OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

mb

05192

Distr.
LIMITED

ID/WG.[illegible]
[illegible]

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Seminar on the development of footwear
manufacturing and leather goods
manufacturing in developing countries

Madras, India, 4 - 13 February 1974

MATERIALS OTHER THAN LEATHER USED IN THE MANUFACTURE OF FOOTWEAR AND LEATHER GOODS [1]

B.C. Harvey*

---

* Director, Production Services Division, Clarks Ltd., Street, England

[1] The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has been reproduced without formal editing.

[illegible]

CONTENTS.

Chapter		Page
	Introduction........................	1
I	Bottoming..........................	2
	A. Soling..........................	2
	B. Heels...........................	11
	C. Top-pieces......................	11
II	Uppers.............................	13
	A. Outsides........................	13
	B. Linings.........................	24
III	"Support Components"...............	26
	A. Insoling........................	26
	B. Stiffeners......................	30

INTRODUCTION.

The development of synthetic bottoming materials for conventional shoes began some twenty-five years ago, and there are now many well proven and accepted formulations in use for both soles and heels; new ones still appear, offering varying advantages.

Development of upper materials, both outsides and linings, has been more recent. They are not used on the same scale as synthetic bottoming; and their use presents more problems for the shoemaker than synthetic bottoms do. The 'skeleton' of the shoe: insole, stiffener, toepuff - has undergone similar change. Materials are on offer which meet not only functional demands in wear, but also technical demands in rapid shoemaking.

The acceptability of all these materials is still to some extent measured by comparing them with leather, for good reasons. Undoubtedly if leather were plentiful and cheap, it would still be used, for most though not all shoe components, in preference to synthetics.

Nevertheless, in examining the reasons for the success or failure of substitute materials they must not be considered simply as substitutes for leather. The question should be, how suitable are they for the purpose for which they are intended? In finding answers to this question, we must have some idea as to the properties we require in an ideal shoe.

I. BOTTOMING.

A. Soling.

Examination of the attributes of the ideal soling must be undertaken with the wearer's demands paramount. But consideration must also be given to the shoemaker's processing requirements, since however attractive a material may be to a potential wearer, it will be useless if it cannot be processed.

The following attributes are required for foot comfort and protection:-

a) Protection against rough and uneven surfaces - sharp stones, etc.

b) Thermal insulation against extremes of temperature, particularly in the milder climates.

c) Slip resistance. The coefficient of friction between the soling and any surface it is likely to come in contact with must be sufficient to prevent slipping.

d) Waterproofness.

e) Permeability. This property is obviously not so important for soling as for upper materials.

f) Flexibility. The degree of flexibility required will depend upon the type of footwear i.e. how will this shoe be used?

g) Light weight.

h) Abrasion resistance, which is a measure of the durability of the material.

i) Flex crack resistance.

j) Dimensional stability: For instance, <u>spreading</u> can lead to more rapid wear and/or distortion of the upper, and sole/upper bond failure.

k) Firm attachment to the upper.

l) Resistance to age deterioration.

m) Resistance to attack by contaminants (e.g. oil).

Given these attributes, to the specified extent, the shoemaker must consider the following processing requirements:-

n) Adhesion properties: it must be capable of attachment to all kinds of uppers.

o) Processability: When, for instance, a polymer is directly moulded to an upper, the process must be relatively simple to control, and must not admit of wide variations of product as a result of slight variations in process.

p) Versatility: By slight modification, if necessary, it should be capable of accomodating fashion trends e.g. from court shoes with very thin soles to the current (European) demand for very thick light weight soling. At the same time it should be suitable for men's and children's shoes.

q) Aesthetic appeal: It must be attractive in appearance and capable of being finished with a suitable lacquer.

r) Economy: The price of the basic material and the cost of processing must not be out of keeping with the end product.

Of course the completely ideal soling does not exist. However, by relating currently available solings to these requirements, and at the same time comparing them to leather, some light can be thrown on their success or failure as soling materials.

Since synthetic rubber was first introduced to the footwear industry as a substitute for leather soling some thirty years ago, the following materials have been adapted for use as soling:

Vulcanised synthetic rubber: solid and microcellular.
P.V.C.
P.V.C. blends
Polyurethane - mainly cellular
Thermoplastic rubbers
E.V.A. - cellular and solid.

Materials such as nylon have been omitted, which are used only in specialised footwear.

Natural crepe and vulcanised natural rubber were of course used much earlier, and crepe has started a comeback in recent years. It will therefore be included in the survey.

