Unit 9

TECHNOLOGY TRANSFER AND THE PRIVATE SECTOR

Transparency 9-1: Technology Transfer and the Private Sector

NOTE: PRESENT PURPOSE AND OBJECTIVES OF THIS UNIT.

INNOVATION

In the private sector, a product innovation occurs when a new product is introduced to the marketplace. An innovation is successful when it is accepted (or adopted) by the final users (i.e., consumers of the firm's products or services). A new process can definitely be an innovation, but this kind of innovation is usually used within the firm itself. Although transfer of process technology offers a great deal of potential for Federal laboratories (particularly in cooperative R&D areas), this session focuses on innovation in the sense of getting new (or improved) products to market.

Technological Possibilities

Transparency 9-2: Model of Innovation in the Firm

To begin this discussion, I am going to introduce the term "technological possibility" to refer to the outcomes of R&D activity. These outcomes may take the form of conceptions, inventions, prototypes, or even full-scale production models. These represent costs to the company and are merely contingent assets. In order for the contingent assets to become earning assets, they must proceed through production and marketing and be introduced into the marketplace as products.

A technological possibility is only a possibility, and most of them never become technological products. A technological possibility is like a fishing license. You have the opportunity and the credentials to go fishing, but you haven't caught any fish yet. R&D must be integrated with the firm's marketing and production activities to turn the technological possibility into a technological product.

2. The required reading by Robbins introduces the concept of technology transfer as a managerially nonintegrated technological innovation process. This concept is fundamental to the management of technology transfer. The required reading by Parker is an up-to-date perspective on the management of technology and its transfer. The optional reading by Ford and Ryan is intended to demonstrate that technology management is a private sector problem also and that pointers for the Federal labs can be drawn from private sector experience. The optional reading by Quinn and Mueller demonstrates a similar point, since it deals with mechanisms to achieve a greater degree of transfer within a company.

3. The value of this session can be enhanced by introduction of agency-specific examples.

ESTIMATED TIME:

15 minutes for presentation
30 minutes with discussion

What are the inputs to the innovation process for the firm?

Creativity--it's hard to define--even harder to identify, but it is something we know is among us. Basic research? Sure, science outcomes are very important to the production of technological possibilities.

Applied research? Certainly.

The next one is a little tougher, perceived need. Here we are talking about a market need. That is, the identification of a problem that can be solved--in this case by a technical solution.

If you talk to the manager of any large, long-lasting industrial R&D operation, you will find that a major part in managing such an enterprise is to limit the activity of some of the researchers with respect to the technically elegant solutions to problems for which there is no perceived need.

Of course, we need development, sometimes referred to as R&D. Technology is an input to innovation processes. It's a result of R&D activities.

Capital, certainly.

Management, generally high-quality, competent managers, but also that special subclass of managers we call entrepreneurs: those special people who are capable of managing new products and new companies.

And then, of course, there is manpower.

Intellect is another input that is very hard to measure, but critically important.

Critical commentary, not only with regard to the technology, but also with respect to where it's targeted to go (i.e., the markets), is a very important lubricant to the technological innovation process. It should be encouraged, and its a manager's job to do that.

Of course, application and dedication, sometimes referred to as sweat, are also critical.

On some occasions, real property is required, in some cases not.

And of course, finally, we have time. Time is a resource. It is a very expensive resource, and this is very important to the private sector. Time costs money, but time also suggests the concept of timing. Timing is important because a product must be introduced when

technology in terms of applications other than those directly related to the primary mission. Technology management is, therefore, a necessary component of Federal laboratory management and of any transfer activities.

The management of technology transfer is the means by which technology management produces technology transfers. Technologies can, of course, be transferred without any effort on the part of management, which has happened in the past and will continue to happen to some degree in the future. However, the management of technology transfer implies an active and organized approach to transfer, which has been mandated by the recent legislation.

In managing technology transfer, we can draw on the experience of the private realm, which is faced with problems that are similar to our own. One of the major portions of the general technology transfer literature deals with problems in the private sector in transferring the results of R&D to production and marketing.

Although problems of transfer from Federal laboratories to the private sector are not exactly the same as those of transfer within the firm, the process offers sufficient parallels for us to be aware that technology transfer is a difficult management problem in the firm and that the private sector has developed some management approaches for dealing with these difficulties.

IF THE OPTIONAL READINGS BY FORD AND RYAN AND BY QUINN AND MUELLER HAVE BEEN USED, THE INSTRUCTOR SHOULD EMPLOY THESE PAPERS IN A GENERAL DISCUSSION WITH THE PARTICIPANTS ABOUT PRIVATE SECTOR PARALLELS. IF NOT, THE INSTRUCTOR SHOULD SUMMARIZE THE POINTS MADE IN THE PAPERS AND ELICIT DISCUSSION FROM THE PARTICIPANTS.

OPPORTUNITIES

Transparency 10-2: The Opportunity

NOTE: OUTPUTS HERE REFERS TO WHAT THE COMPANY HOPES TO ACHIEVE THROUGH INNOVATION RATHER THAN THE PRODUCT OUTCOME OF THE INNOVATION PROCESS.

NOTE: OPPORTUNITY COST IS THE COST ASSOCIATED WITH CHOOSING ONE ALTERNATIVE OVER ANOTHER. ESSENTIALLY, IT IS A QUESTION OF HOW TO MOST EFFECTIVELY USE AVAILABLE RESOURCES.

CAN THE PARTICIPANTS IDENTIFY ANY OTHER OUTPUTS TO THE INNOVATION PROCESS?

The Genesis of Innovation

Transparency 9-6: The Genesis of Innovation

Next, we need to know something about the genesis of innovation: where does it get started, how does it get going? In an industrial setting the answer is simple: there is supply-push innovation and there is demand-pull innovation.

Supply-push can be characterized as a situation in which one says "I have (a technology), don't you need?" Demand-pull is expressed as "I need (a technology), don't you have?" Clearly, demand-pull is a much greater force for making innovation happen in the private sector than is supply-push. Government labs (usually, but not always) start from a position of supply-push. They have the technologies, and the challenge is to make people know they can use the technology--that they need what the labs have to accomplish their own objectives.

