MANAGEMENT OF TECHNOLOGY
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by

M.R.S.SURYA NARAYANA REDDY

Assistant Professor

Department of Management Studies

UNIT-I Technological innovation

The need for a conceptual approach, technological innovation as a conversion process factors contributing to successful technological innovation. Strategies for research and development : research and development as a business, resource allocation to research and development, research and development strategy in the decision making process, selection and implementation of research and development strategy, research and development and competitive advantage, new product development techniques for creative problem solving.

Introduction

Technology is a Greek word derived from the synthesis of two words: techne (meaning art) and logos (meaning logic or science). So loosely interpreted, technology means the art of logic or the art of scientific discipline.

Paap defined technology as "the use of science-based knowledge to meet a need.“

According to **Harold Koontz**, "Management is the art of getting things done through and with people in formally organised groups."

Reduced costs of operations. For example, Dell Computer Corporation used technology to lower manufacturing and administrative costs, enabling the company to sell computers cheaper than most other vendors.

In the context of business, technology has a wide ra range of potential effects of Management

New product and new market creation. For example, Sony Corporation pioneered the technology of miniaturization to create a whole new class of portable consumer electronics (such as radios, cassette tape recorders, and CD players).

Improved customer service. The sophisticated package-tracking system developed by Federal Express enables that company to locate a shipment while in transit and report its status to the customer. With the development of the World Wide Web, customers can find the location of their shipments without even talking to a Federal Express employee

Technology Management

The U.S. National Research Council in Washington, D.C., defined management of technology (MOT) as linking "engineering, science, and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization“

Technology management needs to be separated from research and development (R&D) management. R&D management refers to the process by which a company runs its research laboratories and other operations for the creation of new technologies

TECHNOLOGY AND INNOVATION

Technological change is a combination of two activities invention and innovation. Invention is the development of a new idea that has useful applications. Innovation is a more complex term, referring to how an invention is brought into commercial usage. The distinction between the two is very important.

As an example, Henry Ford did not invent the automobile; companies in Europe such as Daimler were producing cars well before Ford founded his company. Henry Ford instead focused on the innovation of automobiles, creating a method (mass production) by which cars could be manufactured and distributed cheaply to a large number of customers.

Innovation Management

Innovation "is derived from the Latin word" innovare "and stands for renewal. From an economic point of view, innovation is something new that brings benefits for an organization and/or society.

Innovation management involves the process of managing an organization's innovation procedure, starting at the initial stage of ideation, to its final stage of successful implementation. It encompasses the decisions, activities and practices of devising and implementing an innovation strategy.

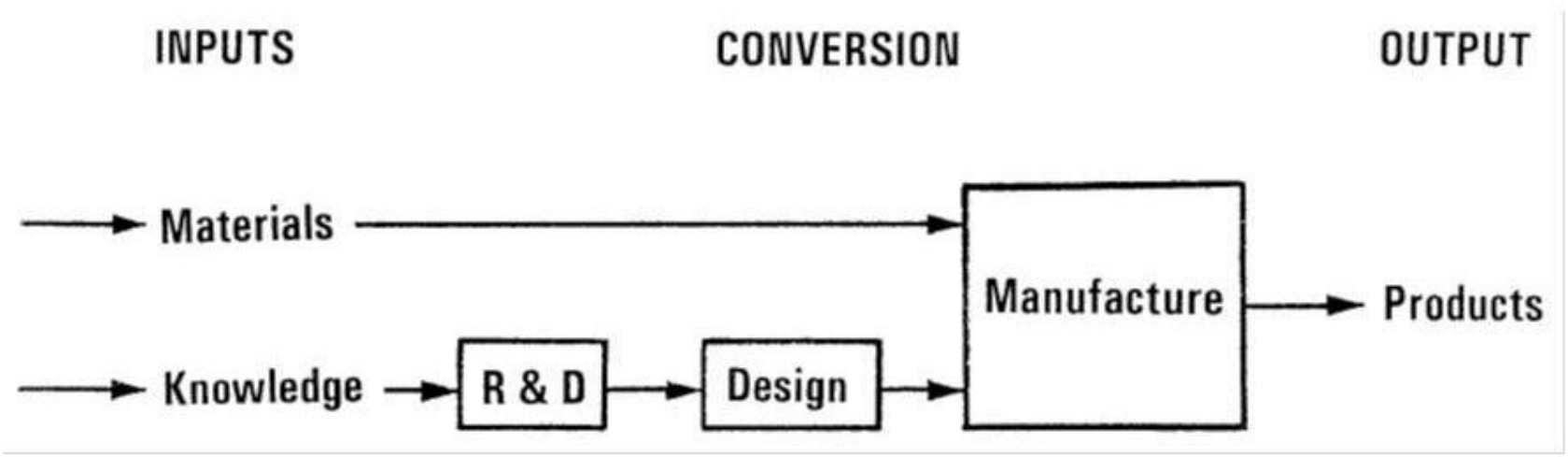
Technological innovation as Conversion Process

Technological innovation and new product development are vital for maintaining industrial competitiveness and increasing manufacturing process efficiency. This in turn leads to economic growth and enhances the wealth of the nation.

Conceptual Approach : It looks at technological innovation as conversion process rather than the development of a thing.

The conceptual approach outlined here is to provide an alternative to the typical product oriented model of technological innovation. The technologist develops an intellectually exciting concept and then immediately processes to design and manufacture a specific product while generally isolated from information on market forces and customer needs.

Technological Innovation- A conversion process



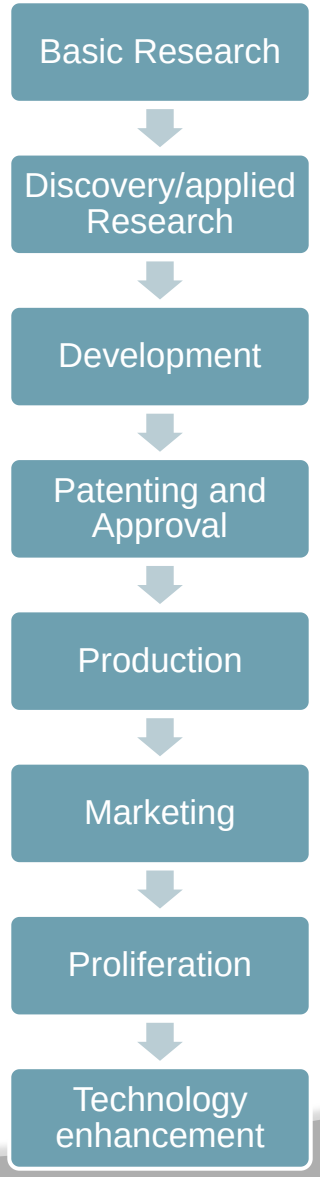
Alternative Approach :

It directly involves the potential users or customers needs in the development of the technological process. Technology is matched to customers needs. The product then becomes merely the carrier of the technology and the form it takes is only defined after then needs have been clearly matched.

This approach considers the process as conversion of scientific knowledge directly into the satisfaction of customer or social needs.

The alternative approach differs some what from the concept of tailoring research to user needs in that it looks directly at satisfying market oriented needs of people or society rather than then needs of specific client groups.

Process of Technological Innovation



Technological Innovation- A conversion process

The process of technological innovation is a complex set of activities that transforms ideas and scientific knowledge into physical reality and real-world application.

The technological innovation process comprises of eight steps:

Basic Research : This is a research for the sake of increasing general understanding of the laws of nature. It is a process of generating knowledge over a long period of time. It may or may not result in specific application.

Discovery/ Applied Research : It is directed towards solving the problem of one or more societies. For example , research conducted to develop a drug for ‘swine flu’, ‘Tamil flue’ etc. here the drug was discovered in the applied research process.

Technological Innovation- A conversion process

Development : This is a human activity that converts knowledge and ideas into physical hardware, software or services. It may involve demonstrating the feasibility of an idea, verifying a design concept or building and testing a prototype.

Patenting and Approval: it is included in the stage of implementation after developing a product/service. Generally the organizations may go for registration of their product/service by patenting. After that they will implementation of the same in this process the set of activities associated with introducing a product into the market place.

Production: This is set of activities associated with the wide spread conversion of design concepts or ideas into products or services. Production involves manufacturing ,production control logistics and distribution.

Technological Innovation- A conversion process

Marketing: This is the set of activities that ensures that consumers embrace the technology. It entails market assessment ,distribution strategy ,promotion and the gauging of consumer behavior.

Proliferation: This and the associated strategy ensure the wide-spread use of the technology and its dominance in the marketplace. Proliferation depends on methods of exploiting the technology and on the practice used for marketing the technology. Ex: Microsoft spreads the use of its internet browser technology by including the browser with its popular windows software.

Technology Enhancement : It entails improving the technology, developing new generations or new applications for the technology, improving quality, reducing cost and meeting customer's special needs.

Technology enhancement increases the life cycle of the technology.

Factors Contributing to successful technological innovatic

The main factors that contribute to successful technological innovations are.

Organizational support : For innovation to occur, the firm must have the willingness ,opportunity and capability to innovate. The following three factors affect each other, but each factor is determined by more fundamental factors.

Willingness: Willingness is determined by both:

1. Attitude towards changes in production in general
2. Knowledge about what changes are possible.

In the context of disrupting innovation by firms representing the dominate technology, willingness is also shaped by the rare commitment of management to nurture new approaches that are at odds with its traditional value network.

Factors Contributing to successful technological innovatic

Opportunity: opportunity involves both supply-side and demand-side factors.

Supply Side : technological gap can exist:

- Between the technology used in a particular firm and the already available technology that could be adopted or adapted,
- The technology used in a particular firm and technology that could be developed.

Demand Slide: Four factors could push a firm towards technological change which include diffusion, incremental innovation or major innovation:

1. Regulatory requirements
2. Worker demands and pressure arising from industrial relation concerns
3. Public demand for more environmentally sound, eco-efficient and safer industry
4. Possible cost savings or expansion of profits

Capacity or Capability

Capacity or Capability can be enhanced by

1. Increase in knowledge or information about more sustainable opportunities ,partly through, deliberately undertaken technology options/opportunity analysis and partly through deliberate or serendipitous transfer of knowledge from suppliers, customers ,trade associations, unions ,workers and other firms as well as from available literature.
2. Improving the skill base of the firm through educating and training its operations ,workers and managers on both a formal and informal basis.
3. By deliberate creation of networks and strategic alliances not necessarily confined to a geographical area or nation or technological regime.

Organizational Components

Innovative organizations can be defined as the integrated set of managerial and organizational elements which work together to create and reinforce the kind of environment stimulating successful technological innovation.

Elements that characterize the innovative organizations are as follows:

- Extensive Communication
- Customer Found : it involves the firms orientation towards both internal and external customers, as well as the implementation of total quality culture.
- Vision, Leadership and will to innovate
- High involvement in innovation
- Effective team working

Models of the Technological innovation Process

The increasing complexity of the technological change and of the innovation activities within firms has also stimulated thinking about how to model the process od technological innovation.

