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**REVERSE LICENSING: INTERNATIONAL TECHNOLOGY TRANSFER TO THE
UNITED STATES**

The Ohio State University

PH.D. 1985

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REVERSE LICENSING
INTERNATIONAL TECHNOLOGY TRANSFER TO THE UNITED STATES

Dissertation

**Presented in partial fulfillment of the Requirements
for the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University**

By

Manuchehr Shahrokhi, B.B.A., M.B.A.

*** * * ***

The Ohio State University

1985

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1985

TO MY FAMILY

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CHAPTER ONE

STATEMENT OF THE PROBLEM

This research focuses on international transfer of technology into the United States. The U.S. licensees', as the recipients of technology and their characteristics, motivations, type of licensed technology and license agreements, are germane to this research study. "Licensing" as an international marketing (sourcing) strategy is the means for such transfers. Thus, this research evaluate the viability of taking a license as an alternative growth strategy from the U.S. licensees' standpoint: Reverse Licensing. (1)

Reverse licensing will be evaluated as a bridge or a transfer mechanism between two groups of firms . The first group consists of thousands of U.S. manufacturing firms which need new "technology" for their survival. The new technology will provide them with an extension on their product life cycle (PLC). Small and medium-sized manufacturing firms are of special interest in this research study. In the following paragraphs more will be said about this group.

The second group consists of thousands of small and medium-sized foreign firms. This group has the technology but lacks the required resources to exploit the U.S. market directly. The scarce resources for this group could be

financial, marketing, and production among others. Reverse licensing could provide these groups with the required international transfer mechanism.

The reason small and medium-sized firms are of special interest in this research study is because of their importance not only in the economy of each state but in the nation's economy (see Figure 1). To see their importance in the U.S. economy, it is sufficient to quote from the U.S. president's 1984 report on "The State of Small Business," transmitted to the Congress: (2)

- * There are 14.3 million non-farm businesses in the U.S. Approximately 99.7% of these businesses are small by U.S. Small Business Administration size standards. (3)
- * From 1980 through 1982 large firms lost 1.7 million net jobs; most of these losses were concentrated in manufacturing (-1.5 million), retail trade (-0.2 million), wholesale trade (-0.3 million), and transportation (-0.1 million).
- * Between 1980-1982, small business generated 2.65 million new jobs, more than offsetting the 1.7 million lost by large businesses. Small business has led the way in job creation during the recovery.
- * Small business employs 48% of the private non-farm workforce, constitutes 42% of sales, and generates approximately 38% of the U.S. Gross National Product (GNP).
- * Firms with fewer than 100 employees generated 51% of the net new jobs growth from 1976-1980. During the 1980-1982 recession, small business enterprises with fewer than 20 employees generated all the net new jobs in the economy.

Source: "The State of Small Business: A Report of the President Transmitted to the Congress," SBA, March 1984.

FIGURE 1

DISTRIBUTION OF INCREASE IN NONFARM NON-GOVERNMENT JOBS BY MAJOR INDUSTRY, NOVEMBER 1982 -- NOVEMBER 1983 (SEASONALLY ADJUSTED)

The above statistics undoubtedly show the importance of small firms in the U.S. Economy. Yet, the statistics for business failures and bankruptcies clearly show which firms pay the tolls in an economic downturn and recession:

- * Ninety percent of approximately 400,000 businesses that dissolve each year do so for voluntary reasons, such as retirement of the owner.
- * Ninety-nine percent of the failed businesses have fewer than 100 employees; over 80 percent are less than 10 years old.(4)

TABLE 1
BUSINESS BANKRUPTCIES AND BUSINESS FAILURES
1981-1983

	Business Failures	Bankruptcies
1981	17,044	47,555
1982	25,346	65,807
1983	31,334	58,898
Percent Change		
1982/1981	45.4	38.3
1983/1982	23.6	-10.5

Source: "The State of Small Business": A Report of the President Transmitted to the Congress, SBA, May (1985), p. 37.

Table 1 shows the changes in the number of business failures and bankruptcies during both economic recession and expansion. During 1981-1982 recession as well as 1982-83 recovery, the percentage changes in business failures and bankruptcies are of special concern.

The number of business failures and bankruptcies might be a confusing indicator of real success and failure. It is quite natural for areas with a high economic growth to have high failure rates in an economic expansion. Also, regions with slower growth are expected to have a high bankruptcy rate.

. . . Nationally, business bankruptcies declined 2 percent between January and June 1983, compared with the same months in 1982. The bankruptcy decline has been more dramatic in areas affected by the 1981-1982 recession: 21 percent in the Middle Atlantic states, 12 percent in the New England region, and 2 percent in the East North Central industrial states, as these regions experienced significant recovery during 1983 (Figure 2).

Recent increases in bankruptcies and failures, however, in the West South Central, Mountain and Pacific regions have shown that the failure/bankruptcy index is a confusing indicator. Areas with significant economic growth like the Mountain states (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada) usually have high business failures and high bankruptcies because of their continuing rapid business formation. Regions with slower growth, however, can also have high failure rates because of a poor business climate in the area (e.g., the Midwest industrial states during the 1981-1982 recession). (5)

Many of the small U.S. firms are forced into bankruptcy because they have one or few products in their product lines when their existing product(s) reach the "declining" stage of Product Life Cycle (PLC), they have to close their doors.

Most of these small and medium-sized firms are unaware of foreign sources of technology. Those which know of overseas sources, find no established "mechanism" or "clearing house" to tap those sources. In most cases, this is not true about large multinational corporations.

Large U.S. multinational corporations (MNCs) have been utilizing this international marketing (sourcing) strategy for the past twenty years. They have tapped the foreign sources and have taken "license" from foreign licensors where the technology fits their existing product lines or marketing channels. They have not limited themselves to the U.S. allies and have utilized the technology from Soviet and other Eastern bloc countries. (6)

For instance as of 1984, in the state of Ohio alone,

approximately 120 U.S. manufacturing firms have acquired license from foreign firms. A complete profile on these U.S. licensees are found in the appendix to this research. As a matter of fact, our research hypotheses (Chapter Five) have been empirically tested using these Ohio licensees as our research sample.

On the other hand, to most of U.S. MNCs, licensing is a "residual" international marketing strategy particularly when they want to expand or penetrate into foreign markets.(7) In the next chapter we provide evidence for such ignorance on the part of U.S. firms.

To show the importance of manufacturing firms in the U.S. economy, suffice to see that as of 1982, almost 32 percent of U.S. enterprises are in manufacturing industries. With structural changes in the U.S. economy and stiff international competition, this sector of the economy is among the hardest hit with the recent economic downturns. Table 2 shows the distribution of non-farm enterprise employment by firm size class and manufacturing industry.

TABLE 2

**NON-FARM ENTERPRISE EMPLOYMENT BY FIRM SIZE CLASS
AND MAJOR INDUSTRY, 1980-1982**

All Industries				
1980	92,971	30,263	12,439	50,270
1982	94,721	32,272	12,976	49,473
Percent Change in Share	1.9	6.6	4.3	-1.6
Manufacturing				
1980	31,249	4,500	3,560	23,190
1982	30,208	4,621	3,480	22,107
Percent Change in Share	-3.3	2.7	-2.2	-4.7

Source: Compiled by author from various tables in the President's Report on State of Small Business to the Congress, Small Business Administration, March 1984.

Various states react differently to economic slowdowns and economic recoveries.

New business incorporations increased 6.6 percent in the United States from January to June 1983, compared with the same period in 1982. The Midwest industrial states (Ohio, Michigan, Illinois, Indiana, and Wisconsin) were adversely affected by the 1981-1982 recession and had a larger increase in incorporations in the first half of 1983 (7 percent) than the rest of the United States. High unemployment during the 1981-1982 period may have helped stimulate this new business formation.

One phenomenon of both the recession and the recovery has been an increasing equalization of regional trends in business formation, as evidenced by recent slowdowns in business formation in Western and Southwestern states that had higher rates of new business formation between 1976 and 1980.(8)

Figure 2 shows the percent change in business bankruptcies and new business incorporations by major

Note: The States included in each of the regions are as follows:
 New England—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.
 Middle Atlantic—New York, New Jersey, Pennsylvania.
 E. North Central—Ohio, Indiana, Illinois, Michigan, Wisconsin.
 W. North Central—Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.
 South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida.
 E. South Central—Kentucky, Tennessee, Alabama, Mississippi.
 W. South Central—Arkansas, Louisiana, Oklahoma, Texas.
 Mountain—Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada.
 Pacific—Washington, Oregon, California, Hawaii, Alaska.

Source: Bankruptcies: Administrative Office of the United States Courts, Statistical Analysis and Reports Division, unpublished data. New Corporations: Dun and Bradstreet Corporation press release, October 11, 1983.

FIGURE 2

PERCENT CHANGE IN BUSINESS BANKRUPTCIES AND NEW BUSINESS INCORPORATIONS BY MAJOR CENSUS REGION BETWEEN JANUARY-JUNE 1982 AND JANUARY-JUNE 1983

census region. On the other hand, Figure 3 shows the share of U.S. jobs during 1980-1982 by major census region.

FIGURE 3

SHARE OF U.S. JOBS 1982 AND SHARE OF NET NEW JOBS -- MAJOR CENSUS REGION

Various states have used different incentive programs and have created promotional offices at home and abroad to entice non-U.S. multinational corporations to directly invest in their states (see Table 42 in Chapter Eight). To encourage "reverse" or "inward" investment, various states have utilized the promotional offices and have made various concessions to foreign direct investors. Reverse licensing would provide the states with similar benefits without concessions. We discuss this in detail in Chapter Three. The literature on FDI in the U.S. is relatively rich and many scholars have investigated various aspects of FDI [see for example J. Daniel (1983), A. Ajami, D. Ricks (1981), J. Arpen, Flowers, and Ricks (1981), Hymer (1976), Hirsch (1970), A. Rugman (1975, 1980)].

Reverse licensing as an international sourcing strategy could help the small and medium-sized manufactur-

ing firms to survive. It can provide them with new opportunities to have access to new and competitive technology. The new technology which would not be possible otherwise. The United McGill Corporation of Columbus, Ohio is a unique example of the ways and means by which U.S. corporations have utilized foreign sources of technology. Reverse Licensing has provided companies with the new technology they need in order to survive and prosper (see appendix).

Reverse licensing could help small and medium-sized foreign firms to reach the U.S. market, a possibility not available otherwise. With the revenues from licensing contracts, these foreign firms could expand their research and development activities and in some cases survive. Without the U.S. market and similar sources of income, they would be in no better shape than their U.S. counterparts.

Source: The Dun & Bradstreet Corporation

FIGURE 4

EXPECTED EMPLOYMENT GAINS BY SIZE OF COMPANY

Small and medium-sized firms will play an even more important role in the U.S. economy. They are expected to grow at approximately 5% during 1985 and the near future. Their share of overall employment gains is expected to be more than 25% compared to approximately 2% for the larger enterprises in the U.S. (Figure 4). With their growth there will be even more business failures and bankruptcies. Reverse licensing could provide them with a "mechanism" to reach out and exploit foreign sources of technology.

In summary, reverse licensing is a "mechanism" for matching the foreign availability of technology (supply) with the U.S. need for technology (demand), a mechanism which would provide the U.S. manufacturing firms (particularly small and medium-sized) with new and competitive sources of technology not possible otherwise. Similarly, it provides the foreign firm (especially small and medium-sized) with the possibilities of reaching the U.S. market. The benefits are not limited to these groups. It is an international marketing (sourcing) strategy which could be used, and has been used, not only by U.S. MNCs, but also by the Japanese and other industrialized nations. The Japanese have acquired most of their technological base and competitiveness by successfully utilizing international licensing for decades.

The problem to be studied is therefore to evaluate the viability of Reverse Licensing as an alternative growth

route and survival of firms whose products are reaching end of PLC for small and medium-sized U.S. manufacturing firms. In other words, the major problem addressed in this dissertation is to critically evaluate licensing as a strategy for acquiring the new technology from the U.S. firm's standpoint.

Organization of the Dissertation

This dissertation is both theoretical as well as empirical. The first five chapters we develop our theoretical model and in the last three chapters, we empirically test our model and research hypotheses.

We first discuss the importance of the United States in the international arena in general and in licensing of technology in particular. The historical role of the U.S. and the factors contributing to the deteriorating position of the U.S. in the international markets are also discussed. This sets the stage for a better understand of those contributing factors, relative shifts in international industrial base, and the type of technology transferred. After a grasp of the marco picture, we take a micro approach and focus on a more specific case(s) of technology transfer(s).

In the next chapter, we discuss the importance of technology licensing in general and reverse licensing in particular. We will make an international comparison in R & D expenditure and activities, patenting, growth rates and

licensing fees and royalties. The implications of these factors and their relevance to reverse licensing will be discussed.

In Chapter Three, we discuss the "internationalization" process of technology and see where "licensing" fits in. After defining technology transfers, types of transfers, models of transfer, we discuss pros and cons of taking a license. Then, we discuss licensing motivations from licensors' as well as licensees' point of view and other licensing issues. Finally, we focus on reverse licensing and compare it with reverse investment and discuss licensing benefits and how state governments should perceive reverse licensing.

In Chapter Four we review technology transfer and technology licensing literature. We will see that the literature on technology licensing is relatively rich but almost all of the literature has taken a licensor's standpoint--the opposite side of what this thesis is all about. This and our previous discussion will enable us to conceptualize and introduce our research model in the next chapter.

Chapter Five builds upon the preceding chapters and first the research model is introduced and then we apply the Net Present Value technique for analyzing licensing decisions from a licensees' point of view. Next we introduce the "Licensing Cycle model" and strategies for

future technological needs. Finally, we focus on licensees' characteristics (i.e., size, R & D and technical competence, dominance), characteristics of licensed technology, type of license agreements, and propose our research hypotheses.

In Chapter Six we put our model and hypotheses to work. In this part of the thesis, we operationalize our hypotheses and develop our research design, methodology, research instrument (questionnaire), and statistical design. We focus on 118 Ohio licenses as our sample and carry out our empirical research. Then we discuss how our questionnaire was designed and through a 'pilot' study we show the reliability and validity of our research instrument.

In Chapter Seven, our focus is on research results and statistical analyses. First, we discuss how our research was carried out and how licensees responded to our questionnaire and our interviews with licensees' executives. We test our hypotheses using Chi-Square (χ^2) and Gamma test statistics. Then, we analyze and interpret the statistical analyses and testing. We compare our hypotheses and statistical analyses of the questionnaire with the results of our interviews with the licensees' executives. Finally, we discuss our empirical findings and those not predicted by our hypotheses and questionnaire.

Chapter Eight summarizes our discussion of preceding chapters and brings our research to a conclusion. In that chapter we also discuss the limitations and the implications of our research and make recommendations for future research in technology transfer and technology licensing.

ENDNOTES

(1)The term "Reverse Licensing" was first used by Professor Lee C. Nehrt in an unpublished report to New York/New Jersey Port Authority, 1979.

(2)"The State of Small Business": A Report of the President Transmitted to the Congress, Small Business Administration, March 1984.

(3)U.S. Small Business Administration's firm size standards include five firm size groups:

	<u>Number of Employees</u>
Smallest	1-24
Small	25-99
Intermediate	100-499
Large	500-999
Largest	1000+

(4)See footnote 2 above, p. 36. Also note that jobs were lost more readily in branches and subsidiaries of multi-establishment enterprises that closed between 1980 and 1982. While large firms do not often close headquarter offices, the branch closure rate increased 300 percent between 1980 and 1982, compared to the 1978-1980 period.

(5)"The State of Small Business": A Report of the President Transmitted to the Congress, SBA, March (1984), p. 40.

(6)See "Defense Windfall: Tapping the Soviet Technology," The Wall Street Journal, April 24 and 25, 1985.

(7)See Alan Rugman et al. (1985) and Zenof (1971) among others in the bibliography section.

(8)See footnote 2, p. 38.

CHAPTER TWO

THE INTERNATIONAL SETTING AND THE UNITED STATES POSITION

This chapter consists of three interrelated parts. The first is a historical analysis of the U.S. international position. The second part focuses on factors contributing to the deteriorating position of the U.S. since World War II. Finally, we focus on international patenting and technology licensing activities.

Following World War II the U.S. was in an absolute leadership and dominant role in international business and international transfer of technology. This dominant role began a downward trend with the rebirth of Western Europe and Japan in the late 1950's to mid-1960's. The slower growth rate in the U.S. in one hand and higher growth rates in other industrialized countries had a double declining impact on the international position of the U.S.

Factors responsible for such deterioration are basically science and technology related. The first and foremost is comparative levels of R & D activities. The second, which is directly related to R & D, is comparative numbers of patenting and innovations. The third is international licensing activities.

Generally, R & D activities, patenting, innovations and licensing activities are interrelated and expectations

are that the higher the R & D activities, the higher the patenting and innovations. Also, the higher the first two, the higher the international technology transfers.

THE UNITED STATES INTERNATIONAL POSITION

Because of the enormous technological lead of the United States in the 1950's and 1960's, U.S. multinational corporations (MNCs) had a dominant role in the international transfer of U.S. technology (see Figure 5). The U.S. MNCs have followed a practice of FDI in some foreign markets and licensing in other markets. Some firms, such as Westinghouse, have avoided FDI and have exploited international markets through a combination of licensing and exporting.

Source: Science Indicators--1982; National Science Foundation, 1983, p. 4.

FIGURE 5

DISTRIBUTION OF NATIONAL EXPENDITURES ON RESEARCH AND DEVELOPMENT IN SELECTED INDUSTRIALIZED COUNTRIES

In 1979, the United States had more scientists and engineers actively involved in R & D than France, West Germany and Japan combined. The United States had 66 percent of all R & D scientists and engineers in industrialized countries in 1969; ten years later the U.S. share was 57 percent. (1)

FACTORS RESPONSIBLE FOR DETERIORATING U.S. POSITION

(a) R & D and Science Factors

During the past twenty years, many of the leading industrialized countries have increased their investments in research and development (R & D) relative to the U.S. The growth rate of their R & D spending as a percentage of their Gross National Product (GNP) has surpassed that of the United States. Some countries (i.e., West Germany) have even spent more than the U.S. and some (i.e., Japan) have closed the R & D gap (see Table 3 and Figure 6).

Source: Science Indicators, 1982, National Science Board,
National Sciences Foundation, 1983, p. 7.

FIGURE 6

**NATIONAL EXPENDITURES FOR PERFORMANCE OF R & D's AS A
PERCENT OF GROSS NATIONAL PRODUCT BY COUNTRY**

An examination of annual growth rates of national R & D expenditures in constant terms shows that the United States lagged behind most other countries during the 1970's. In the mid to late 1970's, the U.S. growth rate of R & D expenditures in real dollars averaged 2 percent compared to 6 percent for Japan, and 4 percent for West Germany. (2)

TABLE 3
NATIONAL EXPENDITURES ON R & D AS A PERCENT OF
GROSS NATIONAL PRODUCT (GNP)

By Country 1961-1982						
Year	France	West Germany	Japan	United Kingdom	United States	USSR
1961	1.38	1.25a	1.39	2.45	2.73	2.64a
1966	2.06	1.81	1.46	2.31	2.89	2.88
1970	1.91	2.18	1.81	2.22b	2.63	3.23
1975	1.80	2.38	1.96	2.05	2.27	3.69
1980 (prel.)	1.85	2.65	2.18	2.2c	2.38	3.67
1981 (prel.)	1.97	2.68	2.36	2.47d	2.45	3.66
1982 (est.)	NA	NA	2.78d	NA	2.58	3.65
% change (1961-1982)	+43%e	+114%e	+100%	+.85%e	-5.5%	+38%

Notes: (a) 1962 data; (b) 1969 data, (c) 1979 data from OECD Science & Technology Indicators (Paris, 1984), p. 75.; (d) 1978-1982 (Japan) data from Science & Technology Agency, Japan, JAPAN 1984, Keizai Koho Center, Japan Institute for Social & Economic Affairs, p. 26; (e) % change for France, West Germany and United Kingdom are for 1961-1981 period.

Source: Calculated by author from: a) Science & Technology Indicators 1982, NSB, National Science Foundation 1984, p. 195; b) see note (d) above; c) see note (c) above.

A closer look at the above statistics indicates that all countries have increased their R & D spendings with the exception of the United States during the 1961-82 period. In fact, the U.S. spending declined by 5.5%; during the

same period West Germany and Japan had the highest growth rates (114% and 100% respectively).

Since the mid-1970's the import share of U.S. consumption has risen, and from 1970-1980 the U.S. market share in high R & D-intensive industrial products has declined(3) (Aircraft, 12.9%; Electronics, 12.2%; and Jet Engines, 8.4%). Recent U.S. balance of payments statistics show that the trade deficit for 1984 was more than \$107 billion. The U.S. trade with West Germany has shown a deficit in chemicals and machinery products and equipment. The negative balance with Japan began to worsen in 1974. By 1978, the deficit in R & D-intensive products was \$5.7 billion--ten times what it had been in 1974.(4) Table 4 shows the overall U.S. trade balance in R & D-intensive and non-R & D-intensive manufactured products for 1960-80 period.

TABLE 4

U.S. TRADE BALANCE IN R & D (INTENSIVE AND
NON-INTENSIVE) MANUFACTURED PRODUCT GROUPS: 1960-80

<u>Year</u>	(Dollars in Millions)	
	<u>R & D-Intensive Balance</u>	<u>Non-R & D-Intensive Balance</u>
1960	5,891	-179
1965	8,148	-2,027
1970	11,772	-8,285
1975	29,344	-9,474
1980	52,404	-22,464

Source: Extracted from Appendix Table 1-24, Science Indicators, 1982, N.S.F. 1983, p. 214.

The losses in the U.S. market share were gained largely by Japan, West Germany, and France. A comparative change in the world export shares of R & D-intensive products show that the U.S. share declined from 35% in 1955 to 19% in 1980, while the combined share of Japan, West Germany, and France increased from about 20% to 43% during the same period (see Figure 7).

Source: Science Indicators--1982, National Science Board, National Science Foundation, 1983, p. 23.

FIGURE 7

COMPARATIVE CHANGES IN WORLD EXPORT SHARE OF
R & D-INTENSIVE PRODUCTS

(b) Productivity in Manufacturing--International Comparison

Productivity growth in the economy in general and in the manufacturing sector in particular is directly related to R & D spending and is another important factor

contributing to the international competitiveness of a country. The United States lagged behind all other industrialized countries during the past decades.

Table 5 shows the productivity growth in manufacturing industries for selected countries during 1960-1982 period. During this period Japan and France had the highest growth rate (480% and 207% respectively) and the U.S. had the lowest growth rate (72%).

TABLE 5

PRODUCTIVITY GROWTH IN MANUFACTURING INDUSTRIES
1960-1982 (Index: 1977 = 100)

Year	United States	France	West Germany	Japan	United Kingdom	USSR
1960	60	39.8	40	22	55.6	55.9
1965	74.5	51.2	53.8	33.1	67.0	68.6
1970	79.1	70.1	68.2	61.4	80.5	77.6
1975	93.4	87.9	89	85.3	94.6	96.3
1980	101.7	112.6	109.8	125.4	108.1	104a
1981	104.6	114.4	112.8	126.3	114.2	NA
1982	103.6	122.3	114.7	127.6	118.2	NA
% change (1960-1982)	+72.6%	+207%	+187%	+480%	+112.6%	86%b

Notes: (a) 1979 data; (b) change is related to 1960-80 for USSR

Source: Calculated by author from Science Indicators 1982, NSB, National Science Foundation 1983, p. 212.

Productivity (output per employee hour) in United States manufacturing leaped sharply upward in the year ending 1983, the most recent one for which data are available. The rise was so sharp as to exceed that of any year back to 1950 except for 1962-1963 when a rise of more than 7% was recorded. A crucial factor will be the pace at which manufacturing output continues to expand.

As a result of the sharp jump in United States productivity, it held second place in the ranking of the seven major manufacturing countries in the world. By contrast, it was next to last in the year before and in the ten year interval, 1973-83(5) (see Figure 8).

Ja=Japan; Fr=France; It=Italy; WG=West Germany; UK=United Kingdom; US=United States; Ca=Canada.

Source: "World Business Perspective No. 81," The Conference Board, August 1984.

FIGURE 8

PRODUCTIVITY IN MANUFACTURING:
A NEW COUNTRY ALIGNMENT?

Finally, a comparison of real gross domestic product (GDP) per employed (Table 6) indicates that the gap which existed between the U.S. and other industrialized nations in the 1950's drastically has narrowed (i.e., Japan's real GDP as a percent of the U.S. GDP increased from 17.5% in 1950 to 74.5% in 1982 -- 325% increase).

TABLE 6

REAL GROSS DOMESTIC PRODUCT(1) PER EMPLOYED PERSON FOR
SELECTED COUNTRIES COMPARED WITH THE UNITED STATES:
1950-82

(Index, United States = 100)						
Year	United States	France	West Germany	Japan	United Kingdom	Canada
1950	100	43.9	39.6	17.5	53.1	84.3
1955	100	47.0	47.7	21.1	51.9	87.6
1960	100	55.7	60.2	26.9	53.7	88.1
1965	100	62.0	64.0	34.9	51.8	87.1
1970	100	73.5	75.0	52.0	56.5	91.9
1980	100	93.2	92.4	70.9	62.3	94.0
1981	100	93.5	92.4	72.5	62.8	94.3
1982	100	95.5	93.8	74.5	65.7	93.5

(1) Output based on international price weights to enable comparable cross-country comparisons.

Source: Science Indicators -- 1982, National Science Foundation, U.S. Government Printing Office, Washington, D.C. 1983.

(c) Patents-International Comparison

Patents granted also are used as another indicator of a country's R & D spending and technological competitiveness. In terms of total number of patents, Western Europe combined had 33,927 new patents in 1973 which increased to 73,337 in 1983 (+116%). The numbers for Japan were 18,410 in 1973 and 54,701 in 1983 (+197%). Not surprisingly, the number of patents was 74,139 in 1973 in the United States and had declined to 56,862 in 1983 (-30%). (6)

A breakdown of total number of patents by nationality of inventors for the United States, EEC and Japan is, perhaps, more meaningful. Table 7 shows patents granted in selected countries by nationality of inventors for 1970-1980 period. During this period, patents granted in the U.S. to U.S. nationals declined from 47,073 in 1970 to 37,152 in 1980 (-21%) and in the EEC patents granted to their individual country nationals declined from 36,565 to 24,965 (-31.7%). In Japan, on the other hand, patents granted to Japanese nationals increased by 78% (from 21,403 in 1970 to 38,038 in 1980).

During the same period, foreign patents granted to U.S. nationals numbered 48,807 in 1970, declining to 31,301 in 1980 (-36%). On the other hand, patents granted to foreign nationals increased from 17,354 to 24,675 (+42%). If patents are any indicators of a country's degree of

inventiveness, the U.S. has become relatively less inventive, at least, compared to Japan.

One implication of such patenting activities is that U.S. corporations can utilize foreign patents as another source of new technology. Even though the number of patents has declined in the EEC, still the 24,965 EEC specific patents in 1980 is a fairly large number as a source of new technology. When one adds this to 38,038 patents in Japan in 1980, it becomes apparent that foreign sources of new technology are almost 170% more than U.S. sources (63,003 for EEC and Japan combined as opposed to 37,152 for the U.S. in 1980).

As noted above, U.S. patents granted to foreign nationals showed an increase of 42% between 1970 and 1980. This means that foreign inventors are becoming more interested in exploiting the U.S. market and for that reason they protect their inventions and property rights in the U.S. The U.S. firms could also utilize these sources which have already indicated that they are interested in entering the U.S. market. More will be said about motivations of foreign nationals for patenting in the U.S. in this chapter.

TABLE 7

**PATENTS GRANTED IN SELECTED COUNTRIES BY NATIONALITY
OF INVENTOR: 1970-80**

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
United States											
Total	84,887	78,218	74,808	74,136	76,276	71,884	76,886	88,889	88,182	88,888	91,887
Granted to nationals	47,679	46,988	51,518	51,801	50,843	48,803	44,182	41,383	40,879	30,806	37,188
Granted to all foreigners	17,384	22,388	23,293	22,838	25,832	25,381	28,074	23,888	25,123	18,248	24,878
Foreign patents granted to U.S. ¹	48,807	48,848	49,828	43,328	38,880	38,300	38,088	38,477	38,848	32,791	31,881
West Germany											
Total	12,887	15,148	20,800	23,834	20,838	18,388	20,888	21,748	23,514	22,834	20,188
Granted to nationals	8,388	8,288	9,842	11,191	9,783	9,077	10,388	10,818	11,881	10,888	9,888
Granted to U.S.	2,882	4,388	4,878	4,948	3,813	3,140	3,338	3,488	3,818	3,718	3,211
Granted to all foreigners	6,801	9,884	10,888	12,743	10,748	9,213	10,870	10,834	11,883	11,838	10,388
U.S. patents as percent of foreigners	44.3	44.8	41.8	38.8	38.4	34.1	31.8	31.8	32.0	31.8	31.8
Japan											
Total	30,878	38,447	41,484	42,338	38,838	46,728	40,317	52,808	48,804	44,104	48,188
Granted to nationals	21,403	24,788	28,101	30,837	30,878	38,888	32,488	43,047	37,848	34,883	38,888
Granted to U.S.	4,774	8,700	8,848	9,488	4,432	4,818	4,038	4,884	4,014	4,825	3,888
Granted to all foreigners	8,478	11,882	12,383	11,381	8,783	8,738	7,882	8,881	7,888	9,241	8,874
U.S. patents as percent of foreigners	80.4	48.8	48.2	48.2	50.8	80.8	81.3	81.1	81.1	80.0	48.1
United Kingdom											
Total	40,888	41,384	42,784	38,844	37,808	40,888	38,787	38,848	40,823	38,800	23,804
Granted to nationals	10,343	10,378	10,118	9,267	8,871	8,180	8,888	7,722	8,484	4,182	8,188
Granted to U.S.	12,788	12,882	13,001	11,717	10,878	11,487	11,034	10,430	11,880	8,881	8,738
Granted to all foreigners	30,888	31,178	32,678	30,487	28,837	31,888	30,842	28,827	32,388	18,818	18,848
U.S. patents as percent of foreigners	41.8	40.7	39.8	38.4	38.1	38.4	38.8	38.1	38.1	38.8	38.1
France											
Total	28,287	31,488	48,217	27,838	34,728	14,380	28,784	31,048	30,830	34,818	28,888
Granted to nationals	17,788	13,888	10,787	10,817	9,382	4,882	8,430	8,381	8,888	8,848	8,438
Granted to U.S.	8,884	11,878	11,388	8,047	4,719	2,881	8,171	8,871	8,818	8,338	8,881
Granted to all foreigners	8,888	37,788	38,488	17,188	18,488	8,788	21,384	22,384	22,467	17,772	19,888
U.S. patents as percent of foreigners	88.3	21.7	31.8	28.8	28.8	28.8	28.8	38.4	38.8	28.8	28.4
Canada											
Total	28,188	28,348	28,388	21,348	21,287	20,844	21,788	20,788	21,788	23,548	23,888
Granted to nationals	1,388	1,887	1,881	1,218	1,388	1,388	1,301	1,381	1,404	1,408	1,308
Granted to U.S.	18,883	17,888	17,288	12,884	12,788	12,288	12,411	11,881	12,488	13,387	13,388
Granted to all foreigners	27,788	27,888	28,744	20,088	19,818	19,284	20,448	19,302	20,388	22,138	22,388
U.S. patents as percent of foreigners	87.1	88.1	84.8	84.7	84.2	83.4	80.7	81.2	81.1	80.8	88.8
Other EEC countries²											
Total	28,184	24,388	24,782	28,280	23,341	22,278	21,713	22,808	18,348	18,387	13,418
Granted to nationals	2,078	2,088	2,188	2,074	1,888	1,788	1,788	1,881	1,788	1,848	1,543
Granted to U.S.	8,878	8,348	8,287	8,071	8,788	8,488	8,384	8,888	8,888	4,848	3,888
Granted to all foreigners ³	24,048	22,388	22,688	23,208	21,472	20,817	19,888	20,888	17,878	14,788	11,873
U.S. patents as percent of foreigners	87.7	38.8	27.8	28.8	28.8	28.8	34.8	38.7	38.8	27.8	28.8

(1) Includes patents granted to U.S. inventors by all the countries shown here (West Germany, Japan, the United Kingdom, Canada, and "other EEC countries"). Patents granted by France are not included due to the wide fluctuations in French patents granted to foreigners.

(2) Other European Economic Community (EEC) countries included here are Belgium, Denmark, Ireland, Luxemburg, and the Netherlands. Comparable data for Italy are not available.

(3) Based on each country as a unit rather than the group of nations as a unit. For instance, patents granted to Denmark by the Netherlands are considered as non-resident or foreign patents here.

Source: "Science Indicators -- 1982," National Science Foundation, 1983 and World Intellectual Property Organization, Geneva, Switzerland.

Various factors influence the level of patenting activities in different industries and different countries. The high-tech status of industries, the maturity of industries, and the level of "innovations" as opposed to patents are among the factors having direct impact on patenting activities.

Source: Franklin, J.J., "Patent Statistics as Technology Indicators: Analysis of The Patenting of Multi-national Enterprises Selected From the U.S.A., Japan, and West Germany in Pharmaceutical and Electrical Power Systems Industries," Unpublished M.S. Thesis, Georgia Institute of Technology, March (1983), p. 16.

FIGURE 9
HIGH-TECH STATUS OF INDUSTRIES

Source: Franklin, J.J., "Patent Statistics as Technology Indicators: Analysis of The Patenting of Multi-national Enterprises Selected From the U.S.A., Japan, and West Germany in Pharmaceutical and Electrical Power Systems Industries," Unpublished M.S. Thesis, Georgia Institute of Technology, March (1983), p. 16.

FIGURE 10
INDUSTRY MATURITY

There are various other factors having impacts on patenting activities and there are various other explanations for the existence of the above patterns:

U.S. corporations have been using more of the trade secret and innovations instead of patenting. The propensity to use patent or to use trade secret differs among industries, firms and inventions:

The propensity to patent is highest in industries, such as the drug industry, where technical advances can be easily copied by competitors, and lowest where they are technically difficult to imitate or where technological advances occur very rapidly. Therefore, one would expect that trends in patenting activity would vary among industries and product fields. However, this does not seem to be the case. Patenting activity by U.S. inventors has decreased in almost all product fields, and therefore, the U.S. drop in patenting may actually indicate a decrease in the production rate of U.S. inventions rather than being primarily attributable to increased use of trade secrets.(8)

The pattern of industrial R & D activities in OECD countries. While the U.S., England and France have given a higher priority to defense-related R & D, Japan and West Germany have spent more on industrial R & D, also U.S. overseas R & D and U.S. affiliates of foreign parents R & D activities.