WHAT DO THE PARTICIPANTS THINK ARE THE IMPLICATIONS FOR TRANSFER ACTIVITIES OF THE SUPPLY-PUSH SITUATION OF FEDERAL LABS?

Industry Motives for Supporting Innovation

Transparency 9-7: Motives for Supporting Innovation

There are perceived conflicts on the part of people on the bench as to where their objectives should be. To what extent does the embracing of the technology transfer philosophy constrain my ability to publish and receive the proper accolades from my peers? And finally, I think we can expect some perceived conflicts of philosophy, as reflected, for example, in the statement: "I work for a government laboratory. I don't believe that profit-oriented, private sector people should capitalize on what we do."

And last, but by no means least, the Congress and the President have decided that we will get on about the business of transferring technology, so we had better figure out how to do it.

ASK THE PARTICIPANTS FOR THEIR COMMENTS ON THE OPPORTUNITIES AND PERCEIVED CONFLICTS.

MANAGEMENT HANDLES

Transparency 10-3: Management Handles

A successful management system will address at least six essential elements of information and control, here characterized as "management handles." Each of these may sound trival, but practitioners recognize that none of them are.

First of all, you need to know when you have something. Under a narrow definition, you've got a stock of invention disclosures. That's all you need. Now what we are saying is, no, here is somebody who suddenly realizes that a process that's been in use in the lab for years may have an application in another setting. That's a starting point for the innovation process just as surely as the classical invention event is.

And yet, how do you capture it? How do you recognize the fact that that's happened? How do you identify the fact that you have facilities and specific knowhow within the laboratory that could form the basis of an eventual transfer? So one section of the management

year like large companies, but firms that do not innovate generally do not survive long.

Growth objectives drive the innovation process in industry with a power that is difficult to imagine unless it is experienced. This sometimes leads to innovative activities that are not wisely carried out because the timetable can't be met for converting the innovation into a revenue/profit stream that helps to meet the growth objective.

NOTE: ONLY THE GROWTH OBJECTIVE IS DISCUSSED. THE OTHERS APPEAR OBVIOUS, BUT THE INSTRUCTOR MAY WISH TO INTERJECT SOME COMMENTS WITH RESPECT TO THEM.

Cost Structure of Industrial Innovation

Transparency 9-8: Cost Structure of Industrial Innovation

Another dimension of innovation that we need to understand is the cost structure of industrial innovation. For most kinds of products or services other than military goods, the cost structure looks something like that represented on the transparency.

The cost structure for industrial firms is such that the R&D phase, which is the beginning part of innovation, takes about 10 percent of the total resources required to get a new product or service to the market. The production (i.e., manufacturing) and marketing (i.e., selling) phases together take about 90 percent.

If you have a technological possibility (a successful R&D result that may have commercial promise), what you are willing to provide someone in the private sector is a license to spend approximately nine times what you have already spent for them to get it to market.

These facts are borne out by myriad studies of innovation processes. It's important to understand that whatever the private sector entrepreneur, businessman, or manager uses that comes out of Federal labs, he is usually going to spend many times more than you have spent to get it to market.

every one of these systems will require the capability of grasping these handles.

NOTE: DISCUSS THE MANAGEMENT HANDLES WITH THE PARTICIPANTS.

PROGRAM BASICS

Transparency 10-4: Program Basics

Broadly speaking, the technology that is to be transferred will take the form of knowledge that is either patented or patentable on the one hand or else unpatented or unpatentable on the other. The patented or patentable knowledge will have been concretized in some form, ranging from an invention on the one hand to a fully developed technology produced as part of mission work on the other.

In most cases of patented or patentable knowledge, additional development work or applications work will be required to make the technology useful to the private sector. The most effective way of accomplishing this work is through participation of laboratory personnel. Thus, in the case of patented or patentable knowledge, technology transfer will be a process with a time dimension and will require joint management of the technology. A cooperative effort is needed to fully accomplish transfer, which, in order to be successful, must result in use. The laboratory portion of this effort can be financed, in part, through a cooperative R&D agreement.

Unpatented or unpatentable knowledge takes the form of knowhow (embodied knowledge), which is manifest in ongoing research and development efforts within the laboratory. Knowhow can be transferred immediately, and perhaps without recompense to the laboratory, through technical assistance. This will probably be the primary form of transfer of unpatentable knowledge.

Unpatented knowledge may be developed over time into patentable knowledge. The primary mechanism for the transfer of unpatented knowledge will probably be a cooperative R&D agreement in which a single firm provides partial funding for a line of research (usually

course, exceptions to every rule. For example, the utility industry is a major investor in cooperative research arrangements designed to find solutions to regulatory matters. But that's still a pretty good rule to follow in general.

WHAT DO THE PARTICIPANTS THINK ABOUT THE RULE?

Vertical Relationships

Let's take a quick look at another aspect of market or industry structure.

Transparency 9-11: Another Aspect of Industry Structure: Vertical Relationships

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This one is concerned with vertical relationships. Suppose you come up with a new aluminum alloy that has great heat resistance properties, or can stand heat and not lose its dimensions and strength, and you think it would be useful to large transport aircraft manufacturers like Boeing and Douglas. Where would you take the alloy for commercialization? Would you take it to the aircraft manufacturer's public accounting firm? No, obviously you wouldn't do that, and you would not likely take it to an engineering services supplier either. Would you take it to the producers of engines? Maybe, depending on how the engine manufacturers are using aluminum at the moment. Would you take it to an aluminum manufacturer? You might. This could be important to the manufacturer.

But if you had a chance to bring demand-pull into play, wouldn't you take it to the airlines, to the aircraft lessors, or to the military and try to get them to specify an aluminum alloy that has these properties. This requirement from the end users (i.e., the customers for all the suppliers) would achieve commercial results. A Federal laboratory might also try to persuade the end users to specify the alloy's properties and then negotiate nonexclusive licenses with all the manufacturers.

