



# AZAS DAN TEKNOLOGI INFORMASI MASA DEPAN

Materi 4. Innovation, entrepreneurship,  
and Technological change

## How Innovation Affect of Society

1 2 3  
4 5 6

Program Pascasarjana FT UNP Padang  Program Magister Chief Information Officer

## Our Topics

- Technology Transfer Hypothesis
- Stage of Technology Transfer
- Approaches and Factor Affecting Technology
- Role of The User
- Characteristic of Innovation and its diffusion
- Role of People
- Boundary Spanning
- IBM Transfer Technology Cases
- Technology Transfer Strategy

Program Pascasarjana FT UNP Padang  Program Magister Chief Information Officer

## Introduction to Technology Transfer

- technology transfer, or tech transfer, may be defined as the process by which science and technology are transferred from one individual or group to another that incorporates this new knowledge into its way of doing things
- A new technology has to have considerable *relative advantage* and has to provide significant value to the customer before it is embraced by the wider user community

## Introduction to Technology Transfer ...

- The new technology can be more expensive than the older technology, but the value in terms of quality, flexibility, and responsiveness it provides motivates the user to take the necessary steps in adopting this technology
- In utilizing new technology, there are numerous management challenges.
- Continuous improvement is the basis of future competitive advantage for a firm

## Introduction to Technology Transfer ...

- Howard and Guile (1992) suggest some general rules for a manager responsible for adopting new technology:
- Do not accept performance as it is and focus on continual improvement.
  - Do not just do the same thing a bit faster (or cheaper, or automatically).
  - Careful reexamination of product and process designs is essential to make significant improvements.
  - Recognize and learn to deal with people's natural reluctance to accept change that is necessary to incorporate innovation in the firm



## TECHNOLOGY TRANSFER HYPOTHESES

- The following general hypotheses are related to technology transfer:
  - Technology transfer of research results is essential if a mission-oriented research organization is to be effective in fulfilling its task.
  - The effectiveness of technology transfer provides the essential measure of productivity of a mission-oriented R&D organization.
  - Effective technology transfer increases user involvement in the innovation process, which, in turn, positively affects R&D productivity and has long term benefits in terms of funding support from the sponsor groups.
  - Institutional and organizational constraints, as well as improper planning for technology transfer, impede the process.
  - Technology transfer techniques and approaches can be developed to facilitate the process.



## STAGES OF TECHNOLOGY TRANSFER

- Transferring technology from an R&D lab to manufacturing, marketing, and the ultimate user is an important function
- Rogers (1983, 1995) suggests five main steps leading to the adoption of technology:
  - Knowledge
  - Persuasion
  - Decision
  - Implementation
  - Confirmation

## STAGES OF TECHNOLOGY TRANSFER ...

- *Knowledge* occurs when a potential user learns about the new technology and gains some understanding of its capabilities and usefulness. At this stage the user wants to know what the innovation is, what its capabilities are, and how it works.
- *Persuasion* occurs when the user forms a favorable or an unfavorable attitude toward the innovation. Here the user is looking at comparative advantages and disadvantages of the innovation.
- *Decision* occurs when the user engages in activities that lead to adoption or rejection of the innovation.
- *Implementation* occurs when the user incorporates the innovation into the way of doing things.
- *Confirmation* occurs when the user seeks to confirm the implementation decision and continues to use the innovation

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER

- Roberts and Frohman (1978, p. 36) describe three general approaches used by industrial research organizations to facilitate research utilization: These are
  - the personnel approach,
  - the organizational link-pins approach,
  - and the procedural approach.

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER...

- **The Personnel Approach**
  - The personnel approach involves movement of people, joint teams, and intensive person-to-person contact between the generator and the user of the research.
  - Suppose an R&D group develops an intelligent and stand-alone air-pollution monitoring device that has a built-in microprocessor capable of real-time analysis.
  - The innovation is complex, requiring some modifications or debugging during manufacturing.
  - Some key members of the R&D group may be transferred to manufacturing to facilitate the process.
  - The enthusiasm and keen insight of the R&D group can thus be transferred to manufacturing, increasing the probability of effective technology transfer.

