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ABSTRACT

A study investigated the role of language in facilitating technology transfer, particularly across international borders. It examined whether language has an effect on the technology transfer process or the politics associated with it when participating countries lack a common language, and whether the English language plays a special role in facilitating transfer. The study was limited to three countries participating in the North American Free Trade Agreement (NAFTA): the United States; Canada; and Mexico. For the three countries, a technology policy, specific area of technology, and the official language were identified and their interrelationships analyzed. It is concluded that there is a direct connection between English language use and technology transfer, one closely tied to socio-political orientation. Potential for changing this situation is considered, and areas for further research are noted. Contains 76 references. (MSE)

# Determining the Limits of English and Technology Transfer

**Research Paper**

**Submitted to Dr. R. Yeager**
**College of Arts and Sciences**
**of**
**West Virginia University**

**In partial fulfillment of the Requirements for**
**Politics of Planned Development**

by:
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**ABSTRACT**

Technology plays a decisive role in the world. There is a need to investigate how the worlds languages and cultures affect technology, and how they are impacted by technology. The problem of this study is to determine if a relationship exists between second English, and technology transfer. The research presents a review of literature and related government documents in support of three topics; technology transfer, aviation, and national languages. The data is compiled into a table that compares the national and international policies of technology transfer with the role of language in the NAFTA countries.

The research findings are a result of an evaluation of the role of policy and technology as compared to languages. The conclusion of the research found that there is a relationship between language and technology transfer. The researcher provides suggestions for further research into the role of language and technology specific areas.

## ACKNOWLEDGMENTS

This research topic is the result of personal interest in the topics of technology, language, aviation, and social development. The researcher found that this combination of topics does not have a wide body of literature to chose from for further research. Of interest though, is the lack of research into this area. Given the wide scale of aviation, technology, politics, and exposure to foreign languages this should be an area where literature and research thrive. However, this is not the case. Particularly difficult to acquire in this research was information. Government sources of information were found to be difficult to uncover. The researcher found himself delving into areas of the internet, libraries, and even in personal conversations with experts that constantly led to dead ends. Though this fact is troubling to discover when conducting research, it is also very enlightening to discover an apparently new area to explore.

I would like to thank to countless people and organizations contacted throughout this research project. Namely the FAA, ICAO, TC, EAA, AOPA, Ohio State University, and the Technology Education Department at West Virginia University. I would also like to thank Dr. Yeager for allowing the opportunity to explore the political influences that comprise my area of interest.

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## CHAPTER I

### Introduction

The development of modern technology has been documented in literature related to the history of technology (Derry & Williams, 1960), and in descriptions of the effects of technology on the different disciplines by authors such as Elull (1980) and Winner (1992). Individual technologies obviously interact with social institutions to help mold social development. The interactions influence social progress, and culture and have been documented in the individual disciplines as far back as the eighteenth century (Pannabecker, 1996; Puk, 1993). The relationships of academic, commercial and governmental areas of technology applications have also been reviewed (Mitcham, 1995).

### Role of Technology Transfer

These authors have also presented their perception of technology and its effects on society: Elull, 1980; Winner, 1992; Ihde, 1979; and Mitcham, 1995. There are arguments that are supportive of the role of technology as found in Mitcham (1995), and Ihde (1979). There are also arguments that refute the role of technology such as presented by Elull (1980) and Winner (1992). These last four authors use empirical data to demonstrate the limited benefits of technology to social development as found in literature reviews. The review of the pros and cons dealing with the transfer of technology between cultures, thus, has been establish through existing literature. The pros and cons dealing with the transfer of technology has support on both sides of the issue. The details of the technology

transfer process include detailed analysis of government agency reports, academic journals, texts, commercial issues, and the development of social institutions that have interacted with local and international technology projects. The need for further research in the technology transfer process may be deemed a mute project since it would be relatively easy to find counter examples to the arguments that may be used in the argument.

An interesting component that is lacking in the research on technology transfer, however, is the effect of languages. It is interesting, because the transfer of technology across international borders invariably involves languages. Languages between countries are rarely the same, except for closely related countries like the United States and Canada (Quebec excluded), or the United States and England where the common use of English is found. The English language of these countries would allow the transfer of information to occur relatively freely, without any notable language barrier. It is common knowledge that the world speaks many different languages. Somehow, the transfer of technology has occurred throughout the world on a grand scale. Does language then have an effect on the process of technology transfer, or the current politics associated with the transfer process. It is in countries that lack a common language that language compatibility may become an issue. The literature on technology transfer does not address the effect of languages, similar or different, as having a role in the technology transfer process.

## Identification of the Problem

The National Science Board (1996) has found that the biggest problems facing technology transfer include the ability to use foreign information sources of technology (4-13). There is a need to investigate the relationship between languages and applied technology (Larsson, 1988). The problem of this research is to determine if a relationship exists between the limit of English, and technology transfer.

## Purpose

Multilingual technical trainers can use this research on the limits of language in technology transfer acceptance in designing technical material used for the transfer of information to foreign users. Translators of technical material will be able to use the language limit information to determine the appropriate fluency level for writing documents. Countries involved in purchasing foreign technology can use the information to determine the amount and type of information that should be included with the new technology. The purpose of this research is to provide information for multilingual technical trainers and translators of technical material.

Is there a limit with English as a source language technical competence and whether foreign language users of technology will adequately operate (or correctly install and maintain) specific equipment? It is proposed that there is a specific level of language acceptance that is related to technical transfer.

## Assumptions

The assumptions of this research are:

1. It is assumed that the technology transfer will occur with the current status of the NAFTA agreement, and that the transfer of technology is beneficial for the countries involved.
2. It is assumed that the documents pertaining to the participant countries language position, and research and development position are accessible and available to the general public.

## Limitations

The limitations associated with this research are:

1. The research will be limited to three NAFTA participant countries; the United States, Canada, and Mexico.
2. The research will be limited to the publicly accessible documents.

## Method

The method of this research will be:

1. The presentation of the problem.
2. A presentation of the research parameters and related literature will be made.
3. The selection and identification of participant countries.
4. The selection and identification of a technology policy that applies to each of the participating countries.

