

I

Technology Management: An Overview

G P Sudhakar

This article gives an introduction to the technology management. It discusses the steps involved in technology management such as Technology Forecasting, Technology Evaluation, Technology Selection, Technology Transfer, Technology Acquisition and Technology Implementation. Technology Roadmapping has been discussed in detail. People related challenges in technology projects are explained. Intellectual property and role of IT in Technology Implementation are also explained.

Introduction

The world war-II is the best example for the usage of technology. By 2020 US army is going to be dominated by Robots. In the post war era and after industrialization, technology has played significant role in human life. With globalization, there are no geographical limits to the spread of technology. Hence, there is need for the study of technology and its management in current days.

For example, in Information Technology industry, if some technology or component is developed in US, it is reaching the developing countries like India and

China in minutes with the help of Internet, data and voice communication technologies. Developing the technology is purely technical work. To develop the technologies and products definitely needs some process to be followed and certain skills are required. Knowledge, process, skills, regulations and experience are needed to manage these technologies, which in turn form the technology management discipline.

According to Galant (2001), *Management* is a key function in any manufacturing or services company, whose main goal is to achieve improved efficiency, effectiveness and efficacy of the organization within the given strategy and the quality of resulting products or services.

Technology

The modern technology has its roots in theoretical science. According to Vijay Kumar (2001),

“Technology involves the application of various fields of Science and Scientific knowledge”.

There are few differences between science and technology. Science is understanding oriented and technology is application oriented. Technology is in internal domain and science is in public domain. Technology can be the result of application of science to simplification, diversification and productivity improvement in any managerial process or product (Penny, 1992).

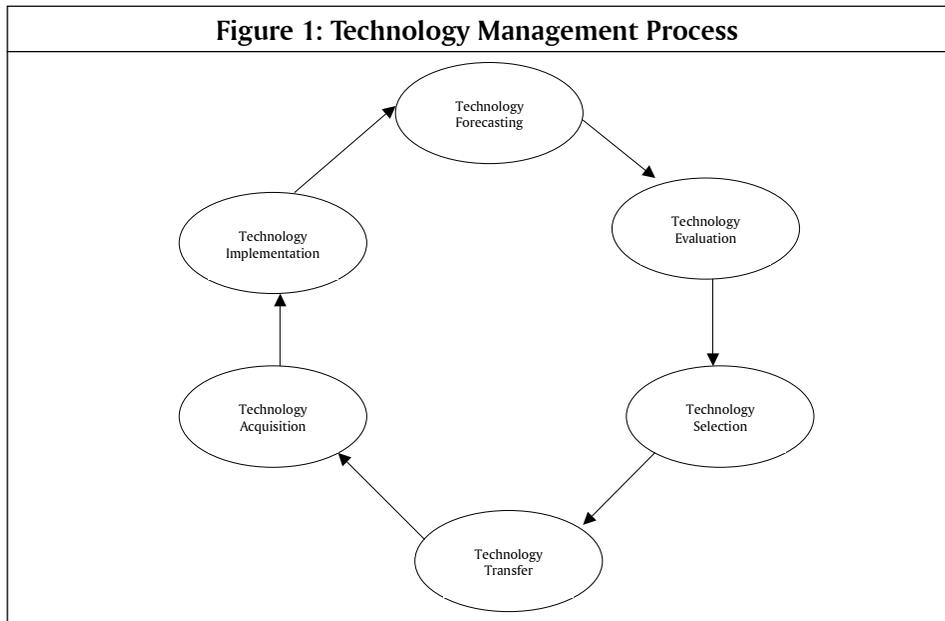
Evolution of Technology Management

Technology Management discipline is interdisciplinary in nature and integrates the concepts from the areas of Economics, Management Science, Psychology, Engineering Sciences, Systems Sciences and Sociology. This discipline is started in the manufacturing industry at the beginning of the industrial era. At present, technology and its management are playing significant roles in order to offshore the work from the developed nations to the developing countries like India, China and Philippines. With the rapid growth of technology, managing those projects has become a challenge for the organizations in industries such as Information Technology, Manufacturing, Telecom, Pharmaceutical, Biotechnology and Nanotechnology.