The status change of an industry (R & D versus non-R & D-intensive) and the maturity of the industry as determinants of patenting activities (Figures 8 and 9).(9)

Foreigners have increased their patenting in the U.S. because of certain characteristics of the U.S. market.

It can be argued that both market pull and technology push are strong forces influencing foreign patenting activity. Perhaps economic promise is a strong determinant factor of the level of foreign patenting in general, while technological inventiveness determines product areas in which foreign patenting occurs.

In the period 1979-1981, in each of the four different product fields, almost half of all U.S. and medicines, primary metals, aircraft and parts (including engines and turbines), and textile mill products. Foreign inventors were granted 40

percent or more of the U.S. patents in four additional fields. Some of these foreign patents are assigned to U.S. organizations or individuals. For example, although 49 percent of all U.S. patents in the field of drugs and medicines are granted to foreign inventors, 14 percent of these foreign-origin patents are actually owned by U.S. entities. U.S. ownership of foreign-origin patents is significant in the product fields of chemicals, drugs, communication equipment, and petroleum and natural gas extractions. Many of these are associated with industries in which there are high levels of U.S. direct investment abroad. It is very possible that U.S. research efforts abroad produced many of these patented inventions and that they are produced by foreigners working for U.S. firms. (10)

(d) U.S. International Technology Licensing

Finally, to show the significance of international licensing of technology and its importance to the United States, we look at the U.S. International Transactions of Royalties and Fees. (7) In 1983, the total amount of such transactions (receipts and payments) was \$8.3 billion of which \$7.85 billion was the U.S. receipts of royalties and fees. Perhaps the statistics published by the U.S. Department of Commerce is the only publicly available information on international licensing of technology. The statistics (see Table 8) clearly indicate the importance of U.S. multinational corporations (MNCs) as licensors in the international transfer of technology. Also, notice the significance of "internal" technology transfers (from U.S. parents to foreign affiliates) as opposed to "external" transfers (from U.S. corporations to unaffiliated foreign corporations.)

Historically, the ratio of royalties and fees (unaffiliated/affiliated receipts) has been low and constant (approximately 25%) in the U.S. But, the same ratio of payments by U.S. firms during 1975-1983 period has been 1.15 or 115%. One implication is that during that period, payments by U.S. corporations have been growing faster than their receipts. This indicates that U.S. firms are buying more technology through licensing arrangements from unaffiliated foreign corporations. Particularly during 1982 and 1983 the growth rates of these payments were 370% and 165% respectively.

While U.S. corporations involved in international licensing of technology were receiving about 1/4 of their royalties and fees from unaffiliated sources, at the same time, they were paying three times higher than affiliated sources to unaffiliated sources in foreign countries. If these ratios are used as indicators of licensing activities, then one realizes that most of the U.S. firms' licensing operations (as licensor) are with their affiliates in foreign countries. During the same period (1975-1983), payments by U.S. licensees to unaffiliated licensors have been greater than payments by U.S. licensees to their foreign affiliates.

TABLE 8

**U.S. INTERNATIONAL TRANSACTIONS OF ROYALTIES AND FEES
(MILLIONS OF DOLLARS)**

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Receipts:										
Fees & Royalties from affiliated foreigners	3070	3543	3531	3883	4705	4980	5780	5794	5561	6275
Fees & Royalties from unaffiliated foreigners	751	757	822	1037	1180	1204	1305	1490	1572	1579
Total	3821	4300	4353	4920	5885	6184	7085	7284	7133	7854
Annual Growth Rate (%)		12.5	1.2	13.0	19.6	5.0	14.6	2.8	-2.0	10.0
Payments:										
Fees & Royalties to affiliated foreigners	-160	-287	-293	-243	-393	-523	-428	-435	72	-170
Fees & Royalties to unaffiliated foreigners	-186	-186	-189	-262	-277	-309	-297	-289	-267	-282
Total	346	473	482	505	670	832	725	724	339	452
Annual Growth Rate (%)		36.7	1.9	4.7	32.6	24.2	12.8	0.0	-53.0	33.5
Total Receipts & Payments	4167	4773	4835	5425	6555	7016	7810	8008	7472	8306

Source: Compiled from various issues of "Survey of Current Business,"
U.S. Department of Commerce.

TABLE 9

**U.S. RECEIPTS AND PAYMENTS OF ROYALTIES AND FEES
(Unaffiliated/Affiliated Ratio)**

	1976	1977	1978	1979	1980	1981	1982	1983
Receipts:								
Annual ratio of unaffiliated/affiliated	.23	.27	.25	.24	.23	.26	.28	.25
Payments:								
Annual Ratio of unaffiliated/affiliated	.64	1.08	.70	.59	.69	.66	3.7	1.65
Receipts: Annual average ratio 1976-1983 period:	.246							
Payments: Annual average ratio 1976-1983 period:	1.15							

Source: Calculated by author from various issues of "Survey of Current Business," U.S. Department of Commerce.

THE GAP BETWEEN PATENTING AND LICENSING ACTIVITIES

A closer look at Table 7 shows that the U.S., the EEC, and Japan have approximately equal patenting activities and almost half of U.S. patents have been granted to foreign inventors. If patents are indicators of a country's degree of inventiveness and technological advancements, logically one expects to see a more balanced international technology transactions. This means that the ratio of U.S. payments to receipts of royalties and fees (unaffiliated) should be approaching unity. With Western Europeans and Japanese gaining in patenting activities and with U.S. losing, then the U.S. payments should be increasing at a faster rate

than its receipts. The U.S. Department of Commerce data do not show that such a trend exists. In fact, the ratio of payments to receipts (unaffiliated) for U.S. during 1977-83 has decreased from 25% to 18%. Also, the overall ratio of U.S. payments to receipt declined from 10% to 5% during 1977-83 (Table 10).

TABLE 10
U.S. PAYMENTS/RECEIPTS OF ROYALTIES AND FEES
(1977-1983)

	1977	1978	1979	1980	1981	1982	1983
Payments/Receipts (affiliated)	.06	.08	.10	.07	.07	.01	.03
Payments/Receipts (unaffiliated)	.25	.23	.25	.23	.20	.17	.18
Payments/Receipts (total)	.10	.11	.13	.10	.10	.05	.05

One explanation of such a contradiction might be related to the fact that the U.S. corporations are not utilizing the foreign sources of technology to the extent that they should. This, in turn, might be due to various reasons: (1) U.S. ignorance of such foreign sources; (2) Absence of a "mechanism" to increase the U.S. awareness as well as to facilitate the "reverse" transfer of technology; (3) Although other countries' grow faster than U.S., still not enough to close the gap; and (4) Foreign direct investment in the U.S. which has increased drastically in

recent years. U.S. Department of Commerce data do not show that this is the case.

TAPPING SOVIET BLOC TECHNOLOGY

Over the years, several hundred large U.S. multinational corporations (MNCs) have been actively scanning international markets on a continuing basis and have acquired patents and know-how from foreign licensors. These U.S. licensees have not limited themselves to the U.S. allies as their foreign sources of technology. They have actively sought and acquired technology from communist bloc countries, especially the USSR and the People's Democratic Republic of Germany (see Trident Motors Incorporated of Columbus, Ohio).

Soviet technology acquired by several U.S. companies in the 1970's, mainly through technical exchanges, is just now being developed for a variety of U.S. military applications. These range from improved armored vehicles and jet fighter engines to better radar equipment, communication systems and even beam weapons. (11)

THE TRIDENT MOTORS INC. CASE

"A small Columbus vehicle manufacturer writes a new chapter today in international economic cooperation." (1) The Company recently signed a contract to assemble and distribute a small, multi-purpose truck built by a state-owned East German company. The agreement is very significant because it represents the first ever joint manufacturing effort in the United States between the Communist-bloc nation and an American company.

According to Denny Vincent, Trident's vice president, the Company should be able to eventually manufacture the truck with Ohio-built parts and create 300 to 500 jobs by the end of the 1980's

The Ohio Department of Development's International Trade Division was instrumental in introducing the German company to Trident. The Department earlier had introduced Trident to a light-weight British engine for a three-wheeled truckster used for refuse collection, grounds maintenance and by police departments.

Trident estimates that approximately 3,000 trucks a year will be sold by 1989 and the truck will be very popular because it is very economical (approximately \$24,000) and does more functions than existing large dump trucks. The German truck will do a variety of functions year-round, and various municipalities with budgetary constraints would be able to save tremendously.

The East German truck is widely sold throughout Europe and highly regarded for its compact size, maneuverability and ability to perform a number of tasks such as plowing snow, hauling refuse and spreading gravel.

(1) The Columbus Dispatch, December 9, 1984, p. 12A.

The above statistics not only show the importance of international transfer of technology, but at the same time are alarming to the U.S. businesses and governmental bodies because of the impacts that such diffusions have upon the U.S. competitiveness and industrial technology in the future. Also, equally important is the implication of the deterioration of U.S. technology on national security and the technological dependence of the U.S.

SUMMARY

To summarize, the post-war dominant role of the United States in international business and international transfer of technology began to deteriorate in the late 1950's and 1960's. Various factors were found to be responsible for such deterioration:

1. The decline in the U.S. share of world scientists and engineers (from 66% in 1969 to 57% in 1979).
2. The growth rate in Research and Development by other industrialized countries surpassed that of the U.S. in many cases (see Table 4 and Figure 6).
3. The shift in the world industrial structure and relative growth of other industrialized countries relative to the U.S.
4. The productivity growth in manufacturing industries of the U.S. also deteriorated relative to other industrialized countries (see Table 5).

TABLE 11

ACTIVE SOVIET LICENSES IN THE UNITED STATES

<u>Technology</u>	<u>Sold To</u>	<u>Date Approx.</u>
Surgical Stapling Instruments	U.S. Surgical Corp. 3M	1964
Hydraulic Rock Crusher	Joy Manufacturing	1969
Pneumatic Underground Punch "Hole Hog"	Allied Steel & Tractor	1971
Evaporative Stave Cooling of Blast Furnaces	Andco Eng.	1972
Aluminum Silicon Alloy	Ethyl Corp.	1973
Production of Hollow Ingots by Electroslag Remelting	Cabot	1973
Flux Cored Electrodes	Chemetron	1974
Magnetic Impact Bonding	Maxwell Lab.	1974
Drug Pyroxan for Treating Central Nervous System Disorders	American Home Products	1974
Ethnozin for Treating Cardiac Arrest	Dupont	1974
Electromagnetic Casting of Aluminum	Kaiser Aluminum Reynolds Aluminum Alcoa	1975
Carboxide Insect Repellant	American Home Products	1975
In Situ Underground Coal Gasification	Texas Utilities Services, Inc.	1975
Carminomycin and Ftorafur Anti-Cancer Agents	Bristol Myers	1976
Bulat Process for Titanium Nitriding	Multiarc Vacuum Systems	1979
Flash Butt Welding of Large Diameter Pipes	J.R.McDermott	1980
Electromagnetic Casting of Copper Alloys	Olin Brass	1980
Cone Crusher	Rexnord	1981
Air Column Separator	Air Products	1981
Medical Preparation Riocidin	Ciba Geigy USA	1982
Biodegradable Polymer Pin for Orthopedics	Medo	1982

Source: John Kiser III, "Tapping Soviet Technology," in Common Sense in U.S.-Soviet Trade, American Committee on East-West Trade (1983), p. 106.

5. The increase in the patents granted to other industrialized countries (i.e, 197% for Japan) and a sharp decline for the U.S. (-40%).(12)
6. A comparison of the ratio of licensing receipts and payments on one hand, and the international patenting activities on the other hand, indicate that U.S. corporations are not utilizing foreign patents and technology to the extent that they should.
7. The changes in the ratio of unaffiliated/affiliated receipts and payments of fees and royalties indicate that U.S. corporations have bought more technology from unaffiliated sources than they sold to unaffiliated sources during 1975-1983 period (see Table 10).
8. The scientific and technological cooperation between U.S. corporations and the Soviet Union and other Eastern bloc countries have resulted in more licensing activities by U.S. multinational corporations utilizing Soviet bloc technology (Table 11 and Trident Motors Inc. case).

In the next chapter, we discuss the internationalization process of business with particular focus on licensing. We also discuss cases for and against licensing, licensing motivations, and compare reverse licensing with reverse investment.

ENDNOTES

- (1) Science Indicators 1982, National Science Board, National Science foundation (1983), p. 4.
- (2) Ibid., p. 7.
- (3) Ibid., p. 22.
- (4) Ibid., p. 23.
- (5) "Productivity in Manufacturing--A New Country Alignment?" World Business Perspective No. 81, The Conference Board, August 1984.
- (6) "Industrial Property Statistics," World Intellectual Property Organization, 1983.
- (7) Royalties and fees (a raw measure of international transactions) show the international licensing transactions and are generally published in the June issue of "Survey of Current Business--A Publication of U.S. Department of Commerce."
- (8) Ibid., p. 8.
- (9) Franklin, J.J., "Patenting Statistics as Technology Indicators: Analysis of The Patenting of Multinational Enterprises Selected from the U.S.A., Japan and West Germany in Pharmaceutical and Electrical Power Systems Industries," unpublished M.S. Thesis, Georgia Institute of Technology, March 9 1983), p. 16.
- (10) See 1, p. 14.
- (11) "Defense Windfall: Technology Purchased From the Soviets Starts to Yield Military Uses," The Wall Street Journal, April 24, 1985, p. 1. Also see The Wall Street Journal, April 25, 1985. Both of these give various examples of how U.S. corporations can and have exploited the technology acquired from the USSR.
- (12) The decline since 1971 has been 40%. See Science Indicator 1982, p. 13.

CHAPTER THREE

THE INTERNATIONAL TECHNOLOGY LICENSING

In the preceding chapter, we examined the international licensing position of the United States. We evaluated the factors contributing to the deteriorating position of the U.S. The statistics showed that there existed a contradiction between the international patenting activities and international licensing fees and royalties.

The contradiction arose when we saw that other OECD countries had surpassed the U.S. in terms of patenting. This implies a significant increase in reverse flow of technology into the U.S. But the data on licensing fees and royalties did not support the expectations. We came to a conclusion that, perhaps, the ignorance of U.S. corporations about foreign technology or the absence of a "mechanism" for facilitating the reverse flow of technology to the U.S. were among the reasons for such a contradiction.

In this chapter, we first define technology and different types of technology transfer, and the internationalization process of technology. Then, we discuss licensing motivations as well as the cases for and against technology licensing from licensees' point of view.

TECHNOLOGY TRANSFER

DEFINITION

Technology is a perishable resource comprising knowledge, skills, and the means for using and controlling factors of production for the purpose of producing, delivering to users, and maintaining goods and services for which there is an economic and/or social demand.(1)

Technology is distinguished from science. Science organizes and explains data and observations by means of theoretical relationships while technology translates scientific and empirical relationships into practice use.(2)

In order to get a clearer picture of the concept of technology transfer and to see the stages through which an idea passes before it becomes a useful product or process, it is useful to see the 1966 M.I.T. scheme on technology transfer:(3)

FIGURE 11

There are basically two types of technology flows or transfers (horizontal and vertical) and the work of Morton (1968) and Killing (1975) is of particular interest in this regard. Figure 11 shows vertical and horizontal transfer of technology. Clearly, vertical transfer is within a firm

while horizontal transfer is intra-firm (between two separate entities).

Firm One	Levels	Firm Two
1. Basic Research Applied Research	Science	1. Basic Research Applied Research
2. Development & Design	Technology	2. Development & Design
3. Manufacturing Engineering		3. Manufacturing Engineering
4. Manufacturing	Production	4. Manufacturing
Vertical	Horizontal	5. Vertical

Source: J.P. Killing, "Manufacturing Under License in Canada," University of Western Ontario, Canada, 1975, p. 28.

FIGURE 12

HORIZONTAL AND VERTICAL TECHNOLOGY TRANSFER

Technology transfer takes place at three levels within a firm (from basic and applied research to development and design to manufacturing). The transfer between two separate firms (horizontal) also takes place at three levels: (a) Science level; (b) Technology level; and (c) Production level.

(a) Technology Transfer at Science Level

The transfer of technology at this level is the flow of scientific information between scientists and engineers (involved in R & D) of different firms. At this stage, basically abstract ideas are communicated and various means

are used. Rosenbloom and Wolek (1970), in a study of more than 3,000 scientists and engineers involved in R & D laboratories, found that professional journals, books, conferences and conversations with fellow scientists were the means of communicating the scientific information.(4) At this stage, transfer of technology is not managed through license agreements because there is nothing to license. The only way for a firm to become part of this technology transfer process is to hire scientists and engineers capable of entering the dialogue:

If you are to tap the world's science and technology you have to create some science. Your admission ticket to the club is to have something of your own to talk about.(5)

(b) Technology Transfer at "Technology Level"

This is the stage where workable ideas are put into commercially feasible ideas. The information flow is related to a product or process which has not been commercially proven. At this stage, license agreements could be used for the transfer of technology. Patents and formulas exist except they are not yet commercially utilized at this stage.

It is important to note that if a firm is to receive information at this stage (as a licensee), it must have its own development and manufacturing and marketing capabilities. Without such capabilities, the licensee would not be able to develop the product and introduce it

to the market.(6) Technology is not a self-contained physical object that is stored on a warehouse shelf and shipped as a package from the supplier to the user. Technology is a body of knowledge transferred by a learning process. When transfer is from one national environment to another, it can be complex, time consuming, and costly, even when transfers are between units of the same multinational enterprise. The time required, the costs, and the effectiveness of technology transfers will vary with such factors as (1) the nature of technology being transferred, and (2) the characteristics, capabilities, and objectives of the parties involved.(7).

(c) Technology Transfer at "Production Level"

The technology transferred at this level is a commercially proven product or process. The recipient of the technology needs technical information (blue prints, engineering drawings, etc.) to begin the production. Depending upon the complexity of the product or process, this technical information varies. Most licensing agreements take place at this level. At this stage, the licensee knows the technology that will be acquired is a commercially proven one, and enters the contract with some confidence. Even at this level, though the licensee will need some engineering competence, both to evaluate the technology being offered by the licensor, and to adapt this technology to local conditions.(8) The absorptive

capability of the licensee is extremely important in the transfer process. The time required, the expenses, and the effectiveness of the technology transfer vary with the type of technology transferred, the recipient's capabilities, and the relationship between parties. A transfer of automobile technology from a Japan firm to a U.S. firm could occur more rapidly, effectively and relatively inexpensively. A similar transfer to a company in a developing country (Mexico) with a limited supply of trained and experienced personnel could take a longer time and be at a higher cost.

INTERNATIONALIZATION PROCESS OF TECHNOLOGY

The proprietor of a "technology" has a monopolistic power over its "firm-specific" advantage. This firm-specific advantage could be technology marketing skills, or management know-how. The technology and its international transfer are defined in the following sections. Here, the focus is on the various options available to the proprietor for exploiting the technology in the global markets. First, the owner might utilize the technology by producing at home and exporting to other markets. Exporting, being the least risky alternative, is the first step in the "internationalization" process of a firm.

Second, the owner might utilize the technology by producing for global markets in the global markets. The production decisions are made on an international

return/risk trade-off. There will be various production facilities around the world and products reach consumers through a multinational network. The risk associated with this strategy [widely known as foreign direct investment (FDI)] are perhaps the highest and, therefore, the returns should be the highest--at least in theory. This could be possible because the proprietor can "internalize"(9) all the benefits of the technology or the firm-specific advantage.

Allan Rugman et al. (1985) regards the proprietor of the firm-specific advantage (FSA) to be a multinational enterprise (MNE) with monopolistic characteristics. The "advantage" is assumed to be retained within the MNE's organizational structure.(10)

The monopolistic nature of the firm-specific advantage leads, in theory, to excessive profits (or "rents"), but these are reduced by special costs of alternative modes of servicing the foreign markets in which the MNE operates [emphasis mine]. These special costs are inherent in running an internal market; so that the profits of the MNE are always smaller than they would be if an external market for the MNE's firm-specific advantage existed it is clear that the MNE have many rivals, so they are really in a situation of monopolistic competition. In such a market structure excess profits are eliminated by the actions of rival MNEs.

Looking at the performance of the world's largest MNEs, they find no evidence of excess profits. Also looking at the relative choices to be made by the MNE for the exploitation of international markets, they argue that:

the MNE runs the risk of dissipation of its firm-specific advantage if it engages in licensing, since the licensees may be able to resell information about the FSA of the MNE to outside parties or to use it themselves to compete against the MNE.(11)

Extending the Hirsch (1976) model to include licensing and the risk of dissipation discussed earlier, Rugman uses the following variables and notations to show MNEs preference for international market exploitation modes.(12)

VARIABLES IN THE CHOICE OF ENTRY MODE

COUNTRY-SPECIFIC COSTS

C Aggregate production function (home)

C* Aggregate production function (foreign)

SPECIAL COSTS

M* Export marketing costs (goods market)

A* Additional cost of FDI (goods and factor markets)

D* Risk of dissipation of firm-specific advantage (risk of lost sales and costs of enforcement of licensing agreement)

The MNE has to choose among alternatives for servicing foreign markets:

1. Export if $C + M^* < C^* + A^*$ (Exporting is cheaper than FDI) and $C + M^* < C^* + D^*$ (Exporting is cheaper than licensing).
2. FDI if $C^* + A^* < C + M^*$ (FDI is cheaper than exporting and $C^* + A^* < C^* + D^*$ (FDI is cheaper than licensing).
3. License if $C^* + D^* < C^* + A^*$ (Licensing costs are

less than FDI) and $C^* + D^* < C + M^*$ (Licensing costs are less than exporting).

Figure 12 summarizes the previous discussion about the alternatives open to the MNE for international market exploitation. (13)

Source: Allan Rugman et al. (1985), p. 130.

FIGURE 13

FLOW CHART OF THE FOREIGN INVESTMENT DECISION PROCESS

Rugman argues that if markets are perfect (no imperfections such as information cost or barriers to trade), exporting is the first option. If markets are "imperfect" (i.e., tariffs or other trade barriers) and if there exists the risk of dissipation of firm-specific advantage, foreign markets are best served through FDI. If such risks are non-existent, but the host nation imposes regulations on the MNE which are greater than the benefits of FDI, then the MNE would license its firm-specific advantage (i.e., technology) to a foreign licensee. The license fees are usually greater to the licensee than the MNE's subsidiary because with the subsidiary, such risks are non-existent. (14)

The third option available to the owner is "Joint Venture." Even though the owner of technology wants exclusive exploitation of the technology ("internalization" or FDI), various barriers and regulations might force the owner into the joint-venture operations.

"Licensing" might be used to utilize the ownership-specific advantage (technology), by allowing the "licensee" to utilize the technology under certain conditions for a specific period of time, and for a specified price--license fees or royalties. A subset of licensing strategy will be the focus of our research endeavor.

Finally, with the complexities in international operations and external and internal constraints on MNCs, the traditional market entry strategies (i.e., FDI, licensing, international trade) might be used in various combinations.

THE INTERNATIONAL PRODUCT LIFE CYCLE (IPLC)

According to the Product Life Cycle (PLC), Vernon, (1966), a product is first introduced in the domestic market (U.S.) where the firm sees a demand for the product. At this stage, the product may be unstandardized, the inputs may vary, and the manufacturing processes may fluctuate. Because of these uncertainties, the firm needs to be close to its customers, suppliers and even competitors. At the second stage, with increased production and overseas demand, the product is "exported"

to overseas markets (usually other developed countries). At the next stage of PLC, when the product is "matured," the need for flexibility in the manufacturing process declines. The firm can make a long-term commitment because of reduced uncertainties and with the economics of scale product cost takes a precedence over product characteristics. At the final stage when the product is "standardized" due to over seas competition, multiple product facility will be utilized. At this stage because of cost consideration the production will be shifted to where the costs are the lowest (LDCs). The investment in LDCs is usually envisaged to be "vertical integration" where the parent company (a U.S. firm) provides the inputs and buys the output for global distribution. The home market now is served through imports. The empirical test of PLC for about 140 categories of nondurable consumer goods has found it to be generally valid.(15)

Source: Alan M. Rugman et. al., International Business, Firm and Environment, McGraw-Hill (1985), p. 44.

FIGURE 14

THE INTERNATIONAL PRODUCT LIFE CYCLE

When the proprietor of a technology is a large firm, it has enough resources and expertise to exploit international markets using various entry methods, namely export, FDI and licensing. But when the proprietor is a small or medium-sized company with limited resources and perhaps limited international exposure, the opportunities for exploitation of international markets are also limited. Because of the firm's limited resources or international trade barriers, FDI and foreign sales offices could be ruled out. The only viable option open to the proprietor might be licensing of its technology. An "appropriate" foreign licensee could provide the small to medium-sized licensor with the opportunity to exploit overseas markets

not available otherwise. The following figure depicts licensing at different states of "internationalization."

Source: L.S. Welch, "The International Marketing of Technology: An Interaction Perspective," International Marketing Review (Spring 1985), p. 42.

FIGURE 15

LICENSING AT DIFFERENT STATES OF INTERNATIONALIZATION

MODES OF TECHNOLOGY LICENSING

Despite the motivations of licensors as well as licensee for technology licensing, there are, basically, four key modes. (16)

- (1) Inventor-Corporation: This is a case where the inventor and patent holder is an individual or a small firm. Due to lack of financial resources, the inventor cannot exploit the invention commercially. Consequently, the inventor has to license the invention to a firm with capabilities

conducted. The research and development effort is so extensive and successful that Westinghouse can count on retaining along lead in product development over its licensees, thereby minimizing the risk that the technology transferred will build a dangerous rival, or that the licensees will wish to terminate the relationship at the end of the licensing period.(17)

In some cases, licensing of technology may be the only way of entering a foreign market, particularly when more and more countries limit their import of foreign made products and FDI.

The very carefully structured trade off analysis in international business texts is becoming increasingly obsolete as an ever larger number of countries decide that certain alternatives, such as direct investment, are not available to foreign firms. Regardless of its relative profitability, licensing is likely to become of increasing interest to firms wishing to enter foreign markets, because of the increasing nationalism in many countries.(18)

- (3) Cross-Licensing: This arrangement usually takes place between two firms of similar standing in terms of technological competence. The motivation there is more of having access to the new development of the licensed technology rather than royalty revenues. Instead of asking the licensee to pay for the technology, the licensee's R & D findings will be exchanged for new developments. Cross-licensing is widely practiced, particularly in industries where the R & D costs are very high

and technology is very advanced (i.e., pharmaceuticals).

(4) Inter-Firm Licensing: This type of licensing arrangement is within a firm (vertical) and the motivations vary with the circumstances. Interfirm licensing has become a common practice in multinational corporations. One motive might have to do with political risk in the host country of the MNCs subsidiary i.e., control over transfers of certain types of fund dividends). Other motives might be legal, financial (i.e., avoiding taxes) and/or due to allocation of the parent's R & D expenditure to its subsidiaries. This type of licensing is not central to this research.

LICENSING MOTIVATIONS

The motivations of licensors for licensing their technology are different than those of licensees. In this section, the technology motivations are discussed.

The Licensor

Licensors license their technology for various reasons: (1) to earn extra revenues not otherwise possible, (2) to extend the technology's life (declining in commercial use in the licensor's market), (3) to establish and/or test the market for future direct investment (FDI),

must be considered in royalty and compensation arrangements. Although there might be provisions for such opportunity costs, the licensor cannot be fully compensated for the mere existence of new competition. Particularly, if the licensee achieves technic and marketing competence and with the licensees' other advantages (i.e., location-specific), it becomes almost impossible for the licensor to compete with the licensee.

The Licensee

Unlike the literature on licensors' motivations for licensing, very few scholars have investigated the licensees' motivations for acquisition of technology through licensing arrangements. In this section, licensees' motivations are central to our analysis. Bloxam (1972) argues that the main decision is whether or not to take a license, and summarizes the cases for and against taking a license.

The licensees' motivations for taking license are essentially: (1) to acquire the needed technology and/or to supplement licensee's own in-house R & D activities; (2) to avoid the risks of R & D expenditures because of the presence of the probability of failure; (3) to acquire the right to operate or to settle a patent dispute. The licensee might have developed the technology independent of the licensor but due to existence of a patent on the

to exploit the invention. In this situation the licensor is not in a position to exploit the invention and the licensee has complete control over manufacturing and marketing of the product and pays licensing fees to the licensor.

- (2) Corporation-Corporation: This is the classic licensing situation where a corporation licenses another corporation its technology (patent rights and in many cases with technical know-how) in exchange for a royalty (i.e., percentage of the sales). Of course, licensing in this case is one of many options open to the licensor (i.e., Joint Venture, FDI). Perhaps the licensor chooses licensing because of a relatively low or no commitment of capital and management and a relatively low or no political risk. The licensor's motivation is to increase its profitability and earn extra revenues by capitalizing on licensor's competence (R & D). Of particular interest in this regard, Friedman and Kalmanoff (1961) comment on Westinghouse's licensing program.

Some companies, of which Westinghouse is a prime example, have specialized in licensing as the preferred form of joint venturing. The reason is the disinclination to commit large amounts of capital abroad--especially in view of the capital-intensive nature of the industry and the high cost of new plants--and because of the research program being

(4) to facilitate the payment for the use of the technology by the licensee where the recipient country has established limitations on transfer of dividends, and (5) because of cross-licensing arrangement with the licensee.

Disadvantages to Licensors

(1) Control: Prior to licensing its technology, the licensor attempts to foresee all the issues and problems which might be raised in the future through the licensing agreement. The field-of-use is one source of conflict between the licensor and the licensee. The licensee might be using technology in other fields not accounted for or compensated for in the contract. Another is geographical restrictions (counter to antitrust laws of many countries). The licensee might be exploiting other markets not included in the contract. Although the licensing agreement might have provisions for such happenings, it is very difficult and costly to maintain full control and police the licensed technology.

(2) Competition: The creation of a competitor for the licensor is another disadvantage. The licensee will be competing with the licensor's product not only in the geographical location or markets covered in the contract but in other markets. This is an opportunity cost to the licensor and

technology, he has to acquire a license; and (4) to get the technology (product) to the market faster. The licensee has the capabilities of developing the needed technology (product) but taking a license will expedite the manufacturing and marketing process.

Disadvantages to Licensees

The cases against taking a license are basically: (1) adaptation costs required to utilize the licensed technology; (2) the opportunity costs lost because of lengthy negotiations; (3) the lost advantages of strengthening own R & D and the "Not Invented Here" syndrome by licensees' own R & D team; and finally, (4) the existing patent laws (weak versus strong law) and ability of the technology recipient firm to build around the patented technology.

LICENSING ISSUES

When using licensing as a means of technology transfer or acquisition, various issues must be dealt with. In the following section, we discuss these issues.

(1) The Negotiation Process

In order to reach a final agreement, licensor and licensee spend a fair amount of time in the negotiation process. Various issues and factors such as legal considerations, pricing and compensation arrangements, the contractual agreement, the licensor-licensee relationship

(2) Compensation and Pricing

Each licensing agreement has its own characteristics and depending upon the technology involved, bargaining power of both licensor and licensee, duration of contract, amount of technical assistance provided, geographical location, and field-of-use of the licensed technology, among others, the compensation arrangements vary.

The compensation arrangements in international technology licensing might have inverse impact and create conflict between the parties and the antitrust laws of various countries involved. Various forms of pricing arrangements (i.e., percentage of licensed technology sales or lump sum etc.) might have direct bearing on the profitability of technology licensing from both parties involved. In other words, restrictions contained in the licensing package might change the technology transfer mechanism (i.e., FDI, licensing, etc.).(21)

(3) Legal Considerations

Legal considerations play a vital role in licensing and success and failure of licensing agreements depends on willingness from the licensor and the licensee and the binding contract (legal) between them. In practice, the licensor owns some intellectual property (know-how) and is willing to sell (transfer) this property to the licensee. The licensee, on the other hand, is willing to receive (acquire) the technology for a fee. Willingness and

and cooperation will be discussed and agreed upon. Negotiation on some of the issues will be smooth but some issues will present difficulties in reaching (or trying to reach) a final agreement. Factors which are discussed during the negotiation might be financial, technical, legal, and organizational and governmental.

- (a) Financial factors include valuation of technology, payment conditions (i.e., currency, financing, inflation) and financial participation by licensor.
- (b) Legal factors include applicable laws and arbitration provisions, secrecy obligation of licensee, scope of geographical rights, duration of technical assistance to licensee, and the product liability.
- (c) Organization and institutional factors include private negotiation between the parties involved, home and host government, and international factors (i.e, U.N., Paris Convention).
- (d) Technical factors include separation of items of aggregate (unbundling), performance guarantees, adaptation and modification of technology, quality control, field of use, and cross-licensing arrangements.

cooperation on both parts are critically important. The only legal arrangement which makes parties abide by their promises is the licensing agreement. The patent system, antitrust laws and other legal considerations are not part of this research study.

(4) Licensor-Licensee Relationship

The success or failure of technology licensing directly depends on the relationship between both parties. Prior to licensing arrangements, usually the licensor and licensee have one or another kind of relationship. Aside from parent-subsidiary relationships, the arm's length arrangement could be in the form of export/import agent or distributor. Depending upon the nature of the licensed technology, frequency of communication (daily, weekly, monthly, yearly) might vary and in many cases, the more frequent (daily) communication and the parties' closeness have been identified as the main factor behind the success of many licensing arrangements. (22)

(5) Licensing Agreements

The licensing agreement is the actual written contractual agreement between the licensor and the licensee. It is the legal document which specifies the rights and obligations of each party. Each license agreement usually contains different parts such as the type of licensing agreement, the licensed technology, the

(6) Licensing Impacts

The licensing arrangements have different impacts in the source country (licensor's country) and the recipient country (licensees' country). This research focuses on the impacts of licensing in the licensee's market. These impacts are as follows: Employment Impacts -- the licensed-technology will have impacts on a number of low-skilled, high-skilled, and managerial jobs in the licensee's market; Balance of Payments Impacts -- the licensed technology (product or process) has a direct bearing on exports and imports of a country. Typically, the licensed technology substitutes for the similar imported products but it could have export potential; Societal Impacts -- the licensed technology will use domestic goods (raw materials and products). The licensing arrangements could have positive impacts on the quality of environment, transportation and communication systems, and worker's health and safety; Income Impacts -- the positive result of the above is additional income not only to those directly involved but to the government and the community, not possible otherwise.

REVERSE LICENSING VERSUS REVERSE INVESTMENT

International licensing of technology is an agreement where the owner of a technology (licensor) in one country "licenses" a foreign firm (licensee) the right to make use of the technology for a specified purpose(s) at an agreed

licensing restrictions, the obligations of each party, and the compensation arrangements.

The agreement actually specifies what will be transferred as a result of the contract. The agreement might be for patent rights only, or it might be for patents plus know-how. Typically, the contract is for both the patent rights plus technical assistance by the licensor (as a package or as a separate contract). The license agreement might be for current know-how (technology) and only for one-time. It might be for current plus future developments and on a continuous basis.

