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RESTRICTED

DP/ID/SER.A/66
26 July 1976
English

07292

ASSISTANCE IN THE SURFACE FINISHING OF WOODEN CASE GOODS FURNITURE

IS/HUN/74/006

HUNGARY

Technical Report: Improvements in surface colouring, printing and coating

Prepared for the Government of Hungary by the United Nations Industrial Development Organization, executing agency for the United Nations Development Programme

United Nations Industrial Development Organization

U. 76-8706

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Prepared for the Government of Hungary by the
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Based on the work of George E. Kirk, expert in surface finishing of furniture

United Nations Industrial Development Organisation
Vienna, 1976

Explanatory notes

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

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

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Hungary is the forint (Ft). During the period covered by the report, the value of the forint in relation to the United States dollar was $US 1 = Ft 20.829.

The following abbreviations are used in this report:

DIN	Deutsche Industrie-Norm (German Industrial Standards)
PVC	Polyvinyl chloride
UF	Urea-formaldehyde
UV	Ultraviolet

ABSTRACT

The project "Assistance in the surface finishing of wooden case goods furniture" (IS/HUN/74/006) originated in a request for technical assistance made by the Government of Hungary, in September 1974, which was approved by the United Nations Development Programme (UNDP) on 16 January 1975. The United Nations Industrial Development Organization (UNIDO) was appointed executing agency and the Hungarian Ministry of Light Industry was the counterpart agency. The purpose of the project was to advise on improvements in the surface colouring and printing procedures used in three recently modernized wooden case goods factories. Although the modernization programme has led to an increase in production to the point where it can virtually satisfy domestic requirements, an improvement in the quality of coatings is still considered necessary both for the domestic market and, more particularly, to enable the industry to compete more successfully in export markets.

This report covers the first part of the project, which began on 28 March 1976 and lasted one month. The following points are stressed in its conclusions.

1. Panel surfaces are prepared in such a way as to prevent the best possible use of the coating materials. This remains the biggest obstacle of all, and it will be impossible to derive benefit from modern coating materials unless a dramatic improvement in surface quality is achieved.

2. There exists a degree of confusion in the factories regarding coating material specifications and testing methods.

3. Existing machinery is in need of overhauling and replacement parts in order to maintain the quality and level of production.

4. Further training of the workers is required at all factory levels.

5. Inspection is designed to rectify defects rather than avoid their recurrence, and is not treated as seriously as would be required for a higher quality standard.

6. The standards for control applied in the coating departments seem to be suitable for the materials and processes used, but the checking of coating weight and viscosity during operation of the plant is not frequent enough.

Specific recommendations are made on both a first-aid and long-term basis for each factory, while recommendations on broader matters and future developments are addressed to the Ministry of Light Industry. The latter, more general, recommendations stress the need for more training, inspection and engineering facilities, the importance of finding and correcting existing faults within the factories concerned, and the adoption of a more uniform approach to the testing of raw materials throughout the furniture industry.

The mission covered by this report is to be followed up by another in the near future.

CONTENTS

INTRODUCTION

In Hungary, the furniture industry employs approximately 6% of the country's working population, this number being spread among 100 factories. Among these are three factories located at Győr, Zalaegerszeg and Nagykanizsa, which employ 850, 1,600 and 1,540 workers respectively. The factories experienced varying degrees of re-equipment over the period between three to five years ago, and in each case new automated production lines for printing and coating were installed.

The case goods type of furniture, with which this project is primarily concerned, is constructed from particle board and covered with veneers, from either native or low-cost tropical species which may or may not be printed by a two-colour process. At present, the coating is made with either clear polyester lacquer, clear nitrocellulose lacquer or acid-cured lacquer. The coating equipment used was imported from the Federal Republic of Germany and Italy, but after installation its maintenance has been ensured solely by the engineering department of the company concerned.

The furniture industry, as a whole, has a turnover value in the region of Ft 980 million (approximately $47 million), and 15% of its products is exported - one half to countries with centrally planned economies and the other to developed market economies. On the other hand, some 12% of furniture sold in the country is imported.

While the effect of modernizing the factories some years ago has been to raise the level of production to the point where it can virtually satisfy the domestic requirement, it is considered that an improvement in the quality of coatings is required, both for the domestic market and, more particularly, to enable the industry to compete more successfully on the export market. As part, therefore, of the 1976-1980 Five Year Plan, the Government is prepared to make a further investment in the industry in order to achieve these aims.

In view of the successful results of previous UNIDO projects (in completely different fields), the Government decided to request assistance in regard to this problem. There had been no previous request to the United Nations Development Programme (UNDP) for assistance to the furniture industry, though a parallel request has gone forward for assistance in the field of upholstered furniture production. The request was formally made on 6 September 1974 and the

project "Assistance in the surface finishing of wooden case goods furniture" (IS/HUN/74/006) was approved on 16 January 1975, with the United Nations Industrial Development Organization (UNIDO) acting as the executing agency and the Hungarian Ministry of Light Industry as the counterpart agency. The original contribution of UNDP was to have been $7,500, but was increased to $9,000 for the three-month period covered by the project as a whole, which it had been decided to divide into two assignments. This report covers the first assignment, which started on 28 March 1976 and lasted one month. The second part of the project is to take place in the near future.

The expert was attached to the Hungarian Ministry of Light Industries, and had the task of advising the management of three recently modernized factories at Győr, Nagykanizsa and Zalaegerszeg on modern surface staining, printing and finishing procedures for wooden case goods furniture. His duties included, in particular, the following:

(a) Assessing the present technology used for the surface finishing of the products;

(b) Recommending the necessary changes in the technology used to improve productivity and quality;

(c) Recommending the quality control procedures for the raw materials plates and the finished products;

(d) Specifying the equipment necessary to carry out the above-mentioned tasks;

(e) Recommending the measures to be taken by the industry, the Hungarian authorities and international organizations to ensure a rapid improvement in the quality of the products and the profitability of the plants.

It was agreed that the first assignment should be diagnostic in nature, so that immediate first-aid recommendations leading to quality improvements might be possible, but its main function was to assess general conditions and prepare, as fully as possible, the information which will be necessary for the proper completion of the second part of the project.

I. PROJECT OPERATIONS

A. Summary of activities

The mission began with a discussion at the Ministry of Light Industry which gave the project a more complete perspective, and a programme was prepared for visiting the three furniture factories using flat-panel automated lines at Győr, Zalaegerszeg and Nagykanizsa. During those visits note was taken of the working of the plant, including details of plant installations and standards of technological performance and a general assessment of the surface finish. Suggestions designed to improve quality were put forward on both a first-aid and a long-term basis, and in each case, on request, plant modifications for increased production were discussed. A related visit was made to the offices and factory of Budalakk, a Hungarian manufacturer of lacquers, where points raised at the other factories were discussed and suggestions were made in regard to new materials suitable for the automated coating plants. Visits were also made to a chair factory, to the Bubiv furniture factory, which is the largest in Hungary but which is not included in this project, and to the Quality Control Institute, where Hungarian quality specifications relating to furniture coatings were discussed and demonstrated. Finally, a further meeting was held at the Ministry of Light Industry, attended by representatives of the Ministry and the directors of the three furniture factories, during which the points raised at the individual factories were openly discussed.

