# RESEARCH-TECHNOLOGY MANAGEMENT

The Industrial Research Institute journal for leaders of technological innovation worldwide January–February 2003



# BETTER FORECASTS, BETTER PLANS, BETTER RESULTS

*Enhance the validity and credibility of your forecasts by structuring them in accordance with the five different ways people view the future.*

John H. Vanston

Overview: *The value that decision makers place on formal forecasts—and the extent to which they act on those forecasts—depends on their conviction that the forecast is supported by* credible *data, treated in a* logical *manner. Structuring forecasts in accordance with the different ways that people view the future can enhance both the validity and credibility of the forecasts. These viewpoints can be classified into five categories: extrapolators, pattern analysts, goal analysts, counterpunchers, and extrapolators. Although there are circumstances under which each of the different ways of viewing the future is most appropriate, the likelihood of a successful forecast is greatly increased when techniques from several of these viewpoints are used in concert.*

Society's long-term ambivalence about projections of future developments is illustrated by the intriguing fact that at the time Greek city states were basing their military strategies on the predictions of the Oracle at Delphi, the Roman Emperor Justinian decreed the death penalty for anyone engaged in forecasting. (Given Rome's subsequent conquest of Greece, it doesn't appear that the entrails-readers provided much help.)

In reality, of course, all important business decisions are based, in large measure, on how decision-makers foresee developments in market demand, competitive threats, new technologies, financial realities, regulatory restrictions, social mores, and a host of other influencing factors.

The key question, therefore, is not whether executives use forecasts, but rather, how they formulate their views of the future and how they act on these views. The value that decision makers place on formal forecasts—and the extent to which they act on these forecasts—depends on their conviction that *credible* data, treated in a *logical* manner, support the forecasts: credible and logical in the mind of the decision-maker, not necessarily in the mind of the forecaster. Therefore, to be useful, a forecast must be both valid—based on solid facts and proven analytical techniques—and credible, meaning convincing to the people making decisions.

The term "valid" instead of "accurate" is used deliberately here. Although all forecasters would prefer that their projections be accurate, actually, the value of a forecast depends not on its specific accuracy but, rather, on the extent to which it contributes to better decision-making. In forecasting, being approximately right is always better than being precisely wrong. In fact, the best forecasts are often never borne out because the decision makers have acted to prevent unfavorable predictions from happening.

Structuring forecasts in accordance with the different ways that people view the future can enhance both the validity and credibility of the forecasts. These views can be classified into five categories:

- Extrapolators.
- Pattern analysts.
- Goal analysts.

*John Vanston is the chairman of Technology Futures, Inc., an Austin, Texas consulting, research and education company that he founded in 1978. Previously, he was a member of the nuclear engineering faculty at the University of Texas at Austin, and a Lt. Col. in the U.S. Army. His special interests include technology forecasting and planning, innovation, and management of technology in uncertain environments. His publications include* Principles for Electric Power Policy, Technology Forecasting: An Aid to Effective Technology Management, Superconductivity: A Practical Guide for Decision Makers, *and* Innovate! Straight Path to Quality, Customer Delight, and Competitive Advantage. *He received a B.S. in general engineering from the U.S. Military Academy, an M.S. in nuclear engineering from Columbia University, and a Ph.D. in nuclear engineering from the University of Texas at Austin.*
**jvanston@tfi.com. http://www.tfi.com.**



0895-6308/03/$5.00 

- Counter-punchers.
- Intuitors.

Each of these views has both strengths and shortcomings that motivate their use under certain circumstances and discourage their use in others. There are specific methods and techniques recognized in the forecasting field that can be associated with each category, and each has its supporters and detractors. Almost everyone feels most comfortable with one or another of these views. Although there are no hard-and-fast rules, it seems that most engineers are basically extrapolators, most pure scientists are primarily pattern analysts, and most marketing people are goal analysts. The majority of executives appear to be intuitors, although, interestingly, many characterize themselves as counter-punchers.

These five approaches, individually and in concert, can provide the foundation for a powerful forecasting program. Following are descriptions of these approaches and some associated techniques, along with illustrations of their usefulness.

**Extrapolators**

Extrapolators believe that the future will represent a logical extension of the past. They believe that large-scale, inexorable forces will drive the future in a continuous, reasonably predictable manner and, therefore, the future can best be forecast by identifying past trends and extrapolating them in a reasoned, logical manner.

Extrapolators normally base their forecasts on straightforward logic that is easily reproducible and that usually provides quantitative results. However, this approach often fails to take into account the fact that changes in driving forces can result in rapid and dramatic changes in trends. For example, the explosion in Internet usage in the 1990s drove the rapid expansion of e-commerce-based businesses. The failure of these businesses to produce the expected profits caused dramatic reversals of this expansion.

*Techniques and Methods*

- *Trend Extrapolation.*—Uses past data to define a pattern of change and extends that pattern to project future developments (*1,* pp. 18–21; *2,* pp. 169–174; *3,* pp. 21–60).
- *Fisher-Pry Substitution Analysis.*—Uses logistic curve formulations to project the pattern and rate of adoption of a superior new technology in a competitive business environment (*2,* pp. 59–60; *4,* pp. 12–16).
- *Gompertz Substitution Analysis.*—Uses exponential curves to project pattern and rate of adoption of a superior new technology in a consumer goods market (*2,* pp. 59–60; *4,* pp. 17–20).

**Extrapolators believe the future will represent a logical extension of the past.**

- *Growth Limit Analysis.*—Projects progress in technology advance when approaching physical, perceptual, utility, or structural limits (*1,* pp. 19–20; *5,* pp. 57–62).
- *Learning Curves.*—A special application of the trend extrapolation technique that projects the rate at which the cost of producing a product decreases as cumulative production increases (*2,* pp. 173–174).

