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DEVELOPMENTS IN THE SYNTHETIC FIBRE INDUSTRY SINCE 196[illegible]

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United Nations Industrial Development Organization

SUMMARY

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Introduction

1. [illegible]

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INTRODUCTION

Facing the increasing population of the world, and the difficulty of increasing the cultivated areas, the problem of satisfying the basic needs of each individual is being raised more and more, in particular as far as food and clothing are concerned.

In order to find solutions, chemistry and, mainly petrochemistry, make a valuable contribution, especially in the field of clothing. Indeed, while the development of fertilizers has made it possible to increase the yield of cultures in appreciable proportions, the synthetic fibre industry has done even better by creating entirely new products, which are completely independent of conventional raw materials, sheep pastures and cotton fields, thus encouraging man a little more from nature's constraints.

This synthetic fibres industry is highly dynamic, under constant evolution; since 1945 substantial changes have taken place in the field of consumption, uses, production and techniques. We shall try to describe some of its aspects, putting the emphasis on the situation in developing countries; we shall then consider the conditions necessary for the establishment of a synthetic fibre industry in a developing country.

I - EXTENT AND STRUCTURE OF SYNTHETIC FIBRE CONSUMPTION

I.1 Consumption of synthetic fibres

I.1.1 World consumption

As indicated in table 1, the share of synthetic fibres within the total natural and chemical fibre market, is constantly increasing: from 5 per cent in 1960, it rose to 6 per cent in 1964 and reached 8 per cent in 1967. This evaluation in terms of tonnage gives however, a rather inaccurate idea of the actual share taken by synthetic fibres in world consumption. Indeed, the weight of textile used to manufacture a given article is greater for a natural fibre than for a synthetic fibre, due to the larger covering factor and lower density of the latter. It can thus be assumed that, on the average, synthetic fibres have a substitution power of up to 80 with respect to wool and 100 with respect to cotton.

Table 1 - World production of textile fibres

10^6 tons

	Natural	Artificial	Synthetic	Total
1960	11 [illegible]	[illegible]	[illegible]	[illegible]
1961	11 [illegible]	[illegible]	[illegible]	[illegible]
1962	11 [illegible]	[illegible]	[illegible]	[illegible]
1963	12 450	[illegible]	[illegible]	[illegible]
1964	12 [illegible]	[illegible]	[illegible]	[illegible]
1965	13 [illegible]	[illegible]	[illegible]	[illegible]
1966	[illegible]	[illegible]	[illegible]	[illegible]
1967	[illegible]	[illegible]	[illegible]	[illegible]

Source: textile [illegible]

The quantity of natural fibres consumed is subject to certain fluctuations, but in the final analysis, it does not increase. The consumption of artificial fibres increases very

slightly (2 per cent per year from 1,063 to 1,087); on the other hand the synthetic fibre market is experiencing a remarkable growth. Their production has increased from 1,350,000 tons in 1963 to 2,465,000 tons in 1967, which corresponds to a growth rate greater than 2% per cent per year. This rate has, by the way, been largely exceeded in 1968 (+ 22 per cent as compared with 1967

There are several reasons for this large development:

- the considerable increase in demand linked to the increase in population and the overall increase in national income, to which can be added the much more moderate growth of natural fibres consumption, have created rapidly expanding outlet for chemical fibres. The artificial fibre market having reached a state of maturity and meeting, for the past few years, a somewhat constant part of total textile needs (of the order of 20 per cent); the use of synthetic fibres has developed to a significant extent.
- the desire of the industrialized countries, which are the largest consumers of textile fibres, of freeing themselves from the pressure of natural textile prices, which are subject to large fluctuations
- a constant lowering of prices
- finally, and especially, the particular properties of synthetic fibres or of their mixtures, and their ease of use in several fields, particularly the clothing and industrial application fields

I.2. Consumption in industrialized countries

The major part of synthetic fibres is produced but is also used in the industrialized countries. As a result, the observations made concerning world production and consumption of synthetic fibres can be applied in their broad aspects to the industrialized countries as a whole.

Same as for the other major industrial products, the United States, Western Europe and Japan, are the three largest centers of synthetic fibre demand

Indeed, the three areas mentioned still absorb 80 per cent of the world's production of these fibres as against 85 per cent in 1963.

Table 3 shows that the volume of synthetic fibre demand in these three areas has exactly doubled during the period 1963-1967, which corresponds to an average annual increase of 15 per cent.

Table 3 - Consumption of synthetic fibres in several industrialized areas

	Tonnage	kg/capita	Tonnage	kg/capita
EEC	[illegible]	[illegible]	[illegible]	[illegible]
Rest of Western Europe	[illegible]	[illegible]	[illegible]	[illegible]
USA	[illegible]	[illegible]	[illegible]	[illegible]
Japan	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]		[illegible]	

It can be seen - with the exception of the EEC countries as a whole - that this increase has varied more or less homogeneously in all these areas.

This rate of growth does not seem, therefore, to depend at present on the level of demand expressed in terms per capita, as shown in the preceding table. This table also shows the relatively high level of demand for synthetic fibres in Japan, although the per capita income is approximately one third of that in the United States. Synthetic fibre consumption per capita is of the same order of magnitude in both countries.

Synthetic fibres being to a large extent competitors of artificial fibres as far as uses are concerned, it is interesting to know the relative volumes of each of these fibre categories; this is shown in table 4 in which are indicated, for the years 1963 and 1967, the respective percentages of the demand for artificial fibres and for synthetic fibres with respect to the total demand for chemical fibres.

Table 3 - Structure of consumption of chemical fibres in several industrialized areas

per cent				
EEC				
Rest of Western Europe				
USA				
Japan				

The substantial gaps during this build-up period can be readily appreciated. In the USA, for example, the use of textile fibres, therefore, occupies a relatively [illegible] fibres in this market that is distinctly higher than [illegible]

[illegible] Japan is distinctly higher than [illegible] Japan is expected, it occupies, from this point of view, an intermediate place with regard to the two groups mentioned.

From the possibility [illegible] that the properties of synthetic fibres with respect to the total use of chemical fibre can be taken, as a first approximation, as an indication of the extent of growth of the market.