5. The selection and identification of a specific area of technology that is found in each of the participant countries.

6. The selection and identification of the official language that is used in the participant countries.

7. The research will then analyze the data.

8. The findings of the research will be summarized and written.

9. Conclusions from the research findings will be drawn.

10. Recommendations for further research will be developed from the results.

11. Definitions of specific terms will be provided, as well as a bibliography.

## CHAPTER II

### Review of Literature

In order to communicate technological advances effectively across country borders, experts in languages and culture were traditionally used. This method allowed the expert individual to operate in the target language and culture almost at the native speaker level. This traditional method continues to be employed in international business transactions where the international buyer is interested in acquiring a form of foreign technology for use in their country. The resultant end of this transaction is a technology transfer across international borders where some form of translation is required for the buyer and seller to negotiate. The effectiveness of this method has come into question recently.

The use of an expert individual, however adept at languages and culture, was not an expert in the technical field. The individual adhered to local customs, traditions and linguistic requirements so as not to offend the buyer. The concern of the company for cultural difference would influence the buyer to purchase the product. The seller company, however, typically provided the expert individual with sales materials, brochures and company profiles to use in closing the business deal. The expert individual then relied on the content of the brochures and materials provided to answer questions that the client may have risen. This tended to result in communication problems that were technical in nature and not linguistic or culturally based. American businesses that utilized this negotiation practice found themselves in a predicament: Should they use fluent language personnel, or use technical personnel in overseas ventures.

## Role of Language

The traditional method of employing language experts appears to be diminishing. Companies realize the limits of language personnel that are not technical experts can have a serious impact on the negotiation process. The impact, typically negative, was difficult to overcome and usually resulted in the company sending a technical expert overseas to assist the language expert in the negotiations. The company technical expert then used the language expert as nothing more than a translator. The current trend is to use the technical personnel in overseas assignments, and employing a native language speaker from the local country to translate the material.

Kaufman (1996) points out the current trend in corporate focus in attacking this issue. There is a trend to use experts in the field of technical specialization in international business. The older practice of using culture and language experts had shortcomings for the negotiations. The language and culture specialists were not knowledgeable of the material being discussed. The language specialists also did not have the business savvy to close the negotiations in a manner that was beneficial for the company. This shortfall affected the business deals of the company. Kaufman explains:

> Unlike a decade ago when companies tended to send specialists in culture and language to foreign countries, the new globalized breed includes middle American managers from middle American companies. Many companies found that the "experts" lacked the business skills and technical expertise that foreign customers demanded. (1996, p. A1)

The non-technical experts relied on their language expertise to negotiate in the target country. Their ability also rested on the assumption that technology was not the controlling factor in international business, and thus relied heavily on the use of brochure and policy translations. However, the language expert did not use all resources available in foreign countries. Translation has become a daily activity, and the material that needs translated today, probably has already been translated and only needs to be located. There are libraries and indexes that catalog technical material for use by language experts in foreign countries, the location and the existence of which are not widely known (Grogan, 1982).

The process of technology transfer involves defeating more than linguistic, social and cultural barriers as shown, it also involves lessening technical barriers to ensure an adequate understanding of technological relationships that cross communication boundaries (Chazan, 1994). The technical barriers to the transfer process were thought to be minimal in nature, and were thus ignored in employing the language expert. The question then presents itself: Is there a relationship between technology transfer and languages?

In the area of technological studies, one accepted philosophy of technology work, (Elull, 1980) is frequently referenced in technology studies. The use of the translated material in supporting and rebuffing arguments in academia has become suspect. The translator of the work did not specify the degree of the translation or the method to be employed, hence, the transfer of the meaning of technology was suspect. The single translation of a work by one individual reflects only that person's interpretation of the work. The interpretation of the work, thus, depends on their competence to translate the material. In reviewing the research on

translations, Zarechnak (1988), found that participant performance in the translation process depended on the individual competency in the content area. However, only in the past decades have the processes that result in translations become the subject of reviews.

One study (Grogan, 1982) on the issue of second language material used in technical transfers focuses on the transfer of meaning. The translation of the technical material is the factor that has become "responsible for the degradation in the transfer of knowledge from the world's authors to European users of between 40 and 50%" (Grogan, 1982, p. 324). Using Grogan's figure, then almost half of Elull's (1980) technology work may have the wrong meaning translated.

The process of developing technical translations and also general translations are a complicated procedure. There is a large amount of specialization required for translations, while there is limited use for the translated material. Technical translations are used to convey technical issues and typically involve specialists in the field, as well as translators. Whereas, general translations can be accomplished without specialized knowledge in a field. Reviews of translated material have been conducted for evaluating their effectiveness. The process of analyzing translations and the process of translating has resulted in a new academic field, Translatology. The Journal of Translatology and other authors (Grogan, 1982; Zarenchnak, 1988; Larsson, 1988) provide recent research into the process of developing technical translations.

## Role of Politics

The North American Free Trade Agreement (NAFTA) is an attempt to standardize laws and regulations dealing with international trade aspects of technology transfer. The complete details of the NAFTA agreement are said to be known to only a few people. However, the information that has been made public shows that a goal is to lesson trade barriers and increases the trade aspects of technology transfer across the participant borders.

The NAFTA focus on the trade aspects of technology transfer has come under scrutiny by a number of researchers in a variety of backgrounds. The question was: "Who will benefit from NAFTA?" existed even though the treaty has been ratified by the countries involved. NAFTA appears to benefit the industries of America in terms of cheap labor supply from Mexico. It appears to benefit Canada through the decrease in import tariffs. The benefits to Mexico are generally limited to newly created jobs. However, there are other issues that need to be considered since the adoption of the NAFTA. The language of the individual countries may have a role in the technology transfer process. There are economic as well as social implications from the adoption of NAFTA.

On the economic impacts, there will likely be a diversion of external trade. The countries of East Asia will feel the impact as the relative number of tariffs and barriers are changed in as a result of NAFTA. The participating countries will see a reduction in the tariffs and barriers to allow for trade transfers to benefit the transfer of trade. The East Asia countries will then be subject to relatively more restrictions when compared with the participant countries (Folsom, 1996).

The social impacts of NAFTA likely will affect the environment. Companies in the participating countries may consider the enforced environmental laws of Canada and the United States as disincentives to research and development efforts. The lack of a solid environmental enforcement policy of existing environmental protection laws in Mexico, however, may encourage the companies to relocate. However, Folsom (1996) states that this may not occur, "studies have shown that "environmental costs have little impact on locational decisions" (p. 245). There will also be social impacts by increasing labor in Mexico. The increase in employment will ultimately lead to a decrease in the poverty rate. These social changes will generally benefit Mexico, as long as the measure is the standard of living. The impacts on Canada and the United States economies will be limited.

