Unit 5

TITLE: KEY IMPLEMENTATION CONCEPTS

PURPOSE: The purpose of this unit is to provide an introduction to some of the key attitudes and approaches for devising an effective technology transfer program and conducting technology transfer activities.

OBJECTIVES: Upon completion of this unit, participants will:

- Have obtained a clearer understanding of the purpose of technology transfer
- Have obtained an understanding of the difference between science and technology and their relationship
- Have obtained a better understanding of the critical function of the private realm in technology transfer
- Have obtained a general understanding of the contribution of research to innovation
- Have obtained a better understanding of the personal dimensions of technology transfer
- Have obtained an understanding of the public good character of technology transfer.

MATERIALS:

Transparency 5-1: Key Implementation Concepts

Transparency 5-2: The Six Key Concepts

Transparency 5-3: Putting Knowledge to Work

Transparency 5-4: Science and Technology

Transparency 5-5: Mutual Benefits

Transparency 5-6: Technology Transfer Contributes to Innovation

Transparency 5-7: Product Life Cycle

Transparency 5-8: People Process

Transparency 5-9: Public Good

REQUIRED READING:

1. Thomas J. Allen, Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information Within the R&D Organization, pages 1-5 of Chapter 1 (Introduction) and Chapter 3 (The Communication System in Technology: An Overview), Massachusetts Institute of Technology, 1977.

example of a technological breakthrough that resulted from scientific findings.

5. 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: 30 minutes for presentation
60 minutes with discussion

Unit 5

KEY IMPLEMENTATION CONCEPTS

Transparency 5-1: Key Implementation Concepts

> NOTE: EXPLAIN THE PURPOSE OF THE UNIT AND WHAT PARTICIPANTS SHOULD HOPE TO ACCOMPLISH.
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> NOTE: IF NECESSARY, REVIEW THE BASIC CHARACTER OF TECHNOLOGY PRESENTED IN UNIT 3 AND THE MAJOR FEATURES OF THE TRANSFER PROCESS PRESENTED IN UNIT 4.

INTRODUCTION

Transparency 5-2: The Six Key Concepts

There are six key concepts that should form the basis of a technology transfer program:

- Putting knowledge to work is the purpose of technology transfer.
- Science and technology are distinct realms, but influence each other.
- Technology transfer provides mutual benefits.
- Technology transfer contributes to innovation.
- Technology transfer is a people process.
- Technology transfer incentives serve the public interest.

The key words are: work, influence, mutual, contributes, people, and public interest. Each of the key concepts will be discussed separately.

KEY CONCEPT 1. Putting Knowledge to Work Is the Purpose of Technology Transfer.

Transparency 5-3: Putting Knowledge to Work

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important health or environmental matters are in this category and also provide a public good. However, the rest of the key concepts that will be discussed are concerned primarily with the direct form of transfer.

NOTE: THE POINT ABOUT USE IS MADE IN THE INTRODUCTION TO THE OPTIONAL READING BY GRUBER AND MARQUIS.

WHAT DO THE PARTICIPANTS THINK IS THE RELATIVE IMPORTANCE OF THE THREE WAYS IN WHICH THEY CAN CONTRIBUTE TO THE STRENGTHENING OF U.S. INDUSTRY?

WHAT LEVEL OF CONTRIBUTION DO THE PARTICIPANTS THINK THE FEDERAL LABORATORIES (OR THEIR LAB) CAN MAKE TO THE DIRECT FORM OF TRANSFER?

KEY CONCEPT 2: Science and Technology Are Distinct Realms, but Each Contributes to the Other.

Transparency 5-4: Science and Technology

Since Federal laboratories are oriented toward basic research, it must be understood at the outset that technology is not merely applied science. The two realms are distinct. Science is concerned with knowing, and technology is concerned with making and doing. These are fundamentally different activities and need to be understood on their own terms.

Throughout most of history, the activity of making was not dependent on science. It was a matter of trial and error to find what worked without understanding the underlying principles. This was why the Chinese were able to create an extraordinary technology before the 15th Century without any science. Even today, many technological advances are achieved without knowing the underlying scientific principles, and some are achieved in opposition to prevailing scientific theory.