Since to consider the properties of each material individually would be too tedious a process, in each case (i.e. for each attribute) leather will be compared with the best and worst of the synthetics.

The attributes in the order given are not necessarily in order of priority, which must vary according to wearer, function and conditions of wear.

a) Mechanical insulation:
In general- cellular materials provide the best mechanical insulation. Cellular polyurethane in particular provides an excellent cushion against sharp stones, etc. Leather soling offers protection by virtue of its stiffness - the pressure being thus distributed over a wider area. Such a sole, in order to give the same degree of protection, must necessarily be fairly bulky.

b) Thermal insulation:
All these materials provide adequate thermal insulation when dry, but thermal conductivity is increased by the absorption of moisture. Leather, by virtue of its fibrous character is extremely absorbent, so that under wet conditions thermal conductivity can be increased to the extent where there is pronounced discomfort through chilling.

c) Slip resistance:
Thermoplastic rubbers show particularly good resistance to slip. Leather with P.V.C. is at the other end of the scale. It can be slippery on dry surfaces and also on wet when heavily saturated.

d) Waterproofness:
Among solings, leather is the only one which cannot claim to be waterproof.

e) Permeability:

Leather is the only one which is permeable. Although the permability of the sole is not as important as that of the upper, it is claimed that under hot conditions, and in those constructions where the foot is entirely enclosed, leather soles are more comfortable than synthetic ones. This must be attributed to their ability to absorb and transmit perspiration.

f) Flexibility:

By hide selection and tanning processes it is possible to produce leathers of different flexibilities. Synthetics, however, with a wide range of base materials and additives (e.g. plasticzers) are capable of giving a much wider range of flexibility. By chemical engineering a material can be produced which is the best suited for a given construction.

g) Lightness:

Although not as dense as some of the solid rubbers and thermoplastics, leather, because of its low durability must necessarily be of adequate substance, so that its overall weight will be greater than that of a synthetic sole of comparable durability. Absorption of moisture can further increase its weight. Cellular materials are the obvious choice where lightness is of prime importance. These can be produced with densities approximately half that of leather.

h) Abrasion resistance:

The wear resistance of leather (as assessed by wear trials carried out by S.A.T.R.A.) is at the bottom end of the scale. Crepe rubber and many synthetics have durabilities five times that of leather. Among these are the higher quality rubbers, p.v.c.'s and cellular polyuretnanes. These latter are the most durable of the low density solings.

i) Crack resistance:
In general, cellular materials are more prone to failure by cracking, but adequate process control can reduce this risk to a minimum. P.V.C.'s also show a tendency to brittleness at low temperatures, but again this tendency can be reduced by selection of polymer and by careful compounding.

Most crack failures however, usually occur after an appreciable amount of wear and are almost certainly due to degradation of one sort or another (see k).

j) Dimensional stability:
Distortion of sole and upper and subsequent bond failure can result either from shrinking or spreading of the sole.

The low grade resin rubbers are the most prone to spreading, and the lower density microcellular rubbers and EVA's are most likely to shrink in wear.

Leather expands under the action of moisture, but contracts again on drying out. Unlike the expansion of the resin rubbers and the shrinking of the microcellulars it is a reversible process, but continued wetting can lead to permanent distortion.

l) Resistance to degradation:
Degradation due simply to ageing, or, more often to the action of a contaminant, can result from a purely physical action of the migration of plasticizer from P.V.C., or more frequently, as the result of chemical action, as in the action of moisture and

sweat on polyurethane. In this case hydrolysis occurs and the polymers are broken down into smaller molecules with consequent disintegration of the material. The generic name polyurethane however covers a whole range of polymers with a variety of structures and properties, and modifications have now been produced which are far more resistant to this type of attack. Now that the problem of hydrolysis has been overcome, polyurethanes are amongst the more stable solings. Unlike many of the rubbers (natural as well as synthetic) they are unaffected by oils and solvents.

The physical properties of leather deteriorate through tannins leaching out under the action of moisture. As a result of detannage the fibres tend to cohere and flexibility is reduced. On drying out cracks can then develop.

k) & n) Attachment to the upper:

The wearer requires a bond which is watertight and does not break down on flexing. Bonds of this type are most readily obtained by moulding the sole directly on to the upper as in the direct vulcanized process, or by injection moulding. The materials which lend themselves to this type of construction are rubber (direct vulcanised), p.v.c., polyurethane and thermoplastic rubbers. The limiting factor with this process, however, is the type of construction and the cost of equipment so that, whereas it is ideal for men's and children's shoes it cannot be easily adapted to the fashion trade.