Technology Management Process

Technology management process in present days include the following steps:

- Technology Forecasting
- Technology Evaluation
- Technology Selection
- Technology Transfer
- Technology Acquisition
- Technology Implementation.



Technology Forecast

The modern way of forecasting technology is through the patents of competitor companies. Many technology-based firms do the competitor analysis using the patents the competitors have. There are many sources of patent databases. Some of them are WPIL (Derwent World Patents Index), EPAT (Database of European Patents), FPAT, USPTO (United States Patent and Trademark Office), etc., (Kadarsah *et al.*, 1999). Using Patent Databases one can read the existing patents and plan for the technology forecasting.

The rapid technological developments are leading towards the short product life cycles (Kadarsah *et al.*, 1999). This is keeping pressure on marketing teams as well. Delphi technique, which extracts the expert's opinion, is widely used as a technique for technology forecasting in modern organizations. Competitive intelligence activities such as searching, collecting and processing are done during this technology-forecasting phase.

Technology Evaluation

Technology evaluation process includes commercial analysis, evaluating inventor's profile, market analysis, environmental analysis and sometimes SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis as well.

Testing the suitability of commercialization of the technology, pilot testing and sample installations are some of the activities done during technology evaluation process. Whether the technology has any adverse effects or not is being studied in this phase. Also the related aspects like, who are the vendors, what is the price range, what are the related products available in the market, how is the reputation of the vendor, etc., are being studied in this phase.

Technology Selection

Once the alternative technologies have been evaluated, and then there is need to select the best technology among those alternatives. Technology selection criteria vary from organization to organization and industry to industry. The selected technology needs to be transferred from the owner organization to the needed organization.

For example, Google and Yahoo are spending more on electricity bills than on the employee payrolls because of their huge data centers' maintenance (Joe, 2007). This is because of their business models, technology strategies and technology selection processes.

Technology Transfer

Technology transfer involves communication process. There are many communications management and cross-cultural management issues involved in this process. Technology transfer also involves negotiations. Both the Client and Supplier should have trust, cooperation and coordination while doing technology transfer.

It may involve transferring the machinery, equipment, tools, manuals, journals, or any other technical documents.

Following are different modes of Technology Transfer:

- i. Licensing
- ii. Joint ventures
- iii. Fully Owned Subsidiaries
- iv. Transnational Organizations and
- v. Multinational Organizations.

The technology vendor gives the license to another organization to produce the specified products or to use the machinery for specific time period. This will be mentioned in the license agreement. License agreement includes price involved, time period i.e. expiry date, location, and quantity, etc.

Technology can be transferred through joint ventures as well. In manufacturing industry, it can be observed in many Japanese and American joint ventures in developing countries like India and China.

Another way of technology transfer is by establishing fully owned subsidiaries in other countries. For example, Microsoft and GE have their fully owned subsidiaries in India in IT and other high technology industries.

By using transnational and multinational organizations one can transfer technology from one country to another country. Major IT MNCs like IBM, HP, Sun, DELL are some of the examples of MNCs operating in India and Telecom giants like Nokia, Motorola and Ericsson are some of the MNCs operating in India. All these MNCs are transferring technology to developing countries from their home countries.

Technology Acquisition

Technology acquisition process involves the logistics management and payment settlement issues. Once the payment is made by the needed organization, the machinery will be shipped to the destination by the source organization. This involves logistics management and dealing with customs-related issues of the destination and

source countries. Also this phase needs us to deal with governments of the respective countries while procuring the goods in regard to tax payments and compliance to regulatory requirements.

Technology Implementation

Middle managers have got important role in technology implementation stage. According to Zack (2008), training, to the users, makes technology implementation more familiar to them. As per Zack (2008), gap analysis needs to be done to find out, the users requirements and what the technology can provide to the users.

According to Paul *et al.*, (2001), technology implementation usually starts with the initiation stage in which organizations do environmental scanning to solve a technical problem or to improve the efficiency. Next step is to adopt the technology through technology transfer, installation, configuration, customization and testing. The succeeding stage is getting acceptance from the user community by giving needed training and support to them. Technology adaptation can be influenced by social, economic, environmental and political factors.

