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INDUSTRIAL DEVELOPMENT AND CONSULTING BUREAU *

TF/KUW/76/001

KUWAIT

Technical report: Artificial leather manufacture

Prepared for the Government of Kuwait by the
United Nations Industrial Development Organisation,
executing agency for the United Nations Development Programme

Based on the work of Mr Lundén, leather and [illegible]

* This report has been reproduced without formal editing.

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Explanatory notes

The monetary unit in Kuwait is the Dinar (KD), which is divided into 1,000 fils. During the period covered by the report (Dec. 1977-Jan. 1978) the value of the Dinar was in relation to the United States dollar was $US 1 = KD 0.284.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

1 Gallon (imperial) = 4.55 litres = 0.0046 m^3.

References to "Tons" are to metric tons.

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Organisation.

C O N T E N T S

INTRODUCTION

The Industrial Development and Consulting Bureau was established 1973 in collaboration with the Ministry of Commerce and Industry in Kuwait and UNIDO/UNDP. It is primarily concerned with promoting investment opportunities in industry by identifying viable industrial projects through carrying out feasibility studies and evaluating those submitted by local entrepeneurs, as well as assisting Industrial Affairs Department in other development objectives.

Kuwait is one of the major oil producting countries, revenues from oil constitute the majority of the total revenues of the country. Its per capita income is one of the highest in the world. Among the objectives of the country's development policies the diversification of its economy is an important objective. The substitution of locally manufactured goods for imported products, and the establishment of viable industries in this connection is recommended.

The Industrial Development Committee has granted licences for the establishment of certain projects for the production of shoes and leather products.

This report covers a study of artificial leather and the feasibility of its production in Kuwait. The study, executed by UNIDO - project TF/KUW/76/001/11 -05/A/32.1.H - commenced on December 4, 1977 and ended on February 3, 1978. The Job Description is attached as Annex I.

SUMMARY

A feasibility study of the manufacture of artificial leather has been carried out.

Although the official statistics in the field concerning imports and exports is difficult to penetrate and at analysis often leads to perplexing results, and no statistics exists on local production, estimates have been made as to actual and potential consumption of different kinds of artificial leather. This market research has been carried out with the aid of government officials, importers, wholesalers, retailers and manufacturers at numerous interviews and discussions.

The consumption at local manufacturing units of artificial leather of the coated fabric type seems to be roughly 25 000 m^2 per year. Other types as coated paper and homogenous PVC sheets, 5 000 and 2 000 m^2 respectively, are of less interest.

If new manufacturing units for shoes, handbags, suitcases and so on were started, a potential consumption of about 175 000 m^2 per year could be envisaged.

A review of different compositions and production techniques revealed that poromerics, the very leather-like upper materials with high air and water vapor permiability, on one hand and the simple plastic sheets on the other, were

hardly possible as products to be manufactured.

The only real possibility appeared to be the PVC coated fabric. Production methods and a production line for this type of artificial leather were out-lined.

Calculation of the break even point, however, for a production at lowest costs and highest possible sales price for the artificial leather selected as protoype, showed a necessary volume of at least 500 000 m^2 per year. Comparing this quantity with those actually used or potenially possible, it is judged impossible to sell this amount, either locally and/or at export, and the project was therefore found to be economically not viable.

For obvious reasons no further studies as to cash flow, financing, localisation etc. were made.

It is recommended that proposals for a production of artificial leather in Kuwait are discouraged for the time being.

FINDINGS

General Comments.

The term Artificial Leather is somewhat ambiguous, having a different connotation to different people. It might mean reconstituted leather, i.e. sheet materials primarily made of leather fibers. It might mean only those materials that aspire to possess all the desirable properties of light upper leather, e.g. the "poromerics", the generic name minted for leather-like materials, which show a high air and water vapor permeability. Or, it might mean any product with a leather-like surface, and so on. For the purpose of this study the term is used in its broadest sense for any man-made material used as a substitute for real leather.

Leather itself is one of the earliest products developed by man. The craft of processing hides and skins into leather has its origin in pre-historic times, making tanning one of the oldest occupations existing. During the time elapsed there has been developed a great number of different leather types with great variations in chemical as well as physical properties, some of these properties to be found in the very difficult to appraise area of appearance and feel, which depend on individual judgment. In fact, there are few materials that can be brought through different processing techniques to exhibit so many different and excellent properties as can leather.

Soon the search for substitutes for leather was started. With the appearance of textiles most of the clothing sector was taken over by these materials. In certain cases, however, as for example for footwear and travelbags, the properties of leather, especially its toughness and surface abrasion resistance, were impossible to reach.

Some of the required characteristics could later be obtained, when plastics began to appear. One of the first example was for book coverings, where the surface abrasion resistance is of importance. So it was, that paper coated with nitrocellulose (collodion, pyroxilin) which has an unusually good abrasion resistance, succeeded in capturing a great part of this big and growing market. At the same time it was probably the first leather substitute in the modern sense. Fabrics coated in the same way were soon also used extensively for upholstery in public places, as for example in cinemas.

Still later the development of new plastics and especially the introduction of plasticized Polyvinyl chloride (PVC), meant a proliferation of leather substitutes in almost all fields, including sole and upper materials for footwear. In the case of handbags, travelbags and similar articles, PVC-coated textiles have more or less captured the whole market and only in the high-priced sector, where quality and fashion are of decisive importance, is natural leather still preferred.

As indicated, the popularity of natural leather is mainly due to the combination of several desirable properties: attractive appearance and feel, high strength and toughness, softness when required, high water absorbtion and water vapor transmission etc.. Some of these properties can be duplicated and often improved upon, but it has been found extreemly difficult to reproduce and combine all, or most of them, in one artificial material. Leather is built up of in the tanning cross-linked protein chains that form small fibers, which in turn are bundled into thicker fibers and so on up to those directly visible by the eye. These visible fibers do not have any loose ends - they start and end up as branches of other fibers. In this way they form a continuous three-dimensional network, which,however, slowly transforms itself into a more and more two-dimensional network the closer the upper surface (grainside) is approached. To this purely bio-physical feature much of the high quality performance of leather is attributed. An artificial leather on the other hand consists of one or several layers of more or less homogeneous materials. The combination of several layers makes it possible to arrive at properties, that one homogeneous material would not be able to provide.

Composition of Artificial Leathers

The most simple type of artificial leather is a homogenous sheet or thick film, the surface of which has been made to

look like leather by embossing it with a so called grain pattern, a design that imitates the pores, wrinkles etc. of a natural leather. The sheet is usually solid all through, but in more advanced products it might be porous, containing a large amount of small air cells.

As to the chemical composition many types of plastic materials have been and are being used for this main layer or coat. Nitrocellulose has already been mentioned for thin coats on paper and cloth. For poromerics, polyurethanes, dissolvable in dimethyl formamide, have been employed in most cases, as has two-component types of polyurethanes for thin, durable coatings on light and soft textiles. The bulk of the materials used for this purpose, however, is made up of PVC, the greater part of which is plasticized with dioctylphtalates to which smaller amounts of other platicizers are usually added. Colouring pigments and auxiliary chemicals are also incorporated.

The polyurethane, made into a paste by dissolving it in dimethyl formamide and spread uniformly on a conveyer, will coagulate when immersed in water. The solvent, completely miscible in water, is removed by prolonged washing, leaving a network of open microporos in the polyurethane.

In the PVC, the pores, either closed or open as required, are usually obtained by using chemical blowing agents, which will decompose and produce gases during the heat-treatment (fusing) of the PVC layer.

For reinforcement or for imparting new properties the sheet or film or coat can be provided with a backing, as a rule of some kind of textile, but occasionally of other materials as paper or plastics. One or more intermediate layers with special properties might also be added.

Structurally the textile backing can be of several kinds. For heavy purposes woven cloth is often preferred, but for medium to light wares knitted fabrics are more common. Lately the so called non-wovens have gained in importance. Most of these are produced by piling carded fiber webs to form mats of required thickness. The mat is immersed in a bath containing binders - usually of acrylics - which are coagulated on to the fibers. Pressing and drying the continuous mat will complete the process. For added strength the thick web before being immersed might be punched with barbed needles in a loom, This treatment will force a certain amount of the fibers to assume a vertical position in contrast to the predominantly horisontal directions of the mass of the fibers.

When using polyurethanes as binder, the method described above using a solution in dimethylformamide will result in a very full-bodied, strong and leather-like composition.

The fibers themselves can also be of many kinds, natural fibers of wool and cotton as well as man-made fibers of nylon, acrylics, polyesters, rayon and so on. Very popular for non-wovens is a blend of polyester and rayon.

In more sophisticated materials a thin coat of more or less contrasting color to the one in the main body is usually applied to the top surface. This will give more life to the product avoiding to a large extent the so called plastic look.

The contrasting color is in general obtained by applying a solution of aniline dyes and a binder. Care must be taken that the binder is compatible with the main coat forming a strong bond between the two.

Finally another top coat might be applied to protect the contrasting color or to give the surface special properties such as a dry or waxy feel, high abrasion resistance, solvent resistance or similar.

Acrylics are used extensively as top coats, but recent developments seem to indicate, that special polyurethane formulations will be still more popular.

The Local Market.

In order to assess the viability of a production of a certain material, i.e. in this case that of artificial leather, it is of course necessary to determine its actual, local consumption as accurately as possible and also its future, potential use.

For this purpose possibly relevant statistics were compiled, including those concerned with natural leathers, as these and artificial leathers to a certain degree are interchangeable. The export/import figures for the selected commodities are shown in Annex II. Unfortunately the quantities are only given as weights (tons), which in almost all instances are very difficult to relate to required area, or pieces (bags, furniture) or pairs (shoes), which later information could easily be transformed into area. The groupings of most of the commodities are furthermore very large, often bringing together disparate products or articles of very different compositions, sizes and uses. An effort to get more details through a study of a sample of the basic, statistical materials in the ministries concerned proved unsuccessful.

In numerous interviews with importers, wholesalers, retailers and manufacturers the figures, however, were checked and rechecked in order to improve on the details.

Combining the information obtained in this manner and the official statistics and also taking into account the very special conditions that characterize the general market in Kuwait, an assessment in rough figuresof the actual and potential [illegible] been made. In practice the main products, which are or could be made of artificial leather, have been examined carefully and their quantities in relevant figures have been estimated. It is obvious that these figures are

very approximative indeed, but they will still serve as an acceptable basis when later considering the viability of a manufacturing unit.

As to the general market the total population in Kuwait is slightly more than one million people, about half of whom are Kuwaiti citizens and the rest expatriates, who have come to work for longer or shorter periods. The per capita income is one of the highest, if not the highest, in the world, which fact ensures a very high purchasing power. The expatriates buy many commodities in excess when they are going to visit their own countries in which usually, due to lack of foreign currencies, there is a huge demand for many articles. Most of these purchases seem to be for watches, cameras, transistor radios and similar products, but also articles of leather or leather substitutes are involved, such as footwear and suitcases.

The imports into Kuwait are completely free and the custom duties are low, 4% of the CIF value. Articles manufactured locally usually enjoy, however, protection with import duties being applied on such products at the rate of 10 to 30%, depending on circumstances and on how important the Government finds the local production.

Some part of the imports is almost always re-exported, in most cases to Saud Arabia and the gulf states. There is, however, a very clear trend for a decrease in these re-exports,

due to the growing import activities in these countries themselves. The products now manufactured in Kuwait on the other hand, also seem to enjoy a good acceptance in these countries.

There is at present no local production at all of Footwear in Kuwait. Some repair-shops exist, which mainly are attaching new soles to old shoes. The government have issued a licens for the establishment of a shoe factory, which, in technical ecoperation with a european company, is planning to produce ultimately about one million pairs of men's, ladies' and children's shoes. From a material point of view the uppers will be all of leather, the soles will be approximately half of leather and half of synthetics and the linings mostly of leather, although synthetic materials will probably also be used to a certain extent. Based upon the import statistics and the interviews within the trade it is estimated that between 2.5 and 3.5 million pairs of all kinds of footwear are sold yearly. Excluding the injection molded, all plastic sandals, 95% or more of the shoes are made of leather, i.e. the uppers are of leather. Only very few uppers of artificial leather were found, but among those the two main types were represented, ordinary coated fabric as well as poromerics. Most linings were of leather, but in the soles, plastics and rubber seemed to be slightly more common than leather.

Although in the world's shoe production synthetic leather

substitutes are absolutely necessary and certainly will increase considerably in both absolute and relative volume, it is unlikely that these materials will increase much in the shoes imported or to be produced in Kuwait.

Taking as many of these factors as reasonably possible into account the following estimates of the yearly consumption were reached:

Estimates in 1 000 m^2; From	Leather	Poromerics	Leather substitutes Coated Fabrics	Leather substitutes Homogeneous Sheets
Footwear Imports				
Uppers	600	10	10	5
Linings	300	50	10	5
Soles	80	-	-	80
Local Production	-	-	-	-
Projected Production				
Uppers	200	-	-	-
Linings	80	50	5	-
Soles	20	-	-	50

Almost all the Garments sold of leather-like materials are made of real leather and this will probably also be the case in the foreseeable future. The total volume is small and the quantity of those made of coated fabrics are totally negligible.

The yearly sales of Handbags seem to be in the range of 150 - 250 000. About half the quantity seems to be made of leather, which is a high percentage, due probably to the

extraordinary purchasing power in Kuwait, which circumstance tends to favour real leather rather than artificial materials. The quantities indicate a consumption of roughly 40 000 m^2 each of leather and artificial leather.

There is no local production of handbags and none contemplated. If a manufacturing plant were established, it would probably not be able to capture more than say 25% of the local market. Add an equal quantity in exports and a possible consumption would perhaps amount to 20 000 m^2 of artificial leathers and these in several varieties and colors.

Sold mainly through book stores School Bags in Kuwait is a fairly important merchandize. Each child seems to get a new bag for each school year and consequently the very high yearly consumption of 250 - 350 000 pieces as indicated by the statistics and the interviews might be reasonable. Leather and all kinds of artificial leathers are represented among the materials used for the bags. Mainly due to its cheap price and evidently still acceptable performance, the most common material used is a plain, relatively thick PVC sheet (without backing) embossed to simulate a leather surface and, with necessary accessories, formed by high frequency welding into bags. Some 80% of the market seem to be captured by these types of materials. About 5% are probably of leather while some 15 % would be made of coated fabrics. Apparently there seems to be little reason for a substantial change in this

buying pattern. A consumption of about 150 000 m^2 sheet materials and 25 000 m^2 coated fabrics seems indicated.

There is no local production and none contemplated at the moment. If such a production unit had existed, probably almost the total amount of sheet material, i.e. about 150 000 m^2, and some 10 000 m^2 of different kinds and colors of artificial leathers could be absorbed.

Evidently due to the extensive travelling by almost all sectors of the public in Kuwait, Suitcases and other Travel-goods are comparatively big articles. It appears that 350 - 450 000 pieces of suitcases are sold each year and this volume will probably be maintained for quite some time to come. Recently, however, there has been a change in the buying pattern. Not many years ago most of the suitcases were made of hardboard and later predominantly of heavy, coated fabrics. Today the trend is towards fiberglass reinforced plastics (polyesters) which can be molded to give strong and abrasion resistant cases, e.g. in samsonite and similar brands. Hard-board and real leather are of course still used to some extent, but really only marginally. Coated fabrics probably do not account for more than about 50 000 pieces, which would indicate a consumption of [illegible] 100 000 m^2 per year.

There is no local production and so far none is under discussion. As calculated earlier, if such a production

existed, perhaps some 50 000 m^2 coated fabrics could be absorbed every year, but this special market might be decreasing.

Furniture manufacture is the only industry activity in Kuwait that actually uses any real quantity of leather and artificial leather. Most of the furniture sold is, however, still imported, although there is a 15 % customs duty to aid in protecting the local industry. It is estimated that only about 40 % of the total furniture sales are produced in the country and this percentage is growing but slowly. There are several factories, but few of any size. Most of them produce only textile covered furniture. Leather is used very sparingly, in most cases for exclusive office furniture, and the yearly consumption for this purpose does proba-bly not exceed 2 000 m^2 which amount when also considering some other small uses seems to agree fairly well with the amount of imported finished leather. Also the artificial leather is used mainly for office-type furniture. For home use the public prefers textile coverings with exception for certain kinds of kitchen furniture. In total some 300 - 400 000 m^2 per year of covering materials seem to be used in the local production plants, but of this quantiy only about 20 000 m^2 is made up of artificial leather and this amount is not expected to increase very much in the future.

Some 25 - 35 000 Motocar Seat Covers are imported each year. Most of them are made of textiles as the public from a comfort point of view prefers these to the artificial leather

with its closed surface. Only for more heavy duty purposes are the coated fabric types being used and it is estimated that about 5 000 pieces are of this type, which is equal to some 10 000 m^2 of artificial leather. No increase in the use of this type is expected in coming years.

There is no industrial production of seat covers in Kuwait and none under consideration, but most auto repair shops will make up new covers, either to replace damaged or worn out or to protect new ones. Again most of the covers are made of textiles, but 2 - 3 000 seem still to be made out of about 20 different kinds of artificial leathers, which would roughly account for about 40000 m^2 of those imported as such. Homogeneous sheet materials and coated fabrics appears each to account for approximately half of the total.

A small amount of artificial leather with a paper base is used for Notebook Coverings. One manufacturer has been using about 5 000 m^2 a year and will probably increase this amount to the double or more in years to come. The quantity used on imported books, notebooks and similar articles are impossible to estimate, but an upper limit would probably be some 25 000 m^2 for this purpose.

Leather and Artificial leather also have several Other uses such as for wallets, belts, desk accessories, table tops, wall coverings and so on. Some of these products are already accounted for above; the quantities used for table tops are,

for example, included among those for furniture, just as wallets and belts are included among handbags. The additional quantities consumed by the rest of these products are very small and for the purpose of this study they are neglected.

The import of leather and artificial leather as such seem to correspond fairly well with the uses as specified above, at least to the degree that can be expected in these very rough estimates.

Summary of Estimates on Yearly Consumption of Artificial Leather.

	In 1 000 m^2	Poromerics	Coated Fabrics	Coated Paper	Homogenous Sheets
I	Total quantities as used in				
	Shoes	60	20	-	110
	Garments	-	0	-	-
	Handbags, etc.	-	40	-	-
	School bags	-	25	-	150
	Suitcases, etc.	0	100	-	-
	Furniture	0	20	-	-
	Motorcar seat covers	0	10	-	5
	Notebook coverings	-	-	25	-
	Other uses	0	0	0	0
	In total roughly	60	215	25	265
II	Quantities used in actual local production				
	Furniture	0	20	-	0
	Motorcar seat covers.	0	3	-	2
	Notebook coverings	-	-	5	-
	In total roughly	0	23	5	2
III	Projected*possible use in local production				
	Furniture	0	25	-	-
	Motocar seat Covers	0	5	-	5
	Notebook coverings	-	-	10	-
	Shoes	50	5	-	50
	In total roughly	50	35	10	55

IV Added potential ** use in local production				
School bags	0	10	-	150
Handbags	0	20	-	-
Suitcases	0	50	-	-
In total roughly	0	80	-	150
V Total Potential use in local production (III + IV)	50	115	10	205

Note: 0 indicates negligible, and - no quantities at all.

* Total possible use at present or projected factories, including a shoe factory licensed for production, probably to start operation inside 2-3 years.

** Supposing that production units are created in these areas, but without any assurance that they would be viable as such.

Production methods.

Here no processing methods or equipment for the production of backing materials will be treated. Woven or knitted fabrics and also non-wovens of different kinds are specialities of the textile industry. Some very large, integrated concerns producing both textiles and coated fabrics will themselves make the backings, but this is unusual and in most cases the artificial leather producer will buy the backing materials ready to be used directly in the laminating operations.

Similarly the production of poromerics based on polyurethanes will not be discussed here. The possibility of starting such an undertaking in Kuwait from scratch is very remote. The machines for this purpose are not normally available on the market - they are fairly simple, but usually

custombuilt and the problems encountered are more related to the processing technique than to machinery.

Generally the methods to produce artificial leather of the most prevalent types can,be divided into two main groups: Calendering and Coating.

A calendering line will normally consist of a Banbury blender or similar and several two-roll mixers, which will continuously feed a big calender, whose 3 to 4 highly polished cylinders are placed closed together in a Z or inverted L or other arrangement. The cylinders of mixers and calender are heated to temperatures of 150 - 200°C in order to heat and fuse PVC, platicizers and other ingredients to a homogeneous mass. From the mixers a fused strip is fed to the calender and spread there between the cylinders to required width and thickness. Close to the last cylinder is usually arranged an embossing cylinder, which will press a leather- like design into the still soft sheet emerging from the caleuder. After passing between cooling cylinders the sheet is wound up for despatching.

Between the calender and the embossing station can also be arranged a laminating cylinder to which can be fed a textile backing made to adhere strongly to the still soft PVC material.

By mixing into the PVC blend a blowing agent and a suitable kicker - a chemical that helps in regulating

the decomposing - cellular PVC can also be produced on the calender.

In a separate "printing" machine a contrasting color can be applied to the upper surface and also, if so required, a top coat.

The production capacity is very high. It is not unusual to find speeds of the material through the calender of up towards 100 meters per minute. With a width of say 1.5 meter and working 3 shifts, which is very common for this type of production, the theoretical capacity would be over 50 million m^2 per year. The investment is, however, also high. A modern calender runs into several million dollars without the auxiliary machinery. The major part of upholstery for autos is produced in this manner.

In recent years a variation of the calendering method has gained much interest. By this method the PVC compound is introduced directly to a 2-roll calender of special construction with a very high heat transfer performance. The compound is heated, fused and calendered to required thickness in one pass. Embossing and laminating can be incorporated and cellular products can also be produced. The speed is of course much slower, but the cost of the machine is also much less. Still, the technique does not easily lend itself to such greater variations in the end products, which usually are necessary for a relatively

small production, that cannot competewith the massproduction from the large calenders.

The Coating is fundamentally done by spreading evenly a viscous paste, poured on the moving band of the material to be coated, in passing under a wide, straight and inflexible knife, which is pressed down against the band. The band is supported and made to move by a series of rolls and cylinders in the coating line. Many different arrangements as to the positioning of the knife, also in relation to a supporting cylinder, are possible. Very thin or very thick coats can be applied. A modern development is the reverse roll coater. In this machine the paste is first spread thinly on a highly polished steel cylinder from which the paste is then transferred to the band to be coated, which is moving at a relatively much slower speed. In this manner, by packing the paste on-to the band, very uniform coatings of widely different amounts can be applied.

The paste can be a solution of resins in organic solvents, as for example nitrocellulose (pyroxilin) in alcohols and ketones, in which case the solvents have to be evaporated which is usually done by passing the band through a drying oven. This leaves a dry, solid coating on the backing material.

Or, the paste can be a plastisol, usually made by dispersing an emulsion PVC powder with other necessary in-

gredients in the plasticizers. The PVC plastisols account for the overwhelmingly greater part of coatings produced in this manner. After being spread the coat has to be fused, which again is done by passing the band through an oven, but this time at a much higher temperature, 160 - 180°C. After cooling, the coating will have changed into the familiar dry, solid but elastic form. Cellular products with good control of the pore structure are also relatively easy to produce in this way.

The method described is the <u>direct coating</u> method. After winding up the coated fabric or paper or whatever it is in rolls, the material is usually processed further by imprinting a grain pattern onto the surface in an embossing calender and then by printing or spraying on a contrasting color and or top coat.

By the indirect or <u>transfer coating</u> method a specially prepared paper (usually silicon coated) is used as the band onto which the paste is spread. The backing is laid on the coat with the aid of a laminating cylinder before entering the fusing oven. After cooling, the release paper and coated fabric are parted and wound up separately. The paper can be used several times - up to 10 passes or more are not uncommon.

The method allows for many variations in the end products, especially if more than one coating station is employed in the line, which is normally the case.

The release paper can be smooth or embossed with an inverted grain design giving a very uniform and stable surface to the artificial leather. This feature is very important, particularly for cellular coats, as a later embossing in a special calender can be avoided. The heat and pressure needed for the embossing have a very adverse effect on the pores, especially if the pores are open, intended to impart a high air and water vapor permeability to the coating.

The laminating system permits the use of very light-weight and open fabrics of almost any kind. Knitted wares or very thin non-wovens are for obvious reasons impossible to coat directly, but are easily laminated in the transfer coating system.

Using several coating stations in the line, a complete, fairly sophisticated artificial leather can be produced in one pass.

The capacity of the knife coating machine as well as the reverse roll coater is quite high, allowing fairly high speeds in both techniques. The decisive factor is usually the fusing capacity. In a modern oven the required fusing time is roughly one minute, i.e. the length of the main fusing oven in meters will approximately give the possible through speed of the coated material in meters per minute. Speeds of 25-30 m/min are often used.

Machinery Considerations.

From the foregoing, comparing the potential market and the machine capacities, it is evident that and artificial leather production in Kuwait on a big calender line is out of the question, if the production is not intended in effect to be sold on the export market. Having no natural sources at all for such a production - indeed everything had to be imported except capital and fuel : all raw materials, backings as well as PVC, plasticizers and other necessary chemicals, machinery and know how as to technology and marketing - it is practically a certainty that such an undertaking would be an economical failure.

The production must in principal be based on the needs of the local market, even though some export should be expected. In order to capture the small local market it would also be necessary to have the means to produce a fairly large variety of products in relatively small runs. As the largest outlet at the moment at least is for upholstery, which need light-weight backings of either knitted or non-woven fabrics, everything points at a coating line using the transfer coating system as the only reasonalble selection. As shown earlier, this method has great versatility as to end products and, well managed, production changes can be carried out reasonably quickly, making short runs, although always economically a problem, easier to cope with.

Normally, for economic and technical reasons, the coating line would at least have three coating stations, which would permit the production of many different types of artificial leather in one pass through the line. Even then, however, a separate printing machine would almost certainly be necessary to broaden further the range of articles possible to make. Although less economic from a production point of view, a combination of a two-station coating line and the separate printing machine would allow practically the same versatility. Considering the low volume and the investments, it would be obvious to try to keep the equipment as small as possible. For this reason the transfer coating line with two coating machines, a separate printing press and of course all other necessary auxiliary machines and equipment is selected as the production unit with the greatest hope of being viable in Kuwait.

Even so, there is the question of suitable capacity. The width of the line is one factor, but decisive in this case are the customers' requirements. For upholstery for example a width of less than 1.5 meter would cause problems. Consequently a width of 1.6 m has been chosen for the machines in the line. As to the coating speed, this, as mentioned earlier, is mainly a question of the length of the fusion oven. An oven less than say 10 meters would give very low and impractible coating speeds. All other equipment in the line can sustain much higher speeds and the total cost of the line would not be

very much less with a smaller oven. Accordingly this length and therefore also a speed of 10 m/min has been chosen for the viability calculations.

Viability Calculations.

For all imported goods, machinery and equipment as well as processing raw materials, the prices below are calculated CIF, Kuwait. No import duties are taken into account as these are exempt for industry, but port charges etc.. are estimated and included. In the case of machinery appropriate spare parts have been included in the prices.

As to capital costs, it is assumed that half of needed capital will be borrowed at an interest rate of 9% from the Industrial Bank of Kuwait and the rest at 0%.

Machinery Costs.

The following processing equipment is deemed necessary:

Mixing Room.

1	3-roll Mill, 600 mm	@	6 600	KD
1	- " - , 500 "	"	5 800	"
1	1-roll Screening Mixer	"	5 800	"
1	Planetary Mixer	"	2 700	"
1	High Speed Disperser	"	4 200	"
1	Vacuum Low Speed Mixer	"	6 300	"
1	Propeller Mixer	"	200	"
2	Balances	"	500	"
	Subtotal		30 100	KD

Coating Line. Width 1.6 m and length about 35 m.

Consists of: Paper unwinding equipment, Reverseroll coater, Drying/prefusing oven 6 m, Set of cooling cylinders, Dancing rolls for regulating paper tension, Knife coating machine, Laminating cylinder with Backings unwinding equipment, Fusion oven 10 m, Set of cooling cylinders, Paper winding machine and Coated fabric Winding machine with edge cutters.
Auxiliary equipment: Boiler for heated oil, Motors and driving equipment, Constant speed and paper tension regulating equipment, Thickness and Temperature control devices. Total CIF Price: 97 100 KD.

Finishing Room.

1	Printing Machine	●	19 400 KD
6	Printing Cylinders ● 700 KD	=	4 200 "
1	Inspection & Measuring Machine	●	2 100 "
	Storage Racks		1 400 "
	Subtotal		27 100 KD

Installation and Start Up costs are estimated at 15 000 KD.

Other Equipment.

	Tool Room equipment		1 500 KD
1	Fork Lift Truck	●	4 800 "
4	Jacks on wheels ● 50 KD	=	200 "
	Subtotal		6 500 KD

Some Laboratory equipment, mainly for physical testing, should be provided and for convenience Office equipment is also added here just as are Air conditioning equipment and Transport means.

Laboratory Equipment estimated at	1 800 KD
Office Equipment	3 800 KD
Airconditioning	7 000 KD
Station Wagon	4 500 KD

Buildings:

It is estimated that about 1 000 m^2, as specified below, would be necessary for the production envisaged.

Production area	550 m^2	@ 60 KD	33 000 KD
Storage area	300 "	" 50 "	15 000 "
Offices & Laboratory	150 "	" 100 "	15 000 "
	1 000 "		63 000 "
Fences, 100 running meters	@ 10 KD		1 000 "
	Total Buildings		64 000 KD

Land.

Taking a possible expansion into account at least double the area of total building space should be required. The land would be leased from government at a rent of 75 KD per 1 000 m^2 and year.

No internal roads should be necessary to build.

Working Capital.

A rough estimate of the capital needed to cover salaries, wages, raw materials and stocks for a period of 3 to 6 months has been made for the different production voulmes. To obtain convenient figures for the total capital needed, the amounts have been adjusted to 143 100 KD for the lower Alternative 1 and 243 100 KD for the higher voulme Alternative 11.

Summary of Investments and Capital Costs.

		Investment	Depreciation
Buildings		64 000 KD	3 200 KD
Machinery:			
Mixing Room	30 100		
Coating Line	97 100		
Finishing Room	27 100	154 300 "	15 430 "
Installation & Start Up		15 000 "	3 000 "
Other Equipment		6 500 "	650 "
Laboratory Equipment		1 800 "	180 "
Office Equipment		3 800 "	380 "
Air Conditioning Equipment		7 000 "	1 400 "
Station Wagon		4 500 "	1 500 "
Total Fixed Capital		256 900 KD	
Yearly Depreciation			25 740 KD
Working Capital: Alternative I		143 100	II: 243 100 KD
Total Capital		400 000	500 000 KD
Interest on Capital:			
5% on half		10 000	12 500 KD
8% " "		16 000	20 000 "
Total Interest		26 000	32 500 KD
Depreciation		25 740	25 740 "
Total Capital Costs I:		51 740	II: 58 240 KD

Salaries and Wages.

Under the circumstances prevailing at a production of this type all the personnel costs, wages as well as salaries, may be treated as indirect, fixed costs, inside certain limits more or less independent of actual production volume. The workers have all to be present, however high or low the production happens to be. To minimize the costs at a low volume an alternative (I), where a smaller workforce would operate more than one type of machinery, is also calculated. Alternative II, the normal, full crew, one-shift operation would in a year produce maximum 10x1.5x60x2,400x0.7 m^2 or about 1,500,000 m^2 coated fabric. The first alternative would produce about 40% of this or maximum 600,000 m^2/year.

	Number		Yearly pay: KD.	
	Alt. I	Alt. II	Alt. I	Alt. II
General Manager	1	1	10 000	10 000
Technical Manager	1	1	7 000	7 000
Sales Manager	-	1	-	6 000
Salesman	1	2	5 000	10 000
Purchasing agent	1	1	5 000	5 000
Accountant	1	2	2 500	5 000
Foreman	1	2	3 000	5 500
Typist/Clerk	1	2	1 800	3 500
Maintenance worker	1	2	2 000	4 000
Skilled worker	5	10	9 000	18 000
Semiskilled worker	3	5	5 000	8 000
Office boy	1	1	800	800
Guard	2	2	1 600	1 500
Driver	1	1	1 500	1 500
Total	20	33	54 200	75 900
+ 10 % Social Charges			5 420	7 590
Total Personnel Costs			59 620	83 490 KD

Direct Material Costs.

It is of course impossible to take into account the very many types of artificial leather, which can be produced in the plant suggested. As a prototype, a commonly used coated fabric for upholstery is selected, which can well represent the total production in calculating break even points etc. ther types would have parallell cost and sales price estimates. Simultaneously the chosen product will serve to show how such an artificial leather is manufactured and its specific composition.

The product would have the following specification:

Color: Any.
Grain: Haircell with fine wrinkles (inverted release paper).
Top Coat: Polyurethane: 10 g/m^2 solid (35 g/m^2 liquid)
Main Coat: Colored, cellular PVC: small pores: 720 g/m^2.
Laminating Coat: Same, but white and 80 g/m^2.
Backing: White, non-woven fabric: polyester/rayon: 80 g/m^2.

Main and Laminating Coat Composition:

	Parts	KD/kg
PVC, emulsion type	55	0.230
Plasticizer	30	0.255
Stablizer	1.85	0.510
Paste regulator	1	0.840
Chemical Blowing agent	1.35	3.200
Pore regulator	3.20	0.775
Pigments in Plasticiser (2:3)	7.60	0.515
Total	100	0.328

The color pigments are premixed in a plasticizer on the small 3-roll mill. All ingredients for the main coat are weighed in a can, mixed by the planetary mixer and then by the high speed dispersing mixer. The resulting paste is passed through the large 3-roll mill, screened in the

1- roll mixer and let to "mature" in the can. Just before the coating is to start, the paste is treated for a short time in the vacuum blender to remove all possible air. The laminating paste usually does not need this treatment, nor to pass through the 3-roll mill.

In the coating line the required amount of paste is coated on to the release paper, prefused in the first oven and cooled again. A thin laminating coat of suitable color, in this case white not to discolor the fabric, is applied in the knife-coating machine, the fabric fed onto the coat and the aggregate passed through the fusing oven at about 170°C. After cooling the coated fabric is separated from the release paper, cut along the edges and wound up in big rolls. In the line only about 70% of total work hours are productive - the rest of the time will be needed for change of papers, cleaning of machines, etc.

The big rolls are transported to the printing machine, where, with the aid of a smooth or engraved transfer cylinder, a thin coat of polyurethane is applied and dried in the drying oven belonging to the machine.

In the inspection/winding machine the artificial leather is visually checked and cut up into rolls of suitable lengths, which are then packed for dispatching.

In the cost specification below provisons are made for rejects, edge cuting losses etc..

Backing @ 0.095 KD/m^2	0.102
PVC coats	0.263
Release paper, 8 times used	0.008
Printing laquer (Top coat) @ 0.565	0.020
Packaging materials	0.012
Fuel oil @ 8 KD/Ton	0.001
Cooling water @ 0.8 KD/1000gall	0.001
Miscellaneous	0.003
Total Materials Cost	0.420 KD/m^2 finished Artificial Leather

Sales Prices.

The artificial leather selected for these calculations would have a CIF price in Kuwait close to 0.550 KD/m^2. In the case of custom duties of say 15 % being introduced for the protection of the local production, the price could probably be increased to 0.630 KD/m^2. Both these sales prices have been used for the further calculations.

Break Even Points.

This simple method has been used for a first evaluations are then necessary.

If X is the production/sales volume in m^2 per year at break even point,
A is fixed costs, in this special case capital costs + salaries & wages in KD/year,
B is the unit sales price in KD/m^2 and
C is the production (materials) unit cost in KD/m^2

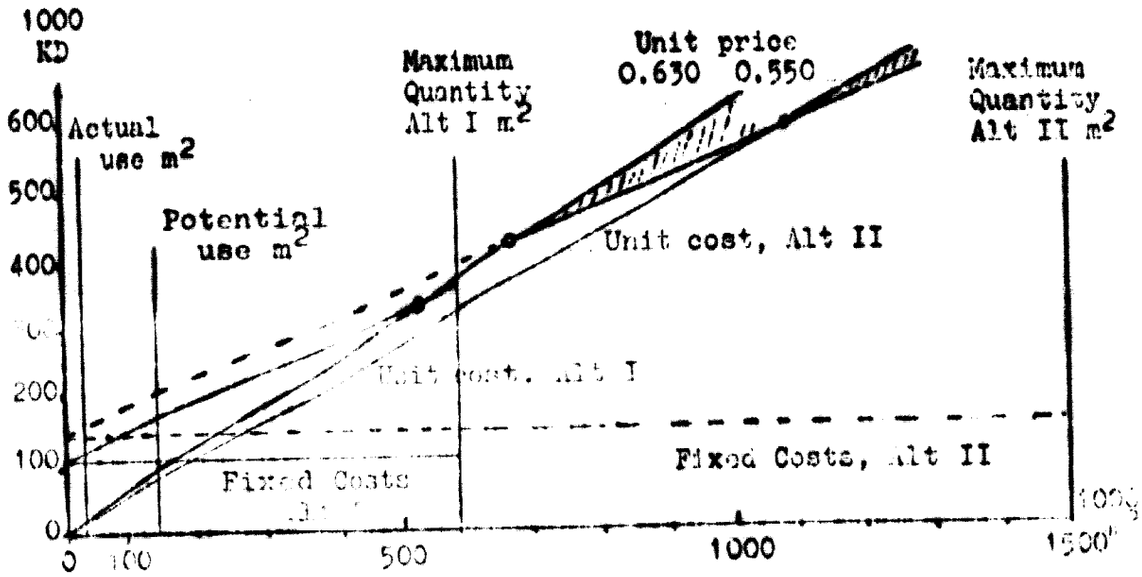
the following simple relation is true: $X = \frac{A}{B - C}$

The break even volumes for the two alternatives of production ranges and the two unit sales prices mentioned would then be:

Unit price	Alt I	Alt II
0.630 KD/m^2	$\frac{51740 + 59620}{0.630 - 0.420}$ = 530 000 m^2	$\frac{58240 + 83490}{0.630 - 0.420}$ = 675 000 m^2
0.550 KD/m^2	$\frac{51740 + 59620}{0.550 - 0.420}$ = 855 000 m^2 (Not applicable, over 600 000 m^2)	$\frac{58240 + 83490}{0.550 - 0.420}$ = 1 090 000 m^2

It is readily seen, how price and volume sensitive this kind of manufacture is. At higher voulmes the return on invested capital will increase rapidly, but unfortunately the quantities possible to sell in Kuwait are far below even the lowest break even volume.

The situation is clearly demonstrated in the graph below.



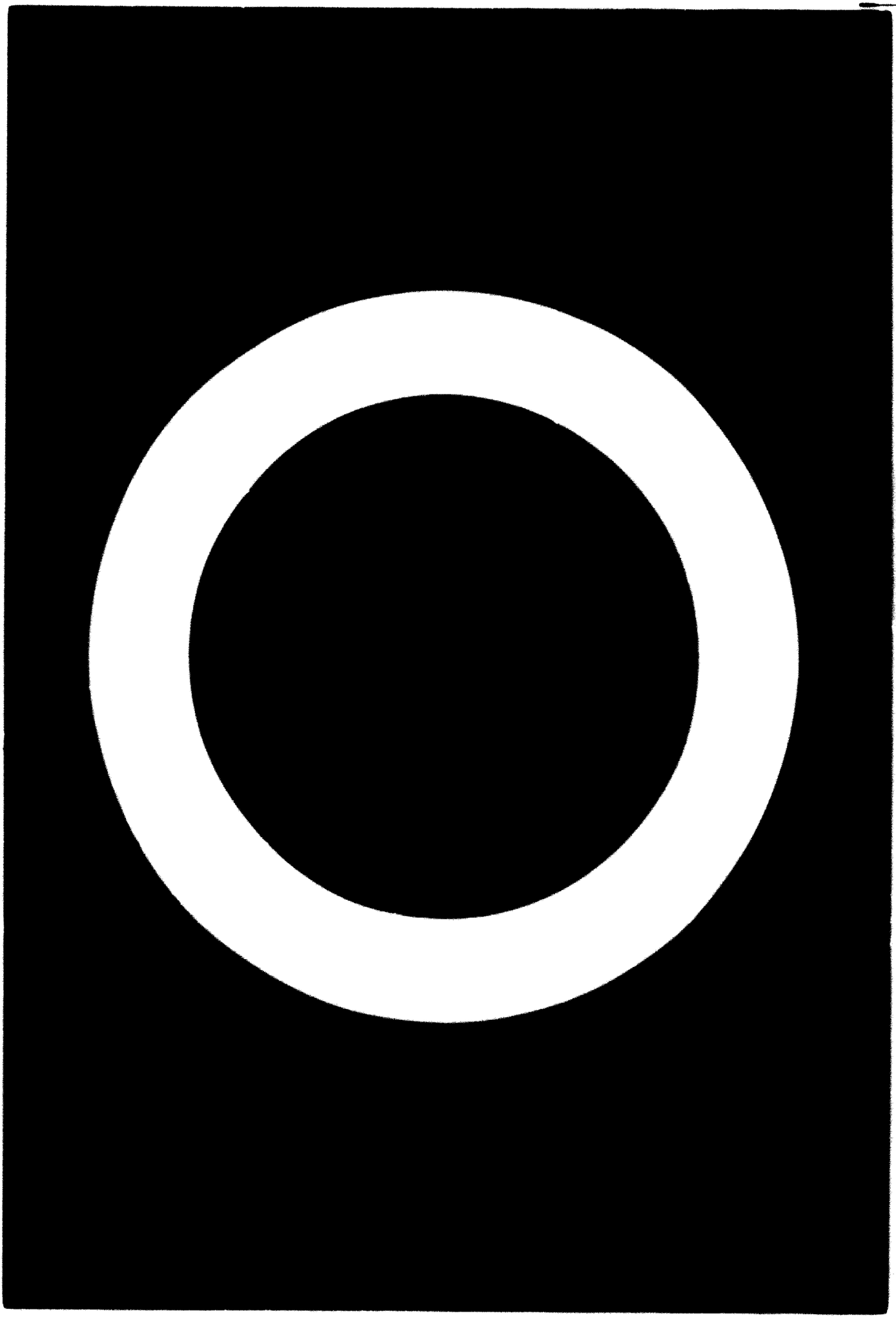
CONCLUSIONS AND RECOMMENDATIONS

The artificial leather of the coated fabric type has been shown to be the only one with a reasonable hope of success in its production. The actual use of this material by the existing manufacturing units in Kuwait, however, is at present only about 23,000 m^2 annually and the break even point at a production at the lowest cost and highest price alternative is as high as 530,000 m^2 per year.

Even taking into account the potential market of 115,000 m^2/year, if and when new manufacturing units of different kinds had been created, or a doubling or trebling of these quantities, would not be enough. An export at calculated prices of the amount needed to fill the gap is almost certainly impossible to achieve. A production of the type studied is from an economical point of view not viable, and the project consequently not feasible.

Because of this result no cash flow, financing, or other, further study has been carried out.

It is recommended, that no action is taken for the time being to interest any party to start a production of artificial leather in Kuwait and also that possible entrepreneurs are discouraged to do so.



Annex I

JOB DESCRIPTION
TF/KUW/76/001/11-05/A/32.1.H

Post Title	Short Term Consultant in the Field of Artificial Leather Manufacture.
DURATION	Two months
DATE REQUIRED	June 1977
DUTY STATION	Kuwait
PURPOSE OF PROJECT	To provide sufficient information and guidelines enabling local investors to take a decision with regard to establishing an artificial leather production plant.
DUTIES	The short term consultant will be attached to the Industrial Development and Consulting Bureau, and will as member of a team of international experts under the leadership of the Project Manager, specifically be expected to: 1. Study local statistics and visit local importers of artificial leather and its products. 2. Assess present requirements for domestic and export markets as well as future potentials. 3. Prepare a feasibility study for setting up a factory for the production of a artificial leather. The feasibility study should include: a) Marketing of the artificial leather to be produced for local and export markets. b) Advice on techno commercial problems of establishing the plant including location, appropriate capacity, engineering, raw materials, fuel, energy etc. as well as man power organization. c) Description of manufacturing process. d) Description of machinery and equipment.

c) Tabulation of estimated project costs, estimation of working capital and suggested capital structure.

f) Estimation of unit costs of production and profitability statements for local and export markets. Calculation of the breakeven analysis.

Recommendations for know how and if necessary for future assistance.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.

QUALIFICATIONS — University degree in chemical engineering or chemistry with extensive experience in the artificial leather industry and in the preparation of feasibility studies.

LANGUAGE — English

BACKGROUNG INFORMATION — Kuwait is one of the major oil producing countries, revenues from oil constitute the majority of the total revenues of the country. Its per capita income is one of the highest in the World. Among the objectives of the country's development policies the diversification of its economy is an important objective. The substitution of locally manufactured goods for imported products, and the establishment of viable industries in this connection is recommended.

The Industrial Development Committee has granted licences for the establishment of certain projects for the production of shoes and leather products.

The Industrial Development and Consulting Bureau which was established in 1973 in collaboration with the Ministry of Trade and Industry in Kuwait and UNIDO/UNDP is primarily concerned with promoting investment opportunities in industry by identifying viable industrial projects, through carrying out feasibility studies and evaluating those submitted by local enterpreneurs, as well assisting the Industrial Affairs Department in other development objectives. Artificial leather manufacture is a project among those identified by the Bureau for investigation.

Annex II

STATISTICS FOR A MARKET STUDY ON ARTIFICIAL LEATHER

Code	COMMODITY	IMP or EXP	1971 1000 KD	1971 Tons	1972 1000 KD	1972 Tons	1973 1000 KD	1973 Tons	1974 1000 KD	1974 Tons	1975 1000 KD	1975 Tons	Jan-Aug 1976 1000 KD	Jan-Aug 1976 Tons
611. 009	LEATHER OTHER THAN CHAMOIS DRESSED	IMP	8	17	10	9	12	11	23	20	16	14	19	9
		EXP	0	0	1	1	2	1	2	3	2	2	0	0
612. 000	MANUFACTURES OF LEATHER OR ARTIFICIAL OR RECONSTITUTED LEATHER N.E.S.	IMP	62	41	60	45	86	62	118	62	144	65	83	30
		EXP	1	1	2	2	19	14	2	1	3	1	3	2
655. 400	COATED OR IMPREGNATED TEXTILES AND PRODUCTS N.E.S.	IMP	162	500	199	625	102	241	201	416	288	618	189	346
		EXP	15	48	19	85	13	41	7	15	12	23	45	64
821. 005	FURNITURE OF SPONGE RUBBER OR SPONGE PLASTIC MATERIALS	IMP	91	274	415	1014	81	183	17	36	55	123	42	94
		EXP	5	13	37	102	44	101	1	1	5	8	23	31
821. 007	MOTOR CAR OVER-SEATS	IMP	-	-	-	-	57	76	111	131	120	117	63	70
		EXP	-	-	-	-	9	14	16	23	18	24	11	14
831. 001	SUITCASES & TRUNKS	IMP	532	915	743	1194	711	1093	986	1112	1579	1744	1301	1569
		EXP	37	134	93	307	251	669	60	71	96	131	186	293
831. 002	SCHOOL BAGS	IMP	146	254	179	319	281	426	401	434	546	455	649	472
		EXP	6	26	14	40	27	50	39	34	60	56	134	112
831. 003	WOMEN'S HANDBAGS	IMP	148	93	148	97	140	82	141	67	233	118	258	127
		EXP	2	2	4	5	16	11	15	9	36	14	75	26
831. 009	OTHER TRAVELGOODS HANDBAGS & SIMILAR ARTICLES N.E.S.	IMP	-	-	-	-	52	38	96	72	143	110	186	110
		EXP	-	-	-	-	2	3	2	3	3	4	18	14
851. 000	FOOTWEAR	IMP	2115	2355	2033	3510	3243	3119	4085	3270	5160	4128	4600	3652
		EXP	73	220	226	574	397	767	234	331	320	335	568	608

Annex III

SOURCES OF MACHINES AND RAW MATERIALS

Almost all industrialized countries have factories which make some of the equipment or raw materials needed for the production of Artificial Leather. As an example, a few well-known German companies in the field are listed below. Other suppliers, including those in other countries, are easily found in trade books or through their embassies.

Mixing Equipment:

Draiswerke GmbH
Speckweg 43-59
Postfach 31 02 20
D 6800 Mannheim 31
West Germany

Gustav Spangenberg,
Maschinenfabrik GmbH
Postfach 20-29
Industriestrasse 49-51
D 6800 Mannheim 1
West Germany.

Coating and Printing Machines:

Dornbusch & Co,
Gravieranstalt
Kalanderstrasse 25
Postfach 570
D 4150 Krefeld 1
West Germany

Kleinewefers Industrie-
Companie GmbH
Kleinewefers-Kalanderstr.
Postfach 1560
D 4150 Krefeld 1
West Germany

Herbert Olbrich KG
Teutonenstr. 6-8
Postfach 297
D 4290 Bocholt
West Germany

Printing Cylinders:

Dornbusch
(See Above)