Probably the best-known example of the extrapolator approach is "Moore's Law." First postulated by Gordon Moore in the early 1950s, this "law" projects that the number of transistors that can be placed on a given computer chip will double every 18 months. A constant doubling rate can also be described as "constant percentage" improvement or as "exponential" improvement. For most new technologies, exponential improvement in basic parameters is an important part of the development process. Progress of this type is often best projected by plotting performance parameters versus time on semilog graph paper. This process typically results in a straight line that can easily be extended to project future progress. Figure 1 illustrates the regularity of this progress in transistor technology over a three-decade period. During this period, Intel, as well as many other semiconductor manufacturers, has used extrapolations of this pattern to set R&D goals (*7,8*).

Another example of the use of trend analysis to examine future advances in technology is presented in Figure 2, a record of advances in transmission rates in local area networks (*9*). Similar exponential trends have been observed in many other semiconductor, electronics and communications areas, e.g., increases in speed and processing power of computers, decreases in the size and cost of telephone switching systems, and increases in fiber cable capacity. The regularity of such trends supports credible forecasts in the relevant areas.

Trend extrapolation techniques are also often useful in projecting how rapidly a new technology will be adopted in the marketplace. Although most people view technology forecasting in terms of the leading edge of what is technically possible, in the real world, the ability to project market acceptance is often as, or even more valuable than knowing when new technologies will

emerge. If one understands the dynamics of market takeover, one can make money in both the new and the old technologies. If one doesn't understand these dynamics, he or she can lose money in either technology.

Figure 3 illustrates two forecasts developed for the Telecommunications Technology Forecasting Group (TTFG) to assist local exchange carriers (LECs) in planning for the installation of fiber cable in their "outside plant" networks (*9*). The first forecast was made in 1997 based on data available from 1995. The second forecast was made in 2000 based on data available from 1999. Although the earlier forecast is slightly more optimistic than the later one, both were valuable to the carriers in their planning processes. This example also shows the importance of updating forecasts as more information becomes available.

**Pattern analysts believe the future will replicate past events.**

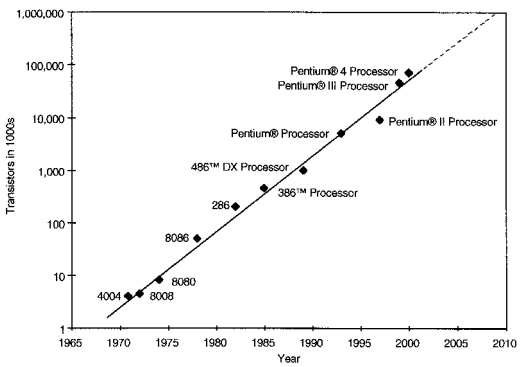


*Figure 1.—This graph of Moore's "law" shows the regularity of improvements in transistors over a three-decade period.*

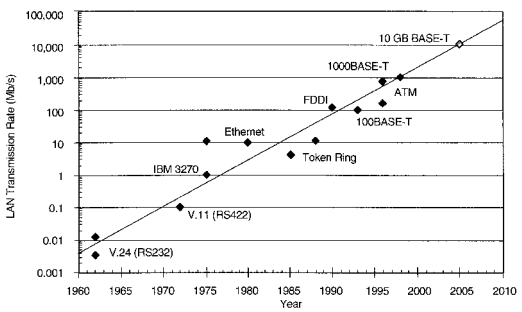


*Figure 2.—This graph displays changes in local area network (LAN) transmission rates over four decades and indicates how the pattern of advance can be used to forecast future rates.*

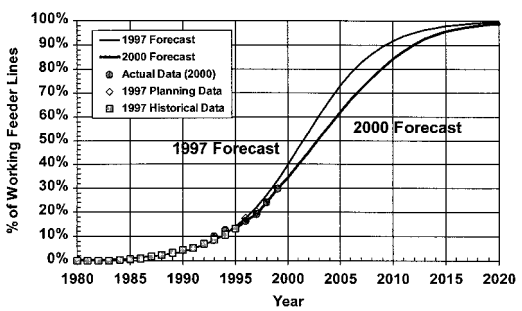


*Figure 3.—Projections, made at two different dates, of the adoption of fiber cable in LEC outside plant networks.*

*Basic Characteristics*

- These techniques are normally valid when the controlling factors are well defined and relatively constant.
- The techniques prove most useful when quantitative projections are required.
- Use of the techniques requires relevant, accurate data.
- The techniques are often useful in defining important questions about possible changes in driving forces.
- These techniques are of limited value when the forces driving change are in flux.

**Pattern Analysts**

Pattern analysts believe that the future will reflect a replication of past events. Powerful feedback mechanisms in our society, together with basic human nature, will cause future trends and events to occur in identifiable cycles and predictable patterns that replicate past experiences. Thus, one can best project the future by identifying and analyzing analogous situations from the past and assessing their applicability to future circumstances.

Pattern analysts take into account the uncanny fact that history often *does* repeat itself. The adoption of color television, for example, closely followed that of black-and-white television and that, in turn, followed the pattern of radio adoption. Thus, one might reasonably forecast the pattern for future adoption of high-definition television by examining the pattern of past adoption of color television. On the other hand, it is quite possible to choose an invalid analogy, and, in any case, future developments never exactly replicate past analogies.

*Techniques and Methods*

• *Analog Analysis.*—Uses one or more analogous situations to project future trends or events (*2,* p. 104; *5,* pp. 39–52).

• *Precursor Trend Analysis.*—Projects future developments in a lagging technology by correlating them with previous developments in a related leading technology. For example, one might project developments in commercial automobiles by correlating them with developments in racing cars (*1,* p. 21; *2,* p. 122; *5,* pp. 39–52).

• *Morphological Analysis.*—Allows envisioning new products and services by first defining the essential functions involved in current products and services and then postulating alternate ways for accomplishing each of these functions and new ways of combining them (*1,* pp. 31–32; *2,* pp. 105–106; *10,* pp. 158–162).