This would not be a complex or difficult problem if technology transfer was simply a handoff of an object. The technology would be entirely in the hands of one organization at one time and then quickly placed in the hands of another. However, in most transfer activity leading to commercialization, technology assumes the form of knowledge that is in the Federal laboratory and in the firm at the same time. Its management is not only dual (i.e., involving two parties), but joint (i.e., involving two parties controlling the technology at the same time).

Because transfer is not a handoff, this joint management must be exercised over a period of time; and during this time period, the technology is usually undergoing change. Technology transfer is, therefore, not a transactional interface between institutions, but rather a protracted relationship involving joint management. The management of technology transfer is a cooperative enterprise in which joint management focuses on developing technology toward its end in innovation.

NOTE: DISCUSS WITH THE PARTICIPANTS THE CONCEPT OF TECHNOLOGY TRANSFER AS A MANAGERIALLY NONINTEGRATED INNOVATION PROCESS (WHICH IS FOUND IN THE REQUIRED READING BY ROBBINS). USE THE REQUIRED READING BY PARKER AS A BASIS FOR DISCUSSING A PRACTICAL APPROACH TO THE MANAGEMENT OF TECHNOLOGY AND TECHNOLOGY TRANSFER.

IF THE OPTIONAL READING BY DRUCKER HAS BEEN USED, DO THE PARTICIPANTS HAVE ANY REFLECTIONS ON THE POINTS MADE IN THIS PAPER?

TECHNOLOGY TRANSFER

Transparency 9-13: Technology Transfer

Now let's turn our attention to the problem of transferring technology to the private sector. Technology (as product, process, or technique) can be transferred in many ways and in many dimensions, some of which are already familiar to you.

An example of a vertical transfer would be a transfer from a supplier to its customer (usually another firm) or from the customer to the supplier. The latter is a common form of transfer and innovation and occurs when a customer finds an improvement which the original supplier then modifies and sells to other customers.

A horizontal transfer occurs when a firm in one industry adopts a technology that was originally used in another, unrelated industry. The most obvious example is computer technology, which has been applied to nearly every industry in products, processes, and services.

And of course transfers occur between public and private organizations--in both directions. Note that a public sector/private sector transfer can also be a horizontal transfer. These are applications of a technology for different uses in different industries and offer significant opportunities for laboratories to contribute to widespread innovation.

NOTE: THE ARROWS IN THE PUBLIC AND PRIVATE SECTOR EXAMPLES ARE IN BOTH DIRECTIONS, INDICATING THAT TRANSFERS ARE RECIPROCAL AND COOPERATIVE RATHER THAN DONOR-RECIPIENT. THE FIRST PARTY MERELY INDICATES THE ORIGINATOR OF THE TECHNOLOGY.

ASK THE PARTICIPANTS IF THEY ARE AWARE OF ANY VERTICAL TRANSFERS FROM FEDERAL LABORATORIES.

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pursued by one person or a small team) conducted in the laboratory and congruent with the product development objectives of the firm.

Under such agreements, one of two things will happen. In many cases, the research results emerging from laboratory work will be folded into a corresponding research effort conducted within the firm and will contribute to product development. The laboratory will not see any specific technology emerge from its research effort and will have difficulty securing from the firm an account of how the laboratory knowledge contributed to product development. In almost all cases, the laboratory contribution will be much smaller than the firm contribution.

In other cases, a specific technology may begin to emerge from the laboratory effort. Under these circumstances, laboratory management will need to look out for the interests of the inventor (or inventors). However, although there may be some exceptions in practice, firms are generally not interested in stealing technologies. It is in their self interest to maintain a working relationship with the inventor because much additional development work will be required, and the successful outcome of this work may be highly dependent on the expertise of the inventor. Under these circumstances, the cooperative R&D agreement may be extended and supplemented by additional funding.

Cooperative R&D thus leads to the transfer of knowledge that is folded into the firm's research effort or to patentable knowledge that continues to be developed jointly. In both of these circumstances, technology (in the form of knowledge) is under joint management control, and the transfer process assumes a time dimension.

Whenever technology developed (or, to be more precise, developing) in a Federal laboratory is directed toward commercialization in the private sector, technology transfer will be a factor in a managerially nonintegrated innovation process. The process is managerially nonintegrated because the technology falls under more than one management structure on its way to commercialization. Since the process is singular and its management at least dual, coordination of managerial effort between the Federal laboratory and the firm is essential to successful innovation.

investment off its books. With the quarter-to-quarter earnings improvement required by many firms (particularly public companies), firms strongly resist wiping investments that are still functionally useful off the books.

Another major resistance lies in the uncertainty or paucity of data related to both the technical aspects and demand side of a technology. You cannot provide too much data to accompany the technological possibilities you are attempting to transfer to others for exploitation.

Some companies have a general tendency to avoid risk, but more often it is difficult to get high-risk ventures financed.

And, finally, we come to the old friends that we talked about before, the extremes of market structure: pure competition and pure monopoly. If there are extremes in the marketplace, there is a great resistance to change, because one firm says I don't need the technology, and another says I would love it, but I can't afford it.

HOW IMPORTANT DO THE PARTICIPANTS THINK THESE RESISTANCES ARE, AND CAN THEY SUGGEST ANY OTHER CATEGORIES OF RESISTANCE?

Data and Information Requirements

There will be many cases of firms approaching the laboratories seeking technology. However, in the case of a technology developed in the course of mission work or independently by laboratory personnel, the laboratories will need to approach industry about commercializing the technology. Given the resistances to technology transfer, how is the laboratory to interest a firm (or several firms) in commercializing a technology?

The answer is that in many cases the laboratory will need to supply scientific data and other information to convince the firm of the commercial value of the technology. The first questions are likely to be these:

task is simply recognition that the first step of an innovation process has occurred.

Once you know you have it, you have to be a little more particular about what it is you have, and this has dimensions of classification, of evaluation, and of some way of categorizing the potential innovation so that it can be properly pursued.

A third element of concern to the technology manager is value. Conceptually, one has to remember that the fact that you have invested X dollars in this technology is in most cases irrelevant to the person who may be interested in transferring it. The difference between cost and value needs to be stressed and should be understood at all levels.

