Unit 4

TITLE: TECHNOLOGY TRANSFER

PURPOSE: This unit provides a general introduction to the nature of technology transfer.

OBJECTIVES: Upon completion of this unit, participants will:

- Have obtained an understanding of the basic reasons why Federal laboratory personnel should be interested in knowing more about technology transfer
- Have acquired an understanding of some of the limitations and misleading implications of current images and models of technology transfer
- Have been introduced to a working definition of technology transfer that can be used as a basis for an understanding of transfer efforts and the content of the following units.

MATERIALS:

Transparency 4-1: Technology Transfer

Transparency 4-2: Why Do We Need To Know?

Transparency 4-3: Technology Transfer Types

Transparency 4-4: Forms of Transfer

Transparency 4-5: Common Image and Models

Transparency 4-6: Investigating the Models

Transparency 4-7: Model Deficiencies

Transparency 4-8: An Adequate Definition

Transparency 4-9: Proposed Definition

Transparency 4-10: Virtues

REQUIRED READING: Issue Paper II--The Technology Transfer Process

OPTIONAL READING:

1. Richard T. Goldhor and Robert T. Lund, University to Industry Technology Transfer: A Case Study in Advanced Technology, Center for Policy Alternatives, Massachusetts Institute of Technology, 1981.
2. Harvey D. Jones, Jr., The Commercialization of New Technologies: Transfer From Laboratory to Firm, Sloan School of Management, Massachusetts Institute of Technology, 1983 (NTIS Order No. AD-A128 233/4/XPS).

NOTES TO INSTRUCTOR:

1. The content of this unit is not fully intelligible apart from the understanding of the nature of technology presented in Unit 3 (Technology). If the participants have not been introduced to Unit 3, the instructor should briefly review the nature of technology presented in Unit 3 before proceeding with the present unit.

2. The definition of technology transfer presented in this unit is meant to be a working definition, subject to modification on the basis of discussion and empirical testing.

3. It is difficult to get a feel for transfer processes unless one has personal experience or a fully documented case study. The latter is not available from the Federal technology transfer literature. As a consequence, the optional readings from Goldhor and Lund and from Jones have been included, though they deal with transfers from universities. Of these, Goldhor and Lund is the most detailed. The instructor may wish to use transfer examples of which he is aware in conjunction with the unit text to clarify or modify the points made.

4. The points for discussion provided in this manual are merely suggestions. The instructor may wish to proceed without discussion or to insert his own questions.

ESTIMATED TIME:

15 minutes for presentation
45-60 minutes with discussion

Unit 4

TECHNOLOGY TRANSFER

Transparency 4-1: Technology Transfer

NOTE: EXPLAIN THE PURPOSE OF THE UNIT AND WHAT PARTICIPANTS SHOULD HOPE TO ACCOMPLISH.

NOTE: IF NECESSARY, REVIEW THE BASIC CHARACTER OF TECHNOLOGY PRESENTED IN UNIT 3.

RELEVANCE

Transparency 4-2: Why Do We Need To Know?

Why do we need to know about technology transfer? Many Federal laboratories look at their primary mission work in terms of technology transfer. Laboratory-created technologies are sent to others for development, are brought back to an agency, and are then sent on to the public and private sectors for application. Since these are transfer activities, most mission work involves technology transfer. Thus, a better understanding of technology transfer will enable the Federal laboratories to do their primary missions better.

In addition, all laboratories engage in transfer activities that are not directly related to primary mission efforts. Such activities include the publication of papers, the presentation of speeches at conferences, the provision of technical assistance, and the allowance of equipment use. Recently, Congress has mandated the extension and formalization of transfer activities not directly related to the primary mission and that these activities be thought of in terms of improving U.S. industrial competitiveness. Every laboratory professional has been given the responsibility of a secondary mission to look for commercialization opportunities in primary mission work, and every laboratory has been instructed to set up formal programs to promote a greater amount of secondary transfer activity. Thus, the

more the laboratories know about technology transfer, the better they will be able to accomplish their secondary mission.

DO THE PARTICIPANTS' LABORATORIES THINK OF THEIR PRIMARY MISSION WORK IN TERMS OF TECHNOLOGY TRANSFER? IF NOT, SHOULD THEY DO SO?

TYPES OF TRANSFER

Transparency 4-3: Technology Transfer Types

The term "technology transfer" is used to cover a wide range of activities. If you scan a library catalog, you will find that most of the literature addresses transfer between nations. However, we are concerned with domestic transfer, which occurs in four major forms:

1. Transfer from the public sector to the private sector (e.g., from a university to a company).

2. Transfer from the public sector to the public sector (e.g., from a Federal laboratory to a municipal government).

3. Transfer from the private sector to the private sector (e.g., from one company to another through licensing).

4. Transfer from the private sector to the public sector (e.g., from an industrial contractor to its sponsoring Federal agency).