• *Feedback Models.*—Refine forecasts by giving special attention to the effects of one development on other related developments. For example, the increasing adoption of facsimile machines increased their perceived value and thus promoted further adoption (*1,* pp. 40–42; *2,* p. 96; *10,* pp. 228–234).

Figures 4 and 5 illustrate pattern analyst techniques in developing business strategies (*11*). Another example was the 1993 request by the TTFG that Technology Futures, Inc. (TFI) help it develop a forecast for the adoption of high-definition television (HDTV) in the United States. Based on past experience, TFI projected that there would be no serious adoption of HDTV before industry standards had been developed. A review of the then current standards activities indicated that standards would be developed in about two years, i.e., in 1995. Experience in similar technologies indicated that 1% acceptance would occur about five years after standards adoption, i.e., in 2000. Finally, it was projected that further adoption would follow the pattern established by color television. The combination of these pattern analyst assumptions led to the forecast shown in Figure 6 (*4,* p. 25).

*Basic Characteristics*

• These techniques are normally valid only when truly analogous examples exist.

• These techniques are most useful when changes are first becoming manifest and little hard data are available.

• In using these techniques, it is best to use a number of analogies if they are available.

• To have acceptable validity, the driving forces behind both the new and the analogous development must be reasonably well understood.

• Problems with these techniques often arise when the dissimilarities between the new and old examples are not clearly recognized.

## Goal Analysts

Goal analysts believe that the future will be determined by the beliefs and actions of a collection of individuals, organizations and institutions. The future will represent the overall aggregate of these many impacting forces. Thus, the future can best be projected by examining the stated and implied goals of various decision-makers and trendsetters, determining the extent to which each can affect future trends and events, and assessing the long-term results of their actions. Goal analysts recognize that neither technical nor non-technical advances take place in a vacuum and understand the impact of strongly held beliefs and opinions in real-world situations. However, while evaluating the role of various stakeholders, there is the danger of overlooking the inexorable forces that will

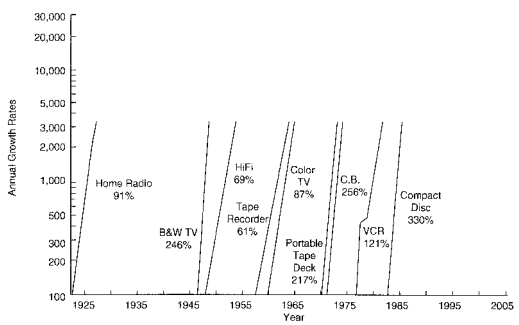


*Figure 4.—Growth in annual sales of a number of consumer electronics products during the early phases of their commercial adoption. Obviously, in all cases, the early adoption rates were quite impressive.*

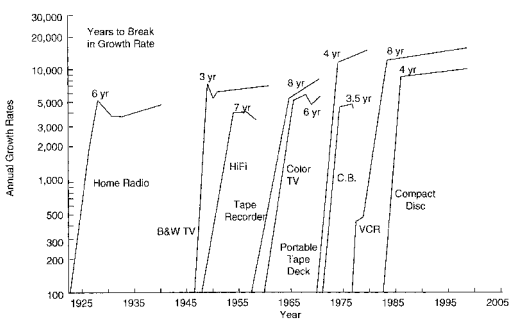


*Figure 5.—In each case, sales growth decreased dramatically after the initial rapid growth period. A perceptive forecaster would, of course, take note of these adoption patterns when projecting sales growth for any analogous consumer electronics product.*

drive change, regardless of the actions of any individual or organization or combination thereof.

*Techniques and Methods*

• *Impact Analysis.*—A technique for uncovering and analyzing the non-obvious, often overlooked, impacts and implications of various trends, events or decisions. It involves the initial identification of immediate, direct impacts and implications, followed by identification of secondary, tertiary, and higher-order impacts (*1,* pp. 29–31; *2,* pp. 303–323; *12*).

• *Content Analysis.*—Identifies emerging trends by collecting, correlating and analyzing information contained in newspapers, magazines, trade journals, etc. The underlying concept is that the amount of information about a trend included in the selected publications reflects the probability and importance of that trend (*13*).

• *Stakeholder Analysis.*—Evaluates the impact that various stakeholders may have on the development of a particular trend or event. Its use involves identifying individuals and organizations that might be impacted by a trend, event or decision. Then, the nature and extent of their influence on the subject is evaluated, and the actions that might be taken to minimize opposition and take advantage of supporters are considered (*14*).

• *Patent Analysis.*—Identifies and evaluates potential business opportunities by examining the number, type and pattern of patents approved and rejected over a selected period of time (*2,* p. 301).

Examples of the impact, positive and negative, of determined individuals and groups abound, including:

• Research on stem cells for medical use has been markedly restricted by anticloning groups.

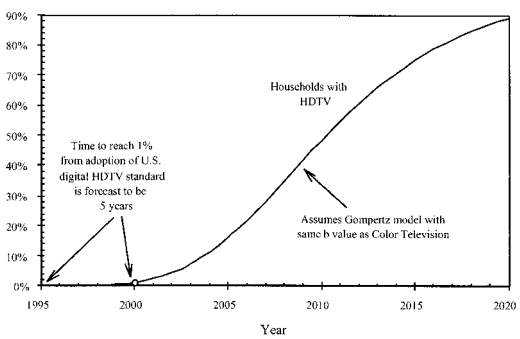


*Figure 6.—This graph projects the percentage of U.S. households currently owning television sets that would own HDTV sets in the years indicated. It has been recently estimated that between 1% and 2% of U.S. households now own such sets.*

**Goal analysts believe actions and beliefs will determine the future.**

• Research on biological processes has been accelerated because of the recent anthrax scare.

• Research on quantum computers has been accelerated because of the need of government intelligence agencies for greater data security.