1.1.3 Consumption in developing countries

In spite of an often rapid initial development, the synthetic fibre demand is still low in the new developing countries of the order of several grams or less of [illegible] in several countries, having a further increase level and in the majority being fibre producers, a change [illegible] this demand is now reaching several hundred grams (Table 4)

Table 4 - Evolution of demand for synthetic fibres
(1,000 t)

	1963					1967					Increase per Year 63/67	Kg/capita 1963	Kg/capita 1967
	Synth. Yarn	Synth. Fibres	Total	Yarn Product Cons. o/o	Fibre Product Cons. o/o	Synth. Yarn	Synth. Fibres	Total	Yarn Product Cons. o/o	Fibre Prod. Cons. o/o			
Cuba	0.2		0.2	1		0.2	1.2	1.2	0				
Mexico	5.2		6.0	77		15.1	9.1	24.2	37	42	4.5	0.145	0.53
South America:	14.4	7.7	22.1	65	34.9	42.3	22.2	64.5	66	71	5.5	0.29	0.81
Argentina	5.0	1.1	6.1	85	15	14.7	2.0	17.0	85	15	3.0	0.20	0.77
Brazil	7.6	3.4	11.0	36	64	13.0	10.7	23.7	45	71	2.7	0.14	0.265
Chile	1.1	1.1	2.2	46	3	2.4	0.9	3.3	65	100	1.5	0.32	0.37
Colombia	1.6	0.5	2.1	55	1	3.7	2.0	5.7	63	100	3.0	0.12	0.31
Peru	1.4	1.2	2.6	23	8	3.5	3.1	6.6	55	12	2.0	0.24	0.53
Uruguay	0.6	0.4	1.0	59	0	0.8	0.5	1.3	100	0	0.3	0.365	0.47
Venezuela	1.9	1.1	3.0	26	0	4.2	2.1	6.3	57	47	3.3	0.365	0.65
Taiwan	1.5	1.4	2.9	15	0	7.0	6.0	13.0	52	35	5.0	0.25	1.0
U.A.R.	0.2	0.2	0.4	50	100	0.2	0.5	1.0	100	47	15	0.02	0.03
India	5.2	4.7	9.9	54	9	7.9	4.5	12.4	40	66	2.2	0.02	0.03
Irak	-	-	-	-	-	-	0.3	0.3	0	0	-	-	-
Korean Republic	7.2	3.5	10.7	1	12	15.5	12.0	30.5	51	22	30	1.2	3.1
Pakistan	-	-	-	-	-	3.1		9.1	13	0	-	-	0.08
Thailand	-	-	-	-	-	2.7	1.7	4.4	39	0	-	-	0.155
Total	58.5	19.0	87.9			135.2	87.5	153.3			21.5		

From Textile Organon

In two Asian countries, Taiwan and the Korean Republic, it is still higher and even exceeds, in the latter country, with 3 kg per capita, the European consumption level.

The size of the structure in the textile sector (in which the influence of neighbouring Japan's economic growth) has certainly contributed to a large extent to this exceptional development. It could be said that the use of textile fibres in these countries is already more than presently observed in the industrialized countries.

His is shown in table 1 which also lists most of the chemical fibre producing countries which are not the import consumers. It emphasizes that the consumption level, on the average, of 27,5 kg per capita in the most developed countries is considerably below 2 kg per capita in the countries that could be recalled, however, that the data for the latter countries are probably much higher.

With regard to the future growth of the demand in each of the countries mentioned, it should be noted that appear to be growing independently from the level of consumption already reached. Thus, high rates of growth could be found for the lowest synthetic fibre consumers (Africa, Asia, Oceania, Latin America) as for the others.

Another possible factor could be not to the growth of synthetic fibre consumption in the future increase in the use of discontinuous fibres, this point will be examined later in relation to the structure of synthetic fibre trade.

The part which the synthetic fibre industry represents in the total volume of chemical fibre consumption is also important, many countries having a consumption where more than 50 per cent of the output of synthetic fibres rather than of the rayon type.

Till 5 years ago, indeed, the use of synthetic fibres was more developed in countries with a high level of consumption, (Korea, Argentina) than in the others (India, U.A.R.) In the first case, this is mainly due to what occurred in the United States.

This fact can be explained as follows: the demand for synthetic fibres developed here on markets in which the penetration of artificial fibres into the textile industry was relatively low. Moreover, these same synthetic fibres appeared at a moment of the fashion boom and their industrialized countries, the penetration of artificial fibres was, on the contrary, reaching its

Table 3 - Evolution of the structure of textile fibre consumption in certain developing countries

	1960		1970	
	Artificial fibres	Synthetic fibres	Artificial fibres	Synthetic fibres
Argentina	[illegible]	[illegible]	[illegible]	36
Brazil	[illegible]	[illegible]	[illegible]	25
Mexico	[illegible]	[illegible]	63	37
Peru	67	33	51	49
UAR	93	[illegible]	87	13
India	[illegible]	11	[illegible]	17
Korea	97	10	[illegible]	3

Even if part of this role of developed countries is still provided by exports from industrialized countries, this emphasizes the val of exchi[illegible] The value of these exports which has risen, within some thousand tons, of the size of the synthetic fibre market in developing countries

In 1971, developing countries, taken as a whole, imported about 200,000 tons of synthetic fibres, which represented from the main world exporters (1). These imports increased more than 50 per cent with respect to those of the preceding year, which themselves exceeded 1,000 imports by 20 per cent.

The increase in demand for these textiles to explain these exports to developing countries has increased by about 10 per cent between 1965 and 1970. That country by itself represented 5 per cent of total exports of the main suppliers, its import has quintupled. In some countries

(1) Results based on commodity trade statistics for all developing countries, appendix class 71

Asia is the main outlet and often the almost exclusive one for Japanese exports. Table 7 shows that the volume of these exports has increased by [illegible] per cent in two years, or 135 per cent if China is excluded from the total.

It can also be noted that the development of synthetic fibre exports has been exceptionally fast both in countries with a high level of consumption (Taiwan, Thailand) and in countries with a more modest consumption. As far as countries that are small importers and consumers of these fibres are concerned, the situation does not seem to have changed to a significant extent during this brief period.

Considering total exports to developing countries (table 6), a progression of the order of 15 per cent per year is noted, which seems to be at least equal to that of consumption.

Another fact must be emphasized is the growth of synthetic fibre exports to developing countries. Even the increase in the share of woven goods with respect to the total (15 per cent in 1966 - 35.3 per cent in 1967) shows the dynamic influence of the local textile industry.

This growth is of course more accentuated if it is assumed that the existence of a specialized textile industry is a favorable factor in the development of synthetic fibre consumption or a necessary step before the installation of fibre production plants.

I.2 Structure of synthetic fibre consumption

I.2.1 Structure of world consumption

As mentioned above, the share of developing countries in world synthetic fibre consumption is still very small. The remarks made regarding the structure of world consumption are, therefore, just as valid for the industrialized countries as a whole.

The change in this structure is indicated in table 8. The importance of the three main families of synthetic fibres can be noted from this table: the cellulosics, polyesters, and acrylics - in 1967, these accounted for over 90 per cent of world production and this share remains practically constant.

