THE PROCESS OF TRANSFERRING MILITARY TECHNOLOGY TO DEVELOPING COUNTRIES

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Abstract

In developing countries, there is a switch from direct arms sales to military technology transfer in order to produce arms in the name of self-sufficiency. The value of domestic arms production in these countries at the beginning of 1980s was about 500 times higher than that of at the beginning of 1950s. This paper examines the developments, sources, strategies, and channels of military technology transfer.

INTRODUCTION

Military technology develops so fast that even some industrialized countries cannot afford to keep pace. Therefore, technologiacl dependence arises mainly from the gap of technical knowledge and skill between supplier and recipient nations. Developing countries[1] are mainly transferring military technology to create and expand technologically oriented armed forces.

The two segments of the term "military technology transfer" may be defined as follows:

Military technology is the understanding and application of specific knowledge, technical information, and blueprints. Specifically, it includes know-how, critical materials, unique manufacturing equipment, end products and test equipment essential to research, develop and produce wea-

[1] In this study, a developing country is defined as a country having annual per capita income of $3,000 or less. Sometimes a developing country is referred as a "third world country", "less developed country" or "underdeveloped country". Throughout this tudy, we use the term "developing country".

pons systems, comprised of a weapon platform (e.g. a ship, aircraft, or armored vehicle), weapons (e.g. a gun, missile or torpedo), and means of command and control.[2]

Technology transfer is simply the flow of technology from a country, other than that from which this technology originates, to another country.[3]

It is possible to distinguish arms and process transfer. Arms transfer entails the import of weapons and weapons systems embodying new technology that have few or no indigenous substitutes. A process transfer, though, entails the import of know-how necessary for indigenous production of needed arms.[4]

The consern of this study is the examination of transfer of conventional military technology to developing countries. It excludes the transfer of nuclear, biological and chemical military technologies.

DEVELOPMENTS IN MILITARY TECHNOLOGY

Between 1789 and 1807, during the sovereignty of Sultan Selim III of the Ottoman Empire, the range of a musket was about 200 meters. It took 30 seconds to load. At the end of the nineteenth century, the musket was replaced by the repeating rifle and the machine-gun which not only increased the rate of fire, but also increased the range to 1000 meters or more. At the same time, quickfiring artillery superceded old-fashioned cannons.[5]

Although major innovations in military technology such as aviation, armored vehicles, and military electronics of many kinds took place during the Second World War, there have also been extensive developments in conventional military technology since the end of World War II. Some examples follow:[6]

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[2] Philip A. Roberts, **Technology Transfer: A Policy Model**, National Defense University Press, Washington, DC., 1988, p. 25.

[3] Edmund Emeka Ezegbobelu, **Developmental Impact of Technology Transfer: Theory and Practice**, European University Studies, Peter Lung, New York, 1986, p. 9.

[4] David J. Louscher and Michael D. Salomone, **Technology Transfer and U.S. Security Assistance: The Impact of Licensed Production**, Westview Press, Boulder, 1987, p. 3.

[5] Malvern Lumsden, "New military technologies and the security of small and medium-sized countries in Europe," **Current Research on Peace and Violence**, vol. 3, no. 1, 1980, pp. 24-25.

[6] Milton Leintenberg, "The dynamics of military technology today," **International Social Science Journal**, vol. xxv, no. 3, 1973, pp. 338-339.

1. Extensive computer-controlled air-defense networks with large, early-warning, over-the-horizon radars for ballistic missile warning and forward emplaced radar networks for anti-aircraft defense.

2. Electronics and air-borne computers play a nearly complete role in advanced combat aircraft: navigation, reconnaissance, bad-weather operations, engaging opposing aircraft, fire control, and weapons guidance. An airborne anti-submarine warfare has undergone enormous development: long-range, long duration patrols, expandable sonobuoy systems, other buoy telemetry, airborne dipped sonars, infra-red and magnetic anomaly surveillance.

3. Advanced weapon quidance, using lasers for targeting of many kinds of ordnance in tactical vehicles and manheld weapons, and ground-support aircraft; night-time target acquisition and fire-control devices; and radars for artillery and mortar location.

4. The impact of artificial intelligence on military technology and tactics may be tremendous. It is expected to see greater autonomy, sophistication and dispersion of weapon systems and personnel.[7] Three specific military areas targeted for initial application of artificial intelligence are an autonomous land vehicle, an Intelligent Pilot's Associate, and naval battle management.[8]

5. There is potential of applying robotics to the battlefield. It is suggested that robotics must first replace people in hazardous jobs, such as combat, since those people can be killed. Second, robotics should replace people in military jobs that may not be hazardous, such as in logistics, to decrease the overall investment in the armed forces. Third, robotics should be used in those applications, particularly in combat, that can overcome the disadvantage in numbers of personnel.[9]

Improvements in the performance of the fighter-bombers may give a general idea about overall developments in military technology after the Second World War. The P-51H, developed in 1944, had a combat speed of 350 knots and could load two, 1,000 pound bombs while the F-16A,

[7] E.W. Martin, "Artificial Intelligence and Robotics for Military Systems," in **Proceeding of the Army Conference on Application of Artificial Intelligence to Battlefied Information Management**, U.S. Navy Surface Weapons Center, 1983, pp. 3-16.