B. Visits to government departments, factories and institutions

Ministry of Light Industry

The programme for this assignment commenced with a meeting at the Ministry of Light Industry, at which a description was given of the significance of the furniture industry, which employs 6% of the working population and can supply the majority of domestic requirements, leaving only 12% of demand to be imported after exporting 15% of its production. There is, however, some dissatisfaction with the quality of production, and a substantial improvement is considered necessary if the plan to export at least 2.5% of production to western countries is to be realized. The major objective of the previous re-organization has been achieved, inasmuch as the supply of furniture has been considerably increased and domestic demand and supply are now in approximate balance, but the department head in question felt that improvement was needed even for the domestic market.

There is a shortage of labour and, though a considerable increase in output is sought, there is no prospect of a significant increase in the number of workers. If plans can be put forward which would justify investment, then the capital can be made available. Naturally, if new plant is installed or a major re-organization carried out, it would be expected to incorporate up-to-date technology, and even while such plans are being formulated or brought into effect, it is hoped that technology will be modernized as far as possible in the existing plant.

The materials used in this industry come from various sources. Hungary, for example, makes particle board, for which a new factory has recently been built with an output of 100,000 m^3 per year. There is also a factory making flaxboard with a present capacity of 40,000 m^3 per year, which is due to be extended in 1977.

Of the veneers, half are home-produced and half are imported African and various other tropical hardwoods. Similarly, some Hungarian softwood (deal) is used for frames; some beech is home-produced and some imported. Urea-formaldehyde glue is used for hot-pressing the veneer to the particle board. Some of the coating materials are produced by a Hungarian company called Budalakk, which makes both polyester lacquers and nitrocellulose (referred to hereinafter as nitro) lacquers, but 40% is imported, partly because of a shortage of production capacity and partly because of the unavailability of certain types. In general, the present coatings are not regarded as fully meeting the requirement of hardness, in the sense of resistance to wear.

A programme of visits to the factories was agreed during the meeting at the Ministry of Light Industry, and it was confirmed that the first assignment, in view of the short time available, should have a diagnostic function, identifying as far as possible any shortcomings existing in the industry, producing recommendations to allow first-aid measures to be taken as appropriate, and assessing product quality and working methods. The improvements resulting from the measures taken could be assessed during the following assignment.

After the visits to the three factories had been made, a further meeting was held at the Ministry attended by representatives of the Ministry and by the directors of the factories. The recommendations which had been prepared for each factory were made openly, since it was felt that each director could learn something useful from the experiences of other factories. Matters of wide

interest, such as the need for more training, inspection and engineering facilities were discussed, with particular emphasis on the importance of finding and correcting the faults which existed within the factories concerned before looking outside, for example to Budalakk, for somewhere to lay blame.

There has been a change in outlook regarding surface coatings, and a trend towards the use of acid-cured materials at the expense of polyester lacquer is predicted. There is also expected to be an expanding requirement for the types of material listed below, for which satisfactory supplies are not available:

Clear acid-cured glossy and matt lacquers

Pigmented acid-cured lacquers

Stains with "non-grain-raising" characteristics, suitable for application by machine on a flat-panel line

Ground coats for printing on veneers

In this connexion, advice was requested on possible suppliers of such materials and plant (see the recommendations addressed to the Ministry in chapter II of this report).

Cardo Butorgyár (Györ)

This factory is 60 years old, and was restored after 80% of it had been destroyed during Second World War. It has grown piecemeal by occasional addition and the layout is not conducive to a smooth work flow. Some modernization took place from 1970 to 1972, resulting in a production increase of 50%. Further modernization is scheduled for completion in 1977 to 1978, and it is hoped that a further increase of 60% can be obtained by 1980, bearing in mind the shortage of workers, the number of which can be expected to increase by only 0.4% in the corresponding period. An improvement in technology is sought which will provide a necessary increase in the level of quality and, in this respect, specific advice was requested from the expert, either immediately or at a later date, in regard to both the types of new machines required and the new materials and techniques to be used on them. It was anticipated that progress would take place in stages.

The present production is limited to 3 or 4 different sets, each set consisting of about 12 pieces, such as cupboards, wardrobes, wall units, coffee tables, chairs, single beds and French-type double beds. The different

sets are characterized, apart from design, by the use of different veneers and different surface coatings. The production of different sets is run in batches to cut down waiting time. There is a special set of furniture, in solid beech frames with pre-painted hardboard panels and beech veneers, which is exported to the Federal Republic of Germany. The plant is operated on the basis of two shifts of eight hours each day and one shift on Saturdays, thus ensuring a daily output of 40 to 45 sets having a surface area of 2,500 m^2.

The types of veneer used include the following (0.6 to 0.8 mm thickness):

Okoume (used with a two-colour print)
Oak (for which a special stain and staining process is requested)
Sapele, mahogany avodire (very pale with a structure similar to sapele)
Beech (also used as solid)

When beech is used as a solid it is kiln-dried, but solid deal, which is used only as the framework for upholstery, is not kiln-dried.

The difficulties of this factory begin to show as soon as material is taken from the store. Piles of timber which have been stored in the factory yard for seasoning have to be unstacked by hand, loaded on to a trolley, and pushed by hand into the kiln, and the process is reversed, again by hand, when drying is completed to a humidity content of 11% to 12%.

The particle board, which is produced in Hungary, has a density of 600 to 800 kg/m^3 and a slightly densified surface (only two thicknesses are used - 14 and 19 mm). It is brought to thickness by a Carstens top and bottom contact sander. The veneers are cut and stitched by machine and applied to the particle board panels, previously cut to size, using a urea-formaldehyde glue and hot-pressed either in a shuttle press or a fixed press with six daylights. At this point, a number of defects, such as open joints and splitting, were visible. The boards next pass to an edging machine which cuts them to size and applies a strip of 1-mm veneer to the edges by means of hot-melt adhesive, then trims off the surplus in order to form a square corner along the edge of the board. Some very poor cutting was seen on this machine, the veneer was tearing at the cut edges of both face veneer and edge veneer, so that the edges frequently had a rough and ragged appearance.

The outside of the boards is sanded on a Bottcher and Gessner contact sander with two pads, using 100 or 120 grit on the first and 120 grit on the

second. When the solid beech parts are used on this machine, the belts are 40 grit on the first and 60 to 80 grit on the second. The inside faces of the boards are belt-sanded by hand. Final sanding before coating occurs on the first machine of the coating line which uses 220 grit. The disparity of sizes of the grits being used makes it impossible to sand out with the final operation the marks left by the previous operation. While this is of little account in the case of a polyester coating and may even provide improved adhesion, the surface is not left smooth enough for the nitrocellulose coating process. Moreover, the hand operation of the belt sander does not leave a surface sufficiently "true" to enable it to be coated evenly on the roller coating machine.