If you have already spent three years and a million dollars in carrying a drug through an approval processes, that adds to the perceived value to the transferee. But you could have spent a lot of money on a perfectly valid scientific discovery that has no perceptible market. It is by definition valueless to the transferee. In other words, value needs to be assessed from the perspective of the person to whom it is being transferred.

Knowing what to do with it leads into a discussion of transfer strategy, which includes dimensions of protection, of the method of transfer, and the characteristics of the receptor organizations.

Knowing who needs it requires an understanding of the organization of the specific private sector of interest. One can start by asking who would be the ultimate user; and then, who is it that is the probable supplier to that ultimate user. There may be additional levels before you reach the point at which you are able to say this is the category of enterprises that are the probable ones to which we can transfer. Then you begin to get specific about firms and agencies that might be targeted.

Knowing how to move it has elements of marketing and sales. It also includes elements of motivation of people up and down the ladder in the laboratory. There needs to be something in the transfer for each of the actors in order that the transfer moves smoothly.

The specific management system that is implemented in one laboratory may be different from that in another in subtle ways. But

where a single firm is interested in gaining a competitive edge. In this case, a patent can be helpful, and possibly the ability to exclusively license will be important to a firm. There are, however, other forms of protection besides patents.

NOTE: SEE UNIT 13 (INTELLECTUAL PROPERTY: PATENTS AND LICENSES).

Transfer Motives

Transparency 9-17: If a Technology Is to Be Sold

To license a technology, or launch it into the private sector, which is the principal focus of what we are about, the motives must be present in the buyer or transferee. There must be sufficient motive or motives there to make the firm want it. Remember: "I need, don't you have?"

The technology must be available, meaning that it must be ready for transfer or for development that can lead to transfer. The people who are crucial to its transfer must be available to assist in its transfer. Without the knowhow of the inventor or developer a technology is often for all practical purposes unavailable.

The technology must also be credible; that is, believable. It must have the data and information that we have talked about.

And most important it's got to be relevant. It's got to address a market so that people will pay money to get something the technology permits to be produced. If it's irrelevant to every market in the world, forget about it. It's a nice curiosity, but there are millions of curiosities that come out of labs, and labs are in the business partly of producing curiosities, because maybe in 20 years what is now a curiosity when added to something else will become a promising exploitable outcome.

Government technologies can be transferred at a far greater rate than has occurred in the past, but it is important to remember that no matter how good a technology is, the market may not be ready for it. And, of course, the price must be right. And what does this mean?

To begin mapping out an approach to the management of technology transfer within Federal labs, let's review quickly what the preceding units have said about the scope of this management task.

First of all, we have defined technology very, very broadly. Technology is not just something on the shelf. It's knowledge, people, and process, and a management approach to technology transfer has got to recognize this.

We have also defined transfer very broadly. It's not just a license agreement. It can also be such things as the transfer of knowhow and people, and the management process needs to comprehend this breadth.

Thirdly, it sounds like a cliche by this time, but technology transfer is a people process. And it is also fragile and complex. Several of the preceding units have cited examples of a technology transfer path that has been interrupted by the unwillingness of an inventor to cooperate, or by any number of other roadblocks. One begins to wonder whether this is an unmanageable process that simply happens.

NOTE: THAT TECHNOLOGY TRANSFER IS UNMANAGEABLE IS A STRONGLY HELD BELIEF IN MANY CIRCLES. THE INSTRUCTOR MAY WISH TO REVIEW HERB ROSEN, "NOW YOU SEE IT, NOW YOU DON'T" (JOURNAL OF TECHNOLOGY TRANSFER, VOL. 5, NO. 2, PAGES 29-33) AS A CHALLENGE AND BASIS OF DISCUSSION ON THIS POINT.

The process is also besieged by a lot of perceived conflicts. Few of these are real, but the perceptions are so strong that management must of necessity deal with them.

First, there are perceived conflicts with the mission of the agency and/or the lab. We have our eye on one target. Doesn't this process of technology transfer distract us?

There are also questions of resource management. What sort of algorithm do we use to determine whether this branching path should be funded and to what level. The research management process itself is complicated.

NOTE: REMOVE TRANSPARENCY FROM SCREEN.

IF THE OPTIONAL READING BY CHAPMAN HAS BEEN USED, DO THE PARTICIPANTS HAVE ANY REFLECTIONS ON THE POINTS MADE IN THIS PAPER?

Unit 10

MANAGEMENT OF TECHNOLOGY TRANSFER

Transparency 10-1: Management of Technology Transfer

NOTE: PRESENT PURPOSE AND OBJECTIVES OF THIS UNIT.

INTRODUCTION

The preceding units have addressed policy and principles. From here on we will be considering tactics and implementation. We are also making another important transition at this point. Heretofore we have been talking about technology transfer. Starting with this unit, we're going to be talking about the management of technology transfer, and we need to reorient ourselves to view technology transfer as a management task.

PRIVATE SECTOR PARALLELS

The management of technology transfer is a part of general technology management, which is concerned with directing technologies and technological activities towards organizational objectives. The scope of technology management is increased when an organization begins to look at technology in terms of different applications. This happens in the private sector when a firm looks at the technological possibilities that have emerged from its R&D effort and then decides whether there are alternatives (such as licensing) to product development by which the contingent asset can be converted to an earning asset.

NOTE: TECHNOLOGICAL POSSIBILITIES AND CONTINGENT AND EARNING ASSETS ARE COVERED IN UNIT 9 (TECHNOLOGY TRANSFER AND THE PRIVATE SECTOR).

Technology management happens in the public sector when a Federal laboratory directs its technologies and technological activities towards primary mission activities. The scope of technology management is increased when laboratory management begins to look at its

Unit 10

TITLE: MANAGEMENT OF TECHNOLOGY TRANSFER

PURPOSE: This session is intended to serve as an introduction to the remaining units, which focus on tactics and implementation. The unit summarizes the opportunities and pitfalls of technology transfer and serves as an introduction to the concept of technology management.