Because of these limitations most footwear is still prepared by the direct adhesive attachment of a sole unit to the upper. With the wide choice of adhesives now available, bonding presents relatively few problems to the shoemaker. Provided both upper and soling are adequately prepared and the correct adhesive selected (by exhaustive testing), satisfactory bonds can be obtained with most materials. With certain soling however, notably low density microcellular rubbers and lower grade resins, the bond is limited by the tear strength of the material itself. With these exceptions, synthetics and natural rubbers give bonds as good as, if not better than leather.

o) Processibility:

Of the materials which are used for direct moulding, P.V.C. is perhaps the most easily processed, polyurethane the most difficult. Because of the possibility of material variation with only slight deviations in processing the product must be continually monitored. This must necessarily add to the ultimate cost of the shoe.

p) Versatility:

The present diversity of styles with high platforms would be extremely difficult to produce if leather were the only soling still available.

Such materials as polyurethane on the other hand, because it moulds readily and is light lends itself admirably to these constructions.

q) Aesthetic appeal:

Leather by tradition, is accepted as the most desirable material from the point of view of appearance. However, many of the synthetics, particularly those which can be produced in pastel shades, have their own particular appeal and are now accepted in their own right by the fashion trade and consumers.

The other feature of leather which by association has acquired a certain aura is its characteristic smell. Microcellular rubber on the other hand, has a particularly unpleasant smell and is perhaps the least pleasing in appearance.

f) **Economy:**

Leather is by far the most expensive soling material. It is followed by crepe rubber which is approximately one third of its price (when reckoned as cost per unit volume), but since it is usually used in relatively thick substances, this is not a true reflection of its cost.

All the synthetics (except those which are used for specialised footwear, e.g. sports shoes) are much less costly. Again the actual cost must depend to a certain extent on the thickness of the sole, and also on the cost of processing. For this reason resin rubber is among the cheapest materials, since it can be, and normally is, used in relatively thin substances.

To sum up: No single material fulfils the conditions set down for the ideal soling. By careful examination of their respective merits however, it is possible to select that material which most nearly meets the requirements of a given construction. By this criterion, leather can only be considered suitable for the type of footwear where cost and price is no object, where aesthetic appeal is important, and where a high degree of permeability and absorption is acceptable. Above all it must not be expected to have outstanding durability. Leather is still used for this rather limited market. Synthetics admirably meet the requirements of all other types of footwear.

B. Heels.

Stacked leather heels are now generally used only on high priced men's and women's shoes; all middle and low priced shoes (the bulk of the market) carry synthetic heels; and in so far as they do not suffer through distortion, either by moisture uptake or wear, they generally give better service than leather heels.

a) Men's 'dress' shoe heels are generally made from moulded polythene, which is cheap and dimensionally stable. Since it cannot be readily lacquered, the heel is moulded in the required colour.

b) Women's court shoe heels are generally moulded in high impact polystyrene, which can be easily lacquer-sprayed to match the upper colours. It is dimensionally stable and of good strength, though in thin sections it needs steel reinforcement.
ABS is fairly widely used in America, but it is more expensive than polystyrene, and is therefore an excessive specification.

c) Women's wedge heels may be made in either cellular rigid polystyrene or fomaed polyurethane. Both may be coloured readily; polyurethane, though more expensive has the advantage that 'natural' effects (leather grain, cork, etc.) may be easily moulded in. Wood is also sometimes used, usually covered with leather or synthetic material.

C. Top-pieces.

Even on high price shoes, leather is rarely used as a complete top-piece, and then only on men's shoes. In such cases, a rubber segment is affixed to the back of the heel where the shoe first hits the ground in walking. Leather is particularly prone to rapid wear from this action, which is why it has largely fallen out of use.

The best top-piece material is solid polyurethane, particularly on women's shoes where the top-piece area is generally small. Cheaper substitutes like polythene or nylon are slippery, and their use has resulted in injury to the wearer, and consequent legal action against shoemakers. On men's shoes, where the top-piece area is larger, high grade resin rubbers may be used.

II. UPPERS

A. Outsides.

Why have synthetic uppers failed to make the impact that synthetic solings have made on the footwear industry? Again the approach must be what constitutes the ideal upper? How do our available materials measure up to this?

Since upper materials can be placed under broad headings of leather, poromerics and coated fabrics comparisons will be made between these three groups.

a) Extensibility/Resiliency:

The shoe must respond to the shape of the foot without applying any excessive pressure at any point. It must not however be so extensible that it completely conforms to the shape of the foot, as this tends to give an unsightly appearance. It also needs to give some support. It will tend to return to its original shape on removal from the foot.

