Unit 3

TITLE: TECHNOLOGY

PURPOSE: This unit provides a brief introduction to the nature of technology, under the assumption that technology can be more effectively transferred when it is understood.

OBJECTIVES: Upon completion of this unit, participants will:

- Have obtained a provisional understanding of technology in its various dimensions
- Have obtained a provisional understanding of how the various types of technology give rise to different transfer opportunities
- Have questioned the widespread assumption that technologies can be identified with objects
- Have been introduced to a new concept of technology that can be useful to transfer efforts.

MATERIALS:

Transparency 3-1:	Technology
Transparency 3-2:	Development
Transparency 3-3:	Intangible Technologies
Transparency 3-4:	Knowhow
Transparency 3-5:	Let's Get Unphysical
Transparency 3-6:	A Technology Is as a Technology Does
Transparency 3-7:	Importance of Functional Concept

REQUIRED READING: Pages II-10 through II-22 (the section on Technology) of Issue Paper II--The Technology Transfer Process. If Unit 3 participants are to be trained with Unit 4 (Technology Transfer) materials fairly soon, the whole of Issue Paper II should be assigned reading for Unit 3.

OPTIONAL READING:

1. Devendra Sahal, Patterns of Technological Innovation, Chapter 2 (The Conception of Technology), Addison-Wesley, Reading, Massachusetts, 1981.
2. Peter Drucker, Technology, Management and Society, Chapter 3 (Work and Tools), Harper and Row, New York, 1977.

NOTES TO INSTRUCTOR:

1. The concept of technology is difficult to pin down, partly because it is used to cover too many disparate phenomena. The purpose of this unit is not to stipulate a definition, but rather to characterize technology broadly, so that Federal laboratory personnel will realize that technology transfer is not concerned solely with hardware items.

2. A definition is provided for product and process technologies that should move the participants away from an object conception of technology and towards a concept of function that will be more useful in identifying transfer opportunities. However, this definition is provisional and should be used as a basis for discussion and tested for applicability.

3. The optional reading by Sahal discusses different conceptions of technology and introduces a functional conception that is slightly different from the one presented in this unit. The optional reading by Drucker forcefully presents a view of technology as activity.

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
30 minutes with discussion

Unit 3

TECHNOLOGY

Transparency 3-1: Technology

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

INTRODUCTION

Obviously, in order to understand technology transfer, we need to understand technology. If we don't know what technology is, we won't know what we should be transferring. In addition, how we think about technology has a large effect on what we think needs to be done in order to transfer technology.

Unfortunately, the term "technology" is vague and is used in many different senses. We need to develop a broad conception of technology so that we will be in a position to realize that we have many different types of transfer opportunities.

CONCEPT DEVELOPMENT

Transparency 3-2: Development

The word "technology" comes from the Greek technologia, which referred to any systematic treatment of an art and included what we would mean by the fine arts as well as the mechanical arts. The Greeks considered technology to be a type of knowledge, or logos, because it was not an instinctive ability and needed to be acquired by learning through apprenticeship.

Since the time of the Greeks, the fine arts have been separated from technology, and technology has come to be closely associated with large-scale industrial production. Today, the term is generally used to cover all of the practical arts, including a wide range of activities such as agriculture, mining, manufacturing, transportation, energy, communications, and medicine.

The practical arts are concerned with the making and doing of useful things. Technology, therefore, is any human activity concerned with the making and doing of useful things. In this sense, farming, mining, and manufacturing would be considered technological activities.

Every technological activity has an end: farming is concerned with the production of foodstuffs, mining with the extraction of valuable minerals, and medicine with the promotion of health. In order to achieve these purposes, various types of knowledge, tools, and techniques are employed. These are the means by which technological activity is accomplished.

Each element of knowledge, tool, or technique is a technology. In farming, for example, a method of plowing would be a technology just as much as would a tool such as a hoe. In addition, the things made or done through the practical arts are usually called technologies, particularly to the degree that those things are artificial. Thus, the word "technologies" refers to the means by which the practical arts are accomplished as well as the things produced by those means.

The things made and done by the practical arts are useful things. The means employed are also useful because they contribute to the productive effort. Thus, technologies are simply useful things.

ARE THE PARTICIPANTS IN AGREEMENT THAT TECHNOLOGY SHOULD BE SPOKEN OF AS ACTIVITY, MEANS, AND RESULTS? WHAT ARE THE PROBLEMS WITH THESE CONCEPTS?

NOTE: ALTHOUGH THE TEXT SPEAKS OF TECHNOLOGIES AS USEFUL THINGS, THE INSTRUCTOR SHOULD BE AWARE THAT THIS IS A MATTER OF GENERAL USAGE AND THAT THE TEXT WILL SOON REPLACE THE CONCEPT OF TECHNOLOGY AS THING WITH THE CONCEPT OF TECHNOLOGY AS FUNCTION.