In the 20th Century, technological advance has become more dependent on an understanding of the structure of the world. But much of what is applied in technological development is old science rather

1. Industries do not always need science to make technological advances. This means that much of what goes on in Federal laboratories is not of great importance to industry. Therefore, it is not enough to make discoveries publicly known and then expect industries to flock to the laboratory.

2. The key concept is <u>contribution</u>. Science is not the equivalent of technology, and much has to be done to produce technology that has nothing to do with science. However, scientific principles can contribute to technological progress. It is difficult for the Federal laboratories to keep track of many of these contributions without knowing how they are actually used by firms. Sometimes firms are unaware of where a particular piece of scientific information originated. It may have been around for a long time before anyone had a specific need to use it. In other cases, an informal discussion between industry and laboratory researchers at a conference may provide just the insight needed by either researcher to try a new approach that achieves results. Although this situation would be considered a chance occurrence, serendipity often provides a significant contribution to an industrial firm's commercialization efforts. Another important example is technical assistance, which may be only indirectly related to commercialization (such as when laboratories assist industries in solving problems related to public environmental concerns). It may very well be the case that a Federal laboratory's most important contribution to the development of commercial or other technologies lies in small pieces of scientific or technical information transmitted by colleagues in informal situations. Unfortunately, these contributions are also the most difficult to trace and record as technology transfer accomplishments.

3. Major opportunities to contribute exist, particularly when the research objectives of the private and public sectors coincide and can be jointly pursued. For example, firms may wish to establish a "window on technology" at the basic research level. A laboratory may already be doing work in the area the firm is interested in. A cooperative research agreement may be structured as the mechanism to transfer research results. In any case, sustainable activity must meet the needs of both parties.

4. Federal laboratories do not commercialize technologies; firms do. The distinctive realms of activity and purposes of private sector and public sector research preclude Federal laboratories from commercializing their own technology (although in some cases laboratory personnel may do so). Therefore, the laboratories are dependent on firms to commercialize any particular technology. Laboratories must make efforts to establish working relationships with firms in order for the laboratories to commercialize their

1. Innovation is necessary for a firm to remain competitive and to grow.
2. There is a potential for a significant financial return on the investment in technology.

There are many ways a firm can acquire technology. R&D (either conducted in-house or purchased from an external organization such as a Federal laboratory) is by no means the only method. A Federal laboratory offers an additional source of technology to the innovating firm, particularly if Federal R&D is intended for commercial application. But why is cooperation needed? Why can't we just "offer" the technology and then let the firm assume complete responsibility to commercialize it?

Even within an individual firm, the transfer process between a research laboratory and the final design and production departments is complex. The R&D personnel must not only design something that is functional (which is difficult enough), but must also design something that can be integrated into existing manufacturing capabilities at a justifiable cost. The firm must produce a product that people are likely to buy, and it must be produced at a cost that allows a sufficient return on the firm's R&D investment. Consequently, new technologies (for the firm) must meet technical, production, marketing, and financial criteria. If the product is not designed with all of these criteria in mind, the risk of unsuccessful innovation is increased.

The insight and skills of the designer are required throughout the process because many modifications to the underlying technology will be made to meet the firm's production, marketing, and financial constraints. The coordination of all the departments is enormously complex and difficult within an organization, even one that is structured specifically to produce products or services. In fact, very few ideas generated within a firm reach the development stage, and fewer yet are commercialized.

These problems are multiplied greatly by acquiring technology from an external organization--and particularly from a public sector R&D organization with different objectives, attitudes, and values. Cooperation between Federal laboratories with mission work that is

1. Few ideas are developed into products that reach the market. This is shown by the "ideas" curve. It is often said that out of 250 ideas, only one will reach the market.

2. The costs of getting a product to market increase dramatically the closer the product gets to market introduction. As a cost factor, R&D is relatively insignificant. In fact, from initial idea through development represents only 10 percent of the cost. Production and marketing generally account for 90 percent.

The important point to observe is that the costs represent an investment to the firm in the uncertain future represented by the life cycle curve. Costs will continue to escalate after innovation occurs.