Table 6 - Exports from industrialized countries to class II countries

(t)

	1965				1966				1967			
	Synth. Fibres for Spinning	Synth. Fibre Yarns	Synth. Fibre Fabrics	Total	Synth. Fibres for Spinning	Synth. Fibre Yarns	Synth. Fibre Fabrics	Total	Synth. Fibres for Spinning	Synth. Fibre Yarns	Synth. Fibre Fabrics	Total
Germany	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (1)	[illegible]	[illegible]	[illegible]	[illegible] (2)	[illegible]	[illegible]	[illegible]
France	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Italy	532	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Netherlands	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Belgium	-	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Great Britain	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
United States	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Japan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] - Japanese textile exports to Asian countries

	Fibre	Yarn	Fabrics	Total	Fibres	Yarns	Fabrics	Total	Fibres	Yarns	Fabrics	Total	Increase %
China	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Other Asian Countries	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	34,211	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Burma		[illegible]	[illegible]	[illegible]		74	[illegible]				4		
Ceylon		[illegible]				[illegible]	[illegible]			[illegible]	33		
India	[illegible]	[illegible]		2,33[illegible]	44[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pakistan		737	[illegible]			[illegible]	74						—
Malaysia			253				452				33		
Singapore		[illegible]	2,[illegible]	[illegible]		12	4,[illegible]	[illegible]		[illegible]	[illegible]	6,[illegible]	
Hong Kong	4[illegible]3	[illegible]	3,414	5,[illegible]	[illegible]	3,[illegible]	[illegible],185	[illegible]	[illegible]	[illegible]	[illegible]	17,[illegible]	[illegible]
Afghanistan			[illegible]				4				[illegible]		
Taiwan	2,[illegible]	3,[illegible]	[illegible]	5,[illegible]	3,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,2[illegible]	14,71[illegible]	+[illegible]
Cambodia		3[illegible]	[illegible]			72	34			127	[illegible]		
Laos		44	3[illegible]								[illegible]		
Viet-Nam Rep			1,0[illegible]	1,[illegible]			4,[illegible]			[illegible]	[illegible]	3,[illegible]	[illegible]
Indonesia			2,[illegible]	2,[illegible]			[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
South Korea Rep	3,[illegible]03	5,31[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	- 5[illegible]
Philippines	[illegible]33	597	3,411	4,[illegible]	2,[illegible]	1,5[illegible]	[illegible],403	[illegible]	[illegible]	[illegible]	3,[illegible]	[illegible]	[illegible]
Thailand	432	64[illegible]	3,326	4,4[illegible]	[illegible]	[illegible]	[illegible]		4	[illegible]	[illegible]	[illegible]	[illegible]
Nepal			—			[illegible]				1[illegible]4			
Ryukyus		55	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,2[illegible]	[illegible]
TOTAL	23,36[illegible]	17,[illegible]43	1[illegible],49[illegible]	50,[illegible]	[illegible]	[illegible]	34,7[illegible]	[illegible]	[illegible]	[illegible]	43,[illegible]	[illegible],1[illegible]3	+[illegible]

Table [illegible] - World production of synthetic fibres (1[illegible])

	[illegible]	[illegible]	Polyester	Other synthetics	Total
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1962	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1965	4[illegible]	1,[illegible]	4[illegible]	[illegible]	2,050
1966	4[illegible]	[illegible],1[illegible]	[illegible]	21[illegible]	2,42[illegible]
1967	[illegible]	1,32[illegible]	[illegible]	25[illegible]	[illegible]
196[illegible]	[illegible]	1,[illegible]	[illegible],	[illegible]	[illegible]

Structure of production (percentages)

	[illegible]	[illegible]	Polyester	Other synthetics	Total
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964	[illegible]	53	2[illegible]	[illegible]	[illegible]
1966	[illegible]	4[illegible]	24	[illegible]	[illegible]
1967	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
196[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Textile [illegible]
Organon

The main tendencies noted in the development of the consumption structure are:

- a relative drop in rayon, which continues, however, to account for over 40 per cent of synthetic fibre applications, due to its relatively low price, the size of the current consumer markets which it enjoys as well as to its standing as required by the industrial sector (tarpaulins, conveyor belts, tyre cord);
- a remarkable increase in polyesters, due to the exceptional quality of these fibres in pure state, mainly in the form of a mixture with natural and artificial fibres, as well as to their growing use in the industrial field;
- a stagnation of the proportion of acrylic fibres. These tendencies should persist, and it could be estimated that in several years, polyesters will be in the same position.

The other synthetic fibres are awaiting specific markets. Depending on the processes developed and plants built in various countries, they occupy varying market shares. Thus the Perlon in the German Federal Republic, Nylon 6 in the United States, Nylon 6 in France and over 50 per cent in Japan. Due to its large number of these fibres and their diversified uses, they, in general, do not have been able to find an adequate and open market which is already held by nylon, polyesters and acrylics. However, polyolefins, due to all their excellent wear resistance and easy dyeing, allowing them to be dyed in various colors, will certainly find a wider application in the future.

1.2.2 Structure of consumption in developing countries

It is difficult to specify exactly the extent of demand for the various synthetic fibres in developing countries as a whole.

However, the data collected on direct textile yarns and fibres gives a first indication of the probable structure of this demand.

Indeed, the major part of textile polyolefins - i.e. 90 per cent - is used in the form of yarns whereas the total quantity of acrylics and

over 70 per cent of polyesters are used as discontinuous fibres; as far as the other synthetic fibres are concerned, they are used for the most part as yarns.

As a result, polyamide consumption is rather close to total yarn consumption; it can be estimated at a value ranging from 60 - 65 per cent of this total (world average). This proportion tends however to decrease as a direct result of the increase in yarn consumption within the total synthetic fibre demand.

Taking into account the preceding observations, the synthetic fiber demand in developing countries can be dealt with in more precise manner.

Table 4 shows the evolution of this situation in certain developing countries which are already synthetic fibre producers.

It can be seen that, in these countries, which are among the largest synthetic fibre consumers, the percentage of yarn with respect to the total has dropped from 67 per cent in 1964 to 62 per cent in 1970. By way of comparison, on the world scale this percentage was, respectively, 55 per cent and 50 per cent for the same years; it remains higher than 50 per cent in the United States and Canada and falls below this value in Japan, which uses relatively little yarn.

A first remark, which is generally applicable, can, therefore, be made as far as developing countries are concerned with respect to other synthetic fibres, nylon consumption is still at a high level.

But this situation is rapidly changing. Indeed, reference being made to the results mentioned in table 4, it can be noted that for an overall increase in synthetic fibre consumption of 11 per cent per year, the progression amounted to 25 per cent for yarns and to over 10 per cent for discontinuous fibres (polyesters and acrylics).