• Adoption of HDTV is being accelerated by government regulations requiring all TV sets to be HDTV-compatible by 2008.

• Research on missile defense has been accelerated by perceived threats of nuclear attack (and the potential for profits in the defense industry).

Often, forecasts of future developments can be based on perceptions of human behavior, rather than on the actions of particular individuals and organizations. For example, in 1987, TFI projected that wireless communications would be a major competitor with wired communications in the United States by the late 1990s. This forecast was based on the belief that the country's obsession with mobility would significantly drive research, commitment and investment in the technology. In 1988, there were fewer than a million wireless subscribers in the United States, and the common wisdom was that the expensiveness of wireless communications would relegate it permanently to a role complementary to the wired network. By 2000, there were more than 100 million wireless subscribers and, in many cases, these subscribers had dropped their wireline services altogether (*15,16,17*).

In any forecast utilizing the goal analyst approach, the impacts of many different groups must be considered. For example, in a recent forecast of the development of communications platforms located in the stratosphere over cities, more than 100 stakeholders were identified, including:

• Federal Aviation Administration,

• Air Transportation Safety Board,

• Department of Air Force,

• airport authorities,

• airlines,

- airline unions,
- Chambers of Commerce,
- aviation equipment manufacturers,
- competitive communications suppliers,
- and air passenger associations.

Because the successful development of the technology would be impacted in different ways and to different degrees by each of these groups, a method for analyzing the impacts was necessary. The method employed was a stakeholder analysis, in which the impacting organizations and individuals were identified, and the nature and importance of their impacts were defined and recorded. To simplify the simultaneous analysis of all of the impacts, a Stakeholder Perception Map, similar to the one shown in Figure 7, was formulated. This map assisted in both the selection of the particular platform to be developed and a forecast of the time required to develop the platform and establish a profitable business. One result of this analysis, for example, was the elimination of one candidate technology (a tethered airship), because of widespread opposition.

*Basic Characteristics*

- These techniques are particularly useful when exogenous factors may be significant.
- These techniques may be of real value when there is a strong possibility that key stakeholders might otherwise be overlooked.
- The logic of some stakeholders, particularly those opposed to the matter under consideration, may not be apparent to those supporting the matter.

**Counter-punchers believe the future will result from unpredictable events and actions.**

- The passion of opponents will seldom be overcome by the greater passion of proponents.
- The value of these techniques may be limited when the stakeholders are not easily defined.

**Counter-punchers**

Counter-punchers believe that the future will result from a series of events and actions that are essentially unpredictable and, to a large extent, random. Therefore, one can best deal with the future by identifying a wide range of possible trends and events, carefully monitoring developments in the technical and social environments, and maintaining a high degree of flexibility in the planning process.

Counter-punchers take into account the complex, interactive nature of our society and the fact that the results of events and decisions are often quite different from those intended or expected. A counter-puncher mentality, it should be noted, may minimize the value of planning that is based on best judgments supported by valid forecasts.

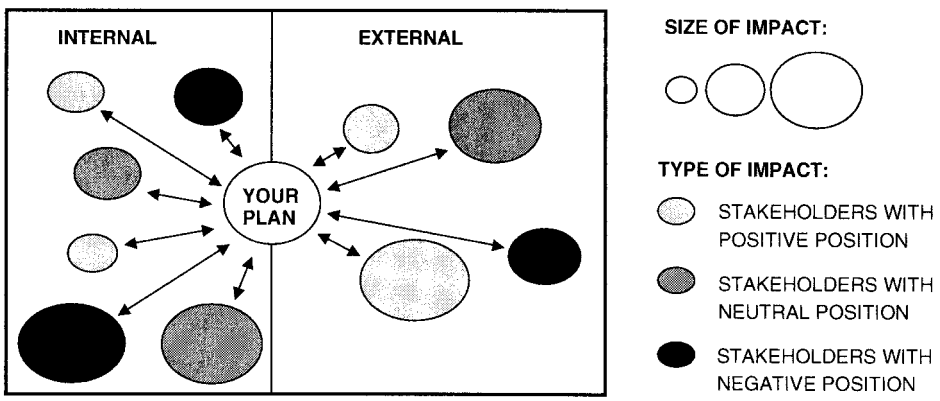


*Figure 7.—Stakeholder perception map presents a graphical representation of the results of a Stakeholder Analysis, and gives a comprehensive and easily understood overview of the nature, extent and importance of both support for and opposition to the issue in question.*

*Techniques and Methods*

• *Scanning, Monitoring and Tracking.*—Includes various techniques for identifying, at an early time, emerging trends and events of importance to an organization. All of these techniques involve the identification, evaluation, analysis, archiving, and dissemination of information. They vary in purpose, focus and utilization (*1,* pp. 13–17; *2,* pp. 93–94, 132–133, 298–299; *10,* pp. 198–201).

• *Alternate Scenarios.*—Develop descriptions of different, feasible business environments in which an organization might be forced to operate. The technique can add rigor and flexibility to the planning process (*1,* pp. 38–40; *2,* pp. 93–94, 132–133, 298–299; *10,* pp. 156–167).

• *Cross-Impact Analysis.*—Permits accounting formally for the interactive impacts that selected trends and events may have on other related trends and events (*1,* pp. 36–38; *2,* pp. 223–241; *10,* pp. 298–300).

In a study for the National Science Foundation, TFI was asked to define the role that the federal government should play in ensuring an adequate supply of electric power in the United States. The most effective policy would, of course, depend on a number of factors (e.g., population, gross national product, international agreements, pollution levels), none of which could be predicted with assurance. Therefore, it was decided to define a series of feasible futures that would essentially bound the range of possibilities, and to develop policy recommendations that would reasonably address any of these possible futures. Six possible scenarios were developed, representing, respectively, a Surprise-Free Future, an Expanded Economy Future, an Economic Malaise Future, a High-Technology Future, a Post-Industrial Future, and a Nuclear Resurgent Future (Figure 8). Appropriate federal policies for each of these scenarios were defined, as well as an overall set of policies that took all of the scenarios into account (*18,* pp. 21–52).