The licensing agreement might contain sub-licensing rights as well as grant back arrangements. Sub-licensing right specifies the right of the licensee in the case of transferring or revealing the licensed-technology to a third party. Grant-back arrangements deal with provision for the transfer of improvements on the licensed-technology from the licensee to the licensor.

The restrictions containing the agreement might include geographical, procurement, field of use, cross-licensing, quality control, and modification demanded by the licensee. It also includes compensation arrangements, legal and technical which have been discussed in the earlier part of this chapter.

upon fee. Reverse licensing is when the licensor is a foreign firm and the licensee is a U.S. firm.

Foreign direct investment (FDI) into the U.S. has been increasing rapidly over the past ten to fifteen years. Most states have encouraged FDI into their states ("reverse investment" or "inward investment," as some states call it), by creating foreign investment promotion offices at home or abroad. Tax concessions, leased factories, low interest loans are among the various incentives used by different states to entice inward or reverse FDI. The major rationale for this activity is that it creates jobs and the costs of this activity are less than the cost of benefit payments to the workers who would otherwise be unemployed.

The negative aspects of these foreign investment promotion activities are that (1) the states forego tax dollars; (2) there is beginning to be some political backlash to foreign investment; and (3) the concessions to the foreign investors can be interpreted as creating unfair competition to existing firms in the same industry.

It should also be noted that the foreign firms which invest in the U.S. tend to be large firms (MNCs), and they are relatively few in number. Consequently, most states are chasing after a relatively few number of firms, which are somewhat reluctant to invest fairly large sums under conditions of significant risk.

"Reverse Licensing" Instead of "Reverse Investment"?

There are many small and medium-sized firms abroad which would like to get into the U.S. marketplace. Because they lack required resources (i.e., financial and marketing) and the risks involved, they cannot invest directly in the U.S. But they have other options: (1) They could set up their own sales offices and try to crack the U.S. market by exporting to it, but this is too expensive and risky for most of these firms; (2) They could find an import agent to handle their products for the U.S. market, but this is usually not effective; or (3) They could license a U.S. company to produce the product in the U.S. and market the product, using the U.S. firm's existing marketing channels. This last strategy is usually the most attractive to the smaller and medium-sized foreign firms from the points of view of cost, risk and effectiveness.

Why don't more of these firms look for U.S. licensees?

Most of them don't even think of the idea. The few which do have no "mechanism" to search for a U.S. partner. Why don't U.S. companies actively seek foreign licensors?

The several hundred large U.S. multinational corporations have been doing this for years. They engage in two-way licensing and are actively scanning foreign countries on a continuing basis for new patents for which they might obtain a license of the U.S. market, where the product fits their product line. But the tens of thousands

of smaller and medium-sized U.S. firms never consider this as a strategy, and also would not know how to go about seeking an appropriate foreign licensor.

REVERSE LICENSING BENEFITS

(a) Small and Medium-sized U.S. Firms

Most of these firms are one or several-product companies which spend little or no funds on R & D. Without new and competitive technology, they gradually go bankrupt as their product(s) reaches the end of the life-cycle (PLC). A license agreement (REVERSE LICENSING) is a new lease on life for these firms. It permits an expansion without any R & D expenditure. Last but not least, the costs of royalty payments are related directly to sales and/or profits of the licensee.

(b) Small and Medium-sized Foreign Firms

Thousands of small and medium-sized firms in foreign countries which have the technology would like to enter the U.S. Because of what was discussed earlier and a lack of financial and marketing resources, they cannot reach the U.S. market. There exists no "mechanism" to provide them with the means of reaching their goals. Reverse licensing will provide them with opportunities not possible otherwise.

(c) Public Sector

How should state governments view reserve licensing?

- 1) Since reverse licensing is not as publicly visible as a foreign direct investment, it has no negative political repercussions.
- 2) It does not necessitate tax concessions and other costs by public authorities.
- 3) It can create as many jobs as does reverse investment, and does so more rapidly.
- 4) It is attractive politically because it assists many smaller and medium-sized domestic companies and creates jobs in many localities.
- 5) It is much easier and less costly to promote reverse licensing than reverse investment because the number of potential foreign licensors is very large, and they can make a positive decision more quickly, as their costs and risks are much smaller than is true for the large, direct investment.

We briefly stated and discussed the problem germane to this thesis in Chapter One. There exists an apparent need for a "mechanism" to match two groups of firms. The first group consists of tens of thousands of small and medium-sized U.S. firms which need new and competitive technology to survive. The second group consists of a fairly large number of small to medium-sized foreign firms. These firms have the technology that is needed in the

U.S., but because of huge capital and other required resource, they cannot directly invest in the U.S. We saw that licensing their technology to U.S. firms was a preferred strategy to these firms.

The "mechanism" for matching these two groups of firms is Reverse Licensing. Reverse licensing will provide foreign firms (with abundant supplies of technology) with opportunities to license their technology and reach the U.S. market. Without reaching the U.S. market many of these firms cannot prosper or survive. Reverse licensing will provide them an extension on their lives.

On the other hand, reverse licensing will provide tens of thousands of small to medium-sized U.S. firms with opportunities to get new and competitive technology. Without such technology (at a very competitive price because of competition among overseas licensors), most of these firms cannot survive. Reverse licensing will be their savior providing them with new and extended lives. In short, reverse licensing is an equilibrating mechanism which will match the supply of technology with the demand for that technology.

Before investigating reverse licensing in more detail and developing our research model, we need to review the related literature. We need to find out what others have to say about international licensing. Therefore, the next chapter reviews the literature and gives us more insight

enabling us to draw on our previous discussions and build a model for attacking our problem.

ENDNOTES

- (1) Stefan Robock, The International Technology Transfer Process (Washington, D.C. National Academy of Science, 1980), p. 2.
- (2) G.R. Hall and R.E. Johnson, "Transfers of United State Aerospace Technology to Japan," in S. Robock and K. Simmonds, International Business and Multinational Enterprise, Third Edition (1983), p. 416.
- (3) J.P. Killing (1975), p. 26.
- (4) R.S. Rosenbloom and F.W. Wolek, Technology and Information Transfers (Boston, 1970), p. 52.
- (5) J.E. Goldman, "Basic Research in Industry," in "Manufacturing Under License in Canada," John P. Killing, University of Western Ontario, Canada (1975), p. 30.
- (6) See no. 3, p. 31.
- (7) See no. 1, p. 462.
- (8) See footnote 3, p. 32.
- (9) See, for example, Allan Rugman for a detailed analysis of "Internationalization" vs. "Internalization."
- (10) See Rugman et al. (1985), p. 121.
- (11) Ibid., p. 122.
- (12) Ibid., p. 122. Also see Magee (1977), Buckley and Casson (1976), and Casson (1976) for discussion related to the "Appropriability" issue.
- (13) See Allan Rugman et al. (1985), p. 130. Also see ibid., pp. 126-128 for an interesting net present value (NPV) method for foreign market entry decision. Summary of NPV method is also in the appendix.
- (14) Ibid., (1985), p. 130.
- (15) Polli, R. and Cook, V., "Validity of the Product Life Cycle," Journal of Business, October 1969, p. 385.
- (16) John P. Killing, Manufacturing Under License in Canada, Ph.D. Dissertation, University of Western Ontario, Canada, 1975, p. 1.

(17)W.G. Friedman and G. Kalmanoff, Joint International Business Ventures, New York, Columbia University Press, 1961, p. 152.

(18)See no. 3, p. 20.

(19)G.A. Bloxam, Licensing Rights in Technology, Chapter Three, 1972 in J.P. Killing, Manufacturing Under License in Canada, 1975, p. 24.

(20)Killing, Manufacturing . . . in Canada, p. 24.

(21)Perlitz (1980), p. 53.

(22)See Millman (1983), p. 31.

CHAPTER FOUR
THE LITERATURE REVIEW
OF
INTERNATIONAL TECHNOLOGY LICENSING

Concern over the implications of the international transfer of technology has heightened in the U.S. Scholars, practitioners, congressional committees, and private and governmental institutions have focused on the subject of technology transfer and various related issues. To date, all research of technology transfer has focused on the implications of such transfers from the United States and has taken a licensor's standpoint. In the following section licensing literature will be reviewed and in the following chapter we will take a licensee's standpoint and build on the preceding concepts, synthesize, introduce our research model, and propose our hypotheses.

In the following section, we categorize the literature on international technology licensing into seven broad often interrelated groups:

(1) Technology Licensing Compensations (Pricing)

Farok J. Contractor (1978, 1980, 1983, and 1984) has pursued the subject of technology transfer extensively and most of his works have focused on the pricing, compensation, profitability, and policy implications of licensing from the licensor's viewpoint.(1)

hardly be found. Conflict may occur if the licensor wants to include a minimum sales volume in the agreement; the legality of this is questioned. American, German and European Community antitrust laws generally permit restrictions on the sales volume by the licensor. Only in the situation where these restrictions are part of a general system of restriction of competition are they against antitrust regulations. Finally, the licensor could also restrict the pricing decision of the licensee.(2)

In Brecher (1982), the theory of international trade is extended in order to analyze optimal commercial policy of a country importing technology for which royalties must be paid to foreigners. A basic model is developed that distinguishes between national and aggregate income, which differ by the royalties paid. Policy combinations for maximizing national welfare are derived, and the national gain or loss from introducing trade of technology is assessed. The analysis shows that maximization of national income can be achieved if the home country combines a trade tax with a domestic commodity-market tax or subsidy depending, respectively, on whether the foreign country is a net exporter or importer of the commodity whose technology is licensed internationally. It is also demonstrated that the maximum level of national welfare for the home country might be lower with than without imported technology, if the foreign country exports the technology used to produce the home-exportable commodity.

Orleans (1982) developed a mathematical model for pricing licensing of technology:(3)

Root and Contractor (1981) using a sample of 102 recent licensing agreements in 41 countries made by 39 U.S. firms with independent licensees developed a normative model in international licensing. Actual behavior of managers is compared to the normative model.

In the normative model, both licensor and licensee have floor and ceiling prices determined by a number of actors; the final negotiated price is a point within the overlap between the 2 bid ranges, or the bargaining range. The managers in the sample companies ranked factors considered in negotiating agreements, and regression analysis was used to identify variables systematically influencing compensation. Results indicate that actual negotiation differs from the model in two major respects:

1. The practice of satisficing rather than maximizing behavior on the part of licensors, and,
2. The lack of any explicit or systematic attention to opportunity costs.

Perlitz (1980) investigated the compensation arrangements in international licensing and their impacts on market penetration, pricing policy, and conflicts between licensee and licensor:

International licensing agreements are viewed as an institutional device for the transfer of technology to foreign firms and organizations. As a result, it is worthwhile to study the impact of different compensatory arrangements in international licensing agreements on the market penetration abroad and to illustrate that particular forms of compensation may bring conflicts between the licensor and the licensee. Studies reveal that in practice the most commonly used forms of payment are based on lump sums and royalties paid either as a percentage of turnover or on the basis of dollar per unit. Royalties paid as a percentage of gross margin or as a percentage of profit before or after tax can

The licensing market bears little resemblance to other markets and it would be surprising indeed if the concept of a license price could be properly examined in the context of conventional price theory Utility of a license is the benefit for which the licensee is prepared to pay a purchase price. The utility of a particular license will depend upon the level of production set by a licensee which in turn may depend not only upon the licensee's cost schedule but also upon the way in which the license price is formulated. The net profit to the licensee will be: Revenue--Cost--License price. The profit as such represents a producer's surplus not a consumer's surplus and the producer's surplus is achieved without imposing any new cost on consumers. The profit from the licensed production represents a net addition to the wealth of the economy as a whole In general, the licensor's minimum price and the licensee's maximum price will be different. If both parties are profit maximizers, neither party will wish to concede to the other more than necessary The negotiated price should lie in that permissible range In a strictly two party system, the transaction price being apparently indeterminate. In this situation the licensor is faced with a monopolistic situation and must make the best of it. The situation is entirely changed if there is more than one potential licensee who is competing in the same market. Suppose the licensor's minimum price in a two-party system is P_0 where $P_0 = R^a - C_1 = R_2 - C_2$ where R and C are the revenues and costs of the competing licenses with different production schedules. In this situation, it will be more profitable for the licensor to grant a license than not to do so.

In general, the natural price of an exclusive license will be the limiting price of the second highest bidder, the license going to the highest bidder at that price, $R_1 - C_1$.

Finnegan and Mintz (1978) take a practitioner point of view with regard to the methods for arriving at initial royalty figures for negotiating purposes. These techniques are:

- (a) Viewing royalty as the minimum return that the licensor reasonably expects to realize;
- (b) relating royalty to be next best alternative available to the licensee;
- (c) considering royalty in reference to royalty rates previously established by the licensor in similar agreements;
- (d) evaluating the royalty with reference to rates prevalent in the industry; and
- (e) treating the royalty as a direct function of the forecasted profits or savings the licensee will derive from the exploitation of the licensed technology.

Method (a) produces the minimum royalty which the licensor would accept, while method (b) provides the maximum royalty to which a licensee would reasonably agree. The figures produced by methods (c), (d), and (e) should provide additional points within the range defined by the figures produced in (a) and (b). By using as many of the five methods as are readily adaptable to the given licensing situations, the licensing parties can effectively determine the range of possible royalties and focus on that range during negotiations.

(2) Technology Licensing Profitability

Branson (1977) has focused on the accounting measurement of profitability of licensing. (4) Caves (1971) and Rodriguez (1975) have focused on the costs of technology transfer. (5) Behrman and Schmidt (1959) through a normative behavioral model show the negotiating behavior of the licensor and licensee executives.

Contractor (1983) in a study of U.S. firm's licensing practices concluded that:

The increasing importance and incidence of licensing for U.S. firms and the concomitant regulatory and legal changes concerning patents and trademarks has created concern for a weakening patent system and technology losses. However, a study of 241 U.S. firms involved in technology licensing reveals that there is little threat of losing technology. Regression results show that small and medium-sized firms were more active in licensing agreements than was previously thought. The size of the firm was the most important factor in the number of licensing agreements undertaken. Larger, internationalized companies do more licensing. Strategy motivations for licensing include lump-sum fees, royalties, new market entry, and other short-term income-generating strategies. The incidence of patents and trademarks was highest for the chemical, pharmaceutical, petroleum, and food processing industries. Thus, a weakening trademark system would hurt those industries most.

Mansfield, Romeo, and Wagner (1979) investigated the effect of American foreign trade on research and development (R & D) activity. The sample chosen was broken into two subsamples:

1. 20 firms in the fabricated metal products, machinery, instruments, textile, paper, and tire industries, and
2. 10 major chemical companies.

Both subsamples evidenced interfirm variation which may reflected differences in the percentage of sales from abroad and the amount of R & D spending. The regression results indicated that development projects have a smaller share of their returns coming from abroad than do research projects. The firms were asked to estimate the effect on R & D if they could not use new technology abroad, or could not export products or processes based on the technology. The firms indicated that expenditures would have fallen.

When industry is held constant, there is no significant relationship between a firm's foreign sales and the ratio of R & D spending to sales. Firms with high foreign sales are more concerned with basic research and long term projects. Product innovations are more likely to be transferred abroad than process innovations, and foreign subsidiaries are the most frequently used channels of international technology transfer.

Teece (1977) found that transfer costs were higher when underlying technology was labor-intensive (disembodied) than when it was capital-intensive (embodied). Presumably, the former involves a much greater need for specially-skilled resources in facilitating transfer whereas capital-intensive are principally "embodied" in new machinery or equipment and hence simpler to communicate and transfer. (6)

(3) Technology Licensing Motivations and Conflicts of Interest

Millman (1983) in analyzing MNCs technology transfer incentives and intergovernmental conflicts affecting the

transfer concluded that:

The impetus behind technology transfer is two-fold:

1. The desire of multinational corporations (MNC) to control and manage their technologies in worldwide markets, and
2. The benefits to be gained by sharing technology.

MNCs undoubtedly will remain the primary channel for technology transfer in private sector unless other efficient channels are developed. Licensing is a widespread practice among MNCs to extend ownership, and it contributes greatly to the complexity of technology transfer. Although Third World nations and newly developing countries are exerting pressure for more equitable technology transfer, they have gained little access to needed forms of basic technology. Governments view technology transfer as part of the foreign policy arena; thus, governments can have significant impact on promoting or hindering the transfer process. Particular examples of Intergovernmental conflicts affecting technology transfer include:

1. US/USSR/Western Europe disagreements following the invasion of Afghanistan,
2. Brazil's nationalistic attitude toward imported technology, and
3. The Peoples Republic of China's first steps into international markets.

Millman (21983) focuses on International Technology Licensing and investigates the factors contributing to the success and failure of licensing contracts. He argues that:

The transfer of technology through licensing is controversial. A licensor receives financial benefits and profits from broader markets, but some firms are hesitant about a potential lack of control over licensee operations. Successful licensing requires an organizational environment inclined toward firm management commitment. A license package is a broad range of technical, organizational, and commercial knowledge that

supports the transferred technology. License packages can include patents, trademarks, procedures, and sales support material. Confidentiality is difficult to ensure in licensing negotiations. Payments, which require careful negotiations, usually include a combination of a down payment, progress payments, and minimum and running royalties. Although some firms resent the dominant role of multinational corporations (MNCs) in licensing, small companies can benefit from the resources of the MNC. Negotiators should be aware of unwritten business rules and ethical standards of foreign countries. Most failures at licensing result from a breakdown of communications between the parties.(7)

(4) Technology Licensing and Its Speed of Transfer

Vernon, R. and Davidson (1979) in a study of 221 innovations by 32 U.S. multinational enterprises, found that speed of transfer had become faster over time (1945-1977). Also, they found that the relative importance of licensing has decreased (from 31.4% in the 1945-55 period to 19.8% in the 1966-1975 period), and MNCs have used their subsidiaries more (from 68.6% to 80.2% during that same period) for the transfer of technology rather than independent licensees (see Table 12).(8)

Mansfield (1974) has focused on speed of technology transfer and his findings were reinforced and supported by Benvignati of the Federal Trade commission. Benvignati (1983) in an empirical research of 40 textile machinery innovations and their speed of transfer between U.S. and leading foreign competitors concludes that:

. . . the speed of international transfer has been greater as time has passed and as commercial transactions between industrialized nations have

TABLE 12

TRANSFERS OF 221 INNOVATIONS BY 32 MULTINATIONAL ENTERPRISES TO THEIR
FOREIGN MANUFACTURING SUBSIDIARIES AND INDEPENDENT LICENSEES,
CLASSIFIED BY PERIOD OF U.S. INTRODUCTION

Period of U.S. Introduction	Same Year or 1 Year After	2 or 3 Years After	4 or 5 Years After	6 to 9 Years After	10 or More Years After	Total
<u>1945-1955 (94 Innovations)</u>						
Via subsidiaries	14	18	11	43	233	319
Via licensees	1	9	28	16	92	146
Subsidiaries as % of total	93.3%	66.7%	28.2%	72.9%	71.7%	68.6%
<u>1956-1965 (70 Innovations)</u>						
Via subsidiaries	24	39	21	46	49	179
Via licensees	7	10	15	13	22	67
Subsidiaries as % of total	77.4%	79.6%	58.3%	78.0%	69.0%	72.8%
<u>1966-1975 (57 Innovations)</u>						
Via subsidiaries	22	37	21	16	1	97
Via licensees	2	4	10	6	2	24
Subsidiaries as % of total	97.7%	90.2%	67.7%	72.7%	33.3%	80.2%
<u>Total, 1945-1975 (221 Innovations)</u>						
Via subsidiaries	60	94	53	105	283	595
Via licensees	10	23	53	35	116	237
Subsidiaries as % of total	85.7%	80.3%	50.0%	75.0%	70.9%	71.5%

Source: Vernon and Davidson (1979), p. 63.

increased. The speed has been slower when the innovating domestic firm was technologically dominant. The data reveal that 88% of the licensed transfer and 100% of the FDI transfers involved technologically nondominant firms and imitators. Because advanced countries have roughly equivalent capacities to lend support to high technology activities and roughly comparable patterns of domestic needs and preferences, the need with which new technologies spread across such countries is not usually thought to be constrained by national levels of R & D infrastructure and scientific capabilities or by lags in domestic demands. Communication and competitive variables which may vary across industries or across specific innovations within an industry are potentially more important determinants than country differences.(9)

(5) Technology Licensing and the "Dependence Issue"

Lake (1976) found that almost all British licensees in the semi-conductor industry were dependent on their U.S. licensors. He also found the diffusion lag (time elapsed between first U.S. introduction and the utilization by the British licensees) was more than three years.

John P. Killing (1977) has done the most comprehensive study of manufacturing under license in Canada. Examining only Canadian-owned firms in the secondary manufacturing sector, Killing found that those Canadian firms with strong R & D capabilities often obtained licenses early in their life cycle and didn't face any restrictions (i.e., export restrictions). His conclusion was that although manufacturing under license provides for a continuous flow of technology to firms with no R & D capability, it is not a good strategy for long-term growth. The reason being an

unhealthy degree of dependence upon the licensor. He argued that licensing of this type is only beneficial to firms which are using it as a means to an end, that end being the establishment of an in-house R & D competence. (10)

Licensing and the formation of joint ventures are discussed from the perspective of the technologically dependent firm in Killing (1980). The conditions under which a firm without technology should attempt to acquire it, via each of two kinds of license agreement and two kinds of joint venture, are also addressed. Examination of data on 74 license agreements and 28 joint ventures indicated that the market for technology is fragmented and inconsistent. A normative model was described, which suggested the conditions under which technology deficient firms should and should not make use of current technology license agreements, current and future technology license agreements, joint ventures in which they own a strong controlling interest, and joint ventures in which they are roughly or exactly equal owners with the technology supplier. In some conditions, buying technology is not a viable corporate strategy, but it can be effective under certain specifications.

Wills (1982) in a sample of 283 of the most profitable products and manufacturing processes introduced by the Canadian firms concluded that "Licensing was not found to

be a significant means of obtaining technology." Crookell (1973) argued that the technology transfer process was more efficient within the firm (parent-subsidiary) than between unaffiliated firms.

(6) Viability of Technology Licensing as an Internationalization Strategy

Zenoff (1970) concluded that "foreign licensing has not been used as a deliberate marketing device and appears to be a residual type of activity." Tesar (1977) in an empirical study of U.S. medium-sized firms found that "the majority of firms do not consider licensing as a viable alternative."

Carstairs and Welch (1982) in a study of Australian firms concluded that:

The mainly small to medium-sized companies in our investigation tend to utilize licensing because of various constraints on the use of other international marketing techniques, rather than because of a positive preference for licensing as such. Despite its adoption in a secondary or residual manner though many firms were still able to successfully expand their international operations via licensing. A key factor in the success of licensing appeared to be the development of effective interaction with licensee in a long term relationship. (11)

Ford and Ryan (1981) have focused on the importance of marketing of technology in improving the return on investment by technology source firm:

Companies facing high research and development (R & D) costs, competitive pressures, capacity limitations, financial difficulties, antitrust laws, and foreign trade barriers must improve the rate of return on technology investments by

marketing technology during all phases of its life cycle. The technology life cycle (TLC), which pinpoints the changing decisions companies face, has the following states: 1. technology development, 2. technology application, 3. application launch, 4. application growth, 5. technology maturity, and 6. degraded technology. Complete marketing of a technology requires: 1. development of a coherent strategy for a full portfolio of technologies, 2. decisions on acquisition or divestment of technologies, 3. awareness of the value of developing technology for direct sales, 4. a clear understanding of the relationship between the sale of technology through licensing and the sale of products based on that technology, 5. recognition of the technology buyer's knowledge of his needs, and 6. reliance of technology marketers.(12)

Caves, Crookell, and Killing (1983) examine "market imperfections in licensing of technology" and concluded that:

Licensing agreements result from a basis on costs and uncertainties of contractual agreements between opportunistic parties. Surveys are conducted of licensors and licensees, concentrating on two classes of hypotheses about imperfections in the market:

1. Licensees take part in a market for specific advantage.
2. Each license agreement is viewed as a pareto-optimal.

Analysis indicates that license agreements fail to capture the full rent for the licensor, enabling the licensee to emerge from the transaction in a stronger position.

Technological licenses are becoming more important in international commerce. Generally, both the source and recipient countries lose if technology transfers are diverted toward agreements that otherwise would have

occurred through joint ownership.

Finan, W. (1975) examined licensing in Britain's semi-conductor industry from U.S. licensors' viewpoint. He found that U.S. licensors don't consider licensing as a major means of technology transfer and they basically grant patent licenses as well as technological assistance. Large U.S. firms, such as Western Electric, Texas Instruments, and Fairchild, intended to be licensors and the royalties charged by these U.S. firms were found to be a function of:

- (a) number of licenses covering the agreement,
- (b) the technological capabilities of licensees--firms with strong R & D capabilities often receive royalty-free licenses and the licensor gets to use the new developments on the licensed technology via grant backs, and
- (c) the licensor's licensing competition.

Industrial Research Institute in its position statement on Licensing of Technology concluded that:

Transferring technology between countries or corporations and from universities and private individuals to commercial enterprises is affected by the licensing of patents and know-how. The government influences this flow of technology through patent laws, antitrust actions, research by government employees, and government-funded research in universities and contract laboratories. In order to promote technology transfer, privately-owned patents should not be subject to compulsory licensing. The government should grant exclusive licenses to government-owned patents, and the no-royalty, no fee basis for the granting of non-exclusive licenses to government should be discontinued. Innovative efforts of private inventors should be

supported, and the inventions originating at the university level should remain the property of the university. These recommendations are based on the studies made by the Industrial Research Institute in 1978.

The U.S. Department of Commerce takes a licensor's viewpoint with the presumption that any time a U.S. company is involved in a transfer of technology arrangement (a licensing agreement or FDI) always the transferor (licensor) is the U.S. company and the recipient (licensee) of technology is always a non-U.S. firm. The following is a check list provided by the Department of Commerce to potential U.S. Licensors and Foreign Direct Investors not to be overlooked: (13)

- 1) If processes are involved, spell out the areas of application and use by the licensee and establish control and periodic review of the licensee's operations.
- 2) It is important to provide for conditions under which the licensee may or may not manufacture competing or non-competing products.
- 3) Establish the right to institute and enforce a standard of quality with particular relation to the use of your trademarks, where permitted.
- 4) Establish the right to inspect the licensees' operations, to receive and evaluate samples of products, to audit books, and to survey licensee sales and advertising efforts at stated periodic intervals.

- 5) It is desirable to train the licensees' personnel in advance of and during the licensed operations; e.g. where and when to train, how many trainees at a time, and for how long. (Establish a basis for payment of training costs and distinguish these costs from royalty obligations.)
- 6) There are provisions for special research and engineering on behalf of the licensee. (Clearly define the scope, time, and assess the costs against the licensee on a cost basis.)
- 7) Provide for the handling of future disputes with the licensee.
- 8) Reserve the right to modify or terminate the license if unsatisfactory changes occur in the ownership or key personnel of the licensee.
- 9) Define the rights and obligations of both parties after termination, including the effect of waivers.

Ruzic (1978) focused on the technology transfer between NASA and industries:

The most effective pace setter of technology has been the space program. The National Aeronautics & Space Administration's technology transfer arm--the Technology Utilization Branch--uses a person-to-person approach to exchange its information with industry. NASA has established a network of Industrial Applications Centers. The centers are located at six universities and provide technical assistance and literature retrieval. The network is the largest information storehouse in the world. The centers interact with NASA field centers. Another method of transferring technology is the biomedical and technology applications teams. These teams try

to apply NASA technology to problems encountered in medical facilities and public sector agencies. NASA maintains a patent licensing program.(14)

Stuart (1979) investigated the technology transfer, patents and licensing and concluded that:

The patent system creates property out of new technology. Patents must be obtained in every country where protection is required. Patents are obtained in different countries in order to:

1. Provide exclusive future protection.
2. Defend freedom of action.
3. Provide licensing for income.
4. Provide licensing for information.

Companies that have in-house patents can negotiate licensing agreements more easily as the licensing company feels that the licensee has prior valuable experience. Licensees must know what is wanted in the agreement and what can be paid for it. A company without technical know-how needs more than a simple patent agreement. While licensing can reduce the risk of new product innovation, there must be in-house research development to maintain a technical level of competence.(15)

(7) Technology Licensing and International Cooperations

Hill (1980) studied the international industrial marketing into the Eastern Bloc countries and the advantages to Western firms found that:(16)

Since the late 1960's, the quantity of industrial cooperation agreements between Western companies and Eastern European foreign trade organizations has increased substantially. In a sample of industrial cooperation agreements, it was found that there were three major types of these agreements:

1. Co-production based on the specialization of partners,

2. The supply of licenses, with payments in resultant products manufactured under the licenses supplied, and
3. The supply of plant and equipment, with payment in resultant products manufactured by the plant supplied.

There are advantages to Western firms for East-West industrial cooperation such as gaining access to new markets, and profitability. However, there are disadvantages as well, including high initial marketing costs. An examination of six case studies of British engineering companies engaged in industrial cooperation with Eastern European foreign trade organizations indicated that such agreements are complex in terms of aspects of design, development, production, costing, and finance. The British companies were able to secure advantages, but not without some difficulty.

Kiser (1982) focused on East-West technology transfer and how U.S. firms can acquire the Eastern Bloc technology. (17)

The Council for Mutual Economic Assistance (COMECON) develops many innovations that U.S. companies would find useful if they knew about them and knew how to get them. US-COMECON commercial contact is very low, however. U.S. companies which do buy such technology mainly do so because it represents a better or cheaper way to do something. They can buy a license in which one party grants certain use rights and/or know-how to another. The COMECON has sold only about 1,500 licenses to market economy nations since 1965. The COMECON's poor performance in selling licenses is due primarily to lack of commercial contact. Personal contact is crucial since many COMECON technologies

are in the research and development (R & D) stage or are process technology. "Successful licensing with COMECON requires honesty, good communications, mutual respect, and especially good personal relationships." The licensee should also be able to make crucial technical improvements. It is also necessary that contracts be detailed and carefully written.

Business Week (1980) investigated the process of tapping Soviet Bloc technology by U.S. firms and found that: (18) products and processes licensed from Eastern bloc countries represent a small but growing flow of technology. International trade experts believe a lot of technology remains to be discovered since 30% of the world's patents are held by citizens or organizations within the Soviet sphere of influence. According to John W. Kiser III, the nearly 50 identified licenses from Soviet-bloc countries are only the beginning of exploitable technology (see Table 11). New drugs are sought routinely among the Eastern European countries with two new anti-cancer drugs recently discovered in the USSR. Soft contact lenses are the result of Czechoslovakian research. A new surgical stapler to close incisions faster is a Soviet development. The Soviet-bloc countries are very strong in basic academic research, while the U.S. is very strong in applied research.

U.S. corporations have utilized the Soviet technology and during the past two decades and the technology purchased from the Soviets has started to yield military applications.(19)

The voice of the LDCs as the recipients of technology from the developed nations is usually echoed through international institutions and conference such as UNCTAD, UNIDO, and WIPO.* Their major arguments have focused on pricing and appropriateness of technology. These organizations argue that technology is a public good and should be transferred to LDCs at no cost or at a very low cost.

Also, the transferred technology is not appropriate for most of recipient LDCs because the technology developed in the industrialized countries is usually capital-intensive and LDCs need more of labor-intensive technology. Most of LDCs are over-populated and need some sort of technology to employ their residence. Cultural differences associated with technology transfer, and the resultant problems require a separate text and are beyond this research.

At various meetings, committees have been formed and their aim has been to introduce a new 'code of conduct' for

*UNCTAD=United Nations Center for Trade and Development, UNIDO=United Nations Industrial Development Organization, and WIPO=World Intellectual Property Organization.

the international transfer of technology. At recent UNCTAD and WIPO meetings the resolution was that a new code of conduct must be introduced during the February-March 1985 meeting of the United Nations. Developed nations, having a great interest and a great deal at stake, cannot afford to ignore such meetings and have actively participated in the formulation of the new code of conduct.

Joelson (1978) focuses on the U.S. laws and the proposed code of conduct on the transfer of technology and argues that developing nations assert that:

Technology is the universal heritage of mankind and that legally binding rules must be adopted to shield their economies and nations from undesirable licensing practices by transnational enterprises who control the bulk of technology. Developed nations feel guidelines should be voluntary and that freedom of contract should continue in this area. (20)

Almost all of the above have looked at international technology licensing from U.S. licensors' standpoint. There are good reasons for the existence of such a bias. For decades, the U.S. corporations had the leading role in FDI and licensing their technology to foreign licensees. Recently, the trend has been "reversed" and foreign firms have been exploiting the U.S. market using various strategies: Export, FDI, Licensing and/or a combination.

This dissertation "reverses" what we have discussed so far and conceptualizes them into our research model and research hypotheses. In the next chapter the focus will be on international technology licensing from the licensees' standpoint.

ENDNOTES

(1) Contractor, F. (1978) focuses on "Costs of Effecting Overseas Technology Transfers," proceedings of Academy of International Business, Manchester, U.K.

_____, (1980) focuses on "Compensation and Costs of International Technology Licensing," Ph.D. Dissertation, University of Pennsylvania.

_____, (1983) focuses on "Technology Licensing Practices in the U.S. firms -- Corporation and Public Policy Implication," CJWB, (1983), p. 80.

_____, (1984) focuses on "Technology Licensing vs. FDI -- An Analysis of U.S. Department of Commerce," Paper Presented to National Science Foundation.

(2) See Perlitz (1980), p. 53.

(3) See Orleans (1982), pp. 3D-29.

(4) See Branson (1977), p. 43.

(5) See Caves et al. (1983) and Rodriguez (1975), February issue of Journal of Political Economy.

(6) See Teece (1977), "The Economic Journal," June issue.

(7) See Millman (1983), pp. 26-46.

(8) See Vernon and Davidson (1979), "The Speed of Technology Transfer by U.S. MNCs to Overseas Subsidiaries and Independent Licensees," p. 63.

(9) See Mansfield (1974), Research Management, January 1974.

(10) See Killing, J. "Manufacturing Under License," The Business Quarterly (Canada), Winter 1977.

(11) See Carstair and Welch (1982), also Kleich (1985).

(12) See Ford, D. and Ryan, C., "Taking Technology to Market," Harvard Business Review, March/April 1981, p. 117.

(13) U.S. Department of Commerce, International Trade Administration, Foreign Investment and Licensing Checklist for U.S. Firms (May, 1983), pp. 8-9.