OBJECTIVE: Upon completion of this unit, participants will:

- Have a conceptual framework for the specific management techniques that will be developed during the remainder of the course.

MATERIALS:

Transparency 10-1: Management of Technology Transfer

Transparency 10-2: The Opportunity

Transparency 10-3: Management Handles

Transparency 10-4: Program Basics

REQUIRED READING:

1. Martin D. Robbins, "Technology Transfer as a Process," pages 65-76 in A Synthesis of Technology Transfer Methodologies, U.S. Department of Energy, 1984 (DE85004635 Conf--8405184).
2. Thornton J. Parker, "Proposed System for Managing Technology in Federal Laboratories," U.S. Department of Commerce, Office of Productivity, Technology and Innovation, 1987.

OPTIONAL READING:

1. David Ford and Chris Ryan, "Taking Technology to Market," Harvard Business Review, March-April 1981, pages 117-126.
2. James B. Quinn and James A. Mueller, "Transferring Research Results to Operations," pages 60-83 in William L. Tushman and William L. Moore, eds., Readings in the Management of Innovation, Pitman Publishing Inc., Marshfield, Massachusetts, 1982.

NOTE TO INSTRUCTOR:

1. This unit is intended to serve as an introduction to the remaining units, which concentrate on various aspects of the management of technology transfer. Thus, it is a pivotal unit between the theories presented in the preceding units and the applications that will be presented in the following units.

Well, it may mean priced low enough for somebody to take it. But "right" doesn't necessarily mean cheap, or give it away. The price is essentially determined by what someone is willing to pay, and this price is always negotiated.

NOTE: SEE UNIT 18 (INTRODUCTION TO TECHNOLOGY VALUE AND PRICING ISSUES).

Buyer Sensitivity

Transparency 9-18: Buyer's Sensitivity

Whenever an industrial buyer is considering options, a technology transfer manager should keep in mind what the total costs are to the firm in exploiting the technological possibility. The total costs are very important. So are the marginal costs, or the incremental costs. But the transfer agent has got to be mindful of that 90 percent of the costs that we talked about.

There are life cycle costs associated with a product that will make it a success or a failure. Life cycle costing is far more relevant to buyers of innovative products and services than is original cost.

The private sector acquirer will be very much concerned, very knowledgeable, and very sensitive with respect to the inherent riskiness of innovation. The failure rates are extremely high.

The laboratory transfer agent must be aware of the romance in a new technology and not get trapped by that. And he must see the need for appropriate performance measures related to any given technological possibility. Those performance measures must be in both economic and functional terms. Laboratories will also need to be sensitive to these concerns in working with the private sector to accomplish technology transfer and innovation objectives.

DOUBLE

Transparency 9-15: Transfer Questions

NOTE: READ QUESTIONS.

Several types of information may need to be supplied to address these questions.

Transparency 9-16: Data and Information Requirements to Support Technology Transfer

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Is scientific data enough? Surely not, if you're trying to transfer something to the private sector. Is scientific data backed up by real or projected performance data to show it works? That's a lot better, but often this is still not enough.

Market data? Usually these would have to be projected, with some estimates made of what the market is and what it's going to do for the taker of the technology.

This is getting closer. And economic data; that is, how much money can be made with it, or how much money will not be made if the firm doesn't have it.

Wrap all these aspects together and you have got a pretty good data package to support the transfer you want to make. Any package that doesn't have these elements covered to some extent severely handicaps your ability to transfer to the private sector.

Now where do you get all this information? Well, you can get it from laboratory-generated materials or from prototypes and test results. You can get it from matching pre-existing specifications with performance and from the operating environment if its reached that stage. You can get market data by making investigations and developing competent projections.

NOTE: SEE UNIT 17 (MARKETING TECHNOLOGY) FOR DETAILS ON MARKETS AND MARKET INFORMATION.

The final question concerns protectability. This is not an issue if the technology is meant for industry-wide use. It is often an issue

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Resistances to Technology Transfer

In technology transfer, the technology that contributes to private sector innovation comes from outside the organization. Innovation is very difficult for a firm to manage, and often there are major resistances to innovation within a firm. These barriers to innovation are also barriers to technology transfer because the problems are aggravated when dealing with a separate organization that has other objectives and goals.

Transparency 9-14: Major Resistances to Technology Transfer and Innovation

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What are the major resistances that are encountered in transferring technology?

First, there is the general resistance to change that is found in all of us. Don't we all resist change from time to time in our personal as well as in our professional lives? It's a natural human quality. This general resistance to change is a tremendous brake on innovation and technology transfer efforts.

Another major resistance is the need for system integration of many innovative products. In the railway field in the United States, for example, we are using 50-year-old techniques and technology to brake trains. The reason the old technology is still used is that in order to change it, you've got to change the coupling system, the braking system, and many other systems in the command and control area related to trains. These changes can't get made overnight, and nobody has devised a scheme yet to stop the railroads for the number of days it takes to reequip couplings, brakes, and everything else.

In this case, system integration is very effective in stopping technological change. No matter how good a technology may be, it has to be able to be integrated into the industry and into the firm's capabilities.

Another resistance to transfer is found in firms experiencing capital losses as a result of obsolescence. Such a firm should be interested in an innovative technology or product that's cost effective. But to adopt this technology, the firm has to wipe a lot of

WHENEVER A BUYER IS CONSIDERING OPTIONS, THERE SHOULD BE SENSITIVITY TO:

- TOTAL COSTS (AS WELL AS MARGINAL COSTS)
- LIFE-CYCLE COSTS
- INHERENT RISKINESS OF INNOVATION
- THE MAINTENANCE OF OBJECTIVITY
- THE ROMANCE OF "NEW" TECHNOLOGY
- NEED FOR APPROPRIATE PERFORMANCE MEASURES
    - ECONOMIC
    - FUNCTIONAL

Another strategy might be to assist in starting up a new firm based on this technology. If successful, this strategy could lead to firm creation and job growth in the local area. It might also be possible to work with state or city agencies to find an entrepreneur for this purpose.