By this stage, it is apparent that a number of the machine operations are not being carried out successfully. Many of the machines are very old and it may be impossible to bring them into first class condition. The quality of maintenance is difficult to assess since the machine age must be taken into account. The choice of grit on the Bottcher and Gessner sander could be changed to give a more even transition, say to 120 and 180, but the hand-operated belt sanders would need to be replaced with a contact sander (cf. the Alberti/Stemag combination at Zalaegerszeg).

Two factors influence the continued passage of boards which are in an inadequate condition along the production line. The first is an apparent lack of background and experience on the part of the machine operators, who may genuinely have had little or no experience of these operations outside the immediate vicinity of the operation for which they are responsible. The second is inspection which operates only to exclude thoroughly bad boards but does not seem to diagnose the operation responsible for producing a low quality result and then feed back the information to that point so that something could be done to avoid the continuance of poor quality production. These two factors are inter-related since if there were to be a feedback of information showing the result of faulty operation, there would be a better understanding of the way that operation should be carried out and an improvement in quality should follow.

A detailed analysis of the equipment installed in the coating line is given in annex II. The coating materials used are a nitro-based basecoat, a nitro-based topcoat, an acid-cured topcoat used over a basecoat believed to be

nitro-based and clear polyester lacquer. The polyester lacquer is used on the outside faces of doors and on table tops. The nitro-based material is used on the inside surface of doors and both inside and outside of carcasses. The acid-cured system is used on the special furniture for export to the Federal Republic of Germany, and also on various solid beech frames, e.g. for tables. The acid-cured lacquer is sometimes applied by pneumatic spray, whereas the other types are applied on the automated line.

The following information regarding specifications and properties was made available at the Győr factory and should be compared with the information obtained at the other factory units described in this report.

Polyester Lacquer

Flexadur 102: supplied by Budalakk (Budapest)
Viscosity as supplied: 45-60 sec DIN 4 at 20°C
Gel time: 5-6 minutes
Mixture for gel test:

		Proportion by volume
(i)	Flexadur 102	100
(ii)	Cobalt naphthenate (6% metal)	3
(iii)	Finox C 50L (C.H.P. solution)	4
(iv)	Paraffin wax solution	1

The mixture is held in a water bath at 30°C and the time of gelation is taken at the point where the mixture forms a string when stirred. If necessary for a particular batch of material, the cobalt addition is modified in order to adjust to within the required limits and, from this adjustment, the actual mixture used in the plant is derived for that batch of resin, with the addition of styrene to reduce viscosity (in both heads) to 24-28 sec DIN 4 at 20°C.

Polyester Lacquer

Polystoll: supplied by Stolllack (Austria)

There is a similar procedure for testing this as for the Flexadur 102, but the gel time is normally faster and the proportion of cobalt in the mixture is reduced. Viscosity limits are adjusted with styrene to the same figures.

Nitro basecoat for roller coating

Budalakk reference 010: supplied by Budalakk (Györ)
Viscosity as supplied: 100 sec DIN 4 at 20°C
Non-volatile: 33%
Composition: nitrocellulose alkyd resin, plasticizer

Before use at the plant, there is an addition of 3% of a matting (or sanding) agent for 010, and the viscosity is adjusted with a mixed thinner to 45-60 sec DIN 4 for use on the roller coating machine or for spraying.

Nitro topcoat for curtain coating

Budalakk reference 012: supplied by Budalakk (Györ)
Finish: semi-matt
Viscosity as supplied: 80 sec DIN 4 at 20°C
Viscosity as used: 35 sec DIN 4 at 20°C
Non-volatile: 30%
No adjustment is made to the gloss.

Printing ink

Viscosity as supplied: supplied by Stolllack (Austria); 45 sec DIN 4 at 20°C reduced to 27-30 sec for the machine with approximately 30% of AXD.

Little information was available about this product, the only other information being that in hot weather viscosity needs to be adjusted with AXD at 10 minute intervals.

Roller coating basecoat for acid-curing lacquer

The material supplied has a viscosity of 30-35 sec, and no further addition of thinner is needed for the machine except to maintain the viscosity during operation. It is believed to be based on nitrocellulose, and is supplied by Stolllack (Austria).

Acid-curing lacquer

Deck Lack T. M. is supplied by Stolllack (Austria). It is used with 3% addition of catalyst and believed to be HCl. The viscosity as supplied is 45-50 sec DIN 4 at 20°C, and it is thinned with a 4-5% thinner for use at 35 seconds. The drying time and pencil hardness (8H) are checked after application on a veneered panel. There is no adjustment of gloss.

Medium oak stain

This is supplied by TVK (Hungary), and used on an experimental basis by hand application on a new range of furniture.

Operation of the coating plant (Győr)

Edges are first sprayed in a booth outside the shop. The over-all speed of the flat panel line was measured and found to be 14 m/min. This made loading and off-loading a difficult operation and seemed not to be justified by the volume of work since the spaces between the panels were quite long. Damage was seen to result from this speed. The spacing is, however, necessary because of the lateral transfer unit halfway along the line which requires gaps of at least one panel length, since the operation is, of course, intermittent. Substitution of this unit by a continuous bend would allow slower operation; however, a bend may be impossible because of the narrow width of the shop.

The first sanding machine does very little good for reasons already described. The first roller coating machine was without an application roller at the time of the visit, and it is in this position that a staining roller coating machine would be installed if the plan to stain by machine is put into effect.

The drying tunnel which follows is heated by electric elements, and in spite of the ventilation, it is doubtful whether this is good practice - certainly it is not ideal - in view of the safety risk with solvent vapours present. Even a switch operated by air flow in the ventilation system capable of switching the elements might not prove effective, in the event of ventilation failure, due to the thermal inertia of the elements. It was not possible to measure the surface temperature of the elements, so the risk could not be assessed.

The Olympic two-colour printer was seen operating with only one cylinder, but both were seen to be worn down to the copper. The operating viscosity of the ink is very low, and coupled with the tendency to need frequent thinning in hot weather, there seems to be a combination which would yield a high wear rate. The cylinder doctor blades were not sharp. High pressure would therefore be needed to maintain a clean print - this would also lead to rapid wear.

The rubber offset roll was very irregular, the doctor blade was not sharp, and wear rate would again be high. There is a contract with a local printing machinery engineer for maintenance of this machine.

It was not possible to assess printing quality during the visit, as the only printing seen was a background print onto beech veneer which was not intended to show detail. The cylinders were protected by a polythene sheeting nailed on a wooden framework which was adequate to protect from dust but not against mechanical damage.

The second roller coater was seen in operation. It is a simple machine not fitted with a doctor blade, and most panels show bands of heavier deposit at the leading end due to evaporation on the roller during the necessary gaps. It was felt that, in order to avoid the complications which would arise if this effect were allowed to produce really heavy coatings, such as blistering due to heat in the drying tunnel, the viscosity should be adjusted to a low level, thereby reducing the non-volatile content. This, coupled with the uneven surface of many panels, fails to give a complete seal of the surface, so that the curtain coating material also has to be reduced in viscosity and non-volatile content to avoid problems when it is dried. The net result is an unattractive surface with a low film deposit.

