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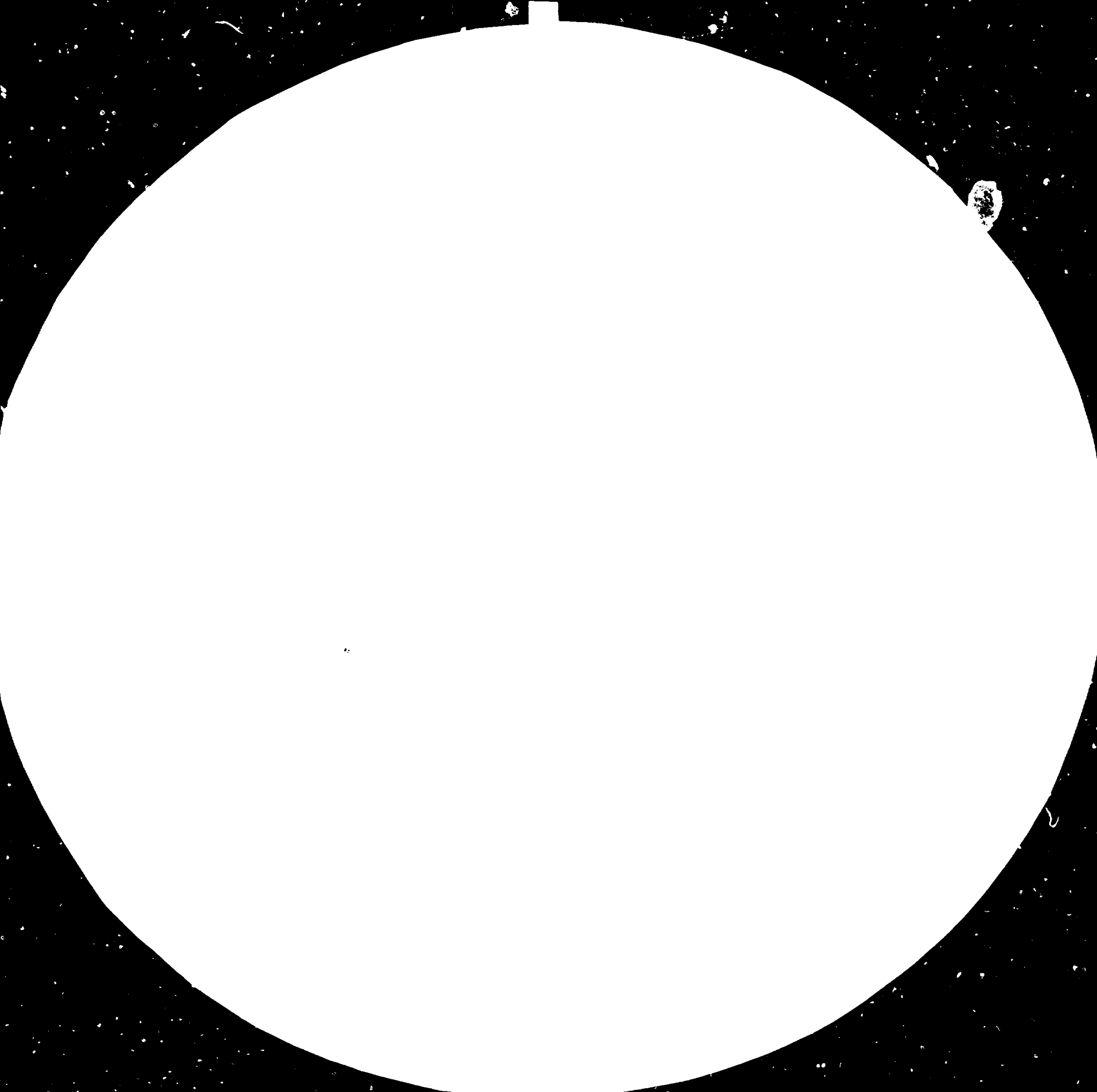

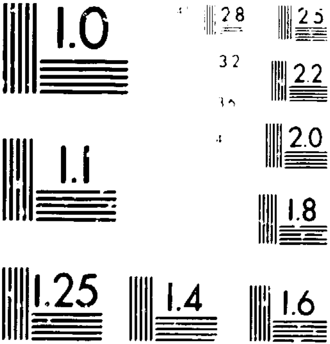

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SOFT LEATHER SUBSTITUTE MATERIALS AND THEIR IMPACT ON THE INTERNATIONAL LEATHER AND LEATHER PRODUCTS TRADE *

by

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CONTENTS

INTRODUCTION

Animal skins may be considered as a unique kind of natural raw materials. They are, however, obtained as a by-product in the food industry. The well-known first report of the Club of Rome pointed out the growth limits - specifically the increasing shortage of natural resources available for the world's industry and human consumption. It has also warned people and organizations everywhere that worsening pollution found all around creates increasingly difficult conditions for the livestock and the animal husbandry. On the other hand, the world population is growing rapidly which means increasing demand for wear articles, among those: footwear, garments, gloves, leather goods etc. which are traditionally made of leather.

The widening gap between the demand for leather and the availability thereof (like any other material of natural origin) challenges science and industry for invention, introduction and application of suitable substitutes. A number of of facts indicate that the situation today in the leather and leather substitutes trade is not sufficiently clear and, consequently, could lead to erroneous opinions and subsequent wrong decisions concerning the future of this subsector. This is even more critical in some developing countries having relatively large livestock and only few natural resources other than hides and skins. There is, therefore, a real need for clarifying the present situation as to leather substituting - paying special attention to the related social, economic and technical aspects.

Background

The Leather and Leather Products Industry Panel meeting in Vienna in 1981, indicated that the information available about the leather substitutes - with special reference to soft materials used for shoe uppers, leather goods and leather garments - is not adequate.

A view was expressed, according to which some of the developing countries hesitate to develop (invest in, start up or expand) their leather and/or leather products industry, because they are afraid of the new, sophisticated and cheaper man-made materials penetrating into the market. For this reason, an in-depth survey and thorough analysis of the real position of the genuine leather and its potential substitutes in terms of their availability, properties, marketing and utilization was requested.

Several studies and projects carried out by agencies of the United Nations (e.g. FAO, UNIDO) and other international and national organizations have directed the attention to the peculiar situation of the developing countries. Some of them possess considerable livestock, having the potential to produce and supply leather (and leather products) to the world market - but many of them lack the necessary know-how and industrial facilities. Others do not have such resources, but need to import either raw materials for the local leather products industry or the products themselves for the domestic market. In both cases a number of factors have to be taken into account when deciding upon the supply. Among these questions one is extraordinarily important: what kind of basic materials should be used?

In most of the industrialized countries the output of labour intensive industries (including the leather and leather products industries) is stagnating or is showing a declining trend over the past decade. Automation, rapid fashion changes, sophisticated production engineering methods, carefully planned market activities - these are only a few of the ways in which the industry is fighting against the recession. Here again one of the main points to be considered is the type of basic materials to be used in the production. One should not forget the fact that in these countries shoe and leather goods factories have been equipped with up-to-date and costly machinery. For the last twenty years, a remarkable number of components (e.g. stiffeners, reinforcements, interlinings etc.) have also been made of various "artificial" materials (paperboard, textile, plastics etc.)

Some new results in the development of poromerics and also the oil crisis led to considerable uncertainty in the leather field - mainly owing to insufficient or incorrect information concerning leather substitutes.

UNIDO, as one of the competent and responsible international organizations working for the overall development of the world industry, in consequence decided to sponsor a study on the subject matter in order to assist all interested Government bodies, institutions and enterprises in their decisions concerning leather substitutes.

Purpose of the Study

The ultimate aim of this study is to give an as objective picture as possible about the present and future impact of synthetic materials which intend to replace the genuine leather in the footwear, leather goods and leather garment industries. The profound analysis should highlight the influence of substitutes on the price structure and the volume of the leather trade taking into consideration fashion aspects, raw material supply, investment requirements, production facilities and application technologies.

The survey and the techno -economic analysis of all collected or available data, information and views of competent institutions and specialists should give a relevant information basis for all those who are involved in policy making, strategy formulation and decision making concerning leather products and their production. This study will try to clear up certain misunderstandings and misinterpretations of the real state of leather substitutes - especially concerning the future trends and possibilities. An objective and independent approach, as was intended by UNIDO and the authors should be of assistance to those who look for sound information about the capabilities of the leather substitutes or their market potentials.

The Scope of Materials Surveyed

The range of materials which can be used instead of leather for various purposes is extremelly wide (as will be discussed in more detail in chapter I). It would have been not only too ambitious but impossible to cover all of them in the present rather moderately sized study. On the other hand, it is quite clear that some substitutes already have found their place in the leather products industries and both manufacturers and consumers prefer or at least readily accept them in the products, e.g. rubber, polyurethane or PVC for soles;wood, metal or plastics for high heels etc. The most problematic areas of leather substitutions are those where the user, i.e. the human body is in direct contact with these components and may appreciate their comfort in wear or use (e.g. in the case of shoe uppers or linings, gloves, garments, bags or furniture covers). In these cases the requirements are more complex and therefore the most suitable leather substitute has a complicated - sometimes rather sophisticated - structure. Consequently, it is also more expensive than those synthetics used for other components. These type of materials have involved and involve still today considerable efforts in research and development. Owing to advertisements claiming too much and misinterpretations as to the new developments achieved by the chemical industry, a kind of uncertainty has appeared in the field and it is felt that a clarification is badly needed.

Considering these factors it was decided that the survey should be limited to the most problematic materials which might have a strong influence on the leather trade as a whole. In order to avoid to be too general the following non-leather materials will be excluded:

i) those of natural origin but used widely for component pre-fabrication or manufacturing (e.g. metal, wood, paper and paperboard, cork, natural rubber);

ii) all kinds of textiles made of natural, synthetic or mixed fibres, having a woven, knitted or non-woven structure;

iii) synthetics (incl. plastics) either used for thick or hard components or applied as compounds for component forming (e.g. different granulates, PVC, TR, EVA or PUR compounds, plastic sheets for reinforcing bags, extruded welts);

iv) as a special exception leatherboard will not be dealt with.

Taking into account these exclusions, only soft sheet leather substitutes mostly or entirely of chemical origin will be covered by this study.

The limits of the material range surveyed were slightly narrowed further by selecting certain industrial subsectors and manufacturing technologies as the main interest. The entire leather and leather products trade would have been too large to survey from the point of view of leather substitutes and the picture gained would have been rather confusing because of the

i) peculiarities of particular products (e.g. saddlery, balls, machine belts);

ii) different sizes of special industries (e.g. upholstery, gloves, footwear, fancy leather goods);

iii) insufficient or incomparable data available from the "smaller" industries (gloves, technical leather products).

Therefore this survey intends to deal with the footwear, leather garments and the leather goods industries only.

The study attempts to give a more or less overall analysis of leather substitutes. The limited time and financial means available for the survey made it impossible, however, to visit more than a couple of major leather substitute material manufacturers and users of these materials.

The intensive publication activity observed in the late 60's and the early 70's has slowed down. Statistics - especially on production of synthetic leather substitutes - are incomplete. The worldwide trade statistics of commodities and productions managed by UNCTAD's computer services do not, for example, have a heading or term related to leather substitutes. Some of the information and certain data are difficult or impossible to obtain because they are either confidential or protected by licences or patents.

Since the study endeavours to be as objective as possible, countries, companies, institutions and trade marks are in general not mentioned or referred to. Some exceptions will be examples to clarify certain points or in a few cases commonly accepted denominations* for different types of materials. The assessments found in some places are based on strict laboratory or wear tests, published data or information which has been checked as thoroughly as possible.

Special Considerations

To be able to get an over-all picture of the situation in the fields covered by this study some figures have to be presented concerning production and consumption. This is needed for hides and skins as well as for leather, leather substitutes and leather products.

It must be realized, however, that exact statistics in these areas are not available, and thus that the figures given usually are very rough estimates, compiled from data collected from many different sources.

On the other hand the figures, being necessary for the analysis, will still be acceptable since the magnitudes will serve just as well as exact quantities for this purpose.

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*) A number of abbreviations will be used in this study and an explanatory list is found in annex I.

CHAPTER I

LEATHER SUBSTITUTE MATERIALS

Historical Notes on Development

The need for substitutes of traditionally used materials arises when a shortage of the respective resource is being felt or when the supply is cut off by unusual events. Another important motive for the substitution would be a new achievement predominantly in the chemical sciences. The rubber and the leather board may serve as examples in the first case while the adoption of polymerisation of PVC to be used in soles, represents the second case.

The first composite man-made soft leather substitute material claimed to be able to perform as well as genuine leather, was marketed in 1963 by Du Pont under the trade mark CORFAM. Just one year later CLARINO from Japan was on the market. Until the end of that decade a considerable number of similar materials were introduced, most of them being patented. Leather products manufacturers witnessed a strong competition among suppliers and an even stronger among research institutions. Even modest estimates would count some 100 various trade marks which had entered the soft leather substitutes' market.

The late 60's and early 70's was the most enthusiastic era for synthetic shoe upper materials. A large number of papers were published at that time - chiefly concentrating on two subjects:

i) the need for man-made substitutes in order to fill the steadily growing gap between the demand for leather products and the limited availability of raw hides and skins;

ii) the interrelation between the structure and the hygienic and comfort properties of composite materials - with special references to water vapour permeability.

In spite of all the efforts, the prices of these permeable leather substitutes remained quite high compared to genuine leather; at the same time their wear properties had not improved very much. The attempts to mix natural and synthetic fibers did not give much better results either. The numerous tests and wear trials also proved that the look and the touch of the synthetic materials were significant when the quality was evaluated by the consumers. Insufficient hygienic or comfort properties could, however, be accepted by certain consumer groups - provided the prices were reasonable.

These circumstances promoted the development of the simpler and cheaper coated fabrics which already had been on the market for quite some time. At first the plain (woven or knitted) fabrics coated with PVC or PUR were sold more and more. Thereafter the coagulated types of materials penetrated into the market and became bestsellers. Their secret: not too sophisticated technology, moderate prices, extremely wide range of colours, prints, embossings and thicknesses, all of which facilitated their use for fashion articles.

The chemical technology is now developing further: some new results in microfibre technology, the invention of the hydrophil fibre - although the production cost are still rather high - are only representatives of the new encouraging results. The genuine leather, however, seems to keep its position for those articles where the properties of leather are the main concern. The material structure of "leather products" for many purposes, where the leather properties are really not needed any more, should be treated separately in their own context.

Genuine Leather

Since all the inventions made to produce a suitable substitute for leather are intended to imitate not only the properties but also the structure of the genuine leather, it is necessary to start with its definition.

The International Council of Tanners (ICT) adopted the definition of leather in 1978. According to this the leather is a general term for hide or skin with its original fibrous structure more or less intact, tanned to be imputrescible.

This definition consists of two parts: the first statement makes it unambiguous that the term "leather" may be used only for materials derived from animal skins while the second statement explains its structure and main property. The genuine leather as such is characterised therefore by its origin and structure and all other materials lacking one of these distinctive features have to be clearly distinguished from leather.

The natural leather has a unique fibre structure. The thick fibre bundles are composed of smaller bundles and these of still smaller bundles until the collagen molecule, formed as a triple helix, is reached. Simultaneously the fibres grow out of and into other fibres, i.e. no open ends are to be found. Furthermore, the direction of the fibres near the flesh-side of the hide or skin is completely and three-dimensionally at random. Closer to the grain-side the fibres are getting thinner and closer until near the surface they form a compact, two-dimensional, almost sheet-like web only broken by the small cavities remaining after the removal of the hair. These hair follicles give the leather surface the typical grain pattern, characteristic for each type of animal. The collagen itself is a protein containing a large number of chemical groups that easily form links with water molecules. The wide range of possible mechanical and chemical treatments of the hide or skin can from the same hide, for example, produce a thin, soft and pliable garment leather or a thick, hard and compact sole leather.

The properly processed leather - mainly due to its fibre structure - can exhibit high tensile and tear strength, good scuff resistance, high air and water vapour permeability (it "breathes") and water retention power, reasonable ability to take and retain shape and a unique look and touch.

Beside these outstanding properties the leather has several disadvantages such as the individuality of each piece, the indefinite form, the almost randomly articulated perimeter, the topography etc.

Soft Leather Substitutes

The survey of the technical literature available on the subject (incl. encyclopaedias, monographies, papers published in periodicals and proceedings of conferences, patent certificates etc.) has proved that the terminology used in connection with leather substitutes is rather confusing. There is no definition of"man-made leather", logically similar to the one made for leather. It is, therefore, more or less unavoidable to make an attempt at unifying the terminology and at constructing a clear definition.

A number of terms have been suggested (in certain areas adopted)during the last 20 to 30 years in order to express the uniquiness of leather substitutes - most of them indicating the similarity by using the word "leather" in the denomination. The soft leather substitute materials (more correctly: those which fall within the limits explained in the introduction) are usually named by one of the following terms: artificial or synthetic leather, leather substitute or alternative, man-made leather or material, coated fabrics, porometric. Sometimes several of these words are applied to the same product (even by its manufacturer) but it is also not rare that the same term is used for quite different types of materials. What is common in most of the expressions mentioned is the grammatic structure having the general form: attribute adjective + subject, where the former is to express the distinctive feature of the particular material, while the latter suggests the similiarity to the reference pattern - the leather. Using words such as artificial, synthetic, man-made etc. wants to give the impression that the subject (in this case: the leather) is being reproduced artificially - which is of course (at least today) impossible and contradictory to the definition of leather.