- (14) See Ruzic (1978), pp. 38-40.
- (15) See Stuart (1979), pp. 10-13.
- (16) See Hill (1980), pp. 139-164.
- (17) See Kiser (1982), pp. 85-92.
- (18) See Business Week, May 1980, pp. 122H and 122J.
- (19) See The Wall Street Journal, April 24 and 25, 1985.
- (20) See Joelson, M., "U.S. Laws and Proposed Code of Conduct on Technology Transfer," Antitrust Bulletin, Winter 1978, pp. 381-385.

In building the research model, the focus is on "horizontal" technology transfer (between two firms on arms' length basis). In Chapter three, we argued that this type of technology transfer is the classical one and most of the licensing agreements take place in this form between two unaffiliated firms. The licensors do not want (or cannot afford) to commit a large amount of capital and the political risks are the least for the licensors. The licensees' motivations are, essentially, costs, risks, and time related. They enter the agreement because the costs and the risks are lower, or the licensed product(s) could reach the market faster.

The licensees' characteristics determine their motivations and the type of license agreements. We argued, earlier in Chapter Three, that technology transfer does not happen at "science" level, because there is nothing concrete to license. Therefore, the transfer was limited (or takes place) at the "technology" or "producer" level.

The licensees with core-skills (characteristics) can enter licensing agreements at both levels. But the licensees without core-skills are limited to the "production" level only. At this level, though, the licensee needs to have at least some engineering knowledge for the transfer to take place. Thus, licensees are not homogeneous or identical and, depending on their characteristics, they differ and the "level" at which they

CHAPTER FIVE
THE RESEARCH MODEL
AND
THE RESEARCH HYPOTHESES

THE RESEARCH MODEL

This chapter synthesizes our preceding discussions by drawing together various concepts and variables related to technology licensing. We put together various pieces to build out model with a focus on technology licensing from a licensee's standpoint. This chapter consists of two main parts. In the first, we synthesize various concepts and develop our research model; and in the second, our hypotheses are proposed.

In developing our model, the main focus is on two things: (1) the licensee's characteristics such as firm's size, technical and marketing competence, and dominance (as compared to the licensor), and (2) the license agreement types (i.e., one-time vs. continuous), which were discussed in Chapter Three.

The main logic for focusing on the licensee's characteristics and the license agreement type is to find out the conditions under which firms manufacture under license, their motivations, and the relationship between licensee's characteristics and the license agreement type to which they commit themselves.

acquire technology is also a function of their characteristics. The type of agreements they enter is also a function of the licensee's characteristics as well as the type of technology involved (industry-specific).

In the Reverse Licensing section (Chapter Three), we argued that every year thousands of small to medium-sized firms are forced into bankruptcy because they are, generally, one or few-product firms. When their product(s) reach the end of their life cycle, they either need to develop or acquire new and competitive technology, or they are gradually forced to cease operations. They either have to develop it internally (most small to medium-sized firms lack the required resources) or they have to acquire it externally (take a license). The possibility of taking a license from other U.S. firms (technologically rich) is remote for the obvious reason that no U.S. firm would like to create competition for itself in the U.S. market.

In developing strategies for future technological needs, a firm needs to evaluate its own characteristics (core-skills) prior to choosing any strategy. Figure 16 summarizes the options available to a firm in need of technology and shows where licensing fits in (as a licensee).

Prior to introducing the licensing cycle model, it is appropriate to introduce a valuation model as a framework for analyzing various options open to the licensee.

FIGURE 17

WHERE LICENSING FITS IN--A LICENSEE STANDPOINT

Essentially, the decisions related to taking a license are long-term commitment in nature and have major impact on the success and failure of the firm in the long-run.

Therefore, the firm (licensee) must carefully evaluate various options (Figure 16 and 18).

THE NET PRESENT VALUE (NPV) METHOD

Firms use various techniques in their capital budgeting decisions. The NPV is theoretically a superior method in corporate capital budgeting. The firm should find the NPV of each alternative by incorporating all relevant revenues and costs [on incremental and after-tax basis] associated with each option. Then the alternative with the highest NPV should be chosen. The following notations are used in the model:

R_t = total revenues from sales of the final product which uses the firm-specific advantage (technology)--firm's own developed or licensed technology

C_t = total input costs for the production of the final product using firm's own developed or licensed (core-skills)

C_t^* = total input costs for the production of final product using licensing arrangement (firm is a licensee)

A_t^* = additional costs incurred to the firm for the development of the new technology

L_t^* = additional costs due to licensing fees (lump sum or royalty rate)

d_i = the discount rate ($i = 1, 2, 3 \dots$)

$\uparrow$ = the firm's tax rate

t = time period ($t = 0$ to $t = N$)

Two options are open to the manufacturing firm in need of the new technology. The firm can develop its own technology independently using its internal resources (I) or use external sources and take a license (L). The NPV of each will be:

$$(1) \text{ Development of Firm's own Technology} \quad NPV_I = \sum_{t=0}^N \frac{R_t(1-\tau) - C_t - At^*}{(1 + d_1)^t} \quad [1]$$

$$(2) \text{ Taking a License [Licensee]} \quad NPV_L = \sum_{t=0}^N \frac{R_t(1-\tau) - C_t^* - Lt^*}{(1 + d_1)^t} \quad [2]$$

The return/risk trade off are assumed to be different because of different risks, cash flow patterns and timing involved for each alternative. Also, note that the licensing fees are in dollar form (Lt^*). If the fees are in percentage form (i.e., % of sales or revenues), the dollar amount should be found or the revenues should be adjusted for royalty payments [i.e., $R_t(1-r)(1-\tau)$ as the after-tax revenues and then Lt^* must be eliminated from the equation]. Also, all the cash flows are assumed to be known with certainty. In case the cash flows are not known with certainty, the certainty equivalent or risk-adjusted technique could be used. By calculating the Net Present Value (NPV) of each alternative, then the alternative with higher NPV will be preferred. In case the NPV for both

alternatives is negative ($NPV < 0$), neither alternative will be chosen. Perhaps the firm will be better off becoming a distributor (assembler) instead of a manufacturer if the Net Present Value of importing (NPV_D) is positive and the highest among the alternatives. This case is not central to this thesis because the focus is on the manufacturing firm. Therefore:

1. Develop own technology when

$$NPV_I > \max (NPV_L, NPV_D) \quad [3]$$

2. Take a license (as a licensee) when

$$NPV_L > \max (NPV_I, NPV_D) \quad [4]$$

3. Become an importer (assembler-distributor) when

$$NPV_D > \max (NPV_L, NPV_I) \quad [5]$$

Since our focus is on manufacturing with and without license, we only focus on the first two alternatives.

Obviously, these two alternatives do not have the same characteristics. First, the risks associated with the first option are far higher than the latter because of the uncertainties involved in investing in R & D and the presence of the probability of failure. It is quite possible that the amounts invested in core-skills do not produce any new technology. Such is not the case when the firm acquires the technology through licensing arrangements. The licensor has already developed the

technology and has patented the technology, therefore the risk of failure is extremely low or non-existent.

Second, the cash flow patterns are different for each alternative. The former requires substantially larger amounts of investment at the beginning of the project, because of the costs associated with the employment of core-skills (far more than the down payment for licensing or technology). The cash inflows throughout the life of the project are higher because of the non-existence of the royalty payment in the first case (internalization).

Third, the timing of the cash flow as well as the introduction of the new product into the market is different for each alternative. In the first case, it might take a year or more before the technology is developed, if it is ever developed! This is not the case for the licensing alternative. The investment at the beginning is far less for the second case and in most cases the licensee could negotiate an agreement without any down payment. The royalty payments are also contingent on the success of the licensee. Thus, like any capital budgeting and risk (uncertainty) problem, it is appropriate to use certainty equivalent technique (coefficient =) among others to adjust the cash flows associated with each option proportionate to the uncertainties of each alternative.

In the next section, we introduce Licensing Cycle Model (LCM), which basically focuses on licensees'

characteristics, motivations, and the type of license agreements. Then, licensee's options will be evaluated and after defining various terms and the research focus, our hypotheses will be proposed.

THE LICENSING CYCLE MODEL (LCM)

As we argued earlier under Licensee's Motivations and cases for and against taking a license (Chapter Three), a licensee enters into a license agreement for various motives. Generally, licensing of technology (from a licensee's viewpoint) is a long-term investment or capital budgeting decision. A licensee has two options prior to licensing of technology: (i) Develop own R & D capabilities and then develop new technology, or (ii) Acquire the technology through licensing. The cost of own R & D, the probability of failure, the time, and the strong patent laws are the most important factors in favor of taking a license. The adaptation costs, the time for the negotiation, advantages of strengthening own R & D and the "independence" and other considerations [i.e., Not Invented Here (NIH) Syndrome] are among the most important factors against taking a license.

The Licensing Cycle Model builds on Killing's Licensing Cycle and tries to see the validity of the model as an alternative growth strategy (i.e., development of own R & D) for the licensee.

Based on LCM the licensees with continuous licensing

agreements have better chances of going through the licensing cycle than those with one-time agreements. In this section we explain the Licensing Cycle Model (LCM) and the process through which the licensee goes through before achieving technical competence. Based on Killing, the Stages of LCM are summarized in Figure 17.

It is important to note that the licensee may or may not have entered (or will enter) the licensing cycle without prior planning. Some licensees do go through the process (stages of LCM) as part of their strategic planning. These licensees have chosen (or choose) to go the licensing route to build up their technical competence and prosperity.

The reasons behind such a decision are numerous. The cost is perhaps the most important reason. Like capital budgeting decisions, licensee has two alternatives with different return and risk trade-offs. The licensee, using the Net Present Value (NPV) approach has preferred the licensing alternative over the development of in-house R & D on his own. The costs associated with licensing are basically the adaptation costs, and the compensations to the licensor on an opportunity cost basis. The costs associated with the second alternative are essentially those of hiring R & D personnel as well as development of the new product.

- Stage One:** The U.S. firm, with a low R & D competence in an industry where technical innovations are very important, is confronted with international competition.
- Stage Two:** Because of its lack of R & D and new technology, the firm is unable to compete effectively. The firm enters the licensing agreement on a continuous basis with a foreign firm and starts production under license. The license, usually, is a complete technical assistance agreement.
- Stage Three:** As the manufacturing starts and sales volume grows, licensee begins to develop its own technical capabilities with licensor's assistance. (2) Gradually production difficulties decline, licensee's R & D capabilities increase, and its dependence on the licensor is reduced.
- Stage Four:** Licensee develops enough of an in-house R & D competence to cancel or renegotiate the license agreement. Stage Four could take a long time (i.e., 10 years) after Stage Two.
- Source:** Based on J.P. Killing's, Licensing Model in "Manufacturing Under License in Canada" (1975), p. 184.

Figure 17

LICENSING CYCLE MODEL (LCM)

A second reason is the risk involved in the development of new products. The probability of failure is much higher for a firm without R & D competence which decides to build its in-house R & D team and develop products than a firm which chooses the licensing route. The reason is the licensor has already developed the product of the future success of the product is not confronted with huge unknown. When a firm acquires the needed technology through continuous licensing arrangements, it has a better chance of building its own in-house R & D competence and the technical and marketing risks are lower.

A third reason is the timing involved. It could very well take a number of years before the firm builds its own R & D competence and develops a new product--if it ever manages to develop and introduce the product (process)! The risks are great to small and medium-sized firms and most, perhaps, cannot afford to survive that long. Therefore, the firm has a much faster and better chance of success with the licensing alternative. The product reaches the market faster and the licensee acquires the needed expertise throughout the process and with the licensor's assistance.

Finally, the patent laws are very important in the choice for or against taking a license. If the patent laws are strong and enforced in the licensor's, as well as the

licensee's, market, the licensee cannot go around the patent.

In Figure 16, we showed that a firm in need of technology has a total of nine options. The options one, four, five and nine are not central to this research, because we are only evaluating the viability of the licensing option from a licensee's standpoint. Thus, we will be evaluating only five options and conditions under which each option is an acceptable one. We argued earlier that the type of licensing agreement and the type of licensed technology were dependent on the firm's core-skills capabilities (licensee's characteristics). Figure 18 shows these five options from that standpoint.

OPTION ONE

The licensee has technical capabilities and can take a license for technology (commercially proven as well as not proven) and technology transfer can take place at both "technology" and "production" levels. The licensee which takes a license on a one-time basis, does so because of the existence of a patent. The expectations are that the technology transfer agreements could take place at both "earlier" and "later" stages of the Product Life Cycle, because of the licensee's competence. In some cases, the licensee acquires the rights to the technology because taking a license is the least expensive option (overseas vs. U.S. R & D costs). Taking a license will not make the

FIGURE 18

DEVELOPING STRATEGIES FOR FUTURE TECHNOLOGICAL NEEDS: THE LICENSEES' OPTIONS

licensee dependent on the licensor. (See for example Tables 2-8 for a list of such one-time arrangements).

OPTION TWO

This option is quite different from the first one. The licensee has the competence but acquire the technology through licensing on a continuous basis. The licensee's motive is, essentially, cost-related. The licensee is expected to have "cross licensing" arrangements with the licensor. The parties have more or less the same capabilities in most cases and the licensing agreement is more of a matter of convenience and mutual benefit. It is also possible that the licensor does not have the required resources (i.e., financial, marketing) to exploit the licensee's market on its own (i.e., export or FDI). The technology transfer can take place at both "technology" and "production" levels. Taking a license is a capital budgeting decision and the licensee has preferred the licensing route. We have numerous examples of this type of licensing arrangement (i.e., AT&T & Olivetti of Italy, AMC & Renault of France, Chrysler & VW of West Germany).

OPTION THREE

The licensee does not have technical competence but buys technology on a one-time basis. The technology transfer could only happen at "production" levels because of licensee's characteristics. Even at this level, the

licensee must have some engineering competence for the adaptation of the technology. At "production" level, the technology is commercially proven and the technology transfer takes place at "later stage" of PLC. The technological changes are not that frequent for the licensed technology.

OPTION FOUR

The licensee does not have the technical competence and acquires technology on a continuous basis. The type of technology should be commercially proven and the licensing takes place at "later stage" of PLC. The type of technology is expected to be non-R & D-intensive in nature because (1) the licensee lacks technical competence, and (2) the chances are that the licensor (source firm) would prefer to exploit the licensee's market on its own and "internalize" the advantages. In the long-run, there might be an unhealthy dependence on the licensor. If the technology is available from various sources (competitive licensor's market), and the technology does not have "strategic" importance, then the chances of such a dependence are remote. In this case, licensing would be an acceptable option.

OPTION FIVE

The licensee does not have the core-skills competence but licensing is considered the first step in the direction

of self-competence (part of licensee's strategic planning). The licensee acquires the technology and gradually builds its own in-house R & D. Of course, the type of technology involved will be commercially-proven and the licensing takes place at "later" stage of PLC. This is, essentially, the case for Licensing Cycle Model (LCM) described in this chapter. If the licensee proceeds as planned and acquires the "competence" within the planned period (i.e., ten years), perhaps this alternative is the preferred strategy as compared to developing own in-house R & D independently.

Prior to the introduction of our research variables and hypotheses, it is appropriate to define and operationalize the variables used in our model:

A. LICENSEES' CHARACTERISTICS:

1. Firm Size

- a. Small - A licensee with fewer than 100 employees and/or less than \$25 million dollars in annual sales.
- b. Medium - A licensee with 100-499 employees and/or \$25-100 million dollars in annual sales.
- c. Large - A licensee with more than 500 employees and/or more than \$100 million annual sales.

2. Core-skills

- a. A licensee is considered technically competent (with core-skills) if it has more than 25 qualified scientists and engineers per every 1000 employees and/or spends more than 3.5% of its net sales on R & D activities.**
- b. A licensee which does not meet the above criterion is classified as a licensee without core-skills.**

3. Dominance

A dominant licensee is one which is larger than its licensor in terms of employees, sales and R & D expenditure. Otherwise it is considered a non-dominant license.

B. THE CHARACTERISTICS OF THE LICENSED TECHNOLOGY

1. Technical and Marketing Uncertainty

The degrees of uncertainty are assumed to be three:

- a. Low - The risks are very low such as the uncertainties associated with a "standardized" product (many home appliances).**
- b. Medium - The risks and uncertainties are existent and the technology (product still changes relatively often in terms of "input" and the manufacturing process).**

- c. High - The uncertainties are very high as is the case for a new product. The technology, the process, and the inputs are changing frequently. The "growth" industries are essentially of this type. See Vernon (1966) and Hirsch (1976) for detailed analysis of various uncertainties.

2. The Product Life Cycle (PLC)

The technology (product) is assumed to go through various stages as were explained by Vernon (1966) and summarized in Chapter Three of this thesis.

C. THE LICENSEES' MOTIVATIONS

Various licensees' motivations are explained in Chapter Three of this research. Briefly, they are, essentially, related to cost, risk, time, or a combination of all three.

The licensees enter licensing agreement because the costs associated with licensing option are lower than building their own R & D capabilities and developing new technology. The risks associated with licensing option (from a licensee standpoint) are lower because of the very existence of probability of failure with in-house R & D option. The timing is extremely important and will have a direct bearing on the profitability and attractiveness of various projects. The licensing option will enable the

licensee to manufacture the product and get it to the market faster.

THE LICENSING AGREEMENT TYPE AND RESTRICTIONS

A. Type

Crookell (1973) classified licensing agreements into three major categories: (3)

1. All technology currently developed or to be developed by licensor.
2. All technology now in place by the licensor (the licensee must have in-house skills to develop future change himself).
3. License for a specified patented product, component, or process.

The first type includes future technology developed by the licensor and therefore it is "continuous" in nature. The other types are basically "one-time" in nature. For our purpose, we divide the agreement types into two broad categories:

- (1) Continuous - a lasting but renewable agreement, and
- (2) One-time - this category includes a license for a patent only or a license for patent plus technical know-how (see licensing package in Chapter Seven for more details).

B. Licensing Restrictions

The restrictions are those explained in licensing issues in Chapter Three, such as geographical, procurement, and cross-licensing.

THE RESEARCH FOCUS

Since there exist no previous studies on technology licensing from the U.S. licensee's standpoint, this research study is unique. Therefore, the research is exploratory in nature and unique in its hypotheses. This thesis investigates the following issues from a U.S. licensees' standpoint:

1. The identification of the type of licensees in the State of Ohio and their characteristics (i.e., size, technical competence).
2. The characteristics of the licensed technology (i.e., stage of PLC and technical or marketing uncertainty).
3. The licensees' characteristics (i.e., dominance) and the pricing of the licensed technology (i.e., royalty rate) as well as the number of restrictions imposed by the licensor.
4. The identification of the type of licensing agreements (i.e., one-time vs. continuous) and licensees' characteristics (i.e., technical competence).

5. The licensees' motivations for entering licensing agreements and viability of licensing as a growth strategy.

6. The licensing impact as viewed by U.S. licensees.

Based upon the above issues and the previous discussion, we can formulate our research hypotheses.

THE RESEARCH HYPOTHESES

Generally, the first six hypotheses deal with the effects of the licensees' characteristics (size, technical competence, etc.) and the last two focus on the type of license agreements (one-time, continuous, etc.). These hypotheses are explained below in their alternative forms.

1. Hypothesis ONE - Small to medium-sized licensees tend to have had products which were in the "declining stage" of their product life cycle.

Hypothesis one formulates our discussions on small and medium-sized firms which are forced into bankruptcy because they do not have new and competitive technology and their existing product(s) have reached the declining stage of PLC. Acceptance of this hypothesis (alternative) implies that these firms start their search for new technology to substitute for their existing technology to stay alive and prosper.

2. Hypothesis TWO - Small to medium-sized licensees are more likely to acquire a license to manufacture products whose manufacturing process (know-how) is

related to that of their existing products (same product line, same process, or same standard industrial code [SIC]).

Hypothesis two simply says that small and medium-sized firms are more likely to purchase a technology directly related to their existing ones because they understand and absorb it better, faster, and at a lower cost. This might not be the case for large firms with different motives for taking license (diversification).

3. Hypothesis THREE - Licensees with a high ratio of scientists and engineers are more likely to acquire the license at an "earlier stage" in the International Product Life Cycle (IPLC) than those with a fewer number of such core-skills personnel.

Naturally, when the licensee has technical competence, it will be in a position to acquire technology at its "earlier" stage of PLC where the risks are higher. Licensees without core-skills, therefore, have to acquire technology (product) at "later" stage of PLC where technology has been commercially proven and the risks are lower. These licensees do not have the qualified personnel to understand, absorb and adapt a technology at "earlier" stages.

Hypothesis FOUR - Licensees with a high ratio of core-skills (technically competent) will tend to begin operations under license in environments of higher

technical uncertainty than those with a lower proportion or no such personnel (technically non-competent).

5. Hypothesis FIVE - Technically competent licensees will tend to take a license under environments of higher marketing uncertainty than non-competent licensees.

Hypotheses four and five directly stem from hypothesis number three except the focus of hypothesis four is on "technical" uncertainty and that of hypothesis five is on "marketing" uncertainty.

6. Hypothesis SIX - "Dominant" licensees are more likely to be able to negotiate a lower royalty rate and fewer restrictions in the license agreement than non-dominant licensees.

Hypothesis six focuses on "dominance" characteristics of licensee and the impact of such characteristics on the licensing compensation arrangements. We argue that when the licensee is the dominant party, the royalty fees paid to the licensor is lower or the number of restrictions imposed by the licensor are fewer. This is not the case for non-dominant licensees.

7. Hypothesis SEVEN - Licensees with continuous license agreements are more likely to go through the "licensing cycle" than those with only one-time agreements, provided they gradually build their own in-house core-skills.

When licensee acquire technology on "continuous" basis although the probability of "dependence" on licensor exists, provided that the licensee builds its own in-house competence (with the help of the licensor and the experience acquired while manufacturing under license), those chances are minimized. After the licensee has acquired the competence, the existing agreement with the licensor could be renegotiated and/or canceled. Such is not the case for one-time and only current technology agreements. This hypothesis is a direct result of our argument about the licensing cycle model.

8. Hypothesis EIGHT - License agreements on a continuous basis are more likely to have higher restrictions (geographical, procurement, etc.) than non-continuous or one-time agreements.

Hypothesis number eight compares license agreement types. Obviously, when the agreement is on "continuous" basis the amount of information and assistance provided by the licensor to the licensee is much more higher than those of "one-time" contracts. Consequently, the licensee has to compensate the licensor accordingly. The compensation might be in the form of higher licensing fees (royalty) or the number of restrictions in the agreements.

Based on our research model and research hypotheses, we should expect the following tabulated distribution of licensees. The expectations of our hypotheses are

summarized in Tables 13 and 14. Note that Less (L) and More (M) indicate the expected frequency of licensees in each cell.

TABLE 13
SUMMARY OF RESEARCH HYPOTHESES--LICENSEES' CHARACTERISTICS

LICENSEES' CHARACTERISTICS	TECHNOLOGY LIFE CYCLE (Stage)		TYPE OF LICENSED TECHNOLOGY		TECHNICAL UNCERTAINTY (degree of)		MARKETING UNCERTAINTY (degree of)		ROYALTY RATE (% of sales)		LICENSE RESTRICTIONS (Number)	
	Earlier	Later	Related	Unrelated	Low	High	Low	High	Less than 3%	More than 3%	One or less	Two or more
Small	L	M	M	L	M	L	M	L	L	M	L	M

Large					L	M	L	M	M	L	M	L
With Core-skills	L	L	L	M	L	M	L	M	M	M	M	M

Without Core-skills			M	L					L	M	L	M
Dominant	M	L	L	M	L	M	L	M	M	L	M	L

Non-dominant	L	M	M	L	M	L	M	L				

Note: 1) L (Less) or M (More) indicates number of firms in that cell.
2) Shaded cells represent the research hypotheses' expectation (1-6)

TABLE 14

SUMMARY OF HYPOTHESES--LICENSING AGREEMENT TYPE

LICENSE AGREEMENT TYPE	Cancellation of License by Licensee due to:		Licensees' R & D Capabilities		Production Difficulty		Number of Restrictions in the License	
	Patent Life & Disagreement	Licenses' Competence	De-creased and Un-changed	In-creased	De-creased	In-creased and Un-changed	One	Two or More
Continuous	L H7a	M	L H7b	M	M H7c	L	L H8	M
One-Time	M	L	M	L	L	M	M	L

Note: 1) Less (L) and More (M) indicate number of firms in that cell.

2) Shaded cells correspond to research hypotheses' expectations (7 and 8)

CHAPTER SIX

THE RESEARCH DESIGN

RESEARCH METHODOLOGY

In order to carry out our research and empirically test our hypotheses (discussed in Chapter Five), we need to operationalize the hypotheses and put them in a statistically testable form. But before that, we need to talk about our sample, population, and research instrument.

Population and Sampling

Our universe consists of all of the licensees in the United States, and our sample consists of all the Ohio licensees. These Ohio licensees are part of 4,038 Ohio manufacturing firms which had participated in Professor Nehrt's Survey of Ohio Exporter Directory. One hundred forty-four of the participants had indicated that they were licensees to foreign licensors, but further investigations revealed that 27 were neither licensees nor manufacturers. We wanted to focus only on manufacturing licensees.

Consequently, our sample consists of 118 Ohio manufacturing licenses [a complete list of these firms and their profiles (i.e. size, industry) are in the appendix].

Research Instrument

Since there is almost no literature on our special topic and there is no public information on international

licensing of technology (for a good reason--trade secret!), it was decided to use a questionnaire as our main research instrument. Also, interviews with 10 licensees' executives were part of this process. After reviewing the literature, (almost all of the literature on international licensing of technology has taken a licensor's standpoint--see Chapter Four), a comprehensive list of important issues in technology licensing (from the licensee's standpoint) was collected. Then consultation with various organizations (i.e., L.E.S.) as well as executives involved in international licensing of technology began, and after a six month period, a comprehensive questionnaire was designed. We wanted the questionnaire to be specific and operational enough to reveal answers to the research questions, yet general enough to entice the executives to answer the questions without revealing any "privileged" information or trade "secrets."

(a) Validity

Several measures were taken to insure the validity of the instrument both in terms of content validity and criterion-related validity. First, a bank of about 100 items was gathered from the literature. Second, the bank of items was sorted out by a panel of eight judges consisting of professors and company executives to determine the appropriateness and length of the items of the questionnaire. Finally, the bank of items was sorted

out by the eight judges into categories of companies engaged in reverse licensing and the taxonomy of factors that motivated such companies. A simple consensus by these judges finally determined which items were best representative of the identified subscales.

(b) Reliability

Our questionnaire was designed in a Likert Scale form and was first sent to 30 randomly selected firms for a "pilot" study. The goal was to determine the reliability (replicability) of the questionnaire. Thirty of the returned questionnaires were coded, tabulated and examined for reliability (internal consistency) of the survey instrument using the split-half method in conjunction with the Spearman-Brown Formula. The split-half method consisted of splitting the questionnaire items into 13 odd and 13 even numbered items. First the two halves were correlated and then the reliability of the whole instrument was determined using the value of the correlation coefficient between the two halves (the Spearman-Brown Formula). The calculations were done manually. The value of the reliability coefficient was found to be 0.94, which indicates that the questionnaire was very highly reliable. [See appendix to this dissertation for calculations of reliability coefficient (r^2) as well as the questionnaire.]

In the next section, we introduce our statistical

design for our data analyses and explain the relationship between the research hypotheses and the research instrument (questionnaire).

STATISTICAL DESIGN AND DATA ANALYSIS

(1) The Choice of Chi-Square as the Test Statistic

Because the data will be in the form of frequencies, and furthermore because the subsequent data analysis must basically involve the analysis of frequencies, the Chi-Square becomes the appropriate choice over all other test statistics. Chi-Square is among the most popular statistical inference procedures today. It is typically easy to implement and can tell one a great many characteristics of a random variable or set of random variables. Chi-Square is widely used for tests of INDEPENDENCE and CONTINGENCY TABLES, tables used to display the dependence of two or more variables. The hypotheses are tested for INDEPENDENCE using their NULL form, which is basically the difference between the "observed frequencies" and the "expected frequencies." With the power of the Chi-Square test, we are able to discover the presence or absence of relationship among our research variables. Once a relationship is found, how can we determine the degree of intensity of that relationship or the strength of the association? Our chosen alpha level for statistical significance is 0.05.

(2) The Choice of Gamma as the Measure of Association

Among the commonly known measures of association, Gamma has the advantage of being more sensitive to the differential distributions of the categories of independent variables. The contingency coefficient is not used because of two apparent weaknesses: (i) it has no sign, and (ii) it never reaches 1 (one), hence, it is not clearly interpretable (see appendix for more detailed analysis). Also, while Lambda and tau both measure the relative reduction in errors of predicting the correct category of dependent variables, Gamma measures the relative reduction in errors of predicting order on the dependent variable. The data in this study is ordinal data. Another advantage of Gamma is simply the fact that while the numerical value of Gamma represents the strength of association, a positive sign indicates that the variables increase concomitantly whereas a negative sign indicates that, as one variables increases, the other decreases.

THE RELATIONSHIP BETWEEN OUR HYPOTHESES AND RESEARCH INSTRUMENT (QUESTIONNAIRE)

The first hypothesis deals with licensees' characteristics (size) and the licensed technology characteristics (PLC). This hypothesis is translated into questions number 3 (size) and number 7 (PLC) of the questionnaire.

The second hypothesis, similarly, translates into questions number 3 (size) and 9 (type) of our questionnaire.

The third hypothesis focuses on licensee's characteristics (core-skills) and the technology characteristics (PLC). The related questions in our questionnaire are number 3c and number 8.

The fourth and fifth hypotheses focus on licensees' characteristics (core-skills) and the licensed technology characteristics (technical and marketing uncertainties). The related questions in our questionnaire are 3c and 12-1 and 12-2 respectively.

Hypothesis number six focuses on licensees' characteristics (dominance) and the license agreement characteristics (royalty rate and restrictions). The related questions are numbers 11, 20 and 17 respectively.

Hypothesis number seven focuses on the LCM and licensing agreement type. The related questions in the questionnaire are numbers 16, 21, and 23 respectively.

Finally, hypothesis number eight focuses on the licensing agreement type (i.e., continuous or one-time vs. restrictions). the corresponding questions, in the questionnaire, are numbers 16 and 17.

In Chapter Seven, the data gathered by our research instrument (questionnaire) will be statistically tested using test statistics introduced in this chapter. Also, the statistical results will be compared with the results from our interviews with Ohio licensees' executives.

CHAPTER SEVEN

RESEARCH RESULTS AND STATISTICAL ANALYSIS

RESEARCH RESULTS: OVERVIEW

This chapter consists of two parts; the first explains how the research was done and the characteristics of the respondents. The second focuses on research results and statistical analysis. We also compare our statistical analysis with the results of our interviews with the licensees' executives. The goal is to see whether our statistical analyses are consistent with what is practiced in real life.

After we were sure that our research instrument was a very reliable one with a very strong correlation coefficient ($r^2 = .94$), the questionnaire was mailed to all 118 firms mentioned earlier. After one month, a second questionnaire was sent to non-respondents. Following the second mailing, most of the non-respondents were also contacted by telephone. The goal was to entice the executives to participate in the survey and to make arrangements for our post-survey interviews with the executives. The goal was to get a better and first hand feel for licensing activity as well as substantiate our statistical analyses. As a result, a total of 51 complete and useful questionnaires were used in our statistical analyses (this is a 43% response rate).

Most of the information contained in the questionnaires was checked later with the public sources (i.e., Standard & Poor's and Harris Ohio), as well as with those executives interviewed and the firms' annual reports. The aim was to make sure that we were using reliable data in our statistical analyses. Fortunately, most of the respondents were either the president, vice-president, or one of their chief executives. The post-survey interviews with ten licensees' executives were with the firms' presidents or chief decision-makers in international licensing area. Table 15 shows the distribution of the companies surveyed, the participants, with the size classifications.

TABLE 15

DISTRIBUTION OF OHIO LICENSEES' SURVEY AND FIRM SIZES

Size Group	No. of Employees	Annual Sales (\$ mill)	Total	Respondents		Non-Respondents	
				No.	Percent	No.	Percent
Small	1-99	\$ 25	50	24	47	26	39
Medium	100-499	100	38	13	25.5	25	37.2
Large	500+	100+	<u>30</u> 118	<u>14</u> 51	<u>27.5</u> 100	<u>16</u> 67	<u>23.8</u> 100

FIGURE 19

LICENSEES' INTERNATIONAL INTEREST

Knowledge about international markets is "perhaps the most important element in the internationalization process" of business. Without such knowledge, a domestic firm is unaware of international opportunities. Of the corporations surveyed, 84 percent indicated that they had international exposure prior to entering the licensing agreement. This exposure could range from a simple foreign distribution agent (41%) to a full overseas manufacturing, sales and service facility (27%). Table 16 and Figure 19 show the international interests of companies surveyed.

TABLE 16
 LICENSEES' INTERNATIONAL INTERESTS

	<u>Number of Respondents</u>	<u>Percentage</u>
1. Overseas Manufacturing, Sales and Service Facilities	14	27
2. Overseas Sales & Service Only	8	16
3. Foreign Distribution Agents	21	41
4. Domestic Operations	<u>8</u>	<u>16</u>
Total	51	100

Different firms used different methods for tapping international opportunities. These methods could basically be classified into five categories. The first is the executive's personal contacts. Because of their experience and exposure to international markets, and because of the nature of the job, it is natural to have different contacts around the world. This method ranked the highest in our survey (weighted average response of 42.8). The second category is direct marketing effort by the parties involved. This direct effort could be initiated by the licensee or the licensor. This category ranked second and third in our survey. The third category is trade and scientific publications (Tech Trade, Le Nouvelle, etc.), associations (LES = Licensing exchange society), or conventions which ranked fourth in the survey. The fourth method used by licensees in tapping international markets and/or locating their licensors was licensing brokers.

These brokers specialize in matching potential licensors and licensees. The last method is getting governmental or international institutional assistance. The government could be the home or host government, and the international institution could be UN, UNIDO, WIPO, etc.

Table 17 and Figure 20 summarize the methods used by licensees in this survey and the importance of each method as viewed by respondent to the survey.

TABLE 17
METHODS USED BY LICENSEES IN LOCATING TECHNOLOGY

	<u>Average Mean Response</u>
1. Personal Contact	42.8
2. Direct Marketing Effort by Licensee	33.8
3. Direct Marketing Effort by Licensor	30.6
4. Trade & Scientific Publications Association and/or Conventions	26.4
5. Foreign Government and/or International Institutions	14.6
6. Licensing Brokers	14.6
7. Home Government Assistance	13.6

FIGURE 20

METHODS USED BY LICENSEES IN LOCATING TECHNOLOGY

West Germany, the United Kingdom, and Japan account for more than 61 percent of the licensors in this survey with West Germany leading the list (34%). Figure 21 shows the home-country of licensors and their rankings.

FIGURE 21

HOME COUNTRY OF LICENSORS

Table 18 shows relationship between the licensees and their licensors prior to the license agreement.