[8] **Encyclopedia of Artificial Intelligence**, 1987, p. 604.

[9] B.J. Brownstein et al., "Technological Assessment of Future Battlefield Robotic Applications," in **Procedings of the Army Conference on Application of AI to Battlefield Information Management**, U.S. Navy Surface Weapons Center, 1983, p. 171.

developed in 1980, had a combat speed of 500 knots and could load up to 20,000 pound bombs.[10]

Currently, the average life span of advanced military technology such as tank and combat aircraft is estimated at less than 10 years. In the case of electronics and computers, the average life span is 5 years. Because of this life span, a new generation of weapons is produced every decade.[11]

REASONS FOR MILITARY TECHNOLOGY TRANSFER

The three major reasons for transferring military technology to developing countries can be stated as follows:

1. The desire for domestic arms production,
2. Economic factors,
3. Characteristics of arms production.

The Desire for Domestic Arms Production

Developing countries comprise the world's leading market for conventional weapons, accounting for as much as three-quarters of the international trade in military systems.[12] Although these transfers have resulted in a significant shift in military technology from developed to developing countries in the form of hardware, there is an apparent decline in arms purchases by developing countries. From a high point of $43.6 billion in 1982, developing countries orders for new weapons dropped to $28.2 billion in 1983, $32.2 billion in 1984, and $29.9 billion in 1985 (in current dollars).[13]

On the other hand, the annual value of the production of weapon systems in developing countries has grown vastly between 1950 and 1984. In 1950, production of weapons was valued at nearly $2.3 million (in

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[10] Seymour J. Deitchman, **Military Power and the Advance of Technology: General Purpose Military Forces for 1980s and Beyond,** Westview Press, Boulder, 1983, p. 42.

[11] Gerald M. Steinberg, "Indigenous Arms Industries and Dependence: The Case of Israel," **Defense Analysis,** vol. 2, no. 4, 1986, p. 296.

[12] Richard F. Gimmett, **Trends in Conventional Arms Transfers to the Thrid World by Major Suppliers, 1978-1985,** Congressional Research Service, Washington DC., 1986, pp. 30-36.

[13] Michael T. Klare, "The arms trade: changing patterns in the 1980s," **Third World Quarterly,** vol. 9, no. 4, October 1987, p. 1258.

constant 1975 prices) or roughly equivalent to the cost in the value was about 500 times higher.[14]

As the data suggest, there is a switch from direct arms sales to military technology transfer such as blueprints and technical information to produce arms in the name of self sufficiency.

Given the high costs and technical difficulties, many analysts have dismissed the possibilities of achieving total self-sufficiency in domestic arms production.[15] However, producing weapons in the name of self-sufficiency is still the most important **raison d'etre** for transferring military technology in developing countries.[16]

The main motivation for indigenous military production is the desire to reduce dependency on foreign arms suppliers.[17] As one researcher states, "almost all of the countries that have embarked upon creating an arms-manufacturing industry have basically done this for political and security reasons. They wish to become more independent."[18]

However, another analyst observed that most of those developing countries with indigenous arms industries are generally dependent to a greater or lesser degree on imports of military technology- in the form of blueprints, technical assistance, specialized machinery and parts from the major developed countries.[19]

Economic Factors

Another motive for transferring military technology is that military technology and domestic arms production benefit the economy of developing countries.[20] The main economic consideration of military technology transfer are threefold.

First, investment in the design and production of technologically advanced weapons in developing countries is seen as a means of creating

[14] Michael Brzoska and Thomas Ohlson, "Arms production in the Third World: an overview," in M. Brzoska and T. Ohlson, eds., **Arms Production in the Third World**, SIPRI, Taylor & Francis Philadelphia, 1986, p. 7.

[15] Gerald M. Steinberg, **Ibid.**, p. 291.

[16] M. Brzoska, **et al.**, **Transnational Transfer of Arms Production Technology**, IFHS (Study Group on Armaments and Underdevelopment), Hamburg, Federal Republic of Germany, 1980, p. 87.

[17] Michael T. Klare, **Ibid.**, p. 1266.

[18] A.J. Pierre, **The Global Politics of Arms Sales**, Princeton University Press, Princeton, 1982, p. 10.

[19] Stephanie G. Neuman, "The arms trade and American national interests," in Vojtech Mostry, ed., **Power and Policy in Transition**, Greenwood Press, Westport, 1984, p. 162.

[20] For a more discussion of economic effects of military technology transfer to developing countries see: J. Sounders, "Impact and consequences of the military

a national technological infrastructure which later can be transferred to the civil sector.[21] Second, developing countries often suffer from excess industrial capacity. Thus, military production may have backward linkages and create demand for inputs produced by horizontally integrated civilian industrial systems. Finally, it is assumed that foreign exchange will be saved and employment created.[22]

Technological Characteristics of Arms Production

Establishing military-industrial complex for domestic arms production would have certain characteristics that force developing countries to transfer military technology:[23]

1. Steadily increasing military research & development expenditure, which result in ever more complex weapons systems,
2. A rising rate of weapon innovation and development which leads to rapid technological obsolescence, and,
3. Increasing complexity of weapon systems which reduces the possibility of "copying" and which allows for effective control of the technology by the licenser over a considerable period of time.