It is recommended here to adopt the term simulated leather. The verb "to simulate" expresses just all that which manufacturers of soft leather substitute materials aim at: to produce artificially something that is similar as much as possible to the genuine leather. In the case of hard leather substitutes the target is somewhat different today because the modern materials (e.g. PVC, TR, EVA) do not pretend to imitate the vegetable tanned leather. They provide both manufacturers and users (wearers) with sometimes even better properties than the "originally used leather" had, while at the same time some of the features of the latter has been completely forgotten.

The recommended definition of simulated leather is as follows:

"Simulated leather is a sheet material of synthetic origin intended to look, feel and perform like genuine soft leather."

This definition has a number of advantages:

i) it does not contradict the definition of leather as adopted by ICT,

ii) it indicates the chemical technology used for the manufacture of such types of materials;

ii) it suggests to everybody that the simulated leather is only a copy or a "synthetic approximation" of the leather;

iv) it excludes all other leather substitutes and alternatives used in the leather products industry.

As special features of the recommended terminology and definition should be mentioned its short but expressive form and that it covers the various types of materials more completely than any other term used in different geographical, linguistic or industrial areas. (It ought to be stated too that the meaning of "simulated" will conform with the explanations found in most of the English dictionaries and encyclopaedias.)

This terminology and the recommended definition of simulated leather will be used in the following pages.

Notes on Terminology Used in Selected Areas

When the first large wave of leather substitutes came during and between the two world wars, the alternative materials had their natural denominations (rubber soles, wooden heels, cardboard reinforcements etc.) - none of them was named as artificial. Later, when further and newer materials penetrated into this area of applications (PVC and PUR, polyethylene, polypropylene and polystyrol, various plastic sheets etc.) their original names were kept and the name of the respective component, which they were replacing was added. The same happened to soft leather alternatives (e.g. textile upper or lining, nitrocellulose toe-puffs).

In the case of soft leather substitutes this tradition has changed, most probably due to economic and marketing factors; the suppliers tried to secure the word "leather" in the name of the new products. The straightforward way to do so was to apply "artificial leather" or "synthetic leather" or "man-made leather" or more generally speaking "leather substitute". There have been attempts on various international congresses to distinguish between soft materials having at least some hygienic or comfort properties like water vapour or air permeability and those materials having no such properties.

This practice is still followed in some COMECON countries. These words, translated directly into Russian, have the same meaning in the USSR.

In some countries industrial standards define the terms to be used. The fabrics coated by any synthetic materials (e.g. PVC, Nylon, PUR) are referred to by Japan standards as synthetic leather, at the same time artificial leather is the one obtained by polymer treatment of a non-woven fabric which is made by twinning the fibre three-dimensionally. (This terminology is evidently just the opposite to the one used in COMECON countries.)

The term"man-made (leather)" is widely used not only in English speaking countries but is met in technical literature written in other languages as well. Particularly in Japan it is applied as a synonyme for artificial leather or poromerics.

At the time of the introduction of CORFAM, the first simulated leather, a new term was invented for these types of materials: poromer(ic). It is being used almost everywhere today but mainly for soft leather substitutes having some hygienic and comfort properties.

The trade mark "CORFAM" has become also a term: e.g. the industrial standards of Poland define synthetic leather upper materials as Corfam-types.

The German language had adopted the word "Kunststoff" = artificial material: applying the same grammatical and semantic pattern the DIN standards use the term "Kunstleder" = artificial leather.

Since the artificial, synthetic or man-made leather as denominations suggest that the material named in this way is a leather produced artificially (which as mentioned earlier is impossible - at least today) it is prohibited to apply them in any official context in UK.

Instead the real name or simply the trade name of the respective material has to be used. This practice is directly connected with the labelling system adopted by the local trade. Some other countries outside UK have also adopted the same or a similar system.

"Coated fabric" was also one of the terms applied to all kinds of soft leather substitutes. It is today chiefly used for those materials which have such a structure, i.e. composed of two layers: a(woven, knitted or non-woven) substrate and a coating layer. There has appeared also another suggestion: "chemical leather" to indicate the process of manufacturing but this term has the same disadvantage as the "artificial leather" and similar denominations.

The annex II lists some terms and definitions adopted in selected industrialized countries.

Classification of Leather Substitutes

The materials used in leather products industries may be classified according to various principles (e.g. as to their origin, components they are going to be used for, structure). Figure 1 represents a fairly comprehensive systematization of the base materials used for leather products manufacturing - with special reference to simulated leathers.

As a first step in leather substitution might be considered the introduction of the material obtained when a coat in the form of a homogeneous foil, having no pores at all, is put on the buffed grain surface or on a split of a natural leather. The straightforward idea of preserving some of the properties and structure of genuine leather is to combine synthetic materials with leather (layer or fibers). It can be done in two different ways: either coating (mainly low quality leather or splits) by a synthetic layer giving a nicer look and better scuff resistance or by mixing collagen and synthetic fibers thereby producing an even sheet using a technology similar to paper manufacture.

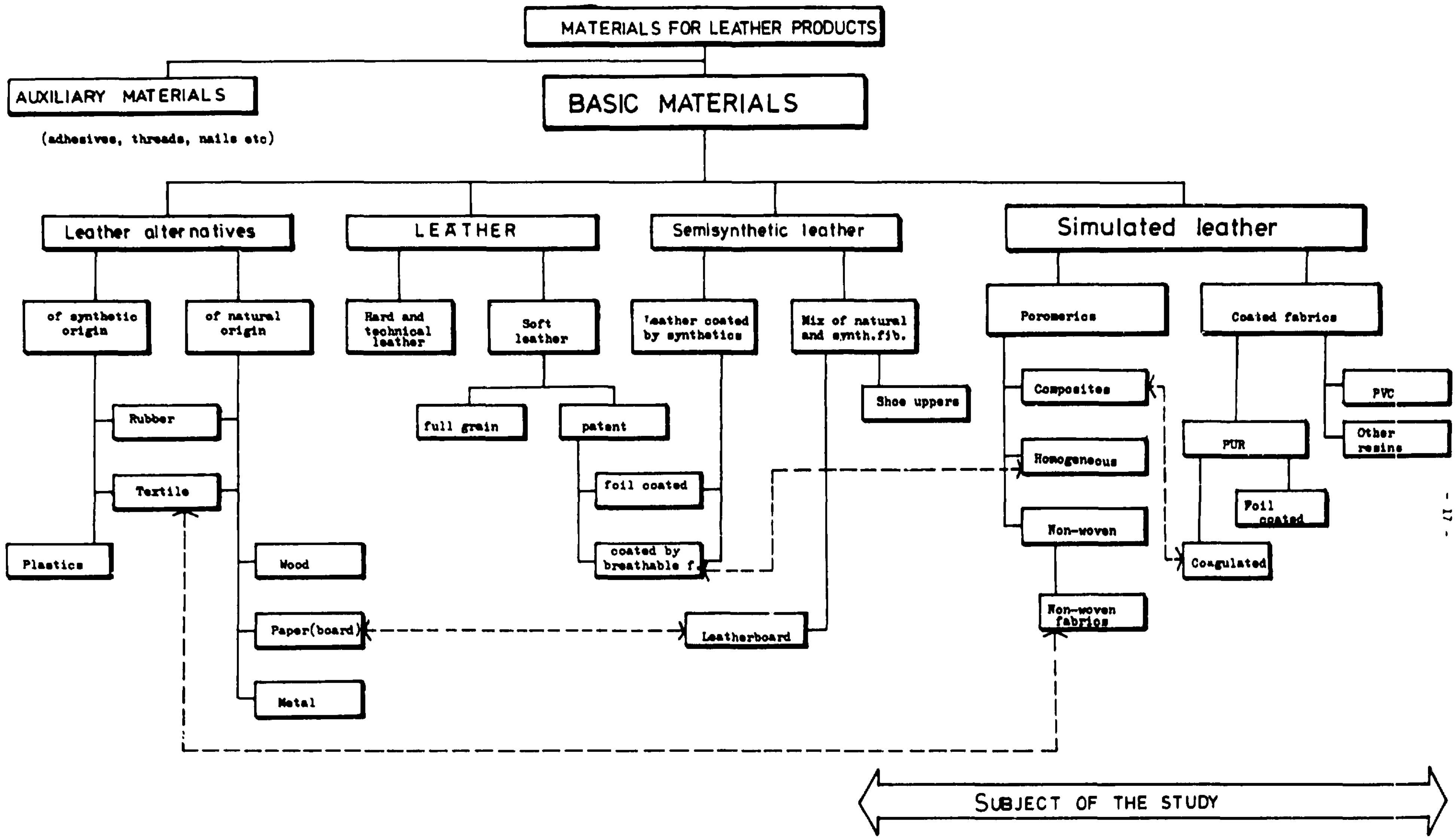

MATERIALS FOR LEATHER PRODUCTS
AUXILIARY MATERIALS
(adhesives, threads, nails etc)
BASIC MATERIALS
Leather alternatives
LEATHER
Semisynthetic leather
Simulated leather
of synthetic origin
of natural origin
Hard and technical leather
Soft leather
leather coated by synthetics
Mix of natural and synth.fib.
Poromerics
Coated fabrics
Rubber
Textile
Plastics
Wood
Paper(board)
Metal
full grain
patent
foil coated
coated by breathable f.
Shoe uppers
Leatherboard
Composites
Homogeneous
Non-woven
Non-woven fabrics
PUR
Foil coated
Coagulated
PVC
Other resins
SUBJECT OF THE STUDY

Fig. 1

These types of materials are referred to by the recommended classification as "semi-synthetic leathers". The best results-both from a technical as well as economic point of view - have been obtained in the case of leatherboards and by foil coated splits. The principle of mixing fibres of different origin has not brought about the expected results owing to technical problems, still unsolved in the manufacturing processes and for the relatively high manufacturing cost. (Even the leather board production faces difficulties: particularly to the shortage in the supply of wastes of vegetable tanned leather) The industry is still lacking a viable method of collagen reconstruction, although the idea was invented by Heiberger already in the early 1950's.

Simulated leathers (as defined in the previous paragraph) may be divided into two groups: promerics and coated fabrics. Poromerics are those simulated leathers having hygenic and comfort properties to a reasonable degree. They may have one or more layers, a finishing layer on the outer surface or have none at all. Poromerics are generally used for shoe uppers , shoe linings and garments. The other group comprises all kinds of textile fabrics coated by a synthetic layer, usually consisting of PVC or PUR.

The classification in Figure 1 shows the complexity or similarity of some materials (dotted lines) - e.g. a thin foil of homogeneous poromer can also be used for split coating (similar for example to the one the PORVAIR markets as PERMAIR).

There are many other possibilities as to the classification of soft leather substitutes (e.g. number of layers, composite materials, properties). Table 1 represents one way of grouping these materials according to the structure and shows the technically possible as of today combinations of layers made of various base materials.

Table 1.

Most common types of artificial soft leather substitutes

	Textile substrate	Intermediate layer(s)	Top layer*	Main uses	Comments - Examples
1	None	None	PVC	Leather goods	Plastic sheets
2	"	"	Coagulated PUR	Shoes	"PORVAIR" poromeric
3	"	Expanded PVC	PVC	Leather goods	Sheet materials
4	Woven fabric**	None	"	All purpose	The main bulk of artificial leathers produced
5	" "	Expanded PVC	"	" "	
6	" "	None	PUR	" "	Higher quality than 4
7	" "	"	Coagulated PUR	" "	" " " 4-6
8	" "	Fabric PUR-impregnated/coagulated	None. Surface buffed	Shoes Upholstery	Different qualities in fibre treatment
9	Knitted fabric**	None	PVC	All purpose	Similar to 4; Bulk production
10	" "	Expanded PVC	"	" "	" " 5; " "
11	" "	None	PUR	Boots; Garments	
12	" "	"	Coagulated PUR	Garments; Linings	
13	" "	Fabric PUR-impregnated/coagulated	None. Surface buffed	Garments; Boots Linings	"ALCANTARA" suède
14	" "	—"—	PUR	—"—	" nappa
15	Non-woven**/***	None	PVC	Leather goods Sock linings	Large production
16	—"—	"	PUR	Sport shoes etc.	****
17	—"—	"	Expanded PVC	Shoe linings	"CEE-PORO"
18	—"—	"	Expanded PUR	" "	"CEE-NOVO"
19	—"—	Fabric PUR-impregnated/coagulated	None. Surface buffed	All purpose - high quality	"BELLESAIME" suède
20	—"—	—"—	Coagulated PUR	—"—	****; "CLARINO"
21	—"—	—"— + fine-mesh net	" "	Shoes	"CORFAM"

* The surface may have no treatment, "gloss-spray" or be embossed and/or contrast-printed - either directly or through the transfer-coating method.

** Fibres may be cotton, polyester, nylon or (rarely) other types.

*** The fibres can be made very fine (mostly Japanese fibres) or extremely fine (as in "CLARINO F").

**** Variations mainly because of different thicknesses of the non-woven fabric (range: 0.1 - 3.0 mm).

CHAPTER II

ECONOMIC FACTORS RELATED TO THE SUBSTITUTION OF LEATHER

As has been mentioned earlier, replacing genuine leather trough a substitute will be influenced by several sometimes promoting and sometimes limiting factors, among which the economic ones are predominating.

Availability of raw hides and skins

The natural leather is the traditional base material for all kinds of leather products since

i) raw hides and skins are by-products (of the meat industry), thus they are relatively cheap;

ii) the leather industry using generally well-known technology, is widely developed all over the world.

The supply of raw hides and skins depends on several factors. The most significant are those relative to the livestock, the take-off rate, the human eating habits, the collection network, the adopted curing and flay ng technique. Beside these, numerous secondary conditions, such as religious traditions, the local climate,available transporting facilities, industrial infrastructure, actual state of international trade ect. have an impact on the supply.

Table 2 shows the most important statistical data and estimated quantities of available raw hides and skins of various origin. Taking the number of animals killed yearly and multiplying by the average surface area , the theoretically possible availability of raw materials for leather production may be computed. In this case it is estimated to be about 1,900 million m^2 a year. If all this amount reached the tanneries and was processed into shoe upper only, then approximately 11,000 million pairs of leather footwear could be produced each year. Owing to the considerable use of leather for garment, gloves, upholstery, leathergoods and sport goods (e.g. saddlery, balls) and due to the limited collection this quantity is much less.

Table 2.

Estimation of the world availability of raw hides and skins

	Livestock population (1981)	Yearly growth rate (1970-1981)	Take-off rate (1981)	Raw hides and skins		Average area of finished leather
				production (1981)	yearly growth rate (1970-1981)	
Unit	million heads	%	%	million tons	%	m^2/piece
Cattle	1,200	1.1	19	6,600	1.1	4.0*
Goats and kids	470	1.5	37	380	2.1	0.5
Sheep and lambs	1,100	0.5	35	1,100	0.1	0.6
Pigs	780	1.5	93	810	5.6	1.1
In total	3,550	1.3	42	8,890	1.2	1.3

* Including splits

The average growth rate of the livestock has been estimated by FAO at 1.1% and the production of raw hides and skins during the last decade has been growing at a rate of 0.9%. Assuming that more effective animal husbandry methods will be introduced in developing countries and an overall improvement will take place in the treatment (flaying, curing, collection, transport etc.) of raw hides and skins in the near future, the rate of increase of supply may be calculated at 1.3% annually.

The livestock population differs by geographical areas and countries. There are large herds in developing countries (e.g. in East-Africa, in Mid-East, in South-America) serving in the future as a potential source for the increase in raw hides and skins supply. On the other hand, these are usually of medium to low grade and have a relatively small usable surface. Another problem is the forwarding, i.e. the cost of transportation, the health regulations in the recipient countries, the complex of tariff and non-tariff barriers which all might create additional difficulties in utilizing these resources.

Limiting Factors in Leather Supply

On the basis of the data presented by Table 2 one may arrive at the conclusion that only 67% of the hides and skins of killed animals are being processed into tanned leather today. There are a number of factors responsible for such a limited supply of raw material; among these the following are of special importance:

i) due to religious reasons a considerable part of the livestock is not available for meat and thus the hides are only to a limited extent useful for leather production;

ii) a large part of the world livestock is kept using very old and ineffective methods of animal husbandry or kept just under the sky; thus the hides and skins of these animals are of a bad quality (sometimes even of no value to the tanneries);

iii) the majority of the animals (especially in developing countries) are killed in farms or in small abattoirs, having neither proper facilities nor sufficient know-how for a proper flaying and curing;

iv) incentives and collection systems are lacking in many developing countries;

v) some countries impose too high export duties on raw hides and skins or restrict entirely the export while the local tanning industry is not yet capable of using fully the domestic supply;

vi) the lack of sufficient knowledge or experience in leather processing in many tanneries result in wastes or materials useless for leather products;

vii) some of the countries (nations, ethnic groups) traditionally eat the skin with the meat;

viii) the food processing industries make use of the protein from the skin for example for producing sausage cases or compounds.

