

# **Technology Management**

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# Agenda

- Introduction
- Classification of Technology
- Roles Relative to Technology
- Technological Change & its' Measurement
- Rate of Improvement, Substitution, & Diffusion of Technology
- Technological Change Theories

Conventionally:  
companies are  
assessed by its  
capital and physical  
assets



But in Modern  
Word  
Technology adds  
value

# Introduction (cont.)

Technology is:

- an ‘engine for economic development’,
- a ‘strategic resource’, and
- a ‘competitive weapon’.
- If aligned with organization’s vision and strategic goals

# Technology

- “practical implementations of intelligence”. (Ferré, 1988)
- “A technology is any systematized practical knowledge, based on experimentation and/or scientific theory, which is embodied in productive skills, organization, or machinery” (Gendron, 1977)
- “Skills to apply proper techniques” (Hakkarainen, 2006)
- “Practical application of knowledge” (Webster 2010).
- Just to conclude, technology can be defined as “all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing services.

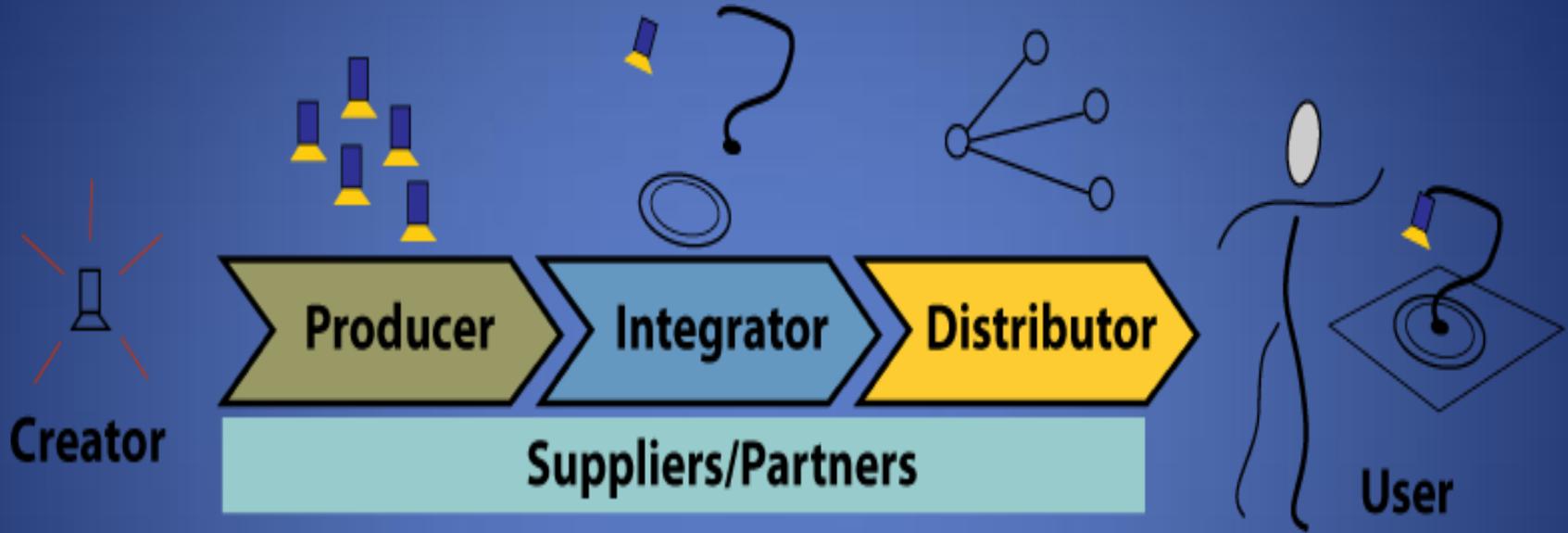
# **Components of Technology**

- **Hardware:** The physical configuration and logical design of the equipment or machinery
- **Software:** The knowledge used for the functioning of hardware.
- **Brain ware:** functionality of the technology with causality.
- **Know-how:** Knowledge of how to do things.

