Chapter 11 - TM-Functions - Planning and Forecasting

Course Contents: TM-Functions - Planning and Forecasting: Nature of Planning, The Foundation For Planning, Planning Concepts, Forecasting, Strategies For Managing Technology.

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Introduction

The capacity of implementing technological change rapidly is becoming an ever more crucial condition for the successful operation of a business. Sophisticated technology management structures have long ceased to be a luxury. For this purpose it is necessary to build, nurture and protect technology skills and complement them with management skills. Technology intelligence, technology strategy, technology know-how, technology planning and technology assessment systems must be implemented and reinforced with appropriate processes and structures to establish an efficient technology management. But, the challenge for companies is to find the most promising solutions to crucial problems:

- Which technologies are relevant for the company?
- Which technological developments could and should companies try to accelerate?
- How important are the technologies which are already applied?
- Which technologies will the company require to manufacture its product range of the future?
- How can companies use their technologies more efficiently?

Technology Planning & Forecasting address such questions and provide a feasible solution. In fact, the purpose of any type of forecasting and the proper role of the forecaster is to assist the

contemporary decision-makers in the choosing of policies and making of plans that are most promising. Technological forecasting provides information about the direction and rate of technological changes. It uses logical processes to generate explicit information to help industry and government anticipate practical, ecological, political, and social consequences of developments in technology. There are four elements in a technological forecast (Martino, 1983):

1. A time horizon.
2. A specific technology.
3. Some parameters to the technology.
4. A probability statement about the outcome.

In the context of Business Firms:

- Establishing technical parameters and performance standards for new products and processes.
- Augmenting new product development efforts as well as improvement of existing products.
- Enabling better timing for new technology introduction and facilitate 'take-to-market' strategy formulation.
- Aiding prioritization of research programmes and identification of techno-scientific skills required for the same.
- Identifying major opportunities and challenges in technological environment and offering guidance for technological planning.

In the National Context:

- Developing technological competencies so as to meet global competition and international trading imperatives.
- Planning for creation of sustainable comparative advantages in select technological thrust areas.
- Planning for the well-being of citizens with the aid of technological innovations.

One of the main aspects of Technology Forecasting is its communication aspect. Technology Forecasting (TF) initiates and fosters the communication between various communities such as:

- Science and science (inter-disciplinary fields)
- Science and Technology
- Industry and politics
- Technology and public administration
- Technology and the general public.

Technology forecasts can be a short, medium or a long-term exercise. Short term forecasts are of usually a year or less, might typically deal with a single technology. Medium-term forecasts might cover a 2-10 year period. Long-term forecasts cover 10-20 years - a time horizon long enough for totally new technologies to emerge. Longer the time frame, tougher it is to predict what is in stock for the future pertaining to technology changes. Sometimes, forecasts misfire because of a fascination of ones own technology and also due to the enthusiasm it generates among market analysts and magazine writers. A classic example is the bold forecast that NASA

made regarding the huge sun-reflecting satellites to illuminate night-shrouded areas of the earth which they predicted would be possible by the mid-1970s. Such forecasts with faulty timelines can be totally worthless to corporate planners, and worse they can turn into money pits. This brings into focus the need for employing accurate technology forecasting methods. The most appropriate choice of forecasting method depends on:

- What is being attempted to forecast
- Rate of technological and market change
- Availability and accuracy of information
- The planning horizon
- The resources available for forecasting.

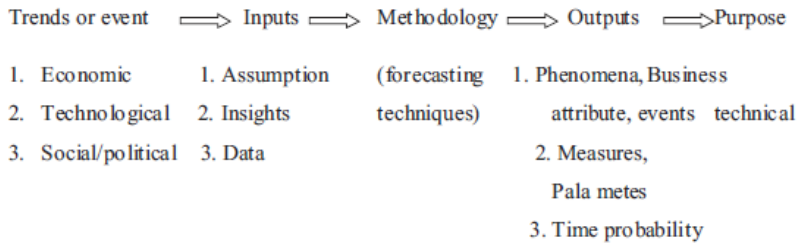
Technology forecasting

According to Stanton Technological forecasting is "the process of predicting the future characteristics and timing of technology. When a possible, the prediction will be quantified, made through a specific logic and will estimate the timing and degree of change in technological parameters, attributes and capabilities".