Besides these factors some others have also an impact on the supply of raw hides and skins but their influence is irregular and impossible to forecast (e.g. speculation, epidemics).

The circumstances above are the cause for the difference between the computed availability and the real supply of raw materials for leather. Taking into consideration the recent trends in the world economy, significant changes are not to be expected in this respect - in other words, these limiting factors will remain effective for quite some time to come.

The Leather and the Leather Products Market

The total leather production in the world is estimated as follows:

leather of	production million m²/year	growth rate,%
bovines	700	2.2
goats	85	0.3
sheep	230	1.9
pigs	200	5.0
other animals	70	-
in total	1,285	2.3

The rapid growth of pigskins utilization is (partly) due to the strong and increasing demand in genuine leather. Pigskins have been used for a long time for lining and also as a sort of alternative to higher quality leathers of other kinds.

About 15% of the finished leather manufactured in the world enter into foreign trade. The developing countries export 8% of their raw hides and skins to industrialized countries. Their share in the finished leather trade is approximately 28%.

The majority of finished leather available to the world market is used for footwear production. The following figures are estimates of the share (in percentage) of selected leather products industries in their utilization of finished leather.

Subsector	Industrialized	Developing	world total
	countries		
Footwear	64%	61%	63%
Leather garment	5%	17%	9%
Leather goods	14%	14%	14%
Other leather products	17%	8%	14%
Estimated use of leather in total million m^2	938	347	1,285
%	73	27	100

It is more difficult to estimate the simulated leather production; a rough appreciation is given below (million m^2/year)

Type	for shoes	garment	others	TOTAL
High quality PUR coagulated	4	17	-	21
Other PUR coagulated	150	18	7	175
PVC/PUR coated fabrics and others	700	80	1,650	2,200
in total	854	115	1,o57	2,396

The major manufacturers of simulated leathers seem to be located in Czechoslovakia, FRG, GDR, Hongkong, Hungary, Italy, Japan, Poland, South Korea, Spain, Taiwan, USSR , UK, USA. These are estimated to produce 80-85% of the total amount. The installed capacities are estimated to be about double of the actual production.

At the end of the 1960's and in the beginning of the 1970's quite a number of new simulated leathers (mainly poromerics) appeared on the market. There were about 100 trade names reaching the leather products manufacturers. Some of the most well-known types were the following: Corfam, Pol-Corfam, Clarino, Xylee, Porvair, Patora, Hitelac, Aztran, Poron, Barex, SK-2, Belesa, Ceef, Viledon, Cellon, Grabona, Saron, Helia, Duracel, Aikas, Skailen, Viledon, Cellon, Opomat, Nordic, Cabron, Cordley, Patora etc. Most of these products have now disappeared from the market and although some other (e.g. Alcantara, Aquiline) have entered the range of materials available for leather products manufacturing, the today's selection of producers and product types is much narrower. On the other hand by the development of coagulated PUR coated fabrics the range of simulated leather in terms of fashion features (colours, thicknesses, prints etc.) became extremely wide - at cheaper prices than those of poromerics.

The world production of poromerics has been growing rather slowly during the last ten years. Even the most successful Japanese manufacturers, for example, could not increase their production more than 18% from 1973 until 1982.

Almost two times as much simulated leather as natural leather is used by the leather products industries. 43% of simulated leather entering into the leather products industry is used for upholstery, 30% for leather goods and only 23% for footwear.

About 8,000 million pairs of footwear are marketed annually in the world. Out of that amount some 42% have leather uppers and of those only 34% are manufactured in developing countries. 33% of the total footwear production is non-leather made in developing countries, chiefly in the Far East. With regard to the consumption the following figures are of special interest:

44% of shoes consumed in industrialized countries have been made of leather - the same figure for developing countries is 37%. The overall apparent consumption are 1 and 4.5 pairs/ capita for developing and developed countries respectively, making the world average 2 pairs/capita.

Shoes with upper made of poromerics and coated fabrics take about half of the women footwear market in industrialized countries. Men are more conservative in this respect, only 5 to 7% of gent shoes sold are made of simulated leather. In the children footwear trade this share is 10 to 12%.

Leather footwear represents about 73% of the imports of leather products from developed, but only 45% from developing countries. These facts attest to the importance of other leather products than footwear for the development of the leather products industry in developing countries.

The share of genuine leather in the total basic materials used in different leather products differs considerable.

	share of		
	genuine leather	leather alternatives	simulated leather
	in % of materials utilized		
Footwear	35	50	15
Leather garment *	70	-	30
Leather goods	10	40	50
Gloves*	85	-	15
Sport goods	10	85	5
Upholstery	3	77	20

*) not counting textile

The leather products market has been stagnating during the last 3 years because of the economic recession. (The most dramatic drop was felt in the fur business, but the high quality genuine leather products manufacturers have suffered as well.)

Demand for Leather Products

The actual demand for footwear is influenced basically by the living standard*, the climate, the urbanization, the level of industrialization and the traditions in clothing of each country or ethnic group. Since shoes serve specific functional purposes the need for them is much more objectively determined than for other leather products. The average consumption of footwear with upper made of natural or simulated leather in the world is about 1 pair/capita, 0.5 pairs/capita in developing and 2.3 pairs/capita in industrialized countries which is just about half of the total consumption.

The real demand for leather footwear is much higher, but the purchasing power and the insufficient supply (especially in developing countries) limit the consumption to the present level. Due to such difficulties there are million of people wearing shoe alternatives (e.g. sandals made of worn rubber tyres). At the same time the world population grows faster than the animal live-stock and the developing civilization strengthens the fashion influence and creates new functions (e.g. sports, leisure etc.)all of which will increase the demand for leather and leather products made of genuine or simulated leather.

*) Figure 2

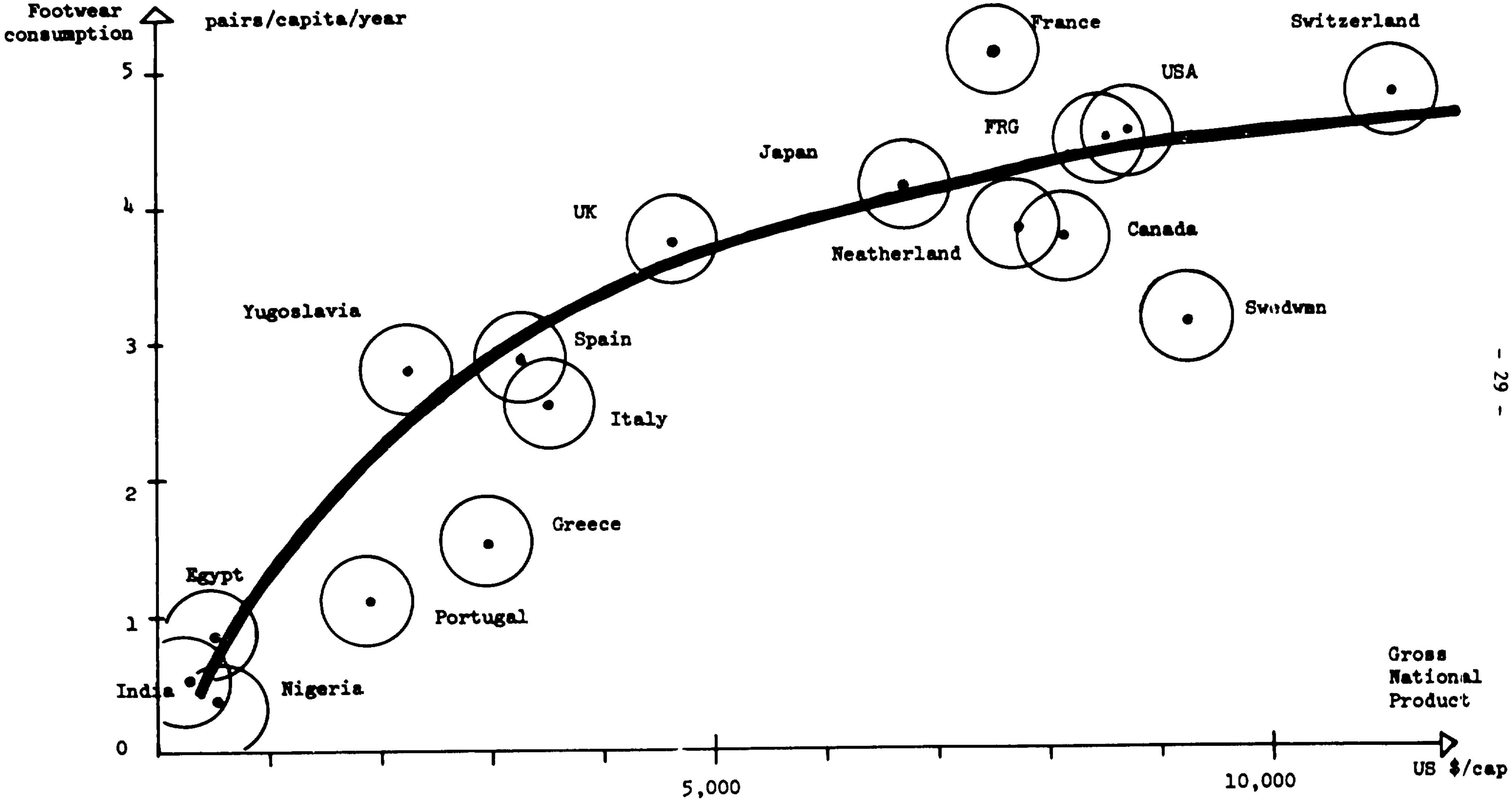

Footwear consumption
pairs/capita/year
5
4
3
2
1
0
France
Switzerland
USA
FRG
Japan
UK
Neatherland
Canada
Yugoslavia
Spain
Swedwen
Italy
Greece
Egypt
Portugal
India
Nigeria
Gross National Product
5,000
10,000
US $/cap

Fig. 2

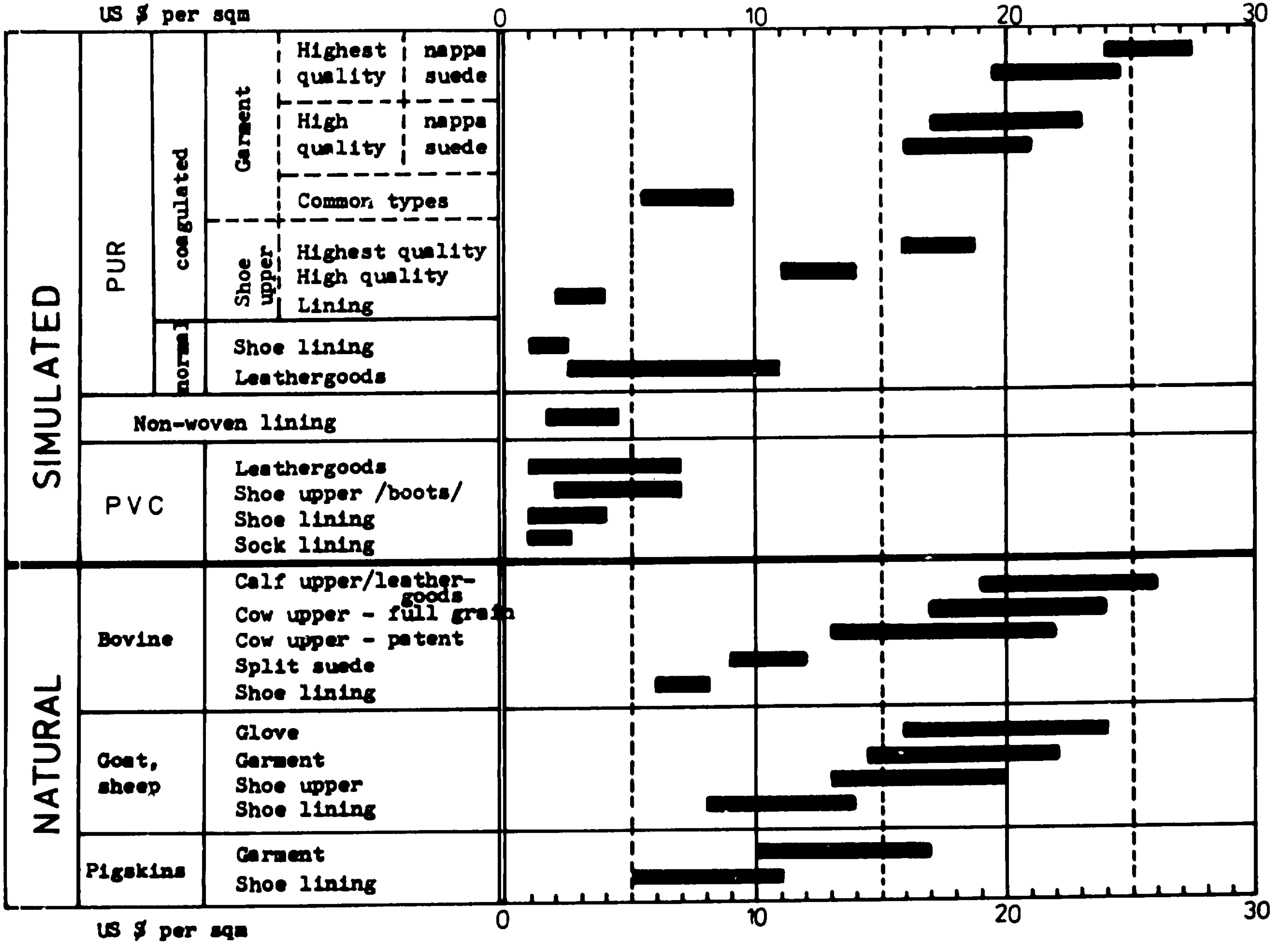
Price Development on the Market

Since the raw hide and skin supply basically depends on the meat production and does as such not follow the changes in the demand in the leather trade caused for example by fashion and changing seasons, the market prices fluctuate almost randomly. For instance the unit price of certain cattle hides from USA was 0.6 $/kg in 1974 and 1.4 $/kg in 1981. The finished leather prices certainly move accordingly but the changes may be felt only half a year later and the fluctuations are never so wide and sharp as are those for the raw hides and skins.

Among the production cost, both for natural and simulated leathers, those of chemicals take a larger and larger share because of technical developments of manufacturing processes and the dramatic price jump encountered on the raw materials market in the second half of the 1970's. Altough the oil prices (oil is the basic material for polymers and other synthetics used for most binders and fibres) went up about 800%, compared with 1973, the prices of chemicals increased, however. only about 50%.

When the first simulated leathers appeared in the market their manufacturers and dealers claimed that these materials were able to substitute specific kinds of genuine leathers (e.g. CORFAM - full grain calf) and the prices were fixed accordingly. This approach has been used by all producers of poromerics and therefore the highest quality simulated leathers used in the footwear and leather garment industries differ only slightly from the prices of "comparable" leather.

Figure 3 gives an overall picture of the prices for natural and simulated leather in 1983. The prices are calculated ex-factory and thus allowances must be made for possible import costs. The wide ranges are due to normal differences in quality, quantity, thickness, surface treatment etc. and some qualities might still be outside the range indicated.



October 1983

Fig. 3

The price structure of leather products is more complex. Average leather shoe prices have been growing about 80% for the last 15 years in industrialized countries, mainly due to the general inflation and the rapid increase in wages. At the same time footwear made of simulated leather cost about half of those intended for the same function made of genuine leather. There is no reliable statistics available for leather goods and leather garments; the product mix is too wide and complicated and the penetration of the leather substitutes varies considerably, depending greatly on the intended use.

Economical Production Quantities

The subsectors of the leather and leather products industry are not equally equipped as to machinery. In other words, they differ by their direct labour requirements in the manufacturing process. It is impossible, due to the inherent complexity of the matter, to give in general any quantitative information as to minimum economic factory sizes and capital requirements for establishing a workplace in these industries.

It is obvious, however, that natural and especially simulated leathers represent the most capital-intensive productions compared with those of leather products. Consequently, the minimum economical size of a manufacturing unit is relatively high. That is the main reason why the simulated leather manufacturers produce a wide range of materials for a broad field of use. Usually they have a few main products providing the bulk of the production. Moreover, many of these producers are at the same time manufacturers of chemicals or basic materials for the chemical industry, providing the simulated leather processing unit with the necessary industrial infrastructure (e.g. energy, stores of chemicals, effluent treatment, transport).

CHAPTER III

REASONS FOR LEATHER SUBSTITUTION

Opinions regarding the reasons why leather products manufacturers look for alternative or substituting materials, are far from uniform. Interviews made with prominent representatives and specialists of both leather and leather products industries, as well as the analysis of available technical literature reveal, however, the existence of a limited number of factors influencing the leather trade. This chapter will try objectively to discuss the situation in this field.