Leather can be produced to give the optimum combination of eleasticity and plastic set required in the shoe for shape retention and comfort. It also has low modulus at low extensions. In addition it becomes softer and more stretchy when wet. This is particularly useful since, in hot weather, the feet tend to swell. At this time the added perspiration absorbed confers on the leather the additional property to stretch.

Poromerics differ widely in structure and consequently in modulus, elasticity and plastic set. Unfortunately desirable comfort features, such as low modulus, are achieved at the expense of the strength of the material.

Coated fabrics consist of P.V.C. or polyurethane coatings on woven or knitted fabrics. The woven backed materials are generally 'tight' and consequently do not conform readily to the foot. This can cause acute discomfort through excessive pressure at the toes. The knitted fabrics, on the other hand, have very low modulus, particularly in one direction. This can give rise to severe distortion, so that this type of material is suitable only for slippers.

b) **Flexibility:**

It must be sufficiently supple to allow the foot to flex naturally without the formation of hard ridges or grooves.

Leather - the suppleness of leather is achieved by virtue of the complex random weave of the fibres. The degree of flexibility can be modified by tanning processes, fatliquoring, etc.

Poromerics in wear produce creases which tend to concentrate at the line of maximum flex as opposed to leather where the creases are shallower and distributed over a wider area.
Because the poromeric creases are sharper and often associated with a stifier material, wearers complain of discomfort through pressure and rubbing at the toe joint.

The flexibility of Coated fabrics is largely dependent on the type and thickness of the coating. A thick P.V.C. for instance, will not be very flexible particularly under cold conditions. It will produce the same type of creasing as poromerics.

c) Permeability/Absorbency:

It must be capable of ridding the foot of excess perspiration by absorbing and transmitting moisture.

Leather is the ideal material for disposing of perspiration from the foot. It can absorb and transmit as much moisture as the foot produces. Also, since moisture is transmitted by an adsorption/desorption process the permability increases with the amount of moisture present reaching a maximum when the leather is saturated. It has also been shown that absorption contibutes more to foot comfort than permeability.

Many poromerics have permeability comparable with some leathers, but leather provides a more satisfactory environment in the shoe by virtue of its greater capacity for water absorption.

By incorporating more hydrophilic fibres it should be possible to improve the absorbency of poromerics.

P.V.C. coated fabrics are impermeable, and of very limited absorbency (provided by the backing fabric).

In a wear trial of leather, poromeric and P.V.C. coated fabric uppers, the latter were found to be the least comfortable due to an appreciable build up of moisture.

Polyurethane coated fabrics have a degree of permeability depending on film thickness and type, but in most cases the combined permeability/absorbency is insufficient to provide complete foot comfort.

d) The degree of water repellency required must be dependent on the type of shoe.

Most leathers are 'shower-proof' and can be rendered for all practical purposes 'waterproof' by suitable treatment.

Practical experience has shown that water repellency of poromerics is only achieved at the expense of permeability.

The impermeable P.V.C.'s will, of course, be waterproof, but the permeable polyurethane films will not be completely water repellent. The great weakness in such footwear is the lack of water-proofness of the seams. They do not bed down, or in the case of stitch holes, close up readily.

e) Low thermal conductivity:

It must provide sufficient insulation to protect from extremes of temperature, but must not retain excessive body heat.

Leather is a good insulator. It owes this property mainly to the fact that it holds a considerable quantity of entrapped air (up to 50% in the case of full chrome leather). Thus the warmth of the foot is maintained in winter, but in summer, when perspiration increases, the leather becomes more conductive, and cooling is effected, (a) by increased conduction, and, (b) by evaporation of moisture (latent heat of vaporisation).

Poromerics are themselves good thermal insulators, but, as with leather, their conductivity is increased by the presence of moisture. Since there is almost always an accumulation of sweat in footwear with poromeric and coated fabric uppers this often results in chilling in cold weather.

f) Strength:

It must be sufficiently strong to withstand normal strains in wear.

Leathers owe their outstanding tensile and tear characteristics to the strength of the fibres and the intricate interweaving of those fibres. Failures only occur where this structure is particularly loose or where degradation of the fibres has occurred prior to tanning, or subsequently, by the degrading action of perspiration.

In general, the poromeric, unlike leather, achieves its strength by a glueing together of the fibres. An increase in strength results almost inevitably in a reduction in flexibility and increase in modulus. A compromise has to be made and poromerics are, in general appreciably weaker than leather of a similar substance.