Before discussing the technology forecasting let us discuss an important model very useful for forecasting is scurve of technological progress. The time invention period is characterized by a period of slow initial growth. This is the time when experimentation and initial bugs are worked out of the system. The technology improvement period is characterized by rapid and sustained growth. The mature – technology period stats when the upper limit of the technology is approached and progress in performance slow down. This is when technology reaches its natural limits as dictated by factory such as physical limits.

This model of s-curve is also known as the technology life cycle helps to know about the life stage of the technology

Forecasting process:-



Classification of Forecasting Techniques

Forecasting Techniques are mainly classified into two types

1. Numeric data-based Technological forecasting Techniques
2. Judgment Based

Numeric Data based Technological Forecasting Techniques

Numeric data based forecasting extrapolates humbly by generating statistical fits to historical data.

Trend Extrapolation

To extrapolate is to in per the future feature from post. It can be distinguish between four approaches with the use of trend extrapolation.

1. ***Statistical Curve fitting:*** This method is applicable to forecasting functional capabilities. Statistical procedures fit the post data to one or more mathematical functions such the past data to one or more mathematical functions such as linear, logarithmic, Fourier or exponential.
2. ***Limit Analysis:*** Ultimately, all growth is limited and there is an absolute limit to progress, either recognized or unrecognized sooner or later, projects must reflect the fact that improvements may get close to this limit but cannot exceed it.
3. ***Trend Correlation***: At, times one technology is a precursor to another. This is frequently the case when advances made in the pre-cursor technology can be adopted by follower technology. When such relationships exist, knowledge of change in the precursor technology can be used to predict the course of the follower technology, as far in future as the lag time between the two.

4. ***Multi Trend Correlation*****:** Occasionally, a follower technology is dependent on several precursor technology rather than on a single precursor. In such cases, the follower is usually a composite or aggregate of several pre cursors. Fitted combinations of the precursors may act to produce change in the follower, but more often the combinations are not fixed and the precursor inputs vary in both combinations strength.

Judgment Based Technological Forecasting Techniques

Judgmental forecasting may also be based on projections of the past, but information sources in such models rely on the subjective judgments of experts.

1. ***Monitoring:*** Monitoring is the process of scanning the environment for information about the subject of a forecast. It is not really a forecasting technique, but rather a method for gathering and organizing information. The sources of information are identified and then information is gatherer, filtered and structured for use in forecasting.
2. ***Delphi Method:*** The bask known of the various judgment approaches to technological forecasting, the Delphi Method uses a panel of individuals who make anonymous, subjective judgments about the probable time when a specific technological capabilities will be available. The results of these estimates are aggregated by a process administrator and feed back to the group, which then uses the feedback to generate another round of judgments.
3. ***Scenarios:*** Scenarios are sets of snapshots of some aspects of the future and / or future histories leading from the present to the future. The scenario set encompasses the plausible range of possibilities for some aspect of the future.

Technology planning

Technology planning is the process of planning the technical evolution of a program or system to achieve its future vision or end-state. Technology planning may include desired sponsor outcomes, technology forecasting and schedule projections, technology maturation requirements and planning, and technology insertion points. The goal is a defined technical end-state enabled by technology insertion over time. Note that sometimes this is referred to as "strategic technical planning" (STP) applied at a program level, although the preferred use of the STP term is at the enterprise or portfolio level [1]. Followings are the key steps of technology planning:

- Forecast the technology
- Internally owned and external technologies
- Analyze and forecast the environment
- Focus on analysis of opportunities and threats
- Analyze and forecast the market/user

Technology planning is a central component of corporate business planning. It is needed both at the corporate level and at the strategic business unit level. An effective technology planning should be:

- Strategic instead of ad-hoc
- Well integrated into organization and its users
- Active instead of reactive
- Create a robust technology infrastructure
- Can still be opportunistic: Take best advantage of opportunities.

There are three important components of Technology planning:

1. People: Assemble a team who will be involved in planning.
2. Process: Devise a planning process.
3. Plan: Provide a planning process framework and Initiate a working-document technology plan.

Once you've built your team and explored your goals and the potential for using technology in your tech strategy, you are ready to start looking at the nuts and bolts of technology management. While technologies can change quickly, your strategies are likely to remain much more constant. Your plan will need to be agile in addressing the implementation of new technologies, and yet built on the solid foundations of your strategy. You can't have any success without devising a good planning process. Adaptable and flexible planning process is the key to a successful technology management. A technology plan provides the guidance to evolve and mature relevant technologies to address future mission needs, communicate vital information to stakeholders, provide the technical portion of the overall program plan (cost and schedule), and gain strong executive support. It should be a basis for an ongoing technology dialog between the sponsor and systems developers. Don't gamble that your plan will be implemented exactly in on time and on budget: build in some cushion.