Balance of Supply of and Demand for Leather

According to recent estimates the world population is about 4,400 million. Taking into consideration the fact that at least half of the population, i.e. 3,100 million people, of the developing countries have no opportunity to wear footwear at all or wear much less than the minimum would require by the local conditions (climate, work performed etc.),tne world average shoe consumption should probably be somewhere about 2.5 pairs/capita. This means, that 11,000 million pairs of footwear ought to be produced yearly. Since the majority of industrialized countries are living in cooler climate than those from the developing world, the share of leather footwear worn in the latter countries probably would be somewhat less. Thus the world overall theoretical demand for leather footwear may be estimated at 5,500 million pairs per year. This quantity would cover sandals composed of thin straps as one, and high leg boots made with leather lining and leather soles as the other extreme. Taking this range into account, the average genuine or simulated leather requirement might be calculated at 22 dm^2/pair. Applying these data for further computations one may arrive at a theoretical demand for leather-like materials of 1,200 million m^2/year only for the footwear industry. If we presume that the hidden demand for leather products other than shoes, is proportionally the same as in case of footwear, then the total requirement for leather and simulated leather would be about 2,400 million m^2.

It has been mentioned elsewhere that the world leather production is about 1,300 million m^2 annually, which constitutes only 54% of the above demand. Taking also into account the growth rate of the livestock and the world population, it is quite obvious that even by utilizing all the raw hides and skins of all slaughtered animals the quantity would in this case not be sufficient for the leather products industry. As a matter of fact, this statement would be true even if the actually existing demand had been used in the comparison instead of the theoretical demand. This also explains why leather substitutes are necessary and favourably received by the leather products industry.

Market Requirements

Above have been given in some details the reasons for the widening gap between the demand and the supply of genuine leather from a purely quantitative point of view. In most of the industrialized countries, however, consumers require a wide range of leather products to be offered by retailers, starting with very cheap canvas shoes and ending with luxurious reptile handbags. In order to provide the trade with such a big selection manufacturers had to find suitable alternative materials. Among possible materials simulated leathers had and have two advantages in this respect: they look like natural leather and especially the coated fabrics are cheap.

Generally speaking, there are different groups of consumers to be distinguished according to their requirements and purchasing power. First of all the markets of gents and ladies are quite different. Men are more conservative and a man usually puts on a pair of shoes in the morning and wears it until the afternoon or evening. There are much less variations in styles, colours and constructions in this group. All this led to a rather strong requirement for comfort: both as to fit and hygenics.

That is why the overwhelming majority of gents' street and casual shoes are made of genuine leather in the industrialized countries. The children's and the men's footwear markets have some similarities. The hygienic properties are, however, even more important and at the same time the wear by children of their footwear is extremely heavy (e.g. the scuff resistance of the upper material is one of the most critical properties which very often is better in the case of synthetics).

The ladies' footwear market, constituting much the bigger part of the total shoe market, has some peculiarities. Women look for fashion first, and in many cases even do not care about comfort. They wear a few pairs of shoes during a day and have a larger stock of footwear at home than their husbands or sons. Their first concern usually is what type (style, colour, heel shape, decorations etc.) of shoe they are looking for, and that is influenced mainly by the clothing fashion. The price is almost always a second consideration. Only a minor part of women can however afford to purchase only genuine leather shoes and even this group sometimes buys fashion shoes made of simulated leather. In that case a natural leather lining was often used to improve the water absorption and thereby the foot comfort. The foot comfort, however, does not matter very much if they wear these shoes only a few hours (and not every day). The heavy competition forces every manufacturer to produce these footwear to be as cheap as possible and therefore it is even seldom today that the shoe made with synthetics upper has natural leather lining.

Many interviews made with customers and the sales statistics indicate that in industrialized countries the main reason for substituting upper leathers is the market requirements. Especially in fashion footwear, there is a contradiction between the production cost and prices women are willing to pay for these shoes. Most of the simpler types of sandals made of genuine leather come from developing countries (chiefly from the Far-East and South America) and are extraordinarily cheap.

In many of these countries, owing to the warm climate, ladies are wearing sandals during the whole year, but these sandals can be made of cheaper simulated leather, making it possible for a wider local population to afford them.

Psychological Attitude of Consumers

In the 1960's people were keen to buy things made of artificial and synthetic materials; they preferred plastic furniture, nylon shirts, jersey costums etc. A few years later, they realized some disadvantages of these articles, e.g. too bright a look, lack of comfort, uniformity. Since the advantages of synthetics also were appreciated (easy care, durability) the demand changed and has now two main features :

i) consumers look for goods which combine the advantages of natural and synthetic materials (like fabrics made of a mix of cotton or wool and synthetics);

ii) the demand for natural materials and products made out of these is also increasing.

This return to natural materials has been caused by a number of factors acting simultaneously. Beside the need for comfort as the main concern may be considered the desire for a "rich look". Natural materials are generally much more expensive; thus wearing goods made of natural leather and wool or using wooden furniture may indicate a better position in life. Not much later after the synthetics caught a considerable share of the consumer goods market, a new fashion line appeared: the "natural look". This situation produced a positive feedback to the manufacturing technology and quality control. Some of the material faults, which had not been allowed in finished leather products (neck creases, heavy grain etc.) became not only acceptable but even desirable in order to show or prove to customers the natural origin of the basic material used.

Today both consumers and retailers consider natural leather and leather products made of genuine leather as of a higher quality than other similar materials and products.

Psychologically the human being is more familiar with natural material and trust them more than synthetics. Sometimes people appreciate natural leather highly even when they perform worse than their substitutes (e.g. soles, stiffeners). This limits the utilization of simulated leather for shoe uppers, leather garments, gloves and most probably this psychological attitude will play a balancing role also in the future.

Some people are extremely sensitive and their share in the total population is growing. These consumers feel themselves extraordinarily uncomfortable, or sometimes they are "hurt" when using clothing made of synthetics. They look for shoes, garments etc. composed of natural materials only and pay practically any price in order to get it.

Fashion Considerations

Leather products industries are fashion oriented - not only in industrialized but in developing countries as well. The fashion might be regarded as a special way of manipulating the market that is to stimulate people to buy more or new goods and thus keep the business running or developing. To do so the industry and the trade have to offer a wide selection, come up with new ideas, create new functions. All this means that new and sometimes basically different materials, constructions and forms, are continuously needed. New functions require special properties, which cannot be performed in the old way. Here alternatives or substitutes to genuine leathers, especially different types of simulated leathers often have good opportunities to be used. These types of materials can be decorated much easier than leather, there are less wastes in manufacturing and thus the production is cheaper.

The fashion is always a mass reaction generating big quantities. For the production of such bulk quantities the natural resources, i.e. genuine leather, are by far insufficient and simulated leathers simply must be used.

The demand for a natural look slowed down slightly the process of substituting leather but could not stop it. Through intensive product development and by adopting sophisticated technologies, simulated leathers (especially the PUR coagulated) achieved such a perfectness that it is sometimes difficult to distinguish them from genuine articles by their appearance or touch.

Economic Factors

Altough the reasons presented above for substituting natural leather have the strongest influence, a number of other (basically economic) factors also have an impact on the leather business.

As has been mentioned earlier, the supply of raw hides and skins and consequently of leather is not constant all the time, while the demand for shoes, leather goods and leather garments is steady or slightly growing. When for some reasons tanneries are not able to provide the leather products manufacturers with adequate quantities of leather, or the leather prices have gone up, the confectioners have to use alternatives and/or simulated leather. Since the prices of the substitutes are more stable, their utilization increases in such cases, thereby penetrating new areas.

All kinds of leather substitutes exhibit homogenity of properties, i.e. they do not have topographical differences, and therefore their forms, sizes and thicknesses are definit.

Using simulated leathers will obviously have the following advantages:

i) better conditions for automation of operations or production processes;

ii) more even quality of leather products;

iii) less wastes in production or no waste at all;

iv) higher productivity and lower skill requirements.

These advantages create benefits in economic terms, i.e. the production costs decrease. This in turn will give the producer the opportunity of obtaining higher profit or of being more competitive on the market or of simply being able to continue to produce leather products (e.g. in industrialized countries or where the labour tends to move to other industries).

The greater part of the R+D activities were concerned with poromerics since they were intended to replace genuine leather in shoe uppers, which as such must be regarded as a very ambitious objective.

CHAPTER IV

PRODUCTION OF SIMULATED LEATHER

Almost each type of simulated or semi-synthetic leather has a unique structure, a defined composition of basic materials and a special manufacturing technology. This chapter aims at giving a short description of the production techniques applied in simulated leather manufacturing without going too much into details.

Research and Development

Just after the introduction of the first coated fabrics both manufacturers and users started intensive R+D works. Most of the efforts have been and are being concentrated on improving the hygenic properties, i.e. to increase the water absorption and water-vapour permeability and on making the surface of the material look like full grain leather.

At the beginning the research was aimed at imitating the fibre structure of genuine leather - introducing a non-woven or microporous substrat as a carrier. The next stage was to increase the hydrofil properties of the substrate or the fibres themselves. The laboratory tests and especially the wear tests and consumer reactions, later proved that beside the hygenic properties the relaxation of the material, i.e. the rheological properties also is greatly important.

The disadvantages of poromerics caused the shoe industry to initiate R+D work as well, mainly oriented towards construction and technology. In order to make the shoes more comfortable the width of the lasts were increased, more open types of footwear were tried or the traditional constructions were made with genuine leather lining. The manufacturing technology also needed some modifications in sewing, lasting and heat-setting (form stabilization).

Coated fabrics involved far less R+D work since they did not aim at imitating all the properties of leather. It should be emphasized that all the time when these types of simulated leather forcefully tried to penetrate the market, a few conditions had changed; in many countries labelling of leather products had become obligatory, raw hides and skins prices were showing a declining trend and at the same time the manufacturing technology and machines used for substitute shoe upper materials could produce bulk quantities of materials required by other industries (upholstery, buildings etc.)

The development in combining natural and synthetic fibres for leather substitution (e.g.collagen) came after the first enthusiastic rush in the 1960's to a standstill. The main reasons for this were the high production costs of these semi-synthetic leathers and the more economical and beneficial possibility of utilizing protein wastes (collagen) for other purposes (e.g. animal feeding, sausage cases).

Another line of R+D activities has produced a new material, combining leather with a thin layer of simulated leather for shoe upper (e.g. Permair).

Researches are continuing in order to find economic ways of collagen reconstruction.

Structure of Simulated Leathers

The structure of almost each type of simulated leather is different but there are also common features. Looking at the cross section, the most complex material has several layers:

i) the substrate or carrier provides the material with the necessary mechanical properties and (not always) assists in performing certain hygenic functions;

ii) the coating may consist of different layers, homogeneous and/or porous;

iii) the top finish which usually is extremely thin, gives the appearance of the material (grain, colour, touch etc.).

The base of the substrate may consist of woven, knitted or non-woven fabric, or a combination of these. Into this basic substrate can then also be introduced synthetic resins or other compounds (e.g. through coagulation of PUR). There are simulated leathers which have a non-woven carrier combined with a woven interlayer. They are usually referred to as three-layer types. The two-layer materials have a single layer substrate and a coating. This means that the finishing layer is regarded as "self-explanatory" and is not counted when looking at the cross section. Among the one-layer simulated leathers there are two main types; the homogeneous sheet (e.g. Porvair) and the simple, non-woven fabric (this is chiefly used for shoe linings and antislips).

The coating may be solid (monolithic),porous, or a combination. The pores may be separated (as bubbles) or interlinked (like in sponges). The coating material is usually either PVC or PUR - very seldom other polymers (e.g. polyamide).

The substrate and coating determine the type of the simulated leather. Therefore their manufacturers generally refer to the actual combination or denomination in the product description.

Raw Materials used for Simulated Leather Manufacturing

The woven, knitted and non-woven carriers used to be produced applying traditional textile technologies (in most cases these components are purchased as such by the simulated leather manufacturing company).

The woven base is often made of cotton and/or viscose fibres which sometimes are reinforced by polyester fibres. Knitted substrates are chiefly made of polyamidefibers. The typical prices of these materials are as follows:

-woven fabrics	1.0 - 1.5 $/m^2$
-knitted	0.8 - 1.2 $/m^2$

The non-woven substrates are composed of various fibres alone or in combination. In 1983 the prices were roughly:

-polyamide fibres (nylon)	2.5-3.0 $/kg
-polyester fibres	1.5-2.0 $/kg
-polypropilen fibres	1.5-2.0 $/kg

Other raw material prices for simulated leather were :

PVC	0.7-1.0 $/kg
PUR	6.0-8.5 $/kg
Dimethylformamid (DMF)	1.0-1.3 $/kg

Manufacturing Processes

As has been mentioned above, the knitted or woven carriers do not need a special preparation but the non-woven substrates require special care and technology. The following will emphasize non-woven carriers for PUR simulated leathers.

The first stage of the manufacturing process is the preparation of PUR and a typical process flow-chart is shown in Figure 4. This may also serve as an example of the production of polymers, most of which are not made by the manufacturers of simulated leathers themselves, but are obtained from outside sources.

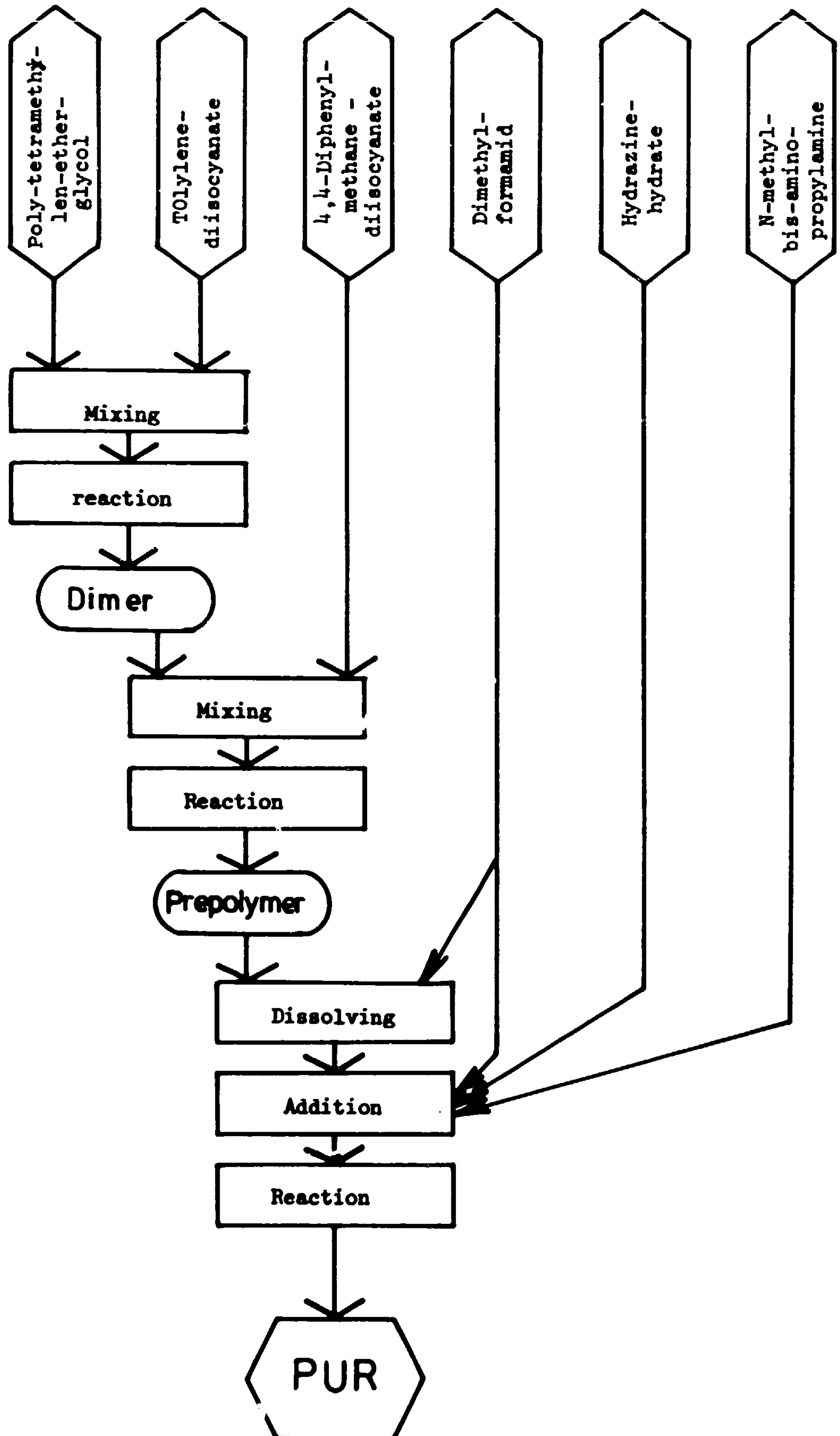

Poly-tetramethylen-ether-glycol
TOlylene-diisocyanate
4,4-Diphenyl-methane -diisocyanate
Dimethyl-formamid
Hydrazine-hydrate
N-methyl-bis-amino-propylamine
Mixing
reaction
Dimer
Mixing
Reaction
Prepolymer
Dissolving
Addition
Reaction
PUR

Fig. 4

The fibres used for the substrates determine a number of properties of the material obtained from them or at least they have a significant impact on the quality. Usually polyamide or polyester fibres (cut or endless) are used; their average diameter is 2-20 μm (collagen fibres are 1-4 μm).