The NAFTA treaty has an effect on the trade aspect of technology transfers among participating countries. There are problems associated with transferring technology from one country to another linguistically different country. The impact of the technology transfer may be found in the country's regulations. The countries involved in the NAFTA developed procedures relating to the adoption of standardized regulations. Research has shown there to be difficulties in obtaining the standardized information when dealing with foreign countries (Balden, 1996). The ease at which such information may be obtained is paramount to this research. The information used for this research has been compiled from original sources in a manner that has not been accomplished before. A foreign country that makes acquiring information of its technology transfer policies may be indicative of the policy in effect in that country.

Technology transfer measures are not standardized around the country. The NAFTA is an agreement to share information. The NAFTA itself does not regulate how the information is to be shared. The manner in which information is shared is left to the parties involved. There does remain a question related to this research: How will technology transfer be measured? A way to measure technology transfer is through research and development (Devore, 1980).

The role of technology transfer is representative of the capitalist structure. The marketing concept of the four Ps demonstrates the relationship of technology transfer to research and development. Marketers consider a number of factors when attempting to sell a product; the product itself, the types of promotion, the price, and the place or distribution decisions that are made. This concept was made popular by McCarthy (1985) in describing to managers, the basics of marketing. The concept was adopted by the American Marketing Association and illustrated as a target. The bull's eye was labeled as the target market. The first ring consisted of the marketing mix variables; product, price, distribution, and promotion. The outer ring consisted of the marketing environment; political-legal, economic, competitive, social-cultural and technological. The concept is also used to describe the strategies used by businesses (Devore, 1980). Folsom (1996) states that the companies focus their resources and efforts to meet the needs their product users.

The countries that are involved in international affairs have complex political issues. Part of the national political issues is the economic and strategic security of the country itself. Therefore, countries have adopted strategies to deal with threats to their national security. Among the threats to national security is the ability of the country to advance itself technologically. These advances are conducted as

governmental and private research and development expenditures. The products of the research and development expenditures are technologically superior to previous applications, and have applications to other fields of knowledge and use. The national research and development products are also transferred out of country as profitable products. It has also been established that the role of research and development organizations in the individual countries are the best known predictors for advancing a country's technological position (National Science Board, 1996). Therefore, research and development strategies will be a strong indicator of the research and development that occurs in a country, and act as a measure of technology transfer as found in research. Countries with the highest research and development are the ones "most successful in using foreign technologies" (Volti, 1992, p. 72).

The research and development organizations have overcome some of the problems associated with using second language material. One such strategy is the sharing of information across borders. The sharing of information has to be carefully employed, as marketers say, "If you want to kill a message, translate it" (Folsom, 1996, p. 267). Individuals and corporations alike recognize the problems associated with specialized product information. As a result, second language material for training the users of technologically transferred products is also produced by research and development organizations (R&D). The managers, technicians, engineers and other workers of the organizations need to be able to make the best of "opportunities that imported technologies present" (Volti, 1992, p. 72). The international research and development organizations have entered into agreements with foreign organizations. These agreements have aided in reducing

production costs and have also resulted in cross-country research co-authorships (National Science Board, 1996, p. 4-22). This method appears to be a solution for the organizations that are able coordinate the sharing of information. However, is there a limit in the recipients use of the translated material?

The National Science Board has also made a determination on the use of technical information. The National Science Board has determined that the resulting information used in technology transfers is not only questionable, but has been and will continue to remain questionable. The individuals that use the training provide add a new dimension to the technology transfer process, although the international processes and "cooperation will continue to face interpretation issues" (National Science Board, 1996, p. 4-21).

Besides international interpretation issues, there are local topics of concern. Interpretation issues do have serious economic impacts. For example, a product name in English (car model) name "Nova" and its Spanish equivalent of "it won't go" resulted in a disappointing adoption of the car in Mexico. What happens when a product does get introduced into a foreign country by small town individuals? One of these local problems, as has been suggested, will be in determining whether the end users of the foreign technology would be able to "adequately operate or correctly install and maintain specific equipment" (Larsson, 1988, p. 98). This issue has a more immediate need to be researched. Lack of research into this area is likely to result in catastrophes. Some catastrophic failures as a result of technology transfer are: the crash of a Boeing 707 in 1974; the 1994 crash of a DC-10; in 1995, the American Airlines crash in Cali Columbia; the 1996 crash of the Avianca flight in New York; the 1996 crash of a flight in Bolivia; and the recent (November 1996)

head on collision of two passenger jets over India. These are only a few of the accidents that have occurred in air transport history. They were chosen to represent the consequences of failed technology transfer where language was a factor.

What may not be apparent is the technology involved in each of these flights. The common denominator in these accidents is rather simple. International aviation is an English speaking environment. Each of these accidents involves a non-native English speaker attempting to communicate, in one fashion or another, in an area where English is required. The results of the failed communication process are obvious in this business. "Apart from the fact that no business could open its doors if there were no language, culture, data, information, and know how, there is the deeper fact that all of the resources needed to create wealth , none is more versatile than this. In fact, "knowledge (sometimes just information and data) can be used as a replacement for other resources" (Toffler, 1990, p. 83).

## CHAPTER III

### Country Selection and Identification.

The participant countries for this research are the participant countries in the North American Free Trade Agreement. The NAFTA treaty participant countries included in this research are the United States, Canada, and Mexico. The agreement will not produce a common market as is found in Europe. The participant countries will maintain their borders, and the customs procedures, immigration requirements, separate laws, currencies and languages. The NAFTA is designed to "remove barriers to trade and investment in both goods and services between the three markets" (Glick, 1992, p. 3).

### Identification and Selection of Technology Policy.

A review of government documents was conducted to identify and select the common means for reporting technology transfer policy. In the individual countries, the means for measuring technology transfer is not concrete. The development of Agenda 21 in the European Economic Community provides a basis for locating the national technology transfer measure. Agenda 21 reflects a national approach to research and development. Agenda 21 is a multinational effort to publish and coordinate the transfer of technology between countries. The goals of the participant countries reflect the emphasis of the R&D activities in the stated national strategies. Technology transfer activities are an important component of international trade. The participant listing of research and development goals are

outlined in the Agenda 21 (or its equivalent) issued by each country. This will aid in determining other NAFTA nation measures.