# Classification of Technology

- **New technology:** newly introduced having influence on the products of an organization.
- **Emerging Technology:** not yet fully commercialized, but has the potential to become so.
- **Low technology:** the technologies that have been used by a large segments of human society to produce products of basic human needs.
- **Medium technology:** a wide set of technologies that fall between high and low technologies.
- **Appropriate Technology:** the technology used for optimal productivity.
- **Tacit technology:** non-articulated knowledge (know-how).
- **Codified technology:** allows people to know how technology works but not necessarily why it works in a certain way.

# Roles Relative to Technology



Investor

Government

# Technological Change

- Alteration in physical processes, materials, machinery or equipment, which has impact on the way work is performed or on the efficiency or effectiveness of the enterprise.
- Involves a change in the output, raw materials, work organization or management techniques.
- It affects the relationship between labor, capital and other factors of production.

# Measurement of Technological Change

The most important factors are:

- **Economic Indices:** Technological change is measured as the weighted average of the change in factor prices, holding inputs constant.
- **Geometric index :** technological change is equal to the change in output not accounted for by the changes in labor and capital.
- **Patents:** Patent statistics have been used as indicators of technological change. (The analysis of the innovation process)

# Measurement of Technological Change (Cont.)

- Rate of Improvement of Technology
- Rate of Substitution of Technology
- Rate of Diffusion of Technology

# Technological Change Theories

## Neo-Classical Theory

- A production function specifies a quantitative relation between inputs (capital and labor) and outputs (production). At any given time there is a given level of technology which determines the techniques available for production.
- Technological change takes place in the form of shifts of the production function towards the origin.

## Limitations

- Only labor and capital are incorporated as factors of production.
- The presence of infinite techniques at a given level is rather unrealistic.
- Only cost-reducing improvements can be described by the production function. Improvements in performance or the appearance of new services is ignored.
- Not able to deal with dynamic problems.

# Technological Change Theories

## Marxist Theory

- Innovations must be labor-saving
- technology is not self generating, but as a process directed by willful, conscious, active people and molded by historical forces.
- The individual entrepreneur invests and innovates because it is rational for profit maximization or necessary for survival

## Limitations

- Undermining of capital-saving innovations.
- Underemphasizing the concept of productivity.

# Technological Change Theories

## Schumpeter's theory

- Innovation is the engine of economic development and as a disequilibrium phenomenon.
- Technological change is a case of innovation more generally and not as another piece of routine economic behavior.

## Innovation

- the introduction of a new good or of a new quality of a good, or of a new method of production,
- the opening of a new market, the conquest of a new source of supply of raw materials, the carrying out of a new organization of any industry.

## Limitations

- Psychology of the entrepreneur is an indefinable phenomenon.
- No explicit attention is paid to the process by which innovation is generated.
- Lack of empirical evidence.

# Technological Change Theories

## Evolutionary Theory

- Technological change is based on Darwinian's biological analogy: mutation (invention) and selection (innovation).
- from a state of flux when product innovation prevails in the search for a successful design, to a maturity phase where incremental process innovation prevails.

## Limitations

- Dearth of quantitative models.
- Many propositions need to be validated.

# Technological Change Theories

## Market-Pull Theory

- The market constitutes a communication channel through which political, economic, social and ecological forces influence buyers in their demand for technological products.
- Continuous changes in these forces have an impact on the response provided by technology with respect to the type, capabilities, performance, safeguards, solutions, etc.
- These messages are transmitted and communicated through the market where buyer's requirements are matched with technological changes and where future demands can be detected by the producers of technology.

## Limitations

- The logical and practical difficulties in interpreting the innovation process.
- Difficulties of defining demand functions as determined by utility functions.
- The incapability of defining the 'why', 'when' and 'where' of certain technological developments instead of others.