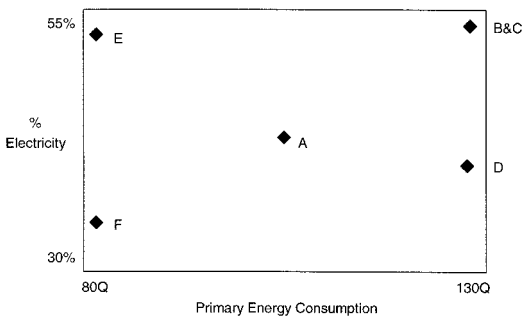


*Figure 8.—Projected total energy usage and the fraction of energy represented by electricity in 2010. Point A represents the* Surprise Free Future; *B, the* Nuclear Resurgence Future; *C,* the High Technology Future; *D,* the Expanded Economy Future; *E,* the Post-Industrial Future; *and F,* the Economic Malaise Future. *One Q represents one quadrillion BTUs of energy.*

**Intuitors see the future shaped by inexorable forces, random events and actions of individuals and institutions.**

The first major conclusion derived from this analysis was that a significant increase in R&D could best provide the flexibility required to plan for the multitude of possible futures. The second was that, given the uncertainty of power needs, having an excess power capacity was more preferable than having a shortage. However, it was believed unreasonable to expect electric utilities to bear the full risk of overbuilding; rather, various elements of the society must share the risk. Recent developments in California reflect the validity of these conclusions.

*Basic Characteristics*

• These techniques are most useful in volatile environments.

• They require continuous updating to be useful.

• To be effective, mechanisms must be in place that allow quick response to situational changes.

• The value of these techniques is limited when changes are driven primarily by established long-term trends.

**Intuitors**

Intuitors are convinced that the future will be shaped by a complex mixture of inexorable driving forces, random events, and the actions of key individuals and institutions. Because of the complexity and interactivity of modern society, no rational technique can be used to forecast the future; the best method is to gather as much information as possible, and then depend on personal intuition (i.e., our subconscious information processing

capabilities) to provide meaningful speculations and insights.

Intuitors take advantage of the marvelous, not-well-understood capability of our brains to integrate vast amounts of information and varied experiences into a synthesized whole. Experiments have shown that certain individuals have extremely reliable intuition and can use it to select innovative options that appear almost magical to others. However, excessive dependence on intuition may result in failure to take into account important, relevant information.

*Techniques and Methods*

• *Delphi Surveys.*—Utilize multiple-round, anonymous input from a panel of subject matter experts to elicit rational projections, promote dialectic interchange, and reach approximate consensus (*1,* pp. 25–26; *2,* pp. 214–217; *10,* pp. 41–46; *19,* pp. 116–133).

• *Nominal Group Analysis.*—A group expert opinion technique that causes participants to use their skills in originating new ideas, evaluating the ideas of others, intelligently addressing differences in opinion, and rating a series of ideas according to agreed-upon criteria. This technique promotes active participation by all members of the group (*1,* pp. 27–28; *2,* pp. 209–212).

• *Structured and Unstructured Interviews.*—A series of techniques involving personal interactions between a person gathering information and a group of people with expertise in a particular subject area. In structured interviews, the questions to be asked and the manner in which they are to be addressed are formulated before the interviews to ensure consistency and minimize bias. Unstructured interviews are more informal than structured ones, and the person conducting the interview normally allows the experts to fashion the interviews according to their own personalities and interests (*1,* pp. 26–27; *2,* pp. 89–92).

In a recent study of how an effective knowledge management (KM) program could be established at a federal government agency, a nominal group analysis was conducted with 16 KM experts from various federal agencies, commercial organizations, consulting groups, service providers, and academic institutions. The group identified 126 actions the agency could take to promote such a program. After discussing each suggested action, the group rated them in terms of long-term impact, ease of application, and time required for successful implementation. Based on this analysis, the agency made major modifications in its KM program, including setting up a formal KM implementation team (*20*).

*Basic Characteristics*

• The techniques are most useful when the overall situation is poorly defined.

• They often prove useful in identifying emerging changes in driving forces.

• They are quite effective in uncovering imaginative concepts.

• Selecting and engaging qualified experts often presents a major challenge when using these techniques.

• Intuitor techniques are normally of limited value when quantitative rigor is required.

**Use of Multiple Techniques**

As indicated, situations occur in which each of the different ways of viewing the future is most appropriate, and both individual forecasters and individual decision-makers are typically more comfortable with some of the approaches than with others. However, the real challenge is not to determine which of these approaches is the "right" one, or even which is best; the challenge is to use these different approaches in concert to develop sound, credible, comprehensive forecasts.

Research indicates that there are two primary reasons why forecasts fail:

• Reliance on outdated, irrelevant, or inaccurate data.

• Use of an inappropriate forecasting model (*21*).

As an example of an inappropriate model, consider two approaches that were used to examine and forecast highway traffic safety in the United States in the mid-1990s. Figure 9 presents the results of a study conducted by Ralph Lenz, one of the pioneers of the technology forecasting discipline (*22*). This graph shows the continuing dramatic decrease in the number of automobile deaths over a period of almost eight decades.

Figure 10 presents the results of a similar study conducted by Caesar Marchetti of the Institute of Applied Systems Analysis. This study indicates that, for the same period, the number of deaths per 10,000 registered drivers remained about the same, i.e., 23. From these data, it appears that there is some sort of societal homeostasis process in place, whereby if the number of deaths exceeds an acceptable level, processes such as the establishment of the Mothers Against Drunk Driving arise to decrease the death rate. On the other hand, if the number of deaths falls below the apparently acceptable level, actions are taken, such as raising speed limits, that restore the balance.