There are no textbook solutions for these questions. They are examples of options in technology management.

HOW WOULD THE PARTICIPANTS EVALUATE THE VARIOUS POSSIBLE APPROACHES?

Selecting a Target Licensee

Transparency 9-12: Industry Structure and Selecting a Target Licensee

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I would like to give one more example of industry structure to indicate some pitfalls. This involves the case of the improved rockbolt.

In a university with a mine-oriented engineering school, one of the professors came up with an idea for a new rockbolt that holds up the roof in mines. The university patent department licensed it; and where do you think they licensed it? To a mine operator.

That's what they did, because they had a very powerful and very generous alumnus of this mining school who owned a coal mine--one coal mine. They took the rockbolt to him, and he licensed it. He had some made by hand, and that was the end of the story. It never got diffused. They gave him all the patent rights, and that was the end of it. So the easy path is not always the right path.

Regulations for Federal technology transfer efforts now require a potential licensee to submit a commercialization plan. The purpose of the plan is to prevent this kind of transfer.

IF A TECHNOLOGY IS TO BE SOLD:

—MOTIVE(S) MUST BE PRESENT IN THE BUYER/TRANSFEREE

—THE TECHNOLOGY MUST BE AVAILABLE

—THE TECHNOLOGY MUST BE CREDIBLE

—THE TECHNOLOGY MUST BE RELEVANT TO THE MARKET

...AND THE PRICE MUST BE RIGHT

WHAT IMPLICATIONS DO THE PARTICIPANTS THINK THIS FACT HAS FOR TRANSFER ACTIVITIES?

Market Structure of the Innovating Firm

Transparency 9-9: Market Structure and Innovation

Another feature of the private sector that needs to be understood is the market structure of the industry in which the target company for a laboratory technology finds itself; that is, the type of markets a company and its industry operate in. The spectrum runs from the economists' highly theoretical pure competition at one extreme, to a monopoly at the other extreme. Where do you find the greatest innovative activity--the greatest propensity to accept innovation and to exploit innovation. Well, the answer is--in the middle of the range.

And why is that?

Transparency 9-10: Market Structure--So What?

The type of enterprise that needs promising technology the most is at the purely competitive end where it is fighting for every edge it can get. In pure competition, there are no real profits. But the firm needs innovation to get off the floor and start rising.

Who needs it the least? The monopolist, because this firm doesn't need to change in any basic fundamental sense--and innovation is a change in the status quo.

But what sort of enterprise can most readily finance a promising technological possibility into an innovation? It's usually the monopolist, because of high profits.

And who can least afford to finance it? It's the purely competitive fellow who is on the floor and can't get off.

Now what does that tell you? One thing it tells you is that firms in the middle range of the market structure spectrum are better prospects for transfer than firms at the two extremes. There are, of

DATA AND INFORMATION REQUIREMENTS TO SUPPORT TECHNOLOGY TRANSFER

- IS SCIENTIFIC DATA ENOUGH?
- SCIENTIFIC DATA PLUS PERFORMANCE DATA?
- MARKET DATA?
- ECONOMIC DATA?

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LABORATORY-GENERATED MATERIAL

ROLE OF THE PROTOTYPE(S)

TEST RESULTS

SPECIFICATIONS AND PERFORMANCE

FEEDBACK FROM THE OPERATING ENVIRONMENT

MARKET PROJECTIONS AND ANALYSES

What are the industrial motives for spending resources on innovation, for supporting innovation? Why does a company do it?

On the top half of the transparency there is something called demand stimulation; that is, the creation of a new demand curve, or the shift of an old one upwards. This is simply creating a new demand or enhancing one that is already there.

Then, there is the motive of cost reduction, which is often of critical importance. For example, in every deregulated industry in the United States, the first item these firms stressed after deregulation was cost reduction. Why? Because, with increased competition also come new entrants who are not saddled with high cost levels. So, deregulation often forces firms to compete with the low-cost producer, and the low-cost producer generally survives. Cost-reducing innovation has been the central focus of every deregulated industry, from the telephone company to the banks to the major transportation companies.

Another motive, of course, is to achieve both: stimulate demand while reducing cost. For example, when jets were introduced in aircraft, the unit cost for operating jets was a lot lower than the unit cost for operating prop-driven aircraft. Demand was stimulated not just be cost reductions, but because you could fly high above the weather, trips were shorter, and there was a lot of glamor.

There is also another set of motives, including dealing with a competitive threat (whether it's actual or expected), meeting a growth objective, or complying with a regulatory requirement.

Many companies adopt growth objectives, usually measured in terms of revenue, with some relationship between revenue and profits stated. A billion dollar company with a 10 percent growth objective experiencing obsolescence in 10 percent of its product line every year would need to have approximately $200 million in new revenues every year to meet its objective. The only place that this can be obtained is from innovation.

The same principle applies to all companies, no matter what size, because all products have a life cycle (that is, they will eventually become obsolete). Small companies may not face the situation every

TRANSFER QUESTIONS

- DOES IT WORK?
- WHAT'S THE MARKET POTENTIAL?
- IS IT PROTECTABLE?

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the market is ready. In addition, timeliness is a factor when a competitor is trying to get a smiliar product out before you do. So we are talking about three different kinds of time issues--time as a resource, the timing in terms of the marketplace that will accept the product, and timeliness in reaching that marketplace.

CAN THE PARTICIPANTS IDENTIFY ANY OTHER INPUTS TO THE INNOVATION PROCESS?

Outputs of the Innovation Process

Transparency 9-5: Outputs of the Innovation Process

We need to understand the outputs to the innovation process as well as the inputs. Outputs are to be found on several different levels. For the firm, the primary outputs of innovation are profits or losses. Another output is increased visibility--what we would call a better image. Creating an image as a technological leader is a strategy for some firms, and these firms rely heavily on continuous innovation as a method to sustain that image.

And of course one of the outputs is growth--expansion as measured in revenue terms, hopefully in profit terms, hopefully in employment terms, and so forth.