As a result of the latest R+D activities made in this field, a new technology for producing a pliable fibre has been introduced in Japan. This method consists of melt-spinning two kinds of polymer mixtures and then to remove one of them by extraction with a solvent. (Figure 5) Similar special fibres can also be obtained by extruding two different types of polymers through a special spinneret designed for composite fibres.

The staple fibres are carded into a loose mat and then needle punched. The conversion of special fibres into a porous fiber or a bundle of fine fibers takes place in the non-woven mat directly or after impregnating the non-woven mat with a PUR solution , by solvent extraction of one of the special fibre components. The monofilament obtained in this way may have a diameter of 1.6 μm. The latent characteristics of the special fibre is that the strong bond between resin and fibre in the mat is broken, thus leaving a flexible sheet material with improved resilience.

The general process of poromerics manufacturing is shown in Figure 6 but the actual technology may show minor deviations from this. The factual application of the principle using special fibres has been introduced in Japan and a rough outline of the manufacturing process is presented in Figure 7. The key operation of the process is the <u>coagulation</u>. Through this a solid which is dispersed or dissolved in a liquid will change into a coherent jelly-like or solid mass which in turn may be a gel or a precipitate, i.e. an insoluble substance separated from the liquid.

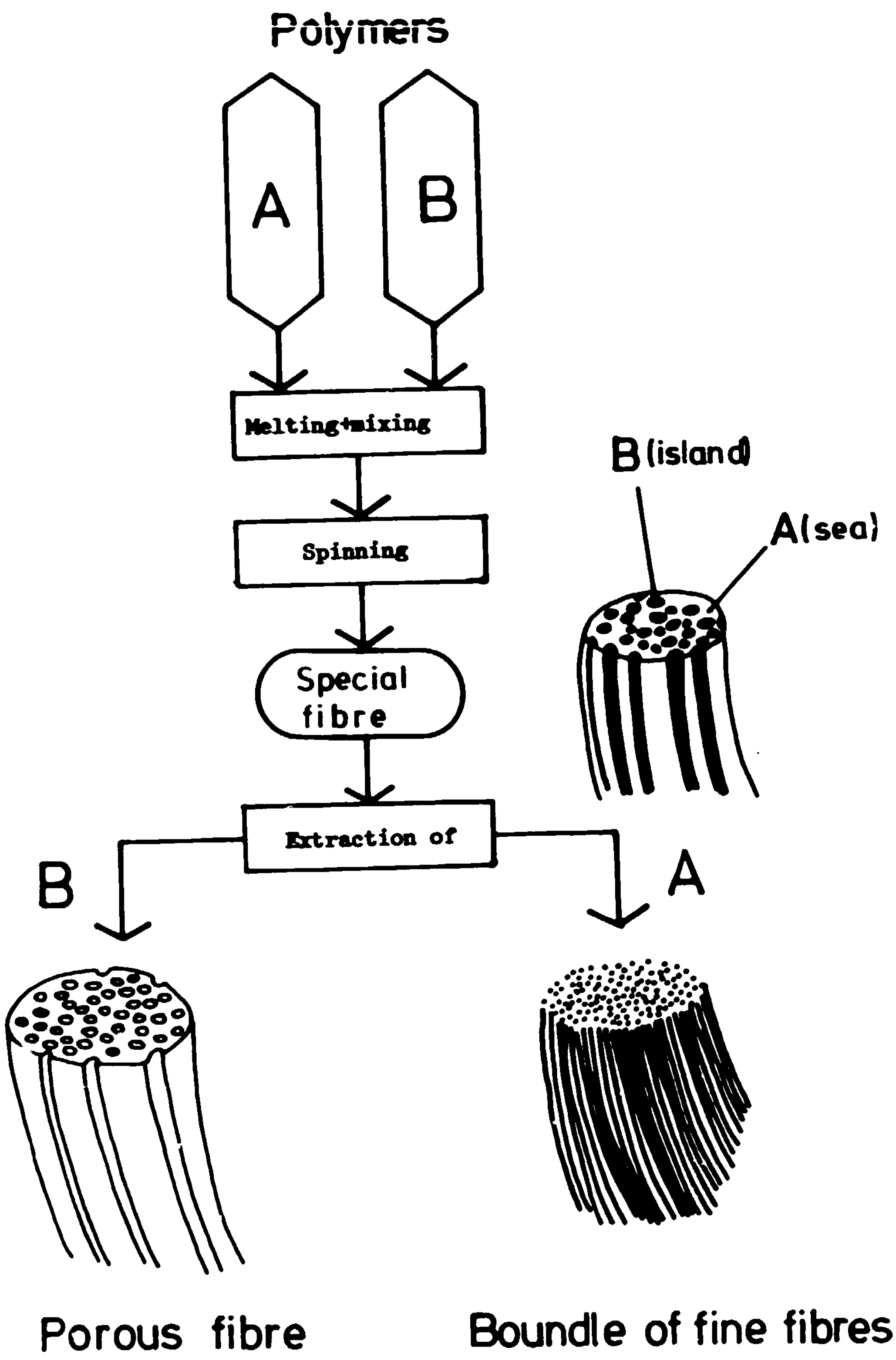

Polymers
A
B
Melting+mixing
Spinning
Special fibre
Extraction of
B
A
B (island)
A (sea)
Porous fibre
Boundle of fine fibres

Fig. 5

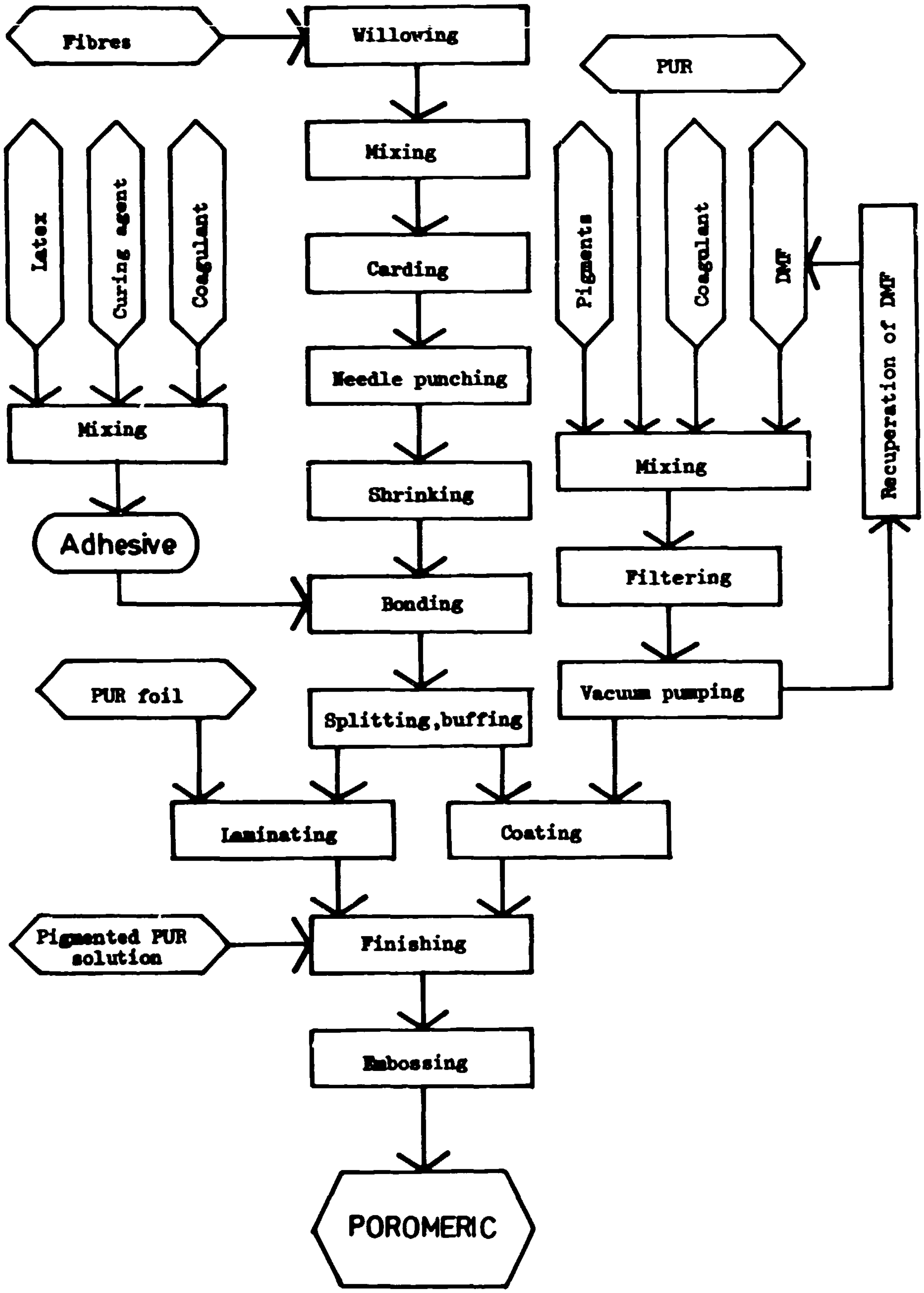

Fibres
Willowing
PUR
Mixing
Latex
Curing agent
Coagulant
Carding
Pigments
Coagulant
DMF
Needle punching
Recuperation of DMF
Mixing
Mixing
Shrinking
Adhesive
Filtering
Bonding
PUR foil
Vacuum pumping
Splitting,buffing
Laminating
Coating
Pigmented PUR solution
Finishing
Embossing
POROMERIC

Fig. 6

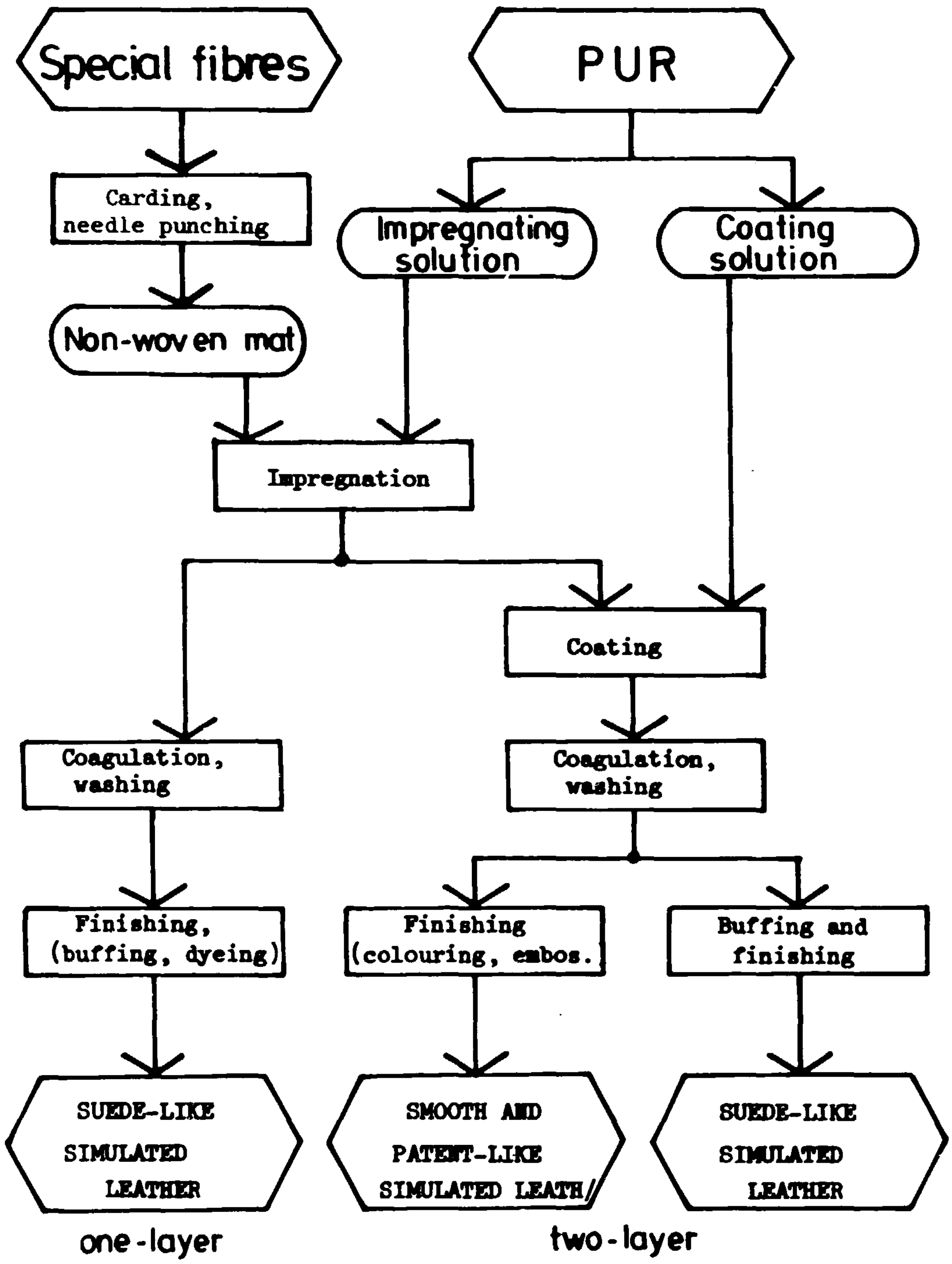

Special fibres
PUR
Carding, needle punching
Impregnating solution
Coating solution
Non-woven mat
Impregnation
Coating
Coagulation, washing
Coagulation, washing
Finishing, (buffing, dyeing)
Finishing (colouring, embos.
Buffing and finishing
SUEDE-LIKE SIMULATED LEATHER
SMOOTH AND PATENT-LIKE SIMULATED LEATH/
SUEDE-LIKE SIMULATED LEATHER
one-layer
two-layer

Fig. 7

In other words coagulation will be responsible for the porous structure of the PUR. The solvent used to dissolve the PUR polymer is dimethylformamide (DMF for s ort) which have the essential properties for this purpose but the solvent is expensive and not very pleasant to work with. At the moment, however, there is no commercially acceptable alternative.

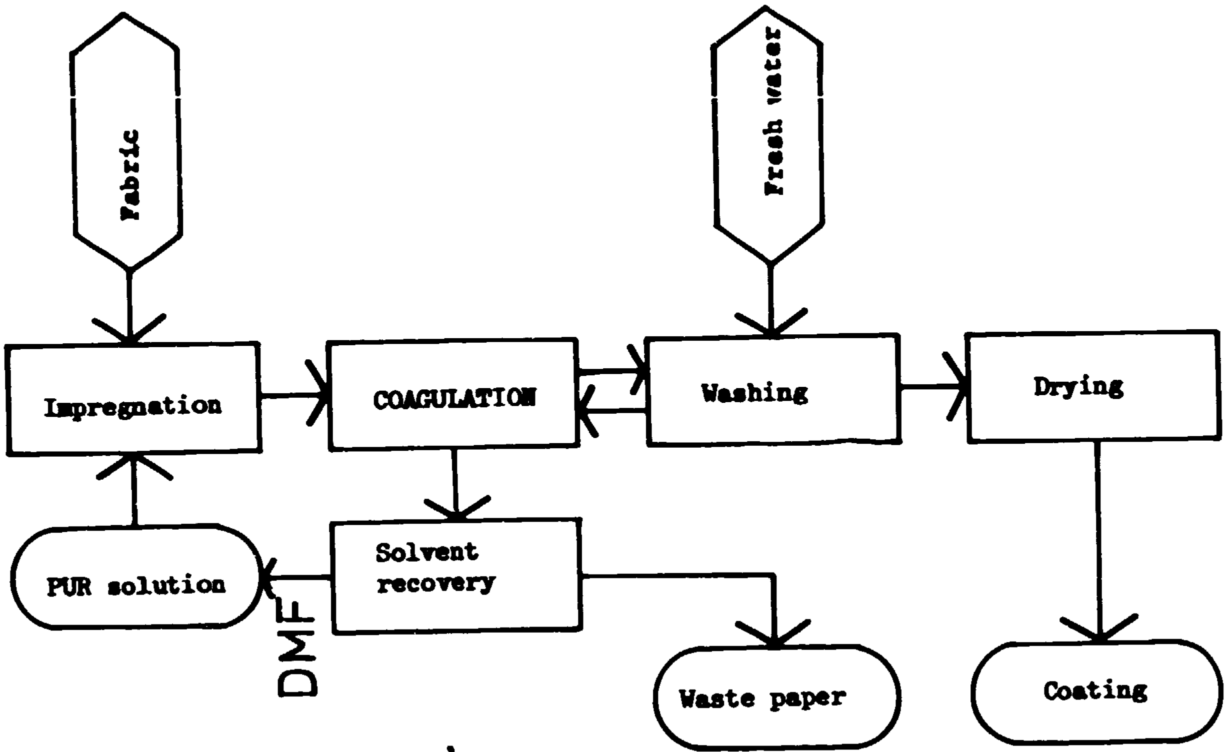
The coating of poromerics and the manufacturing process of coated fabrics are fairly similar. The resin for the coating may be PVC or PUR, but the latter in coagulated form is taking an increasingly larger share of the simulated leathers produced today. This manufacturing process for coated fabrics has the following stages:

i) dissolving PUR;

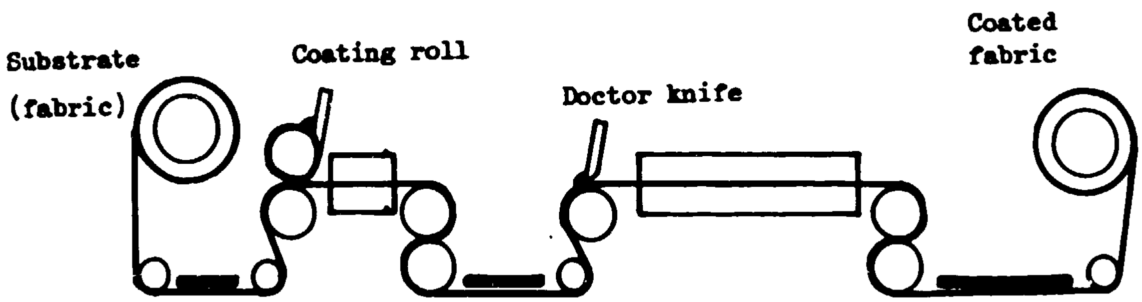
ii) coagulation, consisting of the impregnation of the fabric, the coagulation itself, the removal of the solvent by washing and the removal of the water by heating (Figure 8a);

iii) coating, which may be a direct process using coating heads or coating cylinders (Figure 8b) or an indirect one, known as transfer coating (Figure 8c).