This dependence on military technology transfer and skills has become a significant factor in the global military trade.

SOURCES OF MILITARY TECHNOLOGY

A focus on licensed production of military products provides a more clear opportunity to examine the sources of military technology.[24]

technology transfer to developing countries," **Australian and New Zealand Journal of Sociology**, vol. 12, no. 3, October 1976, pp. 204-212; Peter Lock and Herbert Wulf, "Consequences of the transfer of military-oriented technology on the development process," **Bulletin of Peace Proposals**, vol. 8, no. 2, 1977, pp. 127-136; and Miguel S. Wionczek, "Growth of military industries in developing countries: Impact on the process of underdevelopment," **Bulletin of Peace Proposals**, vol. 17, no. 1, 1986, pp. 47-58.

[21] Steven R. Rivkin, **Technology Unbound: Transferring Scientific and Engineering Resources from Defense to Civilian Purposes**, Pergamon Press Inc., New York, 1968, pp. 61-79.

[22] Saadet Değer, **Military Expenditure in Third World Countries: The Economic Effects**, Routledge & Kegan Paul, London, 1986, p. 154.

[23] P. Lock and H. Wulf, "The economic consequences of the transfer of military-oriented technology," in M. Kaldor and A. Eide, eds., **The World Military Order: The Impact of Military Technology on Third World**, London, 1979, p. 218.

[24] Licensed production is the most clear evidence of a military technology transfer. Although data concerning licenses are scarce, they are more available than

Table-1 shows that a small number of countries dominate the sale of military licenses for major weapon systems. The United States of America (USA), the United Kingdom (UK), France (FR), the Federal Republic of Germany (FRG) and the Soviet Union (USSR) together account for almost 85 per cent of all licenses sold to developing countries

Table — 1. Matrix of licensed-production projects for major weapons 1950-1984

	Licenser									
	USA	**UK**	**FR**	**FRG**	**USSR**	**ITALY**	**SPAIN**	**ISRAEL**	**Others**	**Total**
By licensee										
Algeria		1			0.5[b]				0.5[b]	2
Argentina	2	1	1	3					1	8
Brazil		1	2	2		1			1	7
Chile	4		1				1		1	7
Egypt		3	3				1		1	8
India		8	5	3	7					23
Indonesia	1		2	2.5[b]			1		0.5[b]	7
Iran	4[a]									4
Israel	2	1								3
North Korea					5.5[b]				0.5[b]	6
South Korea	10					1				11
Malaysia				2						2
Pakistan		1		1					1	3
Peru	1					1	1			3
Philippines	1	1		1						3
Singapore		5		2						7
South Africa			4			2		1		7
Taiwan	5							2		7
Thailand			1	1						2
TOTAL	**30**	**22**	**21**	**17.5**	**13**				1	3
By weapon category						5	4	3	7.5	123
Aircraft	15	6	12	4.5[b]	5	3	3		3.5[b]	52
Armourd Ve.	3	2	4	1	4	1			3	18
Missiles	2	1	2	3	1			1		10
Ships	10	13	3	9	3	1	1	2	1	43

[a] All cancelled before start of production.

[b] Split in order to indicate two design countries.

Source: M. Brzoska and T. Ohlson, "Arms production in the Third World: an overview," in M. Brozoska and Thomas Ohlson, eds., **Arms Production in the Third World**, SIPRI, Taylor & Francis, Philadelphia, 1986, p. 26.

data concerning other channels of military technology transfer (D.J. Louscher and M.D. Salomone, **Ibid.**, p. 4). As a channel of military technology transfer, licensed production agreements later in the study discussed in detail.

during the 35 years under consideration with respect to the number of production licenses granted, the USA is the most diversified supplier. The USA has nine recipient countries. This is the same number of licenses as for FRG and the UK, and one fewer than France.

The main recipient countries of US military technology are South Korea and Taiwan. On the other hand, only India, North Korea and Algeria use the military technology of the USSR. India is also an important market for British and French military technology. Israel not only produces weapons under license, but also has become a supplier of military technology. It has licensed ships to South Africa, and ships and missiles to Taiwan.

Most licenses (42 per cent) are for aircraft production technology. While the USA, the UK and FRG dominate the supply of naval technology, the USA and France together account for 52 per cent of the aircraft licenses. Licenses for the production of armored vehicles are less frequent and in general their production is relatively lesser.

THE VINTAGE OF TRANSFERRED MILITARY TECHNOLOGY

There is a lengthy time lag between military design and military production or between production start and initial deployment of the weapon systems in developing countries. This time lag is a measure of the technological level of the arms production process. Another such measure is the vintage of the technology used.[25] Generally, the Stockholm International Peace Research Institute (SIPRI) data show that mature technologies are often easier for developing countries to master and that they are also less restricted by the original owners of the technology.[26]

As shown in Table-2, such vintage comparison can be made for weapons produced under license. This shows that the technologies transferred are of varying vintages and that sophisticated and more or less obsolete technologies are being utilized side by side.