## Technology Transfer

The problem of technology transfer is reflected in policy development. The area of technology transfer relates to national and international policy makers that are concerned with international sovereignty issues. Technology transfer can affect the security of a nation, and the future economic viability of nations. Implementing policy that is based on trade is mirrored in research and development policy. Dupuy (1993) explains that the components involved are "Broadly defined, technology transfer encompasses the transmission of material and products, as well as designs, research methods, techniques, and documentation" (p. 2709).

In determining technology transfer components, there are issues that are considered problematic. These problems have been studied and it was found that the companies involved in research and development (R&D) are the leaders of the technology transfer process. The issues that face technology leaders have been identified as:

1. Measuring and improving R&D productivity/effectiveness,
2. Balancing long-term/ short-term R&D objectives/ focus,
3. Reducing cycle-time R&D,
4. Making innovation happen,
5. Integrating strategic technology planning with corporate strategic planning,

6. Managing R&D for business growth,

7. Gaining access to external sources of technology,

8. Managing the R&D portfolio,

9. Organizing and determining the role of R&D in centralized and decentralized businesses, and

10. Integrating the enterprise (coordinating R&D with all other corporate activities (National Science Board, 1996, p. 4-13).

The implementations of solutions to these problems are often taken at the corporate and national policy level. These issues do not, however, limit themselves to the private sector. In the public sector, R&D also occurs. Though the issues that face nations are often more complex the infrastructure of the nation plays a role in solving these issues. The problems that confront the corporate leaders are often solved as policy decisions at the national level.

## Technology Planning Strategy

To implement procedures at a national level, a comprehensive technology infrastructure policy needs to be developed. Strategic global concepts help to differentiate the national attitudes that arise in R&D policy. For example, U. S. manufacturers tend to pursue automation as a primary means to reduce costs in the manufacturing process. Japanese corporations tend to use automation as a means for achieving an increase in manufacturing quality, or for use in manufacturing processes where there is no substitute. These attitudes become integrated into the national objectives for strategic technologies. As a national strategic policy is

developed, Tassey (1992) explains there are a number of mechanisms that need to be addressed:

1) funding civilian R&D;

2) conducting civilian R&D, particularly generic technology and infratechnology research;

3) comprehensive and rapid diffusion/ transfer of research results;

4) removing technical, financial, and transaction barriers to commercial applications of new technology; and

5) providing technical, managerial, and market information needed for global market penetration. (p. 255)

Strategic planning in international science and technology addresses these issues in national objectives. The main topic in the international arena is on cooperation between nations.

## International Cooperation

International cooperation is essential to R&D efforts. There are constant pressures of funding for specialized disciplines. The world's science budgets are required to pool together scarce resources to solve an increasing number of demands. Increasing areas of knowledge are being explored by science, and these efforts are becoming more advanced. The end result is an expansion in the number of R&D cooperation opportunities. The larger organizations, or cooperatives, are producing complex projects that cross many fields of science.These activities are under the imperative to be conducted on specific locations, on a world wide scale,

and also produce new opportunities for cooperation with former Cold War adversaries. The development of the internet and high speed computer networks help to increase the real-time interactions for data exchange between the world's scientist and engineers. This communication cooperation has helped to enhance progress against global threats. Global threats require international science and technology cooperation efforts in areas such as HIV/AIDS, and other new and re-emerging diseases that are too expensive or complex for any one organization to tackle (Strategic Planning Document, 1996).

International cooperation in technology transfer has been an effort to provide a center for coordination. A framework was developed and has been publicized. The framework of the coordination program was developed by the Commission of the European Communities (1990). The Commission of the European Communities (CEC) determined that for the continuation of research activities, there should be three areas of focus. The three areas of focus are: enabling technologies, the management of natural resources, and the management of intellectual resources. To expand on the enabling activities, specific examples were provided. Each of the enabling technologies comprise of six cooperation areas on the international level:

- enabling technologies:

1. information and communications technologies;
2. industrial and materials technologies.

- management of natural resources:

3. environment;
4. life sciences and technologies;
5. energy.

- management of intellectual resources:

6. human capital and mobility. (CEC, 1990, Article 1)

Technology transfer is an international effort. The effort seeks cooperation at the international government level, at the national level, and at the corperate level. In order to increase the transfer of technologies, knowledge about the technologies has to be made available. To foster the wide spread distribution of information related to technology, a strategy needs to be developed. Part of this strategy is in defining the role of role of technology.

United States Technology Policy

Determining the role of science and technology (S&T) in research and development (R&D) in the United States required the identification of the technologies involved. The task had not been undertaken on a public national level prior to the 1990s in the United States. In April of 1991, the technologies were identified by the government. The White House listed 22 areas of interest in the document. These areas of technology were identified as "critical to the national prosperity and to national security" (World Almanac, 1992, p. 200). The technologies are: surface transportation; environment; materials processing; electronic and photomic materials; ceramics; composites; high performance metals and alloys; flexible computer integrated manufacturing; intelligent processing equipment; micro and macro fabrication; systems management; software; microelectronics and opto-electronics; high performance computing/networking; high definition imaging and displays; sensors and signal processing; data storage;

computer simulation; applied molecular biology; medical; energy; and aeronautics. With the public listing of the strategic areas of technology, the activities of technology transfer were "now an important mission component of Federal Laboratories" (NSB, 1996, p. 4-20). These areas were developed in cooperation with the National Science Board (NSB). The NSB is an independent organization designed to advise the American administration on issues related to science and technology.

In the formative stage of developing the strategy for a technology policy, eight areas were considered (1991) as shown in the US Technology Policy table. In 1994, these areas were reduced to 5 strategic areas. In 1996, the strategic areas were termed critical to national security science and technology policy, and expanded upon.