Jean Hiedemann
Kühlstrasse 10
Ossendorf
D 5 Köln 30
West Germany

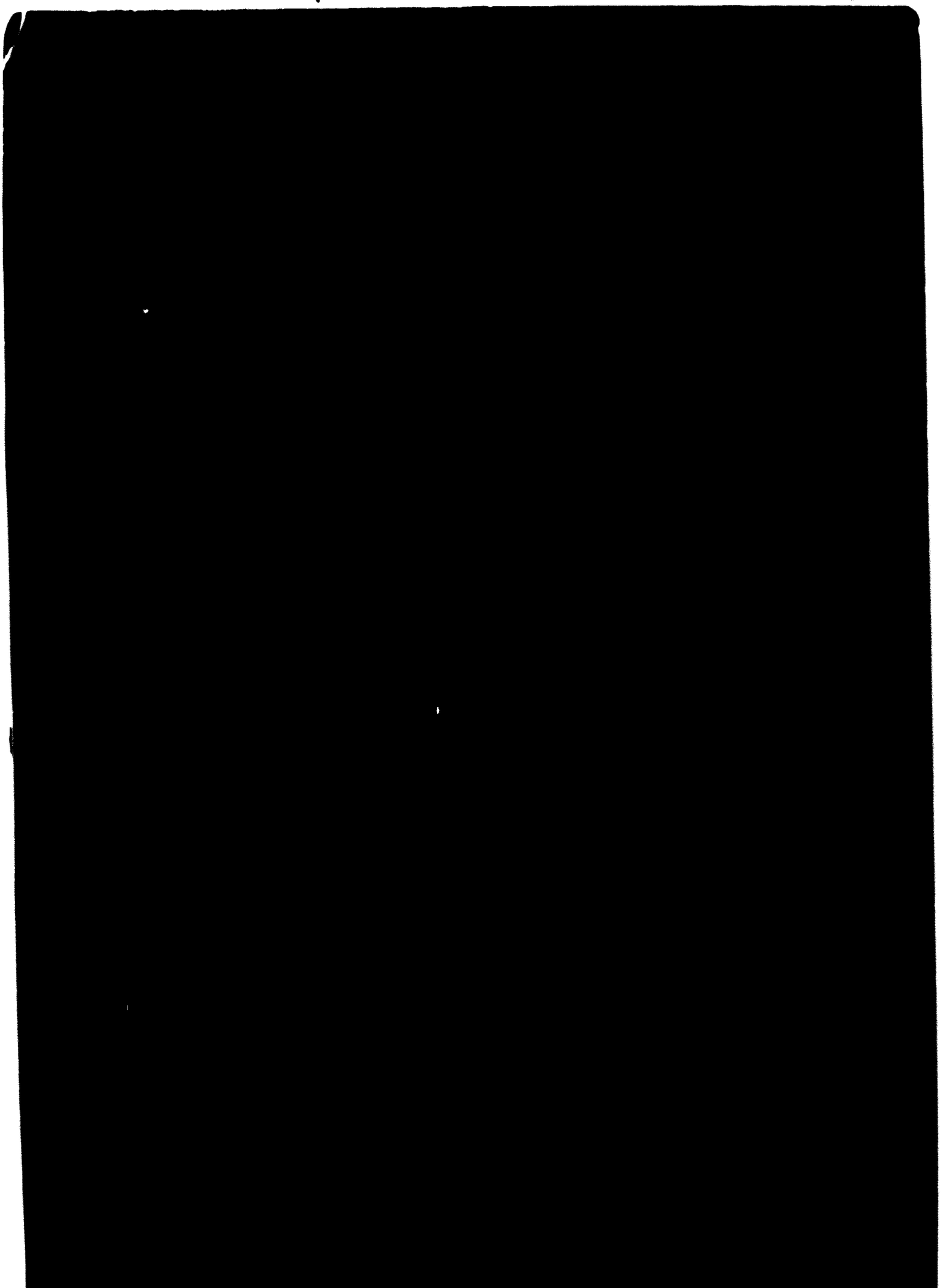
A.+E. Ungricht
Rudolfsstrasse 43
Postfach 388
D 4050
Mönchengladbach 1
West Germany

Raw Materials: PVC, Plasticizers, Auxiliary Chemicals, Pigments, etc.

BASF AG
D 6700 Ludwigshafen 1
West Germany

BAYER AG, Bayerwerk
D 5090 Leverkusen
West Germany

Chemische Werke
Hüls AG
D 4370 Mar 1/
Recklinghausen
West Germany.



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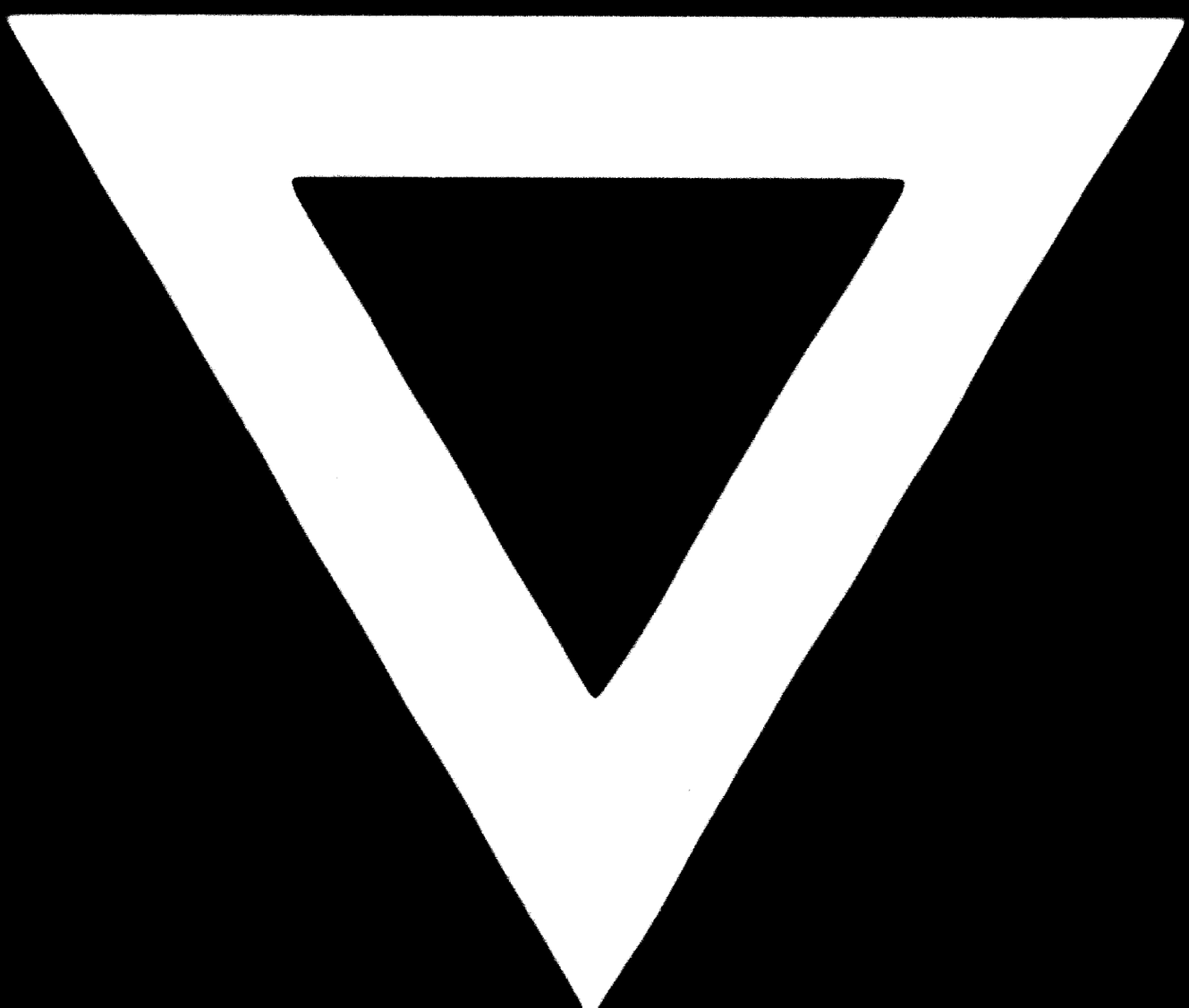

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