On the average and over time, for all weapons produced under license, the vintage gap has neither increased nor decreased but there are marked differences when technological sophistication is singled out. When simple technologies are transferred, the vintage gap is very short. For instance, small patrol craft designs transferred from the Soviet Union to North Korea, and British and German designs transferred to Singapore, and

[25] M. Brzoska and T. Ohlson, "Arms production in the Third World: an overview," **Ibid.**, p. 23.

[26] SIPRI, **SIPRI Yearbook 1987: World Armaments and Disarmament**, SIPRI, Oxford University Press, Appendix 7c, 1987, pp. 270-282.

American light-plane designs to Chile are of this kind. However, the vintage gap increases when more advanced technology is transferred.[27]

Table — 2. Vintage of selected advanced major weapon systems produced under license

Licenser	Year of initial production in licensing company	Designation	Licensee	Year of initial production in licensee country	Vintage gap (years)
USRR	1956	MIG-21	India	1966	10
Italy	1957	MB-326	Brazil	1971	14
FRG	1969	Bo-105	Indonesia	1976	7
France	1970	SA-315 Lama	Brazil	1979	9
UK	1971	Jaguar	India	1981	10
USA	1971	F-SE/F	South Korea	1980	9
France	1971	SA-342 Gazelle	Egypt	1983	12
France	1975	Alpha Jet	Egypt	1982	7
Armored vehicles					
USRR	1958	T-55	North Korea	1974	16
USRR	1971	T-72	India	1984	13
Switzerland	1974	Piranha	Chile	1981	7
USA	1974	M-109-A2	South Korea	1984	10
Missiles					
USRR	(1958)	AA-2Atoll	India	1968	(10)
FRG	1960	Cobra-2000	Brazil	1975	15
UK	1968	Swingfire	Egypt	1978	10
France	1972	Milan	India	1984	12
Ships					
USRR/China	1958	Romeo Class	North Korea	1974	16
UK	1959	Leander Class	India	1966	7
France	1973	Batral Class	Chile	1980	7
FRG	1973	Type 209/3	Brazil	1982	9

( ) uncertain data.

Source: M. Brzoska and T. Ohlson, "Arms production in the Third World: an overview," in M. Brzoska and T. Ohlson, eds., **Arms Production in the Third World**, SIPRI, Taylor & Francis, Philadelphia, 1986, p. 24.

[27] M. Brzoska and T. Ohlson, "Arms production in the Third World: an overview." Ibid., p. 24.

Table-3 shows an approximation of the technological level that can be obtained by comparing start of design studies with deployment year for domestically designed weapons. This average time lag is about 7 years for aircraft, about 5 years for armored vehicles, about 6 years for missiles and nearly 3 years for ships. The level of sophistication also proves to be the decisive factor. For more complex weapons the time lag is above these averages.[28]

Table — 3. Design deployment time lag for selected advanced major weapons of domestic design

Producer	Designation	Design year	Deployment year	Time lag (years)
Aircraft				
India	HF-24 Marut	1956	1964	8
Taiwan	AT-3	1975	1984	9
Brazil	AM-X	1977	(1987)	10+
Armored vehicles				
Israel	Merkava-1	1967	1978	11
South Africa	Ratel-20	1968	1976	8
India	Main Baatle Tank	1974	(1985)	11+
Missiles				
Israel	Shafrir-2	1962	1970	8
Israel	Gabriel-2	1969	1978	9
Brazil	MAA-1 Piranha	1975	(1984)	9+
Ships				
North Korea	Najin Class	1970	1976	6
Brazil	Niteroi Class[a]	1972	1979	7
India	Godavari Class[b]	1977	1983	6

[a] British design from 1970; first Brazilian built ships laid down in 1972.
[b] Stretched version of UK-designed Leander (Nilgiri) Class.
( ) uncertain data.

Source: M. Brzoska and T. Ohlson, "Arms production in the Third World: an overview," in M. Brzoska and T. Ohlson, eds., **Arms Production in the Third World**, SIPRI, Taylor & Francis, Philadelphia, 1986, p. 25.

From a purely strategic efficiency point of view, developing countries may receive optimum benefit from transferring the highly sophisticated military technology. However, since there is an increasing rate of obsolescence over time, increasing proportions being spent on new vintages will make the resource cost prohibitive. Therefore, the macroeconomic cost of military technology must be considered too.[29]

[28] M. Brzoska and T. Ohlson, "Arms Production in the Third World: an overview," **Ibid.**, p. 25.
[29] Saadet Değer, **Ibid.**, p. 179.

STRATEGIES FOR MILITARY TECHNOLOGY TRANSFER

Developing countries use "Path" and "Engineering" strategies to acquire military technologies.

Path Strategy

In the path strategy, military technology transfer moves through several steps. The following suggestive steps are the learning stages which are likely in the transfer of military technology.[30] Any country may be at different steps with regard to different technologies. For instance, Turkish fighter-bomber production depends more upon foreign design and components than shipbuilding.

Step one: maintenance and repair of transferred systems

The recipient country develops a repertoire of maintenance capabilities. It learns how to repair, maintain and rebuild foreign built equipment. In order to promote domestic skills, foreign supplier or domestic civilian industries provide this type of information.