INTANGIBLE TECHNOLOGIES

Transparency 3-3: Intangible Technologies

One of the problems in addressing technology transfer is that we often limit our conception of technology to the things made and done and to the tools and processes of making and doing. This conception places a very heavy emphasis on the hardware aspects of technology.

However, it should be kept in mind that the activities of making and doing are not reducible to the hardware of production. The word "technology" also covers the ways in which things are made and done, which would include a wide range of techniques, methods, and approaches.

The industrial research laboratory, for example, is an important element in modern making activities, but it is not a physical thing. Rather, it is a revolutionary approach to innovation that combines innovation-oriented research, an interdisciplinary staff, and the systematic application of science to technology.

In looking for technologies to transfer, Federal laboratories should not overlook the non-hardware aspects of technology. They can make important contributions to the organization and management of production, quality control, methods to encourage greater creativity, improvements in the way people use tools, personnel strategies, and so on.

These are important aspects of technology, and the laboratories should understand that anything that contributes to the improvement of making and doing activities is a form of technology transfer.

DO THE PARTICIPANTS AGREE THAT THE CONCEPT OF TECHNOLOGY SHOULD COVER INTANGIBLES? NOTE: A WIDE RANGE OF INTANGIBLE TECHNOLOGIES EMERGES FROM AN UNDERSTANDING OF TECHNOLOGY AS ACTIVITY, WHICH IS COVERED MORE FULLY IN THE ISSUE PAPER AND IN THE OPTIONAL READING BY DRUCKER.

ARE THE PARTICIPANTS AWARE OF ANY TRANSFER EXAMPLES INVOLVING INTANGIBLE TECHNOLOGIES? NOTE: THE INSTRUCTOR MAY WISH TO REFER TO J. GORDON MILLIKEN AND EDWARD J. MORRISON, "MANAGEMENT METHODS FROM AEROSPACE," HARVARD BUSINESS REVIEW, MARCH-APRIL 1973, PAGES 6-164 (DISCONTINUOUS).

TECHNOLOGY AS KNOWLEDGE

Transparency 3-4: Knowhow

In addition, the literature on technology and technology transfer often speaks of technology as a type of knowledge that can't be captured on paper. It is variously referred to as embodied knowledge, knowhow, or simply skills. Such knowledge resides in persons and refers to their ability to do things, which is a synthesis of personal characteristics, book learning, and experience.

Knowhow is one of the most valuable technological commodities, since it is the expertise of people in making and doing that is the primary determinant of the success or failure of organizations. One of the major forms of technology transfer from Federal laboratories lies in the application of knowhow to problems arising in the private and public spheres.

Another major form of transfer lies in the movement of people. Skill contained within the laboratories, and to one degree or another acquired within the laboratories, is transmitted to other public organizations and the private sector through job change.

Knowhow is also transmitted through personal contact. An important aspect of technology transfer is not from the Federal laboratories to other institutions, but rather within the laboratories themselves. It is called on-the-job training and occurs when incoming employees gain or increase their capacity for technological work by working with senior employees in whom skills are embodied.

A similar situation exists when a laboratory assumes an educational function in cooperation with a university. In working with laboratory personnel, graduate students acquire skill in teamwork and interdisciplinary applied research. Since these are technological skills, their transmission from laboratory personnel to students through collaborative work is an important form of technology transfer.

Thus, an adequate concept of technology must include technology as knowledge, and technology transfer must be understood to encompass the movement of people and personal contact.

HOW IMPORTANT DO THE PARTICIPANTS THINK THAT KNOWHOW IS IN TECHNOLOGY TRANSFER ACTIVITIES?

PHYSICAL EMBODIMENTS

Transparency 3-5: Let's Get Unphysical

Another problem in addressing technology transfer is that we often identify hardware technologies with their material form. Various consumer products, for example, are sometimes referred to as technologies. This way of speaking is misleading and causes problems when we attempt to identify technologies for transfer.

Of the technologies that take on a physical form, the two primary types are products and processes. Tools are sometimes included, but most tools employed in manufacturing establishments are someone else's products and therefore can be included in the product category.

In order for a physically embodied technology to be capable of use, it must appear in a material form. We can't use a product or a process that we can't see or touch. However, physically embodied technologies shouldn't be identified too closely with matter and particularly with how they look as products.

We know that a technology must precede its physical embodiment for three reasons:

1. A technology comes into existence with its invention. An invention may exist only as a description on paper, or it may appear as a rudimentary model. In either case, the technology is a long way from a product or process.

2. Most technologies never become products or processes. They are abandoned somewhere in the midst of development for various reasons.

3. Many technologies have a wide range of product applications. Such technologies are generally referred to as base technologies. Because of their many potential applications, they often prove to be more valuable than single-application technologies.

In each of these cases, the technology is clearly something other than its material manifestation. Thus, we should not refer to products as technologies, but rather speak of technologies embodied in products. Processes are a little different, because the word "process" can be used to refer either to the hardware of the process or else to the process as a means of achieving something. In the latter case, the technology is not in the process but is the process itself.