Most polyurethane coated fabrics were produced originally for the clothing industry, and hence have relatively low tear strength. They need to be adequately reinforced when used in footwear.

g) **Resistance to degradation:**

It must not be affected by perspiration.

Leather - Hides are tanned to protect them from degradation. Excessive perspiration can cause detannage leading to embrittlement of the leather, but because there is little likelihood of perspiration build-up in a leather upper, this type of failure rarely occurs.

Early poromerics showed premature failure due to hydrolysis of the polyurethane. The problem has now been largely overcome by changing the prepolymer and by using stabilizers.

Polyurethane coated fabrics are subject to the same type of failure as the poromerics. P.V.C.'s become brittle through plasticizer migration. Choice of suitable plasticizers greatly reduces the incidence of this type of failure.

h) **Finish fastness/Scuff resistance:**

It must retain its original finish/gloss or be capable of restoration by polishing. The finish must be resistant to abrasive action.

There is a wide range of finishes which can be applied to leather. By a suitable combination of these, satisfactory resistance to rubbing and scuffing can be obtained.

The finishes of most poromerics are fast to rubbing. They are, in particular, more resistant to wet rubbing than leathers, so that they can be cleaned by means of a damp cloth. Their scuff and abrasion resistance is dependent on the structure of the microporous layer, as well as the chemical and physical nature of the surface film. The scuff resistance of most poromerics is reasonably good.

P.V.C. coated fabrics are in general resistant to surface damage.

Polyurethane films are much less firmly attached to the base fabric and hence are more prone to damage by scuffing. This is particularly so in the case of thin films which are readily fractured.

i) Resistance to flex cracking:

The material itself, or the finish, must not crack on flexing.

Leather owes its superior resistance to flexing fatigue to their unique structure. Provided the finish has elastic/modulus properties compatible with the leather and provided its adherence to the leather is satisfactory, flex failure is unlikely.

Poromerics are in general inferior to leather in their resistance to cracking on flexing, but nevertheless most stand up to normal wear.

Flex cracking is a particular hazard with P.V.C. coated fabrics. Because of their thermoplastic nature they show an increased tendency to crack in winter conditions. This can also be aggravated by plasticizer migration (see (g)).

Polyurethane coated fabrics vary considerably in their flexing qualities. Flex crack resistance is dependent on type of polymer, film thickness and adhesion to the base fabric; and can even be affected by quality of pigment.

j) Adhesion of Finish:

The adhesion between finish and material and between finish coats must be sufficiently strong to prevent peeling.

Polyurethane finishes, because of their poor adhesion to the substrate (leather or synthetic) are the most susceptible to peeling in wear. Where adhesion is inadequate peeling occurs from any points where the finish has been broken, e.g. the feather edge or from flex cracks or scuffing.

k) Capable of fabrication:

The upper components must be capable of being joined e.g. by stitching or welding.

Another feature of leather which is a direct result of its complex fibre weave is its stitchability. It can be stitched with very little loss in strength and the stitches will be held firmly and show little tendency to pull through. This is important in fashion shoes as it enables the shoemaker to use very fine stitching with only a very narrow edge margin.

With poromerics stitchability is not quite as good as with leather, but has been found satisfactory. Use of the correct shaped needle is essential and much more important than with leather. The integral poromerics can be welded with ease without using adhesives; the layered poromerics cannot.

Coated fabrics react in much the same way as poromerics. Before welding, some preparation needs to be carried out, buffing or solvent wiping, as well as coating both surfaces with an advesive.

1) **Lastability:**

It must withstand the strains imposed in Lasting.

Leather is the easiest upper material to last because of its ability to both stretch and compress. Even heavy weight leathers can be lasted with comparative ease because of leather's ability to absorb moisture quickly and consequently become more malleable.

The main cause of problems in manufacture is the inability of the grain surface to stretch as much as the main body of the leather. This results in unsightly cracking of the grain surface. This occurs mainly at the toe area where most stretch takes place and results in shoes which are unacceptable in appearance.

Poromerics are not as easy to last as leather because of their lack of compressibility. Satisfactory results can be achieved when the correct pattern cutting techniques are used and the lasting machines are set up accurately. Some poromerics have so much ability to stretch that it is an embarassment. In this case the material needs to be taped and backed to restrict stretch rather than to strengthen.