Although some of the statements are somewhat vague, the intents of the statements do shed light on the areas of interest for policy implications. The role of government in the technology transfer process is evident and is maintained throughout the policy development process. There are three areas that illustrate the role of government in the stated technology transfer policy:

> (1) funding of R&D performed in the private sector, (2) funding of Federal laboratory research activities and the effective transfer of that knowledge to the private sector, and (3) funding of basic research (especially at universities) and encouraging of industry-university research relationships (Leyden, 1992, p. 4)

| 1991 US Technology Policy | 1994 US National S&T Policy | 1996 US National Security S&T Policy |
|---|---|---|
| Increase Federal investment in support of basic research (especially at universities) | Maintain leadership across the frontiers of scientific knowledge; | Maintain technological superiority |
| Participate with the private sector in perceptive research on generic, enabling technologies that have the potential to contribute to a broad range of government and commercial applications. | Enhance connections between fundamental research and national goals; | Invest broadly in basic research |
| Continue the Federal government's development of products and processes for which it is the sole or major consumer. | Stimulate partnerships that promote investments in fundamental science and engineering and effective use of physical, human, and financial resources; | Use commercial technology where possible |
| Streamline Federal decision making structures and mechanisms to eliminate unnecessary and cumbersome regulations and practices that inhibit industrial competitiveness. | Produce the finest scientist and engineers for the 21st century; | Incorporate affordability |
| Encourage international cooperation in science and technology where beneficial , and inform U.S. researchers of opportunities to participate in R&D initiatives outside the United States. | Raise scientific and technological literacy of all Americans | Access international science and technology |
| Improve the transfer of Federal laboratories' R&D results to the private sector. | | Address global problems at the root of conflict |
| Promote increased collaboration between industry, Federal laboratories, and universities. | | Mobilize resources in an enhanced interagency fashion |
| Expedite the diffusion of the results of Federally conducted R&D to industry. | | Sources: Strategic Planning Document, 1996; Leyden, 1992, p. 3; NSB, 1996, p. 4-25 |

The growth of a technology policy is not limited to the United States. Until recently, there has not been an effort to create an explicit technology transfer policy. At the national level and the international level, the developments of policies are gaining momentum. Mexico followed a similar process in developing a national science and technology policy.

Mexico Technology Policy

The use of indicators as a measure for science and technology has been through a development process that began in the 1970s. It was with the development of the Consejo Nacional de Ciencia y Tecnología - CONACYT (National Science and Technological Council, CONACYT) in 1970. The CONACYT was formed as an independent council designed to advise the Mexican administration on policy in the areas of science and technology. The main activity of the CONACYT is in developing and strengthening the basic technological and applied research to promote teaching and the research centers in Mexico. To accomplish this objective, they participate in the allocation of funding from the state and other sources, and direct the funding to academic institutions and research centers for specific research programs and projects. This aid is also in the form of designing and implementing a national scholarship program. Coordination with international organizations and foreign governments to further technical cooperation is an activity that helps to promote the overall international programs of exchange (Goals of the Mexican Science and Technology Policy, 1996).

In the following table, the focuses of CONACYT's policies are depicted in a similar fashion to that of the United States. The 1970's data reflects the initial policy framework development. The 1994 data reflects the policy that was implemented at the adoption of the National Agenda 21, at the time no information and the 1996 data reflect the current status of the national technology policy.

| International S&T Policy | Mexican S&T Policy | CONACYT S&T Policy, 1996 | CONACYT S&T Policy, 1970 |
|---|---|---|---|
| To promote basic and applied research to speed development | Contribute to the understanding and solution of national problems | Develop and strengthen basic technological and applied research to promote teaching and research centers | Institutional infrastructure in higher education and research in relation to education reform |
| Foster and sponsor visits, graduate studies, and scientist and researcher exchanges between national and oversees institutions, to strengthen national research capabilities | Improve and enhance the human resource development | Allocation of funding from the state and other sources, and direct the funding to academic institutions and research centers for specific research programs and projects | Institutional infrastructure in promotion of basic research |
| Promote excellence networks of the scientific community to link up with the most advanced research centers in the world | Tie in scientific activities and standards to international trends | Designing and implementing a national scholarship program | Institutional infrastructure in scholarships and exchanges |
| Establish and consolidate cooperation with other countries or multilateral agencies | Increase Mexico's competitiveness and modernization | Coordinate with international organizations and foreign governments to further technical cooperation | Formation of the National Scientific and Technological Information and Documentation Service |
| Promote workshops, symposia, conferences, and seminars on specific scientific scientific and technological issues with government, education, and business participants | Upgrade national technological capabilities | Promote the overall international programs of exchange | Study and formulation of options for the solution of urgent national problems of arid zones, food, sugar industry, pollution of the environment, State of Yucatan, energy. |
| Improve the international dissemination of scientific and technological activities within nations | Encourage private sector R&D activities | | Dispositions for better utilization of natural resources, and marine sciences programs |
| Participate in joint research with the international community in common interest to the involved countries | Improve and support human resource development in industrial areas | | Studies towards the broadening of the transfers of technology, standardization, patents, information and data organization |
| | Increase efficiency in health, education, and housing services through acquisition and development of state of the art technologies, as well as protection and improvement of the environment | | Sources: Goals of the Mexican Science and Technology Policy, 1996; Richards, 1975, p. 151; Guidelines of International Science and Technology Policies, 1996 |

Canada Technology Policy

The use of indicators for science and technology in Canada has a brief history. As the policy developed recently in the United States, the role of science and technology in Canada has only recently been defined. The new cabinet of Canada, after the 1993 elections set out to change the intention of research and development spending in the country. The new focus is on supporting areas where Canada has a distinct advantage. This translates into areas where a clear market exists, and also where jobs can be created. The policy of Canada on science and technology can be seen in the table below. As a result of a national science and technology review, recommendations were made for the focus of science and technology development. As a result of the recommendations a policy was established.

| Canada S&T Review | Canada S&T Policy |
|---|---|
| Focus the federal S&T investment | Increasing the effectiveness of federally supported research |
| Anticipate and adopt the right policies and regulations | Capturing the benefits of partnership |
| Increase partnerships and collaboration | Emphasizing preventative approaches and sustainable development |
| Capture the full benefits of new technologies | Positioning Canada competitively within emerging international regulatory, standards and intellectual property rights |
| Promote a stronger science culture | Extending science and technology linkages internationally |
| Manage for results | Promoting a stronger science culture |
| | Source: http://canada.gc.ca/depts/science/english/strata-e.html |

Of the methods employed by the three participant countries, the Canadian method appears to have been developed with national consensus. The United States policy was developed by the President with his advisors. The Mexican policy was

developed through a political process, and the Canadian policy was developed with national consensus building.

## Identification and Selection of Specific Technology.

A technological area that uses English as its primary mode of instruction used in the countries involved in the research is critical to understanding the potential for technology transfer. The areas of major emphasis in technology related areas are broken into three major areas; production systems, communication systems and transportation systems.

## Areas of Technology

There are basically three areas that have been identified as components of the area of technology. Devore (1980) has labeled these areas as production systems, communication systems and transportation systems.

### Production Systems

Production systems refer to the ability of man to use technology to produce materials that increase social development. The increases in materials goods are the areas of food production, material goods, and services that promote the health and well-being of individuals. Individual services included in production systems are the durable and non-durable goods that are used for increasing the sustainablility of communities (Devore, 1980).