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER...

- **The Organizational Link-Pins Approach**

- This encompasses specialized transfer groups that contain engineering, marketing, and financial skills; use of integrators who act as third-party transfer coordinators; and new venture groups.
- A special “technology transfer group” is formed to specialize in moving innovations from R&D to demonstration, to manufacturing, and to the ultimate user

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER...

- **The Procedural Approach**

- This includes joint planning, joint funding, and joint appraisal of research projects using research and user groups from manufacturing and marketing.
- This procedural approach, which involves joint planning and participation in the innovation process by the user community, can be utilized quite effectively.
- User groups that include personnel from manufacturing, marketing, field users, corporate funding sponsors, and the research community can be organized for major R&D products

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER...

- **Factors Affecting Technology Transfer**
  - In a study involving 26 companies, Bosomworth (1995) found that the central research efforts of large corporations vary widely in their organization, objective, and strategic approach to research investment and technology transfer.
  - One of the most important findings was that a formal technology transfer process tends to shorten the time required to move the technology from research to commercialization.

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER...

- **Factors Affecting Technology Transfer...**
  - A study of high-performance computer development companies and projects found that the differences in performance are correlated with skills and routines aimed at technology integration (Iansiti, 1995)
  - Furthermore, high project performance is linked to a broad approach to resolving critical problems, merging deep technical knowledge with a detailed understanding of the specific environment in which the new technologies would be applied.

## APPROACHES AND FACTORS AFFECTING TECHNOLOGY TRANSFER...

- **Factors Affecting Technology Transfer...**
- Cetron (1973, p. 11) describes a number of factors affecting technology transfer:
  - National policies, laws, and regulations (e.g., taxes and tax credits, tariffs, and health and safety regulations)
  - Corporate policies
  - Market demand
  - Scientific base of the nation and industry
  - Level of R&D effort
  - Education level
  - Availability of capital

## ROLE OF THE USER

- Customers are increasingly being viewed as partners versus passive recipients in the innovation process.
- Customers can be included in the early stage of idea generation, and throughout the development process.
- Their input helps to make manifest barriers to diffusion as well as ways to surmount barriers, thus reducing the risk of innovation.

## ROLE OF THE USER...

- Finnish telecommunication giant Nokia solicits input from users to help refine existing product offerings, to broaden its customer segments, and to generate new ideas for offerings (Ewing, 2008)
- In an effort to encourage people to take advantage of the full capacity of their handsets, Nokia has used the Internet to test consumer reaction to products that are works in progress
  - For example, “Sports Tracker” was posted on a website open to the public (GPS technology)
- Nokia staff has traveled to the developing world and let people sketch their dream cell phones. One person included a sensor to monitor water quality.

## ROLE OF THE USER...

- Von Hippel (1988, p 107) notes that involving customers in the innovation process has several advantages:
  1. The lengthy trial-and-error period in understanding detailed customer needs is shortened because trial and error is accomplished by the customer
  2. Customer input can actually lead to a design ready for manufacturing.
  3. Small customer niches that are otherwise too expensive to serve can be reached.

## ROLE OF THE USER...

- Von Hippel (1978, p. 31) makes a strong case for the role the user plays in the innovation process and in technology transfer:
  - *We have found that 60–80% of the products sampled in those industries [manufacturing process equipment or scientific instruments] were invented, prototyped, and utilized in the field by innovative users before they were offered commercially by equipment or instrument manufacturing firms.*
- Von Hippel provides a variety of other examples in which customers become partners in innovation from General Electric, 3M and the software industry.

## ROLE OF THE USER...

- In fast-moving high technology arenas, von Hippel suggests that partnering with lead users is wise.
- Harryson (2008), for example, suggests that industry partnerships with university researchers are most effective in the exploratory creative phase of innovation, while lead users are best in the commercial exploitation phase, as they help in defining final applications and thus speed up commercialization.