Plainly, the Lenz study indicates that automobile safety in the United States consistently improved over an 80-year period and that, in all likelihood, this improvement will continue. Conversely, the second study indicates that safety remained essentially constant for the same period and will likely remain so for the foreseeable future. Which analysis is correct? Obviously, both—each addresses a different issue. The decrease of deaths

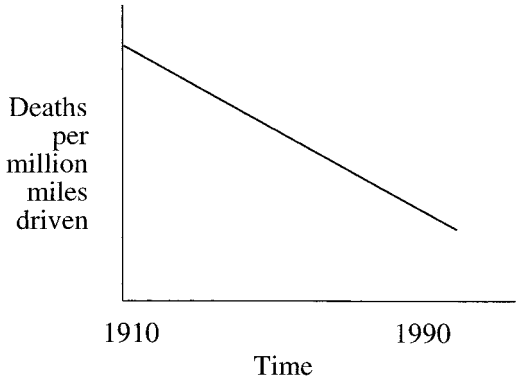


*Figure 9.—How the number of people killed in automobile accidents for each million miles driven has changed over an 85-year period.*

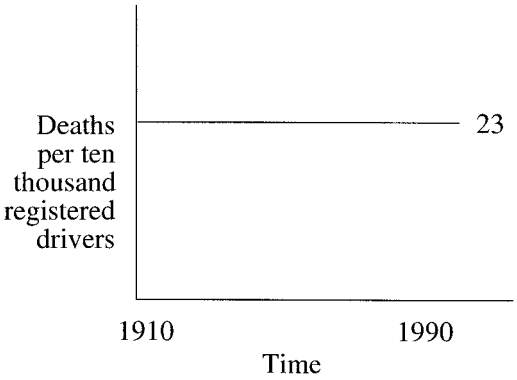


*Figure 10.—How the number of people killed in automobile accidents for each 10,000 registered drivers has changed over an 85-year period.*

per mile driven is offset by the fact the Americans are now driving more miles. The point is that a forecast based solely on either model could be subject to misinterpretation.

One approach to minimizing reliance on an inappropriate model is to use a series of methods when making the forecast. The likelihood of a successful forecast is greatly increased when at least one technique from each of the five viewpoints is used. If the results from each of the techniques are essentially the same, one can feel reasonably comfortable with the result. If, on the other hand, the results are significantly different, the reasons for these differences should be analyzed. This multi-method process will not only result in more valid forecasts, but will also contribute to the acceptance of the forecast by decision-makers because there will be at least one method to which each one will relate and, therefore, accept.

An understanding of the multi-model strategy can also assist in the organization of forecasting groups, either permanent or ad hoc. To ensure that all approaches are considered, the group should ideally include a mixture of different forecasting types. Although most individuals evidence elements of each of the five approaches in their forecasting activities, almost everyone leans naturally toward one or two approaches over the others. Selecting a mixture of forecasting types minimizes the possibility of neglecting one or more of the listed viewpoints.

A final application of the multiple-model strategy involves the individual. In order to make more valid forecasts, people must recognize their natural propensities and force themselves to consider situations from all of the various viewpoints. If a person is a natural extrapolator, for example, he/she should force him/herself to consider how a pattern analyst, goal analyst, counter-puncher, and intuitor would look at the situation. This self-discipline will minimize the probability of being trapped by an overly restricted viewpoint. We are all, of necessity, prisoners of our own pasts.

## X Corp's Options

A few years ago, our company was asked by the planning committee of a medium-sized chemical company (X Corp) to assist them in addressing a major strategic challenge (*23*). A major market of the company was in bulk plastic material, and this market was being threatened by a new process utilizing an advanced catalyst developed by a much larger chemical company (Y Corp). This new catalyst would allow production of a superior plastic at a lower cost. The larger company was willing to license the use of the new catalyst to X Corp, but only

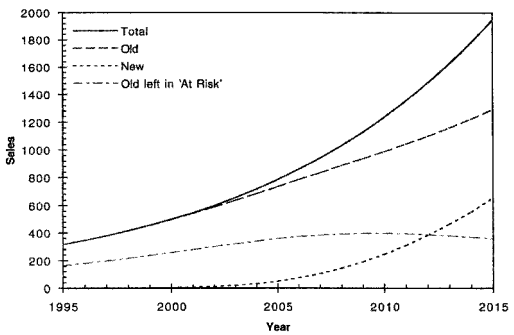


*Figure 11.—How demand for various types of plastics will develop over time in the industrial liners market sector. One line shows the total market for plastics in the segment, one shows the market for the old plastics, one for the new plastic, and one shows how the potential sales of the X Corp in old plastics would be impacted by the emergence of the new plastic.*

under conditions that were both expensive and very restrictive. X Corp, therefore, was faced with the following options:

- License the catalyst in spite of the cost and restrictions.
- Postpone licensing with the expectation that costs and restrictions will eventually be eased (this option would probably result in loss of profits and market position).
- Develop a comparable catalyst independently.

It was apparent that the most desirable option would depend, in large measure, on future markets for the new plastic, as well as the rate of technical advance in the area. We determined that future market demand could best be projected by use of either Fisher-Pry or Gompertz substitution analysis (*extrapolator model*). However, since substitution of the new plastic was just beginning, there were no data available for conducting this analysis. Therefore, it was decided to use data from a similar past substitution process, i.e., the substitution of low-density plastics for high-density plastics (*pattern analysis model*). This analysis not only demonstrated that the use of the Gompertz approach was more appropriate than the Fisher-Pry approach, but also provided parameters that allowed projecting how rapidly the new plastics would replace those currently being used.

The next steps were to define the individual segments of the total market, to determine how vulnerable each market was to substitution, and to project how rapidly the new plastics would take over each market segment. The segment definition was accomplished by personal interviews, and the market vulnerability was determined by a Delphi survey using X Corp and supplier personnel (both *intuitor model* techniques).