The twin-headed curtain coater is used to apply either 80 g/m^2 of nitro to soft veneers, such as okoume, after printing, or the first coat of polyester. For this, the first head pours the peroxide mixture and the second the cobalt mixture. The quantity is measured by a graduated cup filled by a small funnel and held in the curtain for 12 seconds. The correct weight deposited depends on the conveyor speed indicated on a dial, but panels of known size are not weighed to check this. The viscosity of materials is frequently checked, and a schedule for machine inspection has been established.

The steam-heated tunnels perform very efficiently on the low solids materials in use. The roller-coated nitro material was dry enough for sanding after the lateral transfer unit. The orbital sander was working well enough in the circumstances, but of course is not used with polyester. The polyester arrives at this point not yet waxed over and receives another coat, firstly of peroxide, then of cobalt mixtures as before, and is placed in the travelling rack tunnel where the full coat was seen to gel in 13-14 minutes.

With a nitro process, the orbital sander is followed by a curtain coating of 80-90 g/m^2 and racked in the tunnel. The output end of this curtain coater leads on to an idle roller conveyor which slopes down in order to bring the panels within reach of the operators. There is no decelerating zone and panels tend to twist on the idle rollers, so that a subsequent panel can overlap, due to the angle between the two conveyors, and fall on top causing damage.

The narrow width of the shop is responsible for great congestion which makes handling very difficult and damage all too likely. Panels finished in nitro are taken out of the shop to be assembled. Panels finished in polyester are taken to an adjoining shop for sanding and burnishing. Sanding is carried out by hand-operated belt sander using first 320 grit, then 400 grit, and burnishing is completed on an automatic machine with calico mops.

It was established that, whilst a printed panel exists showing the quality of printing when the cylinders were new, there is no regular check of print quality and colour from production. A special request was made for advice on the specific type of machine which would apply stain evenly over the surface of oak panels (Furnix range) and the type of stain suitable for use with it to produce a "medium oak" colour.

An analysis of daily production showed that the areas covered by nitro lacquer and polyester lacquer are respectively 7,000 m^2 and 2,000 m^2, the total linear throughput being 20,000 m. For an immediate increase in production the plant layout might be re-arranged in the following order (the numbers refer to the sequence of machines given in the relevant part of annex II):

(1) Sander
(2) Roller Coater
(3) Electric oven - preferably replaced by steam oven (7) for safety
(12) Sander
(4) Olympic Printer
(5) Roller Coater
(6) Curtain Coater
(7) Steam oven, working at low temperatures but, for safety, preferably replaced by machine No. 3 not connected as a heater but only with ventilation to remove solvents
(8), (9), (10), (11) As existing (for transfer, heating and cooling)
(13) Curtain Coater

This would make it possible to achieve a full coating of basecoat and topcoat at this point, leaving the travelling rack oven free. If a curtain coater with sander can be obtained, this could be used to apply on the soft veneers with drying in the travelling rack tunnel. Polyester would pass through as at present. The shop is, however, already congested, and it would be difficult to handle any extra flow of work.

Finally, it was requested that panels representing normal production should be sent to the Quality Control Institute for testing.

Zala Butorgyár (Zalaegerszeg)

This company was formed eight years ago by the concentration on one site of a group of small furniture factories which had existed in that area. The buildings are quite large and modern and extension is proceeding in the dispatch section in order to provide a warehouse with its own rail siding. Modern finishing lines were installed three years ago. The factory has the fourth largest output in the country and employs 1,600 workers. They prefer to use Hungarian coatings, but feel there is an element of uncertainty regarding the quality delivered and consider it wisest to use Stolllack polyester from Austria on the outside faces of doors, with Flexadur, produced in Hungary, on the inside. The quality of the coating has been satisfactory up to now because production had been behind demand, but now that production is close to demand, it is considered that people will become more selective. There is also a strong feeling that an improvement in quality will be necessary to take up a position in new markets, which must include export.

As at Györ, production is based on certain sets of furniture which differ from each other mainly in regard to the type of veneers used. The veneers were more numerous than at Györ and included also koto, sycamore, aco, koris and paldau. Doors were balanced with a coat of polyester on both faces and other parts finished with nitro lacquer inside and outside. Small doors, about 40 cm in length were seen to be finished in Stolllack polyester outside and nitro inside. The particle board is of 600-800 density, with two densified surfaces and containing a UF resin content of 12%.

The large boards are cut to size, and the veneers, which have already been cut, stitched on a Kuper machine and taped by hand, are laid in a shuttle press with a cycle of 70 sec at 120°C for most veneers and 80 sec at 120°C for beech.

Thicknessing of the boards before veneering is carried out to limits of ±0.15 mm on a Carstens contact sander. The boards are then cut to size and veneer is applied to the edges with hot melt adhesive on a Stefani machine; then they are taken to an Alberti/Stemag combination of bottom and top sanders, using 150 grit on the bottom (inside) faces and 150 followed by 180 grit on the top (outside) faces.

Up to this point, the flow of boards is quite well conveyorized and movement is efficient. The thicknessing of the particle board was checked using a micrometer and was within the limits indicated when checked at various parts of the board. A large sequence of boards was seen, however, leaving the final sander with the veneer tapes still showing on the surface - indicating that the sanding head needed to be brought lower. Instead of adjusting the machine, these panels were taken to one side and belt-sanded by hand using a coarse grit (120). Thus, while it could be said that the panels were inspected and action taken, the action did not produce a suitable result and did not aim at preventing the occurrence of bad work. Time was not available to go into the details of thicknessing and machine setting, but such action would be likely to be well justified by an improvement in the panels presented for coating. The edging line was running quite well, giving a good full corner on both the face and edges of the panel.

Such an installation may entail various engineering difficulties. Once the machines are bought and installed by their manufacturers, there is no promise of further skilled attention and service from the manufacturers. Moreover, it is very difficult to take an unskilled worker, possibly without an engineering background, who perhaps has previously been working on the land, and raise his level of skill to the point where he can properly operate a sophisticated machine or even read a micrometer and understand the significance of 4 decimal places. If, when maintaining such machinery, a man with insufficient skill had, for example, to dismantle and re-assemble a bearing, the effect could be quite disastrous. A team of mobile specialists in this type of machinery is therefore needed to deal with maintenance and emergency breakdowns.

Attention should also be given to education at all levels. In this connexion, support might be extended, for example to existing facilities in a nearby secondary school which, being adjacent to a full-scale factory, could provide good practical training for the students.

A detailed analysis of the coating line is given in annex II. The materials used on the coating line include nitro basecoat with nitro topcoat on sides, insides and shelves, also on the inside face of small doors. Doors are coated with Stolllack polyester on the outside face and Budalakk polyester on the inside face.

The following material specifications were provided.

Polyester lacquer

Flexadur 102: supplied by Budalakk (Budapest)
Viscosity as supplied: 45-60 DIN 4 at 20°C
Binder: 100%
Dilution with styrene: unlimited
Gel time: 6-18 minutes depending on mixture

Mixture for gel time test

	Proportion by volume
Flexadur 102	100
Siccosol 0C02	3
Finox C50L	4
Paraffin solution	1
Styrene	0-4

The gel time normally falls within 5-15 minutes and is adjusted to be within 5-8 minutes for use in the factory at a viscosity of 35 sec. By arrangement with Budalakk, the viscosity of the lacquer supplied is, however, 35 sec DIN 4.

