EDUCATION AND EXAMINATION COMMITTEE

OF THE

SOCIETY OF ACTUARIES

COURSE 7 PRE-TEST STUDY NOTE

APPLIED FUTURISM

An Introduction for Actuaries

by

Alan Mills, FSA
and
Peter Bishop, PhD

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Applied Futurism

An Introduction for Actuaries

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I. Introduction

Futurism is a discipline that systematically explores what we can know about the future of human systems, and how we can use that knowledge to attain desirable futures.

Actuaries are also concerned with the future of certain human systems, such as the insurance industry, corporate employee groups, social security systems, etc. Therefore, you might think that the methods and tools futurists use are similar to those actuaries employ. In general, though, this is not the case. There has been very little cross-fertilization among futurists and actuaries.

This situation must change. The increasing complexity and interdependence of the world will soon outstrip the usefulness of traditional actuarial science. Traditional actuarial science is most useful for closed stable systems; that is, systems which have recurrent characteristics over a long period of time and which are more or less insulated from the impact of other systems. Insurance markets and employee groups were once systems of this type. But no more. These and most other social systems are increasingly open, interdependent, and unstable.

Actuaries must explore new methodologies and tools for dealing with open unstable systems. For the past 50 years, the discipline of futurism has developed and tested a methodology and tools to apply to these systems. This study note introduces the methodology and tools of applied futurism.

Plan of the Study Note

The intent of this note is to provide you sufficient knowledge, skills, and attitudes about applied futurism, so you can commence to use its tools and perspectives in your day-to-day work as an actuary.

Knowledge

In the note, we will orient you to the general field of futurism by reviewing its history and comparing it to similar disciplines such as strategic planning, economic planning, and actuarial science. We will also bring you up-to-date on the current state of knowledge about how change happens in our world of complicated open systems, and why we need the tools of applied futurism. Finally, we will describe the methodology and tools of applied futurism. If you wish to learn more about applied futurism, Appendix C provides a basic bibliography of important works in this area.

Skills

We will also show how the methodology and tools of applied futurism are applied in practice, and give examples of their application. A common theme running through the study note is how applied futurism might be used to solve the looming problems of the U.S. social security system. As you may know, recent projections of the social security trust fund indicate that it will go bankrupt in about the year 2030, primarily because of the demographic impact of the baby-boom cohorts. The year 2030 is precisely the time when the youngest baby boomers will turn 67 and be eligible for full social security benefits. So, here we have a major problem affecting us all. We will explore how a futurist might approach the social security problems, as a means to help you develop skills to use the methodology and tools of applied futurism.

Attitudes

We also hope that by reading this note you will adopt some of the attitudes of applied futurism in your actuarial work. Among these are:

- Appreciation of the limitations of quantitative and analytical techniques in dealing with change in human systems, and of the usefulness of 'softer' tools such as intuition, judgment, scenarios, and visioning.
- Emphasis on long-range foresight to recognize problems in time to choose viable solutions.
- Realization that everything is connected to everything else, and that a wide perspective is necessary to approach the problems of human systems.
- Recognition of the importance of human values in our work.
- A bias towards action to achieve desirable futures.

Specific Learning Objectives

After you study this note, you should be able to do the following for the actuarial exam:

1. Outline how futurism developed, name several important futurists and their primary contributions, and name prominent organizations devoted to applied futurism.
2. Describe how applied futurism compares to similar disciplines such as strategic planning, economic forecasting, and actuarial science.
3. Describe the general methodology that futurists use, and apply this methodology in a case study.
4. Describe the following applied futurism tools, and show how they might be used in a case study:

- Cross Impact Analysis
- Decision Modeling
- Delphi Technique
- Environmental Scanning
- Futures Wheel
- Gaming and Simulation
- Genius Forecasting
- Relevance Trees
- Scenarios
- Systems Dynamics
- Trend Impact Analysis
- Visioning

For your convenience in studying, Appendix A is a glossary of special terms used in the note. Appendix B provides a bibliography of interesting and useful works in applied futurism, broken down by application category.

II. History

Futurism is a relatively new discipline that is still in its early stages of development. In order to appreciate what futurists have accomplished, and to understand the conspicuous underdeveloped areas of applied futurism, it is important to review its history.

Futurism has developed in four phases:

- The first phase began after the end of the Second World War and continued through the early 1960s. This was a period of strong growth and optimism in the world economy and a period when the U.S. was under threat of nuclear attack. During this time futurists showed that we can profitably study the future; they laid down the philosophical and methodological foundations for futurism, and several futurism tools were developed.
- The second phase was the late 1960s and early 1970s. This period was the high water mark of futurism. The discipline grew tremendously during this period; important futurism organizations sprang up, and much important work was accomplished.
- The third phase was the late 1970s and early 1980. This was a period of energy and economic crises, and social flux; there was little confidence about the future. Futurism itself experienced a crisis. It had not predicted the conditions in the world economy, and seemed unable to respond to the changing needs of society. Therefore, the third phase was a period of retrenchment and reexamination.
- The fourth phase started in the late 1980s, and continues to the present day. It is a period of economic growth, accelerating change, complex international interrelationships and problems, and emphasis on the practical. Futurism has responded by becoming more multi-dimensional, international, and practical.

In this section, we will briefly review the major developments in these phases, and highlight eminent futurists and organizations that contributed to this development.

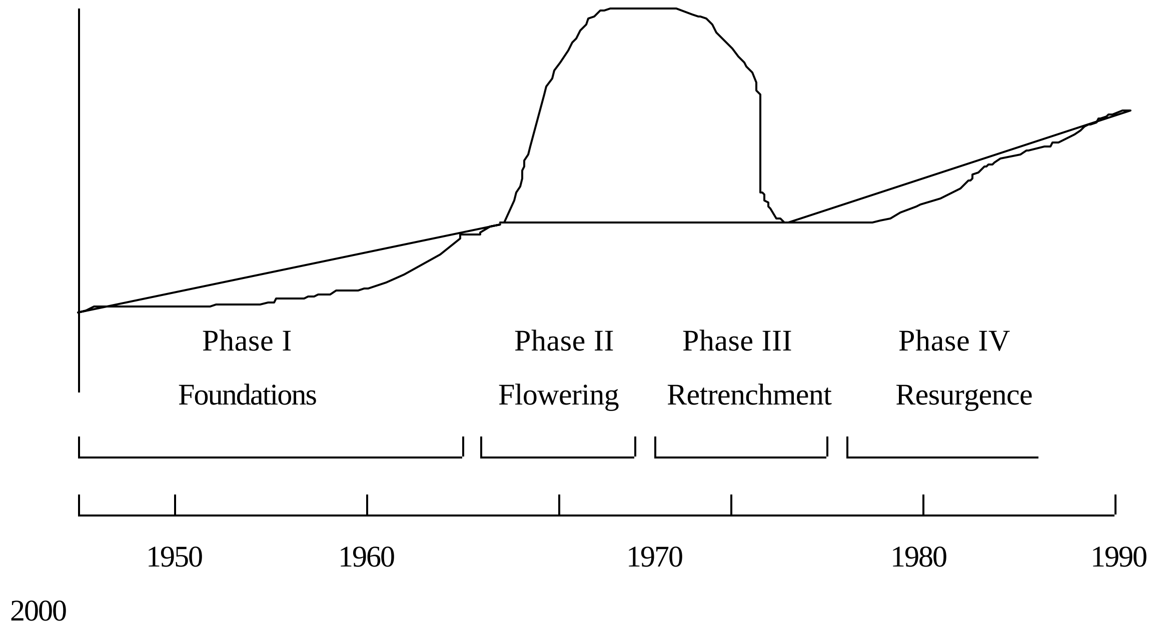


Figure II.1

History of Futurism

Phase I: Laying the Foundations of Futurism

The foundations of futurism were developed along two paths. Along one path, European futurists laid the philosophical and humanistic foundations of the discipline. Along the other, U.S. futurists developed its core methodology and tools.

Philosophical Foundations

In the aftermath of the Second World War, the devastated countries of Europe needed long-term strategic plans for reconstruction. These plans required critical thinking about the long-term future. Therefore, a few planners, especially in France, began to explore what could be known about the future. Gaston Berger was one of these planners. He created one of the first organizations devoted to applied futurism, the Centre International de Prospective in Paris. Berger championed the concept that we can invent or create our future; the future is not necessarily thrust upon us. In the Prospective group, experts from a variety of fields focused on developing desirable futures for mankind, and determining what could reasonably be accomplished.

In 1964 another Frenchman, Bertrand de Jouvenel, published the classic work *The Art of Conjecture*. This work rigorously explores the possibility of knowledge about the future, and so lays the philosophical foundations for the discipline. De Jouvenel argued that prediction per se is logically impossible, that the future is a fan of possibilities, and that a study of the future must be an art rather than a science. He also established an applied futurism organization in Paris, the Association Internationale Futuribles, which is still active.

These and other European futurists laid the intellectual foundations of futurism, and emphasized the place of human will and values in the discipline.

Methodological Foundations

The methodological foundations and core tools of futurism were first developed in the U.S. These first tools had a quantitative and analytical bias.

Futurism arose in the U.S. after the Second World War because for the first time in its history, the U.S. was vulnerable to surprise attack from enemies thousands of miles distant; the technology of missiles and atomic bombs made this possible. Planning to defend ourselves from that attack took a different approach from conventional military defense. Conventional forces take time to assemble and prepare themselves for battle. That time gave planners time to flesh out their concepts with specific tactics.

Nuclear conflict was different. When the missiles appeared on the radar screen, planning time was over. Out of that necessity, the war game and ultimately the scenario were born. Rather than planning every contingency, which were innumerable, planners ran commanders through mock battles to prepare for the real one. They could not predict the way the actual attack would occur nor could they map all the possibilities of the future. Rather they tested themselves against plausible ways it might occur, believing that their practice would make them better for the real thing.

Another strain that led to futurism was the development of large complex military systems. ICBMs, nuclear submarines, and advanced fighters all took years to develop. Had the technologies that went into those systems been baselined at the start of the planning period, the technologies would have been outmoded by the time the systems were built. The military therefore had to invent technology forecasting

To perform this work, several important future-oriented research groups were founded. Among these were the RAND (an acronym for **R**esearch **An**d **D**evelopment) Corporation. RAND's mission was to explore the future of technology, especially the technology of warfare, and the strategic policies of the nation. Olaf Helmer at RAND explored the applicability of scientific forecasting and the use of expert intuition in applied futurism. He developed several tools for applied futurism, including the Delphi Technique, a structured approach to maximizing the usefulness of expert opinion, and the Cross Impact Analysis Technique.

Herman Kahn was another futurist at RAND. He developed the Scenario Technique and founded the Hudson Institute, which focused on long-term future studies relating to military strategy and world economy. In 1967 he and Anthony J. Wiener published a milestone in the literature of futurism, *The Year 2000: A Framework for Speculation on the Next 33 Years*. This book gave a broad picture of the direction of the world over the next three decades. It took a scientific approach, replete with charts, graphs, and tables of data. It demonstrated that the future can be studied seriously with scientific tools.

Olaf Helmer also spearheaded the establishment of the Institute for the Future. This institute is still one of the most important private organizations for applied futurism; it has been instrumental in institutionalizing research on the future. It is located in Menlo Park, California, and specializes in large-scale business, social, and non-security governmental issues.

Private enterprises also became interested in applied futurism during this period. Companies such as IBM, Exxon, Shell, General Electric, and Bell Telephone employed futurism tools to examine the long-term future.

Phase II: Flowering

The late 1960s and early 1970s were a productive period for futurism. Books like *The Population Bomb* and *Future Shock* came out during that time.

The system dynamics tool was developed during this period; and Dennis Meadows and others used this tool to produce what is considered the first global model that viewed the world as a complex of interrelationships among systems. The results of his work was published as *The Limits to Growth*, a book of far-reaching significance. This work warned that if the trend of exponential growth in population, industrialization, pollution, and consumption continues, then the world will reach its physical limits in about 100 years, and our societies will disintegrate.

Also, three important networks for futurists were established; they are still active:

- The Club of Rome is an international group of scientists, humanists, planners, and educators who combine their expertise to examine world problems from a global perspective. Their aim is to influence decision-makers at the global level.
- The World Futures Studies Federation consists mainly of professionals who are active in applied futurism. It has been instrumental in helping countries outside of Europe and North America establish applied futurism organizations.
- The World Future Society has its headquarters in Bethesda, near Washington, D.C. Its membership comes from a wide variety of people interested in the future. From a membership of less than 100 in the 1960s, it grew to over 30,000 during the 1970s; its membership is now about 15,000. The World Future Society publishes the magazine *The Futurist*.

It is important to note that the World Future Society is oriented more toward futurists in North American, whereas the Club of Rome is more European in orientation. The World Futures Studies Federation is a truly international organization.

Phase III: Retrenchment

In the usual way of things, the expansion and flowering of futurism was followed by contraction in the late 1970s and early 1980s

The watershed events of the mid-70s turned things around. The Arab oil embargo shook people's confidence in American hegemony and Watergate shook their confidence in government. The result was a turn toward a more conservative economic and political agenda. The conservative economic agenda highlighted short-term occupational gains over the longer-term societal aspirations of the 60s. As a result, the 80s were a low point for futures thinking because of the emphasis on the short term.

The popularity of futurism waned; membership in futurist organizations dropped, funding for research dropped, and futurists began a period of self-examination. This reexamination was fruitful. It produced a new global perspective in futurism.

Phase IV: Resurgence

The fourth phase commenced in the late 1980s and continues through today. The mood of the prior period began to reverse itself as the costs of short-term thinking became more apparent in the form of government debt and the looming social security crisis. Random shocks like the fall of Communism, the destruction of the ozone, and the savings and loan crisis awakened people to the need for global long-term perspectives. Information technology, in its infancy during the early 80s, has clearly begun to transform society. Finally, the approaching millennium has piqued people's interest in the next century.

We are experiencing a period of general economic growth, accelerating change, complex international interrelationships and problems, and emphasis on the practical. Futurism has responded by becoming more multi-dimensional, international, and practical.

During this period of complexity and rapid change, it has become clear that the quantitative futurism methods of the past are no longer useful in anticipating the often surprising changes that complex social systems undergo. Therefore, futurists have developed new tools to deal with these systems. Another indication that futurism is becoming more practical is that futurists have begun to emphasize the implementation stage necessary to attain desired futures, rather than focusing solely on research and analysis.

Many countries outside of Europe and North America now have significant applied futurism organizations, including Eastern Europe, the former Soviet Union, developing countries in South America and Africa, India, Japan, China, and Australia. Most of these have developed during this latest period.

In addition, futurism organizations in North America and Europe have become stronger and more multi-disciplinary in approach.

III. Terminology

Futurists have not yet agreed on a consistent terminology to describe their methodology and tools with precision. Different authors may use the same term with different intended meanings, or use different terms to mean the same thing.

Nevertheless, for consistency in this study note, we will adopt one terminology. This section defines the terms we will use to describe the characteristics, methodology, and tools of applied futurism. For your convenience, there is a glossary of these terms at the end of the note.

Futurism

As we have seen, futurism is a relatively new discipline with multiple roots and a rich international diversity. This explains in part why futurists have found it difficult to achieve consensus about certain vital aspects of the discipline. As a prime example, there is no consensus yet about a name for the work of futurists. Some prefer the term "futurism", while others use "future studies" or "futures research". European futurists tend to use "prospective studies"; "futurology" is also sometimes heard. In the U.S. the term "futurism" seems to have the widest acceptance, and so we use it for this study note. You should note, however, that "futurism" is also an art movement begun in Italy around the turn of the century. It is characterized by giving expression to the energy and movement of mechanical processes. Mechanical processes are hardly the stuff of futurism!

Applied futurism is the practical application of futurism. It applies the methodology and tools of futurism to the needs of a specific group or organization. Applied futurists work for specific clients while more general futurists publish their results as part of the intellectual discussion of our time. Most futurists do both, but the distinction is useful to point up the practical applications of futurism in addition to its societal focus.

Systems and the Domain of Observation

We have seen that futurism is concerned with human social systems and how they change over time. Thus, the concept of system is central to futurism.

For our purposes, a ***system*** is any collection of objects that functions as one unit. Examples of systems are:

- the planetary system, consisting of the sun, planets, and perhaps a moon or two.
- the earth's weather system, including all air masses around the earth.
- the U.S. social security system, including the U.S. population, the social security law, the Social Security Administration, etc.

A ***human social system*** is any system that includes interacting humans as a component. Clearly, of the three examples of systems given above, the U.S. social security system is the only human social system.

A ***system of interest*** is a system which is the focus of study. A ***peripheral system*** is any system that might have some impact on the system of interest. So, the U.S. social security system might be a system of interest for an applied futurism study, whereas the social security systems of Europe would be peripheral systems for such a study. Even the weather system could be considered a peripheral system since the greenhouse effect could affect the performance of the economy which in turn would affect how well the government could meet its social security obligations. A distinguishing characteristic of futurism then is that it places more emphasis on the effects of peripheral systems in the long-term future.

As we will see in the section on the nature of change, everything in our universe is connected to everything else in some way. An atom at the edge of the universe has some impact on our weather system, which in turn has some effect on the social security system. Every peripheral system has some impact, however insignificant, on the system of interest. So, to completely understand the behavior of the system of interest, we would need to monitor all systems in the universe. Clearly, this is not possible. We must limit our observation to a subset of peripheral systems that we think has the most important impact on the system of interest. This subset is the ***domain of observation***.

The domain of observation includes some of the peripheral systems. We assume that impacts on the system of interest arising from peripheral systems not included in the domain of observation are either negligible or will occur beyond the time horizon (see below for a discussion of the time horizon). Establishing the domain of observation bounds an applied futurism study. At the same time, bounding the study incurs the risk of leaving out a critical influence. While that risk cannot be completely discounted, futurists tend to include more peripheral systems than other forecasters do and run less of that risk as a result.

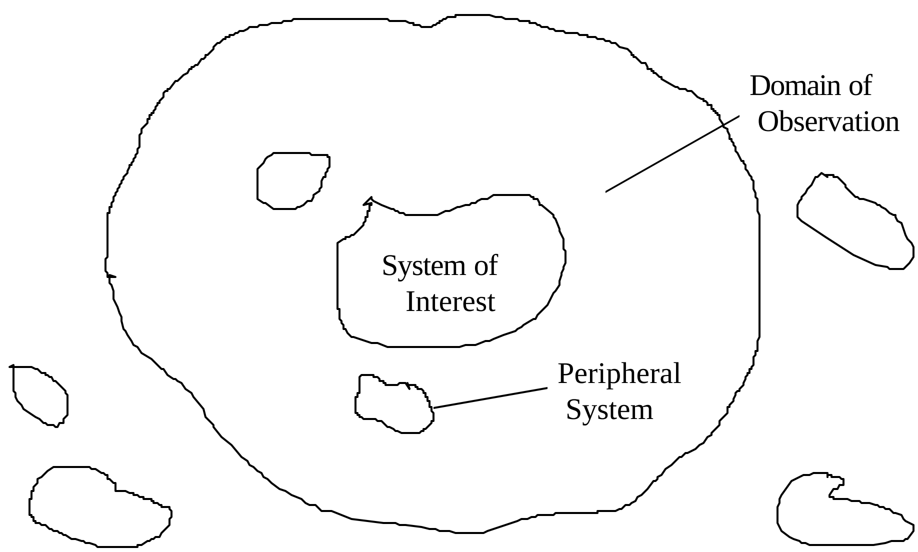


Figure III.1

System of Interest and Peripheral Systems

Describing Systems

Just as we cannot monitor every system, we cannot be concerned with every characteristic of a system; they are too numerous. We must limit our attention to a few. ***System attributes*** are those characteristics of a system that we focus on for study; generally, system attributes fully describe the system for purposes of the study. For example, the attributes of the planetary system for a particular study might be the position, velocity, and mass of each of the planets and moons in the system.

A system's attributes change over time. For example, the position and velocity of the planet Earth change with time. The ***current state*** of a system is the condition of the system's attributes at time 0 of a study. The ***future state*** is the condition of the system's attributes at some future time t > 0.