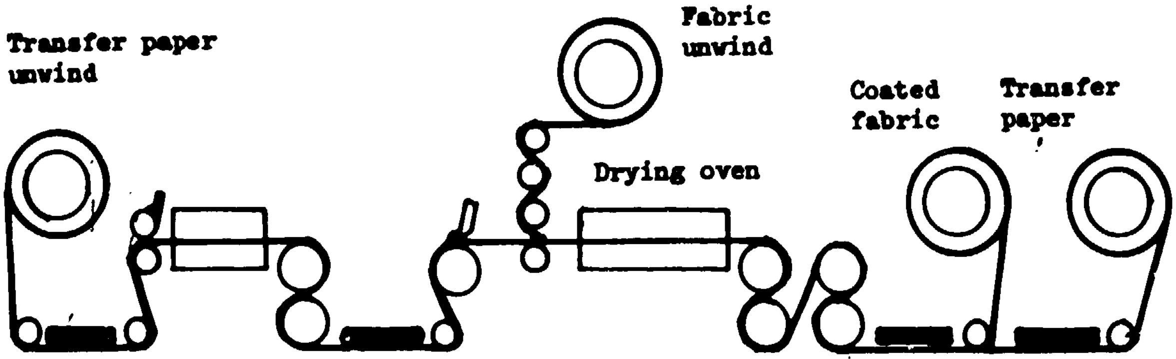
Most of the simulated leathers of the PVC-coated fabric type are also produced on similar coating machines as those described under iii) above. Instead of the PUR solution , a dispersion of PVC resins in suitable plasticizers (resulting in a plastisol), mixed with pigments etc., is used to coat the substrate - usually a fabric, woven, knitted or non-woven. The PVC coat(s), homogeneous, or porous with the aid of a blowing agent, will then be cured in fairly high temperature, fusing ovens, replacing the drying ovens shown.


Fabric
Fresh water
Impregnation
COAGULATION
Washing
Drying
Solvent recovery
PUR solution
DMF
Waste paper
Coating

a)


Substrate (fabric)
Coating roll
Doctor knife
Coated fabric

b)


Transfer paper unwind
Fabric unwind
Coated fabric
Transfer paper
Drying oven

c)

Fig. 8

Another method is to make a PVC foil in a calander system and then directly or in a later operation, for example with the aid of an adhesive, laminate the foil to a suitable substrate.

The final operation in simulated leather manufacturing is the finishing. It may consist of

- embossing in order to produce a grain on the surface;
- spraying for colouring, touch and improvement of the surface resistance;
- microperforation using a needle-roll or electronic beams.

When using the indirect transfer coating method, the embossing may not be necessary, since the grain pattern would be impressed on the transfer paper instead.

There are two main technologies developed for semi-synthetic leather manufacturing. In the first method (Figure 9) tanned leather fibres are reformed into a fibrous sheet from ground leather scraps.

According to the other method (Figure 10) untanned collagen is dissolved from raw hides followed by reconstituting the collagen into a fibrous web through a chemical process. The resulting sheet is then tanned and coated with a water vapour permeable polymer to produce the semi-synthetic leather.

The overlapping area of genuine and simulated leather manufacturing is the laminated split or "laminated leather". The traditional use of PVC or PUR for patent or corrected grain leather still belongs to the tanning industry. When first homogeneous PVC and then PUR foils were used for covering splits (e.g. methods named Baycast or Levacast), arguments arose regarding the proper classification of such materials and how to label products made of them.

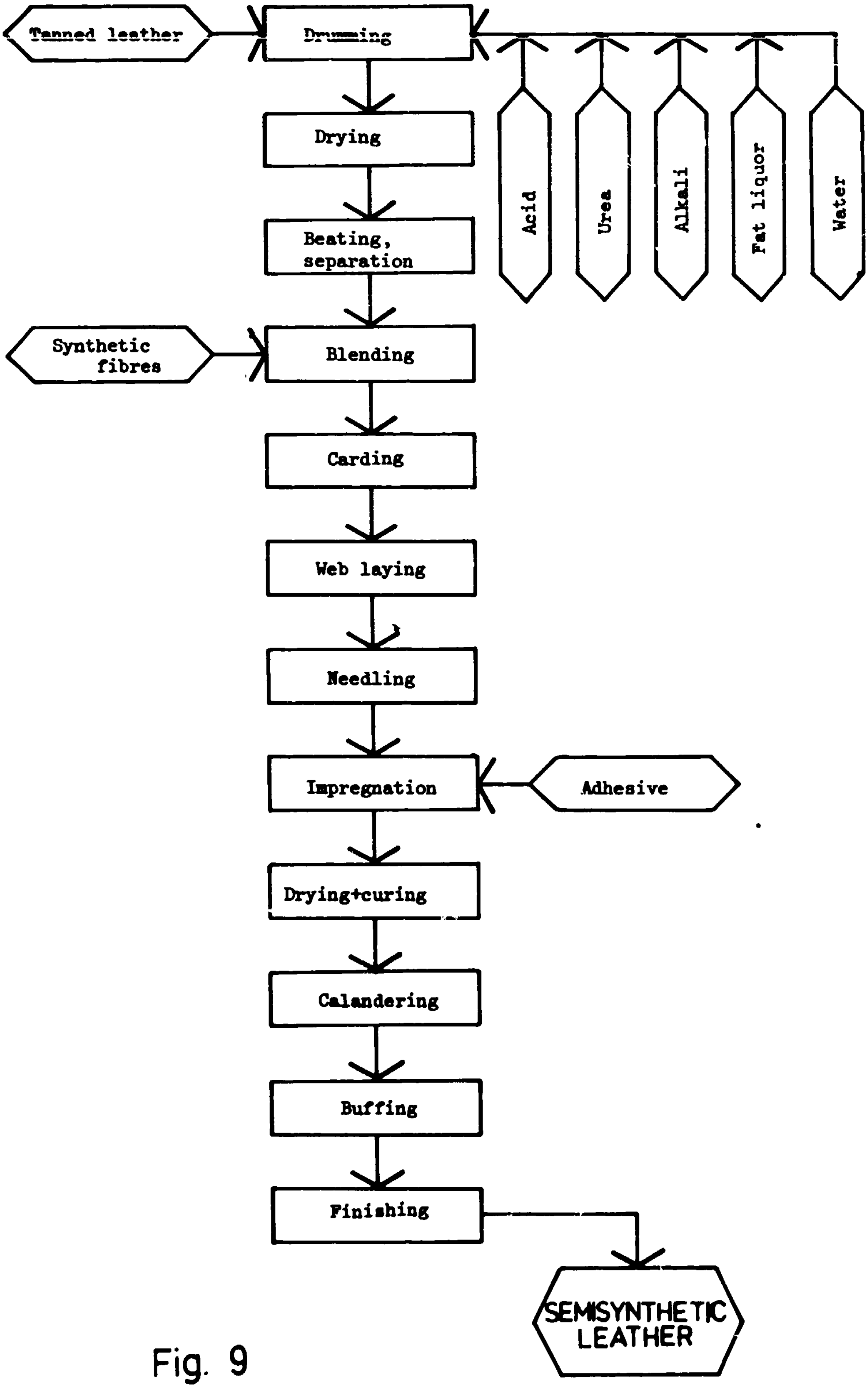

Tanned leather
Drumming
Acid
Urea
Alkali
Fat liquor
Water
Drying
Beating, separation
Synthetic fibres
Blending
Carding
Web laying
Needling
Impregnation
Adhesive
Drying+curing
Calandering
Buffing
Finishing
SEMISYNTHETIC LEATHER

Fig. 9

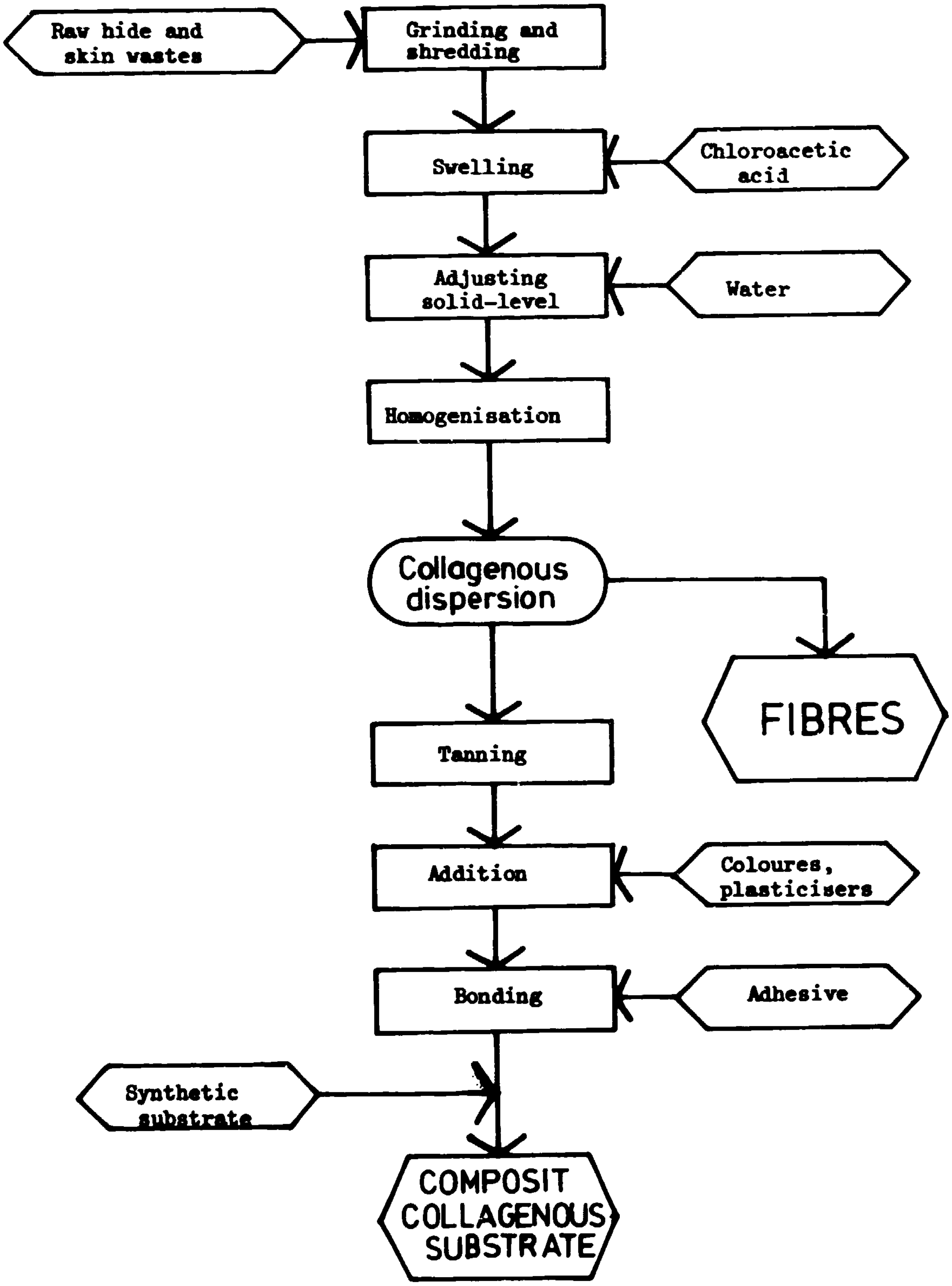

Raw hide and skin wastes
Grinding and shredding
Swelling
Chloroacetic acid
Adjusting solid-level
Water
Homogenisation
Collagenous dispersion
FIBRES
Tanning
Addition
Coloures, plasticisers
Bonding
Adhesive
Synthetic substrate
COMPOSIT COLLAGENOUS SUBSTRATE

Fig. 10

A new method should also be mentioned - the application of a thin, permeable polyurethane foil (marketed under the trademark "Permair") into chrome tanned splits, pigskins, crusts or other leather which would otherwise have limited application in footwear manufacture. The bonding is done by any of the well known lamination processes with or without adhesive, using heated rollers or plates to apply the pressure needed.

Effluent Problems

Manufacturing processes of simulated and semi-synthetic leathers create only relatively few problems concerned with environmental protection. The water consumption of the technologies is not too high, the waste water purification is relatively simple. The only real problem might be the DMF concentration in the workshops (6 to 15 mg/m^3 air and in the effluent). Recycling of DMF during the process has been accomplished with a surprisingly high efficiency in many places.

The wastes of materials during their manufacture (e.g. edges of rolls) and in the leather product factories (e.g. cutting wastes) are usually disposed of from the plants in the usual ways. They are burned, buried or simply added to other types of garbage. Attempts have been made to grind and/or granulate these wastes and then to add them to the unvulcanized rubber mix used for heavy shoe soles or tyres. The only entirely recoverable simulated leather is the homogeneous type (e.g. Porvair), the wastes of which can be used directly in the processing of the new batches of the same type of product and this method is widely used in practice today.

CHAPTER V

TECHNO-ECONOMIC ANALYSIS OF USING SIMULATED LEATHERS IN THE LEATHER PRODUCTS INDUSTRY

Properties of Simulated Leathers

The larger part of the R+D means (both money and research efforts) has been allocated to improve the properties of simulated leather, aiming at narrowing the gap between these and those of natural leather. The quality of a basic material used for leather product manufacturing is determined by the combination of several properties having different dimensions and therefore it can seldom be expressed numerically. Some of the properties are desired to be as high as possible (e.g. water vapour permeability) others need to be at a minimum (e.g. weight) but many of them should be inside an optimum range (e.g. elongation, relaxation). The requirements are subject to the intended use and consequently the suitability of a particular material is checked against the type of product to be manufactured from it.

Since the natural finished leather has been and still is considered as the target for the development of the substitute material, simulated leathers are also tested using the same methods as for leather. The laboratory tests are usually carried out according to international standards by the International Standard Organization (ISO) through the International Union of Leather Technologists and Chemists (IULTC). Most national standards organizations have adopted them and the well known institutions (CTC, PFI, SATRA, TNO) as well as the leather and leather products trade at large are using them in their daily work.

The tests investigate either the physical or the chemical properties referred to as IUP or IUC with an allocated number (annex III provides a complete list of the internationally accepted test methods which are used for simulated leather).

One group of properties of materials used for leather products comprises the basic physical characteristics: thickness, weight, apparent density. Most poromerics have a thickness of more or much more than 1.0 mm; thus they would be used for children's and gents' footwear rather than for women's. Only the homogeneous types and those newly developed, based on the new, extremely fine fibres are suitable for light ladies shoes fitted with a lining. The weight (i.e. the mass of material of a unit area) varies according to the function to be performed:

	Simulated leather	Natural leather
	g/m^2	
Garment	200-300	320-380
Shoe upper	500-800	700-1000
Leather goods	700-900	800-1400

There is a linear correlation between the thickness and the weight of the material. The apparent density of poromerics is 0.4-0.6 g/cm^3, the same for simulated leather intended for leather goods is 0.5-0.7 g/cm^3, while the genuine leather has an apparent density of 0.65-0.90 g/cm^3.

The strength properties inform about the behaviour of the material during the forming operations in manufacturing (e.g. lasting, heat-setting) and the ability to retain the shape in wear. The most important of those properties are shown in table 3 along with commonly accepted requirements for shoe production.

Table 3.