Polyester lacquer

Polystoll is supplied by Stolllack (Austria). Tests and adjustments are made in the same way as for the Flexadur but using a lower cobalt content. Gel time is normally 5-8 minutes when received and is adjusted to the same limits of viscosity for the machine.

Nitro basecoat for roller coating and spraying

O10-es alaplakk: supplied by Budalakk (Györ)

Viscosity 70-100 sec: DIN 4 at 20°C

Non-volatile: 26% (minimum)

Drying time: 10 minutes (maximum)

Nitro topcoat for curtain and spraying

O12-es Fedőlakk: supplied by Budalakk (Györ)

Viscosity as supplied: 50-80 sec DIN 4 at 20°C

Non-volatile content: 22% (minimum)

Drying time: 10 minutes (maximum)

Operation of the coating plant (Zala)

The materials are prepared and adjusted, according to the instructions **issued by the** laboratory, by one man responsible on each shift. Coating **weight is** checked and adjusted at the beginning of each shift and there may be **occasional** checking by the laboratory. Weight deposited is checked using an **aluminium** panel measuring 50 x 10 cm and, in the case of polyester, where **both heads** are in use together, the peroxide mixture is checked first, then the **cobalt** mixture pump is started and the double coating weighed. The cobalt **mixture** weight is calculated, and the two should not differ by more than 10-15%. The total film weight (from 4 heads) is 516 g/m^2 for the outside faces and 430 g/m^2 for the inside faces.

There is some variance, according to the absorbency of the veneers and these **figures** have been checked experimentally and conform with the quality **requirement** of the Hungarian specifications. The choice of viscosity has **derived** from tradition and experience. Pouring is not carried out if the **ambient** temperature is below 23°C. The method of control is quite good, but **should be** carried out more frequently. Although in the near future the coating **weight is** to be checked every 2 hours, it would be more appropriate to check **every hour**, or even every half hour.

When the nitro coatings are used, the viscosity **is** reduced by adding **half a** volume of thinners to one volume of lacquer. This is probably brought **about by** the variable surface quality of the boards and by the lack of doctor **blade on the** roller coater. Once again, the surface sealing is far from **complete and** a low viscosity topcoat is needed to avoid bubbling. Topcoat **viscosity** is 20 sec DIN 4. A very low dry film weight remains on the panel **and the** surface appears starved. The printing machine was not seen operating **and, on** inquiry, it appears that very little printing is carried out.

In a separate section, there is a water wash spray booth where sealer is pneumatically sprayed on frames made on solid beech for chairs and tables. After spraying, the sealer coat is dried by passing along a platform conveyor in a drying tunnel at 40°-45°C. After about 5 minutes (the conveyor is controlled by hand, intermittently), it is hand-sanded with 320 grit, sprayed with topcoat, and once more taken through the drying tunnel. As to the relative merits of this type of spraying as compared with airless spraying, it seems, in general, that airless spraying is ideal for spraying into the corners which occur so much on these frames and can give a fuller and more even coat. The airless system cannot, of course, be a substitute for experience and spraying by hand is very much an acquired skill. It is interesting to note that most people agree from experience that it is easier to train a new worker to use an airless gun than to re-train a worker who already has skill in using the pneumatic gun.

Daily production is as follows:

(a) Printing (under nitro): 3,872 linear metres;

(b) Nitro coating (including (a)): 26,631 linear metres

(c) Polyester: 7,961 linear metres.

The conveyor speed is 12 m/min, but is limited in practical terms to 10 m/min. Production is carried on in 11 shifts per week.

Kanizsa Butorgyár (Nagykanizsa)

The enterprise started as the integration of two companies which had been founded in 1915 and 1952 and were united in 1962. Re-organization started in 1969 and was finished in 1972, as a result of which the production level increased by 250%, with an increased labour force of only 8% to the present level of 1,540 workers. The present production is 60/40 in favour of upholstery work to carcass products, and the need is felt to reverse this ratio, so that a very large increase in the volume of surface treatment is anticipated. Plans include the installation of new mill machinery, and close attention will be paid to assisting the smooth movement of work through the factory. There is already a volume of export from the factory which it is intended to increase. Higher standards are therefore sought and advice was requested for help on specific problems, which are subsequently dealt with in the chapter devoted to recommendations.

The coating materials were at one time bought mainly from Stolllack in Austria, but now a change has been made mainly to Budalakk products. In general they are satisfied with the nitro coatings, but have had some surprising results from the Hungarian polyester. The parameters of this material are not consistent, and it is more prone to surface defects than the Austrian material. The furniture design covered a wider range of types than in the other two factories, but only one additional very dark veneer was used.

In the preparation of the boards, special attention was paid to the glue-spreading operation and the veneer press, which are at the centre of a number of problems. The process seemed to be carried out in the proper manner, and assurance was given that the manufacturer's recommendations were being followed for the preparation of the UF glue. It appeared, however, to be rather thin, and this might account for the defects brought to light. During sanding of the boards on a Carstens machine using 100 then 150 grit, close attention was paid to detail, especially on doors, but very many surfaces were sanded with hand-operated belt sanders which leave a far from level surface and are no doubt responsible for much of the trouble experienced on the offset gravure printer, on which it was complained that it was difficult to obtain an even result.

There was a greater level of awareness at this factory than at the Győr and Zala factories of the technology of working with wood, and a high standard in the laboratory and on the coating line. A panel was displayed which had been coated with a tinted material on the roller coater. It showed three colours. At first, there was a heavy colour, extending along the panel for a length which it was agreed corresponded to one circumference of the application roller, then there was a similar length of medium depth of colour and, lastly, a band of light colour. It was pointed out that this demonstrated very plainly what was happening all the time with clear materials but was not apparent. When the roller is rotating without any work passing through, evaporation of some solvent takes place on the roller surface and the viscosity of material on the surface rises. The effect accumulates so that after a very short time, the roller has a thick coating of concentrated, high-viscosity material on its surface which may take more than one revolution of the roller transferring lacquer to a panel to eliminate and replace with fresh material.

At Kanizsa, there is a Hymmen roller coater fitted with a doctor blade which cleans the surface of the application roller at each revolution and ensures that fresh material is fed to the roller all the time. This machine, properly adjusted, can apply quite strong colours without leaving bands of different colour. A detailed layout of the plant is given in annex II.

The coating materials comprise polyester lacquer used on the outside of the doors and nitro finish elsewhere on carcasses. A Kopperschmidt airless gun is used for spraying hardwood pieces and a special nitro topcoat is used for this. The method of pouring the polyester lacquer is interesting. A coat of cobalt mixture is poured first, at 160 g/m^2 and on the same machine 230 g of peroxide mixture is poured. After passage through the tunnels, a single coat of 160 g/m^2 of cobalt is poured, and then the coating is allowed to harden.