DO THE PARTICIPANTS THINK THESE CATEGORIES ARE SUFFICIENT TO COVER ALL TYPES OF TRANSFER?

ORIGIN OF THE TERM

Transparency 4-4: Forms of Transfer

The term "technology transfer" did not come into existence until 1963 in a Denver Research Institute (DRI) report on The Commercial Application of Missile/Space Technology. DRI had been assigned the task of identifying the commercial applications of space research, which at the time were called "byproducts." DRI found that the

byproduct terminology was misleading because it suggested that industry was interested in the hardware items produced by the space program, that something was ready to go to market, and that transfer was a simple matter.

Although DRI found some examples of what could be called byproduct transfer, they were fifth in importance after other types of transfer, including: (1) stimulation of basic and applied research; (2) new or improved processes or techniques; (3) improvements to previously existing products that were used in the space program; and (4) materials and equipment availability.

Moreover, DRI found that in the byproduct transfer cases, it was not the space products that industry was interested in, but the technologies underlying them. The term "technology transfer" was coined to avoid the misleading implications of "byproduct transfer." Ironically, the term has come full circle, with "technology transfer" now understood by the public as equivalent to what used to be called "byproduct transfer."

ASK THE PARTICIPANTS IF THE FINDINGS OF THE DRI REPORT ARE CONSISTENT WITH THEIR EXPERIENCES?

ARE THE PARTICIPANTS AWARE OF ANY EXAMPLES OF WHAT COULD BE CALLED BYPRODUCT TRANSFER?

IMAGES AND MODELS

Transparency 4-5: Common Image and Models

The prevailing image of technology transfer is one of "getting it off the shelf," as if technologies were like commodities in a retail store. The store advertises its wares, the potential buyer comes in to shop, the salesman picks the selected items off the shelf, and the purchaser leaves with something ready to use.

DO THE PARTICIPANTS BELIEVE THAT THIS IS THE PREVAILING IMAGE?

Problems inherent in this image are compounded by models of technology transfer that present the process as an interaction between two elements, variously designated as source-user, donor-recipient, transferrer-transferee, and developer-implementor, with an arrow between the two pointing to the second element and ostensibly representing the transfer process. The problem with such models is not so much that they are wrong as that they are misleading.

CASES

Transparency 4-6: Investigating the Models

NOTE: BRIEFLY DISCUSS EACH OF THE CASES.

Obviously, for transfer to take place, something must be transmitted from one institution to another; it is the directional arrow and the terms that prejudice the models. Let us examine a few cases to see how we would feel if we were in the private sector and were attempting to work with a public sector that was using the standard models:

1. A company sees a product opportunity in work being conducted by a public institution. The institution does not see the opportunity, so the creative act that transforms the technical knowledge into a potential product is supplied by the company. Nevertheless, according to the model, the institution is the source and the company is the user.
2. A company establishes a relationship with a public institution to develop a technological possibility to prototype stage. Most of the work is done in the company laboratory, with participation by an institutional scientist. Nevertheless, the institution is the donor and the company is the recipient.
3. A company spends two years overcoming immense difficulties to extract a technology from a public institution and then is designated as a transferee.
4. A company becomes aware of an object that has been created by a public institution. In order to produce a marketable product, the company must go back to the drawing board, using the technological form underlying the object as the basis for development. Although the company does 95 percent of the development work to produce a marketable product, the public institution is the developer and the company the implementor.

ASK PARTICIPANTS IF THEY HAVE ANY OTHER EXAMPLES THEY WOULD LIKE TO DISCUSS.

MODEL DEFICIENCIES

Transparency 4-7: Model Deficiencies

NOTE: IF TIME ALLOWS, EACH OF THE NOTED DEFICIENCIES SHOULD BE DISCUSSED, ELICITING FROM THE PARTICIPANTS THEIR OWN TRANSFER EXPERIENCES.

The two-element, one-direction model leads us to think about technology transfer in the wrong way. It is misleading because:

1. It suggests that the transfer initiative comes from the institution in which the technology originates. This may be the case in some circumstances; but the relative degree of effort of the transfer parties can only be judged after the fact. Under any circumstances, technology transfer does not occur without mutual effort and therefore should be understood as a cooperative endeavor.

2. The directional arrow does not encompass the transfer process. Technology transfer is not an event that occurs between two institutions, but a process in which they both participate.

3. The locus of value in technological development is radically misplaced in the originating institution. This causes the institution to overvalue what it has to offer, to withdraw into itself in the expectation that what it has to offer is sufficiently attractive, to disregard the needs of potential users, and to depreciate the efforts that must be expended by others to bring a technology to the point of innovation.