## ROLE OF THE USER...

- The role of design and designers is increasingly important in making technology-based products user friendly and aesthetically pleasing to the customer.
  - Apple with iPod, iPhone and iPad : aesthetic and user friendliness
  - Bang & Olufsen : combination of technology and artistry
  - The One Laptop per Child : entertaining for children who have never used a computer

## CHARACTERISTICS OF INNOVATION AND ITS DIFFUSION

- Rogers (1983, 1995) describes five different characteristics of innovation, as perceived by the potential adopter, that affect its rate of adoption:
  - *Relative Advantage*
  - *Compatibility.*
  - *Complexity.*
  - *Trialability.*
  - *Observability.*

## CHARACTERISTICS OF INNOVATION AND ITS DIFFUSION...

- *Relative Advantage*. The degree to which the innovation is superior to ideas it supersedes
- *Compatibility*. The degree to which the innovation is consistent with existing values, past experiences, and needs of the user
- *Complexity*. The degree to which the innovation is relatively difficult to understand and use
- *Trialability*. The degree to which an innovation may be tried on a limited basis (in other words, without committing to full-scale, total operational change)
- *Observability*. The degree to which the results from the use of an innovation are visible and easily communicated to users and other decision-makers

## ROLE OF PEOPLE

- The role of people in technology transfer has been well recognized as a *technology gatekeeper*
- Allen (1977, p. 141). Roberts and Frohman (1978, p. 37) describe two other gatekeeper—*market gatekeeper and manufacturing gatekeeper*—who have relevance to technology transfer

## ROLE OF PEOPLE...

- ***The market gatekeeper***
  - *The market gatekeeper* is a communicator who understands what competitors are doing, what regulators might be up to, and what is happening with regard to the marketplace.
  - This type of a gatekeeper brings vital information to the R&D organization and keeps the R&D research focus on target and toward the kinds of activities that are likely to be accepted and implemented successfully.

## ROLE OF PEOPLE...

- ***The manufacturing or operations gatekeeper***
  - *The manufacturing or operations gatekeeper* understands enough of the practical and constrained environment of manufacturing and of the operations of the user community to keep the R&D personnel well informed about the manufacturing and operations requirements.
  - This individual makes sure that the concepts developed by R&D can either be manufactured profitably or be made a part of the operation procedures of the user community

## BOUNDARY SPANNING

- One main and perhaps crucial ingredient in technology transfer is *boundary spanning*.
- This requires some elaboration.
- Engineers should be able to communicate effectively with other engineers, economists with other economists, and so on
- The point is that with the increase in the complexity of science and technology, specialization has become necessary, and this increased specialization can inhibit communication
- The added problem in tech transfer is that the communication network needs to go beyond the research community to include the user community, the marketing people, and the manufacturing groups
- This would require boundary spanning—going beyond the immediate boundary of one's discipline.



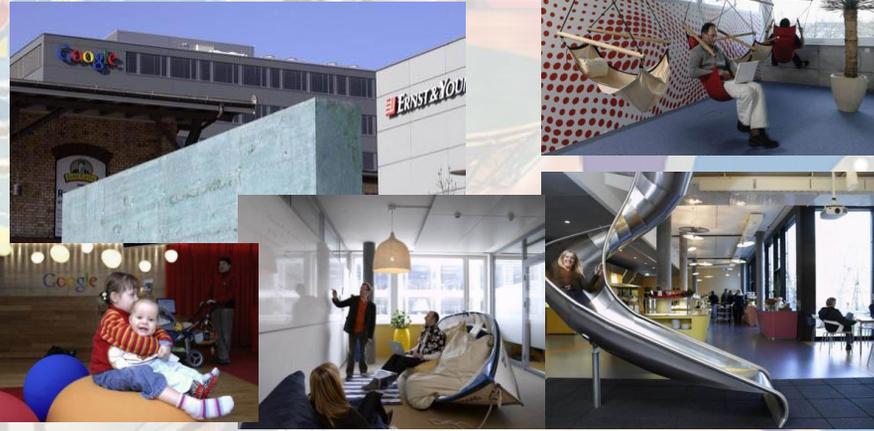
## BOUNDARY SPANNING...

