPI (B) • DERWENT (B) • NORIANE (B) • TRANSINOVE (B)	• SSC TECHNOLOGIQUE • TECHNOLOGY BROKERS • S S C GÉOGRAPHIQUE (FOR A SINGLE COUNTRY)	• CPE • CNRS • INPI • DRET • ANRT • ANVAR • BRIST-ARIST	• TECHNICAL CENTRES (1948 LAW) • AFNOR
MONITORING OF COMPETITION	• INDUSTRY PRESS • CUSTOMS DATA • DIRECTORIES (KOMPASS, DUN & BRADSTREET)	• KOMPASS (B) • DUNSDATA (B)	• BUSINESS INFORMATION SERVICES	• CUSTOMS SERVICE • CFCE • EMBASSIES	
BUSINESS MONITORING	• CUSTOMERS' ECONOMIC AND TECHNICAL PRESS • MOCI • BALO • BODACC	• BALO (B) • BODACC (B)	• PROCESS SERVERS • PRIVATE DETECTIVES	• BUSINESS TRIBUNALS • LAND REGISTRIES • COFACE • I.N.S.E.E.	
ENVIRONMENTAL MONITORING	• ECONOMIC PRESS • BANK BULLETINS • DOCUMENTATION FRANÇAISE	• SYNDONI (B) • CISI (S) • G. CAM (S) • INSEE (B) • FRANCIS ECO DOC (B)		• D.S.T., R.G.	

Source: MARTINET, Bruno and Jean-Michel RIBAULT, (1988) *La veille technologique, concurrentielle et commerciale, Sources, méthodologie, organisation*, Paris, Éditions d'organisation, p. 109.

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