Coated fabrics are incompressible like poromerics so that pattern cutting is again very important. Some polyurethane coated fabrics tend to be rather weak in the weft direction. This means that the cutting direction becomes very critical for good results to be achieved at lasting.

m) Shape retention:

By treatment, such as heat setting, it must be capable of retaining its shape after slipping from the last.

Leather - excellent results can be achieved by either leaving on the last for up to 7 days or heat setting at 120°C for 5 minutes. Forcing excess moisture into the leather after lasting has the effect of relaxing the tension on the leather which, in turn, produces better shape retention.

Poromerics and Coated Fabrics - because of the thermoplastic nature of these materials moisture has little effect on them. Higher heat setting temperatures are required than those used with leather. 140°C for 5 minutes would be required to produce results comparable with leather.

n) Sole adhesion:

It must be capable of bonding firmly to soling material.

As long as leather is prepared correctly, i.e. the grain layer completely removed to expose the corium, good bonds to all types of soling materials can be achieved. Occasionally certain leathers cause problems because of their high oil content which breaks down the bonding adhesive.

Preparation of poromeric materials is also most important. The correct method will vary from one material to another and, therefore, the manufacturer's recommendations should be closely followed.

The same comment also applies to coated fabrics. P.V.C. coated fabrics are prepared with felt wheel or solvent wipe, but polyurethane adhesives on both upper and the sole, must be used.

Polyurethane coated fabrics are prepared with fine wire brush to expose but not damage the fabric layer.

o) Heat resistance:

The material and the finish must be unaffected at the temperatures used in manufacture.

Most semi-chrome and all full chrome leathers are sufficiently heat resistant for current shoemaking techniques, e.g. heat setting, back moulding, etc. However, full chrome leathers are necessary for direct vulcanizing. Thermoplastic finishes can give problems.

With poromerics higher temperatures are required for heat setting, but in general these can be achieved because they are stable at these temperatures.

Coated fabrics are readily marked at heat setting.

p) Versatility:

It must meet the demands of fashion in types of construction and finish. The material should not impose limits on the design.

Leather - by selection of skins, tanning processes and finishes it is possible to achieve most of the effects required by fashion designers.

Although poromerics can be given different types of finish, they cannot be given the 'handle' of some of the softer leathers.

P.V.C. coated fabrics are rather limited in their application, but polyurethane coated fabrics are ideal for many of the current footwear styles.

q) Economy:

The fact that poromerics are supplied in rolls gives some economies in manufacture compared with leather. Polyurethane coated fabrics are slightly more expensive than the lowest priced poromerics. P.V.C. coated fabrics are the cheapest.

B. Linings.

Many of the properties required in upper outside materials are also required in linings; but notably, flexibility, permeability, and absorbency.

Leather is without doubt the best lining material; alternatively, if the shoe is of a type which is acceptable unlined, it should be so made. Again however, with the cost of leather rising rapidly, alternatives have been developed. They may be grouped under three main descriptions:-

a) P.V.C. coated fabrics. As they are impermeable, and have limited absorbancy, they should be used as quarter linings only. They are adequate as linings for strap sandals.

b) Foam-backed synthetic fabrics. These linings, used mostly in women's shoes give an immediate feeling of comfort: but their lack of absorbency can lead to discomfort in wear. Some of these materials are therefore perforated; this makes them somewhat more acceptable.

c) Random fibre fabrics. This is a relatively new development, which looks promising. The materials have good permeability and absorbency; but so far their structure demands a minimum substance which renders them suitable only for quarter linings, in which function they perform well.

The same assessments apply to socks, which are, after all, a lining for the insole.

III. "SUPPORT" COMPONENTS.

A. Insoling.

The insole is the foundation of the shoe, being the base on which to work and contributing largely to the ultimate shape retention and performance in wear of the finished product. During the last twenty years changes in manufacturing processes have been such, that the requirements for a good insole have changed accordingly.

The original demands were that the insole should receive and hold securely in wear the tacks, staples, stitches or ribbing demanded by welted, nailed, rivetted or stitchdown constructions. These demands were great and only the strong fibrous structure of a well prepared leather would cope with them. It also gave, as is still the case with it and upper leather, good foot insulation, absorption and permeability, and good shape retention. Adhesives had not been developed for use where a good strong direct bond, as in sole attaching, was required. Further, the substance required to hold stitches and nails made shoes rigid, which gave rise to the need to "break shoes in". As the effects of water and perspiration built up in the leather insole, it blackened and hardened, contributing to the deterioration of the shoes.

Hardening, curling and ultimate cracking of insole leathers under heavy perspiration conditions caused shoes to curl up at the toes, because of the overall shrinkage of the leather fibres. Much work was done by tanners to produce the ideal insole tannage, but at a high price.