According to Rothwell (1992), there are five generations of the models of innovation process :

1. First Generation : Technology Push
2. Second Generation : Market Pull
3. Third Generation : Coupling model
4. Fourth Generation : integrated model
5. Fifth Generation : Systems integration and networking

Issues in managing technology in the large firm

Linkage : Linking technology to business strategy has turned out to be one of the most critical factors that help to generate success in managing technological innovation for the large firm.

People Linkage : First and perhaps most important in ‘people linkage 'weaknesses is the relatively low participation rate of the senior marketing people in providing technology ties to the market .

People Weakness : The second ‘People Weakness’ with regard to linkage is the chief financial Officer. The CFO presiders over what for many companies is the single largest aggregation of expenditures, namely R&D expenditure.

Leverage: How does the company go about leveraging its internal R&D via access to resources that are out side its usual base ? It is second vital element for driving successful technology management.

Introduction- Research & Development

R& D is a complex process involving generation and development technology involving several parameters and steps.

The factors that influence R&D include social , economic and political environments or factors at national and international levels as well as the business strategies of a corporation or a firm.

The steps range from concept and basic research to utilisation of technology .

Sound R&D management with a viable technology strategy is important for the continued competitiveness and growth of a firm.

Concept of R&D

Research is a science based and development is technology oriented. Together they create processes , products and services which may or may not benefit mankind.

The following descriptions make the meaning and outcome of R*D clear

Gibson (1981), Research is that exploratory activity that seeks to discover or extent the principles of nature. Development is the application of existing scientific principles, along with economic and other constraints, to the design of devices and processes that meet the needs of human kind.

Evolution of R&D Management

A new era of global competition is underway, driven by new tools in information technology in other fields (Larson,2001).

R&D activities have changed dramatically since 1950. Roothwell and Zegveld (1985) identify three important factors.

- **Technology Explosion :** They estimates that 90 per cent of our present technical knowledge has been generated during the last 55 years.
- **Shortening of the Technology Cycle:** Ex; the market life of production cars has decreased from approximately 10 years in the 1960s to approximately six years in the 1990s. In some cases, a particular model may be restyled after only three years.
- **Globalization of technology:** Developing countries have demonstrated an ability to acquire and assimilate technology into new products.

R&D as a Business

Is R&D a business ? Business involves investing with a risk for making profits. Is R&D a profitable activity? Or is it a cost to be recovered in price of product or services?

R&D is Risky and Profitable : Technological innovations generate income in two ways:

1. Within the organization , there is value addition in processes and products resulting cost savings and sales revenues.
2. Incomes from transfer of technology by the method of licensing , franchising or outright sale.

R&D as a Cost : Top executives may view R&D as cost without immediate revenues. Existing methods for funding R&D in corporations are usually based on the following:

1. R&D is supported as an overhead (OH) expense.
2. R&D is supported as an investment.

R&D as a Business

R&D as an Investment : Management considers R&D as an investment which gives a return associated with a level of risk.

Management concerned with short –term return for expenditure, on the basis of their immediate returns do not favor long-term projects. One of the most common criteria used is return in investment (ROI).

Call option for Exploratory Research: Call option is suggested to projects – (i) Which require large expenditure (ii) which are difficult to accept as a cost of doing business under OH funding scheme, and (iii) whose returns are quit unpredictable.

These projects are associated with the strategic positioning of the company.

Elements of R&D strategies

Although the great bulk of R&D takes place in large firms, significant inventions have emanated from small firms and from individuals.

Examples include Xerography and the Apple II personal computer. These innovations occurred because of the entrepreneurial spirit of individuals like Chester Carlson and Joseph Wilson ,in the case of Xerox , and Steve Jobs and Steve Woznaik, in the case of Apple.

How do the firms select R&D strategies and implement them? The selection is influenced by various factors as shown in below table , A brief description of the various aspects of strategy follows:

Strategy Choices for R&D

S.No	Strategy Elements	Choices
1	Objectives	Defend existing business; Drive new business; Develop technological capability ; Explore new technology developments
2	Technology Portfolio	Core Technologies; Complementary technologies; Peripheral technologies; Emerging technologies; Based on normative , comparative and forecast needs
3	Sources of Information	In-source (in-house research and development), outsource (External linkages to customers linkages to an external network of firms. Linkages to universities and government laboratories)
4	R&D Organization	Internal ; External (universities, Government laboratories , alliances, joint ventures, outsourcing etc). Based on competitive position and strategic importance.
5	Resource availability	Internal (if sufficient); External(Alliances, Government laboratories and universities)
6	Resource Allocation	Overhead cost (Accounting method); Capital budgeting Criteria (for projects with certainty) Call option (for uncertain projects)

Objectives of R&D

An integrated R&D strategy aims at developing technology portfolios that serve short-term and long-term objectives of the business. A Company can choose short-term objective like defending or long-term objective like building technological capabilities.

- Defend, support and Expand current business
- Drive new business
- Broaden and deepen technological capability
- Explore new technology developments

Designing Technology Portfolio

From an R&D perspective , a company's technological portfolio may comprise the following: The portfolio mix depends on the chosen objectives, core competencies and resources.

1. Core technologies
2. Complementary technologies
3. Peripheral technologies
4. Emerging technologies

Core Technologies: The core technology is usually central to all most of the company's products. Expertise in this area may also dominate the laboratories of the R&D department as well as strategic thinking.

Ex: In the photocopying industry photographic technologies are core.

Designing Technology Portfolio

Complementary Technologies: are additional technologies that are essential in product development.

Example: Micro-processors are becoming essential in many products and industries.

For photocopying industry there are several complementary technologies including micro-processor technology and paper-handling technology, which enable the lifting, turning, folding and stapling of paper.

Peripheral Technologies: is defined as technology that is not necessarily incorporated into the product but whose application contributes to the business.

Computer software is often in this category . The photocopying industry is increasingly using software to add features and benefits to its products, such as security.

Selection of R&D Strategies

Based on the mix of elements described above different strategies can be evolved and selected for implementation by a firm.

1. **Radical vs. Incremental innovation strategies :**

Features	Radical Innovation	Incremental innovation
Significance	Major novelty (e.g. entirely new products)	Minor improvements in existing products and processes.
Approach	A fresh look on old problems	Determination in solving problems within a given frame – work.
Typical people triggering innovation	1. Critical individualists 2. Mission-oriented teams	Front-line workers
Organization where the innovation takes place	Outsiders and new entrants	Within an organisation

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Upstream vs. downstream Technologies: upstream competencies include technology development and product design. Providing consumers with a new product that requires no reeducation may be a much easier way to enter a new market with a new product.

Even when consumers in developed markets appear to want the same products as are sold in emerging economies, some redesign is often necessary to reflect differences in use, distribution, regulations and standards.

Ex: Thermax has developed a high fluid velocity shell type boiler. This reduces the size of a boiler by a third for the same capability. For the Indian market , the boiler has to be designed to the Indian boiler regulation standards (IBR),but for global markets the boiler has to meet British Standards or the US standards (ASME)-both these differ from IBR standards.

Single vs. Portfolio of Technologies

Single Product technology strategy with a consistent process and technology is the least complex approach a firm can take. Firms using this strategy are small and the market is local. To sustain market these companies adopt the following strategies.

- To increase market penetration they employ new marketing strategies
- They continuously improve the technology
- They sell current products in new markets
- They enhance product-new or improved versions are offered.

Product strategy is in response to a complex environment of change characterised by high risk and high return. A firm will have different unrelated technologies , products and processes.

External vs. Internal R&D strategies

Given the growing use of external sources of technology, the R&D manager now has to determine which from of R&D is most appropriate for the organisation.

Sources of External R&D: Broadly, there are three sources of external technology:

1. Other Companies: Inter-company relationships in the form of co-operative research or strategic alliances are on the increase.
2. Universities : Partnering with universities may assume the form of consulting,licensing,applied research contracts, and use of specialised facilities.
3. Government laboratories: Only the government can afford some of the facilities that are vital to the industry: High-intensity gray-light sources, enormous banks of high-end computers, and specialised radiation sources, to name just a few.

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Protection vs. Diffusion Strategies: A critical element of formulating a firms' R&D strategy is determining whether and how to protect its technological innovation. Based on this, firms consider the continuum between a wholly proprietary strategy and a wholly open strategy.

Diffusion Strategies : The goal of any diffusion strategy is to spread the word about your innovation and encourage users to adopt it. In the case of the Orange Grove, the targeted users are faculty, both tenured and adjunct.

Implementation Strategies

The three implementation decisions are: Organisation, resource allocation and evaluation.

Organisation: in case of organisation the two issues around which deliberations take place are:

1) Centralisation vs. Decentralisation
2) Mechanistic vs. Organic

Centralisation vs. Decentralisation : Decentralising R&D activities to the divisions of the firm enables those divisions to develop new products or processes that closely meet the particular needs of a division. The solutions they develop are likely to fit well within the operating structure of the division, and be closely matched to the requirements of the customers served by that decision.

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If the firm centralises R&D in as single department , it may maximise economies of scale in R&D, enabling greater division of labour among the R&D specialists and maximising the potential for learning-curve effects through the development of multiple projects.

It also enables the central R&D department to manage the deployment efforts and avoiding the possibility that valuable new technologies are underutilised throughout the organisation.

Mechanistic vs. Organic vs. Ambidextrous

Mechanic structures are not suitable for fostering innovation. They achieve efficiency by ensuring rigid adherence to standards and minimizing variation, potentiality stifling creativity within the firm.

Organic Structures that are more free-flowing, and characterized by low levels of formalization and standardization, are often considered better for innovation and dynamic environments. In the organic structure, employees are given far more latitude and dynamic responsibilities and operating procedures.

Tushman and O'Really (1996) argue that the solution is to create an ambidextrous organization. It is complex in form because it is composed of different architectures. It aims at collectively achieving both short-term efficiency and long-tern innovation.

Resource Allocation

Corporate –level R&D must devote its energy to highly leveraged opportunities –the ones that create new business or turn entire business around (Schmitt,1983). Leveraging opportunities require up-front R&D investment in a balanced spectrum of programs. These can include:

1. Focused and targeted short-term projects
2. Focused and targeted long-term projects
3. Speculative and exploratory work
4. Supportive research projects for existing products and services

They are several key factors that need to be considered when allocating funds to R&D and R&D is not like other functions to be funded on an annual budgetary basis. It requires a much longer-term approach to allow developments of knowledge over time.

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1. **Long-term needs:** Budgets are influenced by the long-term strategic technological needs of the business.
2. **Short-tern needs:** Establishing the R&D budget for a business is influenced by short-term performance fluctuations.
3. **Size of funds :** Depends on the need of the project funds will be allocated
4. **Conflicting Demands:** It is unusual for unlimited funds to be available ; hence, business functions usually compete with other departments for funds.
5. **Strategy Direction:** company's long-term growth objectives and the need for stability exert influence on the size and shape of the budget.
6. **Backlogs:** distortions introduced by large projects and unfinished projects will have influence on the budget decision.
7. **Competitors:** Expenditure by competitors is another major factor.

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Approaches for allocating funds to R&D

1. **Inter-firm comparisons :** While R&D expenditure varies greatly between industries, within similar industries there is often some similarity . It is possible to establish an appropriate figure for its own research effort by knowing a competitor's R&D expenditure , the number of research personnel employed etc.
2. **A Fixed Relationship to turnover :** R&D expenditure an be based on a constant percentage. Turnover normally provides a reasonably stable figure that grows in line with the size of the company. For instance , a company may decide to spend 2 percent of its annual turnover on R &D. A criticism of this method is that it uses past figures for future investments.
3. **A fixed Relationship to profits :** Another method is fixing R&D expenditure as percentage of profits. This is undesirable . it implies that R&D is a luxury which can nly be afforded when the company generates profits.

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4. **Reference to previous levels of expenditure :** In the absence of any criteria for measurement, a starting point for discussions is likely to be the previous year's expenditure plus an allowance for inflation.

5. **Costing of an Agreed Programme:** An R&D manager is concerned with managing research projects, so the allocation of funds for each individual project may seem attractive. This allows him or her add together the requirements for certain projects and arrive at a figure.

6. **Internal Customer –Contractor Relationships :** In some large multinational companies, the individual business units may pay for research carried out on their behalf by the R&D function.

Financial Evaluation of Financial Evaluation of Research and Development Projects

Financial evaluation of research and development projects: the need for cost effectiveness, financial forecasts, risk as a factor in financial analysis, project selection formulae and allocation of resources, DCF and other techniques of evaluating research and development

Introduction

To assess the financial feasibility of a project idea, that the manager must examine the capital costs ,operating costs and revenues of the proposed project.

The financial evaluation of any project involves the following steps

1. Estimating the investment to be made
2. Estimating the income from the project either in terms of profits or cash flows.
3. Apprising the project by comparing the investment made with the income to be derived from the project.

Need for Cost effectiveness of R& D Project

1. Resources are rare and so proper utilization of resources is pre-requisite for success of projects.
2. It helps to determine future expected contributions for project.
3. It helps to minimize cost of project thereby increasing profitability
4. It helps in monitoring and evaluating the project
5. R&D projects are very important. Successes of R&D projects are imperative to the success of the organization
6. Effective cost management of R&D projects is necessary for success of organizations.

Cost based approach

Using a cost to price approach, engineers can compute costs involved. They add the estimated prices of purchased components and estimated production costs for each part that goes into the new product.

Databases contain current component purchase prices, product routings and bills of material for exiting parts enable design engineers to estimate the cost of new parts.

Price based approach

In the price cost to approach , desired margin is deducted from the price fixed. This "price down, cost down", method suggests that production costs must decline as the price of a product declines. In other words , the market determines the acceptable cost of a product.

The cost possibilities which should be investigated include:

Stand by cost	Future Costs
Marginal Cost	Sunk Costs
Differential cost	Out-of-pocket cost
Opportunity cost	Joint costs
Comparative Cost	Volume costs

Financial Analysis

It refers to an assessment of the viability , stability and profitability of a business, sub-business or project.

Financial analysis considers financial forecasts and risk in project.

Financial analyses often assess the firms profitability ,liquidity, solvency and stability.

R&D Financial Forecasts

To Conduct a financial forecast , the project manager must collect information about

1. Project cost estimates
2. Different ways of financing the project
3. Working capital requirements
4. Profitability projections
5. Projected Cash Flows of the project
6. Projected Balance Sheet.

Project Cost Estimates

While there is considerable variation in the scope, degree of formality and level of sophistication in financial planning across firms, most corporate financial plans have certain common elements.

These are:

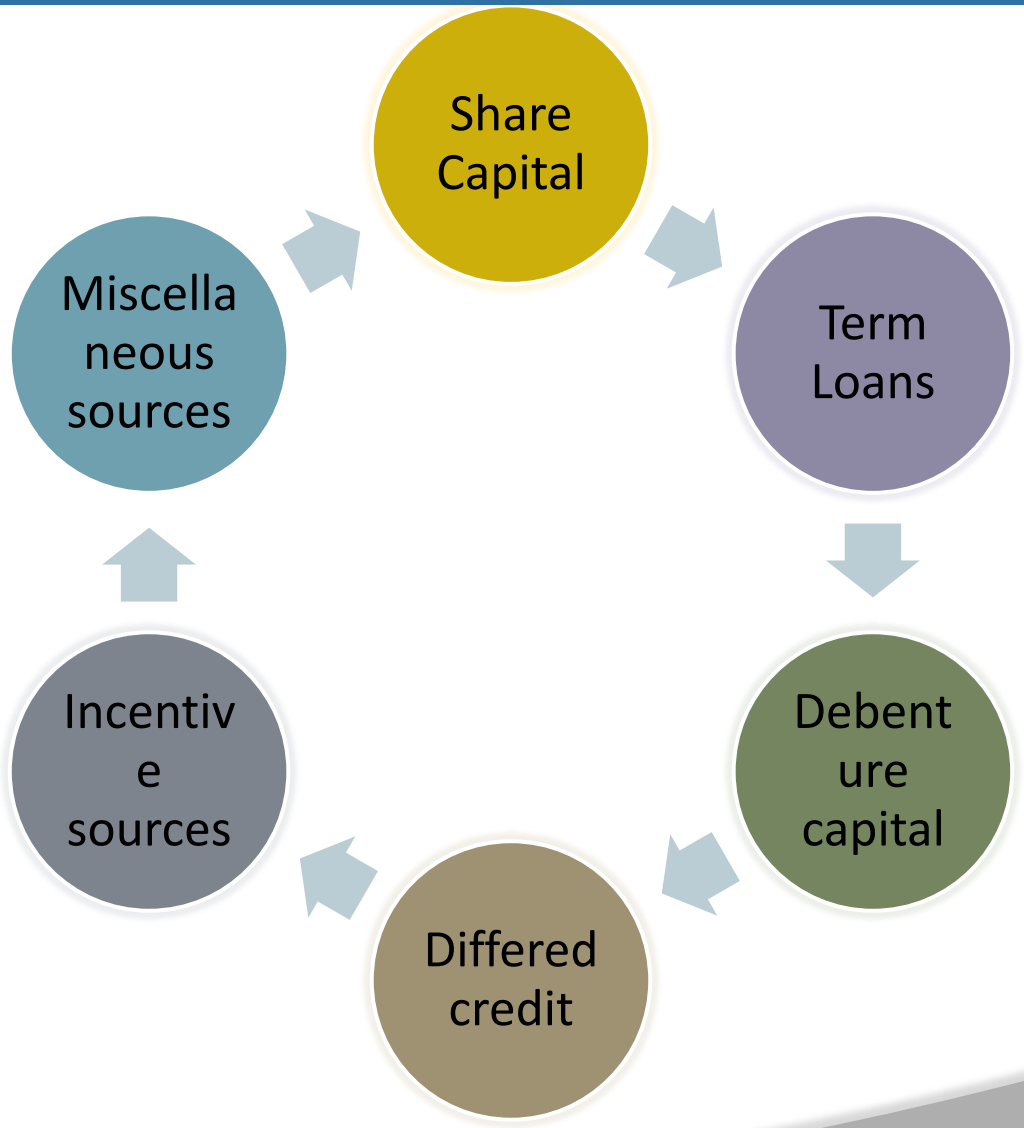
1. Economic assumptions
2. Sales forecast
3. Performa statements
4. Asset requirements
5. Financial Plan
6. Cash budget

Types of costs in the project

The various costs involved in a project can be grouped under the following sub-heads.

1. Land and Site development
2. Building and civil works
3. Plant and machinery
4. Technical know-how and consultancy fees
5. Transport and erection charges
6. Preliminary and pre-operative expenses
7. Miscellaneous Assets.
8. Provision for Contingencies
9. Margin money for working capital

Ways of Financing the Project



Working capital Requirement and its financing

In estimating the working capital requirement and planning for its financing , the following points have to be born in mind

1. **The working capital requirement consists of the following**

- Raw material and components
- Stocks of goods –in-process
- Stocks of finished goods
- Debtors
- Operating expenses and consumable stores

Working capital Requirement and its financing

2. The principal sources of working capital finance are:

- Working capital advance provided by commercial banks
- Trade credit
- Accruals and provisions
- Long-term sources of financing

3. They are limits to obtaining working capital advances from commercial banks . They are in two forms:

- The aggregate permissible bank finance is specified as per the norms of lending ,followed by the lending bank
- Against each current asset a certain amount of margin money has to provided by the firm.

Working capital Requirement and its financing

4. The Tandon committee has suggested three methods for determining the maximum permissible amount of bank finance for working capital.

The method that is generally employed now is the second method. According to this method , the maximum permissible bank finance is calculated as follows.

Working capital= Current assets-Current liabilities

The implication of this norm is that at least 25 percent of current assets must be supported by long-term sources of finance.

Project Selection

Project selection is a systematic process of choosing a project idea for implementation from the available alternative project ideas.

The project manger attempts to decide which idea to choose, which technology to develop and which methodology to follow in selecting a project.

Project Selection Formulae : A project clients and management teams become sophisticated , the focus of a project organization is mainly on aspects such as how to choose the right projects and how to prioritize them.

The project manger has to carefully prioritize all the available process options and choose the best.

A wrong choice of a project may result in ineffective use of resources and project failure.

Criteria for Project Selection Formulae/ Models

Today , organization's are specializing in getting and executing the projects.

Every project is important is important for the firm and each project demands separate development and implementation strategies.

According to Souder the project selection model should fulfill the following characteristics:

1. Realism
2. Capacity
3. Cost
4. Flexibility
5. Ease of use
6. Easy Computerization

Models for project selection

Numeric models use numbers as inputs and non-numeric models use discussion , suggestions to select a project.

The project manager uses either one model or a combination of the two models, to help him select best model, although they do not provide a complete decision.

In order to construct a project selection model, the project manager generates a list of objectives. The list includes the goals and interests of the firm such as improving the brand image, generating employment for certain categories of workers, expanding the business etc.

Broadly, project models are of two types.

Models for project selection , Cont..

Non –Numeric Models : Theses models use inputs other than numerical data to select a project. These models are constructed based on the subjective evaluation, ideas and opinions of the project manager and the project team. Although these models seem simple to use, they require the team to understand the practical use of these models:

- **Scared Cow**
- **Extension of product line 4**
- **Opening necessity**
- **Competitive necessity**
- **Comparative benefit**
- **Q-sort Technique**

Models for project selection , Cont..

Numeric Models: Firms depend on numeric models heavily while selecting a project. Most firms consider the numeric models more useful than non-numeric models which are very subjective and unscientific. Broadly numeric models are of two types:

1. Profit/ profitability Models: The profit/profitability models are followed by the project manger are
   - Pay-back method
   - Average Rate of Return (ARR)
   - Net Present Value (NPV)
   - Internal Rate of Return (IRR)
   - Probability Index
2. Scoring models : As all the profitability models focus on a single decision criterion, the project manager uses scoring techniques that involve multiple criterions to select a project. In these models, decisions are arrived at by the discussion of the project team with top management. Some of the scoring models are

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(i)Un weighted 0-1 Factor Model : The management first lists factors that can normally be considered in rating a project for selection.

Management constitutes a team of raters to select project. The people involved in the team must be familiar with goals of the organization and the firms potential project portfolio.

The list of factors is given to the team of raters and the project is selected on the basis of the score given to each project idea.

The evaluators rate every project idea, and the management selects the project with the highest factor score.

Advantage: it gives equal weightage to the opinions of all the raters and produces an explicit final result.

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The list of factors is given to the team of raters and the project is selected on the basis of the score given to each project idea.

The evaluators rate every project idea, and the management selects the project with the highest factor score.

Advantage: it gives equal weightage to the opinions of all the raters and produces an explicit final result.

Cont…

2. Unweight Factor Scoring Model: The disadvantage of unweighted 0-1 factor model is that the raters are forced to choose either 'qualified ' or 'not qualified' for a particular factor.

The unweighted factor scoring model overcomes this limitation by constructing a simple linear measure of scale, normally a scale from 1 to 5. the rater can choose any values from 1 to 5 , where 5 is very good, 4 is good , 3 is fair , 2 is poor and 1 is very poor.

The management can also include a factor , the expected future profit from a particular project in the next three years.

3. Weighted Factor Scoring Model : The two models talked about earlier are based on the assumption that every factor that is included in the first of factors is equally important.

But this assumption is not true, and often impracticable. Therefore the management considers weighted factor scoring models where the factors are weighted as per their importance.

Cont…

Then scoring for each factor becomes the product of the factor weight and the factor. The sum of all the factor scores gives the project score. The above calculation is done by using the formula.

Where:

S= Project score

Fi = Factor score of factor

Wi= Weight assigned to the factor's

N= number of factor

The Delphi technique or the brainstorming technique is used to assign weights to each factor.

Allocation of Resources

Resources are rare so, they are allocated to R&D projects judiciously. To allocate the resources properly evaluation of R&D projects are done.

Project Evaluation : Project evaluation are response to demands for accountability , demonstration of effective, efficient and equitable use of financial and other resources; recognition of actual changes and progress made. Project can be evaluated with discounted and non dis-counted techniques.

The major criteria used by the project manager are:

- Non-discounting criteria
- Discounting area

Discounting Cash Flow Techniques

The methods are :

(a) Traditional Methods

- Payback period
- Accounting rate of return method

(b) Discounted Cash flow methods

- Internal Rate of return Method
- Net Present value method

Net present value Method

- The internal rate of return is usually used to calculate the profitability of investments made in a financial product or projects(NPV) of all cash flows from a particular project equal to zero.
- Net present value= Present value of net cash flow-Total net initial investment
- **The steps to calculating the net present value are:**

1. Determine the net cash inflow in each year of the investment.
2. Select the desired rate of return
3. Find the discount factor each year based on the desired rate of return selected.
4. Determine the present values of the net cash flows by multiplying the cash flows by the discount factors
5. Total the amounts for all years in the life of the project
6. Subtract the total net initial investments.

Internal Rate of Return Method

The internal rate of return is a metric employed in capital budgeting which is used to measure the extent of profitability of potential investments. It is also known as ERR or economic rate of return.

IRR is defined as the discount rate that sets the NPV of a project to zero is the project's IRR.

Total initial investment = Annual net cash flow x Annuity discount factor of the discount rate for the number of periods of the investment's useful life

If A is the annuity discount factor, then

A= Total initial cash disbursements and commitments for the investment / Annual (equal) net cash flows from the investment

IRR Advantages

- It considers the time value of money even though the annual cash inflow is even and uneven.
- The profitability of the project is considered over the entire economic life of the project. In this way, a true profitability of the project is evaluated.
- There is no need of the pre-determination of cost of capital or cut off rate. Hence, Internal Rate of Return method is better than Net Present Value method.
- Sometimes, the pre-determination of cost of capital is very difficult. At that time, Internal Rate of Return can be used to evaluate the project
- The ranking of project proposals is very easy under Internal Rate of Return since it indicates percentage return.
- It provides for maximizing profitability.
- Internal Rate of Return takes into account the total cash inflow and outflows.
- It gives much importance to the objective of maximizing shareholder's wealth

IRR Disadvantages

- This method assumed that the earnings are reinvested at the internal rate of return for the remaining life of the project. If the average rate of return earned by the firm is not close to the internal rate of return, the profitability of the project is not justifiable.
- It involves tedious calculations.
- This method gives importance only to the profitability but not consider the earliest recouping of capital expenditure. The reason is that sometimes Internal Rate of Return method favours a project which comparatively requires a longer period for recouping the capital expenditure. Under the conditions of future is uncertainty, sometimes the full capital expenditure can not be recouped if Internal Rate of Return followed.
- The results of Net Present Value method and Internal Rate of Return method may differ when the projects under evaluation differ in their size, life and timings of cash inflows

Payback method

The payback period of an investment is the length of time required for the cumulative total net cash flows from the investment to equal the total initial cash outlays.

At that time, the investor has recovered the money invested in the project.

$$\text{Payback period} = \frac{\text{Total initial capital investment}}{\text{Annual expected after-tax net cash flow}}$$

Payback method- Advantages

This method is Easy and Simple:

Pay-back method is easy to calculate and simple to understand. Its quick computation makes it a favourable among executives who prefer snap answers

Ranking of Projects:

This method is preferred by executives who like snap answers for the selection of the proposal. The projects are ranked in terms of their economic merits without much complications.

It Stresses the Liquidity Objective

Because this method gives importance to the speedy recovery of investment in capital assets.

Useful in Case of Uncertainty:

Pay-back method is useful in the industries which are subject to uncertainty, instability or rapid technological changes because the future uncertain-ty does not permit projection of annual cash inflows beyond a limited period. It reduces the possibility of loss through obsolescence.

Handy Device or Method:

This method is handy device for evaluating investment proposals where procession in estimates of profitability is not important

Payback method Disadvantages

It ignores annual cash flow: Pay-back method totally ignores the annual cash inflow after the pay-back period.

It considers only the period of pay-back: Pay-back method does not consider the pattern of cash inflows or the magnitude and timing of cash inflows.

It overlooks capital cost: Pay-back method overlook the costs of capital i.e., interest factor which is an important consideration in making sound investment decisions.

No rational basis of decision: There is no rational basis for determining the minimum acceptable pay-back period. It is generally subjective decision of the management which creates so many administrative difficulties.

It is delicate and rigid: A slight change in operation cost may affect the cash inflow and as such pay-back period shall not be affected.

This method over emphasises the importance of liquidity as a goal of capital expenditure decisions:

Terminal Value Method

It is assumes that each cash flow is reinvested in another project at ac certain rate of interest. It is also assumed that each cash flow is re-invested elsewhere immediately until the termination of the project.

If the present value of the sum total of the compounded re-invested cash flows is greater than the present value of the outflows, the proposed project is accepted, otherwise not.

Advantages:

1. This method has the advantage of the cash inflows being re-invested once they are received.
2. It is mathematically easier to compute as compared to IRR
3. It is easy to understand
4. It is suitable for each budgeting requirement.

Accounting rate of return method

The accounting rate of return of an investment measures the average annual net income of the project (incremental income) as a percentage of the investment.

$$\text{Accounting rate of return} = \frac{\text{Average annual net income}}{\text{Investment}}$$

Advantages:

- It is very easy to calculate and simple to understand like pay back period. It considers the total profits or savings over the entire period of economic life of the project.
- This method recognizes the concept of net earnings i.e. earnings after tax and depreciation. This is a vital factor in the appraisal of a investment proposal.
- This method facilitates the comparison of new product project with that of cost reducing project or other projects of competitive nature.
- This method gives a clear picture of the profitability of a project.

Cont…

- This method alone considers the accounting concept of profit for calculating rate of return. Moreover, the accounting profit can be readily calculated from the accounting records.
- This method satisfies the interest of the owners since they are much interested in return on investment.
- This method is useful to measure current performance of the firm.

Disadvantages:

- The results are different if one calculates ROI and others calculate ARR. It creates problem in making decisions.
- This method ignores time factor. The primary weakness of the average return method of selecting alternative uses of funds is that the time value of funds is ignored.
- A fair rate of return can not be determined on the basis of ARR. It is the discretion of the management.
- This method does not consider the external factors which are also affecting the profitability of the project

Other techniques of evaluating R&D

Analytical Hierarchy Process (AHP): It allows the decision maker to considers the importance of a variety of criterion in establishing various investments in technology.

A hierarchy of criteria is established and the mechanism for evaluating each investment against each criterion is available.

Examples:

1. Payback-cost benefit ratio
2. Market or spin-off ratio
3. Business sector priority
4. Continuing availability of funding
5. Degree of existing staff capability
6. Technological risk
7. Service to other goals

Portfolio Grid

According to James Matheson and Michael Menke the cornerstone of developing and effective R&D portfolio strategy is to focus on decision quality.

Sis steps process to help value projects in the R&D portfolio

1. Identify the appropriate frame-the unique context and decision elements-for the project.
2. Generative creative, achievable alternatives.
3. Develop meaningful, reliable information
4. Establish clear values and trade-offs
5. Apply logically correct reasoning
6. Build a commitment to action.

Conjoint Analysis

It is a family of techniques (including discrete choice, choice modeling, hierarchical choice, trade-off matrices and pair wise comparisons) used to estimate the specific value individuals place on some attribute of a choice, such as the relative value of features of a product or the relative impotence of different outcomes of development project.

Conjoint analysis is a statistical marketing research technique that helps businesses measure what their consumers value most about their products and services.

For example, a TV manufacturer would want to know if their customers value picture or sound quality more? Or, do they value price more than picture quality. Conjoint analysis helps to put a value on each feature to help businesses tailor their products and services to exactly what the majority of consumers are looking for.

Forecasting Techniques- Trend extrapolation

Envelop Curves : A serious constraint on growth curve is overcome by appropriate specification of the capability to be forecast.

For example , below fig shows a growth curve for the speed of propeller driven aircraft and only data for propeller-driven aircraft.

If remove the modifier propeller –driven from the capability to be forecast, it can add data on jet; ram jet and rocket planes, as in fig further.

If we generalize the capability even more to “speed of travel”, we get figure below, a series of specific growth curves super-imposed on one chart and enveloped by a single curve, termed and envelop curve.

Fundamentally, envelop curve is a combination of growth curve and trend analysis.

Research and Development

Program planning and control, portfolio planning, project planning and control, project termination, resource allocation and management. New product development: new product development as a competitive strategy, market research for developing new Products. Commercialization of research outcomes, industrial design, product architecture and design for manufacture, developing indigenous substitute for raw materials.

Introduction

R&D Programming Planning and Control Approach define how the projects required realizing the benefits.

The Planning and control approach will describe how the programme will be planned and then the methods that will be implemented to ensure the programme is adequately controlled thereafter.

The Key document in relation to planning and control is the R&D programme plan. The program plan is not merely a chart of work streams within the organization, it includes

- Milestone for key review of progress
- When significant capabilities are realized within the programme.
- Dependencies and interfaces across the programme.

R&D Programme Planning

R&D Programme planning addresses what needs to happen when, by whom, how long it will take and how progress will be monitored.

It is not a one-off activity at the outset of the programme, but a continual activity, e.g., as projects progress or major step changes in capability occurs.

Programme planning is essentially creating and then maintaining the programme plan that forms a complete picture of how the specific programme will progress.

The following key areas that will be considered during programme planning and will be incorporated within the programme pla:

- Project Portfolio
- Project Schedule
- Project Dependencies
- Resources

R&D Programme Control

Programme control details how the programme plan will be actively managed to ensure successful realization of benefits and achievements of outcomes within the organization.

- Project Control
- Prioritization
- Risk and Issue Management
- Communication
- Programme level Impacts
- Monitoring Progress

R&D Portfolio Planning

Concept of R&D Portfolio : The concept of business portfolios and the strategic options appropriate to developing and optimizing them began taking shape in the 1960s and became a powerful and pervasive planning tool in the 1970s.

Four types of developments projects commonly appear consider by an organization, advanced R&D, breakthrough , platform and derivative project. Over time , a particular technology may migrate through these different types of projects.

1. **Advanced R&D projects** – are the precursor to commercial development projects and are necessary to develop cutting-edge technologies.
2. **Breakthrough Projects** – involve development of products that incorporate revolutionary new product and process technologies.

Cont..

3. **Platform Projects** –typically offer fundamental improvements in the costs , quality and performance of technology over preceding generations.

4. **Derivative Projects** – involve incremental changes in products and processes.

Pushing the concept of business/ product portfolios further, to the associated but somewhat different notion of the R&D portfolio, understood and applied even in 1990 by few of the world's most sophisticated companies.

Role of R&D Portfolio manager

- The effective Investment manager must first help the client clarify and select appropriate investment goals , stable income, security, accumulated wealth or a balance of all.

- The investment adviser builds a portfolio investments that have the best chance of accomplishing the goals within risk constraints acceptable to the client.

- The adviser seeks balance among the investment characteristics of current yield , capital appreciation and tax benefits and attempts to manage risk through diversification.

Types of Research & development Project Portfoli

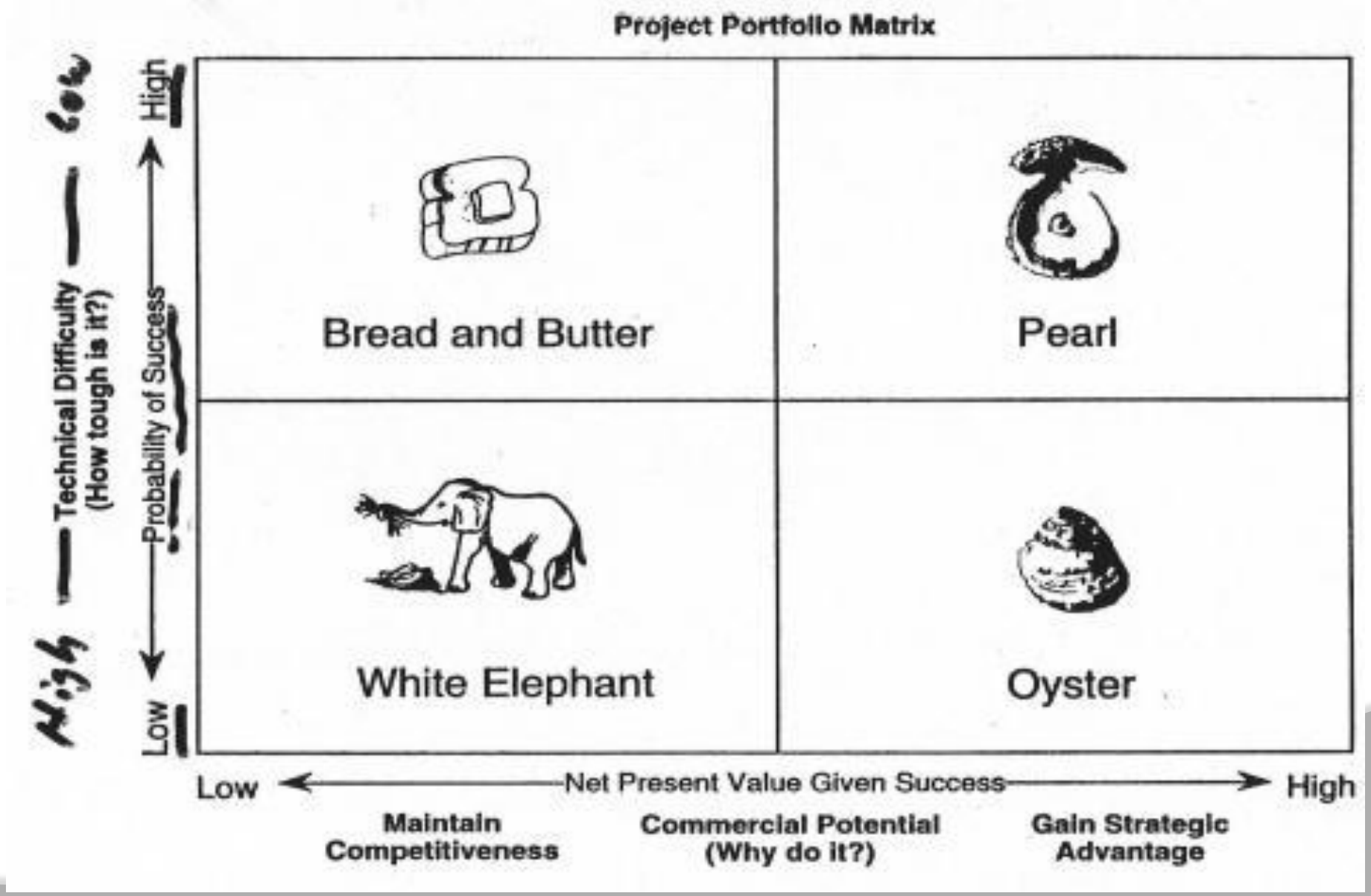
The Research and Development Portfolio should a mix of different types of projects drawn from the following categories:

1. Basic research and Advanced Development projects
2. Breakthrough Development Projects
3. Platform development projects
4. Derivate Development projects
5. Alliance products

Managing R&D Portfolio

Manage the R&D portfolio Objectives	Measures
Actively manage the product/offer portfolio for superior innovation and customer positioning ,performance and profitability	1. Actual versus desired mix of projects (advance development, platform, derivative and outsourced) 2. Actual versus desired spending on projects of each type 3. Net present value of product in project pipeline 4. Reach (customer feedback and revenue projections based on prototype of products in pipeline) 5. Option value from project portfolio
Extend current product platforms into new and existing	1. Number of project leveraged from existing platforms that are targeted at new markets. 2. Number of life cycle extension projects
Extend product portfolio through collaboration	1. Number of licensed products 2. Number of joint projects in new or emerging markets 3. Number of technology or product partners

R&D Grid in different project



Characteristics of project Portfolio matrix

Bread –and-butter Projects: The upper left quadrant represents projects with high probabilities of success and good commercial value. These projects usually focus on evolutionary improvements to current products and processes in existing business areas.

Examples:

- A new form of insulin
- Upgraded software tools with new features and ease of use
- Product extension of an anti-parasitic drug
- Manufacturing cost reduction program
- One-pass truck for garbage collection and recycling

Pearls

The upper right quadrant contains projects with the greatest potential for both commercial and technical success.

Pearls address revolutionary commercial applications and they deal with proven technical advances.

Ideally ,we would like our R&D portfolios too contain dozens of pearls , as each one is poised to produce long term competitive advantage.

Examples include:

- Sub-surface imaging to locate oil and gas
- Next generation IC chip
- Artificial heart
- Phase III drug for an unmet medical need
- Replacement for silver in offset printing

Oysters

The lower right quadrant of the R&D grid represents early stage projects designed to produce new strategic advantage. They have blockbuster potential but breakthroughs are needed to unlock this potential.

Here ,the potential pay-off is very high but the probability of success is initially low. The majority of the projects in this quadrant ,in fact, are expected to fail. But those that do succeed should win big.

Some Examples of oyster projects are:

1. New approach to pain control
2. Optical computing
3. Technology for high-definition projects
4. Intelligent packaging materials
5. New kind of plastics

White Elephant

Projects in the lower left quadrant of the grid are like the kings white elephants; they consume resources , displace more promising projects and are unlikely to enjoy technical success or produce substantial commercial value.

Obviously ,no rational person would select one of these beats for his firm's portfolio-and few would claim credit for their inceptions.

But almost all companies have them. Invariably ,white elephants begin life as oyster or bread-and-butter projects, but become white elephants as commercial or technical defects emerge.

Examples of white elephants include;

1. Video tape rental vending machine as prices dropped
2. Innovative approach to cancer that was potent but too toxic.
3. Too small an investment in micro-electronics.
4. Technical approach to match competitor's actions

R&D Project Planning

The R&D project management is a part of project management. Project planning is one of the most significant activities of project management.

Project planning is a common thread that intertwines all the activities from conception to commissioning and handing over the clockwork to clients.

Project planning encompasses the essential activities such as work breakdown structure, statement of work and accurate time estimates and schedules which help further in anticipating snags in a project and overcome them.

Project controls are tools developed to diagnose the system for deviations from the actual plans/schedule.

Infact,project controls are measures taken by the project manager in order to minimize the gap between the planned output and the delivered output.

Objectives of R&D Project Planning

Analyzing: the aim of project planning is to visualize how the job will be done, in what order and with what resources by syncopating the project or part of the project, to a number of manageable activities.

Anticipating: is to focus on probable potential problems, to plan and overcome and is to predict associated risks so that their effects can be minimized.

Scheduling: is to identify appropriate resources to enable optimum utility of the available scare resources at each aspect of the project and also considering multiple projects together –for the organization as whole.

Coordinating and Controlling: is to seek for an un-interrupted network on the shop-floor as well as with outside parties and contractors involved in the project so as to develop a platform for appropriate estimating and controlling the time and costs**.**

Information Management

Functions of R&D Project Planning

- It provides a basis for organizing the work on the project and allocating responsibilities to individuals.
- It is a means of communication and co-ordination between all those involved in the project
- It includes people to look ahead
- It instills a sense of urgency and time consciousness
- It establishes the basis for monitoring and control.

R&D Project planning for Unknowns

There are two major types of unknowns: known unknowns, and unknown unknowns

Planning for known unknowns : predicting known unknowns involves thinking ahead and asking " what could go wrong?" much of the success or failure of an R&D project can be determined by thinking ahead about what could go wrong ad then using a structured approach to address the most important issues. One way to do this is by conducting a fatal flaw analysis.

Fatal flaw analysis: Starts with a brainstorming session with key project personal perhaps several other creative people not associated with the project, to answer such questions as : "What could possibly go wrong with this project? Or "What might happen that could have a bad effect on this project?'

During this brainstorming step , list all suggestions without making any judgment about their merit, validity, applicability, worth, etc. in this step , **you are just brainstorming flaws, not judging them**.

Cont..

The flaw ideas listed in box 1 "A", or top , priority . They are very probable and have a high negative impact of the project. Therefore, you must carefully address ways to either prevent these flaws from occurring and /or find a way to prevent these flaws from occurring and/or find a way to prevent the damage if and when they do occur.

The flaw in boxes 2 and then 4 are of "B", or next, priority. They also must be addressed ,being suppressed in importance only by the "A" priority.

Then "C" or third , priority items, found in box 5 , should not be ignored and should be dealt with as project resources permit. The flaws listed in boxes, 3,6,7,8 and 9 are either so unlikely or of so little impact that project resources probably do not justify dealing with them.

Planning for unknown unknowns

the common way of dealing with unknown unknowns is to add a contingency to the project cost estimate based on corporate policy and the uncertain nature of the project.

Contingencies for very uncertain R&D projects can be much as 30% or more of the total project cost.

A time contingency should also be added to the project duration estimate for unknown estimate for unknown unknowns.

And, performance contingencies are also needed. The magnitudes of these time and performance contingences depend on the specific project.

Tools of R&D project Planning

Bar-Chart: The Gantt chart shows a plan of action and how well progress is going hand –in-hand with the plan**.**

Merits	Demerits
Simple to draw and read	Difficult to update where there are many changes –charts can quickly obsolete and therefore be described.
Good for statistic environments.	Does not equate time with cost
Useful for providing overview of project activities	Does not help in optimizing resource allocation
Very widely used and call for no special knowledge of mathematics	Used only for small projects and is not helpful for medium sized or big projects.

Line –of-Balance

It is a specialized technique for repetitive tasks. This technique was developed to handle bulk activities in reasonably sized batches of a similar task-group.

Merits	Demerits
This is an excellent means to show resource allocation on the activities in an easily understandable manner.	This can not be applied for complex 'one-time projects' having multiple and inter-related activities.
This is exclusively used in construction industry or projects where the progress has to be often checked and to be made available to the layman.	It is only indicative on the minimum level of inventory rather than the optimum batch size which is essential for the complex and dependent activities.

Tools of R&D

Linear Programming (time- changing chart): This is a special tool for the road contractors. This has been in use successfully in the construction of large canals and drainages in under –developed regions and especially useful in tunneling for industrial effluvium.

Network analysis: It is powerful, logical and analytical technique. It is most effective used for complicated projects, especially those with external constraints and complex interrelationships.

This is performed through PERT and CPM techniques. Network analysis has a good and comprehensive logical basis, lends itself easily to computer processing and can be used as an effective control tool.

R&D Project Control

The successful execution of a project requires regular and continuous review and control of the project. During the planning stage a project has to be reviewed for correctness of financial and other variables provided in the plan.

The process of control involves 4 major steps as given below

1. Setting control of standards
2. Measurement of actual performance
3. Comparing the actual performance with the standards so as to find out deviation, if any, and also to determine the causes of deviations
4. Taking the corrective action.

Types of control Processes

The process of controlling a project is highly a complex task. The complexity is more than fixing the problem after waiting for something to go wrong.

Cybernetic Control: It is like a steering in an automobile that enables the controller to keep the project on track.

Cybernetic controls are generally used to monitor and control tasks that are carried out more or less continuously ,Eg., Software Projects

Cybernetic controls can be classified into 3 types, depending upon the sophistication of the standards set:

1. A first order control system
2. A second order control system
3. A third order control system

Types of control Processes

Go/No-go Controls : Go/No-go controls are instituted to check whether the output meets the preset cost and time standards.

These control systems are flexible and apply to all the aspects of project management.

Cybernetic system functions automatically and continuously ,while a go/no-go system functions only when it is put into application by the controller and is periodic.

Types of control Processes

Post Controls : These are the control systems that are applied after the completion of the project. These are called post project controls or reviews.

A post control report has the following sessions.

1. Objectives of the Project
2. Milestones check points and budgets
3. Final project result report
4. Recommendations for performance and process improvement.

Project Termination and Close Out

All projects have fixed start date and completion date. Project termination is a process that occurs whether a project is successful or not. Termination rarely has much impact on technical success or failure. But a huge impact on other areas,

1. Residual attitude toward the project (client, senior management and project team)
2. Success of subsequent projects

So it makes sense to plan and execute termination with care.

Types of Project Termination and close out

Administrative closure : This involves preparation of closure documents of the project being handed over to the customer as well as other administrative actions to ensure that the project and its assets are redistributed.

The other areas included in administrative closure are, archiving, facilities and personnel re-assignment.

1. **Post implementation evaluation report(PIER):** it records the success and failure of the project with historical record of the planned and actual budget schedule.

The PIER should normally contain the information about, project sign-off, staffing and skills, project organizational structure , schedule cost, risk quality configuration, customer expectation management and lesson learned.

Types of Project Termination and close out

2. Preparation of Report: It is the responsibility of the manager to prepare the report with input from the entire team, customers and the major stakeholders. If all the project managers cannot be consulted, a few must be taken into confidence before preparation of the report.

3. **Other important Administrative Documents:** There are some other documents associated with the closure of the project and include customer project sign-off and project documentation.

4. Collection of Project Archive Data: historic project data is an important source of information to help improve future projects. The following project data is required.

(i) Project Note Book (ii) project Plan (iii) Correspondence (iv) meeting notes (v) Status report (vi) Contract file (vii) technical documents (viii) files, program, notes etc.,

Types of Project Termination and close out

Financial Closure : Financial closure is the process of completing all financial and budgetary aspects of the project being completed. It is of two types:

1. **Project account closure:** It is an internal process that formalizes the termination of a project for the staff within this category.

The project completion date for a project is the date that all project related activities need to produce a product which should be completed.

2. Processes of Contract closure : It is the process of terminating contract that outside organizations or business have with the agency as part of the being performed.

In order to close a contract, it is important to collect all the pertinent documentation for review , which include all oroginal contract and supporting documents such as schedules contract changes and performance reports.

Types of Project Termination and close out

3. Financial Audit : It is through examination of a project by an evaluation team and includes detailed overview of the projects financial procedures, budgets, records, etc.

Audit can be done department –wise or budget as whole depending upon the size of the project. This can be done any time throughout the project period.

Audit Requirements: To make accurate audit, following information is necessary for assessment.

1. Budget plans (Staff and resource baseline)
2. Staff time sheets
3. Contracts with external organizations
4. Procurement Guidelines
5. Budget status report
6. Purchase reports
7. Change control results

Types of Project Termination and close out

Celebration of success : One step of the closeout phase is the customers acceptance of the system. This is a critical and important step, as the customer decides when the project is completed.

The questions that can determine success include :

1. Where the success objectives include
2. Do the stakeholder and customers view in a positive manner
3. Was the project well-managed?
4. Did the team worked together and knew wrong and right?
5. The success of the project can be celebrated in the form of a formal party and appreciating the efforts of the team members through gifts and certificates.

Factors affecting Project termination

Some other key factors that call for project termination are:

1. Probability of meeting technical objective is very low.
2. Inability of R&D to resolve the technical problems
3. ROI is not significant or is very low
4. High cost involved in running it as an individual project
5. Market potential of the delivered output is very low
6. Constantly changing market needs
7. Requires a vey long time to gain profits
8. Bears a negative impact on other profits
9. Problems created by intellectual property rights.

Resource Allocation and management

One of the main problems faced by a project manager is resource allocation. With the help of the network techniques ,the project manager can identify the critical activities. For completing the project in time ,he must have the required at his disposal.

A project manager frequently comes across resource constraints. There may be delay in the arrival of building materials.

With regard to resource constraints , a project manager may face one of the following two situations:

- Resource Levelling
- Resource smoothing

Resource Allocation and management

Resource Levelling : There are situations demanding that the project should be completed by a specified due – date. This due date for project completion is decided by the management various reasons.

Example: A canal lining project might be required to be completed before the monsoon sets on ; on school building might be required to be completed before the school re-opens after vacation.

The objective of the project manger in such a situation is to level as far as possible the demand for resources throughout the project execution time, keeping in view the constraints that the “specified “ project completion time should not be exceeded.

Resource Allocation and management

Resource Smoothing (Fixed resource limit scheduling) : The nature of problem under this head is that there is no time constraint; it does not mean that the project duration can be stretched too far.

Increase in project completion time will lead to increased overhead expenses. Hence ,though the project duration can be extended to satisfy the resource constraints, it shall be done in such a way that the project duration is extended to the minimum possible extent and at the same time satisfying the resource constraints.

The essential rules are :

1. When more jobs compete for the same resource, preference is to be given to the job/jobs with least float.
2. Jobs once started should continue till they are finished, i.e., breaking of jobs is not allowed
3. It must be ensured that the resource constraint is not violated at any stage while performing that above exercise.

Role of resource Manager :

The resource manager plays a key role in the development, allocation ,performance management of R&D resources. Key responsibilities include :

1. Recruitment and Hiring
2. Mentoring
3. Resource Allocation
4. Workload Management
5. Talent Management
6. Career management
7. Performance Management
8. Compensation and rewards Assessment

Role of resource Manager :

9. **Training needs identification**

10. **Remedial action :** Effectively address and correct any performance issues.

11. **Grows and supports :** Grows and supports the consulting division as required with strategic recruiting ,retention and compensation plans.

12. **Overall Resourcing :** understand business imperatives and react effectively to all resource issues. Ensure that we have the team in place; at the right time ,with the right skills to meet all development project challenges.

13. **Third party /outsourcing liaison**

TECHNOLOGICAL FORECASTING FOR DECISION MAKING

The definition of technological forecasting, forecasting, system inputs and outputs, classification of forecasting techniques, organization for technological, forecasting, current status.

INTRODUCTION

Definition: **"Technological forecast is a prediction of the future characteristics of useful machine, tools, equipments, procedure or techniques." ---- Misthin**

"Technological forecasting is the process of predicting the future characteristics and timing of technology."

Elements of Technology Forecast

Elements of Technology Forecast

Time : Time forecast should be stated clearly, as it defines the time frame and time relevance of the technology forecast .
Timing and as assessment of the performance level of technology into the future is essential.
Time forecast means (a) It is the future date when forecast is realized.
(b) This can be a single point or time of span.
Probability : It has the following four elements each of which must be properly defined so as to make a proper technology forecast and reap maximum benefits from it.
Get the subject right
Get the technology right
Get the context right
Get the assumptions right
Multiple approaches are best
Do it simply

Elements of Technology Forecast

Time : Time forecast should be stated clearly, as it defines the time frame and time relevance of the technology forecast .
Timing and as assessment of the performance level of technology into the future is essential.
Time forecast means (a) It is the future date when forecast is realized. (b) This can be a single point or time of span.
Probability : It has the following four elements each of which must be properly defined so as to make a proper technology forecast and reap maximum benefits from it.

Get the subject right
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Technology Forecast Principles

Factors necessitating forecast of technology

- To maximizes gain from events external to an organization
- To maximize loss associated with uncontrollable events external to an organization.
- To maximize gain from events those are a result of action taken by an organization.
- To forecast demand for production and inventory control.
- To forecast demand for facilities and capital planning
- To develop administrative plans and policies internal to an organization.

Benefits of Technology

- The forecast identifies limits beyond which it is not possible to go.
- It describes the alternatives that are open for choice.
- It indicates the possibilities that might be achieved if desired.
- It furnishes warning signals which can alert the decision maker that it will not be possible to continue present activities.
- Estimate the future performance of components which will be available from suppliers at the firm plan to introduce a new design.
- Anticipate technological changes which will allow firm to gain a competitive advantage by alerting firm's organization or distribution method.

Technology Forecasting process

Forecasting process:-

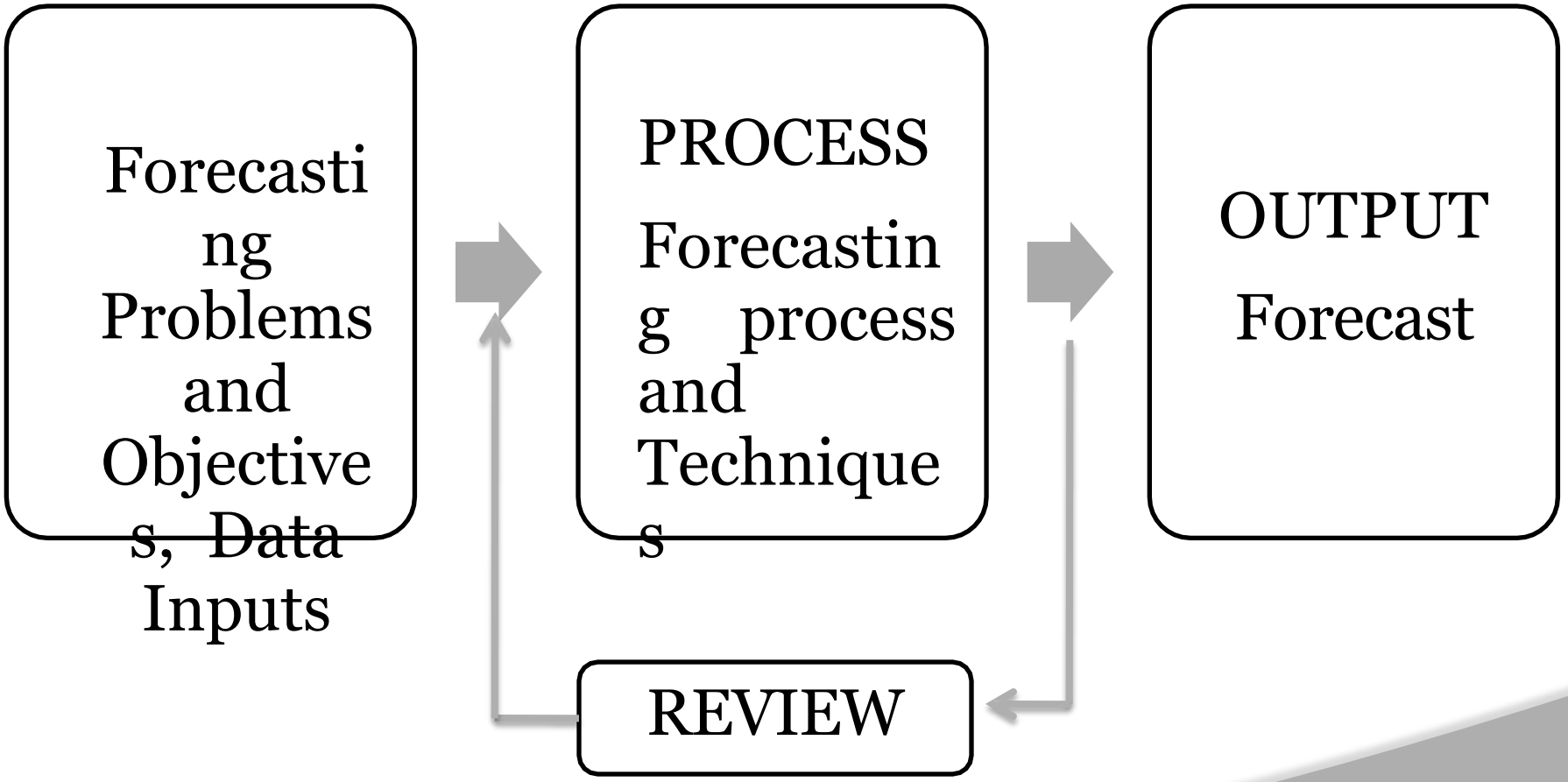
Trends or event ⇨	Inputs ⇨	Methodology ⇨	Outputs ⇨	Purpose
1. Economic	1. Assumption	(forecasting	1. Phenomena, Business	
2. Technological	2. Insights	techniques)	attribute, events	technical
3. Social/political	3. Data		2. Measures,	
			Pala metes	
			3. Time probability	

Why Technological Forecasting

- It is Indispensable
- It improves Quality of Decision making
- Scanning the technological environment
- Anticipating emerging technological changes
- Identifying suitable technologies by evaluating various alternatives
- Planning for future technology needs

Technological Forecasting Model

Viewed as a Input – Process – Output System



Inputs to technological forecasting system

The inputs to the forecasting system are:

Assumption : There are always number of assumptions which form the basis of understanding of how any system works. These assumptions must be questioned since they may not sufficiently reflect the condition of the future. Thus we note that

1. Assumptions should be identified and assessed in relation to the future when they may no longer be true
2. They should be noted and made explicit.
3. The factors which invalidate previous assumptions frequently arise from economic, political or social changes.
4. Mathematical forecasting models always incorporate assumptions.

Inputs to technological forecasting system

Quality of thinking : It has to applied to the evaluation of the future. In discussing the outputs it was stressed that the starting point must be the identification of the appropriate phenomena or events which will shape the future environment of the business.

Data : In order to quantify it is necessary to have data which must relate to the present and the past. Unfortunately the quality of data is usually poor. At one extreme, we have demographic statistics which for most practical purposes are sufficiently accurate.

Classification of forecasting techniques

The major techniques for technological forecasting may be categorized in to two types.

1. **Numeric Data-based technological forecasting techniques**

Trend Exploration :

Statistical curve Fitting

Limit Analysis

Trend Correlation

multi trend Correlation

Trend Extrapolation, qualitative Approaches

Growth curves

Envelop Curves

Substitution model

Classification of forecasting techniques

2. Judgment based Technological forecasting techniques

(a) Monitoring
(b) Network Analysis
(c) Scenarios
(d) Morphological Analysis
(e) Relevance trees
(f) Delphi Method
(g) Cross-impact Analysis

Trend Extrapolation : to extrapolate is to infer the future from the past. It there has been a steady stream of technological change and improvement, it is reasonable to assume that the stream will continue to now. It can be distinguished 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 past data to one or more mathematical functions such as linear , logarithmic, Fourier or exponential. The best fit is selected by statistical test and then a forecast is extrapolated from this mathematical relationship.

Forecasting Techniques- Trend extrapolation

Limit Analysis : Ultimately ,all growth is limited and there is an absolute limit to progress, either recognizes or unrecognized. Sooner or later, projects must reflect the fact that improvement may get close to this limit but cannot exceed it.

Example : the lowest temperature achieved in the laboratory is presented in below figure.

Forecasting Techniques- Trend extrapolation

Trend Correlation : At times, one technology is a pre-cursor to another. This is frequency the case when advances made in the pre-cursor technology can be adopted by the technology.

When such relationship exists , knowledge of changes 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. Further , extrapolation of the precursor allows a forecast of the follower to be extended beyond the lag time.

Forecasting Techniques- Trend extrapolation

Multi Trend Correlation : Occasionally, a follower technology is dependent on several precursor technologies rather than on a single precursor.

In such cases , the follower is usually a composite or aggregate of several precursors.

Fixed 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.

Example : improvements in aircraft speed may come from improvements in engines, materials, controls , fuels, aerodynamics and from various combinations of such factors.

Forecasting Techniques- Trend extrapolation

Qualitative approaches : At times, standard statistical procedure do not result in neatly fitting trends that the forecaster can extrapolate with comfort.

Forecasts generated in this way are less precise than statistically based forecasts, but not necessarily less accurate.

One example of this kind of qualitative trend extrapolation is the prediction of aircraft complexity. The attempts to quantify this trend have not been successful.

Forecasting Techniques- Trend extrapolation

Growth Curves : The growth pattern of a technological capability is similar to the growth of biological life. Technologies go through an invention phase, an introduction and innovation phase and a maturity phase.

In doing so, their growth is similar to the S-shaped growth of biological life.

Technological forecasting helps to estimate the timing of these phases. This growth curve forecasting method is particularly useful in determining the upper limit of performance for a specific technology.

An example of growth curve analysis is shown in fig

Forecasting Techniques- Trend extrapolation

Envelop Curves : A serious constraint on growth curve is overcome by appropriate specification of the capability to be forecast.

For example , below fig shows a growth curve for the speed of propeller driven aircraft and only data for propeller-driven aircraft.

If remove the modifier propeller –driven from the capability to be forecast, it can add data on jet; ram jet and rocket planes, as in fig further.

If we generalize the capability even more to “speed of travel”, we get figure below, a series of specific growth curves super-imposed on one chart and enveloped by a single curve, termed and envelop curve.

Fundamentally, envelop curve is a combination of growth curve and trend analysis.

TRANSFER OF TECHNOLOGY

Transfer of technology: modes of technology transfer, price of technology transfer, negotiation for price Of management of technology.

Definition of Technology Transfer

"Technology transfer can be defined as a process by which science and technologies are transferred from one individual on group to another that incorporates this new knowledge into its way of doing things"

--- Jain and Traindis (1990)

" The process of providing the technology developed for one organizational purpose to other organizations for other penalty used purposes."

---The National Aeronautics and Space Administration (1995)

Technology Transfer vs. Technology Acquisiti

The verb ‘acquire’ means

To come into possession of get as one’s own.

To gain for oneself through one’s actions or efforts

“ Technology acquisition is the process of acquiring a new technology , new product, processor service by the efforts of a individual or an enterprise or any other macro entity. The process can be conducted either internally or externally to the enterprise.”

Differences – Technology Transfer and Technology acquisition

Technology Transfer	Technology Acquisition
Slightly wide in scope	Slightly lessor in scope
Includes both formal and informal arrangements /processes.	Usually includes formal arrangements / processes.
May or may not have legal boundaries	Usually have legal boundaries.
Focus on transfer from transferor to recipient.	Focus on the transaction from the angle of acquirer.

Classification of Technology

Technology transfer can be divided into two types

Horizontal Technology Transfer: implies transfer of technology from one firm to another.

Vertical Technology Transfer: from an R&D organization to a firm. It involves considerable risk**.**

International Technology Transfer: it is across national boundaries.(industrialized countries to developed countries)

Regional Technology Transfer: one region of the country to another . Ex: Hyderabad to Bangalore

Cross-Industry or technology transfer: One industrial sector to another sector. Ex: Space program to Commercial Applications.

Classification of Technology

Inter firm Technology Transfer :one firm to another firm. Ex: CAD expertise and CAM machines .