The mixtures used in each head were noted and the final composition of the applied film was calculated for comparison with the orthodox mixture.

Table 1. Three-head method for pouring polyester lacquer; composition and density of coatings applied

Coating	Composition of coating (parts by weight)				Rate of application (g/m^2)
	Polyester	Cobalt	Peroxide	Paraffin	
Applied by 1st machine					
1st head	100	6	-	0.5	160
2nd head	100	-	10	1	230
Applied by 2nd machine	100	6	-	0.7	160
Final film	100	3.49	4.18	0.77	550

In the mixture described in table 1, the final weight of paraffin is rather low, but both cobalt and peroxide are on the high side. This may well play a part in the surface defects which have been noticed at this plant. In particular, the paraffin level in the third head is lower than desirable, and better results might be obtained if it were increased.

A four-head method is sometimes used.

Table 2. Four-head method for pouring polyester lacquer; composition and density of coatings applied

Coating	Composition of coating (parts by weight)				Rate of application (g/m^2)
	Polyester	Cobalt	Peroxide	Paraffin	
Applied by 1st machine					
1st head	100	-	7.0–8.0	0.5	125
2nd head	100	5	-	1	125
Applied by 2nd machine					
1st head	100	1	7.0–8.0	0.5	130
2nd head	100	5	-	1	130
Final film	100	2.5	3.5–4.0	0.75	510

Although the total paraffin content is slightly lower in the mixture described in table 2, the cobalt accelerator content is only just over two thirds the quantity required in the mixtures for three-head operation. The key to this is the level of paraffin in the final pouring.

In operating the plant, there have been several difficulties with the heating, which were receiving attention during the visit. Mechanical problems have been recognised indicating wear on some of the machines. The printing cylinders were well protected mechanically by a flexible cover composed of wooden slate glued to a canvas backing. There was further protection for the standby cylinders using a thick padded plastic cover.

The materials checked by the laboratory are:

AMICOL M-50 (UF glue used for veneering)
Nitro basecoat and lacquer
Polyester lacquer
Solutions and thinners

Stains are checked very rarely; they are delivered ready mixed but may be adjusted.

The following specifications were given:

Polyester clear lacquer

Flexadur ER 102: supplied by Budalakk (Budapest)
Viscosity as supplied: 49.5 sec DIN 4 at 20°C
Specific gravity: 1.086
Reactivity: sufficient

The mixture for testing reactivity after adjusting the temperature of the resin to 20°C is as follows:

50 g polyester resin
3.5 g peroxide
2.5 g cobalt naphthenate solution
0.2-0.3 g paraffin wax solution

The maximum gel time is 10 minutes; a normal time is 7 minutes. At gelation, the temperature is about 30°C. The cobalt solution is specified as 5.8 to 6.2% metal content. A formula derived from the test is sent to the works with the acceptance certificate and used for mixing.

Nitro basecoat

Budalakk 010: supplied by Budalakk (Győr)
Characteristics:

	Specification	Typical test result
Non volatile	20-25%	23.0%
Viscosity	100 sec DIN 4 at 20°C	94 sec DIN 4 at 20°C
Visual inspection		Colour satisfactory, free from bits
Drying time of 0.12 mm film	2 min	2.81 min
Specific gravity	0.936	

Nitro glossy topcoat

Budalakk 011: supplied by Budalakk (Győr)
Non volatile: 27.8%
Viscosity: 91 sec DIN 4 at 20°C
Drying: 2.9 min
Visual inspection: colour satisfactory, free from bits.

Operation of the coating plant (Kanizsa)

In this factory, the panels are edged with PVC foil, and there is no need to spray edges before coating. The brushing machine seemed to be operating as efficiently as any of its type, but some panels are received with so much sanding dust on them that the machine could not entirely manage to clean the surface. Measures should be taken in the panel preparation shop.

The first roller coater has no doctor blade, though the second has one fitted as standard. The effect when used with tinted material has already been described and demonstrates what is happening all the time. The viscosities of both top and basecoat are low, and the standard of finish does not match the effort put into it.

A high standard of control was seen exercised in the shop: coating weights are checked by weighing a 50 x 10 cm aluminium panel quite frequently. The printing machine was not seen in operation and was said not to be frequently used though the revised programme of production is likely to call for more printing. Panels for the polyester finish are brushed, then pre-heated and given two coats at the first curtain coater, heated gently in the tunnels, then given a final coat at the end of the flat line and transferred by hand to the travelling rack tunnel. They are taken off, after returning along the rear, for cooling and stabilized for 24 hours before polishing.

There is a Heesemann sander which has two cross belts, using 240 then 320 grit. This last pad does not give good results owing to distortion present on large panels, possibly to the heating effect produced by two previous belts, and possibly to the low paraffin content in the final coat when the three-head process is used. The panels are, therefore, finally sanded by hand-operated belt sander with 400 grit.

Burnishing is completed on a Gianida automatic polishing machine fitted with eight transverse calico mops. Two grades of polishing wax are used, and although extraction devices are fitted, a great deal of wax and dust can be seen in the air near this machine and deposits occur in the immediate proximity. Unfortunately, this machine is sited quite close to the input end of the coating line and there is a possibility that some specks of wax fall on the panels and cause craters.

For nitro panels, the full flat line only is used. Panels are given two roller coatings with sanding only after the first, then curtain-coated and dried in the tunnels before stacking at the end of the flat line. Curtain coating weight is 100 g/m^2.

For hardwood solid parts, the sanding is with 80 then 120 grit and the coating is applied by Kopperschmidt airless spray. The coating can be applied in a very positive manner and the spray goes completely into corners. The chief disadvantage is that normal materials must be very considerably thinned before use and this leaves a low dry film weight. Budalakk has made a special topcoat for this process (004) which can give quite good results. A sealing coat of 010, drastically thinned, is applied, dried in the platform conveyor tunnel, hand-sanded with 200 or 280 grit, and a topcoat is then applied and dried in the tunnel.

At the end of the visit a number of recommendations were made covering various specific points. These appear below in the section devoted to recommendations. It was requested that on the occasion of the next visit, the expert should provide full details concerning the materials and plant necessary for large-scale staining using either a tinted material for roller coating or a stain applied by roller and brushed. In addition, panels should be taken from normal production and sent to the Quality Control Institute for examination on the basis of the appropriate Hungarian specifications.

The rate of production was given as 6,400 m^2 per shift, with 11 working shifts each week. The conveyor is 1.3 m wide and operates up to about 65% of its capacity. There is a five minute break in each hour to minimize the effect of vapour inhalation.

Quality Control Institute (Budapest)

The visit to the Quality Control Institute began with an analysis of a list of specifications operative in Hungary. This made it possible to identify the specifications which were directly of interest to the testing of surface coatings. It was established that a number of the specifications which had been abstracted referred only to dimension, selection of timber and mechanical properties, and that the one of real interest in testing the quality of surface coatings is MSZ/12294/1-7z. This is a parent specification with variations in acceptance figures for different coating types according to the nature of the coating. These are known as MSZ/12294/2, /3 and /4.