Judging from the nature of exports to developing countries, as a whole which still provide an important substantial part of the supply to these countries, the following can be noted, as previously: the high percentage of exported yarns - and, therefore, of nylon - with

respect to the total (except fabrics) and, on the other hand, the progressive decrease of this percentage. Indeed, the latter varied in 1965, 1966 and 1967 as follows: [illegible] per cent, [illegible] per cent and [illegible] per cent of the total.

Several examples of the structure of consumption in developing countries are given below (tables [illegible] and 10) on the basis of which several remarks can be made:

- in a large number of developing countries, variations in structure with respect to time are larger than in industrialized countries; this results, in particular, from sharp changes from one year to the next in the volume of imports but is also a sign of markets in the process of being organized;
- for the same reasons, it is not yet possible to define a typical structure of demand which developing countries might tend to approach and which might resemble, for example, that of industrialized countries. But it is also possible that the structure of demand more adequately adapted to the particular needs of each area (climate, [illegible]) will remain much more diversified from one developing country to the next than it is at present between industrialized countries.

Thus, polyester consumption is distinctly higher than that of nylon in the Philippines and especially in Indonesia, which was never the case, up to now, in industrialized countries. Similarly, a relatively high demand is noted in Korea and Pakistan.

Table 7 - Evolution of the structure of consumption in two developing countries

a) India

%	1963/64	1964/65	1965/66	1966/67	1967/68
Nylon 6	67	52	53.5	64.0	53.2
Polyester	33	48	38.7	33.3	42.2
Acrylics	-	-	1.8	1.4	3.7
Polypropylene	-	-	0.5	0.2	-
Polyvinyl alcohol	-	-	5.4	0.2	0.9
TOTAL	100	100	100.0	100.0	100.0

b) Korean Republic

%	1963	1967	1968
Nylon	71.4	54.5	25.5
Polyester	7.0	12.9	23.1
Acrylics	13.9	25.9	31.4
Polyvinyl alcohol	5.7	2.7	19.9
TOTAL	100.0	100.0	100.0

Table 10 - Structure of synthetic fibre consumption in several developing countries (1975/76)

%	Indonesia	Iran	Pakistan	Philippines
Nylon	22	40	46	32.4
Polyester	41	50	30	40
Acrylics	37	10	24	15.6
TOTAL	100.0	100.0	100.0	100.0

Source ECAFE

II - USES AND FIELDS OF APPLICATION OF SYNTHETIC FIBRES

II 1 Introduction

Several aspects of the substantial development in synthetic fibre demand observed during the past few years have been described, this development being still the more remarkable as the consumption of the other types of fibres has only increased to a small extent and has even shown a small decrease in certain countries.

The reasons for the success of synthetic fibres will now be analyzed. We shall attempt to do this by studying the evolution in the demand for synthetics in the main textile markets, which consists mainly of the current industry, but also and in increasing proportion, of the furniture industry and industrial uses. Some background information relating to properties and uses of the main synthetic fibres will first be given below.

II 2 General background

- The essential properties of nylon comprise their tensile strength, chemical and grease resistance. They are easily washed and dry rapidly. They are used, for the most part, as continuous filaments.
- Polyesters are generally used as discontinuous fibres, as a mixture with artificial and natural fibres, mainly cotton. Polyesters impart new properties to these mixtures, such as wear resistance, elasticity, lightness, crease resistance which were the basis of their success. Their main uses as yarns are in fabrics for furnishing and dress goods.
- Acrylics were initially considered as substitution products for wool showing some of its characteristics such as appearance, softness, high covering factor. Acrylics have their own characteristics, the main ones being good weather resistance and quick drying. They are used as discontinuous fibres, mainly as a mixture with wool.

- The polyolefins have characteristics and a consumption structure which is rather different from that of other synthetic fibres. From the point of view of properties, their excellent wear and weather resistance may be mentioned. These fibres are used mainly in the manufacture of furniture articles and upholstery of industrial products such as cables, nets and bags. The fact that it is difficult to dye polypropylene is mentioned, but restricted dyeing was for a long time, but this drawback seems to have been partially overcome. It is to be expected that these fibres will play a significant role in other areas, particularly that of furniture.

II.3 Uses in industrialized countries

Since 1964, a country by country breakdown of the garment industry (domestic and industrial utilization) has been noted in the uses of synthetic fibres. Table 11 gives indications concerning the United States.

Table 11 - Uses of synthetic fibres in the United States (in per cent)

	Man-made fibres		Synthetic fibres	
	1964	1967	1964	1967
Men's clothing	22	20	14	17
Women's clothing	21	23	24	21
Domestic uses	40	34	35	35
Industrial uses	17	13	27	27
TOTAL	100	100	100	100

Source: Textile Organon

- Men's clothing - The penetration of synthetic fibres in this market has been increasing continuously. This development is to be attributed especially to the rapid growth of discontinuous fibres in the three main outlets, which in practice, comprise shirts, trousers and woollen clothes production. Polyester fibres are still the most widely used in these fields

most often as a mixture with cotton or wool. Their share has increased in particular in knitwear at the expense of [illegible] yarns are only slightly [illegible]

- Women's clothing - Like their [illegible] of the market with the aid of the fibre, [illegible], synthetic fibres are [illegible] and cover [illegible] for the [illegible] clothing sector. By [illegible] of synthetic fibres [illegible] additional [illegible] the past few years.

The proportion of continuous fibres with respect to synthetic fibres, as a whole, is [illegible] the past [illegible] the case of [illegible], and this gives an [illegible] the [illegible] of the household [illegible] this field, nylon yarn is still the [illegible] used, the use of polyester is, however, [illegible] about [illegible] the consumption of [illegible] skirts [illegible] the [illegible] of discontinuous fibres. In this polyester fibres still [illegible] [illegible] fibres are also [illegible] in articles such as [illegible] and [illegible].

- Furniture - [illegible] industry [illegible] rapidly growing outlet for [illegible] fibres but [illegible] [illegible] major part of these [illegible] by [illegible] which tends, however, to decrease to the [illegible] of [illegible] [illegible] on the market, polypropylene, which has certain [illegible] large scale [illegible] the last few years for [illegible] of furniture, furniture [illegible] and articles for the [illegible] [illegible] a small market for synthetic fibres. The [illegible] fibres have still the most widely [illegible].

- Industrial [illegible] - The major part of synthetic fibres used in this sector is intended for the [illegible] of the cords [illegible], especially at present, nylon now occupies [illegible] dominant position in the manufacture of tyre [illegible]. The share of the

ds

has been increasing constantly; however, polyester fibres, which have just made their appearance on the market eight, ten years, taken up substantial place provided their prices become more competitive in other industrial applications such as rayon, cotton, large capacity textile machinery (polythene) can be used more and more, but use of this material requires cheap prices.