Step two: assembly of subsystems from imported components

At this step, manufacturing capabilities are expanded to domestic assembly under license of component packages provided from major industrial suppliers. Licensed assembly in the military production is almost totally dependent on foreign design and components.

Step three: final production of the weapon system and production of basic components

At the third step, the recipient country develops a capability to manufacture basic components of a weapon systems designed by a supplier, as well as providing the final assembly of the weapon system. Foreign technical assistance is provided for the establishment, organization and operation of facilities to produce or to assembl components, or end items of foreign designed equipment.

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[30] The Path strategy of military technology transfer has been discussed in various forms and combinations in the defense literature, for example see: D.J. Louscher and M.D. Salomone, **Ibid.**, pp. 3-4; Dale W. Church, "Countertrade, technology transfer and international defense sales," **Defense Management Journal**, vol. 20, 1984, p. 10; and H. Tuami and R. Vayrynen, **Transnational Corporations, Armaments and Development**, St. Martin's Press, New York, 1982, pp. 118-120.

Step four: production using imported design

Domestic arms production starts by using imported weapon designs. Also, production can be accomplished through reverse engineering of foreign weapons. The recipient country develops on engineering ability to modify technology designed by a supplier. This capability, combined with the production knowledge, industrial organization, and technical skills acquired through licensing, copraduction, foreign design assistance and joint venture permits the production of weapon systems.

Step five: the capability to design weapon systems indigenously

This step assumes that the knowledge and capabilities to produce a significant number of major components exists. Minimal depndence on foreign sources for design, organizational knowledge, technical skills, components, and critical technical and organizational skills for end item assembly is required.

Step six: production based on local research and design of new system

At the sixth step, through transferring military technology, a country achieves capability not only to design but also to manufacture weapon systems using all domestic components. This stage marks true self-sufficiency in production, and it is the ultimate objective of the military technology transfer process.

Engineering Strategy

The view that military technology transfer should follow the steps that lead to self-sufficiency in military production is still predominant developing countries. However, especially with respect to the later steps, there are two main reasons that undirmine the path strategy.[31]

First, because of fast developments in military technology, even many developed nations which have outlays on research & development cannot afford to keep up with. Since the rate of technological obsolescence is accelerating, there is a need for more frequent replacement of products and product improvement programs. As a rule, beyond a certain point the technical problems of import substitution are substantial. Dependence on imported know-how and materials normally increases with the degree of sophistication of the weapons. Attempts to increase the domestic content per unit of output also often lead to a steep rise in costs.

[31] M. Brzoska and T. Ohlson, "Conclusions," in M. Brzoska and T. Ohlson, **Arms Production in the Third World**, SIPRI, Taylor & Francis, Philadelphia, 1986, p. 283.

Second, the concept of total self-sufficiency has lost much of its meaning during the past two decades. This is true even for most of the developed countries. For instance, Japanese, German, and Swedish aircraft have engines that are designed in other countries. Only arms producers in the United States and the Soviet Union have managed largely to avoid having to use foreign components.

Therefore, after creating an adequate industrial and technological base a developing country may replace the path strategy with engineering strategy. Add-on engineering and add-up engineering are the two types of the engineering strategy.

> Add-on engineering refers to the adaptation of an existing weapon systems to specific needs by changing components, adding features or taking them away, and trying to incorporate as many indigenous parts as possible.[32]

In other words, it is an updating, upgrading, improving and adapting of existing weapons technologies.[33] In the early 1960s, South Africa first produced French AML vehicles under license, then since the early 1980s, by using add-on engineering strategy, it has produced the Eland armored cars. Israeli combat aircrafts, Kfir and Nesher are also the result of this strategy using French Mirage blueprints; shafrir missile is based on the Sidewinder. The Egyptian Early Bird missile is based on the Soviet SA-2; and the October Class fast attack craft in the Egyptian Navy largely resembles the Soviet Komar Class.[34]

On the other hand,

> add-up engineering is more demanding in terms of technical know-how and previous production experience... The idea is to raise sources of supply throughout the world to integrate imported components into a new and functioning weapon system.[35]

Brazilian armored vehicles made by Engesa corporation and aircraft made by Embraer corporation; South Korean howitzers and ships, and Taiwanese missiles and artillery are designed by using add-up engineering transfer strategy. This strategy can also be used with respect to "simpler"

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[32] M. Brzoska, "South Africa: evading the embargo", in M. Brzoska and T. Ohlson, eds., **Arms Production in the Third World**, SIPRI, Taylor & Francis, Philadelphia, 1986, p. 206.

[33] Ron Matthews, "The development of the South African military industrial complex," **Defense Analysis**, vol. 4, no. 1, p. 12.

[34] M. Brzoska and T. Ohlson, "Conclusions," **Ibid.**, p. 284.

[35] M. Brzoska, "Conclusions," **Ibid.**, p. 284.

military products such as the production of jeeps and trucks in the Philippines.[36]

Implementation of add-on and add-up engineering strategies require a certain level of technological base. Therefore, some channels of technology transfer should be used to acquire that capacity.