4. The technology to be transferred is presented as a discrete, fully developed item that is to be handed over in a process that has been reduced to an event. Transfer activities then center on communicating the results of what has been accomplished with the expectation that when transfer occurs, it will take place swiftly and smoothly.

5. What is transferred (or is to be transferred) appears ready for use by the receiving organization or environment. However, when we enter the realm of possibilities (e.g., when a technological idea has not yet been developed into a prototype), the need for development work is extensive. A similar situation exists at the opposite end of the development spectrum, when an object has already been produced (e.g., as the result of mission-oriented work in a Federal

laboratory). Generally, the object as it exists is of little use to the private sector. The receiver must use the technological form underlying the object to fashion something quite different that will be acceptable in the marketplace.

6. A closely related issue is that the model appears to preclude development work in the transfer process itself; that is, preparation of a technology to increase its transferability is not assumed to be integral to the transfer process. However, in many cases, preparatory work is needed.

7. The possibility of joint management of a technology as it is being developed seems to be precluded. Technology appears to be fully in the hands of one organization at one point in time and then in another at another point in time, with no managerial overlap. Although there has not been a great deal of joint development work between the private sector and Federal laboratories, this is one of the major reasons that transfer accomplishments have been so modest.

ASK THE QUESTIONS: WHAT ARE THE VIRTUES OF THE TWO-ELEMENT, ONE-DIRECTION MODEL? ARE THERE ANY OTHER DEFICIENCIES IN THIS MODEL?

DEFINITION CRITERIA

Transparency 4-8: An Adequate Definition

NOTE: EACH OF THESE POINTS NEEDS TO BE DISCUSSED SEPARATELY SO THAT PARTICIPANTS HAVE A CLEAR UNDERSTANDING OF THE RATIONALE FOR AN APPROPRIATE DEFINITION. PARTICULAR ATTENTION NEEDS TO BE PAID TO THE NATURE OF TECHNOLOGY, THE TRANSMISSION OF KNOWLEDGE, AND THE ISSUE OF USE. THESE ISSUES ARE COVERED IN LOUIS M. MOGAVERO AND ROBERT S. SHANE, WHAT EVERY ENGINEER SHOULD KNOW ABOUT TECHNOLOGY TRANSFER, pages 1-5.

In attempting to devise a more adequate definition of "technology transfer," and particularly one that would be useful to Federal laboratories, we must keep a few things in mind:

1. Technology is a type of human activity, an activity in which people engage in the making and doing of useful things. There are many aspects of making and doing that cannot be covered by a concept of technology as hardware. Methods,

approaches, and techniques are examples. In addition, an adequate definition of technology transfer would need to encompass technology as embodied knowledge or knowhow.

2. The transfer of technologies from Federal laboratories does not involve the movement of physical things. This often happens in the case of international transfer, when implements and even turnkey factories are transferred. However, almost all transfer activity from Federal laboratories will involve the transmission of knowledge or information about technologies.

3. Transfer does not mean movement or delivery, but rather the use of knowledge. Nothing has been transferred unless it has been applied. Thus, technology transfer may be thought of simply as the use of knowledge. This emphasis on use is strong in the technology transfer legislation, since it is only through use that technologies can create jobs and businesses. Technology transfer is not merely a matter of licensing or sale of a patent, which may result in a company filing the patent and not using it at all; rather, it is a matter of making certain that the technology will be used, for example through insistence on a commercialization plan.

Thus, an adequate definition of technology transfer would need to encompass three elements:

1. It would need to cover the transfer of technology in the form of skills embodied in people as well as the transfer of disembodied technologies.

2. It would need to stress knowledge transfer.

3. It would need to identify transfer with use.

ASK THE QUESTION: ARE THERE ANY OTHER CRITERIA FOR AN ADEQUATE DEFINITION?

DEFINITION

Transparency 4-9: Proposed Definition

Using these criteria, we can propose for discussion the following definition:

> Technology transfer is the process by which knowledge concerning the making and doing of useful things contained

within one organizational setting is brought into use within another organizational setting.

This definition does not cover cases of international transfer where products, rather than knowledge alone, are brought into application. However, it does cover cases of transfer between organizational components of a company engaged in carrying out the innovation process, since the primary mode of transfer is informational in these circumstances.

NOTE: DESCRIBE WHY THE MOVEMENT OF A TECHNOLOGY FROM ONE COMPONENT OF A COMPANY TO ANOTHER IS INCLUDED IN THE REALM OF TECHNOLOGY TRANSFER. FOR A CLARIFICATION OF THIS POINT, SEE MICHAEL J. C. MARTIN, MANAGING TECHNOLOGICAL INNOVATION AND ENTREPRENEURSHIP, CHAPTER 13.