Generally speaking, the most prominent case of synthetic fibres, for each of the main textile industry sectors, in the established countries (these observations are sometimes in contrast with the evolution of the structure of consumption in the United States of the main fibres types between 1960 and 1970) is briefly recalled. The substantial decrease in the rate of the clothing output per worker can be noted. On the other hand, development in this sector has been much faster for polyesters.

As far as acrylic fibres are concerned, the share of the garment industry is preponderant. Moreover, polyolefin fibres are for the most part used in the industrial sector.

Table 12 - Structure of synthetic fiber demand by major sectors of use in the United States

Percentage	1,91					1,97				
	[illegible]	Polyester	[illegible]	Other	Total	[illegible]	Polyester	[illegible]	Other	Total
Clothing	37	28	31	-	100	32	19	47	2	100
Furniture	61	15	22	1	100	1	12	35	12	100
Industry	36.5	9	7.5	-	100	70		2	28	100
Other	56	24	-	-	100	43.5	3.5	53	-	100
Total	62	18	17.5	2.5	100	45.5	37	17.5	0.5	100

Table 13 - [illegible] by industry and [illegible] in the Republic of Korea

(Number of establishments)

Industry	1960			1967			1968			1971		
	Total	Republic of Korea	Foreign	Total	Republic of Korea	Foreign	Total	Republic of Korea	Foreign	Total	Republic of Korea	Foreign
Clothing	33	26	7	73	73	-	71	71	-	33	33	-
Furniture	23	20	3	54	54	-	53	53	-	53	53	-
Industry	31	30	1	[illegible]	[illegible]	-	[illegible]	[illegible]	-	[illegible]	[illegible]	-
Various	13	8	5	13	13	-	13	13	-	13	13	-
TOTAL	100	84	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

II.4 Uses in developing countries

In 1974 the majority of synthetic fibres consumed in developing countries was used in clothing, the remainder going essentially into the manufacture of tyre cords. Domestic uses were negligible.

An increase in the share of industrial uses was noted in the past few years. This is due mainly to the development of the manufacture of tyre cords using synthetic fibres, but also to the appearance of various outlets such as fishing nets, ropes, and heavy capacity bags. The countries that have recently become or soon followed the evolution set out in the more industrialized countries. The furniture industry is still very small.

The evolution of uses of synthetic fibres in India is shown, by way of example, in table 14.

Table 14 - Outlets for synthetic fibres in India (%)

	1973	1974
Clothing	[illegible]	[illegible]
Tyre cords	12	[illegible]
Other industrial uses	1	5
Total	100	100

III - PRODUCTION OF SYNTHETIC FIBRES

III.1. Polymerisation and spinning plants

III 1.1 Location of the world production

The evolution of synthetic fibre production in certain regions is shown in table 15.

Throughout the beginning of the synthetic fibre industry, the United States, Japan and Europe have been dominating the production of these fibres. In 1963, these three areas accounted for 93 per cent of synthetic fibre production in the world and this percentage has remained practically constant.

Table 15 - Evolution of synthetic fibre production

1'000 tons

	1963	1964	1965	1966	1967
United States	913	[illegible]	[illegible]	[illegible]	1,033
Japan	230	35	[illegible]	450	505
Western Europe	[illegible]	520	[illegible]	655	835
Eastern Europe	[illegible]	190	330	165	200
United States	22	30	45	50	70
Africa	[illegible]	[illegible]	35	45	60
Asia *)	27	40	58	82	105
World	1,330	1,[illegible]	2,350	2,420	2,[illegible]

Source: Textile Economics

*) Except Japan and Australia

The United States with 36 per cent of world production is still and by far the largest producer country; from 1963 to 1967, the rate of annual growth in production was of the same order of magnitude in the United States and Western Europe: approximately 15 per cent. Japan is developing its production at a much faster rate, which is similar to that of Eastern Europe: 25 per cent per year.

The share of developing countries in the production of synthetic fibres is still quite small; it rose from [illegible] per cent in 1963 [illegible] 1967 [illegible], production in most of these countries [illegible] was [illegible] but very significant, the quantity of synthetic fibre produced in [illegible] is very small. It should be noted that the world production of synthetic fibres increased by [illegible] tons [illegible] 13 to 15%, developing countries contributed only [illegible] tons to this increase.

[illegible] Situation in developing countries

The small contribution of developing countries in world production [illegible] of course, it can be otherwise according to table 15 [illegible] that, [illegible] contribution for increased installed capacity [illegible] to synthetic fibres.

[illegible] - Production capacities in developing countries (tons/year)

	1964	1967	1970
Argentina	12,000	[illegible]	37,000
Brazil	17,000	24,000	35,000
Chile	600	3,500	7,000
Colombia	1,000	10,000	13,000
Mexico	4,500	12,000	40,000
Peru	600	3,000	5,000
Uruguay	1,000	1,300	1,400
Korea	2,000	3,500	40,000
India	1,200	6,000	20,000
Iran	-	-	2,000
Pakistan	-	-	3,200
Thailand	-	-	1,400
U.A.R.	500	[illegible]	[illegible]

Source: Textile Organon

Although acrylic and olefinic fibre plants are in existence in developing countries, particularly in Brazil, Korea, India and Mexico, the production is mainly cotton and polyester. Table 17 illustrates the structure of production capacity in several countries

Table 17 - Structure of synthetic fibres production capacities (1969) a/

Country	Nylon	Polyester	Acrylics	Total
Brazil	53	47	-	100
[illegible]	[illegible]	-	-	100
[illegible]	100	-	-	100
[illegible]	83	17	-	100
[illegible]	100	-	-	100
[illegible]	50	50	-	100
[illegible]	[illegible]	-	-	100
[illegible]	78	22	-	100

The developing countries' production have to make up to more or less [illegible] the drop in the domestic production in their consumption. In Latin America, [illegible] increased from 13 per cent in 1963 to [illegible] in 1967. In Asia, [illegible] relatively [illegible] the former [illegible] by India, for example [illegible] per cent of its consumption in 1963 and 50 per cent in 1967.

[illegible] - Special case of developing countries

[illegible] plant size as indicated in Table 18

[illegible] highly [illegible] capacities can be [illegible] this [illegible] be [illegible] than for the chemical industry [illegible]. This is due to the fact that the minimum size of [illegible] plants increases very slightly, because, on the one hand,

the tonnage required to satisfy a market is relatively low, and on the other hand the most expensive part of the installation, spinning, is subject to investment variations which are almost proportional to its capacity.

The average plant size in developing countries is very much smaller than that in industrial countries. This is, of course, to be explained by market limitations, as the first plants of these are spinning units operating on imported polyarn.