TABLE 18
LICENSEE--LICENSOR RELATIONSHIP

	<u>Number of Respondents</u>	<u>Percentage</u>
1. No Relationship	26	51
2. Licensee as Licensor's Distribution Agent	8	15
3. Licensor as Licensee's Distribution Agent	4	8
4. Other Licensing Arrangements	6	12
5. Others (i.e., Partnership)	<u>7</u>	<u>14</u>
Total	51	100

Most of the respondents to our survey came from non-electrical manufacturing (SIC 35), chemicals (SIC 28), fabricated metal (SIC 34), and stone, clay and glass (SIC 32). Figure 22 shows the distribution of these licensees by industry.

FIGURE 22

DISTRIBUTION OF U.S. LICENSEES BY INDUSTRY

Figure 23 shows the motivations of licensees for acquiring foreign technology through licensing. Licensees clearly indicated that they entered licensing agreements because they needed the technology, to supplement their own R & D, to diversify, to avoid risks of R & D expenditure, or simply to acquire the right to operate because of patent laws. These licensees had realized that in order to survive the international competition, they needed to have new and more efficient product(s) or process(es). There are two ways to stay competitive: (1) do your own internal R & D and develop new products or processes, (2) buy technology from external sources through licensing. Each option has its own advantages and disadvantages. (Explained in Chapter Three). For now, the major advantages of developing one's own technology are the "independence" and "internationalization" issues. The major disadvantages are the costs, timing and "Not Invented Here (NIH) Syndrome" which could alienate licensees' core-skills.

FIGURE 23

LICENSEES' MOTIVATION FOR TECHNOLOGY LICENSING

The major advantage of licensing are clearly the costs, timing and risks involved. In most cases, the licensor has already introduced the technology in the home-market, and therefore the product is commercially proven. The R & D costs are at least partially recovered. Thus, the licensor looking at the royalties as a "residual" income, can afford to sell the technology at a cost below what it would have cost the licensees had they decided to develop the product on their own. Since the product is commercially tested, the risks are minimal and, in most cases, the royalty payments are related to the volume of licensees' sales or profits. Also, the costs to the licensee are contingent upon the success of the licensed product. A major disadvantage of licensing technology from

licensees' viewpoint is the important issue of 'technology dependence' on the licensor. To remedy this shortcoming, different ways are explained in detail under 'Licensing Model--Licensing Cycle' (See Chapter Five).

TABLE 19

LICENSEES' MOTIVATION FOR TECHNOLOGY LICENSING

<u>Motivation</u>	<u>Weighted Average Response</u>
1. To acquire the needed technology and/or supplement own R & D	38.2
2. To diversify operation	36.4
3. To avoid risk of R & D expenditure and/or acquire technology not available in the U.S.	32.2
4. To acquire the right to operate because of patent	26.0

TESTING OF HYPOTHESES AND STATISTICAL ANALYSIS OF RESULTS

FIGURE 24

LICENSEES' PRODUCT'S LIFE CYCLE (STAGE) IN THE U.S.
(Prior to Licensing)

Hypothesis Number ONE:

- H_0 : In international technology licensing, the stages of product life cycle and licensee's size are independent.
- H_1 : Small to medium-sized licensees will tend to have had products which were in the "declining stage" of their product life cycle prior to licensing. Table 20 and Figure 24 summarize the empirical results.

TABLE 20
LICENSEES' SIZE AND PRODUCT LIFE CYCLE

Licensees Size	Product Life Cycle Stage		Total
	Earlier	Later	
Small & Medium	10 (27.03)	27 (72.97)	37
Large	9 (64.29)	5 (35.71)	14
Total	19	32	51

(Note: Number inside parenthesis in each cell indicates row percentages.)

SAS: Statistics for two-way Tables

Chi-Square (χ^2) = 6.032 Df = 1 probability = .0140

Continuity Adj. Chi-Square = 4.543 Df = 1

Gamma = -0.659

Because $x^2 = 6.032$ and the probability is .0140, we reject the null hypothesis. This implies that small to medium size licensees have had products which were at the "declining" stage of PLC. As was explained earlier, for these small to medium-sized firms (usually single product), in order to survive, need to have new products. They either have to do in-house R & D and develop new products, or they have to buy the technology to keep them afloat. Licensing of technology turns out to be the option chosen by the companies surveyed. The motivations of these licensees are explained throughout this paper. In the case of these companies surveyed, basically licensing of technology was an extension of their life, without which they have had to close their doors. This point was clearly repeated by the executives interviewed. Perhaps the following statement by the president of a medium-sized machine tool company best summarizes the executives' view:

" . . . We bought technology to stay competitive and without the German's help, we couldn't have done it It is probably cheaper to do it that way than to develop it yourself. There's a limit to your capability and I think we are seeing more and more of this. Not just companies our size, but even IBM and others Why does GM have a deal with ISUZU? or Toyota? Or why does AT&T have a deal with Olivetti?"

Hypothesis Number TWO:

H_0 : Licensees' size and type of licensed technology are independent.

H_1 : Small to medium-sized licensees are more likely to acquire license to manufacture product(s) whose manufacturing process (know-how) is related to that of their exiting products [same product line, same process, or some standard industrial code (SIC)] than larger licensees.

TABLE 21

LICENSEES' SIZE AND TYPE OF LICENSED TECHNOLOGY

Licensees Size	Type of Licensed Technology		Total
	Related tech.	Unrelated tech.	
Small & Medium	27 (72.97)	10 (27.03)	37
Large	5 (35.71)	9 (64.29)	14
Total	32	19	51

(Note: Number inside parenthesis in each cell indicates row percentages.)

SAS: Statistics for two-way Tables

Chi-Square = 6.032 Df = 1 Probability = .014

Continuity Adj. Chi-Square = 4.543, Df = 1, Probability = .033

Gamma = .659

Because of their limited resources and expertise, and because of easier technology diffusion, small to medium-sized licensees tend to buy a technology directly

related to their existing technology (same product line, same process, etc.). They normally lack the required resources (R & D) to develop technology that they need. When they lack such resources, buying unrelated technology requires its own expertise and know-how and therefore they would not be able to utilize the technology. In most cases, they simply buy the related technology in order to survive and if they desire to buy unrelated technology, they have to have a reasonable number of qualified scientists and engineers to facilitate the transfer process. And if they can afford to have such core-skill personnel, perhaps they could afford to live without the foreign technology. But the major problem is that these firms usually lack such personnel. As a result they have to stay with what they know and what they do best.

Almost 73 percent of small and medium sized licensees surveyed indicated they bought similar and related technology. But 65 percent of the larger licensees bought unrelated technology which clearly indicates that larger firms can afford to venture into new fields because of their resources. A Chi-Square (χ^2) of 6.032 with probability of 0.014 indicates that the test statistic is significant at .01 and of course the null hypothesis is rejected. A Gamma of .659 shows a moderately strong association between the variables (licensee size and type of technology acquired).

Interviews with the licensees' executives later on clearly substantiated the above findings. Consensus among executives was:

" . . . Similar products require the least amount of investment and changes on our part. We already had the resources and knowledge to accommodate the technology The transfer process was easier and faster . . . that's what we wanted. We couldn't afford spending more on R & D and/or hiring new personnel . . . Different or unrelated product(s) is a whole new world to us. It is like starting from scratch and we couldn't afford that."

FIGURE 25

COMPARISON BETWEEN LICENSED PRODUCT AND LICENSEES' OTHER PRODUCTS

More than 64 percent of those surveyed indicated that the technology they bought was similar to their own technology (product) or used a similar manufacturing process. Figure 25 compares the licensees' other products with the licensed product and Hypothesis Number 2 statistically verifies that small to medium-sized licensees

do acquire a technology similar to their own.

More than 60 percent of the respondents indicated that the licensed products were in the "later" stage of the Product Life Cycle. Only 39 percent indicated they bought technology at its "earlier" stage. Interviews with the executives revealed that almost all of those which bought technology at an earlier stage (R & D level or early commercial use) either had very qualified core-skill personnel (more than 3.5 percent spent on R & D or more than 25 for every 1,000 employees), or licensing was more of a "marriage of convenience" for both parties. The bottom line is that it is almost impossible to buy technology at its "earlier" stage (especially at the R & D stage) without sufficient numbers of qualified scientists or engineers. Such an attempt is doomed to failure. Hypothesis number three statistically substantiates this point and Table 22 summarizes the licensed products' PLC stage in the licensor's market.

TABLE 22

LICENSED PRODUCT'S LIFE CYCLE IN LICENSOR'S MARKET

Stage of PLC	Number of Respondents	Percentage of Respondents	Rank
<u>R & D Stage</u>	3	5.8%	3
<u>Early Commercial Stage</u> (Less than 5 years)	17	33.4%	2
<u>Mature Stage</u> (In commercial use more than five years)	28	55.0%	1
<u>Declining Stage</u>	<u>3</u>	<u>5.8%</u>	3
Total	51	100.0%	

Hypothesis Number THREE:

- H_0 : Licensees' R & D and technical capabilities (core-skills) and the PLC "stage" of technology acquired are independent.
- H_1 : Licensees with a high ratio of scientists and engineers (core-skills) are more likely to acquire license at an earlier "stage" in the international product life cycle (IPLC) than those with fewer number core-skills employees.

TABLE 23

LICENSEES' CHARACTERISTICS AND PRODUCT LIFE CYCLE

Characteristics	PLC of Licenses Technology		Total
	Earlier Stage	Later Stage	
With Core-Skills	13 (56.52)	10 (43.48)	23
Without Core-Skills	8 (28.57)	20 (71.43)	28
Total	21	30	51

(Note: Number inside parenthesis in each cell indicates row percentages.)

SAS: Statistics for two-way Tables

Chi-Square = 4.073 Df = 1 Probability = .0436

Phi = .283

Continuity Adj. Chi-Square = 3.001, Df = 1, probability = .08

Gamma = .529

The null hypothesis will be rejected because of $X^2 = 4.073$ with degree of freedom = 1, and the probability of .0436 (significance level). The alternative hypothesis will be accepted which is what was expected. When a technology (product) is at its earlier stage of international product life cycle (IPLC), the degree of uncertainty about the product is higher. Little is known about the technology and its commercial success, which is not the case for a commercially proven product (this tends to happen at the later "stage" of the product--when the product is

"standardized"). At an earlier stage ("R & D" stage or "introduction" stage or "growth" stage), the recipient of technology (licensee) must have the resources (scientists and engineers--core skills) first to understand the technology and then to implement it--basically facilitate the transfer. Licensees with a higher percentage of their employees as core skill (R & D or technical) can afford to enter a licensing agreement for a product at its "earlier" stage of IPLC.

In our sample, 56.5 percent of those licensees with core-skill personnel bought technology at its earlier stage but only 28 percent of those without core-skills could afford to take the risk of entering a license agreement for a product at an earlier stage. Of the respondents, 71 percent indicated that they bought technology when the technology was commercially proven or at its "later" stage of IPLC (Table 23).

Hypothesis Number FOUR:

H_0 : Licensees R & D and technical capabilities (core-skills) and technical uncertainties associated with the licensed technology are independent.

H_1 : Licensees with a high ratio of core-skills (technically-competent) will tend to begin operations under license in environments of

higher technical uncertainty than those with a lower proportion or no such personnel.

TABLE 24

LICENSEES' CHARACTERISTICS BY DEGREE OF
TECHNICAL UNCERTAINTY

Licensees' Characteristics	Technical Uncertainty		Total
	Low	High	
With Core-Skills	8 (34.78)	15 (65.22)	23
Without Core-Skills	18 (66.67)	9 (33.33)	27
Total	26	24	50

(Note: Number inside parenthesis are row percentages.)

SAS

Chi-Square (X²) = 5.059, Degree of freedom = 1, probability = 0.245

Continuity Adjusted Chi-Square = 5.318, Degree of freedom = 1, probability = .0458

Gamma = -.579

Because X² = 5.039 with one degree of freedom and probability of 0.0245 (significance level), also continuity adjusted Chi-Square of 5.318, df = 1, and probability of 0.0458, the null hypothesis will be rejected at .05 level.

A gamma of -0.579 shows a moderate inverse association between research variables (licensees' characteristics and degree of technical uncertainty associated with the licensed technology). The alternative hypothesis will, therefore, be accepted.

The empirical results are consistent with the alternative hypothesis. Of the licensees with core-skills, 65.2 percent did actually acquire technology where technical uncertainties were high. On the other hand, almost two-thirds of those without core-skills purchased technology with a low degree of technical uncertainty.

The product life cycle and technical uncertainties are closely related. At the "introduction" stage, technical uncertainties are much higher than in the "standardized" stage. Naturally, licensees without core-skills personnel cannot afford to acquire technology at its "earlier" stage of PLC. They do not have the 'technical expertise' to comprehend the technology. This is not the case for licensees with core-skills. Their core-skill employees would allow them to venture into new technology and the diffusion process is smoother where there are qualified scientists and engineers on the licensees' staff.

The newer the technology, the higher the degree of technical uncertainties involved. The uncertainties or risks are essentially associated with the degree of technical "success" or "failure" of the technology. When the new technology is utilized, the uncertainties involved diminish over time. Licensees without core-skills, therefore, seek commercially proven technology when technical uncertainties are minimal.

Vernon (1966) and Hirsch (1967) have emphasized the

lack of product standardization and fluctuations in required materials and processes as the major sources for higher technical uncertainties in the "earlier" stages of PLC.

The product itself may be quite unstandardized for a time, its inputs, its processing and its final specifications may cover a wide range. Contrast the great variety of automobiles produced and marketed before 1910 with the thoroughly standardized products of 1930's.(1)

As a product goes through different "stages" of its life cycle, technical uncertainty declines. At the "introduction" stage, techniques change very rapidly, in the "growth" stage variations in techniques still are frequent, and in the "mature" stage changes and innovations are very few.(10) The technical uncertainty declines over time and with the maturity of the product. It also varies from product to product.

Technical uncertainty varies from product to product, even at the same stage of product life cycle. That is, there will likely be more technical uncertainty in the early stage of a new video tape recorder than the early stage of a new pair of shoes, although in both cases this uncertainty will decline over time.(2)

Hypothesis Number FIVE:

H_0 : Licensees' R & D core-skills and marketing uncertainties associated with the licensed technology are independent.

H_1 : Licensees with a high ratio of core-skills employees will tend to begin operations under license in environments of higher marketing

uncertainty than those with a lower proportion or no such personnel.

TABLE 25

LICENSEES' CHARACTERISTICS BY DEGREE
OF MARKETING UNCERTAINTY

Licensees' Characteristics	Marketing Uncertainty		Total
	Low	High	
With Core-Skills	6 (26.09)	17 (73.91)	23
Without Core-Skills	20 (74.07)	7 (25.93)	27
Total	26	24	50

(Note: Number inside parenthesis are row percentages.)

SAS: Statistics for two-way tables

Chi-Square = 11.458, DF = 1, Probability = .0007

Continuity Adj. Chi-Square = 9.617, DF = 1, Probability = 0.0019

Gamma = 0.780

Because of Continuity Adjusted Chi-Square (X^2) = 9.617, degree of freedom = 1 and probability = 0.0019, the null hypothesis will be rejected. The alternative hypothesis will be accepted which basically says that licensees with core-skills will tend to acquire licenses to manufacture where the degree of marketing uncertainties is high. Similar to our discussion for technical uncertainties, licensees with core-skill employees will have the resources to venture into newer technology than

those without such skills.

Also there exists a direct relationship between marketing uncertainties and IPLC. The newer the technology in international markets, the higher the marketing uncertainties. Licensees with qualified core-skills (technical and marketing) can better evaluate the new technology and its chances of success in international markets. Obviously this does not imply that when a product is a "success" in one market, it is going to be a success in international markets. Cases are numerous where a product has been a success (technically and/or marketing) in one market and has been a failure in other markets due to technical and/or marketing mix. A prime example of a technical success or failure is the case of Honda when it was first introduced in the U.S. about two decades ago. Apparently the sub-compact Honda was not made for U.S. highways. Obviously the car had to be withdrawn from the market. A few years later, Honda introduced a different version of the Honda Civic which turned out to be among the most popular sub-compact cars in the U.S. today.

A prime example of marketing success or failure is perhaps the Chevy Nova's story in the Spanish speaking countries. Regardless of its technical performance in the U.S. and around the world, Nova apparently did not have that much success in Spanish speaking nations. The words "No va" mean "no go" in the Spanish language. Apparently

customers in Central America did not want to buy something which is not going to move! They wanted to buy reliable means of transportation!

A licensee with core-skills (technical and marketing) can afford to enter a licensing agreement under an environment of higher technical and marketing uncertainties. Their core-skills employees will be instrumental in the licensed products' technical and marketing success. This is hardly the case for licensees without such expertise. The empirical results substantiate the above argument.

Perhaps the analogy could be made between the declining marketing uncertainty and diffusion process involved in the adopting of a new product. Adopters of any innovation are generally classified into five groups, according to the order in which they adopt the innovation.(3)

Adopter Category

Innovators	First	2.5%
Early Adopters	Next	13.5%
Early Majority	Next	34%
Late Majority	Next	34%
Laggards	Remaining	16%

"Innovators" tend to have venturesome characteristics and are highly knowledgeable about international markets. In some cases they are the deviants from the norm. "Early Adopters" tend to have a higher position in the society and in most cases they are opinion leaders. They have some

knowledge of the product or innovation. "Early majority" tend to rush to adopt the innovation or product as soon as they are convinced that opinion leaders have adopted the innovation. "Late Majority" group is usually skeptical and they tend to wait until the public opinion strongly favors the innovation before they proceed. Finally, "Laggards" tend to be older, to be suspicious of innovations, and to take the past and tradition as their point of reference. Basically, the adoption process is conceived of a set of five mental stages through which an individual passes from first hearing about an innovation until he finally adopts it: (1) Awareness, (2) Interest, (3) Evaluation, (4) Trial, and (5) Adoption.(4)

Licensees with core-skills such as "early adopters" and "early majority," after having heard about the technology and having interest in the technology, are capable of evaluating the technology or even adopting it. These licensees have the capability of buying technology at a "technology level" where the product or process is not commercially proven. They have the core-skills to develop and successfully commercialize the product.

Licensees without core-skills, similar to "Late Majority" and "Laggards," being skeptical of innovations and taking the past and tradition as their point of reference, wait until public strongly favors the adoption. They don't have the resources to enable them to evaluate

the technology. To them, the new technology is a huge unknown. They have to wait for the technology to be commercially-proven and they usually purchase the technology at "production level" where there is no technical or marketing unknown.

TABLE 26
SIZE COMPARISON BETWEEN LICENSORS AND LICENSEES

	Variables:					
	Sales		Number of Employees		R & D Expenditure	
	No.	%	No.	%	No.	%
Licensee <u>SMALLER</u> than Licensor	34	68%	33	66%	34	68%
Licensee <u>EQUAL</u> to Licensor	1	2%	4	8%	5	10%
Licensee <u>LARGER</u> than Licensor	15	30%	13	26%	11	22%
Total	50	100%	50	100%	50	100%

Dominant vs. Non-dominant Licensees

A licensee is considered to be a dominant when it is larger than its licensor in terms of total sales, number of employees and/or R & D expenditure. In our sample, most of U.S. licensees were non-dominant. These licensees were smaller than their foreign licensors in terms of sales (68%), number of employees (66%), and R & D expenditure (68%). When a licensee is larger than its licensor, say in terms of sales or R & D expenditure, it will have the upper hand in the negotiation process and the chances are that it

can negotiate a license agreement in its favor.

This "dominant" characteristic provides the licensee with the opportunity to negotiate a license agreement with a lower royalty payment for the licensed technology than a non-dominant licensee. A dominant licensee will be able to enter an agreement with fewer number of restrictions (i.e., export, procurement) imposed on the licensee.

Table 26 compares the licensees in our sample with their licensors in terms of total sales, number of employees, and R & D expenditure. Hypotheses number six is a direct attempt to verify the above arguments. Hypothesis number six focuses on the royalty payment and restrictions in the license agreement and tests the "independence" between royalty rate and restrictions of the licensees dominant characteristics.

FIGURE 26

INTERNATIONAL TECHNOLOGY LICENSING TYPE OF
COMPENSATION ARRANGEMENT

The royalty rate and number of restrictions in the license agreement reinforce the idea that the dominant characteristics of licensee plays an important role in the compensation arrangements and the number of restrictions in the license agreement.

TABLE 27

INTERNATIONAL TECHNOLOGY LICENSING TYPE OF
COMPENSATION ARRANGEMENT

<u>Type of Compensation</u>	<u>Number</u>	<u>Percentage</u>
Percentage of Sales or Volume	42	49.4
Minimum Annual Payments	16	18.8
Lump Sum Payment	14	16.5
Licensed Product(s)	8	9.4
Graduated Decreasing Royalty	4	4.7
Graduated Increasing Royalty	1	1.2
Total	85	100.0

The compensation arrangement could take different forms. In most cases the percentage of sales or volume is the most widely used method (49.4% of our sample) in international licensing of technology. The minimum annual payments and lump sum payments are the two next important methods in our sample (18.8% and 16.5%, respectively). Table 27 and Figure 26 summarize the type of compensation arrangement and their frequency of use by U.S. licensees in our survey.

Hypothesis Number SIX: (a) Royalty rate vs. licensee's dominance

H_0 : The dominant characteristics of licensees and

the "royalty" rate are independent.

H_1 : "Dominant" licensees (larger than licensor in terms of size and/or R & D expenditure) are more likely to be able to negotiate a lower royalty rate than non-dominant licensees.

TABLE 28

LICENSEES' CHARACTERISTICS BY ROYALTY PAYMENTS

Characteristic	Royalty as a Percentage of Net Sales		Total
	Less than 3%	More than 3%	
Dominant	15 (83.33)	3 (16.67)	18
Non-Dominant	15 (46.88)	17 (53.13)	32
Total	30	20	50

(Note: Number in parenthesis indicate row percentages.)

SAS: Statistics for two-way tables

Chi-Square (X^2) = 6.38, DF = 1, Probability = .0115

Continuity Adj. (X^2) = 4.952, DF = 1, Probability = .0261

Gamma = 0.700

Because of $X^2 = 6.38$ with one degree of freedom, the null hypothesis will be rejected and the alternative hypothesis will be accepted at .021 significance level.

This indicates that dominant licensees in our sample did actually pay a lower rate than non-dominant ones.

Eighty-three percent of the dominant licensees were able to negotiate a license agreement with three percent or lower

and 16.7 percent had to pay more than three percent of their net sales (of the licensed product) as royalty. A Gamma of .7 indicate a strong association between the research variables (dominant characteristics and royalty rate).

On the other hand the case for non-dominant licensees was quite different. They were divided almost in half: 53 percent of the non-dominant licensees were paying more than three percent of their net sales to their licensors to compensate them for their licensed technology. Almost 47 percent were paying three percent or less of their sales as the royalty payment. This raised the question of how these licensees managed to negotiate such low rates. Further investigation and interviews with the licensee executives revealed that most (72%) of these licensees were able to negotiate a lower rate because their licensors were more interested in other things than royalty payments. The licensors in most cases were more interested in establishing their product in the U.S. market and/or they didn't have the resources to exploit the U.S. market by themselves (See The Masstron Inc. case).

Another reason for such an arrangement was because of "cross-licensing" arrangement between the licensor and the licensee. The licensors apparently had sacrificed their royalty rates for their access to the new development in the area of licensed technology by their licensees. In

some other cases the competition in the licensors' market as well as the type of the licensed technology had a major impact on the royalty rate. The number of restrictions imposed on the licensee was also important in the compensation arrangements. The lower the number of restrictions, the lower the royalty rate.

In the following paragraphs the empirical research on the pricing of technology licensing by other scholars will be reviewed.

The empirical results on pricing of technology licensing and royalty rates are inconclusive, in general, and vary within a wide range depending on the nature of the industry and the type of licensing agreements. (5)

Goldscheider & Marshall (1971) found that the royalty rate for all industries was 5-6 percent of the licensee's net sales. Enlow (1974) found the royalty rate to be 3-5 percent in the computer field. Conte (1976) studied the royalty payments in the pharmaceutical industry and concluded that the royalty rate was 10-15 percent of the licensee's net sales for "exclusive" licenses. The rate for a "sole" license was found to be 7-10 percent and for a "non-exclusive" agreement the rate was 4-7 percent of the licensee's net sales. Eckstrom (1977) found that the royalty rate for petroleum processes and products to be around one percent of net sales (i.e., Union Oil Company) and in some cases to be as low as .1 percent, but his

conclusion was that the overall rate for the petroleum industry was about five percent of net sales. Hashbarger (1971) found the rate to be 3-5 percent of licensee's net sales in the chemical industry. Talbott (1972) put the royalty rate at 1-5 percent for the automobile industry. Coogan (1972) concluded that the royalty rates for an "exclusive" license in the wood and paper products industry was six percent, but the rate for a "non-exclusive" license was 4-5 percent. Finally, Orlean (1982) looked at the pricing licensing of technology for "high tech" such as applied physics, optics and electronics and the royalty rate was found to be about five percent of the licensee's net sales.

Hypothesis Number SIX: (b) Licensees' dominance versus number restrictions in the license agreement

- H_0 : Licensees' dominant characteristics and the number of restrictions in the license agreement are independent.
- H_1 : Dominant licensees are more likely to be able to negotiate fewer restrictions in the license agreement than non-dominant ones.

TABLE 29
 LICENSEES' CHARACTERISTICS BY NUMBER OF
 RESTRICTIONS IN LICENSE AGREEMENT

Licensee's Characteristic	Number of Restrictions		Total
	One or Less	Two or More	
Dominant	13 (76.47)	4 (23.53)	17
Non-Dominant	13 (38.24)	21 (61.76)	34
Total	26	25	51

(Note: Numbers inside parenthesis indicate row percentages.)

SAS: Statistics for two-way tables

Chi-Square (X²) = 6.63, DF = 1, Probability = .01

Continuity Adj. Chi-Square = 5.188, DF = 1, Probability = .0227

Gamma = 0.680

Because X² is 6.63 and the degree of freedom is one, the null hypothesis will be rejected at .01 significance level. As a result, the alternative hypothesis will be accepted. The Gamma of .68 indicates a strong association between the dominant characteristics and number of restrictions in the license agreements. In fact, 76.5 percent of the dominant licensees were able to negotiate license agreements with one or less restrictions imposed on them by their licensors. The case for non-dominant licensees is different. Almost 62 percent of the dominant licensees had to accept two or more restrictions in their

license agreements. This is consistent with our earlier discussion of licensees' dominant characteristics and their bargaining power in the licensing negotiation. The restrictions are of various types with geographical restriction as the most widely used in the licensing agreement.

FIGURE 27

TYPE OF RESTRICTIONS IN THE LICENSING AGREEMENT

This research does not deal with the legal aspects of some of these restrictions (Figure 27), particularly the geographical (i.e., export) and procurement restrictions. It is illegal or violation anti-trust law to impose such restrictions (tying clauses) on the licensee. Analysis and implications of such restrictive clauses are not central to this research study.

Source: Welch (1985)

FIGURE 28

THE LICENSING PACKAGE

The Licensing Package

In order to effectively use technology licensing as a strategy for market penetration (as a licensor) and tapping of international sources of technology (as a licensee), firms need what Welch (1985) calls "the licensing package." The main components of the licensing package are shown in Figure 28.(1)

Non-patentable know-how is generally considered by users to be the critical part of technology transfers. Frequently the technological knowledge incorporated in patents is of limited value to potential users because of additional work needed prior to the introduction of the product in the market. Increasingly, both sellers and

buyers of technology recognize the value of "commercial know-how" in various forms. In many cases, the commercial "accompaniment" is the preeminent motivation for the licensee seeking the technology.(7)

Having discussed the importance of the commercial know-how, it should be natural for licensees in our survey to prefer the patent plus technical assistance package over pure patent rights. Table 30 shows the components of the licensing agreement or what was really acquired by the licensees in our survey.

TABLE 30

COMPONENTS OF LICENSE AGREEMENTS:
(What Licensees Acquired via Licensing)

<u>Agreement Transferred</u>	<u>Number of Respondents</u>	<u>Percentage</u>
Patent Rights Only	11	21.2%
Patent Rights plus Technical Assistance (know-how)	36	71.0%
Other	4	7.8%
Total	51	100.0%

FIGURE 29

**LICENSEES' MOTIVATIONS FOR LICENSE
AGREEMENT CANCELLATION**

EMPIRICAL TEST OF LICENSING CYCLE MODEL (LCM)

Hypothesis number Seven is a direct attempt to empirically test LCM. As explained in Chapter Five, licensees who have completed the licensing cycle (Stage Four of LCM) have a tendency to cancel their licensing agreements. In general, cancellation of license agreement might be due to (i) expiration of patent life; (ii) disagreement due to marketing and/or compensation arrangements; (iii) obsolescence or non-competitiveness of the licensed technology; and (iv) licensee's technical competence.

Sixty-four percent of the respondents to our survey had indicated that they had completed the licensing cycle

and had canceled their licensing agreements. Table 31 and Figure 29 summarize these licensees' motivations for the cancellation of their license agreements. Seventy-two percent of the cancellations were because of licensees' technical competence, technology obsolescence, and disagreement due to marketing and/or compensation arrangements. Nineteen out of thirty-three (57.6%) of these licensees had continuous licensing agreements and 42.4 percent had one-time agreements (See Table 32).

TABLE 31
LICENSEES' MOTIVATIONS FOR LICENSE
AGREEMENT CANCELLATION

<u>Motivation</u>	<u>Number</u>	<u>Percentage</u>
1. Patent Life Expiration	9	27.3%
2. Disagreement due to Marketing and/or Compensation Arrangements	7	21.2%
3. Obsolete or Non-Competitive Technology	7	21.2%
4. Licensees' Competence	<u>10</u>	<u>30.3%</u>
Total	33	100.0%

We statistically test hypothesis seven in three separate but interrelated ways: (a) licensee's motivations for canceling the agreement, (b) licensee's R & D capabilities, and (c) licensee's dependence on the licensor as well as production difficulties.

Hypothesis Number SEVEN: (a) License agreement type versus licensee's cancellation motives

- H_0 : Licensing cycle and type of licensing agreement are independent.
- H_1 : Licensees with continuous license agreements are more likely to go through the licensing cycle than those with one-time agreements.

TABLE 32

LICENSE AGREEMENT TYPE BY LICENSEE CANCELLATION MOTIVES

<u>License Agreement Type</u>	<u>Parent Life & Disagreement</u>	<u>Licensees' Competence</u>	<u>Total</u>
Continuous	5 (26.32)	14 (73.68)	19
One-Time	11 (78.57)	3 (21.43)	14
Total	16	17	33

(Note: Numbers in parenthesis are row percentages.)

SAS: Statistics for two-way tables

Chi-Square (X^2) = 8.812, DF = 1, Probability = .003

Continuity Adj. Chi-Square = 6.844, DF = 1, Probability = .008

Gamma = -0.822

Because X^2 is 8.812, with one degree of freedom and probability of .003 (significance level), the null hypothesis will be rejected and the alternative will be accepted. A Gamma of -0.822 shows a very strong inverse association between license agreement type and licensees'

motivations for cancellation of the license.

Seventy-three percent of licensees with continuous license agreements had canceled the agreement because of licensees' competence and 26 percent had canceled it due to the expiration of the patent life and/or disagreement with their licensors. On the other hand, 78.6 percent of licensees with a one-time agreement had canceled the agreement due to expiration of the patent and/or disagreement with licensors.

LICENSE AGREEMENT TYPE AND LICENSEES' CHARACTERISTICS

Crookell (1973) classified licensing agreements into three major categories:

- (1) All technology currently developed or to be developed by licensor.
- (2) All technology not in place by the licensor (the licensee must have in-house skills to develop future change himself).
- (3) License for a specific patented product, component, or process. (8)

The first type is different from the second and third because it includes the future technology to be developed by the licensor. This type of license agreement is basically continuous while the second and third are one-time agreements. For our purpose, we basically divide the agreement types into two broad categories: (1) continuous--a lasting but renewable agreement between the

parties, and (ii) one-time--this category includes a license for patent only or a license for patent plus technical know-how (see licensing package for detailed analysis of technical know-how and commercial "accompaniment").

The patent without know-how may be of limited value to the licensee, but like other elements in the "licensing package," it contributes to the marketability of the whole. For technology recipients, the existence of a patent is often the first checking point in their consideration of the technology or offer. It represents a stamp of technological credibility. A number of Australian firms, for example, have indicated that in order to reach the first stage of market penetration in the U.S., it was necessary to be able to offer U.S. patent rights.(9)

The success of a one-time agreement with the patent plus know-how (licensing package) is dependent upon the technical and marketing capabilities of the licensee. Since the ultimate success of the licensing arrangement depends on the success of the licensee, the contribution of the licensor will have a great impact on the end result. Unless the licensee has the capabilities to fully absorb the technology and market it successfully, the licensing of one-time will be doomed to failure. This doesn't mean that the licensee must have the core-skills prior to the licensing agreement. As long as the licensee realizes that

in order to absorb and apply the acquired technology, he needs to develop his core-skills with the assistance he receives through the licensing package. This assistance could be both technical and marketing--in essence what Welch (1985) calls commercial "accompaniment."

The continuous license agreement is quite different from the one-time agreement in that it includes a lasting relationship but a renewable one. The technological and marketing skills of the licensee in absorbing and applying the technology transferred are also critical. Much depends on the ability of both parties to establish and nurture a productive, interactive relationship, for it is through effective relationships that the technology is successfully transferred.(10) If the licensee does not have the necessary core-skills prior to a licensing agreement, and if he wants to achieve technological competence within a reasonable time, it is his responsibility to develop those core-skills through the licensing process. Welch (1985) succinctly explains the licensing process in Figure 30: the post-agreement activities will be critically important to both parties. If the licensee has to achieve technological "independence" (from the licensor), he has to develop his own core-skills and through long-run interaction with the licensor has to achieve technical and commercial competence.

FIGURE 30

THE LICENSING PROCESS IN A FOREIGN MARKET

Source: See Welch (1985), p. 47

It is important to realize that, although the licensor is concerned about future competitive threat from the licensee, in many cases it has a vested interest in the success of the licensee as well. Because, for whatever motive the licensor is licensing his technology and know-how, he realized that the success of the license is also the licensor's success. Therefore, it is up to the licensee's executive to look at licensing of technology as a strategic policy decision, and take the necessary steps throughout the process.

Hypothesis Seven deals with the licensing agreement types and licensees' characteristics. Hypothesis eight deals with the license type and number of restrictions

imposed on the licensee. Before getting into the discussion and empirical tests of the above hypotheses, it is appropriate to see what type of licensing agreements our sample (U.S. licensees) have. Table 33 shows that almost 61 percent of the respondents to our survey had licensing agreements of the continuous type as opposed to 39 percent with the one-time agreement.