# Technological Change Theories

## Technology-Push theory

- Technology is an autonomous or quasi-autonomous factor.
- One-way causal determination approach, i.e., from science to technology to the economy.
- Technological developments occur exogenously through discoveries, theories, ideas and R & D work, which may or may not then create demand for their output.

## Limitations

- Failure to take into account the intuitive importance of economic factor in shaping the direction of technological change.
- Lack of understanding of the complex structure of feedbacks between the economic environment and the directions of technological change.

# Management

- Fredmund Malik defines management as "the transformation of resources into utility."
- Management can be an art and to some extent a technology.
- To achieve desire goals, it provides a knowledge base of guiding principles & processes like planning, organizing, staffing, motivating and controlling activities of the organization.
- 
- Now-a-days, majority of these functions are managed or performed through technology. So, The successful use of technology has become a competitive edge.

# Technology Management

- Technology Management is a set of disciplines that allows organizations or a nation to manage their *technological* fundamentals to create competitive advantage through planning and developing its technological capabilities such as:
  - technology policy;
  - technological forecasting and assessment;
  - technology strategy;
  - technology transfer;
  - technology project management;
  - technology research and development;
  - human resource management in terms of innovative capabilities, flexibility and contribution
  - continuing improvement of process and product technology.

# TM Definitions

- NRC/National Research Council (1987) describes TM as “*a process, which includes planning, directing, control and coordination of the development and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization.*”
- The Association of Technology, Management and Applied Engineering defines “*Technology management as the field of study that impacts skills and knowledge, designed to improve the entire process of technological change and from systems planning and design, to introduction, to evaluation of effectiveness*”.

# **Three levels of TM**

- **Normative level:** deals with the company's major decisions associated culture and policy.
- **Strategic level:** a comprehensive technology strategy.
- **Operative level:** changes in the businesses strategies to enhance efficiency.

# Types of Technology Management

- Macro Technology Management: at the national level.
  - Planning for the development of technological capabilities at the national level.
  - Identification of key sectoral technology and related fields to be developed.
  - Determining ‘make’ or ‘buy’ decisions, i.e., whether importation or self-development is to be pursued.
  - Establishment of institutional mechanisms for directing and coordinating the development of national technological capabilities.
  - Design of policy measures for controls.

# Types of Technology Management (Cont.)

- Micro Technology Management: firm or project level.
  - Responding to competitors who are using technology as a strategic weapon.
  - Integrating technology strategy into the overall corporate strategy.
  - Identifying and evaluating technological options and innovations and the factors relating to their success and failure.
  - Directing research and development itself, including determination and definition of project feasibility.
  - Monitoring and planning technological obsolescence and replacement.