Any firm that engages in successful innovation and skillfully manages the process usually becomes much more flexible in the context of what markets it can address. It becomes more sensitive to market possibilities, and it becomes more diverse. The company usually becomes both larger and stronger.

We also have excitement as an output of innovation processes. People get involved in it. They get excited. It is an exciting, stimulating business to be involved with.

And, of course, there is risk. Innovation--because it is costly and market acceptance of the new product is uncertain--presents a high level of risk in time, money, and opportunity cost.

MAJOR RESISTANCES TO TECHNOLOGY TRANSFER AND INNOVATION

- GENERAL RESISTANCE TO CHANGE
- NEED FOR SYSTEM INTEGRATION (AS CONTRASTED WITH STAND-ALONE)
- WHERE CAPITAL LOSSES WOULD RESULT (OBSOLESCENCE)
- UNCERTAINTY OR PAUCITY OF DATA — BOTH TECHNICAL AND DEMAND
- OVERAVOIDANCE OF RISK
- MARKET STRUCTURE EXTREMES ("PURE" MONOPOLY OR "PURE" COMPETITION)

At the bottom of the diagram, we have the marketplace. The marketplace is the firm's customers. It is the customers who decide whether the innovation is successful, and they decide by choosing (i.e., buying) the firm's product rather than a competitor's product. Consequently, the firm usually measures "success" in terms of the dollars generated through sales as compared to the dollars invested in developing, producing, and selling technology-based products. The greater the return on investment, the greater the success.

Transparency 9-3: Technological Possibilities

The concept of a technological possibility in the private sector can be applied to the situation in a Federal laboratory. R&D within the laboratory produces a great number of technological possibilities, some of which are used in mission work. The ones that are not used are contingent assets. In addition, the ones that are used are contingent assets in the sense that they may have other applications.

The challenge to the Federal laboratories in their technology transfer efforts is to convert these contingent assets into earning assets. Since technology transfer takes place only if something is actually used, this conversion takes place when the private sector uses a lab-generated technology to produce a product.

That produces earnings for the company and also may provide some revenue for the inventor and his laboratory. But, from the perspective of Federal technology transfer, these are not the important earnings. The real earnings are in the form of job creation and other public goods.

DO THE PARTICIPANTS UNDERSTAND THIS PUBLIC GOOD CONCEPT OF EARNINGS?

Inputs to the Innovation Process

Transparency 9-4: Inputs to the Innovation Process

TECHNOLOGY TRANSFER

- BETWEEN ENTERPRISES
- BETWEEN INDUSTRIES
- BETWEEN NATIONS
- VERTICAL TRANSFER
- HORIZONTAL TRANSFER
- PUBLIC SECTOR ⟷ PRIVATE SECTOR
- PRIVATE SECTOR ⟷ PUBLIC SECTOR

NEXT

INDUSTRY STRUCTURE AND SELECTING A TARGET LICENSEE

THE IMPROVED ROCKBOLT

MINE OPERATOR

↑

DISTRIBUTOR OF MINING EQUIPMENT/SUPPLIES

↑

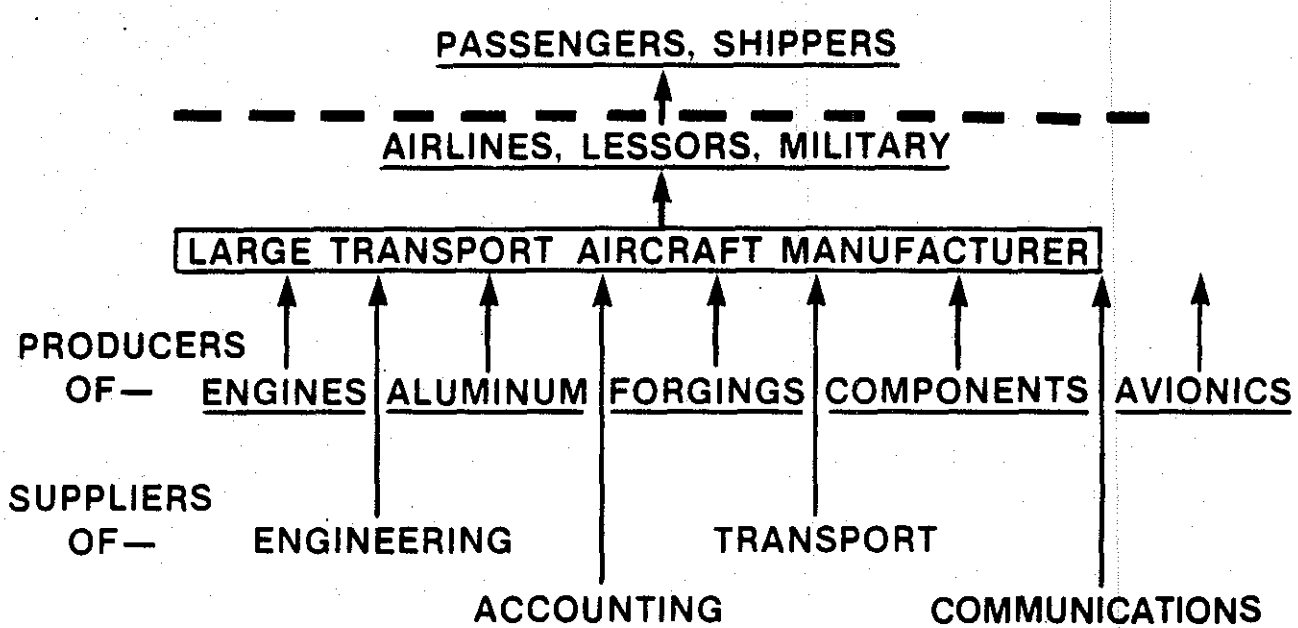
MANUFACTURER OF OTHER MINING EQUIPMENT/SUPPLIES

↑

ROCKBOLT PRODUCER: PRESENT? NEW?