Table 10 - Average synthetic fiber plant size t/y/year

	1/ 3	1/
United States	1 ,000	13,000
Japan	6,000	8,000
Western Europe	1,500	7,500
Eastern Europe	4,000	4,000
Latin America	500	1,500
Asia 4/		500

4) Except Japan and Australia

III.2. Production of monomers

III.2.1. Use of monomers

The main monomers used in synthetic fibre production are:

- for acrylic fibres, acrylonitrile
- for nylon [illegible] caprolactam
- for nylon [illegible], adipic acid, hexamethylene diamine and adiponitrile
- and for polyesters, dimethylterephthalate and terephthalic acid

Fibre production is still the main outlet for each of these monomers. Caprolactam, with the exception of a Soviet synthesis plant*), is likewise, to an excessively [illegible] used in the production of nylon 6 (fibres 75 per cent and plastics 25 per cent).

Over 90 per cent of dimethylterephthalate production is used in the manufacture of polyester fibres, the remainder being used mainly to produce polyester films.

Nylon 66 is the only outlet for hexamethylene diamine. As far as adipic acid and acrylonitrile are concerned, their uses are indicated in table 19 below.

Table 19 - Outlets for adipic acid - Outlets for acrylonitrile (per cent)

Adipic acid		Acrylonitrile	
Nylon 66	60	Acrylic fibres	63
Plasticizers, synthetic oils	7	ABS and AS resins	14
Polyurethanes	5	Nitrile rubber	10
Miscellaneous	28	Miscellaneous	13
	100		100

*) no more operating in 1976

III.2.2. Location of the production

As indicated in table 20 practically all plant producing monomers used in the synthetic fibre industry are concentrated in the industrialized countries.

Africa, Asia and Latin America dispose production capacities, which are not shown in this table, are also located in Europe, the United States and Japan.

Table 20 - Monomer production capacities
1.000 tons/year

	Caprolactam	Acrylonitrile	DMT/TPA
United States	880,000	650,000	2[illegible],000
Western Europe	520,000	280,000	250,000
Eastern Europe	250,000	170,000	120,000
Japan	3[illegible],000	2[illegible],000	3[illegible],000
Rest of the World	17,000		
World total	1,[illegible],000	1,2[illegible],000	[illegible]0,000

Circumstances have now been favourable in the last few years to the installation of monomer production units in developing countries. On the other hand, there has been and still is an overcapacity in the production of caprolactam and, to a lesser extent, of dimethylterephthalate and terephthalic acid, mainly because of decreases in their export prices. The United States have also been active in incorporating a product [illegible] (see paragraph 71) on the other hand, certain producing countries have established [illegible] blocking, by prohibitive tariffs, their imports from countries in which are located plants whose operation is based on their process, thus controlling and coordinating their monomer exports.

Certain developing countries whose local or export market is expanding, have, however, established the possibility to consider the production of monomers, several plant construction projects having been planned, particularly in Mexico, Colombia and India.

IV - EVOLUTION OF TECHNIQUES

IV.1 Polymerisation - Spinning

IV.1.1 Nylon 6

The tendency which has already started towards continuous polymerisation techniques has become more pronounced; most new plants are using this principle.

Processes whereby the molten polymer is extruded directly after polymerisation have been developed; the intermediate production of chips, their washing and drying is thus eliminated. It should, however, be noted that the majority of plants continue to produce chips; the main advantages of this technique being, on the one hand, a lower proportion of monomer in the yarn, and on the other hand total independence from the polymerisation and spinning sections, from changes in production programs or interruptions of the extrusion process, thus avoiding any risk of disturbing the polymerisation.

IV.1.2 Polyesters

Before 1968, the polycondensation was exclusively carried out in a discontinuous manner. Several companies have developed continuous processes, thus providing an outlet for spinning of the molten polymer. The consumption of utilities and losses are small, and it is possible to completely automate the polycondensation section.

This technique is still not widely used; because the flexibility of such continuous plants is very small, it is necessary, in order to justify their use, that the yarn grades be spinned for long periods of time and that production from the polycondensation and consumption of the spinning plant be perfectly balanced; moreover, the continuous process is economical only for capacities exceeding 15 tons/day.

IV 1 3 Polyacrylonitrile

The main characteristic of the past few years in the field of polymerization and application of acrylonitrile is due to the discovery of new solvents capable of dissolving not only the monomer but also the polymer.

The use of these solvents, which are generally inorganic or zinc chloride solutions, has made it possible to effect the continuous wet spinning of the polymer in solution coming immediately from the reactor.

IV 2 Production of monomers

IV 2 1 Caprolactam

The raw materials used in the manufacture of caprolactam are: phenol, cyclohexane and, in the process developed by SNIA VISCOSA, and still used exclusively by that company, toluene.

The choice between phenol and cyclohexane as a basic raw material is linked to circumstances that are peculiar to each region. But, in general, it is said that cyclohexane has displaced phenol, because of its greater availability and, of course, because of its lower price. Most of the plants built since 1964 are based on the use of cyclohexane.

The main exceptions were the plants constructed in Italy by Sicedison and in Great Britain by Imperial Chemical.

In the United States, Allied Chemical is the only large producer still using phenol, but it should be noted that this company uses phenol produced in its own plants.

The processes used in 1964, with the exception of the SNIA VISCOSA and PNC of TOYO RAYON processes, were characterized in that they produced large quantities of ammonium sulfate, approximately 4.5 tons per ton of caprolactam.

This ammonium sulfate was obtained, on the one hand, at the rate of 2.1 tons in the production of hydroxylamine and, on the other hand, at the rate of 1.5 tons in the neutralization of the oleum required in the Beckmann rearrangement.

The outlets for ammonium sulfate have been progressively decreasing, particularly in the industrialized countries. As this tendency became more pronounced, it was thought that the SNIA VISCOSA and Toyo Rayon processes could still increased interest as expected, they were used in new industrial plants, but only by the companies which developed them. The large consumption of electricity and the dependence on control of lasers, which are manufactured in Japan only, can explain the fact that the photochemical process has never been used outside the Toyo group.

New processes or improved existing processes, having a tendency to eliminate or reduce the production of ammonium sulfate, have been developed.

In the United States, Union Carbide has recently put into operation a new process in which cyclohexane is directly oxidized to caprolactone with peracetic acid. The caprolactone reacts with ammonia to give caprolactam. There is no production of ammonium sulfate, but on the other hand, approximately 1.8 tons of acetic acid is formed per ton of caprolactam.

Another process should also be noted, developed by the Mechim Chem. Co., which has not been used on an industrial scale, but which seems to be attractive: cyclohexanone is nitrated to 2-nitrocyclohexanone is reduced to caproic acid which is then cyclized to caprolactam. Acetic acid is produced which can be dehydrated by pyrolysis and recycled.

Several process owners, particularly Stamicarbon (subsidiary of DSM) and Inventa (subsidiary of Bauer Werke AG) have developed new methods for the production of hydroxylamine, thus eliminating the major part of the ammonium sulfate by-product.