Technology implementation has influence on the behavior of the employees. Either it can have positive, negative or neutral effect on the employees. Some employees may support the advanced technologies. Some may resist the new technologies because of fear of job loss, fear of failure, fear of safety, etc.,. Hence, technology implementation can be done with the pilot implementation, sufficient training and counseling to the employees. This reduces the resistance from employees.

Technology Roadmapping and Roadmaps

Technology roadmapping process consists of three stages, i.e., preliminary activity, development of roadmap and follow up activity (Marie & Olin, 1997). The preliminary activity includes satisfying essential condition, defining the scope and boundaries of technology roadmap, and proving the needed leadership. The second stage, development of roadmap, consists of identifying the requirements, specifying technology areas, finding out the technology alternatives, and create the technology roadmap. The follow-up activity includes validation of the roadmap, develop implementation plan, and review and update the roadmap (Marie & Olin, 1997).

Technology roadmap is the result of technology roadmapping process. Technology roadmaps are of two types as mentioned below (Marie & Olin, 1997).

1. Product Technology Roadmap and
2. Emerging Technology Roadmap.

Emerging Technology Roadmap concentrates on single technology (Marie & Olin, 1997). Whereas, Product Technology Roadmap can include multiple technologies, which constitute the product. Many US-based companies are using technology roadmapping as technology planning tool to better position their products and their organization. People can make better technology-based investment decisions by using technology roadmapping. This is one of its advantages.

Technology roadmapping can be done at the organization level or at the industry level. For example, IBM and Nokia organizations do technology roadmapping at the organization level. Consortiums like Symbian and OMG (Object Management Group) do the technology roadmapping at the industry level in mobile communications and IT industries respectively. Technology roadmapping should be built by keeping corporate strategy, technology planning, business development and product marketing, in mind. It involves employees from different business functions of the organization such as engineering, operations, marketing, R&D and corporate planning, etc.

People Issues in Technology Management

People challenges in technology-based projects include:

- Two extremes—Either addiction to technology or resistance to technology
- Resistance to change
- Against automation
- Insecurity feeling
- Fear of safety, disability and health problems, etc.
- Fear of job loss.

While implementing technology projects, communication is very important in the projects. There should be defined organization structure, reporting structures and communication paths in the organization. This helps in proper project execution under the leadership of technical managers and project/program managers.

In technology projects, there is possibility for the conflicts among team members in the project. The reasons can be technical issues, administrative issues, project priorities, resources, schedules, etc. These conflicts are to be resolved by the technical or project managers. There are many conflict resolution techniques and motivational techniques that managers can adopt for the success of the technical projects.

Intellectual Property

In case of Information Technology transfer issues, intellectual property issues are involved. The writer/organization of the software source code will have the intellectual property rights. So, the source code should not be copied without prior copyright permission from owner. Research papers, articles and software source code are some of the intellectual properties the academic and knowledge-based organizations have in current days. The authors or the organization will have the copyrights for this intellectual property. If someone needs to copy, reproduce the same content, he/she needs to take the reprint permission from the author/organization. Similar norms are followed in the case of Trademarks and Patents.

Technological Developments in the World since 1980

1980-1990

In Computer Science, IBM PC was released in 1981. NASA has first launched Space Shuttle, *Columbia*, on a space mission STS-1. Switzerland has opened the world's longest highway tunnel, St. Gothard Tunnel in 1980. Apple Computer Corporation has introduced the Apple Macintosh, which used a computer mouse and GUI interface. Space Shuttle, *Challenger*, exploded on its launch killing all seven astronauts aboard, in 1986. IBM has introduced first laptop computer. Internet concept has just started in late 80s. HIV virus and AIDS disease have been identified for the first time in the history. Fax machine has become a tool for international communication in late 80s.

1990-2000

The Space Shuttle, *Discovery* has placed the Hubble Telescope into orbit. World Wide Web (www) concept has been introduced. Carbon nanotubes were discovered in 1991. Web browser has been developed to browse the Internet. Intel has developed Pentium chips. The Channel Tunnel was opened between England and France. In Computer Science, The Java Programming language was introduced by SUN Microsystems. NASA made Mars pathfinder to land on the surface of Mars. The scientists have announced the cloning of a sheep in Scotland. Many Computer viruses were found and XML (extensible markup language) was developed. First Blackberry was released in 1999. In Computer Science, Distributed and Object Oriented computing was widely used.