NOTE: THE INSTRUCTOR MAY WISH TO BRIEFLY DISCUSS THE DEFINITION AT THIS POINT. HOWEVER, IT WOULD PROBABLY BE BETTER TO CONDUCT THIS DISCUSSION AT THE END OF THE UNIT, AFTER THE VIRTUES OF THE DEFINITION HAVE BEEN REVIEWED.

VIRTUES

Transparency 4-10: Virtues

NOTE: REVIEW THE VIRTUES QUICKLY, WITHOUT DISCUSSION.

This definition has the following advantages:

1. It indicates that technology is generally transferred as knowledge. This knowledge is of two types: (a) embodied in the form of knowhow; and (b) disembodied in the form of information. Information about technologies may be verbal or written, or it may be transmitted through observation of techniques and methods in operation.

2. It indicates that transfer is a process rather than a discrete event. The dimensions of the process are not identified, except to say that it is terminated through application. Application may occur solely within a company (e.g., as a technique), or there may be an initial application within the company for product development purposes that eventually results in a product application.

3. It identifies the specific content of the knowledge (i.e., concerned with the making and doing of useful things). But, it does not restrict the knowledge to what would generally be called technologies. Rather, it includes all information conducive to the technological enterprise.

4. It does not make any assumptions about where the knowledge originates. The knowledge might have been developed by the containing organization; it might have been acquired from another organization; or it might have been developed through joint research within the containing organization conducted by the containing and obtaining organizations.

5. It indicates that technology transfer is a problem of interchange between organizations.

6. It does not convey any suggestions about who is doing the transferring. Generally, joint efforts are required. However, transfer can occur in some cases almost entirely through the efforts of users. In any case, the fact that transfer terminates in use means that the user must always play a prominent role.

7. It does not make any assumptions about the status of the technology or technologies that are transferred. Transfer may be simple application, or it may require development or adaptation, either within the user organization or jointly between the user organization and the containing organization.

8. It identifies transfer with use. Nothing has been transferred unless it has actually been used. This shifts the focus of transfer activities toward the concerns of users, rather than producers, and relates transfer to the innovation process.

REMOVE TRANSPARENCY

CONCLUSION

This definition should cover all aspects of technology transfer from Federal laboratories. It addresses normal transfer activities between existing organizations, covers the movement of people with embodied skills between organizations, and is applicable to conditions in which a person from a Federal laboratory leaves to start up a new company, carrying with him acquired technologies as well as embodied technical ability.

In cases other than the movement of people, information is the vehicle of transfer from Federal laboratories. However, information is not equivalent to formal publications. Written information may include such things as design plans, sketches, and engineering data. Other information may be acquired verbally and may involve protracted discussions. In addition, information may be acquired merely by observation of others in action and the technologies upon which they are working. Joint development work provides a mixture of verbal, written, and observational exchange.

The definition that has been proposed for technology transfer should provide the laboratories a framework for transfer action, thereby assisting the laboratories in fulfilling their primary and secondary missions. However, it is up to us collectively to determine whether this is, indeed, a useful working definition.

NOTE: PLACE THE DEFINITION (TRANSPARENCY 4-9) BACK ON THE SCREEN FOR DISCUSSION. POINT OUT THAT THE DEFINITION IS NEW. ASK THE PARTICIPANTS WHETHER THE DEFINITION IS ADEQUATE TO THEIR UNDERSTANDING OF TECHNOLOGY TRANSFER. YOU MAY WISH TO INCLUDE THE DESCRIPTIONS OF THE VIRTUES AS A HANDOUT.

NOTE: IF THE OPTIONAL READINGS HAVE BEEN USED, ASK THE PARTICIPANTS WHAT THEY THINK ABOUT THE IMPLICATIONS FOR THEIR TRANSFER ACTIVITIES OF THE PICTURE OF TRANSFER PAINTED BY JONES AND BY GOLDHOR AND LUND.

NOTE: THIS PRESENTION DOES NOT ATTEMPT TO MODEL THE TECHNOLOGY TRANSFER PROCESS. AS A FINAL EXERCISE, YOU MIGHT ASK THE PARTICIPANTS TO ATTEMPT TO DEVELOP A BETTER MODEL THAN THE TWO-ELEMENT, ONE-DIRECTION MODEL. EXAMPLES FOR SOLICITING OPINIONS MAY BE DRAWN FROM: JAMES A. JOLLY AND J. W. CREIGHTON, "THE TECHNOLOGY TRANSFER PROCESS: CONCEPTS, FRAMEWORK AND METHODOLOGY," JOURNAL OF TECHNOLOGY TRANSFER, VOLUME 1, NUMBER 2, PAGES 77-91; AND F. R. BRADBURY, "TECHNOLOGY TRANSFER," PAGES 107-118 IN FRANK BRADBURY ET AL., EDS., TRANSFER PROCESSES IN TECHNICAL CHANGE.