Stamicarbon produces hydroxylamine by hydrogenation of nitrate ions on a catalyst.

Inventa produces hydroxylamine - HTP - by reaction of nitrous gas with hydrogen and nitric acid in the presence of a solid catalyst.

The production of these intermediates, linked to superphosphate plants, can be explained by the necessity these plants have to diversify their fertilizers and obtain products richer in nitrogen, and better suited to be more completely assumed by the plant and by the soil. In order to accomplish this, phosphate ore is dissolved in nitric acid by ionic exchange in the solution obtained, calcium is removed in the form of insoluble calcium sulfate by addition of ammonium sulfate solution, which is a by-product of the superphosphate plant. After filtration, the mother liquor is neutralized and converted into nitrophosphate fertilizers. Steps for the improved and economical technique, particularly for small plants to be built in Africa.

We have just seen the substantial changes introduced in caprolactam production technology, particularly, the development of two new processes on the basis of cyclohexane and phenol. The cyclohexanone production techniques have also undergone their improvements, but, in addition, the processes in existence before have been substantially improved and can still be perfected, in particular, from the point of view of capital used in the production of equipment and the two-layer process, i.e. the field of heat exchangers, through the use of more powerful pumps without any increase in their dimensions.

IV.2.2 Adipic acid - Hexamethylenediamine

Just as for caprolactam, it should be noted that, since 1964, cyclohexane and diphenol phenol have played a capital role in the manufacture of adiponitrile, the basic intermediate of hexamethylene diamine. Before 1960, adiponitrile was obtained from adipic acid or butadiene. Since that time, it has been developed and used industrially the electrolytic hydrodimerization of acrylonitrile to adiponitrile. This is the first introduction, at the industrial scale, of electrochemistry into petrochemistry.

A Japanese firm, Asahi Chemicals has developed a process based on the same principle, which would make it possible, while operating at low acrylonitrile concentrations at the cathode, to use another less costly and more selective solvent, but it does not seem that this process has gone beyond the pilot plant stage.

II.2.3. Dimethyl-terephthalate - Terephthalic acid

Up to now, two industrial processes were used for the manufacture of dimethyl-terephthalate: the Witten, the Mid Century and the Henkel processes. All three were applied in new plants with a seeming preference for the Witten process, while the Henkel technique, using toluene had a good success in Japan.

The great innovation of these past few years is the appearance of fibre grade terephthalic acid, which is sufficiently pure to eliminate the esterification step. These processes are well suited for this production: Amoco, Dubay and Inventa. It seems that, at present, only one industrial plant is in operation based on the Amoco process.

It is still difficult to predict the result of dimethyl-terephthalate-terephthalic acid competition, in which price will play a determining role, polyesterification rates and polyester grades being the same. Certain remarks, however, should be mentioned concerning the possibility of using terephthalic acid in the manufacture of polyesters for tyre cords. The main advantage of terephthalic acid are, on the one hand, the fact that in the production of polyester 1 ton of terephthalic acid is equivalent to 1.2 tons of dimethyl terephthalate and on the other hand, the absence of methanol by-product.

On the other hand, dimethyl terephthalate has a higher bulk density (0.4 instead of 0.6 for terephthalic acid) which gives it a distinct advantage from the point of view of transportation costs.

IV.2.4. Acrylonitrile

As predicted, the manufacture of acrylonitrile from propylene has practically eliminated the route based on acetylene, due to greater simplicity of the process, limitation of purity problems and cost of raw materials. [illegible] is the [illegible]

Since [illegible] route of acetaldehyde is developed and used industrially; but [illegible] to give rise to the process [illegible] some of these have been [illegible] solvent separation [illegible] for the [illegible] to obtain [illegible] to mount [illegible]

The [illegible] of the reaction conditions [illegible] characterization of the [illegible] and ammonia on [illegible] and advances have been [illegible] The most [illegible] this report in the development [illegible] particular, the [illegible] make it possible to increase the capacity of existing plants [illegible]

It is [illegible] that the process starting from propylene will be displaced in the years to come; however, the processes using this route can still be [illegible] and new advances can be expected, particularly in the field of catalyst selectivity.

- CONDITIONS REQUIRED FOR THE ESTABLISHMENT OF A SYNTHETIC FIBRE INDUSTRY IN A DEVELOPING COUNTRY

1. Introduction

We have endeavoured to describe certain aspects of the substantial development of the synthetic fibre industry during the past few years: the remarkable increase and evolution of demand, the reasons for this success, the significant changes that have taken place in the field of production and of economic options.

The existence of this situation in developing countries leads to the following general observations:

- Consumption of synthetic fibres, although rapidly increasing, is still very low;
- There still is no production of monomers in these countries, but in the field of polymerization - spinning, definite advances have been made from the point of view of capacity increases and production economics.

It can be considered as very encouraging that in producing developing countries, the share of consumption which is met by local production is constantly increasing.

However, since 1968, only three developing countries have been added to the list of synthetic fibre producers.

It seems, therefore, that the establishment of a synthetic fibre production industry (polymerization - spinning) in a country wants with care in choosing the units to define the conditions required for carrying such a project through. The case of monomer production will then be examined.

V.2. Textile industry

The textile industry will be the main client of the synthetic fibre producer. It is, therefore, necessary that a productive and dynamic textile industry exists in the country, which is equipped with modern machinery capable of treating synthetic fibres. It is also desirable for this industry to have some know-how in using synthetic fibres, i.e., existence of previous exports of the fibre to be produced.

In countries where the local textile industry is not in a position to satisfy a substantial part of the population's textile needs, it would be advisable to develop this industry before contemplating production of synthetic fibres.

V.3. Size of the market - Choice of fibres to be produced

The potential consumption of synthetic fibres whose production is contemplated must reach a minimum level justifying the installation of economic capacities. This notion of economic size is, of course, difficult to calculate; it depends on local conditions and is often distorted by protective customs measures; this problem will be examined later by considering the fundamental economic principles which must serve as a basis for the decision to build a synthetic fibre plant. It can be said, however, that the installation of polymerisation capacities below 1,000 tons per year for nylon, and of 3,000 tons per year for polyester and acrylonitrile are not generally desirable. On the other hand, spinning-texturing-finishing units may be established with lower capacities, which may be as low as 500 - 600 tons per year. Figure 1 gives an indication of the effect of production capacity on profitability of a polyester polymerization spinning plant.

Because of these limitations, it is generally recommended to developing countries, to start with production of synthetic fibres which are likely to have the largest market, nylon and polyester.

On the other hand, if the polymerization capacities indicated above cannot be considered, it is desirable to limit activities, in a first phase, to spinning - finishing plants operating on imported polymers.