2000 Onwards

Quantum Computing, Biotechnology and Nanotechnology are picking up in 2000s. Medical devices are being developed by using Nanotechnology. Internet is used in developed and developing countries. Mobile technologies are growing and widely used in countries like Finland, India and China in addition to US and European countries. Fourth generation mobile standards and technologies are being introduced. Digital Camera and Pentium M microprocessor are introduced. NASA has launched a successful mission to Mars. Indian Space Research Organization plans for an unmanned mission to the Moon.

Role of IT in Technology Implementation

Information Technology has played significant role in technology implementation. With the developments in command and control systems, manufacturing technologies, and machinery, there is need for the organizations to improve their competencies in Information Technology areas. For example, in technology forecasting stage itself organizations need competitive IT environment for searching, selecting, and processing the data.

Many manufacturing industries are using IT to manage their spare parts/stock, inventory, supply chain, vendor management, and customer management activities. Hence, IT has got significance in technology-based projects.

Conclusion

We have discussed the technology management process, technology roadmapping, people issues in technology management, intellectual property issues and the technological developments in the world in the recent past in this article. Adoptability, cultural barriers, environmental aspects and resistance to change are some of the barriers of technology transfer. However, with the proper training, counseling and regulations in addition to the efficient technology management will ease the technology transfer process easy in the world. With the developments of WTO and globalization, technologies are being transferred between the countries much faster compared with early days.

(G P Sudhakar is a Consulting Editor at Icfai Research Centre, Hyderabad. He can be reached at purna24@hotmail.com).

References

1. Ammeon (2008), Technology Evaluation, 2008, Available at http://www.ammeon.com/Technology_Evaluation/Default.38.html
2. Joe Vanden Plas (2007), Jeff Wacker: Forecasting the Technology Future, WTN News, November 17, 2007, Available at <http://wistechnology.com/articles/4330/>
3. Kadarsah Suryadi, Agus Salim Ridwan, Henri DOU & Andrian Purnama (1999), Technology Forecasting in Competitive Intelligence: The Use of Patents Analysis, *International Journal of Information Sciences for Decision Making*, No 3, February 1999, Available at http://isd.m.univ-tln.fr/PDF/isd3/isd3a17_suryadi.pdf
4. Lisa Su (2007), Management Evolution, Available at <http://www.the-chiefexecutive.com/features/feature1063/>, 03-Jul-2007
5. Marie L. Garcia & Olin H. Bray (1997), Fundamentals of Technology Roadmapping, 1997, Available at <http://www.sandia.gov/PHMCOE/pdf/Sandia'sFundamentalsofTech.pdf>
6. Michael A. Cusumano (1988), Software Technology Management: "Worst" Problems and "Best Solutions", 1988, Available at <http://dspace.mit.edu/bitstream/handle/1721.1/2194/SWP-1972-18147820.pdf;jsessionid=13DE050310CA809EA697275DEF31F001?sequence=1>
7. Paul Jen-Hwa Hu, Patrick Y.K. Chau, Y.K.Chan & John C.K. Kowk (2001), Investigating Technology Implementation in A Neurosurgical Teleconsultation Program: A Case Study in Hong Kong, Proceedings of 34th Hawaii International Conference on System Sciences,

- 2001, Available at <http://csdl.computer.org/comp/proceedings/hicss/2001/0981/06/09816013abs.htm>
8. Penny Risdon (1992), Understanding the Technology Transfer Process, 1992, Available at http://www.sas.upenn.edu/African_Studies/Comp_Articles/Technology_Transfer_12764.html
 9. S. Galant (2001), Innovation Management Practices In SMEs: The Case of Technology Adaptation To Meet New Market Demands, ESA ISD, May 9th, 2001, Available at <http://conferences.esa.int/isd2001/19.pdf>
 10. Vijay Kumar Khurana (2007), *Management of Technology & Innovation*, Ane Books India, New Delhi, 2007.
 11. Zack Swinney (2008), DFSS Technology Tips For Successful Technology Implementation, 2008, Available at http://www.isixsigma.com/library/content/c000910_a.asp