Some physico-mechanical properties of simulated and natural leather

Property	Unit	Direction*	Simulated leather for garment	Natural leather for garment	Simulated leather for shoe upper	Natural leather for shoe upper	Common requirements in footwear manufacture
Tensile strength	N/cm	L	60-150	120-180	80-180	160-450	min. 100
		W	30-60	50-65	50-110	100-300	
	MPa	L	5-9	10-18	7-14	14-24	min. 10
		W	3-5	4-7	5-10	10-18	
Elongation	%	L	50-90	45-60	30-100	25-45	.....
		W	50-150	50-70	30-140	35-65	
Young's modul	MPa	L	-	-	20-50	25-40	
		W	-	-	8-25	20-30	
Tear strength	N	L	10-18	14-18	30-60**	50-80	min. 25
		W	15-25	15-17	35-80**	40-80	
Lastometer test (burst)	N		-	-	160-280	650-800	
	mm		-	-	7-18	6-15	min. 7
Peeling strength	N/cm		10-25	2-10	14-30	3-12	min.10/2***

* L - length (longitudinal); W - width (perpendicular to longitudinal)

** Poromerics only

*** for simulated/ for natural leather

There are several other physical properties which any material used for leather products have to possess. In the case of garments the crease recovery (for simulated leather 85-95%, for leather 65-75%) has a certain importance. The surface of the material must resist abrasion, scuffing, rubbing, solvents, light etc. but there is no uniform or standard test method which can give a single reliable and quantitative characteristic and therefore it is almost impossible to compare different types of materials without being very specific as to the use etc.

The most critical aspect of simulated leather for footwear and garments is their hygenic properties. There are sophisticated laboratory test methods for measuring water vapour permeability, water absorbtion, air permeability, water resistance, desorbtion etc. The moisture absorbtion and permeability are, to a degree, synergistic; absorbtion alone would provide comfort perhaps a few hours from the time the shoes are first put on but good permeability is not only necessary to maintain this comfort throughout a normal day's wear, it also aids absorbtion by transpiration. Table 4 gives the approximate quantities for these properties performed by different types of materials used in shoe upper manufacturing. The air permeability of simulated leathers is 4-10 $cm^3/m^2/h$ - for leather this is ten times higher.

Combining permeable PUR foil with crust or split (as for example suggested by Porvair) a material may be achieved with the excellent properties of the poromeric ("breathability", abrasion resistance and water repellence) along with the regular and complementary features of leather (strength, comfort and moisture absorbtion).

In order to improve the hygenic properties of coated fabrics (especially those coated with PVC) the electron beam perforation process has been devised. Using this method very fine perforations in the range of 0.05 to 0.20 mm in diameter with a density of 50-500 holes/cm^2 can be produced, whereby a water vapour permeability of 2-10 $mg/cm^2/h$ can be obtained but at the same time the tensile strength will, unfortunately, show a significant drop.

Table 4.

Some hygenic properties of materials used for shoe uppers

	Water vapour permeability*	Water vapour absorption**
Unit:	$mg/cm^2/h$	%
Simulated leather		
- coated fabric		
. PVC	0	1-6
. PUR coagulated	0.6-1.0	1-6
- poromerics	1.0-3.5	1-7
- permeable PUR foil	5.0-15.0	1-2
Semisynthetic leather	1.5-4.0	2-4
Natural leather		
- corrected grain		
. PUR patent	0-2.0	15-25
. impregnated	0.5-3.0	15-25
. coated with PUR foil***	1.0-3.5	15-25
- full grain	2.0-8.0	14-35
- crust	10.0-15.0	20-35
Minimum requirements	1.0	6-10****

* Isotherme test at 20°C and gradient RH 97/65 %

** For 24 h at 20°C and gradient RH 60/100 %

*** PERMAIR (PORVAIR) type

**** Corresponds to 8 $mg/cm^2/8h$

Internationally accepted standards for materials do not exist for leather or simulated leather. There are, however, national standards (chiefly in countries of centrally planned economies) or institutional or company guidelines, prescribing the requirements as to the properties which serve as a basis for the evaluation of different materials.

Design and Range Building

It has already been mentioned that leather products made of simulated leather in most cases aim at the medium and lower price bracket of the market and at the same time also that not too small quantities will have to be produced. The other important condition is that the product must either follow the latest fashion lines or be used for a special purpose (e.g. safety boots). These considerations determine more or less the design directions as far as styles and product types are concerned.

The most important problem to be solved in footwear construction, particularly when designing a new product family or new styles, is how the foot comfort should be provided. In general the following rules are applied when the use of simulated leather is contemplated:

i) the specific shoe which normally is to be used for a short time of the day only (e.g. house footwear);

ii) certain fashion footwear for women which will be used mainly on the streets and never for prolonged periods;

iii) boots or similar footwear where some of the components will be made of simulated leather (e.g. boot legs), while the critical parts (e.g. vamps) are made of natural leather;

iv) open type footwear (e.g. sandals, slippers, clogs);

v) closed shoes will either have linings (especially the quarter parts) made of genuine leather or perforations, which can serve as decorations, are made in the uppers.

The hygienic properties of shoes made of simulated leather may thus be improved to a certain degree by using linings and inner components (counters, insoles etc.) having an ability to absorb moisture during the wear and dissipate it during the night. At the same time consumers can also help to alleviate the problem by changing their wearing habits. If the shoes, having simulated leather uppers of a closed construction, were worn only a few hours (not more than 5-8 hours) and not every day continuously, then the complaints would be much less.

Since the rheological properties of simulated leathers are entirely different from those of genuine leather, the pattern engineering methods applied must be modified as well. As a general guideline adopted by manufacturers in making shoes with synthetic uppers, at least a half but usually one fit wider than the same construction with leather, would be required. The allowances for lasting margins also differ - the actual correction however is subject to the mechanical properties of the particular simulated leather to be used. In certain cases the angle of the ramp folding axis needs modification.

Components made of coated fabrics on texile substrates can not be skived on the reverse side. This drawback needs special care in designing, i.e. special edge processing techniques have to be applied or the product will end up with a very poor appearance.

Technological Considerations

When the first simulated leathers appeared on the market the most popular argument in sales promotion was the promising possibility to increase the productivity by ignoring certain operations (such as sewing if using high-frequency welding/ moulding, surface reinforcing, finishing etc.) or multiplying the output of others (e.g. cutting in several layers).

Publications such as leaflets produced by manufacturers and dealers of these materials presented comparisons of technologies and manufacturing processes with simulated and natural leathers and sometimes indicated an overall reduction of direct labour consumption (interpreted as an equal increase in productivity of the workshops) by as much as 30-50%. The past two decades just have not proved these rather ambitious forecasts to become true - due to a number of limiting circumstances:

i) the majority of footwear manufacturers had no opportunity to specialize the production lines for simulated leather application, i.e. the machinery used for genuine leather shoe manufacture was used unchanged;

ii) equipment suppliers have not developed the special machinery (except HF welding/moulding presses) needed for poromerics and/or coated fabrics processing;

iii) shoes made of simulated leather by applying the highly productive methods (especially those achieved by HF welding) were of rather low quality, had an appearance directly displaying the synthetic character of the upper, all of which practically spoiled the market and consequently the demand for these types of shoes declined rapidly.

iv) since the canvas uppers penetrated fairly quickly into the (mainly sports) footwear market, the R+D efforts were divided between them and simulated leathers.

Following the general technological process in the manufacture of leather products the operations listed below have to be mentioned as differing from those applied in natural leather processing.

In cutting (manipulation) two operations are worth mentioning; the cutting (clicking) itself and splitting. The promising methods developed especially for leather substitutes cutting, water jet and laser cutters, could not generally penetrate this subsector because of the high capital investments involved. In addition, the average shoe and leather goods factories could not utilize their large capacity and the unique equipment background (electronics, optics, computer and hydrolics) required special care and maintenance. The high power beam clicking presses - some of them have a maximum cutting force of as much as 1.5 GN - are also relatively expensive. On the other hand the ever-growing demand for more precisely cut components limits the number of layers that can be cut (simulated leathers are usually cut in 4-8 layers today). Bridge type clicking presses offered by certain equipment manufacturers still lack full automation. None of them uses available programs for layout optimizing and the separation and collection of cut components have not been mechanized.

Upper components of natural leather are usually split because of the uneveness in the thickness of finished leather. In the case of coated fabrics, splitting is of course not needed at all. In principle, with poromerics it should also normally not be required either, but owing to the relatively thick materials offered or supplied, there are instances when special components will have to be equalized this way.

Skiving and edge folding among the preparation operations used to create difficulties - especially in the case of coated fabrics. Some of these materials are impossible to skive and therefore the edge binding is preferred. A new dimension in decoration was opened up by introducing high-frequency (HF) technology which is, however, applicable only to simulated leather having a thermoplastic surface and structure. HF welding carried out simultaneously with the cutting of upper and lining (made also of synthetics) produces edges which are by far not as good as those by folding or binding.

Poromerics generally can be decorated by applying HF welding on the surface. The most exciting effects may be achieved by HF moulding (in presence of, or without, powder or a plastisol) on PVC coated fabrics.

In shoe upper assembling (closing) and in assembling other leather products made of simulated leather, stitching and welding are different from those used for natural leather products. HF welding can be used to interconnect components only when both the coating and the substrate are thermoplastic and the welding line is a plane curve. (This technique is used mainly for shoe lining and leather goods assembling.) Edge folding of poromerics are more complicated to perform in the usual machines; in the case of thin, coated fabrics this may be done without skiving.

The ordinary, widely used sewing machines are used to stitch together simulated leather components. There are some modifications or limitations in this respect:

- only synthetic threads are suggested to be used (No.40-80 depending on the total thickness);
- the preferred needle size is 60-80 with P and Lr point profile (for PVC coated fabrics thinner needles and R points are used);
- the lower thread tension should be relatively slight (0.12-0.16 N);
- the presser/roller foot pressure should be light (50-70 N);
- the number of stitches must be less than 5 stitches/cm for garment and 8 stitches/cm for shoe upper materials;
- in some cases the speed of the stitching machine has to be limited to 3500/min (3500 RPM).

The lasting, making and finishing of shoes made of simulated leather have several operations needing special care in their execution.

Lasting machines have to have lower tension power, i.e. the upper is pulled very lightly on to the last, and the lasting margins are folded onto the insole. Both poromerics and coated fabrics may be used in moulded (slip-lasted, moccasins etc.) shoes and the string lasting is also applicable. Fixing the lasting margins to the insoles may be done by applying hot-melt adhesives but the nailed waist and heel-seat lasting is much more reliable.

All shoes having simulated leather uppers must undergo heat-setting in order to stabilize them before the lasts are pulled out. The humid phase (steaming) is not necessary,since they are not hydrophil,but the surface temperature should not be higher than 100-130°C depending on the material structure.

The most critical operation in shoe assembling is the soling when the cemented (stuck on) method is used. Simulated leathers, especially the coated fabrics cannot be adequately roughed, if the traditional abrasion papers or brushes are used. Generally coated fabrics are simply cleaned by wiping the lasting margin with a solvent, which can clean the surface from oil, fat and similar dirt. Thin poromerics and PUR coagulates are brushed by rotating discs composed of hard leather straps, while the thicker ones are roughed in the ordinary way. The other important matter is the type of adhesive to be used. The manufacturers prefer PUR adhesives with added isocyonate. If only a drop of adhesive, however, gets on the surface of simulated leather, it may leave a stain which cannot be removed.

Finishing (shoe room operations) is undoubtably simpler in case of uppers of simulated leather than of natural leather; it is usually limited to cleaning the surface. On the other hand, surface damages on poromerics and coated fabrics caused by the technological process, improperly performed, are almost impossible to repair - these shoes have to be rejected.

Simulated leathers in leather garment manufacturing have brought less modification to the assembling technology. The sticking on of linings is carried out within 12 to 18 s at 120-130°C. The pressure should be light (under 0.1 MPa). Steam pressure is about 4-5 bar for 2-3 s and the ironing is performed below 120 °C at 2 bar steam pressure, using covering cloth.

Summing up the above facts and considerations, it may be concluded that savings can be achieved only in a few operations. Comparing the productivity of leather products manufacturing using simulated and natural leathers respectively, the difference does not make more than 10 - 15% - sometimes it is even less than 10%. More benefits may be obtained by the better utilization of the surface area of the material, in other words, the saving in wastes due to the uniformity and fixed sizes of the material may be as much as 5-15%. Taking into consideration the marketing of leather products, especially footwear, made of leather substitutes, namely the depressed prices and the heavy competition coming from the Far East, the savings are nominal - they are eliminated by the lower profit margin which is usually achieved when selling these products.

More benefits (however difficult to express in monetary terms) are gained in leather garments and leather goods production. Jackets, shirts, handbags, suitcases etc. are generally composed of components having relatively large areas (from 5-60 dm^2). To get the best cutting value from the surface of a genuine leather, especially in the case of kidskins, is a fairly difficult task - complicated by faults, topography and shade differences among the leather pieces. Here simulated leathers have attained considerable savings or - what might be even more important - made mass production possible.

Marketing Aspects

In many industrialized countries leather products like any other goods in retail, have to have a label indicating the origin of the composite materials. Altough the actual implementation of this system varies by countries, there are common points in all of them:

i) the origin of the upper and the sole (bottom), sometimes the lining as well, is declared separately in case of footwear;

ii) leather goods and leather garments are also labelled stating the type of material used for the outer part and - separately - for the lining;

iii) the most widely used terms are: "genuine leather" or "natural leather" and "synthetic" or "man-made";

iv) the label has to be attached to the products and to the wrapping (package, box) too on a clearly seen place and must be well separated from other information;in some countries labels have to be inside, outside or in both places in the case of footwear.

In some instances, it is remarkable how rigorous the rules are regarding the terminology used on labels. In UK, for example, the word "leather" must never be combined with attributes indicating artificial origin.

All kinds of materials are tested in industrialized countries - either by leather products manufacturers or by special institutions - before their introduction and when being shipped.

Some of these institutes and laboratories, quite frequently in co-operation with a consumer's council, issue quality certificates verifying the performance of the materials. Of course the positive statements made by suppliers or dealers in their advertising, product leaflets etc. are to assist in the marketing and the sales promotion. At the same time customers have to be aware of the balance of all the important properties of the material. Information concerning other characteristics are usually available through the suppliers.

The trade marks used for simulated leathers, or names of the material, even the technical denominations, sometimes slightly suggest the distinctive feature of the leather substitute in question. Not a long time ago, artificial or existing words, sometimes of a Greek or Latin origin, or some part of them, indicated hygienic properties of some poromerics (e.g. Porvair, GraPOR) The new products, especially those PUR coagulated tend to be named using Italian phrases - recommending themselves as most fashionable.

Technical Services from Suppliers

The serious manufacturers of simulated leathers provide their clients (both actual and potential) with necessary know-how as to the methods of processing, technologies, new product lines, possible economic benefits, sources of auxiliary materials and special machinery. The usual pattern of keeping leather products manufacturers well informed in order, of course, to maintain or increase orders, are the following:

1) suppliers, their dealers or agents publish leaflets, technical literature, product descriptions, organize conferences or practical demonstrations on material ranges offered and their methods of technological applications - they also participate in all important professional exhibitions and fairs (e.g. Pirmasens, Paris, Milan, Birmingham, Leipzig);

ii) technical staff of the manufacturing company use to visit from time to time their customers and provide the local specialists with practical guidance, hints or suggestions on how to utilize even better the unique features of that particular leather substitute;

iii) technicians arrive on the spot on request and assist in product development, solving special technological difficulties, adjusting machinery or setting technological parameters (e.g. heat setting);

iv) many of simulated leather manufacturers publish periodical brochures on fashion aspects along with small sample booklets, sketches and colour ranges for the fothcoming season;

v) some of the suppliers have fairly good co-operation with other companies (e.g. fitting suppliers, equipment manufacturers) and they mutually recommend their partner's services or package deals.

The test results published or advertised are usually fairly reliable but usually also incomplete.

Some manufacturers and suppliers of simulated leather are initiating or expanding their activities in developing countries. The main motivation would be based on the offer, according to which the production processes using simulated leather will need less expertise to produce ("high quality") shoes in large quantities badly needed by the local population. There are companies acting together in these countries which offer all the necessary technical support and also assistance in financing the starting up period, equipment supply, training and marketing of the finished products.

CHAPTER VI

THE FUTURE OF SIMULATED LEATHER

It is impossible and would be misleading to express the facts, their interpretation and their influence on the leather products industry of both the developing and the industrialized countries in one statement having a single, firm and unmistakable meaning, which would be valid everywhere and in all cases. The same applies to future trends. Hopefully the previous pages have shown the complexity of the present situation concerning leather substitution, the uncertainty and contradicting character of trends monitored through the past decades, and which does not give a reliable basis for a mechanical extrapolation. In the following, therefore, the possibilities and the limiting factors will be dealt with as realistically as possible, rather than going into irresponsible futurism.

Ways and Means of Further Development

The history of science and technical development shows that it is extremely difficult to foresee revolutionary jumps or to estimate the time required for solving particular scientific problems. On the basis of a survey and interviews made with leading specialists and experts working in this field, some points, however, are worth mentioning:

i) no synthetic material will in the near future be able to produce the hygienic and comfort properties of the collagen fibres;

ii) chemistry has not provided such inventions, which would assist in the elaboration of a revolutionary new product type or processing technology; the R+D activities will therefore probably concentrate again on some known ideas as for example:

- new ways of collagen reconstituion,
- production of very fine and hydrofil fibres;

iii) in spite of the relative stagnation found in the R+D of simulated leathers a few new ideas have come up which most probably will be heard of in the future, e.g.:
- utilization of polypeptids,
- application of biotechnology or biochemistry for "constructing" a leather-like structure;
- forming "breathable" simulated leather directly to the shape of the product to be manufactured.