TABLE 33
TYPE OF LICENSING AGREEMENT

	<u>Number of Respondents</u>	<u>Percentage</u>
One-Time Technology Transfer (Current Technology)	20	39.2%
Continuous Technology Transfer	31	60.8%
Total	51	100.0%

Hypothesis Number SEVEN: (b) License agreement type vs. licensees' R & D competence

H_0 : Licensees' R & D level and capabilities and type of licensing agreement are independent.

H_1 : Licensees with continuous technology agreements are more likely to develop their own in-home R & D competence than those with one-time agreements.

TABLE 34

LICENSE AGREEMENT TYPE OF LICENSEES' R & D CAPABILITIES

License Type	R & D Capabilities		Total
	Decreased	Increased	
Continuous	2 (6.45)	29 (93.25)	31
One-Time	14 (70.00)	6 (30.00)	20
Total	16	35	51

(Note: Numbers in parenthesis are row percentages.)

SAS: Statistics for two-way tables

Chi-Square (X2) = 10.679, DF = 1, Probability = 0.0011

Continuity Adj. Chi-Square = 8.522, DF = 1, Probability = 0.0011

Gamma = -0.845

Because of $X^2 = 10.679$ with one degree of freedom, we reject the null hypothesis at .001 level and accept the alternative hypothesis. A Gamma of $-.845$ indicates a very strong inverse association between the license type (continuous or one-time) and licensees' R & D capabilities. Ninety-three percent of licensees with continuous license type indicated that the R & D capabilities have increased as a result of the license agreement. Only 30 percent of licensees with a one-time agreement were able to increase their R & D capabilities, and 70 percent indicated that their R & D capabilities, in fact, decreased or remained unchanged. Post-survey interviews with licensees'

executives revealed that the main reason was that the licensees didn't need as many R & D personnel after the agreement! Although they had bought technology on a one-time basis, the agreement in most cases was a complete "licensing package" where the licensors provided them with technical and marketing know-how. As one senior executive put it:

. . .Immediately with the licensing arrangement, we realized that it was cheaper to buy the whole package and let them do the job [R & D]. All we needed was a few qualified engineers to adapt the technology. We had no reason to keep our R & D people and pay them very high, or at least that many Our relationship with our licensor is a very close one and they have helped us very generously Ten years down the road if we need new technology, we would not hesitate to contact our present licensor. If they have it and if they are reasonable, we will buy it from them. Otherwise we get it from somewhere else. We will see more and more licensing arrangements in the future. The costs [R & D] are half overseas [compared to U.S.].

Hypothesis Number SEVEN: (c) License agreement type vs. production difficulty and licensees' dependence on licensors

- H_0 : Type of license agreement and level of production difficulties associated with licensed technology and the degree of licensees' dependence are independent.
- H_1 : Licensees with continuous license agreement are more likely to be able to reduce or eliminate the production difficulties associated with licensed technology and to

reduce their "dependence" on the licensor than those with one-time agreements, provided they go through licensing cycle model.

TABLE 35

LICENSE AGREEMENT TYPE BY DEGREE
OF PRODUCTION DIFFICULTIES

License Type	Degree of Production Difficulties		Total
	Decreased	Increased	
Continuous	27 (87.1)	4 (12.9)	31
One-Time	7 (35.0)	13 (65.0)	20
Total	70	17	51

(Note: Numbers inside parenthesis are row percentages.)

SAS: Statistics for two-way tables

Chi-Square (X^2) = 8.4, DF = 1, Probability = 0.0038

Continuity Adj. Chi-Square = 6.641, DF = 1, Probability = 0.001

Gamma = 0.741

Because $X^2 = 8.4$ with one degree of freedom, the null hypothesis will be rejected at .0038 significance level. The alternative hypothesis will be accepted. The Gamma of .741 shows a strong association between license type (continuous or one-time) and the degree of production difficulties associated with the licensed technology.

Eighty-seven percent of licensees with a continuous agreement indicated that the degree of production

difficulties associated with licensed technology decreased and only thirteen percent indicated that it either remained unchanged or increased. Licensees with the one-time arrangement were equally divided.

It is natural that when the agreement is of continuous form, the relationship between the parties is closer, particularly if the licensee has the core-skills of his own. Because of the vested interests that the licensor has in the contract, the licensee's success is his ultimate goal. And if the licensee has the core-skills and through the assistance they receive (from the licensor), they should be able to overcome the difficulties (faster) than if the licensee does not have his own core-skills or if the licensing agreement is one-time only. Obviously, the licensor is more interested in a lasting but renewable relationship in most cases. The continuous type usually contains clauses for "cross-licensing" arrangements through which the licensor will have access to the new development on the licensed technology or in some cases the spill-overs.

Again the licensee must be cautious. A continuous licensing agreement would be beneficial if the licensee realizes the fact that he should not be trapped and be at the mercy of the licensor. A licensee with technical competence not only understands the technology but absorbs and applies the technology better and faster. The

licensing agreement and future cooperation with the licensor does not need to end when and if the licensee achieves the competence. Both parties could mutually benefit from the license through cross-licensing and no-royalty arrangements. Both could be licensor as well as licensee and both could share the high costs of R & D. The important message is that the licensee should try to learn the ART or technique of "fishing" if he does not want to be dependent on the licensor for the "fish." Table 36 summarizes the results of our survey: Licensees' View of Licensing Impacts. The results empirically verify the hypotheses 7b and 7c discussed in this section.

TABLE 36
LICENSEES' VIEW OF LICENSING IMPACTS

	Decreased		Unchanged		Increased	
	No.	%	No.	%	No.	%
Production Difficulties	34	66.7%	15	29.4%	2	3.9%
Licensees' Profit Margin	7	14.3%	18	36.7%	24	49.0%
Licensees' R & D Capabilities	4	7.8%	12	23.5%	35	68.7%
Licensees' Dependence on Licensor	35	68.7%	13	25.4%	3	5.9%

Hypothesis Number EIGHT:

H_o : Type of license agreement and number of restrictions in the agreement are independent.

H_1 : License agreements on a continuous basis are more likely to have higher restrictions (geographical, procurement, etc.) than non-continuous or one-time agreements.

TABLE 37

LICENSE AGREEMENT TYPE BY NUMBER OF RESTRICTIONS

License Type	Number of Restrictions		Total
	One or Less	Two or More	
Continuous	6 (19.35)	25 (80.65)	31
One-Time	14 (70.00)	6 (30.00)	20
Total	20	31	51

(Note: Numbers inside parenthesis are row percentages.)

SAS: Statistics for two-way tables

Chi-Square (X²) = 13.081, DF = 1, Probability = 0.0003

Continuity Adj. Chi-Square = 11.043, DF = 1, Probability = 0.0009

Gamma = -0.813

Because X² is 13.08 and the degree of freedom is one, the null hypothesis will be rejected and the alternative hypothesis will be accepted. The Gamma of -.813 shows a very strong inverse association between license type (continuous and one-time) and number of restrictions in the license agreement. The licensee will have access to the new developments on the technology by the licensor.

The restrictions could be of various forms; the most important include: (i) geographical; (ii) procurement; and (iii) cross-licensing (grant-back).

The legal aspect of these restrictions is not central to this research. The important point is when the licensee acquires a patent only (one-time) it could be that it is not that great a value to him (discussed earlier). Of course, when the agreement is for the patent plus technical assistance (licensing package), the licensor not only provides the licensee with the legal rights but he must facilitate the technology transfer (through his scientists and engineers). The adaptation process is not free of costs and the licensee has to pay for those costs. Finally, when the licensing agreement calls for a "continuous" transfer of technology from the licensor to the licensee, the transfer not only includes the current technology but the future development as well. Consequently, the costs associated with the continuous transfer (current and future) are going to be higher than a one-time transfer.

The licensee has to compensate the licensor for these costs.(11) The compensation could take various forms as discussed under compensation arrangement. In many cases, the compensation for the costs might take the form of restrictions in the license agreement. Of course, geographical restrictions limit the licensees' operations

to a specific market or region (i.e., North America). The procurement restriction is a kind of tying clause forcing the licensee to buy certain parts or materials from the licensor.

In addition the licensing income there is also the possibility of building up sales of associated plant and equipment, parts, raw materials, etc. In a study of Finnish companies licensing to independent foreign licensees, it was found that the aggregate value of exports of associated plant and inputs was more than double the value of licensing income (Oravainen, 1979, p. 99). Over one-third of respondent firms in an Australian study indicated that licensing has produced sales of associated product (Carstaris and Welch, 1981, p. 48).(12)

Table 38 summarizes the type of restrictions in the license agreements and their importance to U.S. licensees responding to our survey.

TABLE 38

TYPE OF RESTRICTIONS IN THE LICENSING AGREEMENT

<u>Type</u>	<u>Number of Respondents</u>	<u>Percentage</u>
Geographical	24	47.0%
Procurement	6	11.8%
Cross-Licensing (Grant-back)	18	35.3%
Other	3	5.9%
Total	51	100.0%

Tables 39 and 40 summarize our statistical analyses.

Table 39 focuses on the first six hypotheses and Table 40 summarizes hypotheses seven and eight.

TABLE 39
SUMMARY OF EMPIRICAL RESULTS STATISTICAL TESTING OF HYPOTHESES
(LICENSEES' CHARACTERISTICS)

LICENSEES' CHARACTERISTICS	TECHNOLOGY LIFE CYCLE (Stage)		TYPE OF LICENSED TECHNOLOGY		TECHNICAL UNCERTAINTY (degree of)		MARKETING UNCERTAINTY (degree of)		ROYALTY RATE (% of sales)		LICENSE RESTRICTIONS (Number)	
	Earlier	Later	Related	Unrelated	Low	High	Low	High	Less than 3%	More than 3%	One or less	Two or more
Small & medium	18 <i>H1</i>	27	27 <i>H2</i>	10	24	13	25	12	20	17	18	17
Large	9	5	5	9	6	8	6	8	7	7	8	6
With Core-skills	13 <i>H3</i>	10	11	12	8 <i>H4</i>	15	6 <i>H5</i>	17	18	5	15	8
Without Core-skills	8	20	21	7	16	9	20	7	12	16	12	16
Dominant	10	8	7	11	4	14	6	12	18 <i>H6</i>	3	18 <i>H6</i>	4
Non-dominant	9	24	25	8	18	15	17	16	15 <i>H6</i>	17	14 <i>H6</i>	21

TABLE 40
SUMMARY OF EMPIRICAL RESULTS
(Statistical Testing of Hypotheses)
(License Agreement Type)

LICENSE AGREE- MENT TYPE	Cancellation of License by Licensee due to:		Licensees' R & D Capabilities		Production Difficulty		Number of Restrictions in the License	
	Patent Life & Disagree- ment	Licen- sees' Compe- tence	De- creased	In- creased	De- creased	In- creased	One	Two or More
Continuous	5 <i>H1a</i>	14	2	28	27	4 <i>H1c</i>	6	25
One-Time	11	3	14	6	7	13	14	6

Note: 1) Entries represent number of firms in each cell.

2) Shaded cells correspond to research hypotheses.

EX ANTE AND EX POST ANALYSIS OF THE RESEARCH HYPOTHESES

(A Comparison Between the Predictions of the Research Hypotheses and the Empirical Results.)

The summaries of the research hypotheses' expectations (Ex-ante) are found in Tables 13 and 14. Also, the summaries of the empirical results (Ex-post) are found in Table 39 and 40. A comparison between Tables 13 and Table 39 (related to the first six hypotheses) clearly indicate that the empirical result were consistent with our hypotheses' expectations (the corresponding cells are shaded and numbered for identification of each of the research hypotheses and the empirical results).

The non-shaded cells are indirect implications of our research hypotheses and for that purpose, we speculated the ex-ante (less or more) in each cell. The empirical results are consistent with the expectation in all of the non-shaded cell except in two: (1) The licensees' size versus the royalty rate, and (2) The licensees' size (small and medium only) and the number of restrictions in the license agreement. In the following paragraphs we will explain reasons for such inconsistencies.

One reason for such inconsistency is that royalty rate is more a function of licensees' other characteristics such as "core-skills" and "dominance" (i.e., R & D spending) than the licensee's size. Our hypothesis six directly tests the independence between licensees' dominance and royalty rate and our empirical results are very consistent

with our research hypothesis. Also a closer look at licensee's core-skills versus royalty rate substantiate our argument.

The relative measure of licensees' characteristics (i.e., licensee's R & D spending as compared to the licensor's R & D both measured as a percent of sales or as a percent of number of employees for both parties), is more important and relevant than an absolute measure (i.e., licensee's size).

Another reason, confirmed by our empirical results, is that there exists a relationship between royalty rate (as a measure of compensation) and the type of license agreement in one hand, and the number of restrictions in the license agreement on the other. If the license does not compensate the licensor for the licensed technology in the form of royalty rate, it has to do so in the form of more restrictions in the agreement. The licensed technology and the "technical package" have a "price" tag regardless of the licensees' size under normal and arm's length arrangements.

The compensation for the licensed technology may take various forms of which royalty rate as a percent of net sales of the licensed technology is one. Others include "lump sum" payment, and "cross-licensing" arrangements which might have been the case for the above inconsistency. In other words, the licensees might have compensated the

licensors through lump sum payment, cross-licensing arrangements, or even number of restrictions imposed on them by the licensors. The restrictions may include geographical limitations, field-of-use, or procurement arrangements (typing clauses).

Still another reason is related to the royalty rate in various industries and its dependence on the nature of each industry and the type technology involved. In other words, royalty rate is more related to the nature and amount of licensed technology and the nature of industry than the size of licensing participants. The size of licensee might be a factor in the licensor's choice of the licensee (see Lodge and Shipley Corp. and Masstron Inc. case).

There seems to be another inconsistency between the indirect implications of our research hypotheses (ex-ante) and the empirical results (ex-post), when we compare the licensees' size and the number of restrictions in the license agreement. This inconsistency relates to small and medium-sized licensees and the number of restrictions. The empirical results related to large firms are consistent with the expectations.

One reason is that the number of restrictions in the license agreement is more of a function of the license agreement type (continuous vs. one-time) than the licensee's size. Also the number restrictions are more directly related to the nature of industry and the licensed

technology as well as the amount services (know-how) provided by the licensor to the licensee regardless of the licensees' size. Our hypotheses 6b and 8, indeed, support this argument and there is no inconsistency between the predictions of the research hypotheses and the empirical results.

LODGE AND SHIPLEY CORPORATION

Lodge & Shipley was established in 1910 and today, after almost 75 years, is a medium-sized manufacturing firm which employs about 450 and has an annual sales of approximately \$20 million. The principal products of the company are (1) machine tools, (2) packaging machinery, and (3) metal end products.

The products in the machine tools industry segment are standard lathes and numerically controlled lathes. The primary products of the packaging machinery segment are case packers and uncasers for bottles. The primary products of the metal end products segment are various metal component parts.

The principal users of the company's products are defense, atomic energy, automobile, farm equipment, machine tool, aircraft, oil service, brewing and soft drink, and various other industries. Therefore, the company's products in particular and the machine tool industry in general play a vital role of strategic importance in the U.S. industries.

Nineteen eighty-four was the third consecutive year of very depressed conditions in a large segment of the machine tool and machinery industries. Competition from imports into the U.S. market became even more intense, particularly as a result of the unexpected rise in the value of the dollar over the year.

It now seems apparent that our government has no intention of restraining machine tools, and thereby preserving minimum capacity for machine tool manufacturing capability in this country. Accordingly, the Company is making accelerated efforts to survive in this new environment, which can only be assumed to be a permanent way of life.(1)

Because of increased international competition and foreign imports, the machine tool industry suffers far more than any other basic industry. In the critical field of CNC machine tools, the Japanese alone account for an astounding two-thirds of the total U.S. market, and to the best of our knowledge, there is no bonafide effort on the part of U.S. authorities to restrain this volume.(2)

In order to survive, the Company initiated a licensing agreement with Olivetti of Italy to import their line of small CNC lathes. According to the Company's 1984 annual report, the Company's total display at the 1984 International Machine Tool Show was Olivetti products. As of 1984, the Company has two licensing agreements, one from Italy and one from West Germany. Without such arrangements, the Company in such a critical industry wouldn't have survived.

There were other U.S. firms interested in a license from Olivetti but according to Lodge & Shipley's president, the determining factor for Olivetti was the relative size of Lodge & Shipley. The licensor wanted to license its technology to a U.S. firm relatively smaller than the licensor, yet with established line of products and technical reputation.

The licensing arrangements gave the company the new and competitive technology to keep them afloat. As of early 1985, the Company was negotiating with a company in Brazil to sub-license the technology they acquired through licensing few years earlier.

(1) The Annual Report of Lodge & Shipley's President -- 1984, p. 3.

(2) Ibid., p. 3.

THE MASSTRON SCALE INC. CASE

Masstron is a relatively small high-tech scale company headquarters in Columbus, Ohio, established in 1978 when a licensing agreement was signed with a Swedish licensor. Today, Masstron employs 74 and has annual sales of approximately \$25 million with \$1 million in exports. Masstron has certain unique characteristics which make it different from other Ohio licensees.

1. The Company was established simply because the licensor's executives knew Mr. Ben Dillon, president and founder of Masstron, personally (a case not predicted by our research hypotheses and questionnaire).
2. Masstron receives the State-of-Art technology from the licensor. [A case not expected of small and newly-established firms and contrary to the established I.B. theories (FDI) where the proprietor of technology simply licenses its new technology to another firm (especially if that firm is in the U.S. with such a large market).] This case supports our argument that there are many small foreign firms with potentially good technology and very anxious to reach the U.S. market but lack financial resources. Reverse licensing is the best alternative (perhaps the only one) available to them.
3. In 1982, after only four years, Masstron not only opened subsidiaries in Canada, but has many advancements around the licensed technology and renegotiated the agreement with the licensor. Since then, because of cross-licensing arrangements, not only does Masstron have access to new developments by the licensor, but it does not have to pay any licensing fees.
4. In late 1984, Masstron was about to sign new contracts with licensees in Brazil and PRC (sublicense).

ENDNOTES

- (1) R. Vernon, "International Investment and International Trade in The Product Life Cycle," in International Investment, John Dunning, ed., Middlesex Penguin Books Ltd., 1972, p. 305.
- (2) See Hirsch (1967) in the reference section of this paper.
- (3) J.P. Killing, "Manufacturing Under License in Canada," University of Western Ontario, Canada, 1975, p. 60.
- (4) Rogers and Shoemaker, "Communication of Innovations," in Simmonds, K. and Robock, S., International Business and Multinational Enterprise, 3rd Edition (Irwin, 1983), pp. 421-2.
- (5) See Simmonds and Robock, International Business and Multinational Enterprise, 3rd Edition (Irwin, 1983), p. 422.
- (6) For a comprehensive analysis of the pricing of technology licensing and royalty rates see Finnegan & Mintz, "The Law & Business of Licensing in the '80's," Clark Boardman.
- (7) See Welch (1985).
- (8) See J.P. Killing (1975), p. 34.
- (9) See Carstairs & Welch (1981), p. 23 and Welch (1985), p. 45.
- (10) See Contractor (1980), pp. 46 and 47.
- (11) Carstairs and Welch (1981) in a survey of Australian firms found these costs constitute 29 percent of total licensing costs.
- (12) See Welch (1985), p. 42.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

Reverse licensing was defined as a term for the international transfer of technology into the United States. This thesis has focused on licensing of technology from the licensees' standpoint. The objectives of this thesis were to investigate the characteristics of U.S. licensees, their motivations for acquiring foreign technology, the extent of technology licensing, the licensing agreement types and to look into the viability of reverse licensing as an alternative growth route.

The thesis began by focusing on a problem facing two groups of firms. The first consists of tens of thousands of small to medium-sized U.S. manufacturing firms, with one or a few products in their product lines and with little or no funds spent on research and development. Without R & D and new and competitive products, they gradually go bankrupt when their existing products reach the end of their product life cycle. We showed the importance of these firms in the states' and the nation's economy, particularly their job and revenue creating potentials.

The second consists of a fairly large number of small and medium-sized foreign firms which have the technology (product) needed in the United States. We argued that most

of these firms are very anxious to enter the U.S. marketplace. From various options available to them we saw that licensing of their technology to U.S. firms was the preferred alternative.

Consequently, we saw an apparent vacuum between these two groups. A "vehicle" for bridging the gap between the foreign firms (small and medium) with a potentially good "supply" of technology and the small and medium-sized U.S. manufacturing firms which have a great "demand" for the technology. To overcome this "problem," and to find the "vehicle," we evaluated the viability of reverse licensing as the missing mechanism.

At the outset we saw the importance of licensing in international transactions with the focus on the U.S. In terms of dollar value, the U.S. total licensing fees and royalties were more than \$8 billion in 1984. Also, the U.S. income from royalties and licensing fees were almost 60% of the income from FDI.(1) This percentage is extremely important because licensing of technology has traditionally been considered as a "residual" alternative open to multinationals. Of course this does not mean that licensing is 60% as important as FDI.

The post-war dominant role of the United States in international business and international transfer of technology began to deteriorate in the late 1960's.

Various factors were found to be responsible for such deterioration:

First, a decline in the number of R & D scientists and engineers in the U.S. The U.S. had 66% of all R & D scientists and engineers in 1969 and ten years later the U.S. share had declined to 57%.(2) Also, R & D spending as a percent of GNP by other industrialized nations surpassed that of the U.S. (i.e., West Germany).

Second, the shift in the industrial structure and productivity growth of the industrialized nations also changed and an international comparison of R & D-Intensive versus non-R & D-Intensive Manufactured products showed that the United States had only \$179 million negative balance in 1960. This negative balance was almost \$22.5 billion in 1980. The productivity growth in manufacturing industries also deteriorated during the 1960-1982 period. While the compounded productivity growth for Japan was 480%, France 207%, and West Germany 187%, the growth for the United States was only 72.6% during that period.

Third, during the 1973-83 period, the patents granted (as indicators of degree of inventiveness) increased by 116% for Western Europe combined, 197% for Japan, and not surprisingly the number declined in the U.S. by 30%. Also, during 1970-1980 period foreign patents granted to U.S. nationals declined by 36%, while U.S. patents granted to foreign nationals increased by 42%.

Fourth, the ratio of royalties and fees (unaffiliated/affiliated receipts) was about 25% during 1975-1983 and remained almost constant. The same ratio for U.S. payments increased from 64% in 1973 to 165% in 1983. This indicates that the U.S. corporations were buying more technology through licensing (from unaffiliated foreign sources).

Finally, the U.S. corporations did not limit themselves to other U.S. allies for foreign sources, and over the past two decades, they have tapped the needed technology from the Soviet Union and other Eastern Bloc countries.(3)

After showing the international position of the United States in technology licensing, R & D expenditures, patents, and productivity, we emphasized the contradiction between a significant growth in the foreign patent activities on one hand, and royalties and fees as indicators of international technology licensing on the other. We concluded that perhaps U.S. firms are not utilizing reverse licensing to the extent that they should.

Next, we moved to the international technology licensing in Chapter Three. In order to understand the transfer of technology and to overcome semantics, technology was defined to be a perishable resource comprising knowledge, skills and other means used in the production process. While "science" organizes and explains data and observations by means of theoretical

relationships, technology translates them into practical use. The transfer of technology might take place at "science," "technology," or "production" levels. There is no room for licensing of technology at the "science level" because there is nothing concrete to license.

At the next level--"technology"--licensing could be used for the transfer process. The technology at this stage is not commercially proved and the licensee must have technical competence to understand, develop, and adopt the technology. The last stage is the "production" level. Even at this stage the licensee must have some engineering competence to adopt the technology. The transfer of technology was found to be either vertical (within a firm) or horizontal (between firms). The focus of this research is on the horizontal transfers--with an emphasis on the recipient of the technology (licensee).

We concluded the section by emphasizing the factors important for an effective technology transfer: (i) absorptive capabilities of licensee, (ii) the type of technology transferred, and (iii) effective communication between the licensor and the licensee.

After taking care of basics (i.e., definitions), we moved on by focusing on the internationalization process of technology and various alternatives open to the proprietor of technology for servicing the global markets. We specifically introduced exporting, licensing, joint-venture

and foreign direct investment as the international market entry strategies. This set the stage for becoming more specific by focusing on technology licensing. We argued that, traditionally, licensing has been used as a "residual" alternative by most multinational corporations.

The licensors' motivations for licensing their technology were: (a) to extend the technology's life, (b) to earn extra revenue not otherwise possible, (c) to enter a foreign market, (d) to establish and/or test the market for future market, and (e) to take advantage of cross-licensing arrangements. The main disadvantages of licensing to licensor were the loss of control over the technology and the creation of a competitor.

The licensees' motivations for entering licensing arrangements were: (a) to acquire the needed technology and avoid the risk of R & D expenditures, (b) to supplement own existing R & D, (c) to acquire the right to operate, (d) to diversify and expand to related or unrelated operations, and (e) to cash-in on the good name and product of licensor. The major disadvantages to the licensee were the "dependence" on the licensor and "NIH" syndrome.

The licensing issues, discussed in detail, were found to be: (a) the negotiation process, (b) the compensation arrangements, (c) the legal aspects of licensing, (d) the licensee-licensor relationship, (e) the license agreement, and (f) the licensing impacts. In this thesis our emphasis

was on the compensation arrangement, the license agreement types, the impacts of licensing, and the licensees' characteristics. Our hypotheses dealt with most of these issues.

We discussed the licensees' motivation for technology licensing and cases for and against license(4).(4) The cases in favor of taking a license were: (i) cost of own R & D, (ii) probability of failure, (iii) timing involved, and (iv) the patent laws.

Next, we focused on reverse licensing and showed the importance of reverse licensing as compared to reverse investment (FDI). In comparing reverse licensing with reverse investment, we argued that there are thousands of small to medium-sized firms overseas which are technologically rich and very anxious to enter the U.S. market. But they do not have the resources (i.e., financial, marketing) and there is no mechanism facilitating their search for global reach. Licensing of their technology to a U.S. firm would be the best possible option open to these firms. Only a few hundred large foreign MNC's can afford the costs and the risk to, or invest in the U.S. Since the number of foreign MNC's is small, each state in the U.S. tries hard and makes various forms of concessions to entice these MNC's to invest in their state.

At the same time, every year thousands of small to

medium-sized U.S. firms are forced to bankruptcy because they usually have one or a few products and spend little or no money on R & D. They are gradually forced into bankruptcy when their product(s) reach the end of the PLC. Because of its employment effect, absence of tax concessions and political repercussions, and costs, reverse licensing not only will do what reverse investment does but would give these U.S. firms new products and an extension on their lives.

A review of the literature showed that almost all the research studies, to date, have focused on licensing of technology from the licensors' point of view. The major emphasis has been on the pricing of technology, the profitability of licensing, the policy implication of technology licensing, and the viability of licensing as a growth strategy. Although most researchers have looked at licensing of technology as a "residual" alternative, few have argued that this is not necessarily the case. Their argument sets the stage for a more general theorem in International Business which incorporates international trade, FDI and licensing.(5) While licensing of technology is "found money" to some, it is the dominant, if not the only viable international strategy to others.(6)

Many scholars have focused on the speed of technology transfer within a firm (vertical) and intra-firms (horizontal) and the general consensus is that the transfer

is faster and more effective in vertical transfers.(7)

While some have emphasized the importance of "internationalization" of technology which gives preference to FDI over licensing.(8) Others have forcefully emphasized the importance of international marketing of technology.(9) A large number of scholars and practitioners have focused on ways of arriving at a licensing rate, licensing base and royalty payments.(10) Some have focused on the dependence issue and their conclusion was that the licensees were found to be dependent on their U.S. licensors.(11)

Finally, a fairly large number of scholars and institutions have focused on East-West trade and technology transfers and are generally divided into two groups. The first group has focused on the technology transfer from West to East and national security and defense issues.(12) The second group has focused on the reverse transfer of technology and its business and military windfalls.(13)

In Chapter Five, the Research Model, we conceptualized our earlier discussions and specifically focused on reverse licensing. We showed that in developing strategies for future technological needs, a firm has two options: (1) developing new technology independently, or (2) acquiring the needed technology through licensing if the firm wants to stay in business.(14)

Depending on the characteristics of the firm and the

nature of the industry, the firm might have various alternatives in its strategy formulation. If the firm is technically competent, it might develop the needed technology using its internal resources or it might be more economical to take a license. Taking a license might be on a one-time basis or on a continuous basis, each having its own advantages and disadvantages.

If, however, the firm is technically incompetent, the alternatives would be different. The firm might decide to build its own core-skills first and then develop the needed technology. This is a very costly and uncertain strategy because of the risks and costs involved as well as the probability of failure. Besides, most small to medium-sized firms do not have the resources and financial capabilities to withstand the international competition and wait for a long time to go through the process.

Alternatively, the firm without core-skills might choose to go the licensing route (Figure 17). Taking a license on a one-time basis would not be enough in most cases because the firm does not have the technical competence to understand the technology not to mention the adoption of the technology.(15) Or the firm might decide to take a license on a continuous basis. Taking a license is, perhaps, the best strategy provided the firm, as part of its strategic planning, gradually builds its own in-house core-skills. The licensing cycle model

specifically dealt with this group (see Figure 18).

We also introduced the Net Present Value technique (NPV) for evaluating various options and emphasized that all the relevant incremental cash flows on after-tax basis must be used. Then, the alternative with the highest positive NPV should be selected. Of particular interest in the analysis is the using of the "appropriate" discount rates because not all options have identical return/risk characteristics. (16)

Finally in Chapter Five, we proposed eight hypotheses as part of our research model. The first six dealt with licensees' characteristics (size, technical competence, etc.), PLC, and the licensed technology characteristics. The last two focused on the type of license agreements (one-time, continuous), licensing cycle model, and the type of restrictions in the license agreements.

In Chapter Six, the research design, we explained how our sample was selected, and how the research instrument was designed. Also, we discussed the statistical design and the logic behind it. We specifically introduced Chi-square (χ^2), Gamma, and Spearman-Brown Correlation Coefficient (r^2). Chi-square tests was used to test the null hypotheses for "independence" between research variables. To adjust for discrete data, continuity adjusted chi-square was used. Gamma was also used to see the degree of association between the variables.

In Chapter Seven, our hypotheses were empirically tested. After a "pilot" study of 30 firms (Ohio licensees) and a very strong reliability coefficient ($r^2 = .94$) using Spearman-Brown formula, the questionnaire was mailed to 118 Ohio firms involved in reverse licensing. After the second mailing and the follow-up telephone calls, 51 completed questionnaires were considered useable and complete (a 43% response rate). Interviews with 10 licensees' executives followed to shed more light on our statistical analysis.

Prior to the discussion of our empirical results, in the following section we focus on the characteristics of the licensees and types of license agreements germane to our thesis.

LICENSEES' CHARACTERISTICS

(a) Licensees' Size and Product Life Cycle (PLC)

According to Vernon, the internationalization of business goes through the firm's product life cycle. In the introduction stage, the firm produces for the domestic market, and it is not until the second stage (growth) that the firm exports to foreign markets. In the later stages, the domestic market might be served through imports. We have discussed the PLC in detail in Chapter Three. Here the focus is on two things.

First, we categorize licensees in terms of their annual sales or number of employees into small, medium, and

large. We argue that licensee's size does matter in international licensing. Second, we argue that small to medium-sized licensees, generally, are more likely to take a license when their existing product(s) reach the "declining stage" of the PLC. If they want to stay competitive, if not afloat(!), they either have to develop new technology or to acquire it through licensing. Various options open to these firms were explained in the previous section and Figures 16 and 18.

Also these firms will tend to take a license to manufacture products similar to the existing product line. This is because their existing resources (production, financial, marketing, etc.) are devoted to their existing line of business (product). As a result, the costs will be lower and the adaptation process easier than non-related technology.

(b) Licensees' Technical Competence and PLC

The PLC was explained in Chapter Three, and licensees' technical competence was explained in Chapters Six and Seven. Here, we argue that there exists a direct relationship between PLC and licensees' competence. This means that when technology is in a certain "stage" of PLC, certain type of transfers can (cannot) take place. For example, when the licensee is technically competent, technology transfers take place at both "technology" and "production" levels (see Chapter Three). But licensees

without core-skills are limited to only "production" level, where technology is "standardized." (17)

License Agreement Types

The agreement types were explained in detail in Chapter Six. Briefly, there are two types: (1) continuous, and (2) one-time. When the agreement is on a continuous basis, the licensor must be compensated for it either through royalties or restrictions in the agreements. When the agreement is for one-time, the costs to the licensee will be lower but the licensee does not have access to the technology advancements by the licensor. (18)

THE RESEARCH RESULTS

The research findings are classified into two categories and are presented in the following sections:

(a) General Findings

- * Eight-four percent of Ohio licensees had some form of international exposure prior to licensing agreement ranging from exporting to a full overseas manufacturing, sales, and services facilities.
- * Fifty percent of the time, Ohio licensees located the technology through direct marketing effort by the licensee and personal contacts.
- * Foreign governments were instrumental in the license agreements twice as much as various U.S. governmental bodies.

- * West Germany, Japan, U.K., Netherlands, and Canada dominated the list of home-country of licensors.
- * Non-electrical manufacturing (SIC 35), chemicals (SIC 28), fabricated metal (SIC 34), and stone, clay and glass (SIC 32) accounted for more than 80% of the licensed technology.
- * Licensees' motivations for technology licensing were Supplementing own R & D (38%), Diversification (36%), Avoid R & D risks (32%), and Patent rights (26%).
- * Eighty percent of the licensees' products were at "mature" or "declining" stage of product life cycle prior to licensing (Figure 24).
- * Seventy-three percent of small and medium-sized licensees acquired similar (related) technology at the "later" stage of PLC as compared to 64% for large licensees.
- * Sixty-one percent of the licensed technology was either at "mature" or "standardized" stages of PLC in the licensors market; 39% of the technology was at "earlier" stages of PLC.
- * Licensees with core-skills acquired the technology at its "earlier" stage of PLC 56.5% of the time, but 71% of those without core-skills acquired technology at "later" stages.

- * Sixty-five percent of licensees with core-skills managed to acquire technology where technical uncertainties were relatively high; 66% of those without core-skills did acquire technology with lower degrees of uncertainties (Table 24).
- * The percentages for marketing uncertainties were 74% and 74% respectively for each group.
- * In compensating the licensor for the technology, percent of net sales was used by Ohio licensees.
- * A comparison of Ohio licensees with their licensors showed that 68% were smaller, 10% were equal, and 22% were larger than their licensors (Table 26).

(b) Specific Findings

The statistical testing of the research hypotheses resulted in the following:

- * Small to medium-sized manufacturing firms tend to look for and acquire new technology (product or process) when their existing technology is at the "declining" stage of technology life cycle. They usually lack a competent own in-house R & D.
- * They search and acquire more of the related and similar technology than unrelated technology. Their motive for the acquisition of technology is directly related to their very existence and because of their relatively limited resources they have to acquire similar technology. The transfer process and the

adaptation of technology is much easier and least costly for them.