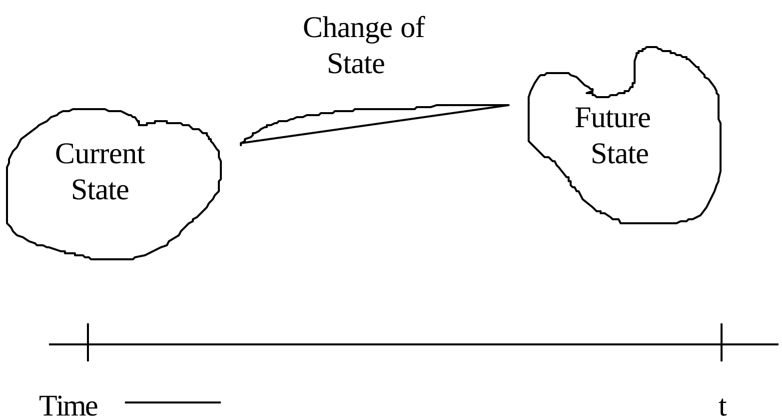


Figure III.2

Change of State

Systems, like mathematical functions, change in two major ways: continuous and discontinuous. A **trend** is a continuous, incremental change over a long period. Examples are the aging of the U.S. population, the destruction of biological species, the growth of world trade. An **event** is a discontinuous, sudden change over a short period. Examples are the collapse of the Soviet Union, the discovery of the polio vaccine, the introduction of the fax machine.

The distinction between trends and events rests on the time scale used. The destruction of biological species, for instance, has been going on for decades and will probably go on for decades more. In geological time, however, a major extinction like that, even one that takes many centuries, is still considered an event. By the same token, the collapse of the Soviet Union was sudden by all reports, except that it still took some days or weeks for the regime to fall, for the Wall to be destroyed, for the Russian coup to fail, etc. Choosing a watch or a calendar can determine whether a change is considered a trend or an event. In a study of the future, therefore, a change will be considered a trend when it is expected to continue for all or most of the time before the time horizon. A change will be considered an event when it is expected to occur in a small fraction of the time before the time horizon.

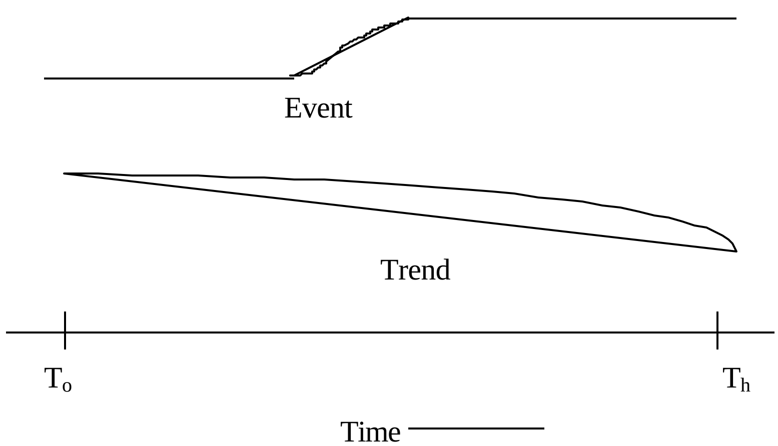


Figure III.3

Event and Trend

Time

In applied futurism, the ***time horizon*** is the period of time that future states of the system of interest are under consideration. For example, the time horizon for a study of the social security system might be 50 years.

The time horizon is another dimension of the domain of observation. Using the spatial metaphor, the horizon is the farthest point of sight. In futures forecasting, where we are more concerned with the dynamics of change than with a specific outcome, the time horizon is the time beyond which the researcher chooses not to consider. The time horizon bounds the forecast on the temporal dimension.

Types of Systems

There are many types of systems. An ***open system*** is one that is affected by one or more peripheral systems. As we shall see, all systems are in fact open systems. However, for purposes of analysis, many systems are considered to be closed. A ***closed system*** is one that is not affected by any peripheral system. These do not exist in reality.

Some systems, particularly physical and chemical systems, can be considered closed as a good approximation. Pendulums, springs, planets, reaction vessels, insulated containers are among the systems that are considered closed for the purposes of calculation. But we mistakenly apply that same reasoning to human systems, none of which are closed to the same degree. Every human system (economic, political, cultural, technological, organizational) is open to outside influences. We may choose to ignore those influences for good reason, but we always run the risk of leaving out a vital influence when we do.

A ***simple system*** is one that includes only linear relationships among its components. A billiard table is a good example of a simple system. The direct cause-effect relations allow one to predict the future position of any of the balls at any future time. Simple interest is another good example.

A **complex system** is one that includes some non-linear relations among its components. A well-behaved complex system would be compound interest, until of course growth escalates to impossible levels. The non-linear growth of compound interest results from a simple form of feedback, when the action of a component touches on a process that returns to influence that same component. In the case of compound interest, the principal is increased by the interest to form a new principal. Cybernetic systems, like cruise control on a car, are complex systems governed by feedback.

All human systems are complex. Not only do they involve many components all affecting each other, but they also involve human consciousness and choice, a sublime form of feedback. Seeing and assessing one's or another's actions moves humans to act to enhance or correct the effect of that action. A common error of planning or policy making is to treat human systems as simple, governed by straightforward linear relationships between the parts. "If we do this, then this will result." It may, but the complex relationships involved make the prediction difficult, if not impossible. Futurism is an approach for handling complex systems.

IV. Characteristics

Even though futurists don't yet agree on the scope of their practice, or even on a name for their activity, there are certain characteristics of their work that distinguish it from other similar disciplines. These are:

- **System of Interest: Human Systems**
  Futurists are concerned with human systems. Examples are the private economy of a community and the political system of a country. Thus, futurism is different from the natural sciences such as physics which deal with non-human systems. Actuaries are also commonly concerned with complex human social systems such as pension systems, the insurance industry, and the U.S. social security system.

- **Time Horizon: Very Long**
  Large complex systems often require significant time to exhibit state changes. Therefore, because futurists study such systems, they employ a very long time horizon to explore their behavior. For example, a longer time line is needed to study world economic problems than to analyze the projected profit of a single company. The time horizon for applied futurism studies is generally from 20 to 25 years, but may extend to 50 or even 100 years for studies of societal transformation. In this respect, actuarial science and applied futurism have much in common.

- **Domain of Observation: Global**
  Because futurists want to understand the real behavior of complex human social systems, they are interested in any peripheral systems that may significantly affect these systems of interest. Therefore, their domain of observation is wide. This distinguishes futurism from actuarial science as it is currently practiced.

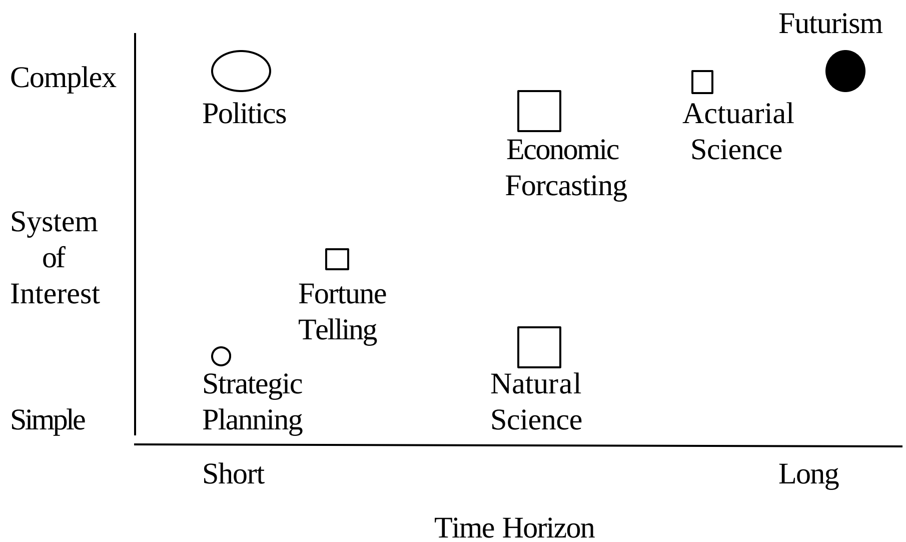
- **Methodology: Multidisciplinary**

  Futurists draw on knowledge and tools from a wide variety of disciplines to solve a problem. Often judgmental and qualitative approaches are used side-by-side with highly analytical and quantitative tools. This is often a point of difference with actuarial science.

- **Action Orientation: Biased toward Participation**

  Futurists want to help people achieve desirable future states. Therefore, they actively participate in creating desirable futures. This is another point of difference with actuaries.

The following figure illustrates how these characteristics distinguish applied futurism from similar disciplines.



Domain of Observation		Methodology		Action Orientation	
Local:	○	Unidisciplinary:	⬭	No action bias:	□
Global:	◯	Multidisciplinary:	●	Action bias:	○

Figure IV.1

Comparison of Related Disciplines

Futurists' Approach to Uncertainty

Perhaps the most important overall distinction between futurism and other disciplines that deal with the future is its approach to uncertainty. Drawing on our experience with natural science, we often try to scientifically *predict* future states by enumerating all of the factors that will influence that state. Our exceedingly poor record of making successful predictions should cause us to rethink that approach. We must assume, in order to be "scientific," that the system is closed to influences other than those we have enumerated. Is that a valid assumption? What if the influences are limitless? Even macroeconomic models that enumerate over a thousand variables are of limited utility over the short run of the next quarter and completely useless for forecasts of more than a year. What is the forecaster to do when he or she must make statements about the future 5, 10 or 20 years from now. Is it possible to establish a closed system over that time period in order to meet the assumptions of "scientific" techniques?

Futurists think not. Rather they admit that the future of human systems, all complex systems in fact, are inherently uncertain and rather than assuming that such uncertainty does not exist, they deal with it head-on, in two ways. First, they forecast in the form of scenarios rather than predictions. Scenarios may be as simple as a range of possible values of some future parameter, but they are usually more than that. Scenarios usually describe a long-term future in which not only the parameters change but the whole nature of the enterprise or the society changes as well. A new arrangement emerges: technologies, rules, relationships, beliefs, values, businesses, and people all change. Scenarios handle transformational change as well as extrapolative; they handle qualitative change as well as quantitative; they handle true novelty as well as the cyclic return of familiar patterns.

The degree of uncertainty inherent in human systems drives the differences among the scenarios. If we really don't know how a particular trend is going to move in the future or whether a particular event will occur, then we have at least two possibilities. Those possibilities, and many more, are described together as a single unit. The description is often in story form for vividness and ease of communication. Here is a world, a plausible world of the future, that includes many elements different than our world of the present. What are you going to do about it?

Secondly, futurists use the uncertainty inherent in human systems to motivate people to action. “The game is not up”, to paraphrase Sherlock Holmes. Things are not as neat and deductive as he would have us believe. Standard predictions are not action-oriented; once the prediction is made, what actions are there to take? However, one can use the uncertainty of human systems to influence trends and events to their advantage.

Futurists encourage their clients to select futures they prefer from a range of scenarios. Agreed on their future preferences, people and organizations can then set to work to influence their occurrence. Notice that no one controls the future, just as no one predicts the future exactly, because the systems are open and the results uncertain. But if they are uncertain, we also have choice to influence those futures we prefer.

Precision vs. Utility

The key attribute of a futures forecast then is not its precision or accuracy. While we all might prefer to treat human systems like physical systems and predict their future, such a preference is impossible. As we will show later in this note, it is generally impossible to make accurate predictions about future states of human systems. For this reason, futurists do not predict. This is another important characteristic of futurism; it is not meant to be precise.

However, applied futurism is meant to be highly useful. Futurists want to prepare their clients for multiple future possibilities--some of which are threats, others opportunities. They also want to assist their clients to choose their preferable future and lay plans and initiatives in that direction. Assessing the certain and the uncertain dynamics of human systems, appreciating the openess and uncertainty inherent in those systems, and conceiving of novel and transformational implications are the futurist's value to modern business and government.

V. How Systems Change

As we have seen, futurism is the study of how human systems change. This section reviews our old paradigm for how systems undergo change, and presents a new paradigm for systematic change.

Determinism: Our Old Paradigm

In the western world, our concept of system change has been dominated for centuries by *determinism*: the belief:

- that change in systems follows simple laws that can be reduced to mathematical formulas,
- that the past of a system fully determines its future in a predictable orderly way, and
- that we can predict the future.

Perhaps the most portentous success of the deterministic view of the world is Kepler's laws of planetary motion and Newton's laws of celestial mechanics. In its heyday, Newtonian physics was the key to understanding the universe. From simple laws, it seemed we could foretell the motions of all celestial bodies, explain the tides, and perhaps even trace the past and future of all matter in the universe. Using this tool, mathematicians predicted the existence and location of the planets Neptune and Pluto without so much as a glance at the sky. A single arc connects Newton's *Principia Mathematica* to a footprint on the moon.

These spectacular successes set the western mind on the path of determinism, a belief that all of nature could be explained by a few simple mathematical equations. Science flowered; analysis and reductionism reigned supreme as the path to knowledge; and scientists believed that even the veil of mystery obscuring the future of humanity could be pierced with sharp formulas and powerful computers. At the core of Issac Asimov's famous *Foundation Triology* is a man who, armed with supercomputers, reams of historical data, and an army of assistants, accurately foretells the future for centuries. Does that sound somewhat like traditional actuarial science?

Flaws in Determinism

Unfortunately, we now know that determinism doesn't work. It is not a useful paradigm for explaining the evolution of systems. Celestial mechanics, the bastion of determinism, can predict the location of planets only a few thousand years into the future, even with the best super computers. In astronomical terms, a few thousand years is only an eyeblink. Further, we cannot answer many basic questions with determinism. For example, we do not know whether the earth's trajectory is slowly collapsing into the sun, or spinning away from it, or whether the solar system is stable. The future of the solar system, a fairly simple system, is largely hidden from us. And celestial mechanics certainly does not forewarn us of a dramatic change of state in the solar system, even though we know that such a dramatic change is a characteristic of complex systems.

Poincaré was the first to stick a pin in the bubble of determinism. In 1892 he demonstrated that it is impossible to accurately predict the future positions and velocities of three point masses, even if you know everything about these bodies at some starting time. Thus, even the most simple of mechanical systems is inherently unpredictable. It does not require a wild stretch of imagination to conclude that determinism is impotent to model the changes in human systems, because human systems are infinitely more complex than physical systems.

But, you may ask, isn't all this just quibbling? Aren't deterministic equations good enough approximations in most cases? Actually, it turns out that our successes with celestial mechanics are largely a matter of good luck. We applied a good approximation to a relatively stable simple system.

However, most systems in our world are not stable. The weather is a prime example. Interestingly enough, we have understood the physics of weather for a long time. We know the equations that perfectly describe how weather behaves. But somehow, even with the most powerful computers, we cannot predict the weather with any accuracy beyond a day or two.

In the 1950s, a meteorologist named Lorenz found out why. He simplified the weather problem by selecting three very simple differential equations in three unknowns that model weather reasonably well. He then showed that the equations are unstable with respect to initial data. The slightest difference in initial conditions produces wildly different solutions. No wonder that weather forecasting is so difficult: the equations of meteorology are unstable because weather itself is an unstable system. The most minute error in the observations, the slightest shift in the initial data, may result in a completely different picture. It is estimated that small perturbations are multiplied by 4 every week, or by 300 every month. Lorenz christened this phenomenon the 'butterfly effect' A butterfly's capricious flight may result in a tropical storm, not tomorrow, but one or two years later. This is why long-range weather forecasting is so difficult: everything, absolutely everything, must be taken into account. No perturbation can be deemed too small to have any influence. For determinism to work, we need to be omniscient; and, of course, we are not.

Our New Paradigm: A Fan of Possibilities

Not surprisingly, we have been unable to predict the future of human systems using deterministic methods. Our standard approach has been to find the "right" laws, the "right" relationships. That has been the approach in social science for over 100 years, but the results have been disappointing. We have a few snippets of understanding, but they fall far short of a comprehensive theory that allows us to predict the future of human systems. Regression and econometrics have been powerless to predict the future because change in human systems does not operate according to laws of deterministic or statistical causality that we can capture.

Our new paradigm is based on the full realization that the future of a human system is inherently unpredictable. Our new paradigms treat the future of human systems as a fan of possibilities. Our task in preparing for the future is to clearly discern these future alternatives.

We now accept that human systems may indeed follow deterministic laws in their mechanics of change, but that this knowledge is not useful to us. From our limited perspective and lack of omniscience, a fully deterministic system may appear completely random.

Deterministic but Random

Randomness is perfectly compatible with deterministic systems. Order and randomness simply depend on your point of view. They can exist side by side.

Instability is one way in which deterministic systems exhibit randomness, such as in the butterfly effect. All the information about the system is available, nothing is hidden, but still we run into randomness. Very slight deviations in initial conditions produce very different trajectories for an unstable system. And there are many such unstable systems. For example, the stock market may be such a system. Once again, quantitative methods and computations based on deterministic equations are powerless.

Another way in which a purely deterministic law may materialize in a totally random sequence of observations is if part of the information is withheld, as it must be in any practical situation. Consider, for example. two stars with a planet moving in a straight trajectory back and forth between them, like in Figure V.1.

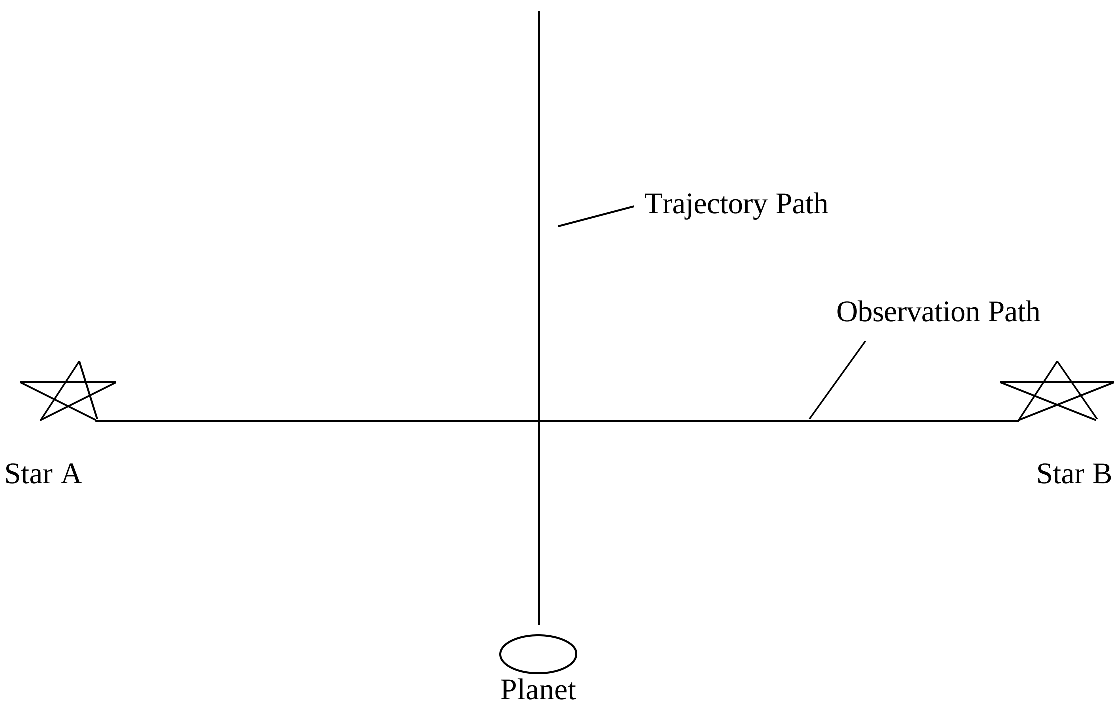


Figure V.1
Two star problem

Because of peculiar astronomical conditions, an observer on the stars can only see the planet for a brief instant when it passes the line connecting the stars (the observation path). Suppose you are the actuary wizard of Star A. The clever citizens of Star A have observed that the planet has passed through the observation path on January 1 for each of the past 100 years. They now ask you to confirm that it will continue to do this, with the proviso that you will be beheaded if you turn out to be wrong. What do you say?

Well, you might perform an actuarial trend extrapolation, and conclude that the planet will continue the same pattern for the next 100 years. This would be a great mistake, however, and could cost you your head. Since you know nothing about the velocity or path of the planet, you cannot predict the next time when it will cross the observation path. The best response would be to say you cannot know the answer, because you do not have enough information.

Thus, determinism can only be a property of reality as a whole, of the total cosmos. But even from the omniscent perspectiveof the whole universe, determinism and randomness may coexist, as we discuss below in the section on chaotic systems; determinism and randomness are not opposite concepts. But certainly, as soon as we isolate a sequence of observations to be described and analyzed, we run the risk of finding only randomness. A perfectly deterministic system may appear to us to be completely random from our limited perspective. Unfortunately, we have no other choice. Global reality, the cosmos taken as a whole, from the most minute elementary particle to the expanding universe, is out of our reach. We can only isolate subsystems for study, and use our limited perspectives to view this inaccessible whole. Even if reality is deterministic, most of what we observe may be raw unpredictability and randomness. Therefore, our new paradigm of the evolution of human systems gives up determinism as a useful path.

Futurism and the New Paradigm

So what do we have to offer in place of determinism? If we cannot trace the future of individual trajectories, if we cannot predict the weather, if we cannot foretell the behavior of a human system, what is there left for us to study? What can we say?