Communication Systems

Communication systems refer to the ability of man to use technology to promote communication. The increase in communication ability include the electronic communication methods: radio, television, and computers; paper communication methods such as news print, magazines, flyers, and public displays; and verbal communication systems such as word -of- mouth, propaganda systems, and the coordination of these methods with other means to facilitate the communication of technology (Devore, 1980).

Transportation Systems

Transportation systems refer to the ability of man to transport people and goods. Included in the transportation sector are the prime movers of people and goods, the power systems. The increases in transportation services around the world have resulted in the ability to travel to almost all locations that are accessible. The ability to travel has progressed through the centuries. The first mode of travel was foot travel, followed by horse travel, boat travel, and in the twentieth century to motorized vehicle travel and to air travel (Devore, 1980).

The last two modes of travel have combined the elements of the transportation systems. The mode of travel by air has resulted in the apparent shrinking of the world and its political boundaries. The result propagated the creation of an international advisory panel to aid in the creation of guidelines for air travel, the International Civil Aviation Organization.

## International Aviation

The International Civil Aviation Organization (ICAO) is a private non-governmental organization. The organization was founded to provide direction and guidance to governments and institutions that are involved in international aviation. The organization is independent form governmental organizations and provides suggested rules to follow in aviation matters. The ICAO has no enforcement powers nor enforcement arm as part of the organization. The ICAO has taken on the task of developing international guidelines for the further unification of airline travel and regulations since the adoption of the NAFTA. Among the proposed regulation adoptions by member countries is the unification of licensing policies and procedures. Prior to NAFTA there were little or no cross transferability to operate or obtain legal documentation to work in another country with the native countries permit. The goal of ICAO's NAFTA review is to ease the legal transferability of current license and operation permits in member countries (Schenkman, 1955).

## United States Aviation

The aviation environment in the United States began with the well-known Wright Brothers flight. The aviation authority is the Federal Aviation Administration (FAA) in the United States. "The FAA is the country specific authority equivalent of the ICAO. This allows tailoring of aviation regulations to the local aviation market conditions, and determines the particular levels of schooling, experience and levels of English language ability. Given the earlier mentioned Spanish language expansion

in California, it has been found that the ethnic differences do exist in this population, but they do not affect the FAA regulation actions. In America, it is possible to conduct aviation business in languages other than English. Theoretically, this could involve the use of 329 different languages. This atmosphere is made possible by the FAA regulations. The regulations allow the licensing of pilots that are not fluent in English. These pilots do, however, receive a restriction on their pilot's license that permit them to fly in situations where English is not required. This is generally seen as permission at uncontrolled airports and overseas operations. In international aviation, however, English is the defacto language that has been recommended for aviation.

Mexico Aviation

According to Stolzenberg (1982), the Spanish speaking Mexican achievement levels are comparable to American achievement levels. Just being of Hispanic origin does not "to play an important role in Hispanic occupational achievement" (Stolzanberg, 1982, p. 82). In discussing the aviation business advances in Mexico, Millman (1996) addresses the issues of ethics and technology transfer and politics. Of particular interest in the article, Millner points out the status of the legal system as allowing the use of questionable business practices in Mexico. The Mexican laws do not prohibit the senators that make the laws of the land from operating, or even owning companies that may benefit from the legislative process. This allows the direct ownership of a company, and future business directions to be determined by the creator of the laws in the country. Many of these business

relationships do have extensive ties with government agencies. It is not unusual for the politician to be in charge of the governmental agencies that provide regulations about the companies. This has been damaging to the internationalization of the Mexican economy. The internationalization is designed to create a free trade zone. This effort was stifled in the past, and is currently being stifled. There is progress being made though, as Millman points out:

> Despite efforts to make markets competitive and transparent, ethics laws remain weak and apparent conflicts of interest abound, a condition that has undermined confidence n President Ernesto Zedillo's efforts to establish a rule of law in Mexico. (1996, p. A18)

The conflicts also extend to the efforts of the Mexican aviation authority. In Mexico, it is permissible to use both English and Spanish in national aviation. The situation in Mexico allows for this flexibility. In international aviation, however, English is the defacto language that has been recommended for aviation.

Canada Aviation

The aviation environment in Canada faced two distinct languages throughout the formation of its authority, Transport Canada. The organization is located in French speaking Quebec, and regulates air travel in both English and French. The ICAO is also located in Quebec. In 1955, the ICAO adopted English as the official language of aviation as a result of a conference held in Chicago. In this effort, countries that were interested in international aviation were encouraged to conduct related communications in English (ICAO, 1955). In fact, it is permitted in Canada

to use both English and French in aviation. The situation in Canada allows flexibility in national language use. In international aviation, however, English is the defacto language that has been recommended for aviation.

## Identification and Selection of Official Language

"Technology has become and increasingly important factor in the economic growth of nations, but its impact will continue to increase for several reasons: (1) more nations are using technology as a major element of their economic growth strategies, (2) in addition to the magnitude of technology's impact, its evolving character is causing major changes in both the structure and behavior of most industries, and (3) the simultaneous breaking down of national boundaries in an economic sense is making most markets global" (Tassey, 1992, p. 20).

## Language Factor

"Technological development, especially of high technology - has become a question of national and international - or transnational - policy and decision. It has become a central if not yet dominant question in national and global politics, affecting "the basic issues of power: political, economic, military and social power - thereby directly affecting the lives and future of people on a mass scale" (Wartofsky, 1992, p. 16).

An analysis of the language factors "is based on three major assumptions that grow out of recent attention to social and political theories of communication

and to the ways in which communication practices are enacted in social and political settings. Duin (1996) explains:

> First we assume there should be some degree of commitment, on the part of most educated individuals, to an increasingly democratic social project - although both the degree and scope of this commitment may vary widely... Second, we recognize that communication , language, is the primary medium for change and reform - as wall as stasis - in any culture. Communication, further, is a complex social and political phenomenon itself... Third, ... teachers and students writing in the technical communication classrooms, are linked by these issues surrounding language, civic responsibility, and social action." (Duin, 1996, p. 326)

## National Languages

The participant countries exposure to the technological area's suggestions will be the treatment English within the country. "The language of the educated classes in the United States is notably different from that of the educated classes in Great Britain. They complain, not only that the Americans have brought into use a number of new words -- the differences and the distance between the two countries might suffice to explain that much -- but that these "new words are more especially taken from the jargon of parties, the mechanical arts, or the language of the trade" (Stone, 180, p. 15-4).