- * Firms with technical competence do acquire more licenses on newer technology than those without. Their technical competence enable them to understand the technology at its "earlier" stages of PLC. Such is not the case for firms without qualified scientists and engineers.
- * Technically competent firms do acquire license to manufacture where the technical uncertainties are relatively high. This is directly related to the above conclusion (PLC stage). We showed the relationship between PLC and technical uncertainty in Chapters Three and Seven. (19)
- * Firms with core-skills do acquire license to manufacture where marketing uncertainties are also higher than those without. This case was explained in Chapter Seven in detail and an analogy was made between "adoption" process in marketing and marketing uncertainties discussed here. (20)
- * There exists an inverse relationship between the firm's dominant characteristics (licensee) as compared to its licensor and the licensing fees. The more the dominant characteristics (i.e., size) of the licensee, the lower the royalty rate and the lower the number of restrictions imposed by the

licensor (see hypotheses six and eight in Chapter Seven).

- * Licensees with continuous license agreements are more likely to acquire R & D competence than those with one-time agreements, provided they build their own in-house R & D throughout the agreement. This implies that the licensees which go through licensing cycle model, have a better chance of achieving technical competence, mastering the technology, and reducing their dependence on their licensors.
- * There is a direct relationship between the license agreement type and the number of restrictions in the agreement. The lower the amount of technology (i.e., patent rights and technical know-how) transferred, the lower the number of restrictions. Therefore, when the agreement is on "continuous" basis, the amount of technology transferred (i.e., licensee's access to licensor's R & D results) will be higher, as well as the number of restrictions imposed on the licensee (i.e., geographical, procurement).

THE RESEARCH IMPLICATIONS

The implications of this dissertation will be discussed from three different angles: (1) The U.S. manufacturing firms in general and small and medium-sized

in particular, (2) The foreign firms (as licensors), and (3) The governmental bodies. Of course, the first and the third groups are of utmost importance to our research.

(1) U.S. Manufacturing Firms

This dissertation began with a single question: Is Reverse Licensing a viable option for U.S. manufacturing firms? We demonstrated, throughout the research, that under certain conditions, perhaps reverse licensing was the best alternative available to U.S. manufacturing firms which need new and competitive technology to survive and prosper (see Chapters Five and Seven).

We also argued that most of these firms (especially small) are forced into bankruptcy when their existing technology reaches the end of its PLC. They have various options (see Figures 16 and 18, for example), and taking a license from foreign sources was the preferred option in most cases. This option is extremely important to the very existence of many firms (especially small and medium-sized firms) as was evidenced throughout the research (particularly the results of our interviews with Ohio licensees' executives).

This possibility is perhaps the least explored one by U.S. firms. Our analyses supports the proposition that Reverse Licensing must be explored more by U.S. manufacturing firms. Of particular importance in this regard is the astronomical cost of R & D and the

comparative advantages that foreign firms have over their U.S. counterparts.

The costs of R & D are extremely important to U.S. small firms which do not have the financial resources to engage in. Reverse Licensing will allow these firms access to foreign R & D and the compensations directly contingent on the "success" of the licensed technology and the U.S. licensees. The very successful corporations in the U.S. have been utilizing this alternative for decades (see Chapter Two). Our research findings are clearly very supportive of this strategy.

Of course, this is not a universal prescription for all firms regardless of their firm-specific as well as industry-specific characteristics. A firm with a low R & D competence in a very innovative industry cannot (and should not) use the licensing option on a continuous basis without building its own in-house R & D. A direct result of such a strategy would be a technological dependence on the licensor assuming the licensor would be willing to license its "state-of-the-art" technology.

But if the firm builds its own in-house R & D throughout the agreement (LCM), or if the firm is in an industry where technological changes are not that frequent, reverse licensing would be among the very best (perhaps the best) strategy.

There is a direct relationship between the amount of R

& D spending, as inputs, and the amount of inventions and innovations as outputs.(21) The statistics provided in Chapter Two, undoubtedly, support this argument and are perhaps among the very significant factors contributing to the deterioration of the U.S. industrial base. In short, the U.S manufacturing corporations should not limit themselves to sources form within the U.S., and should explore reverse licensing as a viable option. Technology licensing might be a "residual" alternative(!) to licensors but, based on our research findings, taking a license (as a licensee) is not a "residual" one.

Firms with core-skills which take license on continuous basis (in most cases are doing it for cost purposes) should realize that the alienation of their core-skills (Not Invented Here Syndrome) should not be taken lightly. Even though the licensed technology might be an asset to the firm (licensee), undoubtedly, the firm's core-skills are by no means liabilities to the firm.

Small and medium-sized firms are of particular interest in this research, because of their importance in the economy, especially their job creating capabilities in the past and years to come (Figure 31).

SMALL COMPANIES CREATE MOST OF THE NEW JOBS ...AND THEIR NUMBERS ARE GROWING

FIGURE 31

ROLE OF THE SMALL BUSINESS IN THE U.S. ECONOMY

Source: "Small is Beautiful," a special cover story, The Business Week, May 27, 1985, p. 90.

(2) Foreign Firms

In Chapters One and Three, we argued that there are thousands of small and medium-sized firms overseas technologically rich which are very anxious to enter the U.S. market, but they lack the required resources to directly invest in the U.S. We saw that from various options available to them, licensing of their technology to U.S. manufacturers was the most preferred alternative. For many of these firms, licensing was the only way of exploiting their technology needed in the U.S.

A direct implication of this dissertation for foreign

firms with a fairly large supply of technology is that reverse technology transfer provides them with the opportunities to exploit the U.S. market, impossible otherwise.

Reverse licensing will probably be the only viable "mechanism" for matching the foreign "supply" of technology with the U.S. "demand" for the technology. The advantages of reverse licensing to small and medium-sized firms will be much more than those to large firms, because small and medium-sized firms lack the required resources to exploit other options.

As a result of reverse licensing, foreign firms will have revenues not otherwise possible and this "found money" will enable them to do more R & D and produce more inventions and/or innovations. The "found money" for many of these foreign firms is the key to their very existence. In Chapter Two, we argued that foreign inventors have increased their patenting activities drastically and in some cases they have surpassed the U.S. (Chapter Two).

One implication of these patenting activities in general and the U.S. patents granted to foreign inventors in particular (almost 50% of all U.S. patents have been granted to foreigners in recent years--see Chapter Two) is that foreigners actively seek to exploit the U.S. market. But the data for royalties and licensing fees indicate that the U.S. firms have not been utilizing the foreign sources

of technology to the extent that they should. Reverse licensing will, undoubtedly, bridge this gap.

(3) Governments

In recent years, governments (especially state governments) have drastically increased their involvement in international trade and reverse investments. Across the U.S legislatures have stepped in and have been studying the "ways and means" of boosting U.S. exports (state exports) as well as boosting "Reverse Investment" in the U.S. To match the international challenge of 1980's and 1990's and to remedy the U.S. ills (poor performance in international markets--i.e., \$123 billion trade deficit in 1984,(22) various governmental bodies have introduced and adopted new incentive programs.

These incentive programs are basically of two types in general. The first is designed to boost the U.S. export and includes various incentive programs from a simple seminar or international trade to the formation of Export Trading Companies (ETC's) and state export financing facilities (SEFF). Table 41 shows a comprehensive list of State Foreign Trade Development Programs.

The second type of incentive programs at state levels includes promotional offices at home and abroad. These promotional offices are created in various forms but with more or less the same goal: to entice foreign investors to invest in the U.S. (explained in Chapter Three). Various

states have been competing with each other in getting the non-U.S. MNC's (few hundreds in total) to invest in their states. In some cases, state initiatives have promoted federal concerns, and in others, federal program shave created state responses.

Various governmental bodies have good reasons for such developmental and promotional programs because such programs have positive impacts on states' economies, save and increase jobs, lower unemployment and perhaps increase tax revenues. In 1983 alone because of \$14 billion decrease in export of U.S. goods and services, 300,000 American jobs were lost. For the period 1980-1983, 1.5 million jobs were lost.(23)

Also, the Foreign Direct Investment in the U.S. has produced millions of jobs in the U.S. in recent years. Table 42 shows the value of manufacturing and land investment in the U.S. in 1981. According to Department of Commerce data, as a result of FDI, 2,343,115 jobs were created throughout the nation in 1981, of which 97,018 were in the State of Ohio.

In Chapter Three, we argued that reverse licensing could provide the same number of jobs and revenues in various states as reverse investment with perhaps more advantages and less political backlash. Our empirical results, in Chapter Seven, particularly the results of our interviews with licensees' executives, reinforced our

TABLE 42

Foreign Investment in the U.S.

Foreign investment in the United States has produced millions of jobs. The table shows the value of manufacturing and land investments in 1981, and the number of direct jobs all foreign investments had created by 1981.

	Value of foreign-owned property, plants & equipment (in billions)	Direct jobs re- sulting from investment
Texas	\$22.4	172,564
California	19.6	240,774
Alaska	8.6	6,576
Louisiana	8.2	45,718
New York	7.1	204,393
New Jersey	6.4	131,784
North Carolina	5.5	86,349
Illinois	5.4	111,850
Florida	5.4	69,963
Pennsylvania	5.4	129,110
South Carolina	5.2	64,896
Ohio	5.0	97,018
Michigan	4.1	65,070
Georgia	4.0	73,742
West Virginia	3.9	34,835
Tennessee	3.7	55,283
Arizona	2.9	29,396
Virginia	2.9	49,115
Minnesota	2.8	32,536
Alabama	2.8	26,501
Oklahoma	2.8	24,459
Washington	2.3	25,329
Wisconsin	2.2	59,666
Colorado	2.2	23,961
Wyoming	2.0	4,070
Maryland	2.0	43,900
Massachusetts	1.9	31,123
Delaware	1.8	35,340
Indiana	1.8	44,881
Utah	1.8	17,188
Kentucky	1.8	25,366
Maine	1.8	17,692
Massachusetts	1.8	52,578
Mississippi	1.4	10,905
Connecticut	1.2	40,128
Montana	1.2	2,830
Hawaii	1.1	16,143
Iowa	1.1	21,741
North Dakota	1.0	3,255
New Mexico	1.0	8,005
Kansas	0.9	14,206
Oregon	0.8	12,281
Arkansas	0.6	17,397
Nevada	0.5	5,654
New Hampshire	0.4	13,355
Nebraska	0.4	5,225
Rhode Island	0.4	9,423
Vermont	0.3	5,689
Idaho	0.3	3,795
South Dakota	0.3	1,324
U.S. total	\$188.6	2,343,118

Source: Commerce Department

Business America, U.S. Department of Commerce,
May 27, 1985, p. 14.

argument (see Chapters Three and Seven).

Because of its advantages, various governmental bodies (State Administrators, Legislatures, Small Business Administration, EXIM Bank, U.S. Department of Commerce), should seriously consider reverse licensing as a viable option in their struggle for the creation of a "global mentality" in the U.S. Instead of (or at least parallel to) the existing reverse investment programs, reverse licensing should be considered and promoted.

This dissertation was to investigate reverse licensing as an alternative to the development of own in-house R & D, and the conditions under which U.S. licensees take manufacturing licenses from foreign sources. The licensees characteristics, the type of licensed technology, and license agreement types were among the questions answered by this dissertation. In order for this research to be complete, it is appropriate to talk about the research limitations and related future research. We discuss these subjects next.

RESEARCH LIMITATIONS

The sample size of 51 for this study (though 43% response rate is considered a relatively good response rate) was relatively too small to allow for higher levels of resolutions in the bivariate analysis for the test of our hypotheses. Because of such limitations, we had to collapse columns and rows in Chi-square and contingency

to the development of the firm's own in-house R & D and purposely didn't discuss many related subjects and issues in international licensing. Many of these issues might have a material impact on the conclusion of this research and recommended options.

One of these issues, not part of this research, are the legal issues and tying clauses in international licensing of technology. These might have changed some of our recommendations. Another issue is the tax treatment of international licensing of technology. Also, this research focused on Ohio manufacturing licensees (the reason for our small sample size!) and our findings, though of general application, are limited to Ohio licensees. Of course, chances are that many of our findings will be applicable throughout the U.S.

The last limitation of this research is related to financial resources (costs) and time. Had we had no budgetary limitations, more interviews with licensees' executives could have been arranged. The interviews, in addition to being interesting, were very informative and rewarding and provided us with new ideas not predicted in our questionnaire (see, for example, Masstron case).

SUGGESTIONS FOR FUTURE RESEARCH

There are various research areas directly related to this thesis that could be considered for further research in international technology transfer in general and

table so that the expected frequencies in each cell be 5 or more. This allowed us statistical analysis and interpretation of the test results.

Because of trade "secrets" and "privileged" information and the limited availability of public information as part of international licensing activities, it is almost impossible to do various types of research studies (i.e., time series, regression and multivariate, etc.). For most such studies an accurate (reliable) and comprehensive data bank is required (i.e., CRISP, COMPUSTAT, etc.). These limitations are (at least up to now) part of the game. The researcher, therefore, has a limited number of options in undertaking research studies in the international licensing area. The research on this topic will be limited to the methodology employed in this research or case studies where a relatively small number of firms are evaluated on a case by case basis.

With increased international licensing activities in general and reverse licensing in particular, hopefully more attention will be given to the topic and various data will be available publicly. Also, more scholars and practitioners will get involved in international licensing scholarly activities and new research methodologies will be developed.

Finally, this dissertation, because of its nature, specifically focused on reverse licensing as an alternative

licensing in particular. We suggest some of the related research topics for future consideration in this section.

- (1) A directly related, or perhaps similar, research would be a duplication of this research for various states. The goal could be whether our findings are of general application for all U.S. manufacturing firms or whether they are limited to Ohio licensees.
- (2) A directly complimentary research would deal with the licensors to Ohio licensees and investigate their characteristics and their motives for licensing their technology.
- (3) Our research focused on Ohio licensees and their characteristics and evaluated technology licensing (from that perspective) as an alternative to own in-house R & D development. Another research can compare technology licensing with other options such as joint-venture or reverse investment alternatives. Such a research could investigate the conditions under which each of these alternatives would be a preferred one.
- (4) A fourth possibility would be industry-specific in nature, and would focus on one or a few industries as the sample. Of course the research should take a licensees' standpoint and investigate the licensees' characteristics (i.e., electronics industry vs. chemicals), their motives for taking licenses from

foreign sources. This type of research could be done for any given manufacturing industries throughout the U.S. or internationally.

- (5) A fifth possibility for future research would build on the existing research (particularly on licensing cycle model). The goal should be to investigate the viability of LCM as a route to the development of in-house R & D. In this way further investigation of LCM would provide us with the general applicability of the model, or whether LCM is more applicable to certain industries or firms than certain others. Such a research could be of utmost importance to U.S. businesses (large and small).
- (6) Another research in international technology would deal with firm specifics with regard to their international marketing of their technology. The research would deal with such questions as why some firms (Westinghouse) would license their technology and (IBM) would not license at all.
- (7) Another research might focus on a firm's size (small or large) as the determinant of its choice for R & D and technical competence. Such a research would investigate the conditions under which each alternative would be a preferred one.
- (8) Another future research might specifically focus on licensing compensations arrangements (pricing) from

licensees' point of view. Such a research would investigate various pricing methods and as its central theme search for an optimum pricing strategy (or model) from a licensee's standpoint.

- (9) Finally, a future research could specifically focus on marketing uncertainties in international technology licensing (hypothesis five). The questions to be answered (investigated) might deal with the conditions under which a licensee receives marketing know-how from its licensor or why some licensee would not license if the licensor's trade-mark is to be used (under what conditions could this be an acceptable option or strategy?). The research could connect licensees' motives with the license agreement type with particular emphasis on marketing. Other related question might deal with the reasons why some licensors would license their technology and only under the licensor's name while others do not care and let the licensees use their own name and trademarks.

ENDNOTES

- (1) Contractor, F. "Licensing Versus FDI in U.S. Corporate Strategy: An Analysis of U.S. Data," Paper presented to Social Science Research Council, June 2-3, 1983, p. 15.
- (2) See Science Indicators 1982, p. 4.
- (3) Also see The Wall Street Journal, April 24 and 25, 1985.
- (4) See Bloxam in J. Killing (1975), p. 24.
- (5) Contractor, F., "A Generalized Theorem for Joint-Venture and Licensing Negotiations," Columbia Journal of World Business, Winter (1984) and an unpublished draft which was under review with a Journal, September (1984), p. 1.
- (6) See Contractor (1983), p. 1.
- (7) See Vernon Davidson (1979), Crookell (1973), & Mansfield (1974).
- (8) See for example A. Rugman and Caves, Crookell, & Killing (1983).
- (9) See for example Ford and Ryan (1981).
- (10) See for example Orleans (1982) and Finnegan and Mintz (1978).
- (11) See for example Killing (1975), Lake (1976), and Wills (1982).
- (12) See for example Hill (1980).
- (13) See for example Kiser III (1982), The Wall Street Journal (1985).
- (14) See Figure 16.
- (15) See Welch (1985), p. 43.
- (16) See Chapter Five for a discussion of NPV.
- (17) Also see Vernon (1966), Hirsch (1976), and Killing (1975).

(18) See Welch (1985) for an analysis of these costs.

(19) Also see Vernon (1966) and (1977), and Hirsch (1976).

(20) See also Rogers and Shoemaker (1983), p. 421.

(21) See for example, Leonard, W., "Research and Development in Industrial Growth," Journal of Political Economy, March-April 1971, p. 232.

(22) See Business America, U.S. Department of Commerce, May 27, 1985, p. 12.

(23) Ibid., p. 12.

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APPENDIX A
THE QUESTIONNAIRE

Appendix A

OSU

THE OHIO STATE UNIVERSITY
COLLEGE OF ADMINISTRATIVE SCIENCE

REVERSE LICENSING: The International Transfer of Technology in the U.S. (Ohio)

Company Name: _____

Product(s): _____

Ownership: Public ☐
 Private ☐

1. GENERAL INFORMATION:1. Please indicate the phrase that best describes your INTERNATIONAL INTERESTS:

A company with:

- ☐ Overseas manufacturing, sales and service facilities.
☐ No overseas manufacturing BUT sales and service facilities.
☐ Foreign agents or similar organizations.
☐ Only domestic operations.

2. Please indicate the EXTENT to which your company uses the following METHODS for finding opportunities for TRANSFER or ACQUISITION of technology.

	Very Great Ext. - 5	Great Ext. - 4	Some Ext. - 3	Little Ext. - 2	No Ext. - 1
Personal contacts	☐	☐	☐	☐	☐
Trade & scientific publications, associations, and/or conventions	☐	☐	☐	☐	☐
U.S. (State) Government Assistance	☐	☐	☐	☐	☐
Foreign Government and/or International Institutions Assistance	☐	☐	☐	☐	☐
Licensing Brokers	☐	☐	☐	☐	☐
Direct market effort by your company	☐	☐	☐	☐	☐
Direct request from potential partner	☐	☐	☐	☐	☐
Other (please specify) _____	☐	☐	☐	☐	☐

3. Please indicate the appropriate box(es) for your firm's SALES, EXPORTS, and NUMBER OF EMPLOYEES (1984 calendar year):(a) Total Sales

- Under \$5 million ☐
 Between \$5-\$25 million ☐
 Between \$25-100 million ☐
 More than \$100 million ☐

Exports Sales

- Under \$5 million ☐
 Between \$5-\$25 million ☐
 Between \$25-100 million ☐
 More than \$100 million ☐

(b) Number of employees

- Less than 100 ☐
 Between 100-500 ☐
 Between 500-1000 ☐
 More than 1000 ☐

(c) Number of scientists & engineers (core skills)

At the time of licensing agreement (year: _____) Number _____
 Now (1984) _____

II. LICENSING MOTIVATION(S):

4. Please rate the following in terms of their importance as MOTIVE(S) for international licensing of technology:

(a) YOUR COMPANY'S MOTIVE(S):

	<i>Most imp.</i>	<i>Very imp.</i>	<i>Some imp.</i>	<i>Little imp.</i>	<i>No imp.</i>
1. To acquire the needed technology and/or to supplement your existing R & D	☐	☐	☐	☐	☐
2. To avoid the risk of R & D expenditures and/or acquire the technology not available in the United States	☐	☐	☐	☐	☐
3. To acquire the right to operate (patent) and/or to settle a patent dispute	☐	☐	☐	☐	☐
4. To diversify your operations (related and/or unrelated product lines)	☐	☐	☐	☐	☐
5. Other (please specify) _____	☐	☐	☐	☐	☐

(b) YOUR LICENSOR'S MOTIVE(S): (in your opinion)

1. To extend the technology's life (declining in commercial uses and/or not used commercially in their home markets)	☐	☐	☐	☐	☐
2. To earn extra revenue not otherwise possible	☐	☐	☐	☐	☐
3. To enter the U.S. market but didn't have financial and/or marketing resources and expertise	☐	☐	☐	☐	☐
4. To establish and/or test the market for future investment	☐	☐	☐	☐	☐
5. Other (please specify) _____	☐	☐	☐	☐	☐

III. LICENSE AGREEMENT AND LICENSEE-LICENSOR RELATIONSHIP:

5. Please indicate HOME COUNTRY of licensor(s):

6. PRIOR to licensing agreement,

- ☐ You had no relationship with the licensor
☐ You were the licensor's distributor in the U.S.
☐ The licensor was your distributor (import agent)
☐ The licensor was a licensee to your other product (process)
☐ Other (Indicate) _____

7. Please indicate the phrase that describes your own other product(s) life cycle (not the licensed product) in the U.S. PRIOR to licensing agreement(s):

- ☐ R & D stage
☐ Early commercial stage (up to 5 years in the market)
☐ Mature stage (more than 5 years in commercial use)
☐ Declining in commercial use
☐ Other (Please specify) _____

8. Please describe the phrase that best describes the STAGE that the licensed technology (product) had reached in the LICENSOR'S market, when you acquired the technology:
- ☐ R & D stage
 - ☐ Early commercial stage (up to 5 years)
 - ☐ Mature stage (in commercial use more than 5 years)
 - ☐ Declining commercial use by the licensor
 - ☐ No longer commercially used by licensor
9. Please COMPARE the licensed technology (product or process) with your firm's other products PRIOR to the licensing agreement and check the appropriate box(es):
- ☐ Similar to your other products (same line...same marketing channels)
 - ☐ Uses same or similar manufacturing process as your other products
 - ☐ Unrelated to your products or manufacturing processes
 - ☐ Other (please specify) _____
10. Please indicate the phrase that best describes the COMPETITIVE nature of the LICENSED TECHNOLOGY: (in your opinion)
- (a) LICENSOR(S) MARKET
- ☐ The technology is (was) uniquely available from licensor.
 - ☐ The technology is (was) available from FEW OTHERS.
 - ☐ Similar technology is (was) available from SEVERAL OTHER SOURCES (technologically and economically competitive).
 - ☐ Other technically or economically INFERIOR technology is (was) available from others.
- (b) LICENSEE(S) MARKET
- ☐ Your company was the ONLY applicant for the acquisition of licensed technology.
 - ☐ There were FEW other applicants for the acquisition of licensed technology.
 - ☐ There were SEVERAL applicants for the acquisition of licensed technology.
11. Please COMPARE your firm (as a licensee) with the licensor in terms of sales, number of employees, and R & D expenditures and check (x) the appropriate boxes:
	<u>Sales</u>	<u>Employees</u>	<u>R & D Expenditure</u>
Licensee is <u>SMALLER</u> than Licensor	☐	☐	☐
Licensee is <u>EQUAL</u> to Licensor	☐	☐	☐
Licensee is <u>LARGER</u> than Licensor	☐	☐	☐
12. Please indicate the technical and marketing UNCERTAINTY associated with the licensed technology when the license was executed (i.e. the uncertainties involved with a commercially-proven product are much LOWER than those of products which are not commercially-proven):
	<u>Low</u>	<u>Medium</u>	<u>High</u>
(1) Technical uncertainty was	☐	☐	☐
(2) Marketing uncertainty was	☐	☐	☐
13. Please indicate approximately how much initial capital investment was needed in order to begin the production under the license:
Under \$1 million	☐	Between \$50-\$100 million	☐
Between \$1-\$10 million	☐	More than \$100 million	☐
Between \$10-\$50 million	☐		

14. Please indicate WHAT was (were) acquired by the licensing agreement(s):

- ☐ Patent rights (manufacturing rights)
☐ Patent rights plus know-how (technical assistance)
☐ Other (Please specify) _____

15. Please indicate your products PRIOR to licensing as well as your licensed-product(s) or process(es):

Prior Product(s): _____

Licensed Product(s): _____

16. Please indicate the TYPE of licensing agreement(s):

- ☐ One-time transfer of technology
☐ Continuous transfer of technology
☐ Other (indicate) _____

17. Please indicate the RESTRICTION(S) contained in the agreement(s). (Check all applicable.)

- ☐ Geographical restrictions
☐ Procurement restriction
☐ Cross licensing (Grant back)
☐ Other (indicate) _____

IV. COMPENSATION & LICENSING IMPACTS

18. Please check the phrase(s) that describe the COMPENSATION arrangements associated with the license. (Check all applicable.)

☐ Percent of sales or volume	☐ Maximum payment
☐ Minimum Annual payments	☐ Raw materials
☐ Lump sum payment	☐ Licensed product(s)
☐ Graduated decreasing royalty	☐ Other product(s)
☐ Graduated increasing royalty	☐ Other (specify) _____

19. Please indicate the percentage of your firm's sales revenue generated by the licensed product, percentage of your net sales spent on R & D, and the number of licensing agreements:

	Licensing Agreement Year: _____	1984
X of sales from licensed product	[]	[]
X of net sales spent on R & D	[]	[]
Number of licensing agreements	[]	[]

20. Please indicate the approximate cost of acquiring technology(licensed product or process), as a percentage of your sales revenue from the licensed product(process):

☐ Under 3%	☐ 8% - 10%
☐ 3% - 5%	☐ 10% - 15%
☐ 5% - 8%	☐ More than 15%

21. Please check the appropriate box(es) for the following:

During the time your firm has been producing under license,

	<u>Decreased</u>	<u>Unchanged</u>	<u>Increased</u>
Production difficulties associated with it	☐	☐	☐
Profit margin associated with it	☐	☐	☐
Your R & D capabilities	☐	☐	☐
Your dependence on the licensor (for current & future technology)	☐	☐	☐

22. Please check the degree to which the technology transfer (license) IMPACTED on the following factors in the United States (Ohio):

	<u>Greatly Increased</u>	<u>Increased</u>	<u>Neutral</u>	<u>Decreased</u>	<u>Greatly Decreased</u>
(1) Number of low skill jobs	☐	☐	☐	☐	☐
(2) Number of high skill jobs	☐	☐	☐	☐	☐
(3) Number of managerial jobs	☐	☐	☐	☐	☐
(4) Export potentials	☐	☐	☐	☐	☐
(5) Use of domestic raw materials & products	☐	☐	☐	☐	☐
(6) Substitution for imported goods & products	☐	☐	☐	☐	☐
(7) Quality of environment, etc.	☐	☐	☐	☐	☐
(8) Other (specify) _____	☐	☐	☐	☐	☐

23. Please indicate whether you are producing any product(s) or utilizing any process(es) NOW that was (were) under license previously, but the license has expired or has been cancelled. ☐ Yes ☐ No

If yes, please choose the phrase that best describes WHY the license was cancelled (not renewed):

- ☐ The patent legal protection (life) had expired.
☐ We had achieved competence in R & D and product development and we didn't need the licensor any longer.
☐ A disagreement with licensor with regard to marketing and compensations.
☐ The licensed technology was becoming obsolete and/or non-competitive and we had acquired competence to develop our own technology.
☐ The cancellation of the licensing agreement was part of our STRATEGIC PLANNING and as soon as we had achieved the technical capabilities, we did not need any foreign assistance.
☐ Other (please specify) _____

24. Do you desire to receive a copy of the research results? ☐ Yes ☐ No

THANK YOU FOR YOUR CONSIDERATION.

Please return the completed questionnaire to:

Professor Lee C. Nehrt - Shahrokhi
 Hagerty Hall, 1775 College Road
 The Ohio State University
 Columbus, OH 43210