This is where the methodology and tools of futurism come in. These are not tools for *predicting* the future of human systems; rather, futurism helps us map out the possibilities that the future may hold, in order to make decisions.

The theoretical basis for the new paradigm is slowly taking shape in the current study of change at the Santa Fe Institute in New Mexico, and at Brookings Institution in Washington, D.C. This work is creating a unified way of thinking about change in systems.

There are three promising avenues in the study of change. Separately they are intriguing because they explain patterns that were heretofore unexplainable and even unrecognizable using the deterministic models of change. These new areas of study are:

- Critical systems,
- Chaotic systems, and
- Complex systems. (The three C's if you will!)

Critical Systems

A critical system is one that is on the verge of catastrophic change. The classic example of a critical system is a sandpile adding one grain at a time. At some time, it gets into a critical or supercritical state where each new grain has the potential to avalanche the whole pile. But this state emerges gradually so you can't tell exactly when the pile becomes critical and, more importantly, which grain will start the avalanche.

We only know when systems were critical after they collapse--the stock market in 1929, the crude oil market in 1973, the savings and loan industry in 1987, the Soviet Union in 1989. To a futurist, the collapse of critical systems in the past suggests strongly that such systems may collapse in the future. But which are they? Ilya Prigogine, the Nobel chemist, calls them systems that are "far from equilibrium." Is the atmosphere far from equilibrium because of an excess of carbon dioxide? Is the federal government far from equilibrium because of unprecedented debt? Is the planet itself far from equilibrium because of too many people and too much material production? No one knows. But the realization that the collapse of critical systems occurs without warning and usually has widespread consequences requires us to consider the possibility.

Chaotic Systems

A second type of change is chaotic. ‘Chaos’, like ‘critical’ and ‘complex’, has a street definition and a technical definition. In the street chaos means disorder, turmoil, randomness. The technical definition is different. A chaotic system is one whose change is minutely sensitive to initial conditions. Prior to the 1960s, system theorists saw only two types of behavior -- deterministic and stochastic. Deterministic behavior was governed by laws; they were predictable and "well-behaved." Stochastic systems were the result of random processes. Each trial was independent of the last; they were unpredictable and poorly-behaved, except in the aggregate. At that time, only deterministic systems were predictable, and all predictable systems were deterministic.

Chaotic systems actually represent a third type of system. As we saw above, Lorenz discovered that the weather is a chaotic system. The most minute differences in initial conditions produce wildly different results.

Chaotic systems are interesting because they are deterministic but not predictable. Every future state is calculated rigorously from the previous one. The simplest chaotic system is the well-known logistic equation:

$$x_{t+1} = a * x_t * (1-x_t) \text{ where } 0 < x < 1$$

When the scaling parameter **a** is above 3.75 or so, the system becomes chaotic. Very small changes in the initial value of **x** will produce significant changes after only a few iterations. Thus this chaotic system is deterministic, but not predictable.

The study of chaotic systems has blossomed in the last 20 years so that it is hard to imagine a system that is not chaotic, or potentially so. If the relatively simple weather system is chaotic, then what about the stock market or any market? How about political candidates running for office? Species as they evolve under different conditions? The interlocking network of computers called the Internet? Might we actually be surrounded by chaotic systems and not be aware of it?

The good news is that even potentially chaotic systems need not be chaotic all the time. When the scaling parameter in the logistic equation is less than 3.75, the system oscillates between one or more values or converges to a single value. Under those conditions the system is deterministic and predictable. The rule may be that well-behaved systems become chaotic under stress, Prigogine's far from equilibrium conditions again. They begin to act wildly, unpredictable. Every event follows inexorably from the last, but it is impossible to see two or three steps ahead in the crazy quilt of competing forces. Describes the computer industry, doesn't it?

The existence of chaos in even the simplest systems gives futurists the justification for the 'fan of future alternatives' they have been looking for. Futurists have been saying all along that apparently well-behaved systems have multiple futures. Now they have mathematical analogues that behave just that way. The tric k is to tell which are predictable and which are not, but the problem is the same. You cannot tell for sure until the system begins to behave unpredictably or until we open our eyes and see the unpredictability in our everyday systems. How much is our belief in the predictability of systems actually a fact and how much is it a hope that we will get "right" relationships "real soon now". In chaotic systems, there are no right relationships. The uncertainty is built in.

Complex Systems

Stephen Wolfram and colleagues at the Sante Fe Institute have introduced us to the third type of system, one that captures chaos in a broader framework. He was working with cellular automata, computer simulations that turn pixels on and off according to a set of rules. The rules are derived from the state of the pixel's nearest neighbors. If a certain number of them are on or off, the pixel itself turns on or off--a very simple system. The surprising result is that simple rules produce amazingly complex behavior.

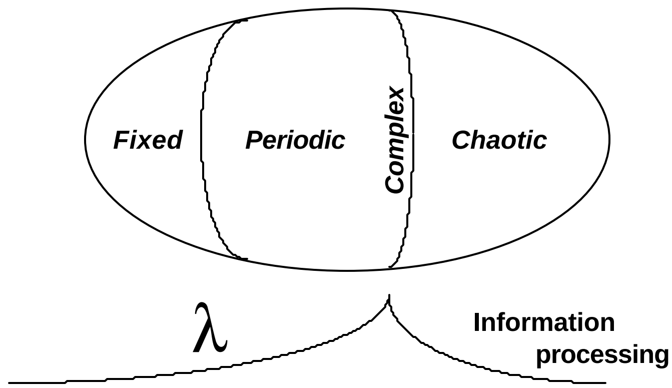
Wolfram was working with line automata, cells in a line that turn on or off depending on whether they are on or off and whether their next-door neighbors are on or off. The lines print successive generations down the page producing a pattern. Each pixel is governed by eight possible conditions (on/off for itself and its two neighbors = 2^3), and each condition can produce an on or an off. The result is 2^8 or 256 different rule sets. When he tested these 256 rule sets, he found no pattern. Changing just one bit in the rule produced much different patterns down the page. Likewise, the same pattern could be produced by different rule sets.

He did notice, however, a similarity among the patterns he observed, which he classified into four categories:

Category I	Constant or fixed -- patterns that turned a pixel on or off and kept it that way. These patterns were either all white, or all black or striped down the page.
Category II	Periodic -- patterns that produced regular patterns down the page, like a checkerboard except they happened to be triangles.
Category III	Chaotic -- no apparent pattern at all, white noise
Category IV	Complex -- patterns that were characterized by what he called long transients, complex emerging patterns that seem to be ordered, but not quite before they blinked out to become fixed or periodic.

Just like Lorenz, Wolfram had glimpsed a new category of system behavior. He called it complex behavior, using a common word again for a technical definition. In his usage, complex systems existed in a narrow zone between the periodic and chaotic. Charles Langton of the Sante Fe Institute put the insight into what is now called the "football."

The Four System Types



The region of complexity, as you can see, has become the ominous Madison avenue term--The Edge of Chaos! But that is partially true. While systems, like large, bureaucratic organizations, like such order, too much order kills them. They need a balance--some order to maintain their identity and some chaos to maintain their creativity and vitality. Langton developed his lamda parameter to describe these four regions in terms of the ability to process information. Complex organizations process the most information. Periodic and chaotic organizations process less. Periodic organizations are too rigid to see most of the signals sent their way; chaotic organizations are too disorganized to execute the behaviors that the signals suggest.

So far complexity theory consists of tantalizing metaphors that seem to explain poorly understood or never before recognized system behaviors. Unfortunately, it has not resulted in rigorous or mathematical descriptions of these states, much less the forecasting tools to understand the future of these systems. Perhaps it never will. As people on the lookout for new, promising developments, futurists are keenly aware of these new theories of change and the implications for understanding the future. Criticality, chaos and complexity all speak to the futurists basic belief: the world is not as simple as Newton, Darwin, Samuelson, or Jordon told us it was. Uncertainty about the future is inherent in human systems, and futurism is the approach for exploring not only the uncertainty, but the alternative futures that result.

VI. Methodology

Our usual approach to planning and problem solving follows a methodology that is exemplified by the traditional steps of western medical diagnosis:

1. Assess the current state of disease
2. Develop possible causes for that state
3. Select one cause for treatment
4. Treat
5. Evaluate the results
6. Pronounce a cure or return to Step 3

We focus on the disease rather than the alternative states of better health that can be achieved. The result is that:

- Many risks to the plan are not recognized, and
- Many opportunities are missed; hence a less than optimum future is selected--generally returning the system to the status quo (i.e., the previous state of 'health').

Even when the plan is to create a system change (like economic growth), planners usually set a goal from a narrow perspective of what is possible, rather than select a preferable future from a robust set of alternative futures. Assessing alternative plausible futures and selecting a specific preferable future are both necessary steps in preparing for uncertain futures in open human systems.

As we have seen, applied futurists help us appreciate the wide range of alternative futures that are available, and then motivate us to attain desirable futures. In providing this service, futurists follow a general pattern of work. This pattern, broken down into six steps, is shown in Figure VI.1. We will call this pattern the applied futurism methodology.

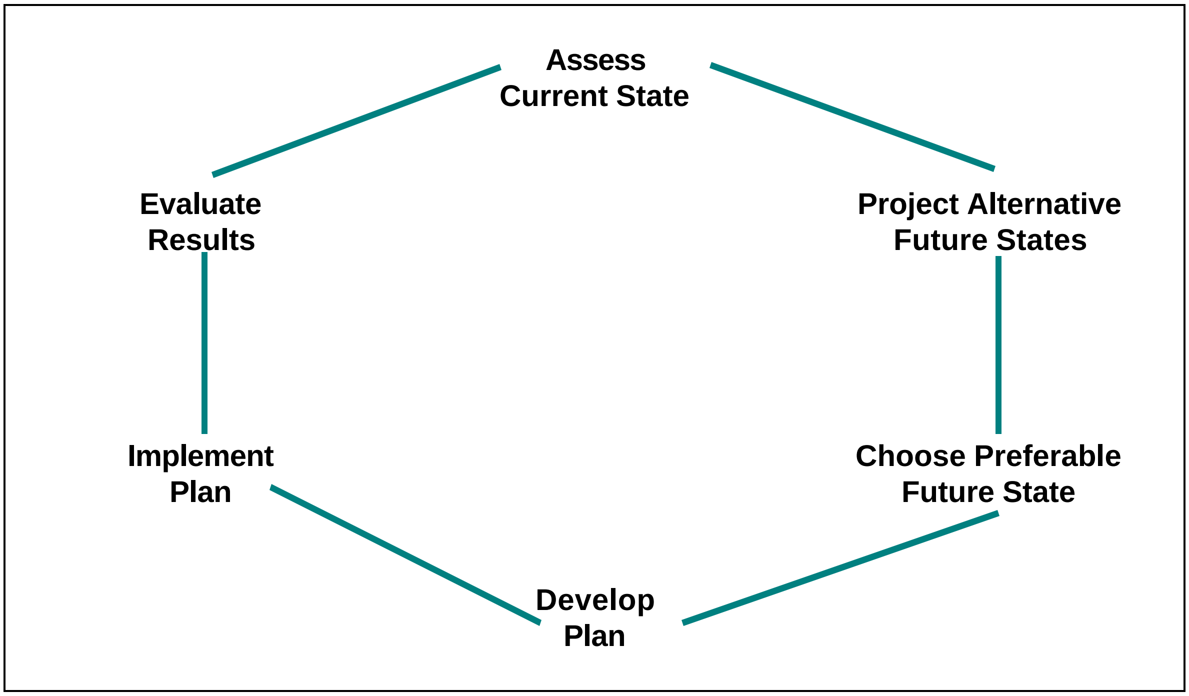


Figure VI.1

Applied Futurism Methodology

Futurists apply this methodology to human systems, and use special tools to carry out each step. We will review several of these tools in the next section.

There are two unusual and noteworthy steps in this method; these are:

- projection of alternative future states, and
- selection of a preferable state,

In order to understand and work with the futurism methodology, let's look at how we as actuaries might use it to achieve a desirable future state for the U.S. Social System:

Assess Current State

First of all, we must understand the current state of the system of interest. To achieve this we might:

- Define the system of interest
- Identify the domain of observation
- Identify the current state -- when did it start, how was it different from previous states?
- Identify the major players (stakeholders) and their relationships
- Identify what is changing (trends and potential events)
- Identify current issues and potential outcomes

For example, if our task were to achieve a desirable future state for the U.S. social security system, our first step would be to understand the current system. We would need to precisely define what we mean by the U.S. social security system. Are we mainly concerned with old age benefits, or all benefits? Should we include the mechanics of payment administration? Etc.

Once we have carefully defined the system of interest, we need to identify the domain of observation, the exogenous systems that significantly impact the social security system. Clearly, the U.S. economy and U.S. society must be in the domain of observation. But what about the world economy and social order? And should we include U.S. or world politics?

The current state did not always exist. It began some time in the past and is continuing today. Identifying when and how it started puts the current state into the perspective of change. For instance, the current state of the U.S. social security system began, of course, with the original Social Security legislation. The appearance of the baby boom from 1947 to 1963 is also part of the mix that contributes a current excess of workers over retirees; the extent of this excess will decrease dramatically in the future.

Another descriptive element includes the stakeholders in the current system. A core group would include the elements of the government (Congress, White House) the social security recipients, workers who pay payroll taxes, and businesses that serve the recipients. One might include the Social Security Administration, but they are probably not independent actors in their own future. We would suspect that the Office of Management and Budget had more influence over the issue because of the surplus revenues that are now "loaned" to the general fund.

We would then identify current issues such as the projected depletion of the trust fund by the year 2030. And we would identify important trends that can impact the social security system, such as the decreasing mortality and personal savings rates. Finally, we would explore interrelationships among the attributes and trends of the systems in the domain of observation and the system of interest, using tools that we will learn in the next section.

Of course, our review of the current state would depend on the actual system under study, and might include many more components, such as constraints and resources, sensitivity analyses, key leverage points, etc.

Project Alternative Future States

We would then explore the alternative future states that are possible for the U.S. social security system. Clearly, there are many. They run the gamut from complete breakdown of the system, to a complete transformation of the system. Figure VI.2 illustrates the spectrum of future states.

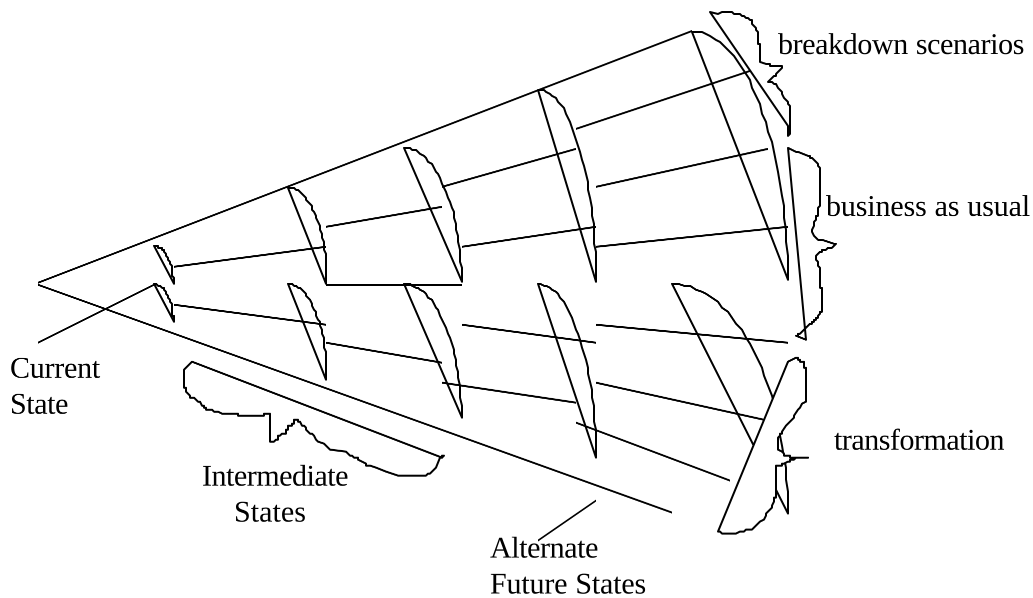


Figure VI.2

The Spectrum of Future States

To perform these projections, we would first need to define the time horizon for study, and identify the projection assumptions. Then we would project several future states, and make sure that they are consistent with our understanding of the current state of the system of interest.

For the social security system, we would likely set the time horizon at 50 to 75 years and use a wide range of mortality, economic, political, and societal assumptions. Alternative future states of the system might range from going bust by 2020, to robust health as a result of privatization.

Choose Preferable Future State

We would then help lead a decision-making process to choose a preferable future state from the range of possible future states, one that best satisfies the needs and values of affected constituents. It is important to note that this step must involve a cross-section of potentially affected people to create a shared and compelling vision of the future. When the affected constituents are not involved in the decision-making process, the lack of their perspectives can lead to a future state that is not really the most desirable. For example, the preferable future envisioned for the U.S. in its early history did not include the perspectives of indigenous Americans or African slaves. We still feel the repercussions of this omission. Thus, this step must involve the client, community, nation, or any other agent affected by the system of interest.

Once a preferable future has been tentatively selected, we must rigorously test it to ensure that it is realizable and will not have undesirable side-effects. There are several tools of applied futurism which we might use for this task.

For example, a preferable future state for the social security system might be characterized by a solvent system with benefit levels at least 90% of promised benefits without a tax increase. We would need to test this against the desires and constraints of the society at large as well as politicians, and we would need to ensure that the preferable future state is not an impossible goal.

Develop Plan

The next step would be to develop a plan to achieve the preferable future state. A plan is a detailed strategy that is expected to move the system of interest from the current state to the preferable future state. For the social security system the strategy might include iincreasing the retirement age for full benefits, and investing the trust fund in the private economy.

Implement Plan

The work of the futurist does not stop with completion of the implementation strategy. Not only do they help to formulate the strategy, but they also help to see that it is actually implemented, that the preferable state becomes a reality. This step is a key component of the work of futurists. They are engaged, value-driven, and action-oriented. For the social security system, actuaries might take a cue from futurists and help achieve a better system by lobbying Congress or acting as expert witnesses to support the strategy.

Evaluate Results

As the implementation proceeds, we would evaluate whether or not the system of interest is on track to achieve the desirable future state. We would monitor the attributes of the system of interest to determine whether they are approaching the characteristics of the preferred future state. For example, we would monitor the level of benefit payouts from the social security system to ensure that they don't drop below the preferred 90% of promised level, and we would monitor whether the system is projected to remain solvent.

Note that applied futurism methodology is a continuously turning wheel: the results of the evaluation step feed back into the current state assessment, and the process continues through another cycle. The futurist carries out several cycles of the methodology, until the preferable future is achieved. For the social security system, we might perform a complete cycle of the methodology every five years.

Also note that the steps of the methodology are internally iterative. For example, the results of the projection of alternative future states often highlights areas that were missed in the prior assessment step.

VII. Tools

Introduction

This section describes the following common tools that futurists use to carry out the steps of the applied futurism methodology given in the last section:

- Cross Impact Analysis
- Decision Modeling
- Delphi Technique
- Environmental Scanning
- Futures Wheel
- Gaming and Simulation
- Genius Forecasting
- Relevance Trees
- Scenarios
- Systems Dynamics
- Trend Impact Analysis
- Visioning

For convenience of reference, the tools are presented in alphabetical order. For each tool, we provide the following information:

- Background
- Description
- Primary uses
- Strengths and weaknesses
- Example of use

In the main, futurists developed these tools because traditional techniques for forecasting and analysis turned out to be inadequate for exploring human systems. For example, trend extrapolation is a traditional forecasting technique that is still in wide use; it is based on fitting a smooth curve to historical data and using future values of the curve for forecasting. Actuaries often use this technique. The technique assumes that nothing will come along to deflect the trend, that the only forces shaping the future are those that exist in history. Ultimately, even for the planetary system, this assumption is wrong. Futurists found by trial and error that forecasts based on this technique missed the real nature of change in human systems. As we have seen, changes in the real world often occur in sudden jumps and fits and starts that do not lie along a smooth curve. So, futurists developed other, more useful tools for analysis and forecasting.

Unlike techniques in the hard sciences such as physics and engineering, the tools of futurism have not been subjected to rigorous testing and peer evaluation. Even though futurists around the world have performed thousands of studies using these tools, there is no single repository for the results so that the techniques could be compared. Therefore, the efficacy and uses of these methods are more anecdotal than proven. Here we present the most accepted tools and describe their most common uses.

Section VIII discusses when these tools are used in the various steps of the methodology, and how they can be used in combination with one another.

Cross Impact Analysis

Background

We have established that systems are interrelated and that there is considerable linkage among agents within a system. Cross impact analysis is a technique to examine these interrelationships, in order to more accurately determine how the system of interest is likely to change.