DO THE PARTICIPANTS THINK THAT IT REASONABLE TO SPEAK OF TECHNOLOGIES AS PRECEDING THEIR PHYSICAL MANIFESTATIONS? IF NOT, WHAT DO THE PARTICIPANTS THINK THAT SOMETHING SHOULD BE CALLED BEFORE IT RESULTS IN A PRODUCT?

NOTE: IN ORDER TO GENERATE DISCUSSION ON THIS POINT, THE INSTRUCTOR MAY WISH TO USE A PATENT ILLUSTRATION OF AN INVENTION AS A HANDOUT AND ASK THE PARTICIPANTS WHETHER THIS IS A TECHNOLOGY. AN EVEN MORE DRAMATIC EXAMPLE IS CHARLES KETTERING'S FIRST SKETCH OF WHAT EVENTUALLY BECAME AN AUTOMOBILE IGNITION (WHICH CAN BE FOUND ON PAGE 136 OF FRANK DONOVAN'S WHEELS FOR A NATION).

TECHNOLOGY AS FUNCTION

Transparency 3-6: A Technology Is As A Technology Does

If a product is not a technology and a process is not a technology if we are merely referring to the hardware aspects, what, then, is a technology?

Every process is composed of various pieces of hardware that have been brought together with a particular end in mind. We would not try to describe a process in terms of its hardware components, but rather in terms of the overall purpose they serve. A process is what a process does, and this is the way that processes are usually described.

Products, on the other hand, are often spoken of as technologies. However, when asked to describe a product-embodied technology such as a pen, we do not begin by saying that a pen is an elongated instrument composed of metal or plastic, often in two parts, with a retractable point, and so on; rather, we begin to describe a pen by stating the purpose that it serves: a pen is an instrument for writing in ink. As with processes, product-embodied technologies are what they do rather than what they are.

For both processes and products, a technology is as a technology does. The technological essence is not in the materials used but in what that particular assemblage of materials has the capacity to do, which is revealed fully in its use. Thus, we can say that the essence of a technology lies in its function: the action for which a thing is specially fitted or used or for which a thing exists.

> NOTE: THESE POINTS SHOULD BE THOROUGHLY REVIEWED IN AN OPEN SESSION WITH THE PARTICIPANTS. THE SHIFT FROM A CONCEPT OF TECHNOLOGY AS A USEFUL THING TO A CONCEPT OF TECHNOLOGY AS FUNCTION (OR SOMETHING SIMILAR) IS IMPORTANT IF FEDERAL LABORATORY PERSONNEL ARE TO BE IN A POSITION TO TRANSFER TECHNOLOGIES THAT HAVE NOT YET TAKEN ON ANY PHYSICAL EMBODIMENT. HOWEVER, THIS SHIFT IS NOT INTENDED TO DENIGRATE THE PHYSICAL EMBODIMENT, SINCE A FUNCTION CANNOT BE OPERATIVE AS A PRODUCT OR PROCESS UNLESS THERE IS A MATERIAL MANIFESTATION. THIS ISSUE WILL ASSUME GREAT IMPORTANCE IN UNIT 7 (THE TECHNOLOGICAL INNOVATION PROCESS).

APPLICATIONS

Transparency 3-7: Importance of Functional Concept

A functional concept of technology is suitable to describe process technologies and product-embodied technologies, both of which have a material manifestation. It is also suitable for describing technologies that do not have a material manifestation. A technique, for example, is a method of accomplishing something. It is, by its very nature, a function.

A functional concept of technology and the separation of technology from matter is important for the transfer efforts from Federal laboratories for three reasons:

1. Although laboratories have many technologies that can be transferred, they seldom have products that can be transferred; and, when they do, it is not the product itself that is transferred, but rather information about the technology contained within the product. Technology transfer is not a transfer of objects but rather transfer of information about technologies.

2. In identifying technologies for transfer, it is important for laboratory personnel to center on the functional aspects.

For things that are in early stages of development, the functional parameters may be quite large and vague. This is particularly the case with new materials, which may have a multitude of uses. The qualities of the materials set the parameters for use and should be used as a basis for discussion about applications. At the other end of the scale, when a technology has been embodied in a product in connection with mission work, the mission product will generally have little immediate potential for application in the private sector. Under these circumstances, it is necessary to reach below the material form and the specific application for which the mission product was designed to determine an underlying and broader functionality that may have applications quite different from the mission product.

3. A technology may have been developed for the sake of getting to some other technological objective as part of mission work. Under these circumstances, the technology might have never been identified as such because it was merely a means. In these circumstances, it is necessary to identify the technology and its functional capacity without particular regard for the end for which it was originally developed.

NOTE: THESE POINTS SHOULD BE THOROUGHLY DISCUSSED WITH THE PARTICIPANTS. ILLUSTRATIVE (OR PERHAPS CONTRADICTORY) EXAMPLES SHOULD BE SOLICITED FROM THE PARTICIPANTS OR DRAWN FROM THE INSTRUCTOR'S EXPERIENCE.