The following qualities are tested:

(a) Scratch hardness by pencil method;

(b) Scratch hardness by Clemen method;

(c) Adhesion by a single cross cut;

(d) Adhesion by cross hatch, noting the percentage loss;

(e) Gloss at 45%;

(f) Lacquer thickness by travelling microscope with scale. In the case of pigmented films, the edge of a 45° cut is measured;

(g) Superficial (surface) smoothness, using a special apparatus;

(h) Water repellance after 15 days drying. A drop of distilled water is put in each of four different places at a temperature of 19°-22°C and covered with a glass Petri dish for 10 minutes. The drops are removed with absorbent paper and the surface examined with a hand magnifier for damage;

(i) Chemical resistance is checked in very much the same way but using:

Acetic acid 20%

Ammonium hydroxide 15%

Sodium carbonate solution 5%

Ethyl alcohol 96%

Red wine

Coffee

Two different types of cooking oil

At the end of this test the liquids are removed with a 3% detergent solution, immediately followed by distilled water, then dried and examined for marking;

(j) Abrasion resistance on the Taber machine which applies a weight on to two abrasive wheels (100 grit) resting on the test panel. Loss of weight is noted after a given number of revolutions:

(k) Cold check is performed under three different severities of test conditions;

(i) Panel is exposed for 8 hours at 60°C then 16 hours at 20±2°C. The test is carried on for 14 cycles;

(ii) Panel is exposed for 1 hour at -5°C then 1 hour at 60°C. The test is carried on for 20 cycles;

(iii) Panel is exposed for 1 hour at -20°C then 1 hour at 60°C. The test is carried on for 20 cycles;

(iv) The panel is exposed under a 300 watt UV lamp at a distance of 30 cm for 4 hours;

(l) Cigarette resistance is checked by leaving a lighted cigarette on the surface for 1 minute, washing with detergent and examining for damage;

(m) Hot water resistance is checked by heating 1 litre of water in a 1.5 litre aluminium beaker to boiling point, then adding a very little cold water. It is then placed on the panel for 20 minutes, after which the panel is examined for damage;

(n) Steam resistance is checked by placing a panel for 20 minutes over the mouth of an Erlenmeyer flask in which water is boiling. The panel is dried and examined.

The method of testing the superficial smoothness of the surface was developed by the director of the Quality Control Institute. It involves placing an apparatus on the surface of the panel which shines a beam of light exactly 1 mm wide on the surface. The reflection of the beam is viewed through a graticule and the width of the reflected beam can be measured, its shape giving an indication of the type of undulation present.

A large number of the tests were carried out during the visit, and it was demonstrated that the Institute is clearly capable of thorough and exact work.

Since no impact test appeared to be specified, some trials were carried out by dropping a steel ball 4 cm in diameter from a height of 60 cm on to a polyester surface. In one case there was no damage to the film, but when an old polyester panel was tested, it gave a number of concentric rings between which there was some loss of adhesion. This test might well be developed.

Some typical acceptance figures are given below:

	Polyester	Nitro	Acid-cured
Clemen	1,000 g	400 g	1,000 g
Pencil hardness	3H	2H	4H
Adhesion	No flaking at edge of a specified saw cut	By crosscut 100%	By crosscut 100%
Gloss (minimum)	90%	90%	90%
Semi matt		30-50%	30-50%
Matt (maximum)		10%	10%
Smoothness (maximum value as measured on above-mentioned scale)	1.8	1.8	1.8

The acid-cured finishes are taking on a new importance in Hungary, and though no specification seems yet to have been drawn up for this type of coating, it is tested by exactly the same methods as the other types. Some doubt was shown as to whether the acceptance figure of 1,000 g on the Clemen test was too high. The chemical resistance test will be extended to 1 hour for this class of material, and trials are to be carried out to find a means of using the Taber machine to measure the development of gloss rub-up on matt lacquers. The Institute agreed to carry out a full test on the panels specially sent from Győr, Zala and Kanizsa.

Szék-és Kárpitosipari V. (Budapest)

This factory makes only chairs, and was not originally intended to be included in this project. However, much that was seen here could be of interest and assistance to the three main factories regarding their departments dealing with solid timber.

There is a very well-equipped machine shop for shaping and preparing the timber which is mainly beech with a little pine. The quality of surface preparation was better than had been seen elsewhere. A good deal of staining was carried out using water stain supplied by Arti Werke (Federal Republic of Germany) or by a Swedish company. Most of the other coating materials are bought in Hungary from TVK rather than Budalakk, whose products are considered to be too expensive, too low in solid content and inconsistent. Trials are also proceeding with materials from PEVDI, whose trade-mark is Xyloc 11.

Kopperschmidt airless spray is used on most work because it gives the smoothest and most even coating. Some work is carried out using hot spray plant and this adds extra work because it leaves so much orange peel on the surface that a pulling-over operation is necessary.

Since this factory manufactures only chairs, it has developed a very high level of expertise in this product line. It makes 1,200 chairs per day, of which 550 are for export, and the standard of quality is quite high.

Bubiv (Budapest)

This visit was included firstly because Bubiv is the largest furniture company, with nine factories in Hungary, and secondly because it uses paper foils. It was not considered very important by the Ministry, which would prefer attention to be concentrated on the three main factories in the project.

The foils are melamine-impregnated paper, printed with woodgrain and applied to particle board with the same sort of glue and in the same shuttle presses as are used for wood veneers. Although the particle board was sanded and thicknessed in the same way as for the wood veneers, some of the output, direct from the presses, was showing a far from level surface. There was no time available to go into the reason for this.

At another factory, where boards laid with foil are used, a greater amount of production is concerned with veneered surfaces. Staining is carried out by hand - a very slow process - and the surface coating unit, though passing a fair volume of work, was very much slower than in the three factories which the project was originally intended to cover.

Information obtained at this factory is really not relevant to the main purpose of the assignment.

Budalakk (Budapest and Győr)

The production units of this company specialize according to the type of product, and it was necessary to visit the city offices, which incorporate the headquarters of the Technical Service Department, and then see two of the factories. Service visits to the furniture factories are infrequent since very seldom are requests for visits received, and the feeling has grown that the furniture factories are well aware of the specifications and test procedures but have modified them to suit their individual circumstances, and are therefore best left without interference. Development work has already commenced on types of stain suitable for machine application. Samples have been sent to Robert Hildebrand of West Germany, which manufactures such machines, and test results are awaited.

Acid-cured materials have already been successfully developed for machine production on veneers for flooring, and there is confidence in the company's capability to carry out further developments as required for the production lines in the furniture factories. When advised of a general feeling of dissatisfaction with the polyester lacquers, the management showed little surprise.

The present formula, Flexadur 102, was developed 16 years ago and was made for drying at air temperatures. When used above 30°C, there is a loss of

styrene which interferes with the smoothness of the surface, and which must be overcome by the addition of a suitable paraffin wax, preferably a mixture of waxes with melting points of 50°-52°C and 60°-62°C. To obtain the necessary increase in reactivity from the resin, which would reduce the amount of peroxide and cobalt which need be added, a change in the composition of the resin would be necessary and the price would be higher. While it is believed that the Stolllack material is more expensive, the extra cost was thought to be covered in some way by the Ministry of Light Industry, and Budalakk, having no means of recovering the cost which would be involved in making a more reactive type, is forced to continue supplying Flexadur 102. The company considers that within two or three months it would be able to produce a lacquer equal to that of Stolllack if the necessary co-operation were forthcoming from the furniture industry.