The idea for cross-impact analysis came from a game called *Future* that Olaf Helmer and Ted Gordon developed at RAND Corporation in 1966. The purpose of the game was to envision a new world twenty years into the future. The game included sixty potential events (technological breakthroughs, legislative measures, natural events, international treaties, etc.) that could occur. Each of these had a probability of occurrence taken from the *Report on a Long-Range Forecast* published by RAND in 1964. The probabilities of these events changed as the game progressed, due to the influence of related events. Recognition of this cross-influence of events is the central focus of cross-impact analysis. The game emphasized that interactions among future events must be recognized in order to obtain a valid portrayal of change.

Over the years the tool has been refined and integrated with other tools of applied futurism such as the Delphi technique and scenario building. Cross-impact analysis has been successfully applied to subjects as diverse as aircraft construction, world geopolitical evolution, and corporate jobs in the year 2000.

Description

Following are the basic steps to perform a cross-impact analysis:

1. Establish the Time Horizon

The first step is to decide the time horizon for the study. Typically, this ranges from 20 to 50 years.

2. Identify Events to Consider

The next step is to identify potential events relating to the system of interest as well as peripheral systems that could have a significant impact on the system of interest within the time horizon. Let these events be denoted E_1, E_2, ..., E_m. The events may be of any type, including events totally outside of our control such as natural catastrophes, as well as events that we may influence such as acts of legislation.

Most studies include between 10 and 40 events. Since the number of event pair interactions is equal to $(m^2 - m)$, it is important to keep the number of events manageably small. The researcher might use the Delphi technique to prioritize the events for consideration. The Delphi technique is one of the tools we describe in this section.

3. Estimate Initial Probabilities

The next step is to estimate the probability that each event will occur within the time horizon. This is typically done using the Delphi technique to capture the probability estimates of a group of experts.

These estimates may be of two kinds:

- The probability may be specified assuming that the other events have not occurred. Thus, the event is judged in isolation, without considering the influence of the other events in the study. In this case, the probability can be adjusted when the other events are assumed to occur.
- The probability may assume that the probability of the other events occurring is taken into account. Thus, this approach reflects the influence of the other events in the study. In other words, the initial probabilities are really final probabilities. In this case, one can not adjust the probabilities any further since they are already the conditional probabilities based on the other events. One may, however, judge whether the final probabilities and the separate conditional probabilities are consistent.

In the first case, cross-impact analysis is used to adjust the initial probabilities to reflect the influence of the other events. In the second case, cross-impact analysis is used to determine if the expert estimates are consistent. The second case is the most frequently used approach. Therefore, we will only address this approach in this study note.

4. Estimate Conditional Probabilities

For each pair of events E_m and E_n, the conditional probability of E_m is estimated given that E_n occurs. For example, if the initial probability estimate of E_m is .15, its conditional probability might become .25 since it would be assumed that E_n would definitely occur.

The cross-impact probability matrix may then be completed, as shown in Figure 1.

Event (E_n)	Initial Probability $P(E_n)$	Conditional Probabilities		
		$P(E_1 \mid E_n)$	$P(E_2 \mid E_n)$	$P(E_3 \mid E_n)$
E_1	0.25	n/a	0.20	0.60
E_2	0.45	0.15	n/a	0.60
E_3	0.60	0.55	0.50	n/a

Figure 1
Conditional Probability Matrix

5. Check for Consistency

The next step is to check the conditional probability matrix for consistency. Since the initial probabilities were estimated taking into account the probabilities of occurrence of the other events, there are limits on the conditional probabilities that can exist. To see this, consider events E_2 and E_3 in the above table. E_2 has a probability of .45 and E_3 has a probability of .60. Thus, in 100 trials, E_2 would be expected to occur 45 times and E_3 would be expected to occur 60 times. Both events would be expected to occur simultaneously at least 5 times in the 100 trials (60 + 45 = 105). Thus, if the conditional probability of E_3 given E_2 were 0, there would be an inconsistency: the overlap of 5 simultaneous occurrences would not be possible. Either the initial probabilities or the conditional probability would have to be modified to maintain consistency.

Thus, there is a band of possible conditional probabilities once the initial probabilities are given. In this step we check to make sure that the conditional probabilities in the probability matrix are within possible limits. If the conditional probabilities are outside the range, then adjustments have to be made. This process of checking for coherence and adjusting the initial estimates is one of the primary benefits of the cross-impact technique.

The limits of the conditional probability for event E_m given E_n may be derived as follows, where $P(E_m)$ denotes the initial probability of E_m, $P(E_m|E_n)$ denotes the conditional probability of E_m given E_n, and $\sim E_n$ denotes the non-occurrence of E_n:

$$P(E_m) = P(E_n) \text{ x } P(E_m|E_n) + [1 - P(E_n)] \text{ x } P(E_m|\sim E_n)$$

$$\Rightarrow \quad P(E_m|E_n) = \{P(E_m) - [1 - P(E_n)] \text{ x } P(E_m|\sim E_n)\} / P(E_n)$$

By letting $P(E_m|\sim E_n)$ equal 0 and 1, the max and min of $P(E_m|E_n)$, respectively, are obtained:

$$\Rightarrow \quad \{P(E_m) - 1 + P(E_n)\} / P(E_n) < P(E_m|E_n) < P(E_m) / P(E_n)$$

Thus, the limits for $P(E_3|E_1)$ in the above table are:

$$\{0.60 - 1 + 0.25\} / 0.25 < P(E_3|E_1) < 0.60 / 0.25$$

$$\Rightarrow \quad -0.60 < P(E_3|E_1) < 2.4$$

Thus, the value of $P(E_3|E_1) = 0.60$ falls within the permissible range. Actually, for this case, any value would be permissible. Can you find any conditional probabilities in the table that are impossible? How do you explain this?

6. Run the Matrix

Next, we 'run' the matrix to observe its behavior. To do this, proceed as follows:

1. Select an event at random from the event set. Suppose, for example, that we select event E_2 from the matrix of probabilities above.
2. Determine a random number between 0 and 1.0. If the random number is less than the initial probability of the event selected, then the event occurs. Otherwise, the event does not occur. Suppose the random number is 0.16; then event E_2 occurs.
3. Adjust the probabilities of the other events, based on the conditional probabilities in the matrix. So, $P(E_1)$ changes to 0.15, and $P(E_3)$ remains 0.60.
4. Repeat steps 1, 2, and 3 until all events have been tested for occurrence.
5. Repeat steps 1 - 4 a large number of times, such as 1,000 or 10,000 times, and keep track of the number of times each event occurs.

The frequency of occurrence of each event determines the new probability of that event. Typically the new probability for an event is very close to the initial probability of the event in the matrix. The reasons for significant differences should be investigated.

7. Test the Matrix for Sensitivity

Often there are several initial or conditional probabilities about which there is considerable uncertainty. For example, in the matrix given above, there might be disagreement among the experts whether $P(E_2|E_1)$ should be 0.20 or 0.10. In order to determine whether or not to expend the effort to further explore the conditional probability, a matrix sensitivity test is often helpful. To test the probability in question for sensitivity, simply vary the probability slightly and run the matrix again. So, $P(E_2|E_1)$ might be changed from 0.20 to 0.10 and the matrix rerun. If there is a significant difference between this run and the original run, then further exploration of the conditional probability would be indicated.

8. Test the Matrix for Policy Changes

The matrix may now be used to understand the often complex chain of effects brought about by policy actions. First, identify the policy action and how it affects the matrix probabilities. Change the matrix probabilities accordingly, and rerun it. The difference between the policy run and the original run reflect the impact of the policy. The results of the policy run are often surprising. For example, it might seem that a certain policy change would increase the probability of a certain event, whereas running the matrix shows that the change would actually decrease the probability.

There are several refinements that can be made to the basic cross-impact analysis described above:

- The time horizon can be broken down into small intervals, such as five-year intervals. The probability matrix would then be expanded to include probabilities of event occurrence for each interval.
- The values of system attributes may be included in the matrix, along with events. For example, in an examination of a country's economic system, values for attributes such as GNP, industrial output, and employment might be included as part of the probability matrix. So, instead of probabilities of occurrence, the *values* of these attributes would be included in the table; and conditional values for an attribute given the occurrence of a certain event would also be included. This allows the tracking of attribute values as well as event occurrence in the cross-impact analysis.
- Random deviations of event probabilities and trend values can be built into the matrix. This would reflect random influences on the system of interest that the matrix does not explicitly reflect.

Primary Uses

The technique is mainly used in the following steps of the applied futurism methodology:

- **Assess Current State**: Cross-impact analysis can be used to understand the interrelationships among systems and agents in the current state. It is also useful in uncovering events that could significantly affect the system of interest.
- **Develop Plan**: The technique may be used to test alternative action plans.

Strengths and Weaknesses

The main strength of cross-impact analysis is that it provides insight into the results of long causality chains. Since the end results of many interacting events is often counter-intuitive, this tool is extremely helpful. The model also forces a detailed probabilistic analysis of interdependent events; this exercise can be quite useful in thinking through the interactions of systems and of agents within a system.

The tool has several drawbacks, including:

- The collection of data is time-consuming and labor intensive. For example, a 40 by 40 matrix requires 1,560 probability estimates.
- The technique is directly dependent on the probability estimates. It is often difficult to develop reasonable probability estimates with a high degree of confidence.
- The technique lacks commutivity. The impact of two simultaneous events occurring is dependent on their order of occurrence.
- The technique is two-dimensional. Only pairs of occurrences are considered. In reality the impact of event E_m on event E_n depends on other conditions. Thus, the technique does not accurately model the complex interactive nature of reality.

Examples

Cross-impact analysis could be used in many ways to examine current and possible future states of the U.S. social security System. For example, a probability matrix similar to Figure 2 (but containing many more events) could be prepared showing the interrelationships among various events related to the System. The impact of alternative strategies to keep the System solvent could then be examined.

Event	Initial Probability	Conditional Probabilities		
		$P(E_1\|E_n)$	$P(E_2\|E_n)$	$P(E_3\|E_n)$
The social security system cuts back benefits	0.25	n/a	0.20	0.60
Social security taxes are increased 20%	0.45	0.15	n/a	0.60
Mortality improves by 20% at all ages over 60	0.60	0.55	0.50	n/a

Figure 2
Example of a Cross-impact Analysis Application

Decision Modeling

Background

An important agent of change for a human system is the decisions of individuals within the system. For example, the decisions of politicians regarding alternative strategies for improving the U.S. social security system will dramatically affect this system. Therefore, it is important to understand the nature of decision-making within the system of interest, in order to understand the behavior of the system. Decision modeling develops a model of the decision process that decision-makers apply to important decisions within the system of interest.

Decision modeling was developed in the 1980s to improve the available tools used to model the replacement of one technology by another. The available tools were mainly formula based, limited to two alternatives, and did not reflect the decision mechanism. Decision modeling replicates the actual behavior of the decision-making process, and may be used for multiple alternatives. It is now used in many other areas than technology replacement.

Description

A decision-maker generally considers many factors before making a decision. Some of these factors are more important than others. Therefore, to make an optimal decision, the decision-maker must weigh the relative importance of the various factors. For example, cost and benefit are often factors considered in decision making. Low cost is generally considered more valuable than high cost, and high-benefit more valuable than low-benefit. The decision-maker must specify the relative importance of cost and benefit, in order to choose between alternatives such as low cost/low benefit and high cost/high benefit.

The first step in decision modeling is to specify the decision criteria to assess the alternatives. Figure 1 below presents a matrix used in decision modeling. C_i represents the decision criteria, such as cost and benefits, and W_i is the relative importance weight for criterion i. A_i are the available alternatives, and Aij are ratings that indicate how well alternative Ai meets criterion Cj. Any relative scale of values may be chosen for W_i and A_{ij}.

Decision Criteria	Decision Weights	Alternatives			
		A_1	A_2	...	A_n
C_1	W_1	A_{11}	A_{21}	...	A_{n1}
C_2	W_2	A_{12}	A_{22}	...	A_{n2}
...	...	...	...	...	...
C_j	W_j	A_{1j}	A_{2j}	...	A_{nj}
...	...	...	...	...	...
C_m	W_m	A_{1m}	A_{2m}	...	A_{nm}

Figure 1
Decision Modeling Matrix

The value of each alternative to the decision-maker is therefore:

$$V_i = \sum_j (W_j \text{ x } A_{ij})$$

Since V_i is dependent on the weighting and alternative rating scales, it is then normalized:

$$\bar{V}_i = \frac{V_i}{(\sum_i V_i) / n}$$

Normalized values greater than 1 are thus better than average for the set of alternatives being considered; normalized values less than 1 are worse than average. Normalization permits comparisons among different decision makers. The highest value of V_i , or its normalized value, is then the preferred decision for an individual decision-maker.

When this tool is applied to model the decision-making process of a large group of decision-makers, it becomes quite interesting. Clearly, at any point in time not all decision-makers will choose the same alternative: some will have different decision criteria from others; some will use different weights from others; and some will not consider various alternatives, because they are too new, too unusual, etc. And, these perceptions are not static; they will change over time as newer alternatives become more familiar, values change, etc.

The tool reflects this variation within a group by using a series of matrices to represent the decision process at regular intervals of time, from the present to the end of the time horizon. Each matrix in the series represents the average decision process at a particular time. Average decision-criteria weights W_i are used in the table, and average weights are also used to indicate the proportion of criteria C_i and alternatives A_i considered by the decision-makers. These weights are obtained by surveying the decision-makers, and by performing historical analyses of the diffusion rate for new alternatives and criteria into the decision-making process.

Primary Uses

The technique is mainly used in the following steps of the applied futurism methodology:

- **Assess Current State**: Decision Modeling is useful in understanding the impact of decision-making processes in the current state of the system of interest.
- **Project Alternative Future States**: The technique may be used to understand how the decision-making process will evolve for alternative future states.

Strengths and Weaknesses

The major strength of the tool is that it allows the futurist to understand the decision-making process for a number of alternatives, as this process varies over time. The tool can also incorporate historical analyses of diffusion rates as well as market research data.

Its major weakness is that it is directly dependent on the weight estimates. It is often difficult to develop reasonable weight estimates with a high degree of confidence.

Examples

Decision modeling could be used in many ways to examine current and possible future states of the U.S. social security System. For example, the technique could be used to model the likely decision-making responsiveness of politicians to proposed alternatives for improving the System in a given future state.

Delphi Technique

Background

The Delphi Technique seeks to maximize the information value from the opinions of a group of people about a particular problem. Typically, the technique is applied to a group of experts.

The method was one of the first tools of applied futurism. Its success helped legitimize the field. Olaf Helmer and Norman Dalkey at the RAND Corporation developed the method in 1953. Helmer first used the method in the early 1960s. They believed that the intuitive judgment of experts is indispensable in applied futurism. In our world of non-deterministic human systems, we must still make decisions even though we have no adequate models or theories; and often we must make decisions quickly. So, the relevant intuitive insights of experts is frequently the best we can do. Therefore, we should try to make the best use of their opinions.

Further, they reasoned that it is preferable to employ more than one expert for this purpose:

- The intuition of experts, especially when there is consensus, is more likely to be useful than the intuition of non-experts.
- Secondly, as Norman Dalkey put it, "n heads are better than one". The likelihood of accuracy increases as the number of experts increases. Of course, the intuition of an individual expert is not infallible. If, however, we can assume that an expert's opinion is right more often than it is wrong, it makes statistical sense that the median estimate of a group of experts is more likely to be useful than the results of a single expert.
- When imagination is needed, a group generates a volume of ideas that increases the chance that a useful idea will surface. This approach, of course, is the basis of brainstorming sessions.
- Applied futurism is multidisciplinary by nature. It is therefore important to obtain insights from experts in various disciplines.

The traditional way to obtain useful information from a group of experts has been a round-table discussion. This procedure has a number of drawbacks. The outcome is often unduly influenced by psychological undercurrents, such as ceding to the opinions of authority figures or aggressive personalities, unwillingness to abandon publicly expressed opinions, or being swayed by majority opinion. Thus, the noise level of open forums often drowns out the useful information.

Delphi solves these problems by polling experts anonymously, thereby eliminating the "me-to" effect of timid participants and giving weaker voices as much weight as stronger ones. Secondly, it polls experts over successive rounds with summary feedback in between. Participants see where they stand in the group and may reflect and even adjust their views accordingly. Thirdly, the feedback in successive rounds often contains reasons for the more extreme views. Sometimes those reasons carry the day convincing others that they are unwittingly making an important assumption or ignoring an important piece of evidence. The result is a deeper discussion about the reasons for positions anonymously held without the ego and conflict that usually appears in discussions about the future.

It is a little-known fact that Delphi is based on an antecedent process developed at RAND to improve the chances of winning horse races by combining the opinions of horse-racing handicappers! After all, these are the experts in the field. And their forecasts are published daily and can be checked against reality within a day or two. Who says futurism isn't practical?

Description

In a typical Delphi study, a panel of experts is first chosen. Each expert has an area of expertise relating to the problem at hand. The number of experts depends on the complexity of the problem, but typically the panel consists of 15 to 35 experts. The experts are anonymous; they do not know who else is on the panel.

The study then proceeds in four steps, or rounds:

1. In the first round, the Delphi coordinator gives a description of the problem to each expert. And the expert provides his opinion regarding the problem.

   The coordinator analyzes the responses. The analysis identifies the range of opinions, the median, and the interquartile range (the interval containing the middle 50 percent of responses). The interquartile range is shown graphically in Figure 1.

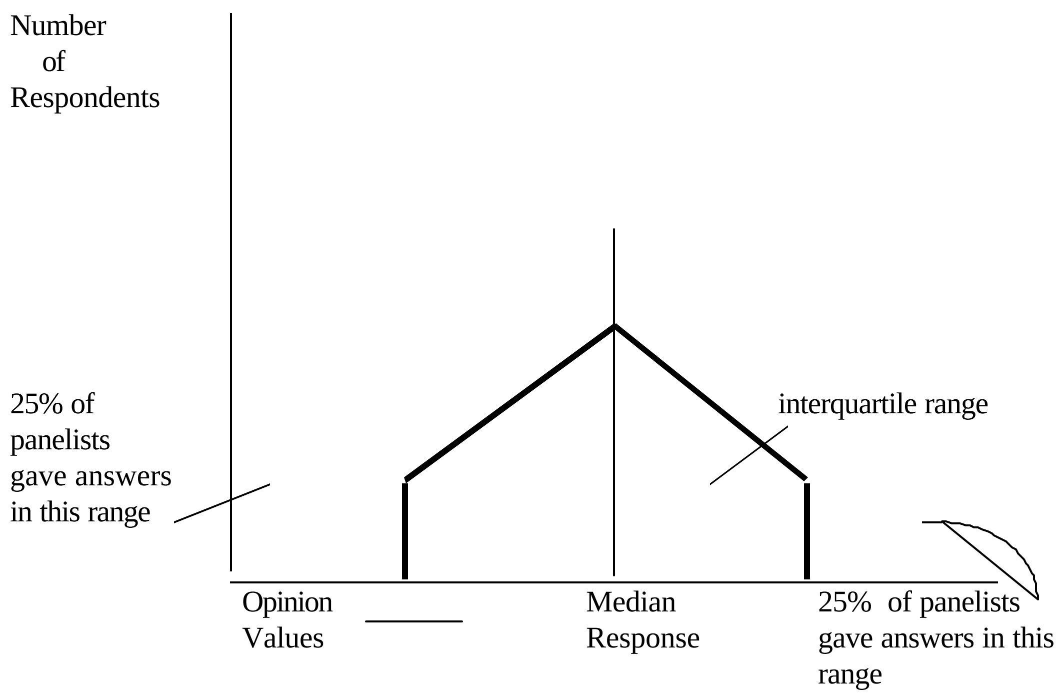


Figure 1
Example of Delphi Analysis Range

2. In the second round, the coordinator feeds back the summarized results of the first round to the panel. Each expert is requested to reconsider his opinion in light of the summary, and revise it if desired. If the expert's new response is outside the interquartile range, he is requested to provide his reasons for the response.

The coordinator then analyzes and summarizes responses from the second round. He prepares a summary of reasons for responses outside the interquartile range.

3. In the third round, the coordinator feeds back the results of the second round to each expert. This provides each expert with a general analysis and a summary of reasons for extreme positions.

   The experts then revise their opinions in light of the new information, and provide reasons for opinions outside the interquartile range. A respondent whose answer remains outside the interquartile range also states why he is not persuaded by the opposing views.

   The coordinator then analyzes and summarizes the results of the third round.

4. In the fourth and final round, the analysis and summary of reasons and counter-reasons are provided to the panel. Each expert then gives his final opinion about the problem, based on the feedback provided throughout the Delphi process.

   The coordinator then provides a summary of the final results to the sponsor of the study, along with details of reasons given by the experts with outlier opinions.