CHANNELS OF MILITARY TECHNOLOGY TRANSFER

Throughout the literature, the channels of technology transfer have been classified according to different criteria.[37] For the purpose of this study, we have classified them according to the degree of participation of the recipient country in the transfer process and the existence of a continuous relation over time. This involves a certain level of division of labor and risk sharing between the supplier and the recipient countries. According to this criterion, military technology transfer channels can be classified under four broad categories.[38]

1. Licensed production agreements,
2. Coproduction agreements,
3. Joint venture agreements,
4. Foreign design assistance.

Although military technology transfer have beneficial effects, the costs are extremely high. In order to lessen the outflow of foreign currency required, some arrangements have to be made. In this study, the term "offset" is used as a generic word to refer to all compensatory arrange-

[36] M. Brzoska and T. Ohlson, "Conclusions," **Ibid.**, p. 284.

[37] For these distinctions see: Daniel L. Spencer, **Military Transfer of Technology**, Washington DC., 1967, pp. 157-159; Stefan H. Robokc and R.D. Calkings, **The International Technology Transfer Process**, National Academy, Washington DC., 1980, pp. 6-7; M.L. Liebrenz, **Transfer of Technology: U.S. Multinationals and Eastern Europe**, Praeger Special Studies, New York, 1982; E. White, **Channels and Modalities for the Transfer of Technology to Public Enterprises in Developing Countries**, ICPE Monograph Series, no. 12, Ljublijana, Yugoslavia, 1983, pp. 16-25; and Office of Industrial Innovation, **Ibid.**, pp. 27-40.

[38] Other channels of military technology transfer will not be discussed separately in this study for three reasons. First, channels such as training, education and consulting are often included under the heading of "show-how" in the agreements of the above-mentioned four categories. Second, although military presence in one country has an impact of upgrading technical potentials, for the purpose of this study, it is not a relevant transfer channel. Finally, as a result of economic considerations, military assistance programs are no longer as important transfer channels of military technology as before.

ments practiced in the transfer of military technology.[39] Therefore each of the above-mentioned channels may be thought of as a direct offset. Moreover, these mechanisms are not mutually exclusive and an agreement of military technology transfer may incorporate elements from each of them.[40] For instance, the Turkish offset agreement with General Dynamics is a joint venture in nature, but it constitutes the coproduction of 160 F-16C/D combat aircraft too.

While licensed production, coproduction, joint venture, and foreign design assistance agreements explicitly entail the transferring of military technology to the recipient country, other major offset types- subcontracting and countertrade may not.[41] The latter two are less likely to encourage the technological advancement of the recipient. Therefore, in this study, only the former four types of offsets are discussed as channels of military technology transfer.

Licensed Production Agreements

A license is commonly used to describe situation where:

> The owner of certain statuary rights in the technology... grants permission to another party to exercise some of those exclusive rights held by the owner of the technology.[42]

Licensing agreements generally include a series of provisions regulating the rights and obligations of both recipient and supplier with regard to use of the technology.[43] The oldest method of international

[39] For a detailed discussion of offsets, see: L.G. Welt, "Military offsets," **National Defense**, March 1984, pp. 20-23; M. Brzoska and T. Ohlson, "The future of arms transfers: the changing pattern," **Bulletin of Peace Proposals**, vol. 16, no. 2, 1985, pp. 130-135; S.G. Neuman, "Coproduction, barter and countertrade: offsets in international arms market," **Orbis**, Spring 1985, pp. 189-213; D.W. Church, **Ibid.**, pp. 9-13; "Countertrade terminology," **Defence Africa and the Middle East**. vol. 12, no. 3, May 1986, p. 22; and G.T. Hammend, "Offset, arms, and innovation," **The Washington Quarterly**, Winter 1987, pp. 173-185.

[40] In the literature, The terms "offset", "coproduction", "licensed production", "joint venture", and "foreign design assistance" are used interchangeably. For example see: S.G. Neuman. **Ibid.**, pp. 183-185, and D.J. Louscher and M.D. Salomone, **Ibid.**, p. 3.

[41] For more discussion of offset types see: U.S. General Accounting Office, **Military Exports: Analysis of Interagency Study on Trade Offsets**, GAD/NSIAD-86-99-BR, April 1986, Appendix II, and S.G. Neuman, **Ibid.**, p. 188-190.

[42] Office of Industrial Innovation, **Ibid.**, p. 28.

[43] Eduardo White, **Ibid.**, p. 30.

production of weapon systems that are developed in another country is the bilateral licensing agreement.[44]

Moreover, these agreements have become very common in international transfer of military technology, both among developed countries and between developed and developing countries. The highly competitive arms market has stimulated these agreements because many arms receivers usually prefer license purchases as a channel of military technology transfer.[45]

In the last one and half decades, licensed production has expanded in the Turkish military industry's role in the manufacture of the G-3, MG-3 infantry weapons, ammunition, missiles and artillery. Table-1 shows overall licensed production in some developing countries by weapon categories and suppliers.