"Research results must be communicated in language that will be meaningful to non academic as well as academic audiences... Put another way, technical

communication researchers, to give academic credibility to their work, have developed their own exclusionary language. This increasingly allusive, "political, ideological, and abstract language gives intellectual stature and a sense of luridation to their work, but it also alienates non academic users of [their] research" (Duin, 1996, p. 50). Given this statement, it is easy to see how a language can influence cross country transfers of information. In this regard, for example, "Japan faces a tremendous obstacle in spreading its ideas and culture already. This is its language" (Toffler, 1990, p. 428).

The role of language within each of the participant countries reflects a political theme. In Mexico, the official language for the country is Spanish, which is spoken by all but members of isolated ethnic minority groups. Rudolph notes that "English and French are sometimes spoken among business elite and small upper class" (Rudolph, 1984, p. xxvi).

In Canada, the official languages are French and English. In Quebec, the official language of the government and commerce is French, though over a fifth of the population are not conversant in it. Quebec itself has been attempting to form itself as a separate country, the last effort failed (Folsom, 1996).

In the United States there are over 329 different languages spoken, none of which are an official language. The principle language spoken is English in the United States (Mujica, 1996; Banks, 1996). Though there is a prediction that California will become a mostly Spanish speaking state in the future, this trend is not seen as encompassing the entire country. There are currently 23 states that do require English in official communications. "Thus, the enormous advantage that the United States holds at present is simply language. English is the "whole world's

language in international science, commerce, aviation, and scores of other fields" (Toffler, 1990, p. 442).

| Mexico | Canada | United States |
|---|---|---|
| Official Language | Official Languages | Principle Language |
| Spanish | English and French | English |

## CHAPTER IV

### Data Presentation

The previous policy issues have dealt with technology transfer, technology and aviation, and national languages. In this section the policies will be summarized and presented in relationship to each other. The data will then be evaluated to show the policy implications that have developed. The analysis of the data will be .

| Policy | International | Canada | United States | Mexico |
|---|---|---|---|---|
| Language | English | French/English | English | Spanish |
| Aviation Language | English | English | English | English |
| S&T Policy | Promote basic and applied S&T research & development | Promote a stronger science culture | Invest broadly in basic research | Upgrade national technological capabilities |
| | Establish cooperation with other countries or multilateral agencies | Capture the benefits of partnership | Maintain technological superiority | Contribute to the understanding and solution of national problems |
| | Researcher exchanges for national research capabilities | Emphasize prevention and sustainable development | Use commercial technology where possible | Increase national competitiveness and modernization |
| | Promote links to advanced research centers in the world | Position nation strategically within emerging international regulatory, standards | Address global problems at the root of conflict | Increase social services through state of the art technologies, as well as protection of the environment |
| | Participate in joint research with the international community | Extending S&T linkages internationally | Access international S&T | Tie in scientific activities and standards to international trends |
| | Improve dissemination of S&T activities | Increase federally supported research | Incorporate affordability | Improve and support human R&D in industrial areas |
| | Promote S&T in government, education, and business | | Mobilize resources in an enhanced interagency fashion | Encourage private sector R&D activities |
| | | | | Improve and enhance the human resource development |

## Data Analysis.

The data will be analyzed using a qualitative approach. This research has collected data on three areas of policy; language, technology transfer, and aviation. The data that has been generated is summarized in the preceding policy table. No effort has been made to code the data for statistical analysis.

## Language Analysis

The data most suited to coding would be country language and aviation language. The use of this language data is subjective to interpretation. The designation of a language in each instance is not equivalent. The use of the language is not defined clearly in documentation.

### International Language

The designation of an international language is wrought with many possibilities. There have been estimates of over 20,000 different languages across the globe. Once the similar dialects and pronunciations are taken into consideration for categorizing the languages, the number is reduced to more than 4,000. The choice of an international language is subjective, and depends on the source of data, and on the purpose of the research. The international language designation for this research is English. The choice comes from the general use of the English language in international organizations that conduct business in the international environment, and through claims by academic authors and researchers.

Canada Language

The Canada language designation comes from official government mandates and regulations. This provides the most concrete data, and results in English and French. The language use, however, is subjective in that the use of French applies to its acceptance Quebec official communications. In Quebec, a fifth of the pollution are not conversant in French, whereas, the remainder of the country relies on English. For the purpose of this research, English will be used as the official language of Canada.

The use of an aviation language designation comes from subjective sources. As both English and French can be used in Canadian air travel, the designation of a single national aviation language is difficult. However, in international aviation Canada follows the recommendations of the ICAO and uses English.

United States Language

The United States language designation comes from the lack of an official government designation. In the documents provided to the public, only English is listed as a language of use in the country, and this is only because it is the principle language spoken. Other languages can be, and are, used in official documents. Therefor the language is subjective. For the purposes of this research, English will be considered the language of the United States.

The use of an aviation language designation comes from subjective sources. As there are over 300 languages that can be used in American air travel, the designation of a single national aviation language is difficult. However, in

international aviation the United States follows the recommendations of the ICAO and uses English.

Mexico Language

The Mexico language designation comes from official government mandates and regulations. This provides the most concrete data, and results in Spanish. The language use, however, is subjective in that the use of Spanish applies to its acceptance in official communications. In Mexico, part of the educated and elite population of the country relies on English. However, the majority of the population uses Spanish. For the purpose of this research, Spanish will be used as the official language of Mexico.

The use of an aviation language designation comes from subjective sources. As both English and Spanish can be used in Mexican air travel, the designation of a single national aviation language is difficult. However, in international aviation Mexico also follows the recommendations of the ICAO and uses English.

## Technology Policy Analysis

The data least suited to coding would be country policies dealing with S&T policy statements. The statements have been developed and issued by the government of each country, and can be considered as valid. However, the statements provided by each country are different, and only general similarities and differences can be stated from the data.

Statement Quantity

The sheer quantity of statements varies with each instance. The international policy contains 7 statements. The Canadian policy contains 6 statements. The United States policy contains 7 statements. The Mexican policy contains 8 statements. The average number of statements is 7 as seen in this research.

Cooperation Statement

The focus of each policy statement is also subject to interpretation. Upon reviewing the international policy statements, cooperation is an underlying issue in 7 of the 7 statements. The Canadian policy statements have cooperation in 4 of the 6 statements. The United States policy statements have cooperation in 3 of the 7 statements. The Mexican policy statements have cooperation in 6 of the 8 statements. Clearly, cooperation is an issue in the policy statements, accounting for 20 of the 28 statements provided.