In most cases, the expert opinions tend to converge as the rounds progress. This is shown graphically in Figure 2. As the graphs indicates, the opinions may converge to more than one focus. This modification and convergence of opinion is one of the most valuable products of the Delphi technique. In addition, with its emphasis on feedback, reconsideration, and reasons for outlying opinions, it helps crystallize a reasoning process for dealing with the problem at hand.

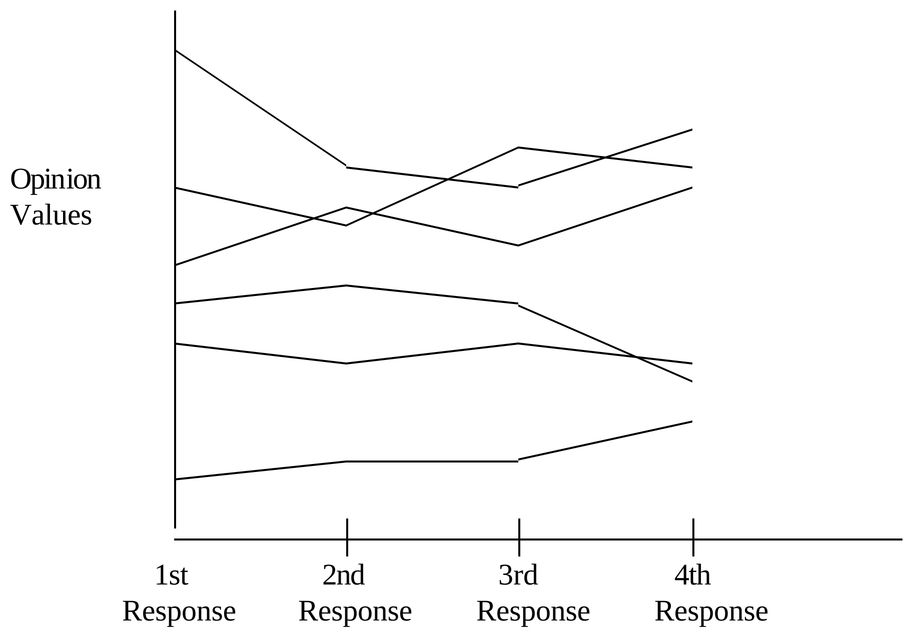


Figure 2
Convergence of Opinion in a Delphi Study

There are several possible refinements to the basic Delphi technique:

- One is to introduce weighted opinions. There are several ways to accomplish this: the experts can assess their competence with respect to various aspects of the problem, or the coordinator can rank competence by testing or otherwise assessing the experts.
- The first round may also be preceded by an initial study to carefully delineate the problem, as well as design and test the initial questionnaire.
- The Delphi technique may be automated, either through the use of computer networks or through automated polling devices in live meetings. Olaf Helmer envisioned a new sort of consulting service which he called Delphi-net or D-net. The D-net consists of a large

interdisciplinary and international roster of experts that decision makers could call upon simply by accessing the computer network and formulating a problem to be addressed through the Delphi technique. The selection of appropriate experts and the administration of the Delphi rounds for the problem could be automated.

- In-depth personal interviews with experts may be substituted for the questionnaires and written correspondence. This approach allows the coordinator to gain additional insight into the reasoning process of experts, to identify biases, and to follow up on innovative lines of thought.
- A new category of software that supports group interaction also contains the benefits of the Delphi technique. Group decision support software (GDSS) runs on a server networked to a series of computer workstations. The computers may be in the same room or remotely accessing the server. All the individuals in the session are actually using the same piece of software simultaneously. Sessions typically begin with a round of brainstorming to get ideas into the system. These are displayed anonymously on a public screen. Further tools allow individuals to sort and select from among these ideas. They can also rate, rank, allocate resources among alternatives in seconds. GDSS has the potential to transform group decision making.

Primary Uses

The Delphi Technique can be useful in any step of the Futurism Methodology where intuitive judgment is called for. For example it might be used to:

- develop a model of the current state,
- identify issues relating to the current state,
- refine the parameters of preferable future states,
- develop alternative action plans to attain a preferable future state,
- make key decisions during plan implementation, or
- evaluate the results of implementation.

Delphi is not a polling technique. It should not be used to obtain a statistically significant representation of public opinion about an issue. Delphi addresses the opinions of a small group of experts; no more, no less.

Also, Delphi should not be used to determine matters of fact. For example, “Given continued trends in emigration, birth, and death rates, what is the expected population of Mexico in the year 2010?” is a question of fact. The answer should simply be computed.

On the other hand, you can ask for numerical projections when the model or the parameters of the model are unknown. For instance, one can compute the ultimate stable population of the world with appropriate assumptions about birth and death rates. But those future values are in great doubt because of changes in fertility, food production, virulent diseases and ecological stress. Therefore, doing a Delphi on this topic would be quite appropriate.

Srengths and Weaknesses

Whether the Delphi technique is useful or not is currently a matter of debate. Several studies have shown that the focus of convergent opinion in a Delphi study is more useful than the opinion of individual experts. In addition, the Institute for the Future examined the validity of a number of Delphi forecasts, and found the results to be statistically encouraging. And the volume of significant Delphi studies has been tremendous; this would indicate that the results are useful.

On the other hand, Fred Woudenberg in his article “An Evaluation of Delphi” claims that Delphi does not produce more useful results, and that consensus is a result of pressure brought to bear on experts who have extreme opinions.

On balance, though, it appears that Delphi is a very useful method to collect and synthesize expert opinions.

One weakness of the technique is that Delphi studies are difficult to perform well. A great deal of work is needed to choose the experts, prepare the questionnaires, and perform the analyses. Another drawback is that the technique takes considerable time. A four round Delphi study may take six months to complete.

Examples

The first published Delphi study was *Report on a Long-Range Forecast* published by RAND in 1964. It contained forecasts of scientific and technological breakthroughs through the year 2000 and beyond. There were 82 panelists, including Issac Asimov, Arthur Clarke, Bertrand de Jouvenel, and Dennis Gabor. A review of the forecasts shows that most of the general scientific forecasts were on target.

In this same period the firm TRW conducted a series of internal Delphi studies aimed at identifying promising areas for future research and development. TRW management found these studies to be quite useful; an incidental benefit of the studies was that the Delphi process established a valuable form of vertical communication among employees at various levels within the firm, which enhanced company morale. The success of this series led to an explosion of Delphi studies.

The Center for Futures Research at the University of Southern California used Delphi in 1984 to produce *A 20 Year Strategic Outlook for the U.S. Life and Health Insurance Industry*. In collaboration with Arthur Anderson, the Life Office Management Association also prepared a Delphi study in 1984 entitled *Changing Horizons for Insurance: Charting a Course for Success*.

Delphi might be used profitably to explore many aspects of the U.S. social security system. For example, an initial Delphi questionnaire might read:

> "The following means have been suggested to increase revenues for the social security system:
>
> - Increase the rate of payroll tax.
> - Increase the base of payroll tax.
> - Invest the funds in equities.
> - Provide participants with individual accounts and allow them to choose their investment.

Please rate each of these in terms of effectiveness and practicality. If you have an idea that might be as effective and practical as those listed, please add it to the list. If you think any of these means are extremely good or, at the other extreme, counterproductive, please also indicate this."

The experts would provide two numbers for each option, to give their judgments about effectiveness and practicality. They would also provide reasons for judgments if they saw an alternative as particularly promising or counterproductive.

Environmental Scanning

Background

As we have seen, all systems are interrelated. Therefore, in addition to collecting internal data about a system of interest, it is important to also collect potentially pertinent data about peripheral systems. Data collection is the job of environmental scanning. It is a tool to detect changes in peripheral systems that may affect the system of interest within the time-horizon. Environmental scanning is often thought of as an early warning system. It detects "weak signals" of important future developments, in order to gain as much lead time as possible for change. Diffusion theory tells us that there is often a significant time lag between the time when a change in a peripheral social system is first detectable, and the time when its impact is felt in the system of interest. There is an analogy in meteorology: small perturbations in the air may be multiplied by 4 every week, and by 300 every month. This is the famous butterfly effect of Lorenz. A butterfly's flight may cause a tropical storm one or two years in the future.

Description

Environmental scanning typically has three components:

- An ongoing "look-out" panel that watches for potentially important changes
- An ongoing literature review, including selected periodicals and on-line data bases
- A scanning data base that contains the results of the panel and literature review

The "look-out" panel typically consists of a rotating panel of ten to fifteen experts in various disciplines. The panel meets at regular intervals to consider the potential impact of developments in peripheral systems observed by individual panelists.

The literature review scans scholarly journals, newspapers, news magazines, industry magazines, books, radio, television, and data bases such as ABI Inform and Social Science Index. The objective is to detect changes that could have a significant future impact.

The environmental scanning data base contains the results of the panel and literature review. For each observed development, data such as the following is maintained:

- Classification
- Description
- Reason behind the development
- Potential impact on system of observation
- Current status of development
- Actors involved
- Source of information
- Date
- Scanner

The data base allows one to look for patterns among the developments.

Primary Uses

Environmental scanning is primarily used in the Assess Current State phase of the futurism methodology, to collect data about the system of interest.

Strengths and Weaknesses

The primary strength is that it is an ongoing systematic process to gather information about peripheral systems. Often peripheral systems are ignored entirely.

Environmental scanning suffers from two complementary problems -- not getting the right information and getting too much. The problem is similar to a database search. The items collected differ from the ideal set in two ways -- good items are left out and bad items are included. One problem of environmental scanning is not to scan broadly enough. Most people work in a defined area and know that area very well. However, they are rarely encouraged to look or work outside that area, hence they know little about it. But the influences on long-term future are growing in that unknown area. That is where the early signals are. In order to compensate for understandable tunnel vision, environmental scanning programs require scanning in preset domains. One common set is Social, Technological, Economic, Ecological and Political (known by its acronym STEEP). STEEP scanning requires information from all five domains before the scan is complete.

The other problem of environmental scanning is getting too much, including a lot that is not valuable. What to pay attention to and what to collect? We all have implicit radar for what we believe are "significant" developments, but what is the basis for that judgment? The use of the scenario technique as a "front-end" to environmental scanning gives some guidance. We describe the scenario technique later in this section.

Another approach is for the scanning team to meet periodically and reflect on what they each thought was significant and why. Why pay attention to that fact or incident? What larger significance does it have? How will it impact the future? Special attention should be given to evidence that contradicts current assumptions about the future. Confirming evidence is nice, but those assumptions are already part of the prevailing image of the future and therefore are part of most decisions. Disconfirming evidence, on the other hand, is the means to a wider set of assumptions and possibilities about the future.

Examples

If the system of interest is the U.S. social security system, peripheral systems might include social security systems of other countries, national and international politics, technology, U.S. culture, etc. Environmental scanning would formally observe each of the peripheral systems, in order to detect changes that might affect the U.S. social security system.

Many companies such as AT&T and Sears maintained environmental scanning programs.

The American Council of Life Insurance (ACLI) at one time maintained an environmental scanning process called the Trend Analysis Program (TAP). TAP relied on volunteers throughout the insurance industry to monitor publications and report on changes or trends. After a number of reports were obtained on a particular development, the ACLI published an analytical report on the development. These reports covered topics such as the American Family in the year 2000, the impact of new immigrants and minorities, the changing workplace, and bioengineering.

Futures Wheel

Background

Futures Wheel is an applied futurism technique that is powerful yet simple. It is a technique that helps structure our thinking about causal chains.

Jerome Glenn developed the Futures Wheel in 1971, in response to a need for a simple method for planners and policymakers to use to explore the complex ripple effects of events and trends. This technique gave rise to similar techniques such as *Mind Mapping* and *Webbing*.

It is currently widely used by corporate planners and public policymakers around the world.

Description

Futures Wheel is commonly used to help a group brainstorm about the long-term impact of an event or a trend that relates to the system of interest. The steps of the technique are:

1. Identify the Central Subject

The subject is written in the middle of a piece of paper, flip chart, black board, or overhead transparency. This subject typically describes an event or trend either in the present or in the future. For example, if the system of interest is the social security system, a subject for a Futures Wheel session might be the trend: the U.S. national savings rate has decreased steadily since about 1965. The purpose of the session would then be to explore the potential ripple effects of this trend. Or, the subject might be a future event such as a younger presidential candidate rallying the working population against the retired population.

The leader of the session draws an oval around the central subject.

2. Identify Primary Impacts

Next, the leader of the session asks the group to identify primary impacts or consequences of the central subject. For example, a primary impact of the national savings rate trend given above would be that the population is unlikely to have adequate savings for retirement. As the primary impacts are identified, the leader draws an oval around each and connects them spoke-like to the central subject. When all primary impacts have been identified, the leader connects them with a ring. Figure 1 illustrates the Futures Wheel after the primary impacts have been identified.

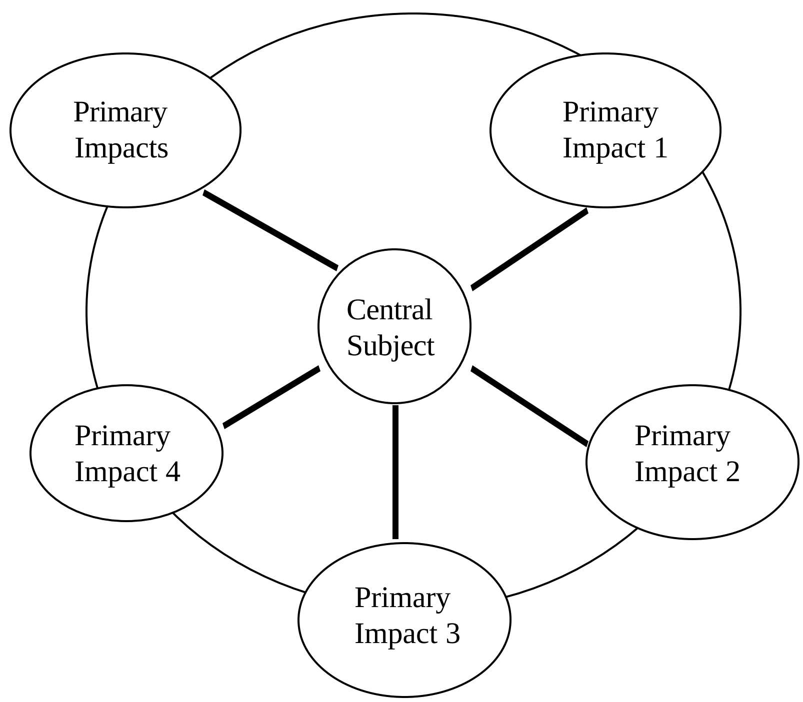


Figure 1
Futures Wheel after identification of primary impacts

3. Identify Secondary Impacts

Next, the leader encourages the group to forget about the central subject, and concentrate instead on each primary impact as if it were a central subject. For each primary impact, the group identifies a series of secondary impacts. The leader draws ovals around these, and connects them to the applicable primary impact. Then the leader connects all secondary impacts with a ring.

4. Identify Higher Order Impacts

Step 3 is repeated for third, fourth, and higher order impacts, and the leader connects these with rings. As Figure 2 shows, the Futures Wheel thus begins to look like wheels within wheels.

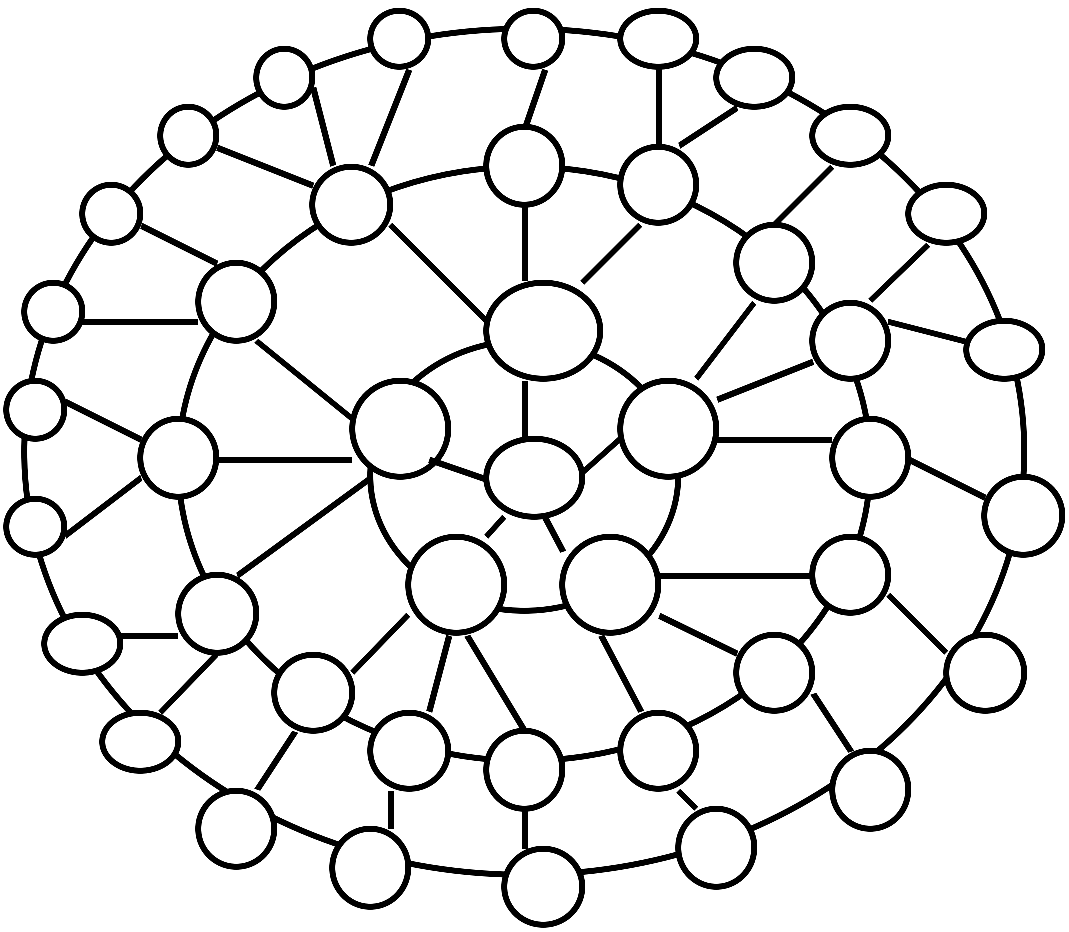


Figure 2
Futures Wheel with third order impacts

It is typical to continue this process through fourth or fifth order consequences.

5. Evaluate the Wheel

The Futures Wheel process often leads rapidly to unexpected results. Therefore, it is important to carefully examine the causality chains for reasonability. To do this, the leader facilitates an evaluation process whereby the group reaches consensus about the reasonability of each causality chain in the Wheel.

There are two major refinements of the Futures Wheel technique:

- The first refinement forces the brainstorming group to consider consequences in each of a predetermined set of applicable environmental areas; these might include political, cultural, environmental, psychological, technological, educational, public welfare, and economic areas. Thus, this variation ensures that the group will consider a realistically wide range of consequences.
- The second refinement is to consider historical causality chains as well as present correlations, in addition to future causality chains.

Primary Uses

The technique is mainly used in the following steps of the applied futurism methodology:

- **Assess Current State**: The Futures Wheel may be used to show complex interrelationships among the agents of the system of interest, or among various systems. The technique is also helpful in developing a formal systems model. Higher-order consequences often cycle back to the central subject, and thus indicate a feedback loop which can be built into the model. The technique may also be used to trace the evolution of a problem, or to project its secondary effects.
- **Project Alternative Future States**: The technique is useful in creating forecasts of a particular item within a scenario for an alternative future state.
- **Develop Plan**: The technique is useful in thinking through the impact of particular actions of a strategic plan.

Strengths and Weaknesses

The Futures Wheel technique is simple to use; no special equipment or analytical skills are necessary. It helps us break our habits of linear and hierarchical thinking, and grasp the power of more organic and pattern-oriented thinking. The technique gives a clear map of the complexity of interactions.

The technique also has some weaknesses:

- It does not reflect the timing of items in a causality chain. Thus, events connected in one 'wheel' may appear to contemporaneous, whereas in fact they would be widely dispersed along a time line.
- The Futures Wheel can become messy, a sort of intellectual spaghetti. Often, the implications of the central subject may be hard to discern among the complexity.

Examples

The Futures Wheel could be used profitably to explore the consequences of various political actions to 'fix' the social security system. The central subject might be:

- Increase social security payroll taxes 20%.
- Reduce benefits 20%.
- Increase the retirement age to 70.

Gaming and Simulation

Background

Simulation is an ancient strategy for learning to deal with complex situations. Military training has relied on "war games" as long as organized armies took the field. Each side playing the enemy to the other, forces would simulate battlefield conditions to increase their skills and harden their talents for the real encounters. That type of simulation is today practiced on football fields around the country with equal vigor. The "B team" plays like the next opponent and gives the starters the chance to simulate the real thing.