All in all, specialists do not expect a revolutionary break-through in hygienic and rheological properties, or in the manufacture of leather-like substitutes in this century. Since the size of the leather market is not big enough to attract chemical researchers or the chemical industry to a higher degree, they are not going to take all the trouble connected with fairly sophisticated requirements. It is almost sure that the new generation of simulated leather will be a "by-product" of R+D, product or process development directed primarily towards other objectives which as a matter of fact has already been the case in recent times.

Factors influencing the Development

The two main factors having a definit impact on the development of simulated leathers are fashion and the need for cost reduction in manufacturing. Designers, producers and retailers of leather products are still full of new ideas requiring suitable technical solutions and among those, appropriate materials. Leather product manufacturers in industrialized countries are under pressure because of the high labour costs while in developing countries the local markets require more and more footwear and leather goods at relatively low prices.

Both these circumstances stimulate the expansion of cheap leather substitutes.

The positive role of simulated leathers in replacing genuine leather is not today expressed as strongly as it was 10-15 years ago. Wearing habits have been changing, the range of leather products has been expanded and the utilization of other alternatives to genuine leather (e.g. textiles) are developing rapidly and at the same time the balance between products made of natural leather and substitutes seems to have become quite stabilized.

People both in developing and industrialized countries need very cheap as well as more valuable leather products (not only consumer groups having different living standards, but even the same individual). That means that the market demands a very extensive price range which would not be possible to meet without leather substitutes. In order to expand this range further, new types of simulated leathers are required and at the same time that the relatively expensive ones are made simpler to manufacture, i.e. cheaper.

Development Trends

The opinions concerning the development of structure, manufacturing processes and effluent treatments are so diverse that no uniform trend can be observed in this field. The following indications seem to be, however, of special importance:

i) coated fabrics, especially those coagulated with PUR will probably prevail in footwear industry;

ii) there is a tendancy in the development of poromerics towards the use of a homogeneous, single layer and two-layer structures; other types will presumably have a minor share in the market;

iii) the use of natural components in leather substitutes in order to provide a certain degree of comfort in shoes and garments will be more important, if cheaper manufacturing methods can be found;

iv) technologies and machinery used in leather products industries will hardly be changed since the manufacturers want to be "safe-guarded" to have the possibility of changing to natural leather products if necessary.

v) the coagulation process requires modification (i.e. to find an alternative of DMF or through other chemical or bio-chemical mechanisms to create the porous structure) in order to make the technology more acceptable from the environmental protection point of view;

vi) the production of special fibres (i.e. sea-island types and microfibrillous) are promising but the production costs need to be lowered considerably;

vii) the simulated leather market lacks some types (e.g. PUR coagulated, coated fabrics and heavy weight poromerics); these would have to be developed.

Several rather extreme opinions may be encountered in the technical literature concerning the future utilization of natural leather in this subsector. Some scientists and economists think that raw hides and skins which have plenty of protein badly needed in the world for food, are too luxurious to wear. Their share in leather products will therefore be very minor (or it might have disappeared completely) by the year 2000. These observers believe in science and technical developments and expect dramatic changes in chemistry during the next two decades. According to the views of the opposing experts, hides and skins will remain a relatively cheap by-product. They see the tanning industry as the only economic user which also has developed very tolerant processing methods at a fairly sophisticated technical level. This group of experts forecast a slight increase in the leather utilization for footwear uppers and leather garments. The future will most probably prove neither of these groups to be right. Rather will a balance between the use of natural and simulated leathers be formed but the actual shares will be subject to the particular countries (i.e. their economy, trade, traditions and general situation).

A fairly safe forecast of future developments in simulated leather production and utilization may be expressed as follows:

i) structure and material composition of simulated leather will remain very similar to those marketed today;

ii) natural leather will always be on the market as a first choice but its substitutes (especially those of imitants) will stabilize the material supply to leather products manufacturers;

iii) the share of simulated leather in leather products will probably be in the range of 55-65% - natural leather utilization in leather goods will decrease further and faster than in footwear;

iv) if no dramatic changes appear in raw hides and skins supply, leather might gain back its previous share or decisive role in case of special products (e.g. safety footwear for foundries) due to fairly intensive R+D activities generated in this field;

v) taking into consideration the growth rates of livestock, human population and living standards of the people it is very likely that the utilization of simulated leather will grow at a considerable rate and during the years remaining of this century will be at least doubled in quantities;

vi) prices of leather substitutes retain their declining trend - not in absolute value but rather compared with natural materials;

vii) the combination of permeable poromerics with low grade natural leather and splits will continue to expand in certain product groups.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Hopefully, the facts and views expressed in the previous chapters provide a fairly comprehensive information basis which should be able to generate ideas for those responsible for technical development, business and marketing of leather products. Owing to the very wide ranges in living standards, industrial and social infrastructures, traditions as well as to the rather uncertain character of economic development in different countries of the world, it would be extremely immodest to draw up conclusions and recommendations which would be valid everywhere. The analysis in this study has also shown that the recent state and the development trends as to leather substitution are very complex and not exempt from contradictions.

Conclusions

Taking into account the main points from the survey and the evaluation of data, development trends and technico-economic considerations reflected on the previous pages, the following conclusions are felt to be the most significant:

1. The genuine leather, mainly due to its unique properties and natural origin and also because of being a by-product processed further bv a traditional but efficient tanning industry remains the most important basic material.

2. The direct main reasons for leather substitution today are fashion and (production) costs and this situation will prevail also in the near future. Leather substitute materials will always on the market fetch a lower price compared with genuine leather.

3. Soft leather substitutes are at present taking a two thirds share of the materials used for shoe uppers and even more in the leather goods industry. Simulated leathers are the most important among these substitutes. Without simulated leather the leather products market could not function properly and it would be impossible to provide the increasing population of the world with clothing accessories.

4. Among simulated leathers poromerics in their present form (with actual structure and properties) will probably never regain their share in leather substitution which they had 10-15 years ago. Coated fabrics, especially PUR coagulated, will continue to penetrate further into the market.

5. Since there are no hides and skins available in sufficient quantities for all leather products, and the gap between the demand for such goods and the supply of natural material will continue to widen, the share of the substitutes (including simulated leathers) is increasing.

6. To be able to produce artificially (by synthesis) a material which features all the unique properties of tanned leather made of animal hides would require such inventions in science and technology that it would be very close to the creation of the artificial life. There is now no indication at all that such a "leather" will materialize. Only very revolutionary, new ideas (probably not in the direction of imitating or recreating the collagen as such, but of synthetizing a material performing certain functions), would make the notion conceivable.

7. These trends and forecasts will most probably be valid until the end of this century. Sudden changes in the consumption (e.g. countries having large populations - like China, Brazil, India - opening their markets and increasing their living standards rapidly) might, however, change the pattern incalculably. One such trend appears to have started recently through the heavily increased imports of hides and skins into China. This country has only a comparatively small cattle livestock (and will probably not try to increase this considerably since protein for its huge population is cheaper to obtain directly from vegetables than through cattle). With an ever increasing demand for leather shoes the imports of leather or of hides will evidently continue to grow, a fact which will greatly influence the - in this connection rather small - international hide market and perhaps at some time cause a serious disruption of this market.

Recommendations

1. In this study the term "simulated leather" has been used throughout to define a soft leather substitute which is made to look leather-like. Such a term is badly needed internationally but the term used here is certainly not presumed to be the only one possible or even to be the best choice. It is, however, recommended that a discussion among relevant experts, institions and organizations is begun which eventually might lead the world over to an authenticated definition through ISO.

2. To obtain the best results in using simulated leathers, especially for footwear, the technologies and machines - as has been shown earlier - should really be adjusted to this purpose. In some cases almost completely new technologies might be required. It is recommended that R+D work to this end should be carried out in countries where simulated leathers are expected to play the most important, or even a comparatively big role for the manufacture of footwear.

3. Especially in developing countries, with an ample availability of raw hides and skins but with a low level of industrialization, it is recommended that the decision-makers, before deciding on new factories in the leather and leather products sector, make a thorough analysis of the conditions in their own specific country and of its position trade-wise in the world. The advantages and disadvantages of organizing in different ways the export, import, production and sale of materials and products in the sector are inter-related factors which should be thought deeply and realistically about.

In some countries,for example,great difficulties have been encountered by erecting large tanneries and shoe factories without having the industrial infrastructure or the resources in personnel and materials which were needed. The expected added value did not materialize and the foreign exchange, earlier obtained by exporting raw hides and skins, was instead considerably reduced. Resources which could have been used to import cheap leathers or leather substitutes and in that way to slowly build up a local leather products industry to supply the heavy local demand, e.g. in footwear, could thus not be made available.

Annex I

ABBREVIATIONS USED IN THE STUDY

RH	- Relative Humidity
HF	- High Frequency
R+D	- Research and Development
$	- Dollars of United States of America

Materials

EVA	- Ethyl-vinyl-acetate
PVC	- Poly-vinyl- chloride
PUR	- Polyurethane
TR	- Thermoplastic rubber

Institutions and Organizations (and their headquarters)

CTC	- Centre Technique du Cuir (Lyon - France)
FAO	- Food and Agricultural Organization (Rome - Italy)
ICT	- International Council of Tanners (London - UK)
ISO	- International Standard Organization (Geneva - Switzerland)
IULTC	- International Union of Leather Technologists and Chemists
PFI	- Prüfungs- und Forschungsinstitut (Pirmasens - FRG)
SATRA	- Shoe and Allied Trade Research Association (Kettering - UK)
TNO	- Toegepast Natuurwetenschappelijk Onderzoek (Waalwijk - Netherlands)
UNIDO	- United Nations Industrial Development Organization (Vienna - Austria)

Countries

FRG	- Federal Republic of Germany
GDR	- German Democratic Republic
USSR	- Union of Soviet Socialistic Republics
UK	- United Kingdom of Great Britain and Northern-Ireland
USA	- United States of America

Units of Measurement

All units applied in the study are official abbreviations of the International System (SI) authenticated by ISO. The following units are mentioned in the study:

m	- meter
mm	- millimeter (= 0.001 m)
μm	- micrometer (= o.000,001 m)
cm	- centimeter (= 0.01 m)
m^2	- square meter (= 10.7639 square feet)
dm^2	- square decimeter (= 0.01 m^2 = 0.1076 square feet)
m^3	- cubic meter
g	- gram
mg	- milligram (= 0.001 g)
kg	- kilogram (= 1,000 g)
N	- Newton (= 0.102 kg-force)
kN	- kilonewton (= 1,000 N = 101.9716 kg-force)
GN	- giganewton (1,000,000,000 N = about 100,000 tons - force)
s	- second
min	- minute (= 60 s)
h	- hour (= 60 min = 3,600 s)
1/min	- 1 RPM (rotation per minute)
^oC	- degree Celsius (centigrade)
Pa	- Pascal (= $\frac{1N}{1m^2}$ = 0.000,0102 $\frac{\text{kg-force}}{cm^2}$)
MPa	- megapascal (= 1,000,000 Pa)
bar	- 100,000 Pa (about 1,02 $\frac{kg}{cm^2}$)

Annex II

TERMINOLOGY AND DEFINITIONS ADOPTED IN SELECTED INDUSTRIALIZED COUNTRIES FOR SOFT LEATHER SUBSTITUTE MATERIALS

Czechoslovakia (ON 647050)

Poromerics: materials similar through their properties and appearance to genuine leather.

FRG (DIN 16922)

Artificial leather: textile fabrics and other sheet materials, with or without a top coating, having the properties and/or appearance corresponding to a particular function.

Japan

Man-made leather for shoe uppers (JIS K 6601): shoe upper material which is made by impregnating high polymer material into a fibre mat and by imitating the structure of natural leather where the high polymer material has an interconnecting microporous structure and the fibre mat has a randomly three-dimensionally entangled structure (instead of the term "man-made leather", "poromeric" can also be used).

Artificial leather: (JIS K 6505) materials obtained by polymer treatment of non-woven fabric which is made by twinning the fibre three-dimensionally.

Synthetic leather: (JISK 6505) a product made by treating fabric or unit goods by polymer

Poland

Synthetic leather: materials type "Corfam" or alike.

Artificial leather:"sky" type materials.

USSR

Artificial leather: all types of materials used for substituting genuine leather (including rubber, texile, plastics etc.)

Synthetic leather: soft composite materials made artificially with some hygenic properties used for shoe uppers and linings.

Annex III

LIST OF TEST METHODS USED FOR BOTH GENUINE AND SIMULATED LEATHER LABORATORY TESTS

IUP/2	Sampling
IUP/3	Conditioning
IUP/4	Measurement of thickness
IUP/5	Measurement of apparent density (volume weight)
IUP/6	Measurement of tensile strength and elongation
IUP/7	Measurement of abscrbtion of water (static)
IUP/8	Measurement of tearing load
IUP/9	Measurement of distention and strength of grain by the ball burst test (Lastometer)
IUP/10	Dynamic waterproofness test for boot and shoe upper leather (Penetrometer)
IUP/13	Measurement of two-dimensional extension (Tensometer)
IUP/15	Measurement of water-vapour permeability
IUP/20	Measurement of the flexing endurance of light leathers and their surface finishes (dry and wet)
IUP/21	Measurement of set in lasting with the dome plasticity apparatus (Plastometer)
IUP/23	The measurement of damage caused by scuff

World Footwear Production

Countries	Year	Leather footwear / m pairs/	Nonleather footwear /m pairs/	Subtotal /m pairs/	Share of nonleather footwear in total production %
Industrialized countries					
Australia	1982	15.5	16.5	32.0	51.6
Austria	1981	11.4	15.2	26.6	57.1
Belgium	1981	2.8	3.2	6.0	53.3
Canada	1981	27.9	15.6	43.5	35.9
Denmark	1981	4.5	2.7	7.2	37.5
Finland	1981	9.5	4.5	14.0	32.1
France	1981	83.8	112.9	196.7	57.4
Greece	1979	13.3	10.6	23.9	44.4
Ireland	1981	3.5	1.2	4.7	25.5
Italy	1981	301.7	143.2	444.9	32.2
Netherlands	1981	8.4	2.6	11.0	23.6
New Zealand	1982	4.8	3.4	8.2	41.5
Norway	1980	1.7	0.5	2.2	22.7
Portugal	1981	27.1	5.9	33.0	17.9
Spain	1981	116.5	52.5	169.0	31.1
Sweden	1981	1.7	5.6	7.3	76.7
Switzerland	1981	5.9	3.0	8.9	33.7
United Kingdom	1982	40.2	50.6	90.8	55.7
USA	1981	375.9	88.5	464.4	19.1
FRG	1981	57.7	40.6	98.3	41.3
Others		27.2	14.3	41.5	34.5
Subtotal		1141.0	593.1	1734.1	34.2
Centrally Planned Economy Countries					
Bulgaria	1981	18.7	13.5	32.2	41.9
Czechoslovakia	1980	61.3	67.7	129.0	52.5
Hungary	1980	43.2	5.8	49.0	11.8
Poland	1981	66.1	78.9	145.0	54.4
Romania	1980	63.6	49.8	113.4	43.9
USSR	1981	738.0	218.2	956.2	22.8
Others		64.7	29.3	94.0	31.2
Subtotal		1055.6	463.2	1518.8	30.5

Countries	Year	Leather footwear /m pairs/	Nonleather footwear /m pairs/	Subtotal /m pairs/	Share of nonleather footwear in total production %
Developing countries					
Brazil	1981	155.0	267.0	422.0	63.3
Chile	1978	8.7	4.5	13.2	34.1
China	1979	116.0	746.0	862.0	86.5
Cuba	1980	10.3	12.7	23.0	55.2
Dominican Republic	1981	4.7	9.14	13.84	66.0
Egypt	1981	56.7	0.8	57.5	1.4
Hong Kong	1980	4.0	169.0	173.0	97.7
India	1980	264.0	82.0	346.0	23.7
Israel	1981	7.8	4.2	12.0	35.0
Japan	1980	41.1	174.2	215.3	80.9
Malaysia	1979	0.3	30.9	31.2	99.0
Nigeria	1979	6.6	23.4	30.0	78.0
Pakistan	1981	12.5	112.5	125.0	90.0
Panama	1979	1.62	0.38	2.0	19.0
Peru	1980	4.7	22.3	27.0	82.6
Philippines	1979	6.0	30.0	36.0	83.3
Singapore	1979	1.0	2.5	3.5	71.4
South Africa	1981	19.1	43.9	63.0	69.7
South Korea	1981	18.9	260.2	279.1	93.2
Syria	1981	8.6	1.3	9.9	13.1
Taiwan	1979	22.0	358.0	380.0	94.2
Thailand	1978	10.0	80.0	90.0	88.9
Tunisia	1981	2.2	11.8	14.0	84.3
Yugoslavia	1980	69.9	22.5	92.4	24.4
Others		321.28	939.88	1261.16	74.5
Subtotal		1173.0	3409.1	4582.1	74.4
World Total		3369.6	4465.4	7835.0	57.0

Source: World Footwear Market, 1983 by SATRA

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