In utilizing Gompertz analysis, it is necessary to determine a starting point of substitution (normally when

| Event | Probability | Impact | Timing | Overall |
|---|---|---|---|---|
| 1. MPE producers form alliances with other resin producers. | 9.14 | 6.14<br>Range of Impact (+3 — +8) [Consistant-1&6] | 8.29 | 7.77 |
| 2. MPE overcomes processability problems in commodity LLDPE market. | 8.14 | 8.00<br>Range of Impact (+3 — +10) [Consistant-2] | 5.00 | 7.46 |
| 3. MPE suppliers adopt end-use patents restrictions that reduce market growth of MPE. | 8.14 | 6.29<br>Range of Impact (-10 — +8)[1+,6-] [Consistant-14] | 7.57 | 7.29 |
| 4. Metallocene producers adopt strategies for rapid recovery of metallocene R&D costs by maintaining high licensing costs, tight enforcement of restrictions, and other aggressive practices. | 6.43 | 6.86<br>Range of Impact (-10— +10)[1+,6-] [Consistant-8] | 7.86 | 6.89 |
| 5. MPE creates new non-PE market opportunities. | 9.57 | 4.29<br>Range of Impact (0 — +10) [Consistant-10] | 6.71 | 6.89 |
| 6. One large competitor announces a major new plant dedicated to metallocene technology with an initial capacity share of 3+% in same market segment in which X Corp participates. | 8.43 | 5.71<br>Range of Impact (+2 — +10) [Consistant-15] | 5.86 | 6.83 |

*Figure 12.—Partial results of an analysis of the impact of various events and actions on a group of forecasts.*

1% of the total market has been captured), as well as a basis for projecting the rate of substitution. Two chemical industry data sources were used to determine when adoption of the new plastic had or would reach 1% in each market segment. These data were based on manufacturers' plans for how much plastic of each type they would use in the coming year.

Based on this starting point input, the rate parameters previously determined, and projections of total plastic use in each market segment, forecasts were made of demand for both old and new plastics. Figure 11 shows the results of one set of forecasts: for old and new plastic usage for industrial liners.

Obviously, the total market for each type of plastic would be the sum of the individual segment markets.

It was apparent that the resulting forecasts might be impacted by exogenous events, such as actions by competitors, suppliers and customers, changes in the market environment, and a host of other factors. Therefore, it was decided to test the forecast against possible impacting factors. To accomplish this test, a group of X Corp and non-X Corp people were asked to list events and actions that might affect the forecast, to estimate the probability of these events or actions occurring, and the potential impact of these events and actions, and the time period in which they were most likely to occur (*goal analysis model*). Figure 12 shows a portion of the results of this activity. These results were used to review, and where appropriate, modify the basic forecast. This activity identified and evaluated 17 important impacting events and actions. Of these, 14 indicated that acceptance of the new plastics would occur sooner than projected and three later than projected. This result strongly suggested that adoption of the new catalyst would occur sooner than originally forecast, and appropriate adjustments were made.

The overall analysis of the various forecasts indicated that if X Corp did not utilize the new catalyst, it would be able to maintain its current sales in the old plastic.

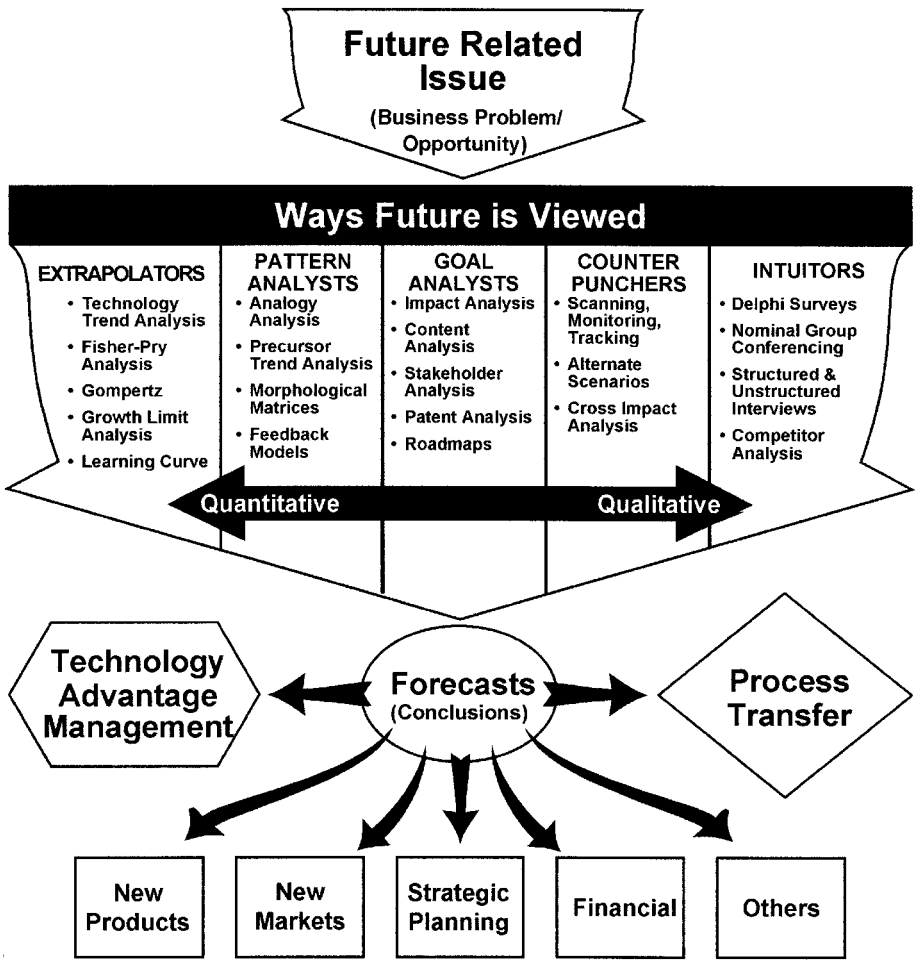


*Figure 13.—By understanding the five different ways of viewing the future, one can develop more valid forecasts which, in turn, can contribute to successful accomplishment of many basic business operations.*

However, all industry growth would be in the new plastic. This was not acceptable to X Corp, which, as a result of this forecast, began an aggressive search for a partner with whom to share research costs (*counter-puncher model*). Indeed, X Corp found a European company with experience in the area that was interested in cooperating to develop a comparable catalyst.