Simulation in business environments has grown over time, but not as rapidly as in the military or sports because the environments are more complex and the outcomes less easy to measure. Nevertheless, a small industry has emerged in the last 20 years to serve the needs of business people to simulate future environments and decisions as accurately as possible.

Description

The field of gaming and simulations rests on three components:

- models of the world
- simulations of activities in that world
- games based on those simulations

A model is a representation of reality. No models are identical to the world because they would be just as complex and hard to handle. Rather, models abstract a set of attributes to highlight and demonstrate their interaction. Models are static or dynamic. An architectural drawing is a static model; a virtual reality rendering of that same building is dynamic. A printed balance sheet is static; a spreadsheet version with various "what-if" options is dynamic. Simulations are based on dynamic models because they change over time, sometimes under control of the individual or group running the simulation.

Dynamic models come in various types as well. Physical models are objects that represent real world objects. The Shuttle Simulator is a dynamic physical model used to train astronauts. Since futurists operate on more conceptual phenomena, they deal almost exclusively with symbolic models. Symbolic models represent world phenomena using language ("word pictures"), graphs (organization chart) or computer-based mathematical equations. Mathematical models represent a large class of future simulations, but not all.

The second component of this activity is a simulation, the interaction between one or more individuals and a dynamic model. As soon as someone puts a dynamic model in motion, he or she is simulating a real world activity. Three basic types of simulations are common in practice:

- Board games have been favorite devices for simulating business processes, even before computers came on the scene. Monopoly, for instance, simulates the operation of a real estate market. One of the most popular simulations, The Beer Game, is a board game that simulates the operation of a beer distribution network.
- Role playing is another simulation device that does not require computers. Individuals are assigned roles in a fictitious situation and play out those roles with other individuals in other roles. Role playing is common in interactive situations like negotiation, sales, psychotherapy and management training.
- The fastest growing field of simulation is, of course, computer-based simulation. Computer programs contain a set of attributes and relationships that change over time with the inputs of the players. Numerous simulations of manufacturing operations, military maneuvers, and market dynamics are available. The U.S. Air Force even has a simulation that "flies" its aircraft against possible opponents.

The final component of this method is the game. A game is defined as a simulation in which people compete against each other or against some standard to increase their performance. A game requires a scoring metric that awards "points" at the end of the simulation. Distinguishing games from simulations makes the point that simulations can be used for individual or group learning as well as for competitive tests of performance. In fact, setting up a competition can distort the learning that one derives from operating a simulation.

Primary Uses

This tool is mainly used in the following steps of the applied futurism methodology:

- **Project Alternative Future States**: A main use of simulation and gaming is the exploration of alternatives. What-if scenarios are the core of futures studies and investigating their alternatives is a common practice. The most well-known such simulation was the World3 model used in *The Limits to Growth* (1972) and *Beyond the Limits* (1992) by Donnella Meadows and others. They built a model of key global parameters such as population, capital formation, economic performance, resource use and pollution. Running that model under numerous conditions, they came to the conclusion that the world's economy was on a path to overshoot and collapse. Like Rachel Carson's *Silent Spring* and Paul Ehrlich's *Population Bomb,* this book raised public awareness to the impending challenges of unfettered economic growth. The model has been disputed, of course, but a strong community of ecologists and modelers still stand by the conclusions. Clearly this simulation played strongly on this issue.

  The investigation of alternatives using simulations, however, is not as common as the use of simulations for training. Policy is conducted in poorly structured problem spaces; training in relatively well structured spaces. Therefore, the challenge of creating valid models in systems that are poorly understood is both expensive and risky. Simulation, therefore, tends to stay in the protected waters of more fully understood systems.

- **Develop Plan**: Futurists are interested in simulations at the strategic level, and some disagreement exists about whether that use is growing or not. Forrest (1995) conducted a series of interviews with simulation manufacturers and trainers and came away with a mixed report. The manufacturers held that the use of simulators for strategic purposes was growing, but they had incentives to say so. *Training* magazine reported that the use of simulations in all training had increased from 43% of firms surveyed in 1989 to 60% in 1995. A mailed survey of corporate training departments found that almost all companies were using more simulation now than they had 5 years ago and that about 80% expected to use it even more in the next 5 years.

When limited to executive training, however, the picture becomes more cloudy. Forrest could not find any literature on the executive use of simulation outside academic departments. Corporate trainers were particularly unwilling to discuss this topic. So the conclusion must be that simulation in training is growing in popularity, but it is not clear whether that extends to the executive and strategic levels or not.

- **Implement Plan**: The tool can be used to train personnel to implement the plan. The training component represents the bulk of all of simulations. From physically training pilots and machine operators to training sales people, nothing comes as close to the real thing as a good simulation. Even NASA astronauts have remarked how much being in space was like their simulator experiences.

Strengths and Weaknesses

Simulation is a marvelous tool for exploring unknown spaces. It allows the learner to explore those spaces at their own pace and using their own interests. As opposed to more discursive forms of learning like reading or listening to lectures, it presents a version of the world that is both more valid and more engaging. When our knowledge of systems is bound by uncertainty, there is no substitute for practice when confronted with a risky future. Military and sports leaders discovered that a long time ago. Business leaders are slowly coming to that realization.

Simulation is not without its dangers and its weaknesses. The simulation is only as good as the model it is built on. No model identically mimics the world. Indeed its advantage is that it simplifies and abstracts the most important aspects. But therein lies the danger. Which aspects are to be abstracted? How are those aspects related to each other? How does the world really work? A biased simulation may be worse than no simulation because it gives a false sense of security that one now knows how the world works.

Good simulations find the optimum balance between two contradictory tendencies. They are complex enough to be a valid model of the world and provide a challenge to the operators, but they are simple enough to be used in a reasonable time. Poor simulations are either overly complex or too simplistic to be of use.

Another problem of course is the cost. Compared to the other applied futurism tools, simulations are enormously expensive. Not only must the core relationships be right, but they must be presented in a manner that people can grasp and manipulate with little or no training. Cost is the reason that simulation is usually brought in from the outside with recognized systems or expertise in the area.

A unique problem to futures simulations seems to be that they are rarely built on real data. More often they are the theories and assumptions of the creator. William Nordhaus makes this point in a critique of *World Dynamics*. "The model [World3] contains 43 variables connected by 22 non-linear (and seven linear) relationships. *Not a single relationship or variable is drawn from actual data or empirical studies.*" Future simulations models, at least to date, have been heuristic devices to explore the assumptions that people make about the future. They have been taken, however, to be valid models of the future based on empirical findings. These two uses represent a weakness in the approach so far.

Examples

Olaf Helmer developed a simulation he called **Simulating the Values of the Future**. It was designed for high school students and uses three groups: planners, social predictors and an evaluation committee. Planners allocate resources to raise probabilities of higher GNP and/or promote better values/freedom; predictors make social predictions based on the allocations and determine likely social consequences; evaluation committees determine preferences and desirability of alternative futures; final plenary assessment assigns probabilities for population sectors.

As discussed above **World3** is a Systems Dynamics model of the world that was developed by Dennis L. Meadows, with Donella Meadows and Jorgen Randers. World 3 is based on two books by the Meadows, *Limits to Growth* and *Beyond the Limits*.

World3 is an elegant model, linking the population, and economic and ecological resources in their complex relationships. In a computerized version the user can view and compare all of the scenarios discussed in *Beyond the Limits*, ask a wide range of "What if.." questions to create different scenarios in a simulation.

The computer program shows the user three windows. In one there are general instructions and decision screens in which the user can change various assumptions on which the model is based. The second window provides summary reports about each simulated scenario (as determined by the decisions in the first window). The third window shows summary charts (plots) which depict the key variables simulated by the model in one, two or three scenarios, as well as explanations of how the factors interrelate.

Clearly, a similar simulation could be made of the variables related to the social security system, and policy makers could 'play' the simulation to gain a better understanding of the future impact of various policies.

Genius Forecasting

Background

Genius forecasting is a subjective process used by an individual with special insight (a 'genius') to make statements about the future. The term 'genius forecasting' is most closely associated with Herman Kahn, who was considered a genius futurist. He showed great insight into the future in many areas.

Genius forecasting relies on the intuition or gut feeling of the forecaster. Futurists have always used intuition in their work. Recently, we have come to recognize subjective and intuitive methods as equal in importance to empirical and statistical methods in helping us understand the future of human systems.

Description

There are two main ways to perform a genius forecast:

- Locate a 'genius' to provide his or her insight, or
- Develop one's own intuition sufficiently to perform a subjective forecast.

Individuals with special insight can be found in the following ways:

- Literature searches (including science fiction) are useful. In the increasingly electronic world of information production, storage, and communications, literature searches should include the Internet. The most creative and subjective work tends not to get into print as quickly or easily as it does into computer conferences, electronic journals, and message groups.

- Another approach is to ask the wisest ones you know who they would recommend and continue asking those recommended the same question in turn until a pattern of respected recommendations and referrals occurs. A similar approach can start with recommendations from professional organizations relevant to the area of interest and review the short resumes in their directories.
- Observation at conferences and other gatherings of creative people is not only useful to identify the genius forecasters but also to see how others react to them. Many who have made important forecasts were ignored.
- Contests could offer a prize to the forecast with the greatest insight and usefulness. The Mitchel Prize from the Club of Rome has stimulated and attracted visions from many futurists and scholars over the years.
- Follow current events to learn whose advice and forecasts showed more insight over time.

And there are a number of ways to develop one's own intuitive powers:

- **Reading:** Reading extensively and eclectically is a basic way to develop subjective forecasting. One should set aside time for reading new material. Wallas in the *Art of Thought* defined four steps for creativity: preparation, incubation, inspiration, and verification. Reading widely is key to the preparation stage.
- **Guessing:** Just as one builds the body by physical exercises, so too one builds the mental ability to anticipate by imagining the future and guessing. A simple way to do this is to keep track of one's guesses, review periodically, determine why guesses are right some times, and why some are not. When guesses are wrong - what was wrong with the mental model of how the world works? When guesses are right - what was right with the mental model of falling bodies?

One could list several items in the news each day and list what one thinks will happen next week as a result. Each week, one will know how the guesses turned out. This approach creates feedback that can be used to improve mental models. Cognitive science is finding that intelligence is increased by responding to feedback. The hard part is actually changing mental models based on feedback. We tend to rationalize why we guessed wrong, rather than change our minds so that we are more likely to guess right next time.

- **Opposite acting and thinking:** Clive Simmonds suggests one way of developing insight is doing the opposite of what has been done before. What once worked will not necessarily always work. Contrarians in the stock market buy when most sell and sell while most buy. Imaging the exact opposite of what you are doing right now can give insight into what might be possible tomorrow.
- **Games and simulation:** Olaf Helmer, one of the original futurists at the Rand Corporation, believes a good way to stimulate genius forecasting is by participating in games that simulate the subject of the forecast. War gaming was used in this way to stimulate insight into war prevention.
- **Meditation:** Meditation is probably the most ancient and universal method to develop insight, intuition, and vision. Although many forms are practiced in many cultures, the general form is the mental act of focusing attention.

Recently, some futurists have begun using some forms of *guided* meditation to help others imagine different possible futures in a variety of situations. Such guided meditation engages mental imagery and intuition, that could lead to insight into a problem.

Another approach to guided meditation begins with values. One focuses on what is the central value of the organization, then imagines how that value is manifested some year in the future. Once some images come to mind, one is encouraged to let the mind wander in this vision and then begin to imagine the events prior to the manifestation of these values as a story back to the present.

- **Perceptual exercise:** The visionary approach uses mental techniques to stimulate new thought. Ideas or thought experiments were used by Albert Einstein. He imagined being a photon traveling at the speed of light through the universe. Suddenly he noticed that his trajectory was bending or curving relative to mass. This insight contributed to his understanding of the relationship of matter to energy. Edward de Bono documents perceptual exercise and how to break out of traditional-only thinking. He believes that the mind is a pattern-preferring mechanism that rejects new input unless stimulated to do so.

  Considering how influential our unconscious processes are, how little we know about them is amazing. One such process is dreaming, which is less understood than building muscles by lifting weights. Sigmund Freud thought that dreams were messages from the unconscious to the conscious mind. C.G. Jung called dreams "the spokesman of the unconsciousness." Dream analysts advise us to keep pen and paper near our bed, so that we can write down our dreams upon waking up. Reviewing such *dream journals* helps us become more aware of our unconscious mental processes, find patterns, and catch our visions.
- **Internships:** The traditional approach to learning is internships. One can stimulate abilities in oneself by working with individuals of great vision and intuition. Organizations that are developing long-term prospective studies might well encourage their members to work with visionary leaders for a specific period to stimulate their intuitive abilities. Today, such internships need not be physical; they can be done through various forms of communications media as well. Interns can also provide fresh insight and stimulate those of great vision to think anew. Such interaction can stimulate both sides of the internship.

Primary Uses

This tool is primarily used in the **Project Alternative Future States** step of the applied futurism methodology.

Strengths and Weaknesses

One key value of genius forecasting is that it cuts time and costs. It is much easier and less costly to collect genius forecasts than it is to build a computer model.

But there are many potential drawbacks. One is how do you find a *reliable* genius? That those of previously useful insights will have good insights again is only an assumption. How do you know when to trust your intuition? What if two genius forecasters contradict one another? How do you know whose judgment to follow?

Genius forecasting should not be a stand-alone tool. It should be bolstered by more objective or analytic work. If we expect too much of subjective methods and promote them as final product, then persons who are less intuitive may disagree with the use of these methods - for the very good reason that vision untested by other means is not tenable.

There are also tactical problems. Bringing together Nobel Prize winners (geniuses by most standards) to forecast the future might seem useful; however, the results of such an attempt would likely be disappointing. Just because one is a genius in chemistry does not mean that the genius' judgments in social sciences are any good. If you want to forecast the future of chemistry, then Nobel Prize winners in chemistry would make sense.

Examples

In dealing with the problems of the U.S. social security system, the subjective input of individuals with special insights into foreign social security systems could be valuable.

Relevance Trees

Background

A relevance tree is an analytic technique that subdivides a broad topic into increasingly smaller subtopics. The output is a pictorial representation with a hierarchical structure that shows how a given topic can be subdivided into increasingly finer levels of detail.

Description

Relevance-tree analysis has proven to be a powerful intellectual stimulus to ensure that a given problem or issue is prepared in comprehensive detail and that the important relationships among the items are considered.

A relevance tree looks much like an organizational chart and presents information in a hierarchical structure. The hierarchy begins at a high level of abstraction and descends with greater degrees of detail in succeeding levels of the tree. The entries at a particular level, when taken together, are intended to describe completely the item to which they are connected in the level above. Ideally, each entry at a particular level is orthogonal; that is, it should not overlap with any other entry, thus being mutually exclusive of other entries. Finally, the items at a given level should be addressed from the "same point of view." These conditions are often difficult to achieve in practice. If pursued properly, the structure can ultimately lead to a clearer understanding of the topic under analysis.

The aim in relevance-tree analysis is to carry the level of detail to the point where the items or issues involved are sufficiently clear, preferably in quantified terms, so that their nature can be reviewed in terms of current conditions and potential options. Alternative assessments result because preparation of a relevance tree often leads to insights about future conditions and important interests that are not current factors in decisionmaking.

Primary Uses

This tool is used primarily in the first step of the applied futurism methodology**, Assess Current State**.

Strengths and Weaknesses

A number of strengths give power to this technique, including:

- *Provision of new insights.* Material is often presented in a manner that creates a greater understanding of a concept. Relevance trees can break down topics in new and insightful ways.
- *Systematic analysis*. This technique allows for a systematic analysis of the current structure of a system.

A potential drawback is:

- *Human error*. The development of relevance trees requires critical judgments. If the underlying thought processes are not insightful, the outcomes of the method will be weak.

Examples

Relevance trees could be used to examine issues relating to the social security system in more detail.

Scenarios

Background

Scenarios are narrative descriptions of the future that focus attention on causal processes and decision points (Kahn 1967). The scenario is the core process in futurism since it describes the alternative futures directly. Coming up with scenarios is part analysis and part imagination. Imagination creates plausible worlds much different than our own; analysis draw out the implications of those worlds for critical variables and strategies.

Scenario development began as war games in World War II, preparing military leaders to deal with the possibilities inherent in a war. They had to prepare the details of war long before the situation became critical. At the same time, they could not develop strict contingency plans or rules of engagements because the number of contingencies, including real, feigned or perceived actions by themselves and the enemy, presented a blizzard of possibilities. They developed the war game, therefore, not to predict the outcome of the exchange, but to practice their decisions and actions under simulated war-time conditions.

The Rand Corporation developed the war game. The Stanford Research Institute (now SRI International) perfected the scenario to provide government and business leaders a methodology to understand the environment of their long-term future. The most successful application of that methodology has been the Strategic Planning Unit of the Royal Dutch Shell Group in London, England. Peter Schwartz, director of that unit during the 1980s, details the process and its application in a highly readable book entitled *The Art of the Long View* (Doubleday, 1991). The methodology employed in this study note is based on Schwartz's work.

Description

The scenario technique alters some of the key characteristics of forecasting and planning to make room for inherent uncertainty about the long-term future:

- The purpose of forecasting using scenarios is to understand the dynamics of how the future will emerge not to predict exactly which future will occur.
- The outcome of scenario forecasting is a set of plausible futures that map the range of alternative futures rather than one "most likely" prediction, because that prediction will still probably be wrong.
- The scenario technique recognizes and incorporates an appropriate amount of uncertainty into the forecast rather than assuming that it does not exist.

Scenario forecasting is still not widely used by planners although it has been around for more than 30 years. Most organizations feel that the pressure of current problems leaves them little time to think about the long term future. When they do spend that time, they want something more solid than a set of alternative possibilities. Unfortunately, the desire for rifle shot accuracy about an uncertain future is misguided and leads to decisions based on erroneous assumptions.

Decisions have to be made, and on the best available information. But decisions made on predictive forecasts of an uncertain future are worse than decisions made on the contingent knowledge of the alternatives in that future. At least the decision-maker using scenarios appreciates the contingent nature of the decision, perhaps even making a more robust and flexible decision as a result. The best decision, in fact, is the one that will be successful in the widest range of possible futures.

The objectives for scenario development are:

- to discover and investigate the forces shaping the future
- to identify key uncertainties in the operation of those forces
- to sample the range of alternative futures that arise when uncertainties break one way or another
- to increase the awareness of and reach agreement on a qualitative model of how the future might develop
- to develop scenarios (stories about the future) that communicate the forces, dynamics, uncertainties and alternative outcomes of the future
- to lay the foundation for monitoring and influencing the future as it emerges

No one scenario is ever overwhelmingly probable; the probability of most scenarios is minute. Accuracy is not the measure of a good scenario; rather, it is:

- Interest (new and fresh that expands awareness of the alternatives for the future);
- Plausibility (a rational route from here to there);
- Internal consistency;
- Description of causal processes; and
- Usefulness in decisionmaking.

The scenario is the simulation of the future under multiple contingencies. The environment of the future is even more unknown and complex than the military environment where scenarios were developoed. No standard simulation model can be completely realistic. Rather the knowledge and imagination of the participants paint the landscape of the future. That landscape, once discussed and agreed to by all participants, forms the backdrop against which strategies and decisions for the future are formed. The stories used to describe that environment can also be used to communicate the alternative futures to the rest of the organization. Finally, the uncertainties also form the platform for a program to monitor how they are eventually resolved. Advance warning of resolution can give an organization an advantage by allowing it to act more surely and more quickly when the future does emerge.

Easily a half-dozen different scenario techniques have been practiced with great effect. They share a common framework with the following steps:

1. Articulate the focal issue or decision that the scenarios are to illuminate.

Scenarios are most relevant when they address a particular aspect of the future. That aspect should be a major issue or decision that faces the organization. How might that organization develop in the next 5 years? What are the possibilities? What might be some of the actions that the organization can take now to prepare for or influence those possibilities?

2. Assess current conditions and trends that will create a different future.

Each technique begins with a catalog of what is constant and what is changing over the forecast horizon. These driving forces are the engine of change.

3. Identify those elements of the future that are uncertain and use them to build the logic for each scenario.

The focus on uncertainties is the *trick* of scenario development. Most forecasting techniques require that a driving force be both important to the focal issue and relatively certain to occur before it is allowed to affect the outcome. In an uncertain world, however, that leaves out a lot. The scenario technique illuminates that blind spot by making the uncertainties the star of the show. What is both important and highly uncertain? If one outcome occurs, that's one scenario; if another, then another; and so on.