Nonetheless, flexible leather insoles on modern lightly constructed cemented shoes or stuck-rib welts are still very good, if the price demanded can be met.

The following are major changes in shoemaking techniques which have led to changing specifications for insoling:-

a) Cement lasting;

b) Stuck-on unit soles, moulded or cut;

c) Direct moulded and injection moulded soles;

d) Stuck on Goodyear rib.

These techniques do not require a tough, thick, fibrous insole.

e) Modern Soling units, especially those used in heavy duty or casual shoes, which are thick and robust (yet lightweight) have considerable shape retention and foot protection themselves, thus diminishing the need for these properties in the insole.

f) The use of prefabricated "unit" insoles with a flexible forepart and waist reinforced by shank backer boards supported by a steel shank, give the necessary good arch support, contributing not only to the durability (especially of women's high heeled shoes), but to the clip of the top line.

The numerous insolings available now may be grouped under the following broad heads:-

a) Latex-bonded leather fibre boards.
Both chrome and vegetable fibre boards can be prepared for a variety of uses, either with a full protective sock or coloured pigment finishes.

They are:-

- i. Flexible
- ii. Resistant to side compression, so may be used for direct moulded shoes.
- iii. Resistant to abrasion and scuff.
- iv. Absorbent and permeable.
- v. Reasonably satisfactory in wear.

However, some tend to be:-

- vi. Dimensionally unstable under high temperature and/or moisture conditions (as in heat setting, and some moulding-on).
- vii. Prone to cracking at the flex points when foot perspiration is higher than normal.

b) Cellulose bonded boards:

These are:

- i. Completely stable under quite extreme conditions of heat and moisture.
- ii. As good as the best of leather boards in internal laminar structure.
- iii. Resistant to sideways compression.
- iv. Not quite so resistant to scuff, as leather board, in certain extreme conditions.
- v. Absorbent and permeable.
- vi. Satisfactory in wear, retaining a clean appearance longer than leather board.

c. Shank reinforcing boards:

These are mainly made of compressed paper. They give adequate support to the waist area when supported by steel shanks (or wooden shanks in lower heeled men's shoes). The difference between the various grades offered lie in their inter-laminar strength, their general stiffness, and their resistance to the pulling through of heel pins. This last requirement is most important and is often overlooked.

Under conditions of high moisture concentration however (particularly in fashion boots and winter boots) these boards may deteriorate rapidly and break up. Also, problems of interlaminar tear when using modern hot-melt lasting adhesives can cause damage both during production and in wear.

Resin bonded thermoplastic shank boards overcome these problems, but at a price.

Generally, these boards are as stable as the cellulose bonded insoles.

d. Recent developments:

i. Expanded E.V.A This has been tried experimentally for some time, and has most of the qualities necessary for flexible insole foreparts, notably extreme flexibility; complete stability; resistance to rotting and deterioration.

Some disadvantages are:- low resistance to sideways compression; some difficulty in bonding, especially in two-part strip insoling.

ii. Random fibre boards. This is a most promising development. Internal laminar strength is some four times greater than the best of the cellulose or leather boards: it has good flexing, absorbency and permeability.

iii. Plastic shank backers. Numerous attempts have been made to provide plastic shank backers with the aim of getting over the drawbacks mentioned above, of the compressed paper ones. So far no totally satisfactory product has been made. Cost is high, because moulds have to be made to accomodate many different sizes and shapes; and cement lasting is rendered very difficult.

B. Stiffeners.

Stiffeners are required to support the back of the shoe in wear, and to maintain a shape which grips the heel of the wearer. Thus, in addition to having to meet the demands on all shoe components as to permeability and absorbency, it must also be structurally strong, but not so strong that it hurts the foot.

Most shoemakers would agree that leather still provides the best stiffener:- it has good shape retention as well as a kindly feel. Only a few bespoke shoes are made with them, however; the cost and the difficulty of processing, has eliminated them entirely from batch-produced shoes.

Work has been done with pre-moulded polythene stiffeners, which have excellent shape retention (the shape is virtually unchangeable, in fact) and a good feel; but difficulties with bonding have halted development.

There are three main types, widely used:-

i. Premoulded leather fibre board.

Gives good bond.
Has good shape retention.
Has relatively kindly feel, depending upon quality.

ii. Finger moulded fibre board impregnated with thermoplastic resin:

These stiffeners are more and more widely used, as more shoes are back moulded and not seat lasted.