The role of R&D measured in time and money from product idea to innovation is represented by the darkened area. This is the area in which an in-house R&D unit or a Federal laboratory is most likely to contribute to the innovation. In many cases, the contribution may have come years before through basic research, which is not represented on the diagram and which is very difficult to relate precisely to this process.

One might say that the dollars invested do not measure the value of creativity, without which nothing would be possible. The fact is that ideas per se have very little economic value. Ideas are plentiful. R&D laboratories are a cost for a firm, particularly since the inspirations for many product ideas and improvements do not come out of laboratories, but from production facility personnel, marketing departments, management, and customers.

Secondly, ideas are cheap. Anyone can have an idea. The function of the firm is to turn the idea into a workable product or service that can be used by the firm's customers or a process that can be used by the firm itself. The firm finds and organizes the resources to accomplish innovation.

The innovation process is long, frustrating, costly, and high risk. Success requires that all of the participants understand the final objective and their role in the process. This is particularly the case when the innovation process involves transfer of technology from entities external to the firm. Cooperation with the other key players in pursuit of a common objective is essential. A narrow focus

2. Why can't technological knowledge be transmitted simply by publishing articles or technology descriptions?

In the case of technological activity, it is clear that knowhow is involved and that skills can only move from one organization to another through the movement of people possessing those skills and knowhow. The movement may be temporary or permanent.

Transferring specific technologies is even more complex. It has been found that successful transfers between organizations generally require some form of participation by people who were instrumental in developing the technology or are acquainted with its use.

Laboratory technologies usually need considerable refinement before they are ready for the commercial marketplace. So, for a firm to be able to use a technology originated in a Federal laboratory to make products, the "art of the technology" must be transferred as well as the technology itself. Also, the firm's efforts to integrate a technology into its manufacturing processes or into a product is difficult, and "bugs" will need to be worked out as the technology actually becomes embodied in commercial products or processes.

Solving these problems requires that the firm's R&D staff and production engineers understand the technology from the inside. The thought processes and development steps that went into making the technology are essential. These processes are not easily transmissible by the written word, which expresses ideas but cannot fully transmit the "how" of activity. In addition, it is virtually impossible to adequately represent a technology through a written description (even with sketches) in such a fashion that it can easily be adopted by a firm, developed, and put into production.

These are such important characteristics of technology that knowhow is often of greater importance in pricing a technology for transfer than patents or copyrights. The originators of a technology are nearly always required to work out the development or to assist in making design modifications. And, the newer and more advanced the technology, the more collaboration will probably be necessary.

A final aspect of technology as a people process needs to be considered: the role of a "champion" in technology transfer. Most new

Congress has now provided incentives appropriate to technological activity in an attempt to generate an interest in participation. Primarily, the incentives provide a method to generate grassroots interest at the laboratories. Interest on the part of personnel is necessary to meet the needs of a management structure that intends technology transfer.

There may be some misunderstanding about the purpose of the financial incentives. Industrially funded R&D and royalties have been promoted on university campuses as a method of increasing revenue to the university, rather than as an incentive to participate in technology transfer. Although cooperative research efforts and licensing can provide additional sources of revenues to laboratories, the danger in this approach is that sooner or later the success of technology transfer efforts may be evaluated in terms of the revenue generated. This would be a serious mistake because the revenues will (for the most part) be modest and long-term in comparison to a public institution's other revenue sources. More importantly, the purpose of technology transfer from the public sector is to promote innovation--which is a public good--rather than to produce revenue for a university or for a Federal laboratory.

It is apparent that the Federal laboratories should not be expected to make a great deal of money on these activities. In fact, many technology transfer activities will represent a cost to the laboratory, as they do now. It should be clearly understood from the outset that the recent legislation is not directed at establishing cost/benefit criteria. Participation is considered a public good. Since the laboratories have been given legislative responsibility for technology transfer, management has considerable flexibility in the use of funds allocated for this purpose.

Laboratory managers must constantly keep in mind that they have been given the ability to participate in innovation by investing financial and personnel resources to get technologies out of the laboratory, through the private sector, and into the marketplace because these activities contribute to jobs, economic growth, and U.S. competitiveness. A major focus of technology transfer is directed at