Once into the identification of uncertainties, it is hard to know where to stop. Unfortunately, only a few uncertainties can be handled at one time because they expand combinatorially. Two uncertain forces with two outcomes each produce four scenarios; three forces produce eight, and four produce 16, clearly too many to consider in one study. So selecting the key uncertainties is crucial.

The selection, however, does not require getting the "right" uncertainties as in predictive forecasting where one must get the "right" factors. Rather the purpose is to map the range of alternative futures, not to predict what will happen. Uncertainties that are independent of each other will do that.

Some techniques pre-select the type of scenarios rather than leaving it up to the selection of uncertainties. Standard candidates include

- the surprise-free scenario (what is expected to happen)
- an optimistic scenario (if things break well)
- a pessimistic scenario (if things break poorly)
- one or two wildcard scenarios (the result of low probability events)

The pre-selected scenarios make the selection of logics or frameworks easy, but they may result in "stock" stories that are less interesting and insightful than frameworks based on actual critical uncertainties.

4. Elaborate the scenario logics into story lines that show how that scenario could plausibly emerge from the present

The scenario logics are the barebones of the scenario, the skeleton of a story. Each scenario requires more meat on its bones to be understood and communicated. A sub-group of workshop participants develop the story for each of the scenarios. The stories contain the plausible dynamics and interesting details about how that scenario came to happen. Writers are allowed to embellish their stories with fictional characters and events as long as they are plausibly contained within the logics outlined above. All of the driving forces suggested above are raw material for the scenarios even though they did not make it into the high impact category.

Groups brainstorm possible story lines and then one person usually takes that material and writes it into a script. Members of the group critique the script, adding more interesting elements along the way. The attributes of a good scenario script are:

- elaboration of the actual scenario logic
- interesting details, including characters, events and issues
- plausible occurrences and dynamics
- drama, conflict and dynamic interaction between forces
- surprising and contrary developments
- favorable and unfavorable elements
- loose ends and an uncertain resolution
- relevance to the primary issue

The real insights into the future occur in the scenario elaboration, not only for the reader, but even more so for the writer. Here the dynamics of change are revealed, assumptions are overturned, the alternative future is made real. "That could really happen" is the result of a good scenario elaboration.

At this point the scenario techniques diverge into many optional endings. One can cast the elaborations into *forms* that represent products that could actually occur in the future. A form is a memorandum from an important client, a newspaper article concerning a breakthrough, a video tape, a radio broadcast, a research proposal. The number of forms is innumerable, limited only by the imagination of the creator. The form gives the scenario an immediacy and reality that an analytical description does not.

Another optional step is to establish a monitoring program to see how the uncertainties are developing. If the outcomes of these uncertainties are critical, then getting an early indication of which way they are going is useful. Fortunately, the uncertainties usually do not resolve themselves in a flash. They take some time to develop, time that can be used to prepare once a monitoring program gives the signal.

An important final step is to explicitly understand the implications of each scenario for the focal issue. What strategies will work in which scenarios? What are some goals that would be common across many of them? What can we do that will be successful under most conditions? The scenarios paint the range of plausible futures. Using that range to test strategies and plans is the ultimate product.

Primary uses

Scenarios are primarily used in the second step of the applied futurism methodology**, Project Alternative Future States**.

Strengths and Weaknesses

Scenarios offer a concise picture of important alternative future possibilities. They are like a rudimentary map of the future, displaying alternative destinations. "If you or the world go this way, then this will result; if that way, then something else." Just as a prudent traveler would not begin a journey without a good map, so a decision maker ought not to embark on the future without a sense of what the possibilities are.

The scenario, however, suffers from bias against qualitative and imprecise results. Although one can add quantities to the story, the value of the scenario is in the qualitative differences between the outcomes. Unfortunately, decision makers prefer their futures tidier than this--not as much variation and what variation there is neatly packaged in a probability distribution. The world, however, does not conform to our scientific and mathematical inclinations. Truly different futures exist out there; to reduce them to a probability distribution is to lose the inherent richness of the story.

One might even accuse decision makers of copping out on their primary responsibility -- making decisions under conditions of uncertainty. The opposite task, making decisions when conditions are certain, requires little skill. In fact, a computer would be just as good and sometimes better than a human decision maker under known conditions. It is when uncertainty and alternatives creep in, when risk cannot be quantified, when the situation is complex and the future hazy, that is when real decisions are made. The scenario technique is perfectly suited for decision makers who are not afraid to face the uncertainty of the future. It raises possibilities, uncovers assumptions, draws out implications, but it does not make the decision. That is left to the guy or gal who makes the big bucks!

Examples

Air War College -- 1996

The Air War College developed a set of scenarios for the future of air power in a year-long exercise. They identified three dimensions of critical uncertainty:

American world view:	Global or domestic
Technology:	Constrained or explosive
World power:	Concentrated or dispersed

The College concentrated on four of the eight possible scenario logics:

- Gulliver's travails: a world in which the considerable power of the U.S. is limited by a technology that does not live up to its billing against multiple small, dispersed throughout the world
- Zaibatsu: a world dominated by gigantic corporations that take over the role of nation states through the application of explosive technology
- Digital cacophony: a world known today as cyberpunk, digitally rich but fragmented and physically dangerous
- King Khan: a world dominated by China, the new economic superpower of the 21st century

To these they added a fifth scenario that was the more or less surprise-free future without major transformation.

Shell Pipeline Corporation

The Shell Pipeline Corporation merged its three major divisions (pipelines, marine and bulk terminals) into one operating unit some years ago. The new management team wanted to explore alternative futures and so launched a nine-month study into the development of scenarios. They came up with five distinct ones:

- Global crabcakes: a strategy in which the formerly domestic pipeline corporation would have the ability to expand into the high growth markets of Latin America and Asia
- Pipe dream: government regulators and industry representatives develop a working arrangement for environmental issues that is both safe for the public and reasonable for the industry
- Good old days: a nostalgic return to the heyday of the oil industry when prices were high and autonomy was almost complete
- Company w/o walls: a look at the human resources side of the future with people coming from unusual backgrounds by contemporary standards
- Free Willy: an independent company free to seek business with any customer

Clearly, the use of scenarios would be highly beneficial in exploring alternative futures for the social security system.

Systems Dynamics

Background

Systems dynamics is an approach to modeling complex systems developed by Jay Forrestor at MIT. Originally designed as a way to model economic processes, the technique became famous as the methodology beyond *The Limits to Growth*, done for the Club of Rome by Forrestor, Dennis and Donnella Meadows and their team in 1972. The study received intense interest (and criticism) because it forecast the overshoot and collapse of planetary growth under almost any conceivable condition. The fact that it came out just one year before the first shock to the oil industry in 1973 did not hurt its popularity either.

Since then, systems dynamics has been used to model hundreds of systems, many of them global or regional in nature. Peter Senge also took some of the aspects of systems dynamics as one of the disciplines in his popular books, *The Fifth Discipline* and *The Fifth Discipline Fieldbook*. Colleagues have applied systems thinking to organizational processes and developed a set of archetypes that they claim explain why organizations fail to recognize and solve their problems.

Systems dynamics is part of the wider field of systems thinking--the holistic, contextual, interactive approach to understanding and manipulating systems. Systems thinking is one of the intellectual achievements of the 20th century although it is so vast, it is hard to pin down exactly what it is. At the very least, it is an antidote to the reductionist, linear intepretation of how systems behave that came out of the machine age. Natural systems, whether ecologies or organizations, do not operate like machines. They are open to their environments; they involve complex feedback loops; they engage in surprising and counter-intuitive behavior. While modeling these systems is harder than modeling simple linear systems, systems theorists claim that choosing the right approach is better than choosing the easy one.

Description

Technically, systems dynamics is a modeling language that permits the simulation of complex system processes. The language is based on four elements that are combined to create the system behavior:

- Stocks: accumulations of a quantity that persists over time
- Flow: the rate at which the stock increases or decreases
- Converters: nodes that convert information from one type to another
- Connectors: lines that transmit information from one element to another

The central features of a system dynamics model is a stock that increases or decreases, like a water tank, depending on the rate of flowing in and flowing out. Population growth gives the best example as depicted in Figure 1.

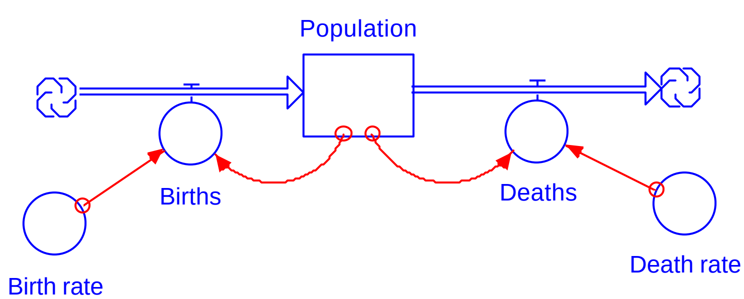


Figure 1

Population Dynamics

In this model, population is the stock, the number of people in the world at any one time. Population increases with births and decreases with deaths. Since the population is the world population, we do not think there is any migration! Births and deaths are influenced by the current population size and their respective rates. Figure 2 shows exponential population growth when the birth rate exceeds the death rate.

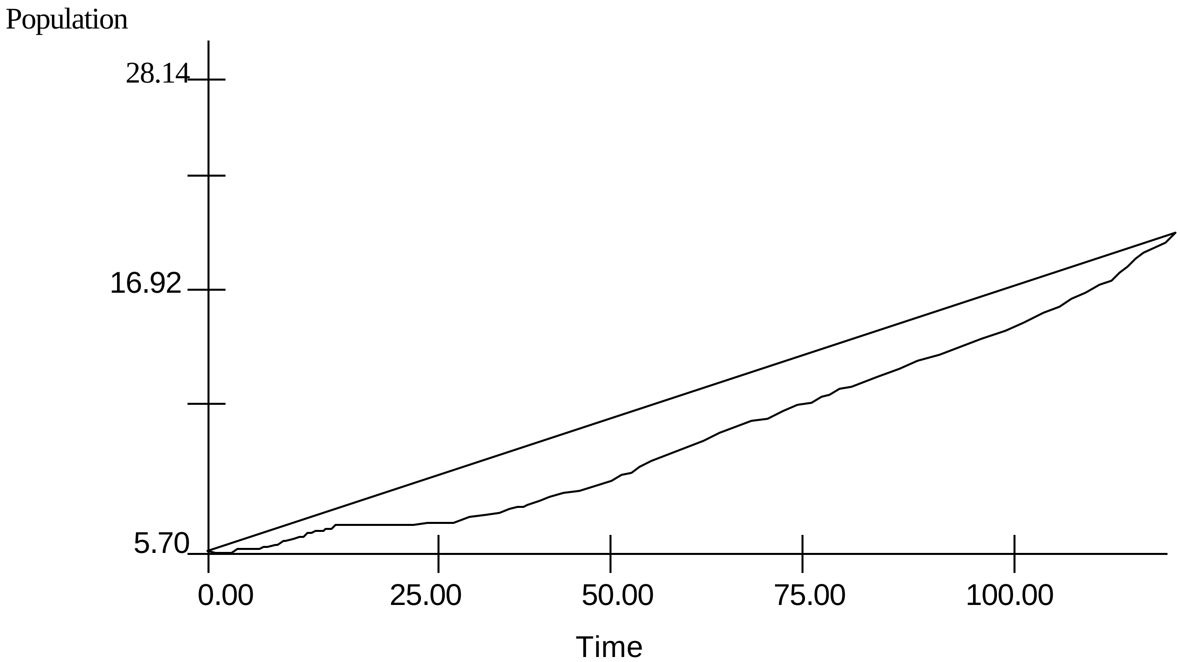


Figure 2

Population at 1.6% Growth Per Year

Of course, one does not need systems dynamics to calculate a simple exponential growth. The constraint, however, is that the death rate increases as the population approaches 15 billion, the presumed carrying capacity of the planet.

Figure 3 now has one more connector from population to death rate.

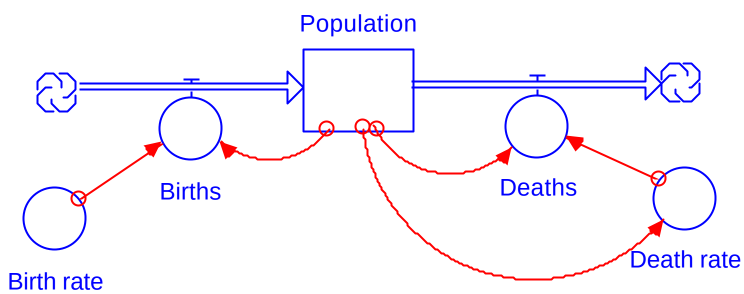


Figure 3

Population Dynamics II

The equations change to reflect that influence, dividing death rate by a factor that goes to zero as population approach 15 billion.

Population(t) = Population(t - dt) + (Births - Deaths) * dt

INIT Population = 5.7

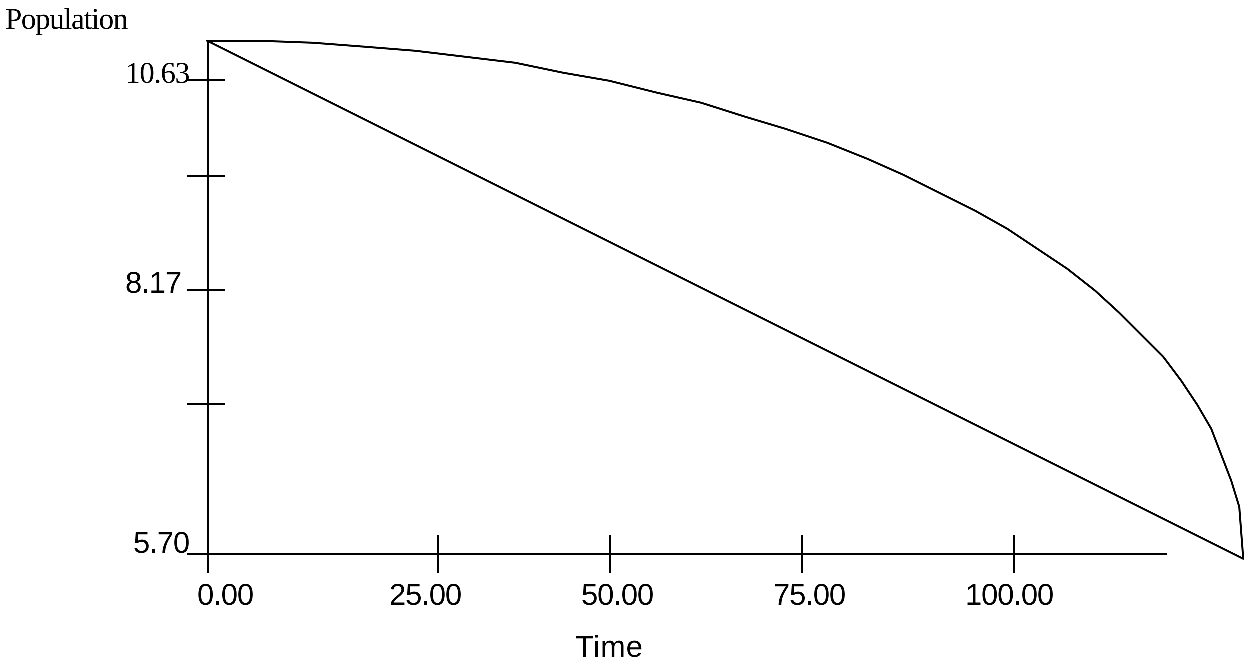
Births = Population*Birth_rate/1000

Deaths = Population*Death_rate/1000

Birth_rate = 30

Death_rate = 14*9.3/(15-Population)

And finally the graph shows an asymptotic increase to just over 10 billion at the point when the death rate matches the birth rate.



Fgure 4

Asymptotic Population Growth

Even this system is a relatively simple one, and solvable with easy mathematical techniques. The value of systems dynamics grows as the systems become more complex. It allows the user to draw simple models, enter the relationships and see the results almost instantaneously with a minimum of mathematical calculations. That ability is especially important when he or she is trying to fit models to complex systems.

Systems dynamics, and modeling in general, are used for two purposes

- to understand the behavior of complex systems
- to forecast future values of important variables.

These two uses are only treated in sequence since understanding clearly precedes forecasting. Understanding the behavior of complex systems follows these steps:

1. Identify the system behavior.

The focus of every system explanation is one or more observable characteristics of the system that begs for explanation. "Why is it doing that?" The system behavior is usually expressed as a time series of the variables of interest. The graphs above are examples of system behaviors.

2. Write a verbal description of the system.

The verbal description is a model of sorts. While not mathematically or graphically elegant, it "tells the story" of the system before the complexities of models and mathematics begins. It is a data dump in which the analyst writes down everything he or she knows about the system, its behavior and possible explanations for that behavior. The system description is not final by any means. In fact, the analyst returns to it often as new information and insight are gathered. It is, however, an excellent starting place.

3. Create a causal model of the system

The causal model is a simplified diagram of the relationship between the system components. It involves only variables names and signed relationships between them. The causal model for the system above would be:

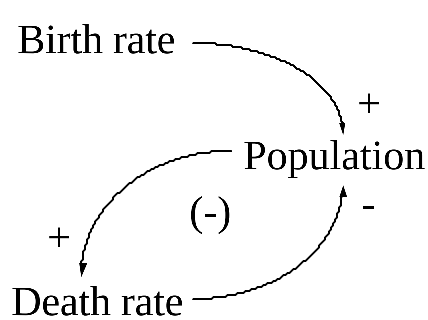


Figure 5

Causal model

It shows that the system has three variables, one exogenous (birth rate) and two endogenous (population and death rate). The arrows show the influences between variables and the signs the direction of the influence: plus for positive or direct influence, minus for negative or reverse influence. The diagram also contains one feedback loop, a negative one, that balances population through the action of the death rate.

4. Create a systems dynamics model from the causal model.

Causal models are excellent ways to articulate assumptions about how the system works using a simple but precise language. The language of causal models does not translate directly into simulations, but the language of systems dynamics does.

5. Create a systems dynamics simulation from the model.

The systems dynamics model is still a drawing. Turning it into a simulation requires specifying the mathematical relationships between the variables and the initial values or boundary conditions of the model. This step is completed when the model replicates the system behavior with reasonable accuracy.

6. If desired, use the simulation to forecast future values of the system behavior.

Some models are purely explanatory. Their purpose is to understand how a target system behaves, not to forecast the future of that system. When forecasting is the purpose, the simulation can be a powerful tool in understanding the dynamics of the system. It has all the manipulative advantages of a simulation, allowing the analyst to investigate alternative views of reality and alternative future conditions.

When possible, the relationships used in systems models should have empirical support. Unfortunately, such empirical support is hard to come by in futures work. Even modeling the earth's atmosphere, a well-studied and relatively well-understood physical system, is taking decades of hard work. How much more difficult might the world's biosphere, economy or political dynamics be. Even then, futurists are often lax in looking for empirical data to support their models. They treat them more as heuristic devices to articulate their assumptions than as objective models of actual processes.

Primary Uses

This tool is used primarily in the first two steps of the applied futurism methodology**, Assess Current State** and **Project Alternative Future States**.

Strengths and weaknesses

Systems dynamics is an easy yet powerful way of representing the behavior of complex systems. Individuals can develop and use the simulations in a stand-alone mode or groups can work together to create models that represent their collective ideas of how the system works. The discussion is often well-informed with surprising insights for all concerned. Having to represent ones assumptions in this structured manner clarifies them and provides an excellent basis for feedback and discussion.

Models of complex systems, however, are not easy to build. Even a model of only 6 or 8 variables can get complicated fast. It is hard to grasp the relationships involved and keep up with the flow of the discussion. Some people drop out because of the tedium or strain of keeping all that straight.

Simulating models is even more difficult. Representing even the simplest conceptualizations in mathematical terms is difficult for many people. Getting the parameters and the initial values right, which is the whole difficulty of modeling, is not be taken lightly. Stella II and the other simulation packages are very easy to use, but they don't do the modeling for you.

Examples

The most famous example of this methodology is *The Limits to Growth*, done for the Club of Rome by Forrestor, Dennis and Donnella Meadows and their team in 1972. The model was revived for the 1992 publication of *Beyond the Limits* by many of the same authors.

Trend Impact Analysis

Background

As we have seen, human systems typically evolve by periods of smooth continuous change suddenly interrupted by discontinuous change from one state to another. They do not always evolve over the smooth arc envisioned by forecasting techniques such as trend extrapolation. Surprise is inherent in evolution. Trend Impact Analysis (TIA) is a trend extrapolation technique that recognizes this element of surprise and discontinuity.

TIA developed in the late 1970s in response to the deficiencies of traditional quantitative forecasting methods; these deficiencies were more and more apparent as the rate of change in the world increased and discontinuities became more frequent. Traditional techniques -- from time-series techniques such as trend extrapolation to econometrics to actuarial science -- ignore the impact of surprising future events. These techniques assume that forces at work in the past will continue into the future; the impact of countervailing events is ignored. Therefore, these methods do not produce useful models of reality over a long time span. They are more useful for projections over a short period.