Coproduction Agreements

Coproduction is based upon government-to-government agreement that permits a recipient country to acquire the technical information to manufacture all or part of supplier origin defense article. It excludes licensed production based upon direct commercial arrangements by the supplier country manufacturers.[46]

The more sophisticated the weapon is, usually the higher the share of foreign parts and know-how. Bilateral and multilateral coproduction of weapon systems are arranged either vertically or horizontally.[47]

Vertical coproduction means that the military-industrial complex of the recipient country not only produces components for a particular weapon system bought, but also produces those components for all the systems which are constructed abroad. These components can be totally or particularly indigenous.

On the other hand, horizontal coproduction contains only the production of components for those weapons systems bought by the recipient nation.

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[44] Defense Systems Management Collage, **Joint Logistics Commanders Guide for the Management of Multinational Programs: A Handbook for Program Managers Involved in International Acquisition**, Defense Systems Management Collage, Fort Belvoir, July 1981, p. 5-14.

[45] Michael Brzoska, **et al., Ibid.**, p. 15.

[46] Subcommittee on Economic Stabilization of the Committee on Banking, Finance and Urban Affairs, House of Representatives, **Offset Agreements**, 99th Congress, Serial no. 99-86, U.S. Government Printing Office, Washington DC., 1986, p. 87.

[47] H. Tuomi and R. Vayrynen, **Ibid.**, p. 139.

Vertical coproduction is more profitable to the producer of the components than horizontal because in the vertical arrangement the factors reducing unit costs are more visible. Since the cost reduction is also beneficial to the seller country, vertical coproduction is preferable too. Therefore, the economic factor may be the main explanation of the fact that vertical coproduction projects have recently been on the increase.[48]

Some examples of corproduction are Germen missile and warship production in Brazil and Turkey; American F-5E fighter and PL-1B trainer in Taiwan, T-41D trainer in Pakistan, and PG-class patrol boat in South Korea.[49]

Joint Venture Agreements

Joint venture can be defined as a development and manufacture of military systems involving more than one military- industrial firm and significant level of interfirm cooperation in the research, design, production and marketing, as well as significant contributions by all partners to development funds and risk capital.[50]

Recently an increasing number of new investments have been joint ventures involving ownership between local and foreign partners. There are various factors contributing to the growth of joint ventures as a transfer channel of military technology. Developing countries may pass legislation either prohibiting total foreign ownership or making incentives conditional upon certain degree of local ownership. On the other hand, technology supplier have become increasingly aware of the benefits of sharing ownership with local partners. These include land, capital, trained personnel and familiarity with local markets.[51]

Equity and contractual joint ventures are the two types of joint ventures.[52]

Legislation of the recipient countries encourage the formation of equity joint ventures on the basis of requirements related to the share of equity in local hands and its effects on the decision making system of the enterprise.

[48] H. Tuomi and R. Vayrynen, **Ibid.**, p. 139.

[49] "Arms, technology and dependence - U.S. military coproduction", **Ibid.**, pp. 31-32.

[50] David C. Mowary, **Alliance Politics and Economics: Multilateral Joint Ventures in Commercial Aircraft**, Ballinger Publishing Company, Cambridge, 1987, p. 3.

[51] Erdener Kaynak, "Transfer of technology: some insights from Turkey", in A.C. Şamlı, ed., **Technology Transfer: Geographic, Economic, Cultural, and Technical Dimensions**, London, 1985, p. 16.

[52] Eduardo White, **Ibid.**, pp. 18-24.

In general, the participation share of the local party in a joint venture is at least 51 per cent. In the Turkish joint venture example, the Turkish Aerospace Industry, Inc. (TUSAS) holds 51 per cent of capitalization as a participation share. The foreign partner General Dynamics with its major subcontractor General Electric, is to aid the capitalization of the plant by providing 49 per cent of the funds required.[53]

The other kind of joint ventures is contractual. Transfer of technology can be the basic objective of the contracts or only one aspect of a more complex arrangement.[54]

The experiences of the Arab Organization for Industrialization (AOI)[55] in Egypt exemplify the joint venture arms projects to transfer military technology. The agreements negotiated with western governments and arms industries followed a basic pattern: the AOI created a subsibiary company which represented a partnership with the supplier. The chairman of the subsidiary was an Arab, while the managing director came from the foreign partner. The supplier agreed to deliver technical assistance and training, as well as some initial equipment over the period of the agreement. In each case, the AOI had the majority interest in the subsidiary company.[56]

Foreign Design Assistance

In foreign design assistance, the supplier country transfers information that may be classified and thus difficult to obtain for designing an indigenous weapon systems.[57]

As shown in Table-4, foreign design assistance has become an important channel of military technology transfer.

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[53] "The deals", **Defence Africa and the Middle East**, vol. 12, no. 3, May 1986, p. 22.

[54] E. White, **Ibid.**, p. 23.

[55] For more information about AOI see: R. Vayrynen, "The Arab Organization of Industrialization: a case study in the multinational production of arms", **Current Research on Peace and Violence**, vol. 2, no. 2, 1979, pp. 66-79. The AOI is also refered to as the AMIO (The Arab Military Industries Organization).