Nitro lacquers with a reference number lower than 010 were produced prior to the installation of the coating lines and intended only for air drying. Materials numbered 010 and 011 were produced by matching the Stolllack materials as originally used on the Kanizsa line, 012 being a slightly modified version of 011 made on request from Cardo. When first made, the viscosities were lower but a request was made by the furniture factories for a higher viscosity to enable more thinner to be added for greater economy.

It was agreed that development work could be undertaken on materials which would produce a higher standard of quality on the machines, but there was a lack of enthusiasm due to the inevitable increase in cost and the question of obtaining a correspondingly increased price. Discussions took place on the specifications for these materials, which are briefly noted below.

010 sanding basecoat

Appearance	Opaque viscous liquid
Colour	8 (Jod scale)
Viscosity DIN 4 at 20°C	120 sec
Solid content	26%
Levelling period after curtain coating (maximum)	10 minutes
Air drying (Bandon Wolff):	
Stage 1 (maximum)	20 minutes
Stage 6 (maximum)	40 minutes
Surface after drying	Smooth, satin, even
Sanding time	1 hour (air-dried 20°C)

Adhesion	When removed, the film takes wood fibres with it
Hazard rating	1
Guaranteed storage life	12 months
Percentage of material hazardous to health (aromatic hydrocarbons)	40%

Lacquers 011 and 012

	011	012
Appearance	Clear viscous	Liquid
Colour (Jod)	3	3
Viscosity DIN 4 at 20°C	100 sec	100 sec
Solid content	24%	26%
Levelling time (maximum)	10 min	10 min
Drying time:		
Stage 1 (maximum)	10 min	10 min
Stage 6 (maximum)	50 min	50 min
Surface	Smooth - Satin	
Clemen hardness	500 g	500 g
Cold check (-20°C to +60°C)	10 cycles minimum, but will take up to 20 or 25 cycles	

Stacking Test

Two wooden panels, each measuring 625 cm^2, are coated with 30 g/m^2 of 010, and, after 5 minutes of air-drying, are heated to 60°-70°C for 15 minutes. After cooling, the surface is sanded and a coat of lacquer, which is air-dried for 15, and then for 20, min at 60°-70°C, is applied. The panels are taken from the oven and, while still warm, stacked face to face with a weight of 25 kg applied. When separated after 24 hours, there should be no sign of damage.

Fire hazard rating	1
Guaranteed storage life	12 months
Percentage material hazardous to health	40%

The Stolllack material had a solid content of only 18% and a lower viscosity. Prior to the request for a higher viscosity to give economy, these lacquers, when reduced to 18% solids, had a viscosity similar to those supplied by Stolllack. Lacquer 012 was developed for the Cardo factory, which wanted more gloss and build, but increase in solid content seems too small to make much difference.

II. CONCLUSIONS AND RECOMMENDATIONS

A. General conclusions

Since the modernization of the three factories which took place three to five years ago, they have justified the investment which was made by a greatly improved level of production. This increase has been achieved with a standard of quality which is, at present, acceptable on the home market. Each company has a completely unique installation and no doubt the problems which each one faces are, in many cases, unique to that installation, though many problems are seen to be common to all factories, and certainly the over-all picture applies to all.

Although the companies concerned are quite old established, they were founded in a very different environment from that which exists today. Some of the machinery was installed more than a working lifetime ago, and has only recently been required to feed the new coating lines. The machines have done hard duty, and overhauling and replacement parts are now needed if quality and even quantity of production is not to fall. Moreover, while some workers have spent many years at the factory, they have only recently been called upon to acquire new skills and learn to operate new machinery, working to standards which were not necessary previously. Further training of the workers is therefore required at all stages in the factories, possibly along informal lines in the case of machine operators, and of a formal nature for more responsible staff.

The individual factories have found their own way out of their problems as best they could, and it would appear that they have, in many instances, worked in isolation. The skills which may have developed to a higher degree in one factory rather than in another seem to have remained in that factory and not been passed on. As a result, there is a danger of complacently accepting things as they are, and also a certain degree of confusion regarding coating material specifications and test methods. In these circumstances, preparations were made, in conjunction with Budalakk, the major material supplier, to draw up agreed specifications and test methods.

During the visits to the factories very little printing was seen taking place, and it was established that the preparation of panel surfaces was not carried out well enough to allow the coating materials to be used as intended.

When polyester lacquers were used, the heavy film thickness compensated for poor preparation. But when nitro-based lacquers were used, an extremely high quantity of thinners was added in order to make up for surface deficiencies causing a low dry film weight, and the surface quality has suffered as a result. This preparation remains the biggest obstacle of all, and it will be impossible to derive benefit from more modern coating materials unless a dramatic improvement of the surface is made.

With regard to quality controls, the standards exercised in the coating departments seem to have developed in a way appropriate to the materials and processes used. Control over the mixing of materials which are to be used on the machines seemed to be carried out conscientiously, but the checking of coating weight and viscosity during operation of the plant was not frequent enough. However, the Quality Control Insitute was visited, and a description and demonstration of the specified tests indicated that the specifications are modern in outlook and the Institute capable of carrying out the tests well.

On the subject of inspection, it was found that existing procedures are designed to correct defects rather than avoid their recurrence, and are not treated as seriously as would be required for a higher quality standard. It was also noted that, except in one factory, printing cylinders were not guarded well enough against mechanical damage.

The Budalakk organization appeared to possess all the facilities necessary to keep pace with the existing requirements of the furniture industry and the development capacity to cater for a higher standard of quality and the new type of acid-curing lacquers, provided that they can receive co-operation from the furniture factories. However, certain economic factors have prevented them from doing all that is possible with polyester lacquers, and they were not truly aware of current problems or contemplated changes. They will therefore try to bring their knowledge up to date with the assistance of the Ministry of Light Industry.

In view of its importance to both home and export markets, the necessary financial investment for the expansion of the furniture industry will be made available in Hungary, and plans for expansion within the five-year period up to 1980 are proceeding. Longer-term plans require sponsorship by the Ministry of Light Industry, and it is essential that the results should justify the investment.

Follow-up assignment

Between the completion of the mission covered by this report and the beginning of the follow-up assignment it would be useful if the furniture industry took action along the following lines:

(a) Assembling specifications and adopting a uniform method of testing, as recommended by the suppliers;

(b) Co-operating more closely with Budalakk in regard to existing and proposed processes;

(c) Implementing, as far as possible, the recommendations put forward in this report.

During the next assignment it will be necessary to concentrate on the following tasks:

(a) Assessing the changes and improvements that have taken place;

(b) Advising on the suitability of plant and machinery proposals received from manufacturers;

(c) Assessing all new products and types of products which have become available;

(d) