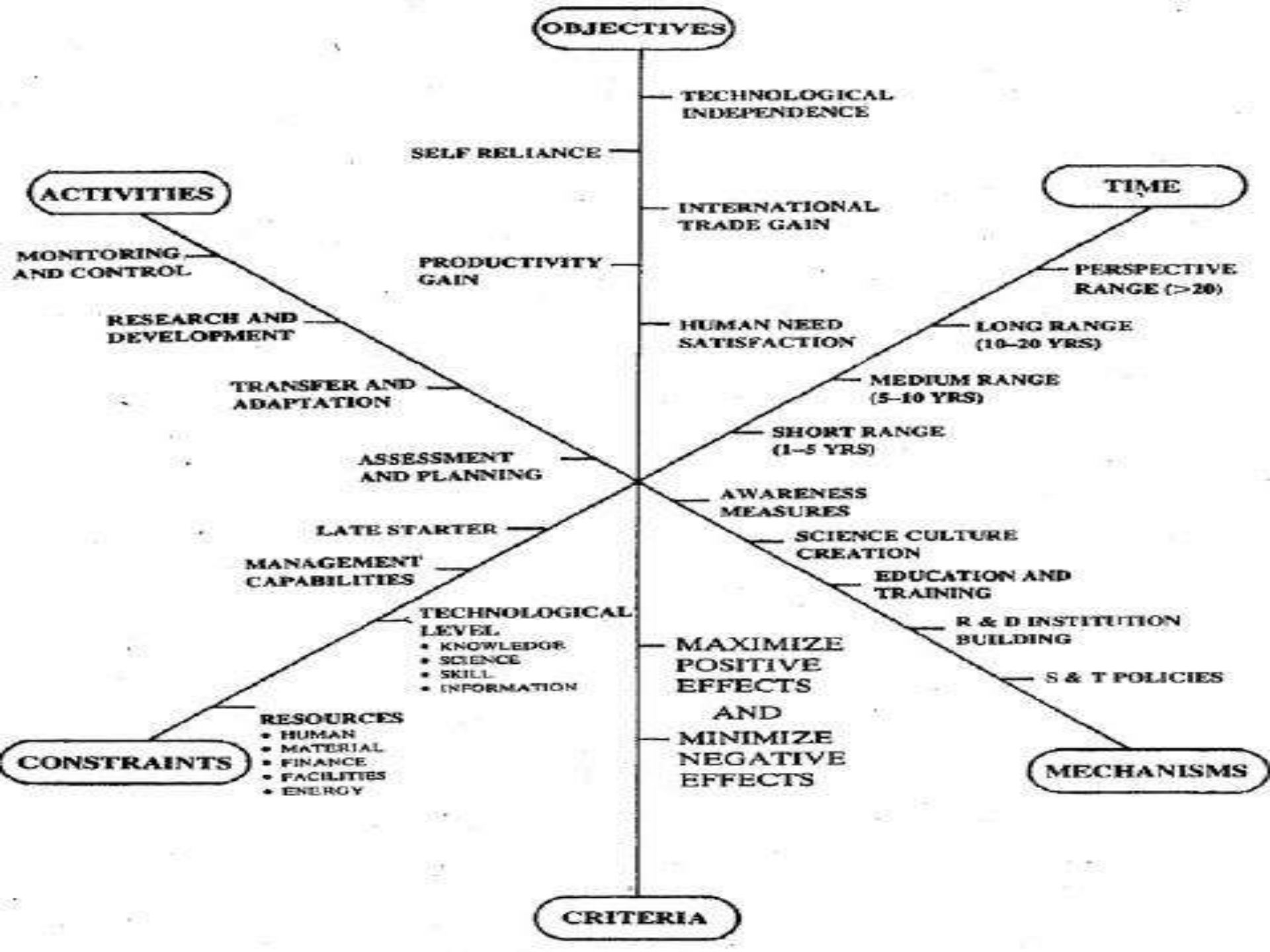


What is technology management ? How technology development progress from invention to innovation ? Explain citing one such example.

- Many factors make up the technology development framework and there are several ways of condensing these into a manageable number of grouping. These factors are grouped around six broad dimensions (as in **figure-1**) :

- 1. **Objective**
- 2. **Decision Criteria**
- 3. **Time**
- 4. **Constraints**
- 5. **Activities**
- 6. **Mechanism**



- Obviously these dimensions are interlinked and a proper management of technology requires a systematic consideration of all of them.
- According to Soleman, **technology management** is the capacity of a firm, a group or society to master management of the factors that condition technological change, so as to improve its economic, social, and cultural environment and wealth. That technology management is important, becomes obvious if one considers both what the economist call the 'input' and the 'out put' aspects of technological change, namely sources of modern technology on one side and its pervasive impact on society on the other. These facts are obvious for all countries . however technology management is more important for those countries which do not participate directly in 'input' aspects or do so less intensively than the industrialised countries and therefore necessarily less well prepared to adjust to and master the 'output' aspects. This is the case today in most developing countries

According to Stephen Millett the following four general factors are considered to successful R & D management :

- A responsiveness to the needs of clients and customers.
- Regular top-down and bottom-up communication
- An awareness that technology alone are not products &
- Recognition that non-technological factors have profound impact on R & D.

Technology development from Invention to Innovation

- Managing technology is taking risks, in novel products and developing new markets. In the world of rapid technological process and changing competitive environments and market needs, firm must pay increasing attentions to developing new innovative products for domestic and world markets, and therefore an efficient technology management system is important for them.
- Let us first clarify the distinction between innovation and invention. Since invention is only the beginning of innovation.

The steps required to transform invention into innovation can be illustrated in the famous Xerox Story.

- **The Xerox Story** : in 1935, **Chester Carlson** was working in the patent office of Mallory Company. His technical background included work as a carbon chemist, printer and then as patent lawyer. He became concerned about the errors in copying patents for public dissemination and the costs involved in copying. Using his chemistry and printing background, he began experimenting the new way to create a copying process. His basic idea was-

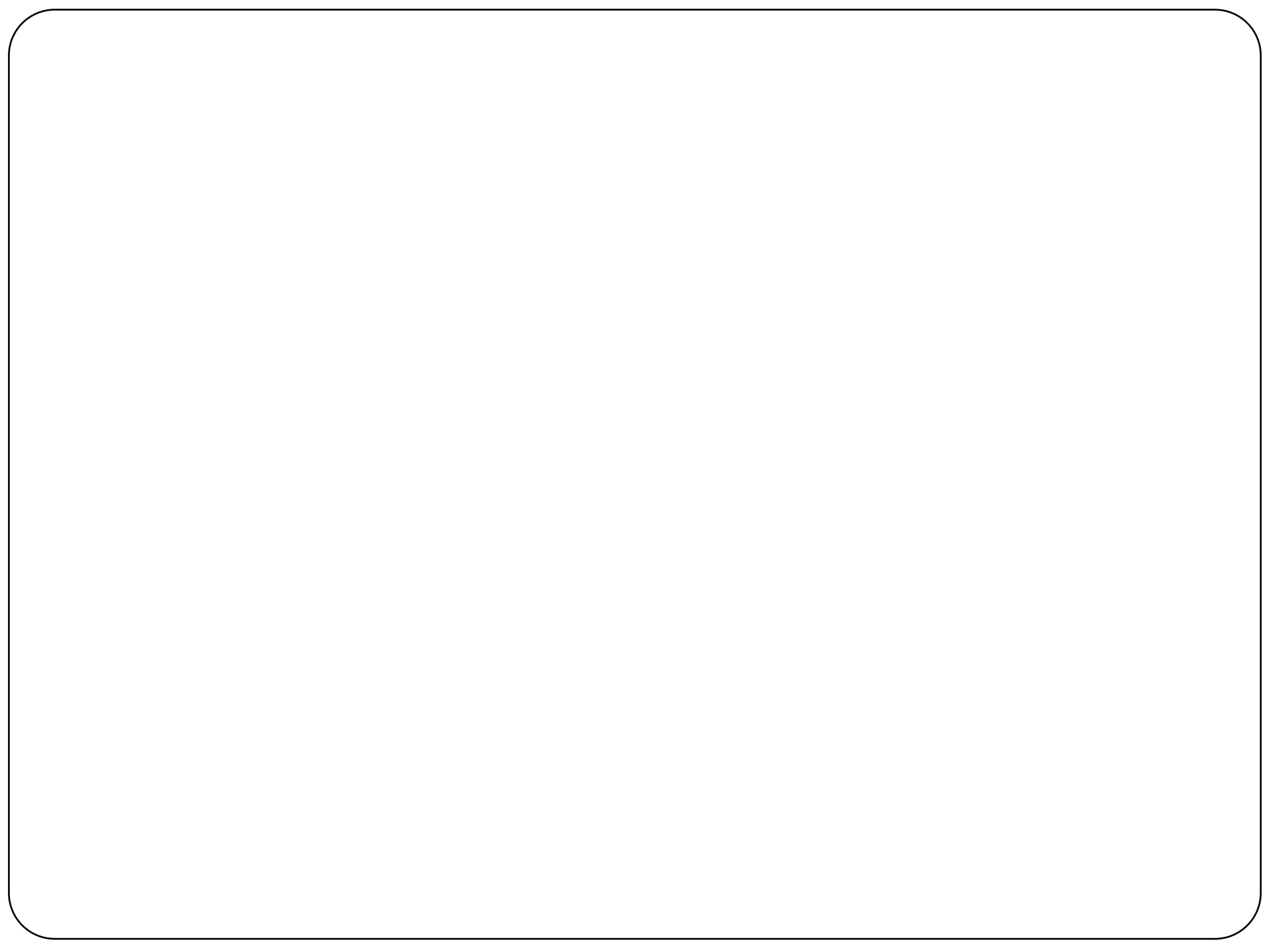
- To project the image of a typed paper onto a blank sheet of paper coated with dry ink.
- b) To hold the ink temporarily at spaces of typed letters by static electrical charges included by the light and
- c) Finally, to melt the ink into the paper by backing the paper. This would produce a quick dry reproduction of a typed page and the process came to be called as **Xerography**.

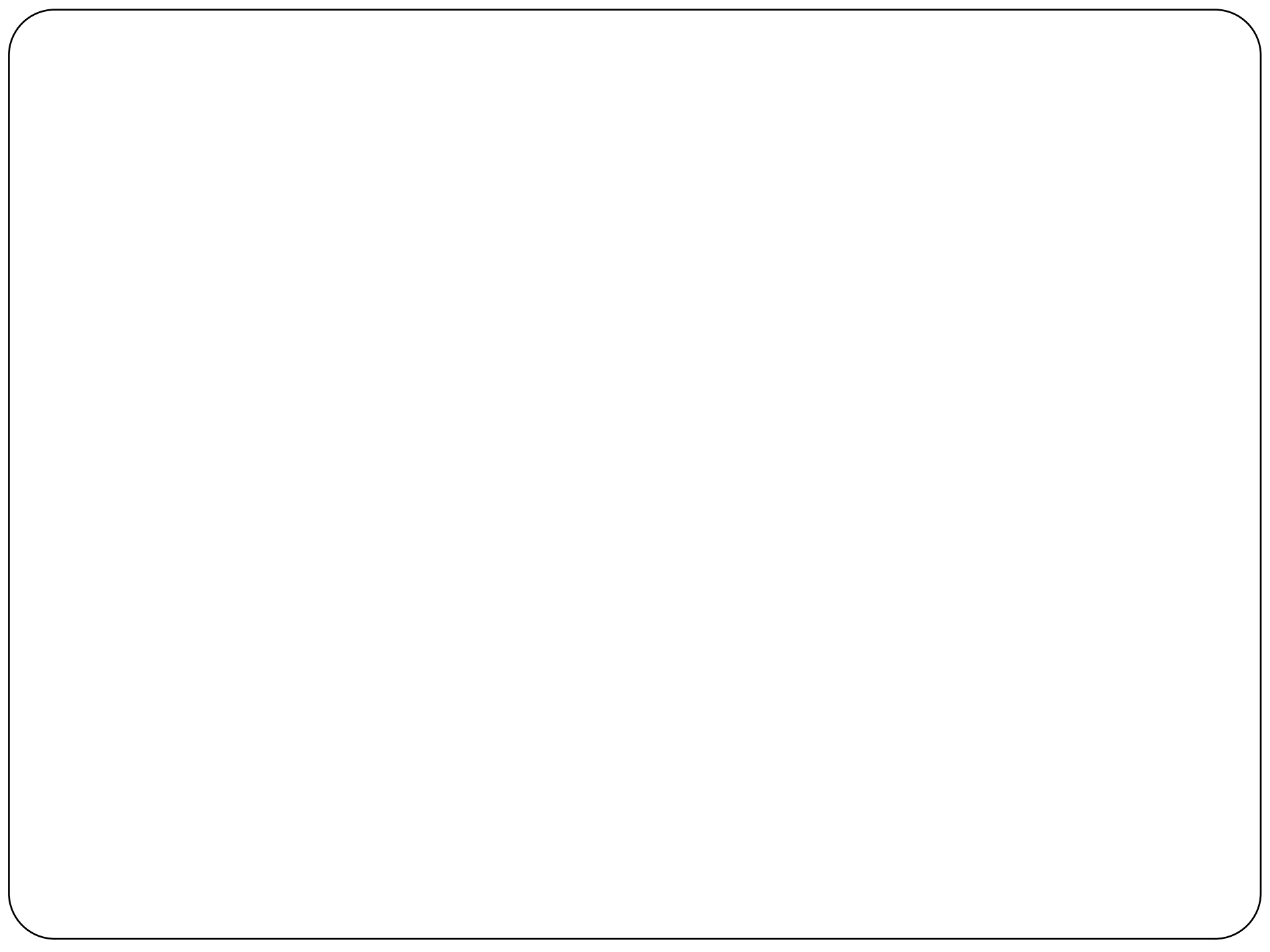
- Carlson succeeded in obtaining a crude image, thereby reducing his idea into practice. He filed for a patent. Yet like all new inventions, it was still not commercially efficient, cost effective or easily usable. It required development. Development of a new technology usually costs a great deal of money, takes time and requires skilled resources. All inventors face similar problem-first conceiving the invention, reducing it to practice, obtaining a patent, then obtaining support for development and commercialisation.

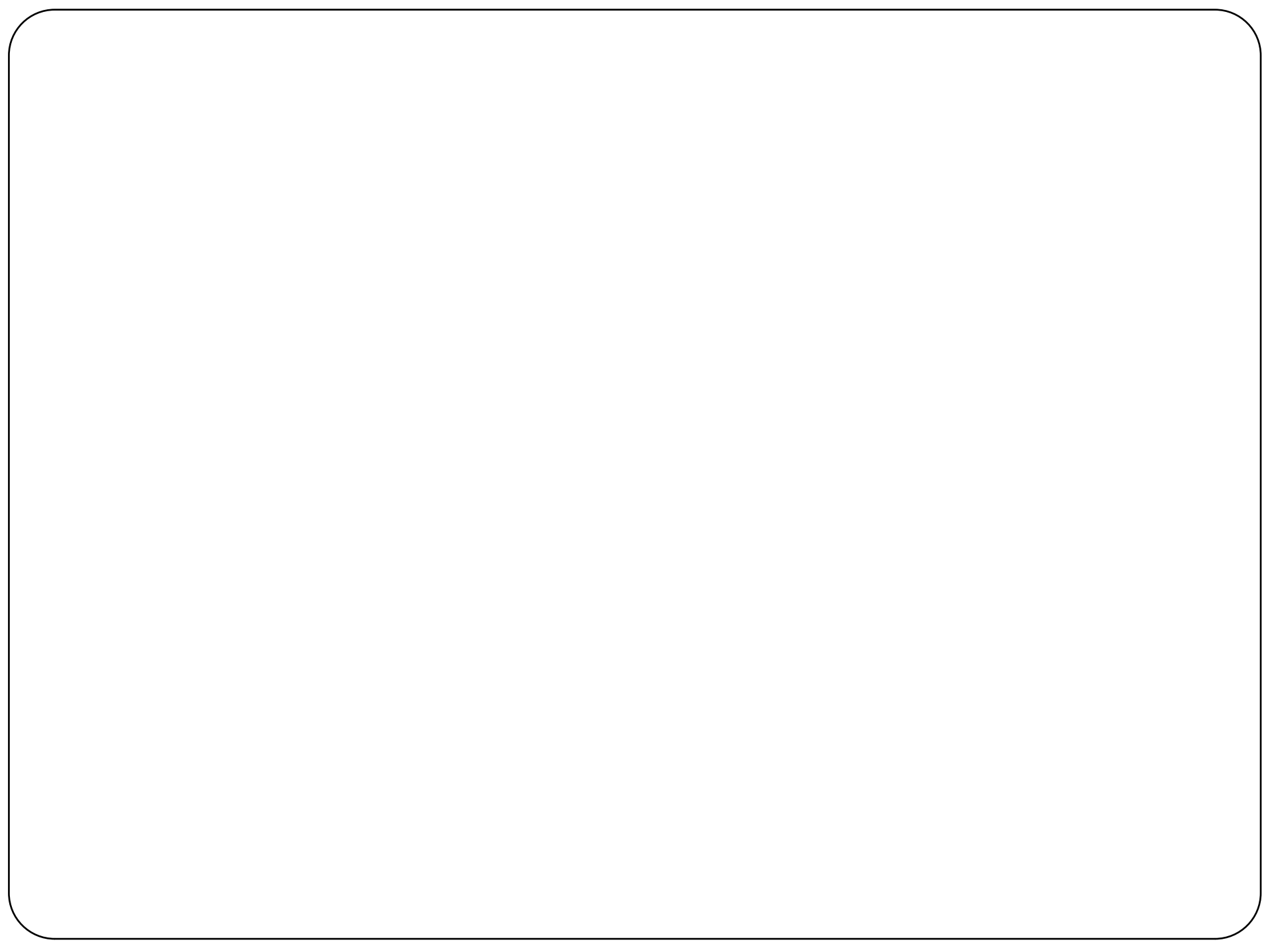
- Carlson went from company to company seeking support. He was turned down, again and again. By 1942, he has obtained the valuable patent on the basic process. Then a venturesome group at **Battelle Memorial Institute** agreed to work on the development in return for a share in potential royalties. Battelle was a non-profit research and development organisation with a range of advanced technological research capabilities. Finally he invention pieces for Carlson began to fall in place-invention, patent, development and commercialisation. In 1945, while Battelle began development of Xerography process, a small company named **Haloid** learned of Carlson patents. **Joseph Wilson**, president, was a risk taker and was looking for new products. Wilson produced the first Copier, using Carlson's patent and Battelle's development.

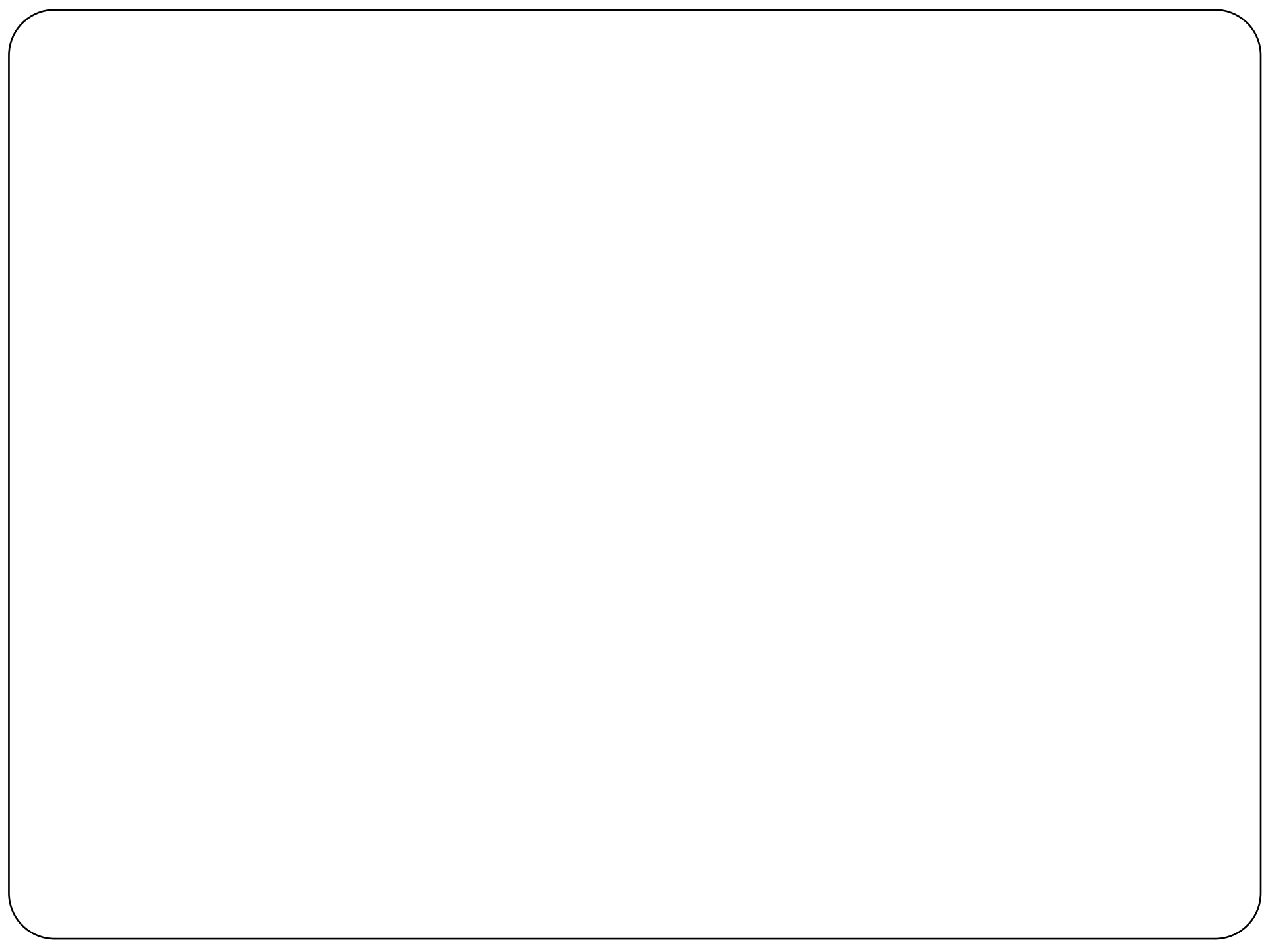
- The rest of the story became business history. That company became **Xerox**, creating a new industry on office copying products. Xerox grew tremendously, keeping a technological and marketing dominance over the industry for almost three decades.

- The interesting questions to ask are : how many companies missed out on the Xerography patents? Why did it take R & D outfit like Battelle to see the technological potential in Carlson's invention? What leadership qualities do innovative, risk taking manager like Joseph Wilson possess?
- Effective technology management in various countries have led to several technological advancements in the past. And if correctly synchronised with business process could dominant in terms of growth and wealth creation.









Scope of Technology Management

It deals with:

1. Strategic Decisions and Strategic Planning

Technology management tells you how to foresee the company. 20 years hence what will be the position of our company? Will it get closed down or will it grow to No.1 company?

What plans we have to make for 20 years.

2. Research and Development

On what topics we have to conduct Research and development? What will be the benefits of research and development? Will it bring us crores of rupees of profit or not?

On what topic we have to conduct Research? What will be the expenditure on Research?

3. Technological Innovations

How to do technology innovation? How to set qualified staff on innovation projects?

4. Technology Transfer

How to get latest technology to India from advanced countries like America? How to build new labours for conducting Research?

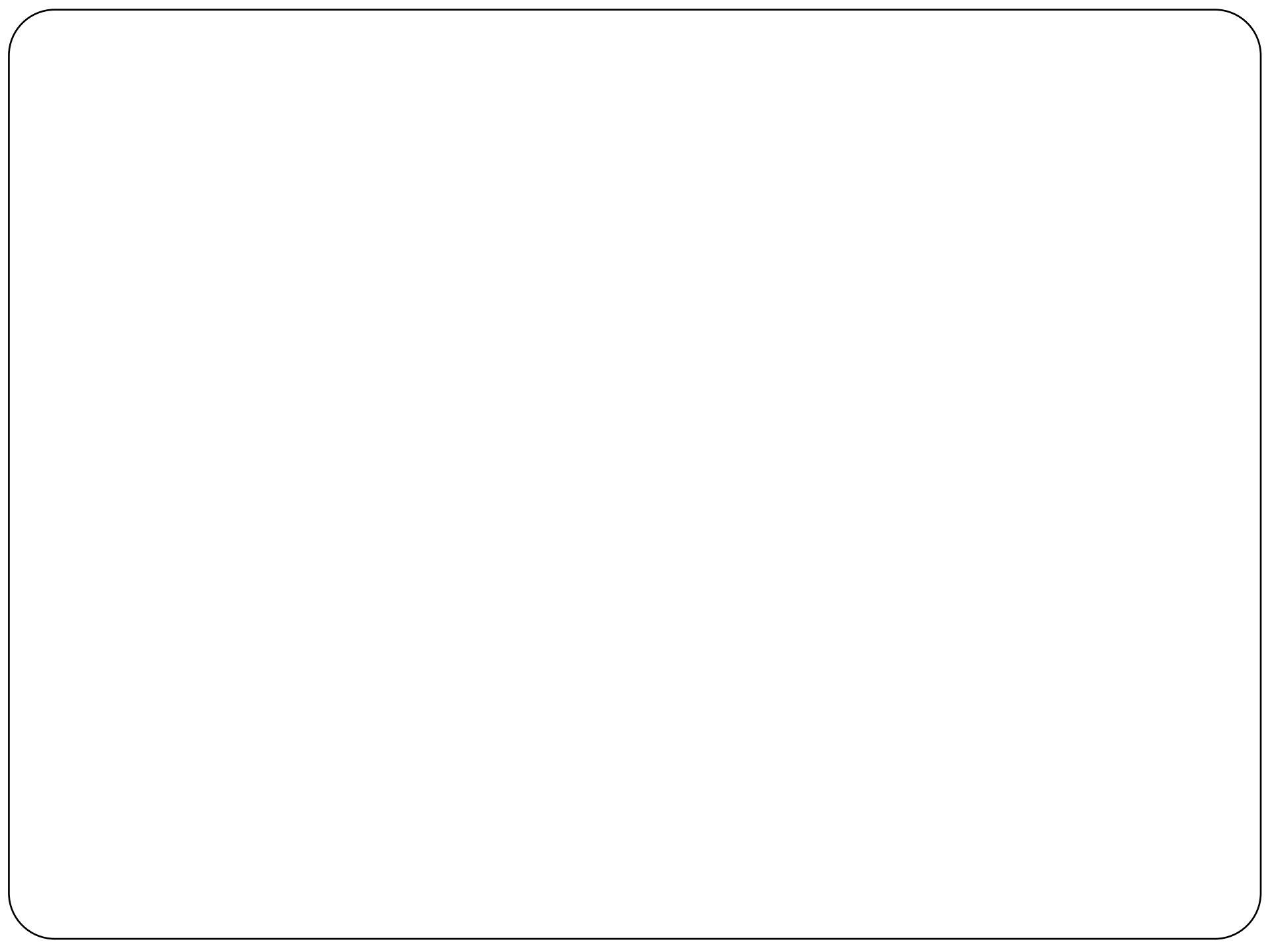
5. Financial Decision Making

How much money we have to invest in the research and development of a particular new product.

6. Quality and Productivity Issues

How to improve the quality and productivity of our goods?

The quality of our goods should be comparable to the best in the world. This will increase demand at our goods.



TECHNOLOGY MANAGEMENT AND GLOBAL COMPETITIVENESS

The competitiveness of a country depends upon the appropriate use of the cardinal principles of technology management.

It depends on how well you use Principles of Technology Management.

It depends upon:

- The strength of national research expertise
- The presence of large number of scientists and engineers
- The information technology
- The Individual creativity
- The co-operation of basic scientific and technological research
- University-Industry interaction.
- The infrastructure like R & D labs with sophisticated machinery and latest equipment reputed technologists and scientists etc.

At an International conference the scientists and Technologists were asked to rate American competitiveness with respect to countries, like Japan, Italy, Canada and Australia. The best country would be given a rank one and worst country a rank of 12. America was given a Rank one along with Japan.

20 years before especially in 1970's Japan, Germany etc. had overtaken America in the field of competitiveness. But in 1994, it was found that America had regained it's No. 1 rank in the field of competitiveness. The regain of competitiveness of American firms i.e., No.1 rank of USA can be directly attributed to the fact that American companies strictly followed the cardinal principles of Technology management.

In some of US universities they have courses like M.S. offered in technology management.

workers is lacking.

SUCCESS STORIES IN COMPETITIVENESS

Story of Japan

Before 1970, made in Japan was a symbol of bad quality. But no more. In 80's and 90's Japan has emerged as an unrivalled leader in quality of goods. Everywhere in the world, Japanese goods have highest sale. Plus, Japan has defeated Americans in America itself in the car industry. The success of Japan over America is mainly due to total quality management principles. Given by quality guru late Dr. Edwards Demings. Commitment to quality dedication and hard work coupled with strong desire to him has placed Japan in No.1 slot in the world map. Their planning is also superb. In Japanese culture life time employment and team works is a vital factor.

The day starts with the singing a company song. The company manager and workers both dine together in the Company canteen. The managers are very much friendly with the workers and it is not unusual for company's Managing Director to visit a worker if the latter is in a hospital. That is superb work culture and team work are also some of main factors for Japanese success. The Japanese have quality circles which are a voluntary informal group of 4 to 5 workers, who meet for one hour every week end, to discuss quality problems and rectify them. The principle of Kaizen (slow gradual improvement in all fields is followed by Japan) Jit-Just-in-time principle is followed

University, Industry linkage is also high. Japanese spend Millions of Yen in research and development in industrial products. All these are factors that gave No. 1 slot to Japan in the field of industrial competitiveness.

ANNEXURE-1

Singapore, Korea and Hong Kong had risen very high in competitiveness, but have fallen behind very soon. The reason is that in these countries strong educational base is lacking. There the

TECHNOLOGY LIFE CYCLE

The performance of technology has a recognized pattern over time. While dealing with technology, we have to carefully consider the position and state in which our technology is situated. There is obviously no point in purchasing obsolete technology for crores of rupees. If we purchase a technology which is going to become out dated or out fashioned within 1 year then it is foolishness and utter loss of money. It makes tremendous sense in purchasing a technology which is the current fashion of the market.

Let us plot the technology performance criteria on Y axis and time on X axis. We get a S-shaped curve which has following critical phases.

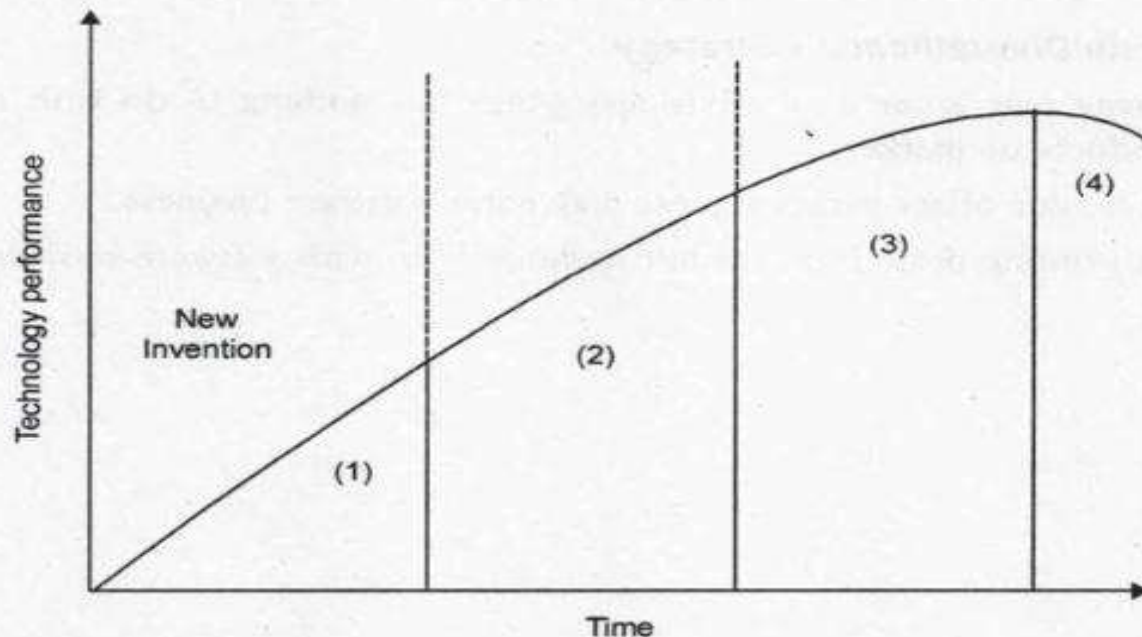


Fig. 1 The s-curve of technology progress

TECHNOLOGY LIFE CYCLES AND PRODUCT LIFE CYCLE 51

where

- 1. = Technology embryonic stage (new invention period)
- 2. = Technology improvement period
- 3. = Technology maturity stage
- 4. = Technology aging or obsolescence.

In the first stage i.e. invention stage technology is know as embryonic. It has slow growth.

The second stage is technology improvement period. In this period there is a rapid growth of technology.

The stage 3 is called mature technology stage. The technology reaches it's maximum upper limit and slows down. For example, vacuum tubes technology was limited by power consumption of heated filament. Scientist could not overcome this limitation. The size of the tube and power consumption were natural barriers for vacuum tube. Hence vacuum tubes failed and their position was occupied by transistors which permitted electronic conduction in solid metals without any limitation.

This stage is called technology aging stage or technology obsolesence stage. vacuum tube technology was rendered obsolete by transistor technology.

A technology in growth and maturity stage has the capability to create enormous wealth and profits for the company. It denotes the correct phase when we have to cash the technology and make profits.

Market Value and Market Share at Various Stages of Technology

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Market Value and Market Share at Various Stages of Technology

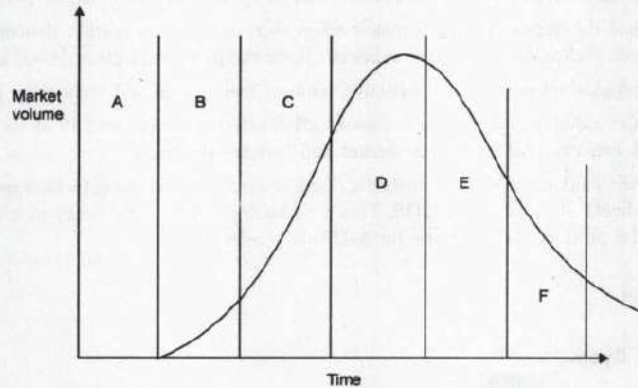


Fig. 2 Market value versus time curve

- A = Technology development
- B = Technology launching
- C = Growth stage of Technology
- D = Technology maturity stage

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TECHNOLOGY MANAGEMENT

E = Technology substitution Stage

F = Technology obsolescence Stage

During technology development phase the market has good response. This is the accurate time when scientists and engineers, are spending crores of rupees in an effort to create new technology which can satisfy and delight the customers. The goal of R & D manager should be to reduce this time period to as low as possible since it is very expensive and doesn't produce any income.

During technology launch stage there will be first slow growth and then rapid growth, of technology. During the rapid growth period technology penetration into market takes place. It becomes popular and it is in this stage that we have to earn millions of crores of rupees as profit. We have to cash this opportunity since our technology has become popular. We have to advertise, offer discount etc, and earn millions of crores of rupees.

After this stage technology reaches maturity stage and sales of product start declining. Even at this stage we can increase product popularity advertising and still earn some income.

The last stage is technology obsolescence stage. Everybody is bored with our technology customers want a change. It is better to change the factory at this stage. We can invest in some new venture which may seem profitable.

Factors Encouraging Technological Innovation

Most of technological inventions are based on scientific discoveries.

Einstein's equation $E = mc^2$ provides way to nuclear engineering and nuclear reactor whereas genetic engineering evolved from the discovery of DNA by Watson and Crick in 1952.

Technological development is encouraged when there is a strong market demand. This is called Market pull. Technology push is also required. These should be available technical knowledge.



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The technological innovation is a collective result of market pull and technology push.

For example, today in Africa there are many AIDS infected people and all of them require a vaccine which can cure AIDS. This is market pull (market demand).

On the other hand scientists are constantly doing research and attaining technological breakthrough in the fields of vaccine for AIDS. This is technology push. As a result of market pull, technology of the product (here vaccine for AIDS) is accelerated.

APPENDIX-1

Product Life Cycle


Key Question: what are technology life cycle and product life cycle ? What are the similarities between the two ?

Answer: Technology life cycle has been discovered previously.

Now we consider the concept of product life cycle (PLC).

Products follow an S-Shaped curve consisting of following phases.

1. Market introduction



- 2. Growth—slow growth
- Growth—Rapid growth
- 3. Maturity and Saturation
- 4. Decline.

They follow an S-shape which is discussed below:

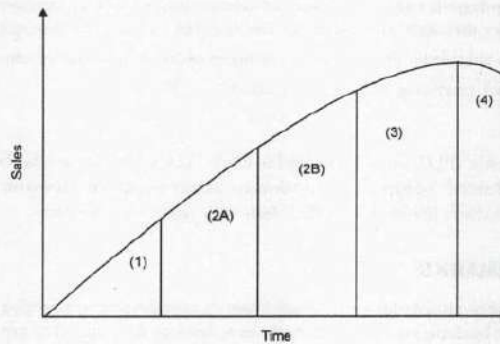


Fig. 3. S-shaped product life cycle curve

- 1. I = Introduction Stage
- 2. 2A = Slow Growth Stage
- 2B = Rapid Growth Stage
- 3. 3 = Maturity and Saturation Stage
- 4. 4 = Decline Stage

1. Introduction Stage

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TEC deals with products life cycle and TEC deals with technology life cycle.

GENERAL REMARKS

In the early stage of technology life cycle, which is known as embryonic or emerging stage, we have to face competition by doing innovation. In stage the technology developing but not fully accepted, companies should provide good quality products to customers.

In the early phase of growth, stage of technology life cycle when the technology is accepted it becomes rapidly pacing technology so it has the capability to become the market leader. At this stage, we have to add new features to existing technology, advertise it heavily in TVs and newspapers and get huge profits, from our superior technology we have to get as much profit as possible.


In the growth stage the technology is also known as key technology and we should to get as much profit as possible.

In the last stage, technology becomes old and is known as nature technology it's popularity decreases and several competitors enter the market. Here is very little chance to get profit so we have to stop the product.

Live Example CDs and Tape Recorders

First of all during 1960's and 1970's Tape recorders become very popular and everyone was crazy about tape recorders companies like Sony, Philips etc., earned huge amount of profit by producing tape recorders of different varieties. But in 1990's CDs and DVD players came into existence. The CDs were very much superior to tape recorder. As a result people purchased CDs and demand for tape recorders fell. As a result, companies stopped selling tape recorders and started selling CDs. CDs became the market king.

Thus in the technology life cycle of tape recorders we can identify the different phases such as embryonic stage, rapid growth stage and decline on obsolescence stage.



TECHNOLOGY LIFE CYCLES AND PRODUCT LIFE CYCLE

In the maturity stage, it is generally necessary to add new features to existing product and advertise it heavily. Sometimes we have to offer discounts, gift prizes. We may produce the product in large amount so that the cost of production is less. This is known as economics of scale. However in the maturity stage the competition from rival companies is heavy and only those companies survive which introduce new product features. We should note that in maturity stage we have to go for innovation by adding new features to product.

Combined Effect of Market Pull and Technology Push

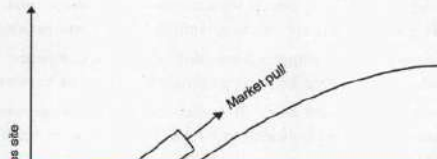
For example let us consider the demand for vaccine or medicines to cure AIDS and cancer. Now-a-days of Lakhs people die because of AIDS and Cancer, hence there is a strong demand for medicines/Vaccines to cure AIDS and Cancer. This demand is called market Pull.

Large amount of research are being done in America and Europe to invent medicines to cure cancer and AIDS. USA spends millions of dollars on research on AIDS, and Cancer curing medicines. This is Called Technology or Science Push.

As a result of technology push and market pull, the innovation is accelerated. Scientists will be under pressure from customers to produce AIDS/Cancer curing medicines and they will work extremely hard to produce medicines. Thus, soon medicines will come.

Thus Market Pull and Technology Push Accelerates the Rate of Technology Innovation

In the above example the time to produce the Cancer/AIDS curing medicine, will become less and soon medicines will come.



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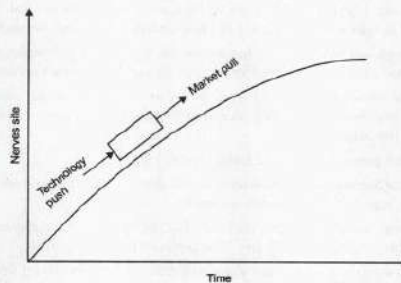


Fig. 4. Technology push—market pull diagram of innovation

Note: For the invention of a new technology there should be market need (market pull). There should also be a Technology (Technology push), men only new product invention can take place.