Intra-firm Technology Transfer : within a firm from one location to another.

Ex: One location to another location (Ex: manufacturing companies)

Reasons for Technology Transfer:

Profit from selling Technology : Ex: Kodak had to quit the Japanese market because of certain restrictions.

Location and Logistic advantage

Competitive Edge : foreign markets through the supply of technically superior products.

Grants and subsidies : various incentives to MNCs.

Limitation of Home Country

Superior capital markets

Enhance Competence

Levels of Technology transfer

- Operational level **:** theses involve manufacturing skills, quality control, maintenance and procurement skills.

- Duplicate level : includes the investment capabilities needed to expand capacity and to purchase and integrate foreign technologies.

- Adaptive level : imported technologies are adopted and improved, and design skills for more complex engineering learned.

- Innovative level : based on innovative skills and formal R&D, that are needed to keep pace with technological frontiers or to generate new technologies.

Methods of Technological Transfer

- **General Channels :** This technology transfer is done unintentionally and many proceed without the continued involvement of the source. Channels of this type of transfer include education, training, publications, conferences, study missions, and exchange of visits.
- **Reverse Engineering Channels:** Other channels in which the transfer occurs with no active contribution from the source include reverse engineering and emulation.
- Ex: A product that is put on the market by Company' X' can be purchased by Company's', reverse engineered , and introduced to the market as competitor to company x' s product.

Methods of Technological Transfer

- **Planned Channels:** The technology transfer is done intentionally , according to a planned process and with the consent of technologically owner.
  - Foreign Direct Investment
  - Licensing
  - Franchising
  - Management Contracts
  - Contract Manufacturing
  - Joint Venture
  - Technical Consortium and joint R&D project

Methods of Technological Transfer

Other Channels: Transfer of technology takes a variety of forms depending on the type of forms depending on the type , nature and extent of technological assistance required.

- Trade in Goods and Services
- Contracts and Agreements
- Research & Development
- Personal Exchange
- Publications
- International Visits, Conferences, Exhibitions
- Teaching and Training

Price of Technology Transfer

The issue of price attracts much attention because of ongoing negotiations between DCs and less developed countries (LCDs).

Generally technology is patented, the seller is in the position of power. This allows seller to choose to whom they will sell, for what price and under what conditions.

Because is each technology is unique, the types of revenues from technology transfer activities may vary depending on the terms of the specific license agreement.

Examples of revenues that are commonly negotiated as part of licensing arrangement include:

Licensing fees

Minimum payments

Cross-Licensing Agreements

Price of Technology Transfer

Licensing fees : These are payments for the use of the technology, typically to cover administrative costs and are usually assessed up front.

Minimum Payments: These are guaranteed amounts that are generally paid annually by licenses and may be applied against earned royalties.

Cross-Licensing Agreements : It is the mutual exchange of specific license between relevant parties.

Ex: A company provides a license to B company for the use of its technology and simultaneously receives a license for the use of to B company's technology this becomes mutual execution.

Price of Technology Transfer

Matters to be attended to cross license contracts:

Matters to be attended	**1.** Number of patents (scope)
	2. Number of products using the patent (business quality)
	3. Effective period for each patent
	4. Value of the invention (the proportion of the entire invention In the section including the patent)
	5. Whether it is from a new inventor or an improved invention (the strength and independence of the patent)
	6. The validity level of the patent (possibility of invalidity)

Negotiation for price of management of technolog

A Technology transfer agreement that results in a satisfactory long – term relationship between two or more parties is one in which the parties recognize that the agreement must provide benefits for each.

Once this principle is accepted by negotiators , the process moves more smoothly.

It can be enhanced in two ways:

1. By preparing a proposed agreement between the parties
2. By conditioning negotiations to arrive at a mutually acceptable final text that gives each party the appropriate rights and obligations.

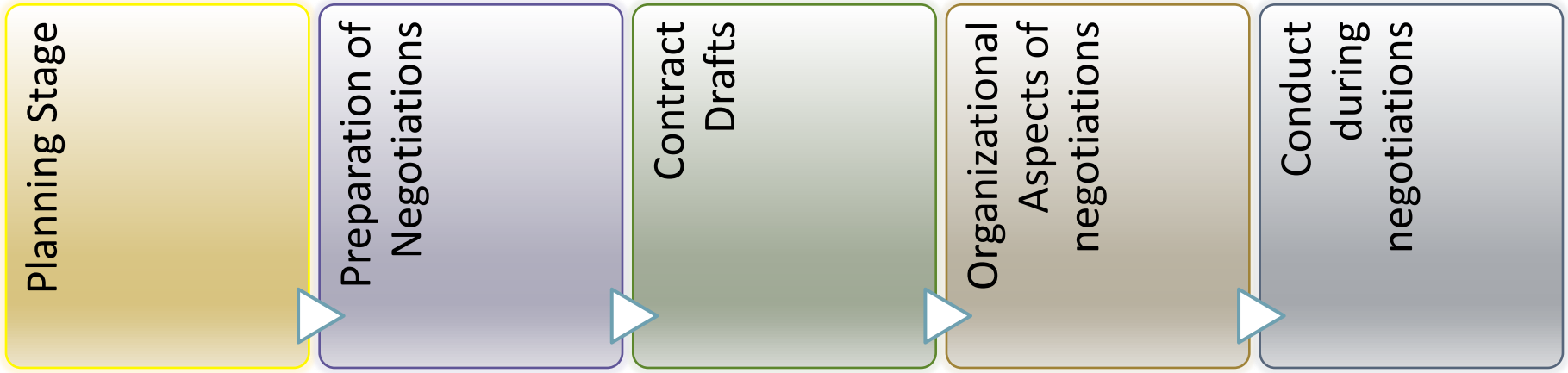
Role and objectives of Negotiations in MOT

Mutually Satisfaction Structure: In the course of preparing for detailed negotiations , the negotiations team presumably formulated a preliminary structure for the proposed transaction.

Executed Agreement : The negotiation team will have prepared a draft of the contract documents that contains terms and condition that it believes are required or desirable to govern the implementation of the transaction.

Long term relationship: The role of negotiations is to provide a process by which agreement can be reached on terms and conditions that are the basis for a lasting, mutually beneficial relationship.

Negotiation process in MOT



Negotiation process in MOT

Planning Stage:

Objectives: Before an agreement is drafted , each party needs to determine its objectives for concluding a deal.

A technology transfer relationship often begins when one party submits an outline or preliminary proposal to another, offering rights to intellectual property or expressing interest in purchasing such rights.

Proposal Analysis: The first step to be taken after receipt of a proposal is to appoint a technical group to analyze it, list all of the questions it raises and identify and request any additional information that is required from the party submitting the proposal.

Information on the subject matter of the proposal should also be sought from independent sources.

Negotiation process in MOT

Preliminary Structure of the relationship :

Once the required information has been collected and analyzed and it is determined that the proposal should be pursued , a preliminary structure for the relationship should be formulated and evaluated in terms of how it will meet needs and objectives.

Ex: If a patent , license is being offered , the technical team should team determine if pertinent know-how, trade marks and or copyrights should be included and should have some idea of the amount of training and on-going technical assistance required.

Negotiating Team : Once a preliminary agreement structure has been agreed upon , a negotiating team should be selected.

Composition of Negotiating Team : The team that does the planning for the negotiation should consist of at a minimum , the chief negotiator , a technical expert, a financial expert and legal expert.

Preparing for Negotiations

Once the negotiating team has been appointed , it should start preparing for formal negotiations with the other party.

Develop key information : Key information like nature of technology of the product, equipment required, raw materials an utilities needed the material flow and product specifications and technical assistance requirements and also financial aspects and other related information.

Defining key objective: Adequate preparation requires the negotiating team to determine how it's technical and economic objectives can be optimized without making the agreement unduly one sided.

Information about other party : Information on financial position may initially be obtained from the party itself. If it privately owned information can also be obtained from large banks and credit agencies.

Negotiation process in MOT

Objective of other party : Acquiring background information about other party may give the negotiating team a good idea of he other party's objectives, priorities and concerns.

It will help to satisfy interests on both sides would greatly facilitate a mutually satisfactory agreement.

Contract Drafts

A draft contract is a “ deal focused “ contract which is as far as possible, complete save for those areas which you wish the perspective providers to “bid back “ as part of the competitive process.

1. Point at which they enter the process.

Cont..

Preparing the first Draft: The first draft of a contract is commonly thought to have an advantage.

The first draft sets agenda for the negotiations an places the onus on the opposing party for arguing for and justifying any substantive changes.

When the required and desirable provisions have been selected and draft has been reviewed and intentionally approved, it should be sent to the prospect in sufficient time for that party to review it before a first negotiation date is set.

Organizational aspects of Negotiations

Some of the more important organizational aspects of negotiations are:

1. **Physical arrangements**

First Category includes as satisfactory hotel accommodations, and high level logistical facilities.

Second category involves the relative size of the negotiating trams, the size of the negotiating room and the seating pattern around the negotiating table.

1. **Meeting length and Frequency**
2. **Informal meetings**
3. **Language differences**
4. **Premature Publicity**

Conducting during Negotiations

Negotiations have different views on how negotiations should be conducted:

1. Adversarial approach
2. Principled Negotiations

Roger Fisher- method calls for negotiators to be problem – solvers with a goal of reaching a wise agreement efficiently and amicably. It has four basic points.

i. People: Separate the people from the problem
ii. Interests: focus on interests , not positions
iii. Options : Generate a variety of possibilities before deciding what to do.
iv. Criteria : Insist that the result be based on some objective slandered.

Negotiating Techniques

1. Defer Difficult Issues / Create a Momentum of agreement
2. Take up general propositions before specific ones agree on the principle before the specific language
3. Use Committees to resolve difficult issues
4. Keep score of Concessions /quid pro quo's/propose package deals
5. Use the two way street Argument
6. Apply the most favored Nations Solutions
7. Spread the Concessions units
8. Structure the negotiations

Negotiating tactics

- Bad guy/ Good guy
- Divide and Conquer
- Trail Balloon Red herring / Straw man
- Threatening Walkout
- Last minute demands

General Provisions of Technology Transfer

Objects of Technology Transfer:

1. The objects of industrial property attached to or separated of the machines equipment that law allows to transfer.
2. Know-how, technology Knowledge in forms of technology process, computer software, drawings, formulas and technical data attached to or separated from machines and equipment's
3. Technical services, training of technicians ,information on the transferred technology
4. The solution for the rationalization of production

If the objects of technology transfer are protected as the object of industrial property then the passage of ownership on or passage of the right to use these objects must be carried out pursuant to law before technology is transferred.

General Provisions of Technology Transfer

Right on technology transfer:

1. The state shall guarantee the interests of individuals and legal persons in technology transfer.
2. Those legal persons ,individuals who are the owners of the objects of industrial property and those who are right to dispose of the objects of industrial property as well as those who are the owners of know-how , technology knowledge have right to transfer the right to use the objects.
3. The authors who create know-how , technology knowledge under the assigned duty or under the concluded contract on technical implementation may transfer these know-how and technology by consents of the owners.