FIGURE 1

POLYESTER POLYMERISATION - SPINNING PLANTS
IN A DEVELOPING COUNTRY *)

*) ~ 60 per cent wool type ~ 40 per cent cotton type

V.4. Selection of technique - Assistance from process owner

Firms in developing countries, desiring to build synthetic fibre production plants, must choose units corresponding to their needs, avoiding certain techniques which are not suitably adapted to their particular case.

Synthetic fibre plants in developing countries are generally characterized by a low capacity and by a necessity to frequently change the type of production. Under these conditions, certain techniques, in particular, the so-called polycondensation - spinning of nylon or the continuous polymerization of polyester are often undesirable while they can sometimes constitute a viable solution for plants with greater capacities and a production which is more specialized.

In order to build plants using proven techniques guaranteeing the quality of the products, the firms in developing countries often open the assistance of a process owner. It is often of advantage for the future plant owner to choose a process owner who is already a synthetic fibre producer, for in that case, the assistance given is not limited to building of the factory. A producer firm, indeed, provides in his own plants for the training of part of the future plant's personnel. He can also help the new producer to solve the problems related to the introduction of the synthetic fibres in the existing textile industry; the cost of this after sales help is much lower for the new producer than the expenses for research and development which he would have had to provide for to set up these plants himself.

V.5. Fundamental economic principles

It is sometimes indispensable for a new synthetic fibre production industry to have customs protection, at least in the beginning; however, this situation, by creating certain problems, should not lead to the achievement of projects which do not comply with the following economic criteria:

- It is indispensable that the currency balance, due to the installation costs, should be adjusted over the course,

- It must be possible for the consumer goods manufactured from local synthetic fibre, produced by the plant, to be produced at prices which maintain their competitiveness with those imported, so as to the largest number of [illegible]

- On the other hand, the plant must be built and organized with [illegible] necessary for its subsequent development, profits, after paying the cost of invested capital, or taxes, must be sufficient to provide [illegible] for the private use of the plants but, furthermore, [illegible] for public utility

Production [illegible]

As was previously [illegible] minimum size, from the economic point of view, for the production [illegible] are, at present, very large, running from [illegible] tons per year. Developing countries have synthetic fibre industries usually [illegible] On the other hand, there [illegible] present, a tendency towards smaller [illegible] The possibilities vary according to the [illegible] produced. How we should, therefore, first [illegible] this possible fibre industry. It must be borne in mind that to [illegible] a plant [illegible] it must be borne in mind that to have stable outlets [illegible] position by [illegible] sufficient [illegible]

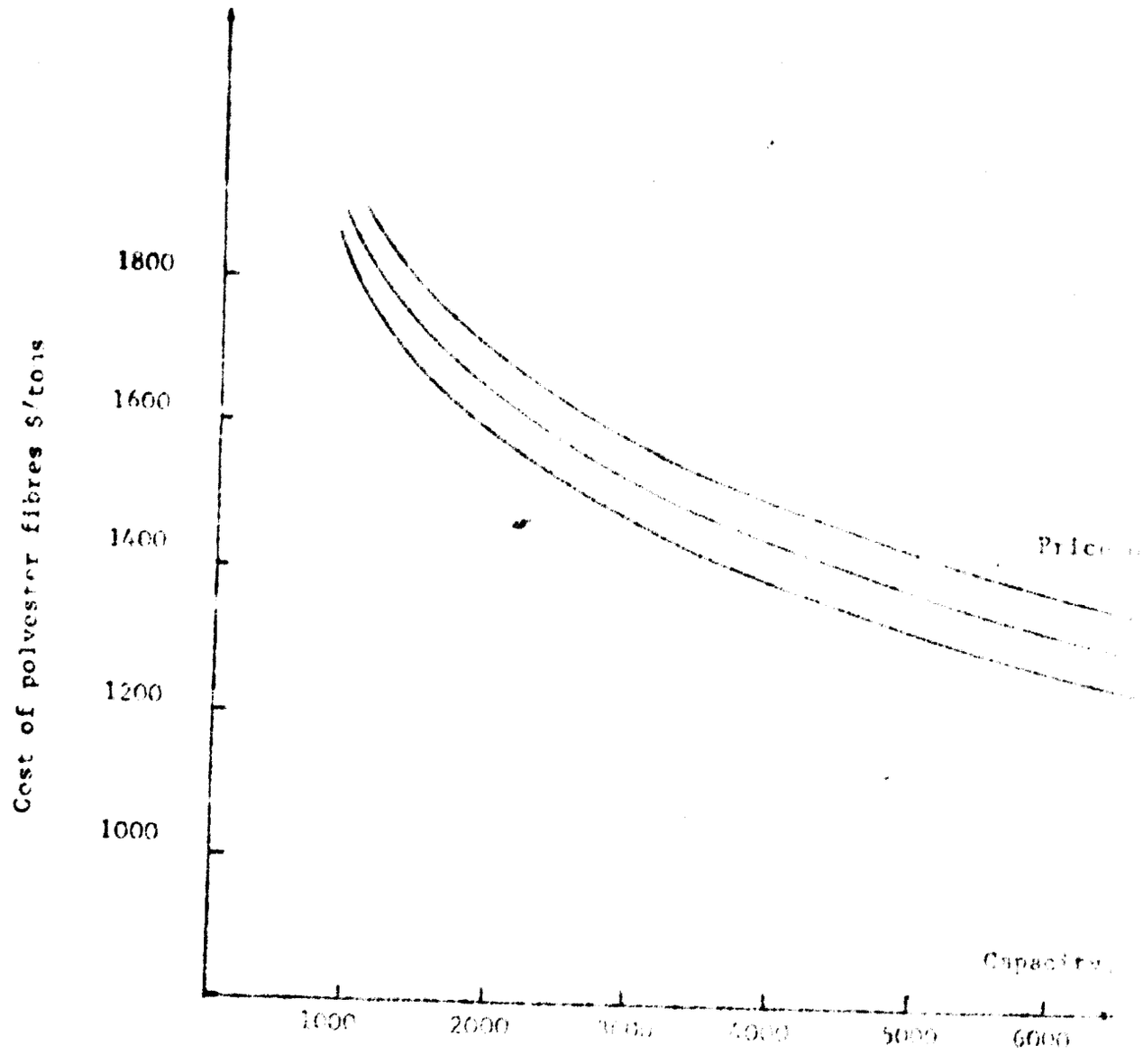
A solution to facilitate the establishment of modern plants in developing countries [illegible] the possibility of several countries thus [illegible] sufficient [illegible] to bear the production of a reasonably sized plant.

FIGURE 1

POLYESTER [illegible]

[illegible]*

Cost of polyester [illegible] of yarns of wool content



*.- 60% wool type 40% cotton type

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