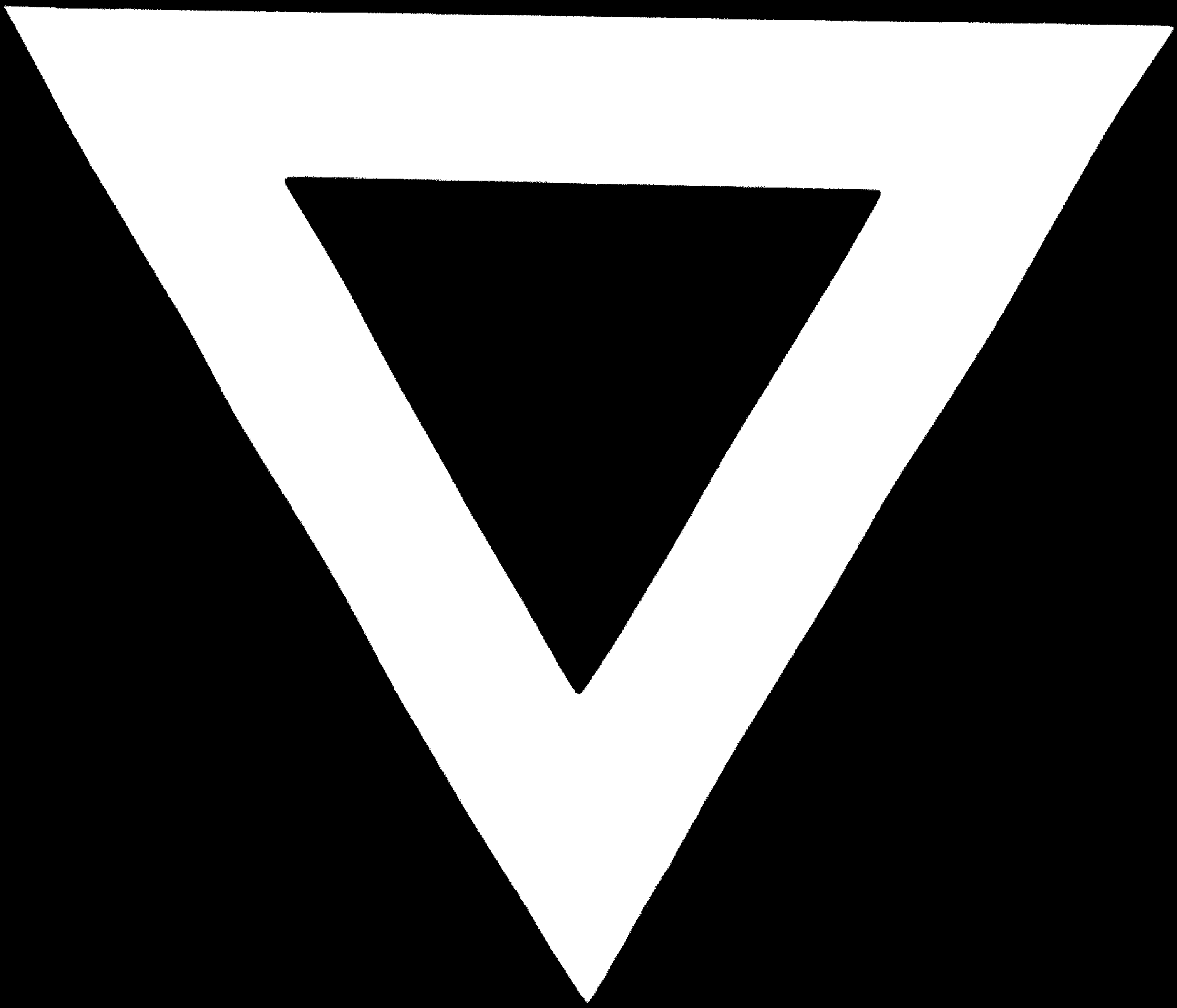
They give adequate wear, but are not quite so good as the pre-moulded stiffener. However, although shape deterioration starts earlier than with (iii) below, it takes longer to complete. This stiffener is therefore generally used in men's shoes and children's shoes.

iii. Fabric based thermoplastic resin impregnated stiffener:

Again used in shoes which are made by back moulding. It is easier to process that (ii), since it softens more readily. Also it has better initial shape retention, but deteriorates somewhat more rapidly. It is therefore generally used in women's shoes.

iv. Random fibre thermoplastic resin impregnated stiffener:

This is a very recent development. So far, it would appear to have very little extra to offer over (ii) and (iii) above.



13.8.74