# Technological Innovation

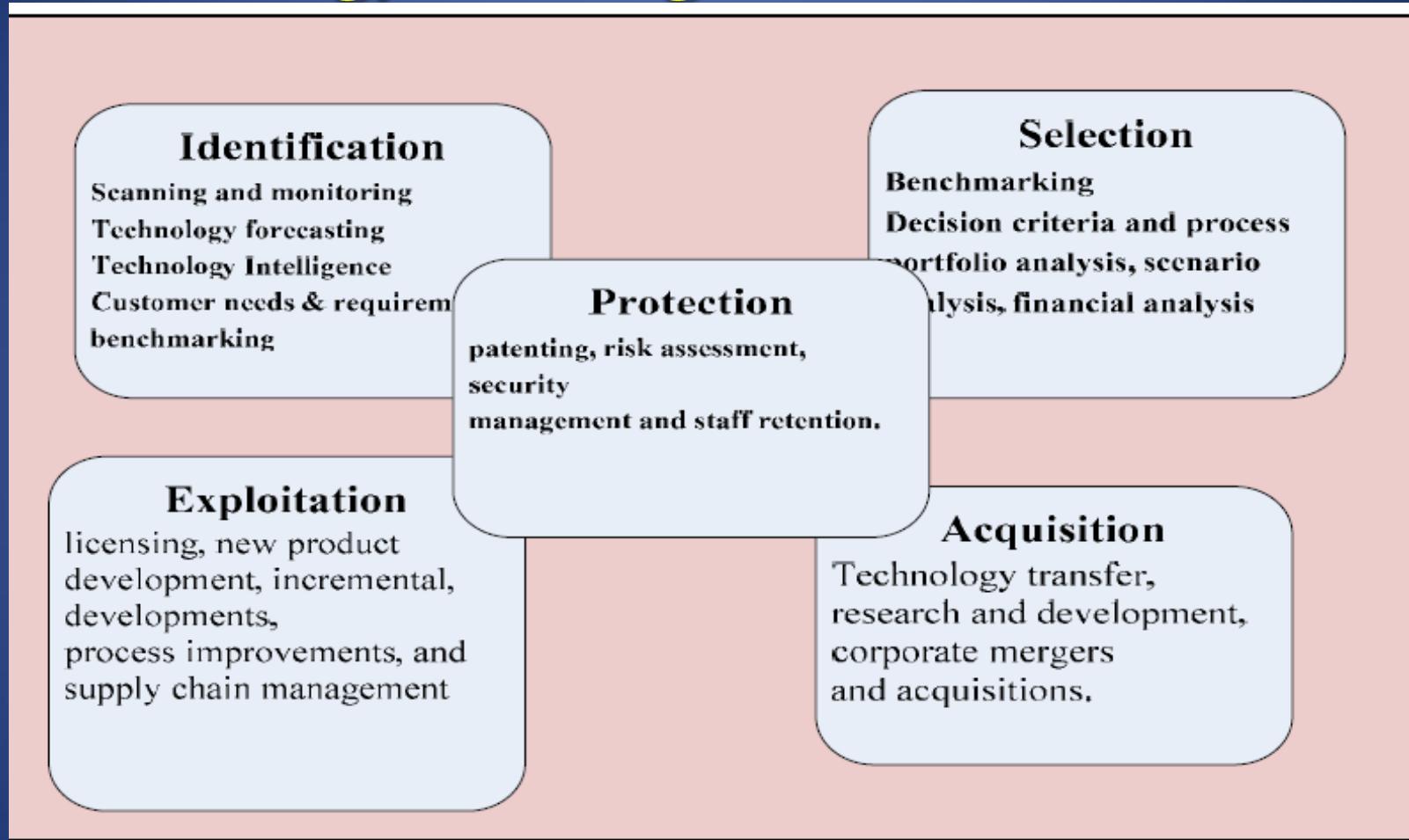
- the development of new tools, devices, products, processes or procedures that are of practical value to society.
- 1<sup>st</sup> Approach (TI as Linear Process):
  - innovation begins with scientific discovery,
  - proceeds through development of practical applications of this discovery, and
  - finally achieves success as dissemination and implementation at the hands of users.

# Technological Innovation (Cont.)

2<sup>nd</sup> Approach (TI as a complex set of activities)

- *Basic research*
- *Applied research*
- *Collaboration*
  - Listen and explore—What can we do together?
  - Learn and adjust—How will we learn together?
  - Focus and align—What should we do together?
  - Link and leverage—What will we do together?
- *Technology development*
- *Technology implementation*
- *Production*
  - Discrete
  - Job Shop
  - Process (batch), and
  - Process (continuous)
- *Marketing/Commercialization*
- *Proliferation*
- *Technology enhancement.*

# Technology Management Framework



Gregory's (1995) five step model

# Technology Management Capabilities

- Capacity and ability to perform technology Identification
- Capacity and ability to perform Selection
- Capacity and ability to perform Acquisition
- Capacity and ability to perform Exploitation
- Capacity and ability to perform Protection
- Capacity and ability to Learn about new technologies
- Capacity and ability to perform Strategic Management
- Capacity and ability to perform Innovation Management
- Capacity and ability to perform Project Management
- Capacity and ability to perform Knowledge Management
- Capacity and ability to perform Technology Management

# Thank You