APPENDIX B
THE COMPANIES SURVEYED

Appendix B

REVERSE LICENSING SURVEY The List of OHIO LICENSEES

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
* 1. A & P Machine Prdcs. CO. 454 Geiger St. Berea, OH 44017	Chemical Treatment pumps	3561	20	1.1-5mm Export	Fred J. Helwig/Pres. Fred Helwig Jr./V.P.
* 2. ADB Almaco Inc. 977 Gahanna Pkwy. P.O. Box 30829 Columbus, OH 43230	Airport Lighting & Navigation Equipment	3648	80	5.1-10mm Rech. facilities, Export	Gary P. Weltlich/Pres.
* 3. Ardell, Inc. 30601 Carter Road Solon, OH 44139	Hair care products	2844	150	10.1-25mm Rech. facilities Import Export	Arnold M. Miller/Pres. Lydell Miller/V.P.
4. Atlas Copco Jarva Inc. 29125 Hall St. Solon, OH 44139	Tunnel boring machines, raise	3531	80	10.1-25mm Rech. facilities Import Export	Luke Nove/Pres. Michael Antochow/Sales
* 5. Avco New Idea Farm Eqpt. 420 S. 1st St. Coldwater, OH 45828	Farm Implements	3523	1200	Over 25mm Import Export	C. J. Stralow/C.Mgr. R. W. McCormick/Sales
* 6. BTL of Ohio 2112 Sylvan Ave. P.O. Box 2570 Toledo, OH 43606	Formaldehyde & Melamine Formaldehyde Adhesives	2891	33	1.1-5mm Rech facilities Export	
7. Murren FECO Division of Bangor Punta Operations 5855 Grant Ave. Cleveland, OH 44105	Industrial heating Eqpt. ovens, conveyors, sheet metal brakes & dryers	3567	100	5.1-10mm Export	Helmut Deichmann/Pres. James D. Anderson/V.P.
* 8. Barneby-Cheney Co. 835 N. Cassaday Ave. P.O. Box 2526 Columbus, OH 43216	Activated carbon purification & recovery equipment	3569	70	1.1-5mm Rech facilities imports Exports	William Clark/Pres. William Vogel/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
9. Bendix Automation & Measurement Division 721 Springfield P.O. Box 1127 Dayton, OH 45401	Dimensional measuring gages, form grinders	3345	400	Over 25mm Rsch facilities Export	Kevin Carey/Mkt.Mgr. B. Skeleton/Pl.Mgr.
10. Biophoric Products Co. 4413 Kings Run Rd. Cincinnati, OH 45232	Steel lined & stainless steel tanks, applicators of protective coating	3551	250	Over 25mm Exports	A. E. Hucks/Pres. A. Roehr/V.P.
11. Blaney Lumber Union St. P.O. Box 8 Bethesda, OH 43719	Treated lumber, machinery mats, blocking Kiln dried lumber	2421	63	1.1-5mm Exports	D. Blaney/Owners R. Blaney/
* 12. Bry-Air, Inc. Rte. 37W, P.O. Box 269 Sunbury, OH 43074	Dehumidifiers, industrial Environmental control systems, plastic drying & conveying equipment	3443	60	5.1-10mm Rsch facilities Export	P. D. Griessner/Pres. S. D. Fitch/V.P.
13. Bryan Metals Inc. 1103 S. Main St. P.O. Box 487 Bryan, OH 43506	Copper & Copper alloy strip	3351	60	Export	B. W. Pollard/Pres. Rex R. Dale/V.P.
14. Buckhorn Material Handling Group 10605 Chester Road Cincinnati, OH 45215	Materials handling, containers & allied equipment for industrial commercial food & inst- itutional applications	3079	100	N.C.	Richard Johnston/Pres. Robert J. Goodman/V.P.
15. Buckhorn 3592 Corporate Dr. Columbus, Ohio 43216	Materials handling, containers & allied equipment for industrial commercial food & inst- itutional applications.	3079	1000	over \$25 mill.	
16. Cambell Mausfeld Co. Melber Energy Systems Div. 100 Production Drive Harrison, OH 45030	Tanks, some Code-nnn code & propane	3443	350	10.1mm-25mm	Robert L. Mergert/CMgr Joe MacFarland/Sales
17. Canfield Industry, Inc. 3632 Western Reserve Canfield, OH 44406	Solenoid valve pilots, pneumatic control valves & electronics	3494	10	501m-1mm Rsch facilities Export Import	John Rasmussen/Pres.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
* 18. Chardon Rubber Co. 373 Washington St. Chardon, OH 44024	Molded & extruded rubber & plastic products	3069	600	10.1-25mm Mach facilities Export	J. W. Keener/JR.Pres. Don W. Sullivan/V.P.
* 19. Cincinnati Gear Co. 5657 Wooster Pike Cincinnati, OH 45227	Gears & gear assemblies	3566	300	10.1-25mm Import Export	Walter L. Rye/Pres. W. Gay/V.P.
20. Cleveland Twist Drill Co. Sub. Acme Cleveland Corp. 1242 E. 49 St. P.O. Box 6656 Cleveland, OH 44101	Drills, reamers, and mills, carbide cutting tools	3545	2100	Mach. facilities Export	James T. Bartlett/Pres R. Russell/V.P.
* 21. Cleveland Vibrator Co. 2828 Clinton Ave. Cleveland, OH 44113	Air & electric vibrators & vibrating equipment	3532	55	5.1mm-10mm Mach. facilities Export	D. Robichard/Pres. J. Tesar/V.P.
* 22. Coe Manufacturing Co. 609 Bank St. P.O. Box 520 Painesville, OH 44077	Vaneer lathes & dryers, fiber & plasterboard equipment	3541	350	10.1mm-25mm Mach. facilities	Fred W. Fields/Pres. George B Milbourne /Sales Mgr.
* 23. Consolidated Ceramic Prdts. 838 Cherry St. Blanchester, OH 45107	Ceramic coated fluxing pipe, protection tubes & thermocouples for alum. ind. & hot top boards & tundish lines for steel industry	3479	200	5.1mm-10mm Export	R. Bruce Mickey/Pres. Gary F. Meyer/V.P.
24. Cor Tec Inc. Sub. UMC Ind. 2351 Kenskill Ave Washington Court House, OH 43160	Fiberglass reinforced plywood panels	3292	180	Over 25mm Export	
* 25. Cosmicoat, Inc. 3400 Cleveland Rd. P.O. Box 73 Wooster, OH 44691	Pavement maintenance & tennis court coatings	2891	33	5.1mm-10mm	Donald J. Harris/Pres. Richard R. Benson/V.P.
26. Crowley Co. 14623 Forest Ridge P.O. Box 281 Newbury, OH 44065	Air moving equipment	3564	10	501mm-25mm Import Export	James J. Crowley/Pres. T. W. Crowley/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
27. Day Mixing Taylor Stiles 4932 Beech St. Cincinnati, OH 45212	Industrial mixers, size reduction equipment engineered systems, waste reclamation systems	3559	120	10.1mm-25mm Mach. facilities Export	Joseph C. Weger/Pres. Robert Miller/V.P.
* 28. Dayton Bareplitch Inc. 1875 Radio Rd. P.O. Box 31308 Dayton, OH 45431	Miscellaneous metal work	3449	80	N.C.	
29. Dayton Superior Corp. 721 Richard St. Miamisburg, OH 45342	Accessories & hardware for the forming of concrete & concrete chemicals, contract manu.	3429	550	Over 25mm Import Export	Glen P. Schimpf/Pres. Thomas M. Carroll /Sales
* 30. Dupps Co. 548 N. Cherry P.O. Box 95 Germantown, OH 45327	Process machinery	3551	185	10.1mm-25mm Export	John A. Dupps/Pres. John A. Dupps Jr./V.P.
31. Dyson, Joseph & Sons Inc. 53 Freedom Road P.O. Box 228 Painesville, OH 44077	Lift truck forks, large threaded fasteners, forgings	3462	250	Mach. facilities Export	Richard Crosby/Pres. Richard W. Foss/V.P.
32. Eagle-Picher Ind. Akron Standard Div. 1624 Englewood P.O. Box 1869 Akron, OH 44309	Machinery molds for rubber & plastic industries	3559	240	Over 25mm Mach. Import Export	L. Mulhollen/Pres. J. Segatta/V.P.
* 33. Eaton Corp. Airflex Div. 9919 Clinton Road Cleveland, OH 44144	Air activated magnetic, hydraulic clutches & brakes	3568	400	Mach. facilities Export	Ray Mack/Gen Mgr. Robert L. Burks/Sales
34. Elu Machinery Co. 9040 Dutton Dr. Twinsburg, OH 44087	Metallworking machinery	3451	20	1.1-5mm Export	Eugen Lutz/Pres. Joachim Scholt/Pl.Mgr.
35. Erickson Tool Co. Div. Kennametal Inc. 34300 Solon Road Solon, OH 44139	Machine tool accessories & carbide cutting tools	3545	350	Mach. facilities Import Export	Quentin McKenna/Pres. Bill Eversole/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
* 36. Etna Products, Inc. 16824 Park Circle Dr. POB 286 Chagrin Falls, OH 44022	Indl. extreme pressure lubricants & systems dispensing lubricants, reclamation of drawing oils, hydraulic oils, rolling oils	2992	20	1.1-5mm Rsch. facilities Import Export	Ike Tripp/Sr. Pr. Ike Tripp Jr. /V.P.
37. Euclid Inc. Daimler-Benz AG. 22221 St. Clair Ave. Euclid, OH 44117	Earth moving trucks	3531	800	Over 25mm. Rsch. Export	Jeorgen Schremp/Pres. Harvey Lebaron/V.P.
38. Exomet Inc. Maple Ave. POB 647 Conneaut, OH 44030	Exothermic insulating products, heating treating eqpt. & supplies	2899	50	5.1mm.-10mm Rsch. facilities Import Export	
* 39. Fairfield Engineering 324 Barnhart St. POB 526 Marion, OH 43302	Conveying & handling eqpt. for steel industry, for rubber, coal, glass, foundry	3535	450	Over 25mm. Export	D. Wearn/Pres. H. McFann/V.P.
* 40. Ferry Inds. Inc. 1050 W. Main St. POB 299 Kent, OH 44240	Die cutters, foam fbrcg. Special machinery builders, automation, rubber test eqpt.	3559	65	1.1-5mm.	W. Harry Covington/Pr.
* 41. Flexiblast Co. 985 W. Locust St. Wilmington, OH 45177	Mechanical wire descaler, custom built machinery	3549	8	501m-1mm Export	H. Steel Price III/Pr.
* 42. Forma Scientific Inc. Mill Creek Road POB 649 Marietta, OH 45750	Environmental cabinets, lab eqpt. furniture, incubators baths, freezers, ovens	3811	312	10.1mm-25mm Rsch. facilities Import Export	Byron Westerman/V.P.
* 43. Postoria Inds., Inc. General Prdts. Div. 1200 N. Main POB F. Postoria, OH 44830	Gas & electric infrared eqpt., indl. & commercial lighting elec. infrared comfort heating, soft ext. trim & air condl.	3567	175	5.1mm-10mm Rsch. facilities Export	E.W. Schalk/Pr. R.E. Justice/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
53. Intercole Bolling Corp. 3500 Walworth Ave. Cleveland, OH 44102	Machinery for rubber, plastics & metal forming industries	3559	100	10.1mm-25mm. Export	James T. Matsuoka/ Gen. Mgr.
* 54. John Zubal Inc. 2969 W. 25th. St. Cleveland, OH 44113	Bookstores	5942	10	125,000 est. financial strength	John T. Zubal
* 55. Kaiser Aluminum & Chemicals Corp./Refractories Div. 41738 Easterly Dr. POB 47 Columbiana, OH 44408	Basic refractory brick (cement, mortars & mixers)	3297	1700	10.1mm-25mm Export	J. Allen
* 56. Kern-Liebers USA Inc. Spring Div. 1510 Albon Ro. POB 396 Holland, OH 43528	Main springs, constant force springs, spiral torsion springs & fine blankings	3495	90	1.1-5mm. Export	Lathan A. Bayrie/Pr. Hans Stein/V.P.
57. Kernella Automatic Machining 8 W. Main St. POB 41 Berlin Hgts., OH 44814	Crew machine products	3451	30	501m-1mm Export	Claude Kernell/Pr.
* 58. Koehring Morgan/Unit ANCA Int'l 947 E. Broadway Alliance, OH 44601	Cranes, heavy weld- ments, auxiliary mill equipment & presses	3536	750	Over 25mm. Export	J.R. Stedelman/Pr. G.L. Everhand/V.P.
59. Koppers Co., Inc. Bldg. Materials Div. 30060 Lakeland Blvd. Wickliffe, OH 44092	Tar coated glass, tar saturated cotton & jute glass matts, cold pro- cessed roofing materials, singled plied roof systs.	2952	50	5.1-10mm Export	Merrill McCarty/ Pur. Ag. R.E. Palent/Plt.Mgr.
60. Kornylak Corp. 400 Meaton St. Hamilton, OH 45011	Material handling con- veyors, storage, cargo, marine systs., plastic machinery for production of urethane foam	3559	85	1.1-5mm Mach. facilities Import Export	Thomas Kornylak/Pr. R. Larson/V.P.
* 60. Liason Int'l Inc. 1440 Fountains Springfield, OH 45504	Paper machinery & Office equipment	5051	50	300,000-499,000 est. financial strength	

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
* 61. LeBlond Machine Tool Madison & Edward Rd. Cincinnati, OH 45208	Lathes, standard & numerical control, machine tools	3541	1000	Rsch. facilities Import Export	D.W. LeBlond/Pr. John Schuitel/V.P.
62. Ledex, Inc. 801 Scholz Dr. POB 427 Vandalia, OH 45377	Positioning & switching prds. manual & PB switches	3679	500	10.1-25mm. Rsch. facilities Import Export	Gerald Leland/Pr. Charles Berthy/V.P.
* 63. Libbey-Owens Ford Co. Glass Div. 811 Madison Ave. Toledo, OH 43695	Floor Glass: automotive and architectural	3231	5000	Over 25mm. Export	R.W. Skeddle/Pr. B.R. Bush/V.P.
* 64. Liquid Control Corp. 7576 Freedom Ave. NW North Canton, OH 44720	Precision liquid dis- pensing eqpt., two components meter-mix- dispense machines	3559	22	1.1-5mm Rsch. facilities Import Export	William C. Schiltz/Pr. William A. Deneen/V.P.
* 65. Lodge & Shipley Co. 3055 Colerain Ave. Cincinnati, OH 45225	Lathes, CMC turning systems	3541	465	Over 25mm. Import Export	W.L. Dolle Jr./Pr. Roy M. Nelson/V.P.
* 66. Loopco Industries Inc. 1981 E. Aurora Rd. Twinsburg, OH 44087	Slitting lines; coil handling, strip, proces- sing eqpt; tube pipe mill auxiliary eqpt. end finishes.	3559	70	10.1mm-25mm Export	Ken Smith/V.P.
67. Lordstown Rubber Co. 5232 Tod Ave. SW Warren, OH 44481	Rubber covered rollers & rubber linings, applicator rubber, pipe, tanks, tank cars	3069	33	1.1-5mm Rsch. facilities Export	Richard DeCamp/ Gen. Mgr.
* 68. Lorenz Industries Lorenz Publishing 501 E. 3rd. St. Dayton, OH 45401	Printing of sacred and secular music	2751	68	1.1-5mm. Export	S. Lorenz/ G. Lorenz/Owners
69. Mantaline Corp. 4754 E. High St. Mantua, OH 44755	Precision extruded rubber products	3069	170	Rsch. facilities Import Export	R.L. Merian/Pr. J.L. Klavitter/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
70. MCB Reagents/ Aff. E. Mureck 2909 Highland Ave. Cincinnati, OH 45212	Laboratory chemicals, biological strains & indicators, solvents & mineral acids	2899	120	10.1mm-25mm Rsch. facilities Import Export	Art Sommerville/Pr. Michael M. Mulligan/ V.P.
71. McPherson & Co. 227 Depot St. POB 92 Berea, OH 44017	Industrial glass	3211	13	Export	K. E. MacPherson/Pr.
72. Mannesmann Demag Corp. Mtrl. Handling Div. 29201 Aurora Rd. Solon, OH 44139	Molists, cranes, stacker systems, motors	3536	275	Over 25mm. Import Export	Wilbert J. Perch/V.P.
73. Manurhin Machine Tool Inc. (DST) Div. Mitac Corp. 11270 Grooms Rd. Cincinnati, OH 45242	CNC screw machines	3441	20	5.1mm-10mm Import	William Ackerman/ Gen. Mgr.
* 74. Maestron Scale Inc. 550 Shrock Rd. Columbus, OH 43229	Scales & balances, except laboratory	3576	75	\$1-5m.	Ben Dillon/Pres.
75. Mayfran Intl. Div. Fischer Inds. 6650 Beta Dr. POB 43038 Cleveland, OH 44143	Conveyors, conveyor- belting, chip handling & processing sys. & paper & refuse handling eqpt.	3535	350	10.1mm-25mm Export	Lawrence R. Fischer/ Pr. Bruce Terry/V.P.
* 76. McGean-Rohco, Inc. 1250 Terminal TW 3203 W. 71st St. Cleveland, OH 44113	Electroplating processes, inorganic, surface preparation, metalworking & trans. cleaning chemicals	2819	200	5-10mm Rsch. facilities Export D & B	D. L. Whitney/Pres. J. E. Vamou/V.P.
77. McNeil Akron Inc. Sub. EMS 96 E. Cronier St. Akron, OH 44311	Rotocast, vulcanizing, presses for tire industry, rubber curing machinery	3559	100	Over 25mm Rsch. facilities Import Export	J. L. Gibney/Pres. W. Harry Covington Jr. /V.P.
78. Midland-Ross Corp. Surface Division 2375 Dorr St. P.O. Box 907 Toledo, OH 43691	Industrial furnaces & waste disposal systems	3567	330	Over 25mm Rsch. facilities	J. B. Andrews/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
79. Monarch Sidney 615 N. Oak Sidney, OH 45365	Precision metal turning lathes, machining centers	3541	400	Over 25mm Rsch. facilities Export	Tony Niemeyer/Pres.
80. Ramco Controls Division 7567 Tyler Blvd. Mentor, OH 44060	Industrial switches & solenoids, electrical controls	3699	195	10.1mm-25mm Rsch. facilities Export	Norman Swanson/Pres. Larry Ward/V.P.
* 81. North American Refractories E. 14th & Euclid Hanna Building Cleveland, OH 44115	Refractories	3255	1400	Rsch. facilities Import Export	Edmond Wright/Pres. H. P. Berry/V.P.
82. Nutro Machinery Co. 3764 Ridge Road Cleveland, OH 44144	Automatic spray machines for painting & glazing	3559	20	1.1-5mm Export	R. M. Tomosko/V.P. Jochen Grocka/G.Mgr.
* 83. Ohio Art Co./Emcee 720 E. High P.O. Box 111 Bryan, OH 43306	File boxes, metal lithographed, toys, trays	3944	600	Over 25mm Rsch. facilities Import Export	W. H. Martens/V.P. Wm. C. Killgallon/Pres
84. Overhead Door Corp. Todco Division 1332 Fairground Rd. E. Marion, OH 43302	Upward acting doors for trucks & trailers, hydraulic tailgates, towing units	3536	150	5.1mm-10mm Export	R. C. Naugh/Pres. John Dahl/V.P.
85. Owens-Illinois Inc. Trading Co. 1 Sea Gate Toledo, OH 43666	Closures for plastic glass & containers, prescription plastic vials, metal container lids	3466	3000	Rsch. facilities Import Export	W. P. Spengler/Pres. W. T. Hardy/V.P.
* 86. Owens-Illinois Inc. 1 Sea Gate Toledo, OH 43666	Glass tumblers, stemware, blown glass	3229	2200	Over 25mm Export Import	Robert J. Lanigan/Pres
87. Pennwalt Corp. 421 London Rd. P.O. Box 363 Delaware, OH 43015	Cleaners, sanitizers, metal treating materials	2899	40	1.1-5mm Export Import	R. Riley/Oper. MGR.
88. Pollock Co. Sub. Gatz Co. 101 Andrews Ave. P.O. Box 58 Youngstown, OH 44501	Blast furnace steel work, hot metal & slag handling equipment & heavy plate fabrication, field	3443	300	10.1-25mm Export	B. L. Shultz/V.P. Tom Nutzyn/Sales Mgr.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
89. Polymer Raymond Inds. Inc. 15730 S. Madison P.O. Box 767 Middlefield, OH 44062	Molded & extruded rubber parts	3069	150	Export	Ronald Raymond/Pres. Bing Medina/V.P.
90. Popped-Right Inc. 135 Wyandot Ave. P.O. Box 687 Marion, OH 43302	Snack foods	2099	125	10.1-25mm Export	D. Warren Brown/Pres Ray Maloney/V.P.
91. Precision Metal Products Inc. 15411 Chatfield Cleveland, OH 44111	Metal stamping & assemblies	3469	20	501m-1mm Export	Thomas Jacin/Pres.
* 92. Pressure Systems Inc. 340 Enon Rd. Ennon, OH 45323	General industrial machinery equipment Hydrolyc Valve	3443	15	2mm 0-1	Douglas E. Arnon
* 93. Protective Treatments Inc. Helen Curtis Inds. Inc. 3345 Stop 8 Rd. P. O. Box 14116 Dayton, OH 45414	Adhesives, sealants (liquids & extruded tape) plastisols, custom pvc extrusions	2821	350	Over 25mm Rsch. facilities Export	C. W. Mercurio/Pres. D.P. Riggle/V.P.
* 94. Questor Juvenile Furniture Co. 1801 Commerce Dr. Piqua, OH 45356	Crib mattresses, nursery pads, juvenile car seats & travel beds, tables, framed high-chairs & play yards, strollers	2512	1412	Over 25mm Rsch. facilities Export	D. F. Mitchell/Pres. Allen Seymour/Sales
* 95. Race Chemical Equipment Corp. 6883 S. Ridge Rd. P.O. Box 115 Unionville, OH 44088	Industrial dialyzers, dialyzer membranes	3559	4	Under 100m Rsch. facilities Imports Exports	Richard Oldani/Pres. Peter M. Oldani/V.P.
96. Rai-Partha Enterprises 5938 Carthage Ct. Cincinnati, OH 45212	Metal figurines	3369	48	1.1-5mm Export	Jack Hesselbeck/Pres.
* 97. Sandusky Foundry & Mch. Co. 615 W. Market St. P. O. Box 1281 Sandusky, OH 44870	Job shop tools, jog MC lathes, MC mill	3125	350	10.1mm-25mm Export	Charles Raiger/Pres. E. McPhillamy/V.P.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
98. Schindler Naughton Elevator Co. P.O. Box 780 Toledo, OH 43695	Elevators	3534	570	Rsch. facilities Export	M. T. Wennerbow/JR.P.
* 99. SCH-Clidden Int'l Co. 925 Euclid Ave. Cleveland, OH 44115	Paints, typewriters, food chemical, emulsifiers	3389	3000	20-50mm	C. K. Brewin/V.P.
100. Seaforth Mineral & Ore Co. Inc. 29525 Chagrin Blvd. Pepper Pike, OH 44122	Coal & other minerals ores	5052	150	over \$25 mill	
*101. Shreiner Sole Co. Taylor Dr. P.O. Box 347 Killbuck, OH 44637	Crepe rubber soles & plastic heels	3069	110	501m-1mm Rsch. facilities Export	V.E. Shreiner/Pres. Patrick W. Roche/V.P.
102. Schulman, A. Inc. 3550 W. Market St. Akron, OH 44313	Proprietary, custom plastic compounds, thermo- plastic resins, high & low polyethylene, polypropylene, lonomer, PVC nylon	2821	50	Over 25mm Rsch. facilities Import Export	
*103. Spartan Chemical Co. 110 N. Westwood Ave. Toledo, OH 43607	Polishes & sanitation goods	2842	380	5.1-25mm Export	Eugene T. Swigart/Pres T. J. Swigart/V.P.
104. Square & Co/Middletown Plant 1500 S. University Blvd. Middletown, OH 45042	Electrical equipment	3699	467	Rsch facilities Import Export	Bob Mattingly/Sales
*105. Steward-Clapat Corp. 1637 Moxahala P.O. Box 2486 Zanesville, OH 43701	Material handling equipment units	3535	40	1.1-5mm Exports	C. T. Stewart/Jr.Pres.
*106. Stroktol Co. of America 201 E. Steels Corner Rd. Stow, OH 44224	Chemicals for rubber industry	2891	28	Import Export	H. J. Bennett/C.Mgr.
*107. Sunstone Corp. 1500 Marguard Ave P.O. Box 763 Cambridge, OH 43725	Ceramic products	3251	280	1.1-5mm Rsch. facilities Export	Spiro W. Bass/Pres. Philip J. Rich/Ch.Brd.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
108. Service Recorder Co. Sycon Corp. 959 Cheney Marion, OH 43302	Time & speed recorders, paper charts for redorders, fuel meters	3823	175	1.1-5mm Rsch. facilities Import Export	A.B. Siemer/Pres. Brendon Rocks/V.P.
109. TLT-Babcock Inc. 411 Independence Dr. Medina, OH 44256	Axle & radial fans, large ventilating systems, silencing equipment & wind tunnels	3999	20	Rsch. facilities Export	Michael J. Nug/Pl.Mgr.
110. TPF Inc. 313 S. Wayne Ave. Cincinnati, OH 45215	Instrumentation, industrial dial thermometers	3823	6	Rsch. facilities Export	Robert Stiens/Pres. Chuck Stiens/Sales
*111. Tecmar Inc. 23600 Mercantile Rd. Cleveland, OH 44122	Microprocessors & systems	3573	50	Rsch. facilities Export	Martin Alpert/Pres. Dave Wertman/V.P.
112. Tremco Inc. 10701 Shaker Blvd. Cleveland, OH 44104	Protective coating & sealants for building maintenance & construction plus sealant for industry	2952	1250	Over 25mm Rsch. facilities Export	Leigh Carter/Pres.
113. Truper Inc. 2901 W. 3rd St. Dayton, OH 45417	Pumps & water systems, softeners	3561	16	101-250m Export	J. A. Sedlock/Pres.
114. United Technologies Williot Div. Carrier Corp. 1760 Tuttle Ave. P.O. Box 1165 Dayton, OH 45401	Roller burnishing tools, tube expanders & cutters machines systems	3542	75	5.1mm-10mm Import Export	Roy B. Pleiman/V.P.
*115. United Technologies Elliot Co. 1809 Sheridan Ave. P.O. Box 239 Springfield, OH 45501	Tube maintenance tubes	3599	105	5.1mm-10mm Rsch facilities Import Export	Wm. C. Sears/V.P.
116. Universal Metal Prdts. Inc. 29980 Lakeland Blvd. Wickliffe, OH 44092	Heat treating & finishing, small stamping	3398	125	5.1-10mm EFS, Export D & H	T.O. Dahlstrand/Pres.

<u>COMPANY NAME & ADDRESS</u>	<u>PRODUCTS</u>	<u>SIC#</u>	<u>EMPL.</u>	<u>ANNUAL SALES</u>	<u>CHIEF EXECUTIVES</u>
117. Walker Mfg. Co. Tenneco Co. Rt. 2 Newark Industrial Park #13 Hebron, OH 43025	Catalytic converters, pipes, mufflers	3714	512	D & B, EFS Export over \$50,000,000	John Novell/Personnel Richard DeMara/Pl.Mgr.
118. Wean United Inc. 1400 Grace Ave. NE Canton, OH 44705	Ironroll foundry	3322	250	Mach. facilities Export	R. J. Wean III/Pres. Edward Bauer/Pl.Mgr.

NOTE: Those indicated by (*) are the respondents to our survey.

APPENDIX C
THE CHI-SQUARE AND GAMMA STATISTICS

Appendix C

1. Chi Square (χ^2) TEST STATISTICS

Consider the following 2 by 2 table.

	A_1	A_2	
B_1	n_{11}	n_{12}	$n_{1.} = n_{11} + n_{12}$
B_2	n_{21}	n_{22}	$n_{2.} = n_{21} + n_{22}$
	$n_{.1} = n_{11} + n_{21}$	$n_{.2} = n_{12} + n_{22}$	$N = n_{11} + n_{12} + n_{21} + n_{22}$

We are interested in determining if the numbers of observations in the cells could have occurred by chance. To operationalize the idea of chance, we note that two events are considered statistically independent if the probability of their joint event is the simple product of the probabilities of each event. In the table, n_{11} is the observed frequency of the joint event ($A_1 B_1$). The expected frequency, n_{11} , is the product of probability of the joint event, $P(A_1 B_1)$ and N , the total number of observations. In general we do not know $P(A_1 B_1)$. However, under the assumption that the frequencies in the table could have occurred by chance, we can calculate it by the definition of statistical independence.

$$P(A_1 B_1) = P(A_1) P(B_1)$$

We can estimate the marginal probabilities, $P(A_1)$ and $P(B_1)$ using the marginal proportions in the table.

$$P(A_1) = \frac{n_{11} + n_{21}}{N} = \frac{n_{.1}}{N}$$

and

$$P(B_1) = \frac{n_{11} + n_{12}}{N} = \frac{n_{1.}}{N}$$

Combining these results yields an estimate of the joint probability

$$\widehat{P(A_1 B_1)} = \frac{n_{.1} n_{1.}}{N^2}$$

and an estimate of the expected cell frequency under the "chance" assumption

$$\hat{n}_{11} = \frac{n_{.1} n_{1.}}{N}$$

Given the actual and expected frequencies in a table, we need some criterion to determine whether the actual departures from the expected frequencies are "large enough" to make the statement, "the observed frequencies could not have occurred by chance." Two important parenthetical comments are in order. First, we always expect some discrepancy between observed and expected, and second, we never make statements like the one above with certainty. Instead we attach a level of confidence to such statements.

The chi square, χ^2 , statistic is the most commonly used criterion for deciding whether observed frequencies are chance occurrences. The χ^2 statistic is computed according

to the following formula.

$$\chi^2 = \sum_{i=1}^R \sum_{j=1}^C \frac{(n_{ij} - \hat{n}_{ij})^2}{\hat{n}_{ij}}$$

The notation used to describe the simple 2 by 2 table has been generalized to cover a table of R rows and C columns.

The χ^2 statistic has a probability distribution associated with it. It is a one parameter distribution characterized by "degrees of freedom." In this situation, degrees of freedom is given by the formula

$$\text{d.o.f.} = (R - 1) (C - 1)$$

Thus, the simple 2 by 2 table has 1 degree of freedom. It was mentioned above that we always expect observed and expected frequencies to differ to some degree and thus we expect the χ^2 statistic to be greater than zero. How much more is given by the degrees of freedom. On average, a χ^2 statistic computed on a table of frequencies generated by chance will equal its degrees of freedom.

The decision problem is: How large should the χ^2 statistics be before we can reject the hypothesis that the observed pattern was generated by chance? This answer is found by examining the probability distribution for the χ^2 statistic.

This figure represents a typical χ^2 probability distribution. The vertical axis is the probability associated with each value of the statistic on the horizontal axis. As with all probability distributions, the area under the curve equals 1. The tic mark at a represents the expected value of χ^2 for this distribution, i.e. the degrees of freedom. The tic mark at b is the critical value of χ^2 statistic. This critical value is chosen so that the area under the curve to the right of b equals some small probability, usually .01 or .05. This critical value of the χ^2 statistic is used and interpreted in the following manner.

If the computed value of χ^2 given by the above formula is greater than the critical value given by a χ^2 probability distribution, we say that the probability of this occurring by chance is very small, in fact less than the probability represented by the cross hatched area in the figure. Furthermore, if the observed frequencies do not occur by chance, we

conclude that some relationship between the two variables in the table generated the observed frequencies. The converse of the statement, "The observed frequencies could have occurred by chance with less than five percent probability." is "We are 95 percent confident that a relationship exists between the two variables in the table." It is this last interpretation that is most common in interpreting tables with the χ^2 statistics.

Below are a set of critical values for a range of degrees of freedom that are defined by the 95 percent confidence level.

95% Confidence Critical Values

<u>Degrees of Freedom</u>	<u>Critical Values</u>
1	3.84
2	5.99
3	7.82
4	9.49
5	11.07
10	18.31
15	24.00
20	31.41
25	37.65
30	43.77

	Low	Medium	High	
Low	6	2	0	8
Medium	15	22	6	43
High	3	34	19	56
	24	58	25	107

The computed value of gamma for this table is .69.

This table represents a moderately strong ordinal relation; only high-medium cell with 34 observations appears to depart from the expected ordered alignment of high-high. If the frequencies had spread over the table according to the marginal proportions, gamma would be near zero. If the frequencies clustered more closely along the diagonal, gamma would be near one.

3. Pearson Correlation Coefficient

The Pearson correlation coefficient is the standard measure of association between two variables that take on meaningful numerical values. It varies from -1, a perfect negative correlation, through 0, no correlation, to +1, a perfect positive correlation.

Intuitively, the correlation coefficient is best illustrated by a scatter plot. Each point in a scatter plot represents an observation on a pair of variables, x and y . The formula for the correlation coefficient computed on n (x_i, y_i) observation pairs is:

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\left[\sum_{i=1}^n (x_i - \bar{x})^2\right]\left[\sum_{i=1}^n (y_i - \bar{y})^2\right]}}$$

where $\bar{x}$ and $\bar{y}$ are the means of x and y ,

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i, \quad \bar{y} = \frac{1}{n} \sum_{i=1}^n y_i.$$

Appendix D

RELIABILITY DETERMINATION USING SPEARMAN-BROWN FORMULA

(A Manual Computation)

ODD NUMBERED ITEMS													Score (X)		EVEN NUMBERED ITEMS													Score (Y)			
Sub- ject	1	3	5	7	9	11	13	15	17	19	21	23	25	X	X ²	2	4	6	8	10	12	14	16	18	20	22	24	26	Y	Y ²	XY
1	5	3		3	3	1		4	4	3	3	3	3	35	1225	4	2	4		3	5	3	4		3	1	1		30	900	1050
2	5	2	1	4	5	1		1	3	1	1	5		29	841	1	1	3		3	3	1	5		2	1	1		21	441	609
3	3		1	4										8	64	2	3	3											8	64	64
4	4	2	1	1	4	1		4	4					21	441	3	2	3		4	4	4	4						24	576	504
5	4	1	1	2	1	1	4	4	1					19	361	1	1	4		1	4	1	4						16	256	304
6	4				4	5		5		3	3	3	3	30	900	4				4	5	4		3	2	3			25	625	750
7	5	1	1	3	3	4		5	3					25	625	4	1	4		4	5	4	4						26	676	650
8	5	1	1	4	5	4		5	5	1	1	1	3	36	1296	3	2	3		4	5	3	5		1	1	1		28	784	1008
9	5	1	2	4	5	3	5	5	4	3	4	5	3	49	2401	3	2	5		4	4	5	3		4	4	5		39	1521	1911
10	3	2	2	5	1	1		4	1	2	2	2	1	26	676	2	2	3		1	4	1	4		2	3	1		23	529	598
11	4	2	1	4	4	4		4	2	1	1	1	1	29	841	3	2	4		4	2	2	4		1	1	3		26	676	754
12	5	1	1	3	3	4		5	3	4	3	4	3	39	1521	4	1	4		4	5	4	4		4	3	3		36	1296	1404
13	4	2	2	4	5	2		5	4	3	1	3	1	36	1296	2	2	4		4	5	3	5		3	2	1		31	961	1116
14	4	2	2	3	4	2		5	3	4	4	5	3	41	1681	2	1	3		3	4	4	3		4	2	2		28	784	1148
15	4	1	1	2	5	1		3	3	1	1	4	4	30	900	1	1	4		2	3	3	4		3	1	4		26	676	780
16	4	2	3	4	4	2		4	2					25	625	2	2			4	4	2	4						18	324	450
17	4	1	1	3	4	1		4	3	1	1	1	3	27	729	2	1	3		3	5	2	5		3	3			27	729	729
18	5	1	1	5	4	1		2	5	1		3		28	784	3	1	3		3	3	1	5			2			21	441	588
19	5	1	1	1	3	1		4	1	3	3	2	3	28	784	3	1	5		2	4	1	4		1	3	3		27	729	756
20	4	1	1	2	5	1		4	2					20	400	3	1	4		3	4	2	5						22	484	440
21	3	3	3	3	4	1		4	3					24	576	1	3	1		4	4	1	4						18	324	437
22	5	2	1	3	4	4		5	2					26	676	2	2	5		4	5	2	5						25	625	650
23	5	1	1	5	4	1		2	5					24	576	3	1	3		3	3	1	5						19	361	456
24	5	2	1	5	4	2		3	3					25	625	3	3	4		5	4	2	4						25	625	625
25	5	2	3	4	5	4		3	2	5	2	4	1	40	1600	3	1	3		3	5	3	4		3	1	1		27	729	1080
26	5	2	1	5	4	2		3	3					25	625	3	3	4		5	4	2	4						25	625	625
27	3	1	1	1	5	5		4	1					21	441	4	1	3		4	2	2	4						20	400	420
28	3	1	1	1	1	1		1	1					10	100	2	1	5		1	1	1	1						12	144	120
29	2	1	1	1	1	1	4	5	1					17	289	3	1	1		3	1	1	1						11	121	187
30	5	2	2	4	5	2		5	3	4	3	4	3	42	1764	2	2	2		3	5	3	4		2	3	3		29	841	1218
SUM														835	25663														713	18267	21426

$$r_{hh} = r_{XY} = \frac{n \sum XY - \sum X \sum Y}{[n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]} = \frac{(30)(21426) - (835)(713)}{[(30)(25663) - (835)^2][(30)(18267) - (713)^2]} = 0.884$$

$$\therefore r_{Rel.} = \frac{2r_{hh}}{1 + r_{hh}} = \frac{(2)(.884)}{1 + .884} = 0.938 \approx 0.94$$

2. Gamma Coefficient

The gamma coefficient is used to measure the degree of association between two ordinal variables. Ordinal variables take on values that can be ordered by some criterion.

Examples are: high, medium, low; no difficulty, some difficulty, a great deal of difficulty.

The gamma coefficient describes the degree to which the ordered values on two variables "align" themselves across all the observations. Alignments can either be positive (high with high, medium with medium, low with low) or negative (high with low, medium with medium, and low with high). The value of gamma ranges from -1, perfect negative ordinal relation, through 0, no ordinal relation, to +1, perfect positive ordinal relation.

The formulas for computing gamma are too complex to provide intuitive understanding. Instead, consider the following 3 by 3 table.

APPENDIX D
THE RELIABILITY DETERMINATION USING
SPEARMAN-BROWN FORMUAL (PILOT STUDY)

APPENDIX E
UNITED MCGILL CORPORATION

UNITED MCGILL CORPORATION

Mr. McGill began in 1951, with two other men as partners, as a sheet metal contractor making heating ducts for building construction. He was more ambitious than his partners and soon bought them out.

In the mid-1950's Carrier Corporation (a major air conditioning manufacturer) bought a machine from a German inventor to make round spiral piping for air ducts. They had difficulty with operating that type of business and sold it to McGill. For many years he had a monopoly in the U.S. for round air ducts, made in a factory and brought to the building site (rather than rectangular ones hand-fabricated as needed) and this was a significant change for the construction industry, giving him national visibility.

There are now hundreds of small competitors for making round ducting, but McGill is the largest, with 30 to 40 percent of the market.

In the late 1950's Armco Steel Company developed the inter-lock floor grating but had difficulty selling it and sold the license and know-how to McGill. Their Columbus plant was the only one in the U.S.--a monopoly for some years. Competition began to build up in the mid-1960's and Mr. McGill now has five to ten percent of the market.

In the 1960's McGill bought a license from a West German firm for iron foundry air pollution control equipment. But most U.S. foundries were very small and just shut down. Also, the German licensor failed to transfer enough technology know-how. It was not a successful agreement and was terminated.

The Owens-Illinois Company (Toledo, Ohio) needed air pollution control equipment for their glass plants and found some excellent technology at a small R & D company in Japan. Owens-Illinois bought world-wide rights (except for Japan) from the Japanese company. They sold the licensed rights to McGill.

In the 1960's, McGill bought the Biggs United Company (Toledo, Ohio). It made autoclaves, for curing rubber tires, for digesting iron ore, etc. Biggs had an international distributor network. But autoclaves are bulky and ocean freight is expensive.

In the mid-1960's to late 1970's U.S. construction contractors operating abroad, particularly in the Mid East, would often order sheet metal work and inter-lock floor

gratings from McGill for export and installation abroad. This pulled them more into the international markets.

In the mid-1970's the Phillips Company (Netherlands) asked McGill to install air pollution equipment (precipitators) in their glass plants in Europe. These were exported from the U.S. McGill then opened up an office in the Netherlands and began looking for licensees for precipitators, in Western Europe. The competition in Western Europe had a lower efficiency precipitator which was, however, much less costly.

Each product line handled its own foreign sales and licensing until about 1983, when an International Department was formed to consolidate these efforts.

McGill developed its own flotation systems, but these are very bulky and must be custom made, so exporting is very difficult.

In the mid-1960's McGill had annual sales of about \$10 million. It has grown to where, in 1984, it had 725 employees and sales of about \$45 million.

Source: Professor Lee C. Nehrt