[56] R. Vayrynen and T. Ohlson, "Egypt: arms production in the transnational context", in M. Brzoska and T. Ohlson, eds., **Arms production in the Third World**, SIPRI, Taylor and Francis, Philadelphia, 1986, pp. 110-111.

[57] M. Brzoska and T. Ohlson, **Ibid.**, p. 27.

Table — 4. Selected cases of foreign design assistance

Country	Designation	Description	Design year	Design assistance from
Argentina	IA-27 Palqui	Fighter	1946	Dewoitine, France
Argentina	IA-33 Palqui-2	Fighter	1950	Kurt Tank, FRG
Egypt	HA-200	Trainer	1960	FRG, Spain
South Africa	Whiplash	Air-to-air missile	1964	FRG
Argentina	TAM	Medium Tank	1974	Thyssen, FRG
Taiwan	AT-3	Trainer	1975	Northrop, USA
Argentina	IA-63 Pampa	Trainer	1977	Dornier, FRG
Brazil	V-28 Type	Frigate	1978	Marine Techaik, FRG
Taiwan	Ching Freng	Surface-to surface missile	(1978)	Israel
Thailand	Thaiang Type	MCM	1978	Perrostaal, FRG
India	Vicram Class	Corvette	1979	The Netherlands
South Korea	Rokit	Maint battle tank	1983	General Dynamics

( ) Uncertain data.

Source: M. Brzoska and T. Ohlson, "Arms production in the Third World: an overview", in M. Brzoska and T. Ohlson, eds., **Arms Production in the Third World**, SIPRI, Taylor & Francis, Philadelphia, 1986, p. 27.

These alternative channels of military technology transfer are not clearly differentiated and they often overlap. In this sense, there are two main points to be considered in the selection of the channel.[58] First, generally, the terms and conditions negotiated within each form a more important than the forms as such. Second, the correct choice of the channel depends on the type and size of the weapon project, internal capacity of the recipient military-industrial firm, and a collection of external factors, ranging from legislation to external finance.

Through the network of licenses, coproduction, joint ventures and foreign design assistance agreements, today's military technology receiver becomes a producer.

ADVANTAGES AND DISADVANTAGES OF MILITARY TECHNOLOGY TRANSFER

Military technology transfer has both benefits and drawbacks for recipient countries as well as supplier countries.

Recipient Country

Through the technology transfer process, the recipient country acquires the necessary military technology which has been technically

[58] Eduardo White, **Ibid.**, p. 36.

without an unacceptably high degree of risk, on a fast timetable. Moreover, the recipient country can supplement its own development programs, and acquire spare parts and components easily.[59] However, the possible disadvantages in becoming a recipient of military technology follow:[60]

1. The recipient could become locked into a particular technology,

2. The recipient may assume the obligation to purchase tied- in products, such as spare parts and associated elements, while utilizing technology, and

3. The recipient can be forced to accept restriction in its marketing and policies relating to the licensed military technology, such as restrictions on export.

Supplier Country

There are several benefits to suppliers of military technology. These include:[61]

1. Maintaining reasonable friendly relations with recipient nations,

2. Retaining a share of the market in recipient countries,

3. Decreasing the balance-of-payment deficits,

4. Establishing the recipient country as a market for both the supplier's spare parts and maintenance services for the transferred technology, and finally,

5. Permitting the supplier to acquire a part-interest in the recipient company in return for supplying the technology, such as in a joint venture.

On the other hand, the recipient country could become a competitor and threaten the lead of the supplier's technology. Therefore, the supplier may choose not to supply its military technology. Moreover, the supplier country also has to worry that technology supplied to unstable regimes may someday fall into the hands of hostile forces. Finally, the growing

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[59] Office of Innovation, **Supplying or Acquiring Technology: A Canadian Business Guide to Structuring and Negotiating Technology Transfer Agreements**, Ottawa, Canada, 1986, p. 7.

[60] Office of Industrial Innovation, **Ibid.**, p. 8.

[61] Elbert C. Parker, **Foreign Transfer of Technology: A Case Study of the GE/SNECMA 10-Ton Engine Venture**, Report no. 5378, Air War Collage, Alabama, April 1974, p. 31.

arms production in the developing countries will reduce the supplier's control over some of its more ambitious and independent-minded clients.[62]

CONCLUSIONS

If the prescribed path strategy of military technology transfer for total self-sufficiency in arms production is followed, it is likely that the efforts moving from licensed to indigenous production to be failed.

There is no developing country achieved the total self-sufficiency in arms production. For example, Argentina in the 1950s and Egypt in the 1960s failed in moving from licensed production to indigenous arms production. Israel, India and Brazil have been more successful, but they are dependent on foreign military technology in terms of blueprints and components.

In order to start indigenous arms production, a developing country, first, ought to create an efficient military technological base and reduce the technological gap by utilizing licensing, coproduction, joint venture and foreign design assistance as channels of technology transfer. Although it depends on terms and conditions negotiated within each channel, joint ventures may be better than other transfer forms. Because, technology suppliers share the risks of the weapon production. After creating adequate military technological base, the path approach of transferring technology may be replaced by engineering strategy.

[62] "Arms, technology & dependency- U.S. military co-production abroad", **North American Congress on Latin America**, January 1977, p. 26.