- How can the communication, mutual understanding, and cooperation between teams of technical and business personnel be enhanced? Griffin and Hauser (1992) recommend:
  - Designing physical facilities that reduce the physical distance between the groups and provides non territorial spaces in which people can informally interact
  - Moving personnel between functional groups, even in a temporary advisory capacity, hiring people with dual skill sets in R&D and marketing who can straddle both areas, and encouraging training of existing personnel in dual skills (for example in management of technology programs in universities)
 Providing opportunities to interact socially via cross functional dinners and picnics, recreational activities, and the like



## BOUNDARY SPANNING...

- Google Office



Program Pascasarjana FT UNP Padang



Program Magister Chief Information Officer

## IBM TECHNOLOGY TRANSFER CASES

- Cohen and colleagues (1979, p. 11) focusing on the transfer of technology from research to a profitable commercial enterprise, describe a study of 18 IBM projects; some of them were successful, while others failed.
- They produced valuable guidelines for moving technology from research to project development. This study can form an archetype for the development of guidelines for technology transfer that are responsive to the unique requirements of a given organization.

Program Pascasarjana FT UNP Padang



Program Magister Chief Information Officer

## IBM TECHNOLOGY TRANSFER CASES...

- As a result of this study, factors identified that affect technology transfer are discussed in the order of their relative importance:
  - **Technical Understanding**
  - **Feasibility**
  - **Advanced Development Overlap**
  - **Growth Potential**
  - **Existence of an Advocate**
  - **Advanced Technology Activities in a Development Laboratory**
  - **External Pressures**
  - **Joint Programs**



## IBM TECHNOLOGY TRANSFER CASES...

- **Technical Understanding**
  - It is necessary that research personnel fully understand the main technology before passing it on. Though this may seem obvious, it is not always the case.
  - It is necessary to evaluate the benefits of new technology in comparison to what is already available and to other competitive advancements.
  - One must identify where it will fit in the product line and what requirements must be met to reach the fit.
  - Possible means of manufacturing need to be exhibited.



## IBM TECHNOLOGY TRANSFER CASES...

- **Feasibility**

- Both the research and the receiver unit must reach an agreement on what constitutes feasibility and then what should be established.
- Some estimate of cost effectiveness should be made.
- In some cases, feasibility implies acceptability by the end user. This would recognize some kind of joint study with real users to establish feasibility.

## IBM TECHNOLOGY TRANSFER CASES...

- **Advanced Development Overlap**

- For projects being transferred out, some overlap of research activities may be needed either to support development or to explore advanced or related technologies.
- For systems work (computer software), creation of a special advanced development effort is often the answer to problems of scaling up or is helpful in answering questions of economic feasibility.

## IBM TECHNOLOGY TRANSFER CASES...

- **Growth Potential**

- When projects are narrowly focused on a specific need and do not have paths to technical growth and product applicability, technology transfer may suffer.
- This is because existing technologies “stretch” themselves and the limited advantage offered by the new technology may not be sufficient to warrant change.

## IBM TECHNOLOGY TRANSFER CASES...

- **Existence of an Advocate**

- A strong proponent activity is needed to help overcome many hurdles during the technology transfer process.

- **Advanced Technology Activities in a Development Laboratory**

- In moving technology from research to manufacturing, advanced technology programs in the development laboratories are often necessary. (For some research organizations, research and advanced development units may work in the same group.)