International Technology Transfer

The statements that equate to providing for technology transfer are the area of primary interest in this research. The international policy statements each deal with technology transfer. This is evident in their use of cooperation as a main theme. Also, the support of S&T R&D are stated directly in 6 of the 7 statements,

and indirectly in the remaining statement. Therefore, the international S&T policy theme supports the cooperative transfer of technology.

Canada Technology Transfer

The Canada policy statements have technology transfer in 2 of the 6 statements. The support of S&T R&D are stated in 4 of the 6 statements, and indirectly in one other. The theme that prevails in the Canadian policy is one of maintaining the current political strength of Canada internally, while influencing international policy in strategic manners.

United States Technology Transfer

The United States policy statements have technology transfer in 3 of the 7 statements. The support of S&T R&D are stated in 7 of the 7 statements. The theme that prevails in the United States policy is one of not just defending the current political strength of United States internally, but offensively maintaining the lead with S&T internationally.

Mexico Technology Transfer

The Mexican policy statements have technology transfer in 3 of the 8 statements. The support of S&T R&D are stated in 7 of the 8 statements, and indirectly in one other. The theme that prevails in the Mexican policy is one of building the internal technological ability of the nation primarily, and using internal

contacts where there is a direct benefit to Mexico. Mexico's policy then can be seen as one of basic needs fulfillment.

## CHAPTER V

### Findings

The analysis of the data has resulted in a number of findings related to languages and technology policy. The findings are presented in brief to these two areas, the findings will then be combined and discussed.

### Language Finding

The subjectivity of designating an official language is obvious given this data. English is the national language of choice in two of the three countries, with Spanish being used in one of the countries. English is also the language of choice in international aviation, as evidenced by the adherence to the recommendation of the ICAO. Thus, it would appear that Mexico is at a disadvantage in the area of aviation.

### Technology Policy Finding

The policy statements have technology transfer in 15 of the 28 statements. The support of S&T R&D are stated in 24 of the 28 statements, and indirectly in four others. The themes found in the policy statements reflect national attitudes. Folsom (1996) describes the attitudes as stereotypes, and further categorizes the NAFTA countries into two views; those of the North American view and those of the Mexican View.

## Technology Policy and Language Finding

The North American View and the Mexican View can be divided along the lines of national languages, however, the distinction comes from marketing tactics. The Mexican literacy rate is slightly below that of Canada and the United States, and the role of the language is not mentioned. Another factor that is pointed out in the distinction is the education level, again the Mexican education rate is below that of the United States and Canada. The North American view and the Mexican View have resulted in a number of stereo types that can be found in this research. From Folsom's (1996) categories, the following table was developed:

| Value Affected | Mexican view of N. American | Mexican view of self | N. American view of Mexican | N. American view of self |
|---|---|---|---|---|
| Type of civilization | condescending, contradictory, not credible | traditional, technically inferior, morally superior | primitive, in need of instruction | advanced, show others how to have democracy and free trade |
| Character | aggressive, at times brutal | brave, but overpowered | submissive, weak | dominant, strong |
| Time orientation | obsessively future oriented, doesn't know how to relax | lives in and enjoys present, respects past | lives too much in present while dwelling on past | planning and action oriented |
| | | | | (pp. 270-271) |

The aggressive stance of the United States policy is evident in the Mexican view of the North American character and time orientation. This is also reflected in the North American View of self in all three values. The North American view of the

Mexican type of civilization is reflected in the Mexican policy, where there is an emphasis to survive and educate the present society.

This findings of language and technology policies when are applied to the area of aviation found a similar correspondence. Aviation personnel of Mexico would have to become competent with English in order to operate in the international environment. English would become a second language, or at least, a second reading language. The use of second language material has already been discussed in this research. The Mexican in international aviation would face translation difficulties, and affect their performance as shown with the previously mentioned aviation incidents. The American and Canadian aviation personnel would be operating in their national language. Misunderstandings on the scale of the Mexicans would be absent.

## CHAPTER VI

### Conclusion

This research had attempted to determine if a relationship exists between the limit of English, and technology transfer. Based on the data collected and the analysis used, this researcher has determined that there is a connection between English and technology transfer. From the data presented, there appears to be a direct connection between English and technology transfer. The connection is one of socio-political orientation and approach. Socio-political in the sense that national language determination is a social process. The population of language speakers determines the national language policy. Socio-political in the sense that the transfer

of technology policy is dependent on language. The development of a national policy for transferring technology assumes that a country can participate in international trade on an even basis with other countries. This research has found this can focus needs to be developed based on the political process of the country, and can proceed only when the national infrastructure has become self supporting. The role of language and national policy, need not be defined on the national level before trade can occur, history has shown this, and so has this research. What is interesting is the original search for a limit of English in technology transfer appears to be one of unofficial policy decisions, rather than official policy. Take the ICAO for example, it has no authority and can only make suggestions and recommendations. The ICAO has had a direct affect on establishing English as the language of aviation, on the international level. However, within the countries, there still exist provisions for the use of other languages.

The limit of English in technology transfer is one of social cooperation. In the international transfer of information, languages do have a role to play. The participants have to decide if there will be cooperation in communications. The participants in an activity may determine that English is not the language of choice for their specific activity. They will then determine which method of communication best suits their activity, or remove themselves from it. The deciding factor does appear to be the social norm when applied internationally.

## Recommendations

This research was based on personal interest and efforts to explore the limits of English and technology policy. There are numerous avenues to explore

quantitatively from this research. Research could be conducted that would explore the different measures of the basic factors of language, technology and aviation.

There also remains a need to determine to what extent technology is adopted by foreign users. How long does a foreigner need to learn a new technology? Are the users competent to use the tools of the trade? Do instructions need to be translated into a native language, even if the foreigner has some control of a foreign language?

## Definition of Terms

The following are definitions of terms used in this research. The terms are defined as follows:

Competence: Refers "to what one knows" (Sauvignon, 1983, p. 9).

Mechanical Aptitude (Technical Competence, and Technical Ability): The ability to adequately operate (or correctly install and maintain) specific equipment (Larsson, 1988).

Performance: Refers "to what one does" (Sauvignon, 1983, p. 9).

Second Language (2L): A second language refers to the use of a language that is not the principle language spoken during the participants country's majority population schooling.

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