Key Components of a Technology Plan

A technology plan provides the guidance to evolve and mature relevant technologies to address future mission needs, communicate vital information to stakeholders, provide the technical portion of the overall program plan (cost and schedule), and gain strong executive support. It should be a basis for an ongoing technology dialog between the sponsor and systems developers and serves as the roadmap for satisfying the gaps over time to achieve the end-state.

Technology plan is a key enabler for the systems engineering function. Based on the future mission or business needs, it defines a desired technical end-state to evolve toward. Because that end-state may not be achievable with current technology, it is important to determine which technologies are available now; which technologies are in development, including their maturity levels and which technologies do not yet exist. This helps influence an investment strategy that can focus on and push the state of the art, and it helps identify requirements that are not achievable at all or may be cost prohibitive.

Technologies requiring further investment and maturation should be assessed as part of the technical planning process. Appropriate risk should be assigned to technologies assessed as immature, with the need for concomitant mitigation plans. Technologies that have been in the research and development (R&D) phase for an extended period (over five years) should be assessed for the maturation trend to determine if additional investment would significantly improve the maturity.

At a minimum, the plan should include identification of all technology being brought to bear for the solutions, the maturation and trend of applicable technologies (forecast), insertion points, required investments, and dependencies.

The process of developing and implementing a technology plan should include the following activities

- **Evaluate the environment for innovative uses of technology.** What is changing in the environment that needs to be taken into account or can be exploited? Where industry headed and what is its technology roadmaps?

- **Define desired results.** Where does the organization want to be within a planning horizon, usually 5-10 years? Envision the future as if it were today, and then work back to the present.
- **Identify the core technologies needed for meeting the vision and focus on those first.** Assess the risks for maturation and focus on investment and mitigation. If the risk is very high, the choice is to wait and depend on the "bleeding edge," or embark on a serious investment program. The criticality of the technology and/or mission drives this choice. If it is indeed a core technology and critical to the success of achieving the end-state, significant investment will need to be applied to buy down the risk. One example of this is the government's choice to invest heavily in cybersecurity.
- **Identify the remaining technologies applicable to the mission or business area end-state.** But, don't become enamored with technology for technology's sake! Keep it simple and focused on the end-state.
- **Establish a quantifiable feedback system to measure progress.** Define what must be done and how it will be measured to determine progress. Define measures of success to gauge whether the implementation of the plan is progressing successfully. Adjust the plan accordingly. Measuring return on investment for those technologies requiring maturation can be challenging; make allowances for failures depending on the assessed risk.
- **Assess the current state of the organization implementing the plan.** Are resources (staff, funding) and processes in place to effectively implement the plan? Are the required skills available?
- **Develop tactical plans with measurable goals to implement the strategy.**

- **Form the roadmap.** Develop the phasing, insertion points, associated R&D investments, work plans or packages, and sequence the activities within each functional and major program area in the tactical plan to form the roadmap. Allocate resources and tasks and set priorities for action during the current year.
- **Assess the life-cycle costs of technology.** Take care not to underestimate the life-cycle cost of technology. This can be difficult. Industry investments in new technology tend to be closely held and proprietary. Often, the full product or prototype is not made visible to the sponsor until it's ready for sale or deployment. So, usually there is a lack of technical detail and understanding of the whole product or technology and its application to the mission area. The result can be increased costs for integration, maintenance, and licensing. Licensing for proprietary special purpose technology can be particularly costly. An alternative is a sole-source relationship.
- **Educate the organization and stakeholders on the plan and its implementation.** Communicate with stakeholders and users using their operational terminology and non-technical language. Users won't support what they can't understand and can't clearly link to their mission. Communicate the plan to outside industry, government laboratories, and associated R&D activities to ensure understanding and form or solidify relationships. The technology plan can be a tool to collaborate on shared investment strategies toward achieving common goals.
- **Implement** the **technology plan.** Monitor, track, and make adjustments to the plan according to periodic reviews.

- **Review the technology plan.** Review annually or in other agreed period by iterating the preceding process.

Technology project management: Find further reading on project planning here http://tech.transparency-initiative.org/fundamentals/technology-project-planning-and-management/