## IBM TECHNOLOGY TRANSFER CASES...

- **External Pressures**

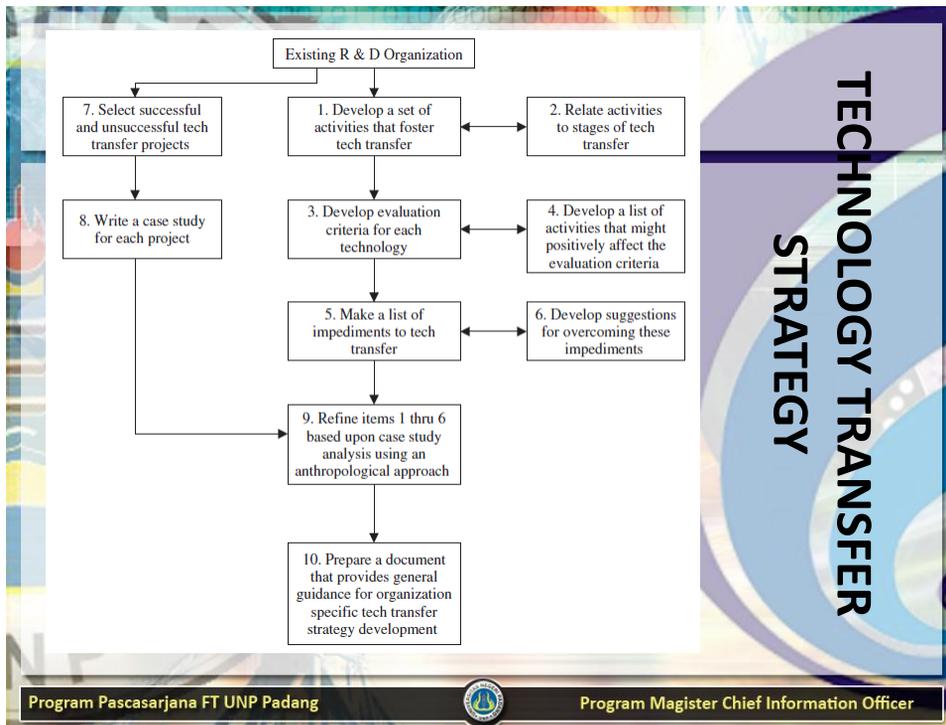
- In some cases, parallel activity by a competitor may help provide the push for technology transfer; in others, regulatory requirements may necessitate adoption of new technologies—for example, advanced waste treatment technologies.

- **Joint Programs**

- Although joint programs with receiver groups are good to have, they do not ensure success.

## IBM TECHNOLOGY TRANSFER CASES...

- Other secondary factors affecting technology transfer relate to timeliness, internal users, government contracts, high-level involvement, individual corporate responsibility, and proximity.
- For the IBM projects studied, however, in no case was the proximity of a development laboratory to a research laboratory an important factor for technology transfer.
- Being close was convenient and saved money, but no transfer failed because of distance (Cohen et al., 1979, p. 15)



## Question for Class Discussion

- From your experience as a consumer or a user of new technology, what kinds of factors persuaded you to adopt new technology?
- What factors worked against adopting new technology?
- Finding another examples for successful of the new technology and failed it self?
- Develop a generalized technology evaluation methodology for new products and systems in a specific technology industry or domain, give an examples in this case!

## References

- Allen, T. J. (1977). *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the Research and Development Organization*. Cambridge, MA: MIT Press.
- Bosomworth, C. E. (1995). How 26 companies manage their central research. *Research Technology Management*, **38**(3), 32–40 (May–June).
- Cetron, M. J. (1973). Technology transfer: Where we stand today. *Joint Engineering Management Congress 21st*, 11–28.
- Cohen, H., S. Keller, and D. Streeter (1979). The transfer of technology from research to development. *Research Management*, **22**(3), 11–17 (May).
- Cohen, W. M., R. R. Nelson, J. P. Walsh (2002). Links and Impacts: The Influence of public Research on Industrial R&D. *Management Science*, **48**(1), 1–23.



## References ...

- Ewing, J. (2008). How Nokia Users Drive Innovation. *European Innovation* (April 30)
- Harryson, S. J. (2008). Entrepreneurship through relationships: Navigating from creativity to commercialization. *R&D Management*, **38**(3), 290–310.
- Howard, W. G., and B. R. Guile (Eds.) (1992). *Profiting From Innovation*. National Academy of Engineering. New York: Free Press.
- Roberts, E. B., and A. L. Frohman (1978). Strategies for improving research utilization. *Technology Review*, **80**(5), 32–39 (March–April).
- Rogers, E. M. (1983). *Diffusion of Innovations*, 3rd ed. New York: Free Press.
- Rogers, E. M. (1995). *Diffusion of Innovations*. 4th edition, 132. Free Press: New York.
- Von Hippel, E. A. (1978). Users as innovators. *Technology Review*, 31–37 (January).
- Von Hippel, E. A. (1988). *The Sources of Innovation*. Oxford University Press: New York.