TRANSPARENCIES FOR UNIT 9

ANOTHER ASPECT OF INDUSTRY STRUCTURE: VERTICAL RELATIONSHIPS



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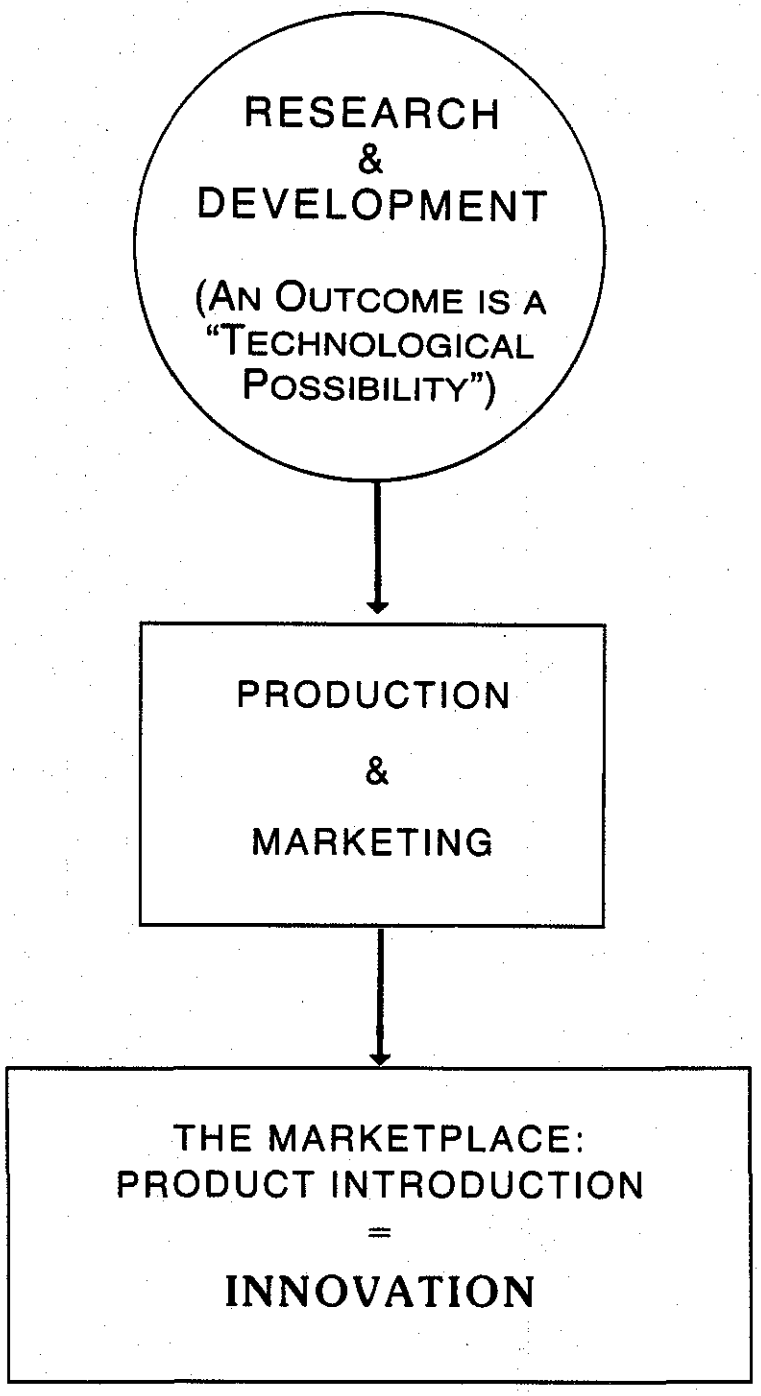
TECHNOLOGY TRANSFER AND THE PRIVATE SECTOR

MARKET STRUCTURE — SO WHAT?

WHAT SORT OF ENTERPRISE NEEDS A PROMISING TECHNOLOGY MOST? LEAST?

WHAT SORT OF ENTERPRISE CAN MOST READILY FINANCE A PROMISING TECHNOLOGICAL POSSIBILITY? LEAST?


RESEARCH
&
DEVELOPMENT
(AN OUTCOME IS A "TECHNOLOGICAL POSSIBILITY")
PRODUCTION
&
MARKETING
THE MARKETPLACE:
PRODUCT INTRODUCTION
=
INNOVATION

MARKET STRUCTURE AND INNOVATION

- "PURE" COMPETITION
- OLIGOPOLY AND "EFFECTIVE COMPETITION"
- "SHARED MONOPOLY"
- REGULATED INDUSTRY
- NATURAL MONOPOLY
- MONOPOLY

"TECHNOLOGICAL POSSIBILITIES" ON-THE-SHELF ARE "CONTINGENT ASSETS"; SUCCESSFUL TECHNOLOGY TRANSFER CONVERTS THEM INTO EARNING ASSETS.

COST STRUCTURE OF INDUSTRIAL INNOVATION

RESEARCH & DEVELOPMENT PHASE	~10%
PRODUCTION PHASE	~90%
MARKETING PHASE	

INPUTS TO THE INNOVATION PROCESS

CREATIVITY
BASIC RESEARCH (SCIENCE)
APPLIED RESEARCH
PERCEIVED NEED
DEVELOPMENT (R&D)
TECHNOLOGY
CAPITAL
MANAGEMENT, INCLUDING ENTREPRENEURSHIP
MANPOWER
INTELLECT
CRITICAL COMMENTARY
APPLICATION AND DEDICATION
REAL PROPERTY
TIME

MOTIVES FOR SUPPORTING INNOVATION
(PRIVATE SECTOR ENTERPRISE)

- DEMAND STIMULATION
- COST REDUCTION
- BOTH OF THE ABOVE

- TO DEAL WITH A COMPETITIVE THREAT (ACTUAL OR EXPECTED)
- TO MEET A GROWTH OBJECTIVE
- TO MEET A REGULATORY REQUIREMENT

OUTPUTS OF THE INNOVATION PROCESS

FOR THE ENTERPRISE

- PROFITS
- LOSSES
- VISIBILITY/IMAGE
- GROWTH
- FLEXIBILITY AND DIVERSITY
- EXCITEMENT
- RISK

THE GENESIS OF INNOVATION

- SUPPLY — PUSH
- DEMAND — PULL