TIA is in common use today. Health Care Futures, a commercial information service, produces forecasts of pharmaceutical markets using TIA. TIA forecasts are also used by several U.S. governmental agencies, including the Federal Aviation Administration, Federal Bureau of Investigation, Joint Chiefs of Staff, National Science Foundation, Department of Energy, and Department of Transportation.

Description

A basic TIA study involves the following steps:

1. Fit a Curve Using Traditional Trend Extrapolation

First, a smooth curve, or a family of curves, is fitted to historical data using the traditional techniques of trend extrapolation. This curve does not recognize future discontinuities.

2. Identify the Event Set

Next, a set of future events is identified that, if they were to occur, would each cause significant deviation from the smooth extrapolation of historical data. A panel of experts typically selects the event set, often through a Delphi study. Each event should be plausible, capable of significant impact, and verifiable in retrospect.

The experts also identify the following information regarding each event:

- the estimated probability of occurrence in each of several future time intervals
- the time from occurrence of the event to *first* impact on the system of interest
- the time from occurrence of the event to *maximum* impact on the system of interest
- the time from occurrence of the event to *steady state* impact on the system of interest
- the magnitude of the maximum impact
- the magnitude of the steady state impact

For example, the information about an event E_m might be:

- Probability of occurrence by
  - 2000: 15%
  - 2010: 25%
  - 2020: 50%
- Years to first impact: 2
- Years to maximum impact: 5
- Years to steady state impact: 10
- Maximum impact: 15%
- Steady state impact: -5%

3. Produce an Adjusted Extrapolation

The analyst then combines the information from the event set with the base trend extrapolation to produce an adjusted extrapolation. First, the expected value of the combined impacts is calculated; this is equal to the sum over all events of the products of:

- the probabilities of event occurrence for each time interval, times
- the expected impact magnitude.

Of course the time lags for initial, maximal, and steady-state impacts must be taken into account. Figure 1 illustrates how TIA is applied.

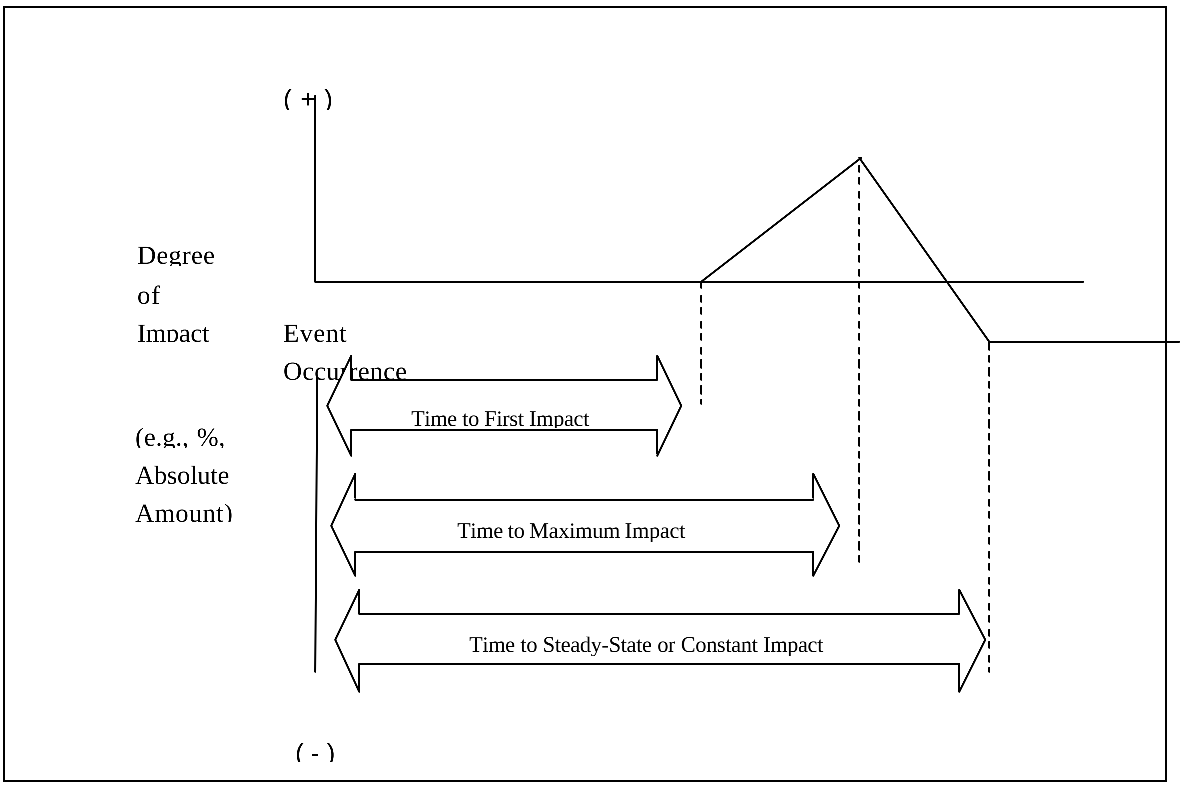


Figure 1

A TIA study commonly includes statistical information, such as the variance and the upper and lower quartiles of the adjusted forecast. This information may be obtained through Monte Carlo techniques. TIA can also be combined with cross-impact techniques if the selected events are considered to be interdependent.

Primary Uses

The technique is mainly used in the following steps of the applied futurism methodology:

- **Assess Current State**: Sensitivity analysis of the event set employed in a TIA study can identify those events that have the most potential to impact the system of interest. This information can help to structure environmental scanning for the system of interest.
- **Project Alternative Future States**: TIA can help to project alternative futures, and to determine which future events are likely to have the most significant impact on the system of interest.
- **Develop Plan**: The most common use of TIA is to assess the impact of alternative policies and strategies, and to determine the probability that a certain strategy goals will be achieved within a desired timeframe.

Strengths and Weaknesses

The primary strength of TIA is that it forces the analyst to explicitly identify and quantify the impact of events that may cause significant state changes in the system of interest. Through the statistical analysis, TIA also provides information about a range of possible futures, rather than a single point forecast.

Clearly, TIA has inherent weaknesses:

- The list of events is certainly incomplete. We cannot identify all events that may have a significant impact on the system of interest.
- And even if the list were complete, we still have the problem of accurately identifying the probabilities of occurrence as well as the timing of the impact and its effects.

On balance, though, TIA is a useful tool to help us make trend extrapolation more realistic.

Examples

The cash flow of the social security system is directly dependent on the mortality rates of the U.S. population. Projection of these rates is usually accomplished using traditional trend extrapolation based on historical patterns. TIA could be employed to investigate events that might cause discontinuities in these smooth projections. Examples of such events are dramatic health care innovations to significantly prolong life, spread of disease that increases mortality, etc.

Visioning

Background

There comes a time when every organization has to change. Not just to improve the way it has always done things, but to change radically--to become a new entity, to completely change its mission and how it approaches that mission. Those times do not come often, nor should they be undertaken lightly, but when they do come, the very life and survival of the organization is at stake.

This section describes an approach to such times. It proposes a way that organizations can renew themselves in as safe and timely a manner as possible. While such change is never easy, this approach does offer the hope that it is possible.

The approach is visioning, the newest tool in the futurist's toolkit. While visions have propelled the great religious and political movements of history, only recently have people explicitly devoted time to developing a vision for themselves, their team or their organization. Visions were supposed to spring full-blown from the minds and hearts of leaders; followers were to recognize the vision as their own and join in.

Sometimes it happens that way. But if leaders are not the visionary type ("Read my lips!"), then the organization must develop its vision in some other way. Visioning workshops are that way, the most recent type of futures practice.

Description

Visioning is grounded in the futurist's three part view of the future:

- the probable or expected future: that which will occur if current trends continue
- the plausible or possible future: that which will occur if something else happens
- the preferred or normative future: that which people want to see occur

Traditional forecasters deal with the probable or expected future. Their models assume that recent conditions will persist at least for the near-term. If they venture into alternative futures at all, they might adjust a parameter or two to get a high-medium-low type forecast. The basic structure of society, their industry, and their organization must stay intact even then for their forecast to be credible.

In their descriptive mode, futurists deal with the plausible future--alternative arrangements of the most fundamental aspects of life: work, family, governance, technology, beliefs, values, etc. They communicate their alternative views in scenarios, stories about how the future might occur. Taken together, scenarios map the range of plausible futures. Preparing for that range is more prudent than assuming that one particular forecast will occur.

Within that range, however, some futures are preferable and some are not. Visions are the selection of the most preferable future one can imagine--where the best happens, where the organizations or the individual becomes the best that it/they can be. Visions are selecting a target, a destination, a far-off mountain to strive for, a star to guide organizations in turbulent times. Visions express the highest aspirations that people have for themselves.

A vision has several characteristic attributes:

Image. A vision is an image of the future, an attractive picture of the future that people can strive for. Most people think of the future in ideas rather than images. Attractive ideas are progress, security, enjoyment; unattractive ones include overpopulation, pollution, sickness, death. None of these are visions, however, because they are not images. What does it *look like?* How does it *feel*? What does it *taste like*, *sound like*?

> "I have a dream!" -- Martin Luther King, Jr.
>
> "Land a man on the moon by the end of the decade." -- President John F. Kennedy
>
> "Free India!" -- Mahatma Gandhi

The vision is something tangible, concrete. Something that people can get excited about. Sports are replete with concrete visions -- trophies, medals, (endorsements!). Politicians work to keep their <u>seat</u> in the legislature. Attorneys see their clients go free or the big check at the end of a long civil suit. Doctors work for the health of their patients; educators the child's visible enjoyment of learning; priests the salvation of their flock. Even the gray world of business livens things up with awards and recognitions and the signs of status in homes, cars, and corporate jets. These are not abstract concepts but powerful images that guide people's actions.

Creating images of the future is like riding a bicycle--pretty easy once you get the hang of it. It is also the most powerful way of portraying a goal. While our intelligence distinguishes us from other animals, we are still a visual species. The visual cortex is more primitive and, in many ways, more powerful than the cerebral cortex. Pictures convey meaning in more immediate and compelling fashion than words do. They are ideal for portraying a preferred future.

Compelling. The vision contains the best future, the one that people can really commit to. It is not only attractive, it is compelling. It draws them like a magnet, almost beyond their control. Visionaries can do nothing but pursue their vision. There are days they perhaps wish they had never had the vision. "Father, let this cup pass from me" is a refrain, not only in religion, but in all visionary pursuits.

At the same time, visionaries cannot imagine their lives without their vision. It becomes a part of them, like another limb. No one suggests cutting off an arm to stop arthritis from hurting. The vision aligns everything, gives a purpose and a context for decision and action everyday.

Unique. The reason people go on is that they feel an obligation to work toward the vision. "If not us, who?" The most powerful visions are unique to the group that produces them. Generic visions are those that could be held by almost any organization -- "The best customer service in the world," "The largest and most profitable company," "A world-class organization"--these are the one-size-fits-all visions of corporate organizations. Not very motivating, are they?

The problem is that anyone can have those visions. Really compelling visions can be fulfilled only by the organization that creates them.

"Absolutely, positively overnight" -- Federal Express

"Using our imagination to delight millions" -- Disney

"Go fast computers" -- Cray Computer

These are organizations on a mission. If they don't excel, the world will be worse for it. Their unique visions drive them to improve and transform themselves everyday.

Spoken by leaders, but owned by everyone. Leaders play a crucial role in adopting and implementing a vision, but it's not the role most people think. Most believe that the leader creates the vision. Its her vision, one that she creates and offers to the members on a take-it-or-leave-it basis. Buy-in to this vision or find work elsewhere.

The actual leader's role is more subtle than that. Leaders speak the vision that is created and owned by everyone. They are the spokesperson for the collective. A group does not speak with one voice. Different backgrounds and interests give everyone a different angle on the vision. The leader speaks the common vision.

But if that vision is not owned by everyone in the organization, it is dead; it has no effect on the organization's performance. Leaders who speak effective visions do so in resonance with individual values and visions throughout the organization. Members recognize it more than accept it. "Yeah, that's it! That's what I meant." The enthusiasm is contagious; it powers the organization through the turbulence of change.

Motivates and gives meaning. A shared vision is powerful. It aligns the forces generated by many, even thousands of individuals, to pull in the same direction. A vision is like a bar magnet that aligns all the little dipoles to produce an external effect. The number of dipoles does not change, but they produce a visible force when they are all pointed in the same direction.

In times of turbulent change. Visions are particularly important during times of fundamental, transformation change. Such change is never easy nor easily understood. Tearing down the old regime and building the new one is messy. It never goes according to plan because the plan itself is the product of the old order. Such times can become directionless; conflict can overwhelm the best intentions. The vision is the one constant amidst this turbulence. It remains the same, the light on the hill, the pole star. Now matter how stormy, we are working to achieve that goal.

Primary uses

This technique is primarily used in three steps of the applied futurism methodology:

- **Select Preferable Future State**
- **Develop Plan**
- **Implement Plan**

The vision sets the direction for the enterprise into the distant future. It is a lofty statement, no doubt about that, but also a very practical one. As one wag put (perhaps Yogi Berra, the reputed source of all quips of the 20th century), "If you don't know where you are going, you may end up some place else." If the organization wants to move, it should have a direction. If it wants to be outstanding, that direction must appeal to most of the people. Increasing shareholder value and making money is fine, but not everyone is equally motivated by that. If the organization wants to truly make its mark, the kind of mark must be known ahead of time. Those are the uses of the vision--setting a clear direction, encouraging people to put aside their differences for the common enterprise, incorporating their personal vision into the common vision, achieving what they want and working hard for the organization at the same time. What could be more practical?

Strengths and Weaknesses

The vision then is a pre-requisite for outstanding, breakthrough performance. Getting to the vision is something else.

The problem of course is that good visions do not spring forth full blown from the leader's brow. Visionaries like Walt Disney, Tom Watson and Henry Ford are few and far between. Waiting for that to happen condemns most organizations to toil away without a vision. They can still do a good job, but they will rarely do an outstanding one without a vision.

Organizations rarely spend time considering their vision. It seems to abstract; it might even be a waste of time. "Don't we all know what we're here for?" The answer is usually no, but that is not clear until the discussion begins. Even when the vision is implicit, stating it, discussing it, committing to it out in the open makes it more real, more tangible, more capable of motivating common action. Nevertheless, it rarely appeals to action-oriented managers. They want to get right to the plan.

Examples

The Enron Corporation was a regional gas supplier located in Houston, Texas 10 years ago. It adopted a vision that set it on the path of tremendous growth. They were going to be "the first gas major." In energy industry terms, that meant a fully integrated, international supplier of natural gas. Up to that time, gas was primarily a regional business industry, little national and no international. The gas industry was also divided into exploration companies, production companies, transmission companies and retail companies. Enron wanted to be all of it, and in 10 short years became that.

Now they have a new vision: To be the first *energy* major in the world. To that end, they are acquiring electricity generation and transmission companies so that it can produce, transmit and deliver any form of energy from the field to the home or business. Having succeeded once, they are a better than even bet to do so again.

Ben & Jerry's makes premium ice cream. From the very beginning, Ben and Jerry had a vision of a socially responsible company--a company that took care of its employees, was benign even friendly to the environment and treated its communities like its customers. They pursued that vision with a remarkable blend of creativity and vigor to become one of the largest ice cream manufacturers in the country. They caught the wave of social responsibility in the society at large and rejected the presumed wisdom that you had to be cruel to be successful. Their employees love it; their communities love it; and their customers must also because they are still doing very well.

Southwest Airlines broke all the rules of the airline industry, and, as a result, is the only airline to have an unbroken string of profitability. The vision was a friendly, low cost, on-time airline. What could be simpler? But then why didn't the majors do it?

In the Southwest case, achieving the vision probably deserves more credit than having the vision in the first place. But without a guiding vision, Southwest could have just as easily gotten caught up in the airline bleeding of the 1980s. But they stuck to their game plan--one aircraft type, city pairs that each make money, no extras like reserved seats or food, a rigorous hiring program, quality before growth, and the other innumerable parts of its winning strategy. The vision gives those strategies meaning and motivates people to be successful, even more than the money does. Fact: Southwest pilots and other employees make less than their counterparts at other airlines do! Vision can be a powerful force.

Now, what is our country’s vision for a new social security system?

VIII. Using the Tools

The table on the next page lists each applied futurism tool we described in the last section and indicates the step(s) of the methodology where it is usually applied. For example, the table shows that environmental scanning is primarily used in the first step of the methodology, Assess Current State.

Applied Futurism Tools	Methodology Steps					
	Assess Current State	Project Alternative Future States	Choose Preferable Future State	Develop Plan	Implement Plan	Evaluate Results
Cross-impact Analysis		X		X		
Decision Modeling			X			
Delphi Technique	X	X	X	X	X	X
Environmental Scanning	X					
Futures Wheel		X		X		
Gaming and Simulation		X		X	X	
Genius Forecasting		X				
Relevance Trees	X					
Scenarios		X				
System Dynamics	X	X				
Trend Impact Analysis		X		X		
Visioning			X	X	X	

Table VIII.1
Primary Uses of Applied Futurism Tools

The tools of applied futurism need not be used in isolation. They are often more powerful when used in combination with each other. The table on the following page highlights some of the more potent of these combinations. Of course, you need to understand the tools themselves before this table is meaningful.

To illustrate how the table works, consider the primary tool Systems Dynamics. As you will see in the description of this tool, Systems Dynamics models are used to produce quantitative forecasts and to estimate the sensitivity to changes in the model variables. Expert judgment collection methods such as the *Delphi Technique* and *Genius Forecasting* can be used to obtain estimates of the variables used for sensitivity analysis. *Scenarios* can provide the backdrop for Systems Dynamics and help ensure the internal consistency of assumptions. If a *Cross-Impact Analysis* of anticipated future events were introduced, then the solution could become probabilistic rather than deterministic through the use of Monte Carlo methods. *Trend Impact Analysis* can also be used to forecast variables used in systems dynamics models.

Primary Applied Futurism Tool	Supporting Tool							
	Cross-Impact Analysis	Decision Modelling	Delphi Technique	Genius Forecasting	Relevance Trees	Scenarios	System Dynamics	Trend Impact Analysis
Cross-impact Analysis			J	J		B		
Decision Modeling			J	J				
Delphi Technique				H	H	H	H	T
Genius Forecasting								
Relevance Trees			J	J				
Scenarios	I		J	J			I	I
System Dynamics	E		J	J	H	C		E
Trend Impact Analysis	H		J	J				

Key: B = Background | I = Internal consistency
C = Clarifies assumptions | J = Judgement gathering
E = Event linkage | P = Presents images
F = Forecast exogenous v | T = Time series questions
H = High order impact | X = Sensitivity analysis

Figure VIII.2

Useful Tool Combinations

Appendix A
Glossary

Change agent **--** a component of a system or an exogenous entity the behavior of which results in change in the system of interest.

Closed system **--** a system that is not affected by any peripheral system.

Complex system **--** a system composed of many objects interacting in non-linear ways and exhibiting some degree of feedback.

Current state **--** the condition of the system's attributes at time 0 of a study.

Domain of observation **--** a small subset of peripheral systems that we observe because we think it has the most profound impact on the system of interest.

Event **--** a sudden notable change in an attribute over a short period of time relative to the time horizon.

Future state **--** the condition of the system's attributes at some future time $t > 0$.

Human system -- any system that includes interacting humans as a component.

Open system -- a system that is affected by one or more peripheral systems.

Peripheral system -- any system other than the system of interest that has a potential impact on the future of the system of interest.

Simple system **--** a system composed of relatively few objects interacting in linear ways.

System -- any collection of objects that functions as one unit.

System attributes -- those characteristics of a system that we focus on for study.

System of interest -- a system which is the focus of study.

Time horizon -- the period of time that future states of the system of interest are under consideration.

Trend **--** an incremental change in an attribute over most of the time horizon.

Appendix B
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Oxford, OX2 8DP UK
Phone +44 865 310166
Fax: +44 865 31089

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[Zukunftsforschung]
Publisher: Swiss Society for Futures Research
SZF, Haldenweg 10 A, Muri, Ch-3074,
Switzerland Phone: 031-952-66-55
Fax: 031-952-68-00

Futures Research Quarterly
Publisher: World Future Society
7910 Woodmont Avenue, Suite 450
Bethesda, MD 20814 USA
Phone: (301) 656-8274
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17 New England Executive Park
Burlington, MA 01803 USA
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Bethesda, MD 20814 USA
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205 S. Beverly Drive, Suite 208
Beverly Hills, CA 90212 USA
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Phone: (0865) 79141
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