**Practical Application**

The principal concepts of this article are shown graphically in Figure 13. When an organization is presented with a business problem or opportunity that requires valid forecasts, the first requirement is a clear, comprehensive definition of the objectives of the forecast, i.e., a determination of how the forecast will address the issue at hand. Next, a plan must be developed for the conduct of the forecast. Items that should be included in the plan include:

- Schedule.
- Scope.
- Approach.
- Resources.
- Project organization.
- Techniques to be employed.
- Evaluation criteria.

In selecting the techniques to be used, at least one technique should be selected from at least two of the views shown in the diagram. In general, the validity of the forecast will depend in large measure on the breadth of techniques used. For a given level of effort, it is almost always better to spread time and resources over a mixture of techniques, rather than concentrating on one or two.

After the integrated forecast has been completed, it can be used as input to strategic planning, for the development of new products or new markets for old products, for financial analysis, or for other practical uses. Using this approach, the five different views of the future can be utilized to develop valid forecasts and contribute to the successful operation of an organization.

If the Greeks had depended on these multi-method forecasting procedures instead of chicken entrails, perhaps Athens and not Rome would have become the Eternal City, and we might all now be advising each other, "When in Athens, do as the Athenians do."

**In general, validity of the forecast will depend on the breadth of techniques used.**


**References and Notes**

**1.** Vanston, John H. *Technology Forecasting: An Aid to Effective Technology Management.* Austin, TX: Technology Futures, Inc., 1988.
**2.** Porter, Alan L., Roper, A. Thomas, Mason, Thomas W., Rossini, Frederick A., and Banks, Jerry. *Forecasting and Management of Technology.* New York: Wiley Interscience, 1991.
**3.** Lenz, Ralph L., Jr. "Elements of Technological Forecasting by Trend Extrapolation." In *Technology Forecasting,* J. R. Bright and M. E. F. Schoeman, Eds. Canoga Park, CA: XYZYX Information Corporation, 1970.
**4.** Vanston, Lawrence K. and Vanston, John H. *Introduction to Technology Market Forecasting.* Austin, TX: Technology Futures, Inc., 1996.
**5.** Martino, Joseph P. *Technology Forecasting for Decision Makers. 2nd Ed.,* New York: North Holland, 1983.
**6.** "Scientific American Interview with Gordon Moore." *Scientific American,* September 1997. Although most authors state the law as a doubling every 18 months, Moore, himself, has stated that he has never used that figure. His first mention of the "law" was in a 1965 article in *Electronics* magazine in which he postulated a doubling time of one year. In 1975, he revised his projected time to two years and, in 1997, he stated that he still believed that two years was the proper doubling factor.
**7.** Moore, Gordon. Personal conversation with the author, Intel Headquarters, 1979. Figure 1 is an updated version of a handwritten graph by Gordon Moore provided to the author in 1979.
**8.** Stix, Gary. "Getting More from Moore's." *Scientific American,* April 2001, pp. 32–36.
**9.** Vanston, Lawrence K. *The Impacts of Competition and Technology on Local Exchange Outside Plant Assets.* Austin, TX: Technology Futures, Inc., 2001.
**10.** Bright, James R. *Practical Technology Forecasting.* Austin, TX: Technology Futures, Inc., 1978.
**11.** Lenz, Ralph L. "Technology Trend Analysis." Presentation developed for *Technology Forecasting Workshops* conducted 1978–1992.
**12.** The *impact wheel* concept was originated by Joel Barker of Infinity, Ltd.
**13.** Kroppendorf, Klaus. *Content Analysis: An Introduction to Its Methodology,* Thousand Oaks, CA: Sage Publications, 1981.
**14.** Stevensen, Ann. *The Stakeholder Strategy: Profiting from Collaborative Business Relationships.* San Francisco: Berrett-Koehler, 1998.
**15.** Ghosh, Shubho. "Wireless Telephony." In *Communications Technology Update. 7th Edition,* A. E. Grant and J. H. Meadows, Eds. Boston: Focal Press, 2000.
**16.** Lenz, Ralph L. *A Critical Examination of the Future Utilization and Application of Cellular Technology in Telecommunications.* Austin, TX: Technology Futures, Inc., 1988.
**17.** Lenz, Ralph L. *Wireless Telephony Market Update: A Quantitative Projection of U.S. Markets.* Austin, TX: Technology Futures, Inc., 1991.
**18.** Vanston, John H. and Frederick, David O. *Principles for Electric Power Policy.* Westport, CT: Quorum Books, 1984.
**19.** Olaf, Helmer. "Analysis of the Future: The Delphi Method." In *Technology Forecasting for Industry and Government.* James R. Bright, Ed., Englewood Cliffs, NJ: Prentice-Hall, 1968.
**20.** Vanston, John H. *Knowledge Management.* White Paper. Austin, TX: Technology Futures, Inc., 2000.
**21.** Ayers, Robert U. *On Technology Forecasting.* Harmon-on-Hudson, NY: Hudson Institute, 1966.
**22.** Lenz, Ralph L. Graph prepared for *Technology Forecasting Workshop* conducted by Technology Futures, Inc., 1993.
**23.** Vanston, John H. *Winning by Coming in Second.* White Paper. Austin, TX: Technology Futures, Inc., 1998. Available online: *http://www.tfi.com*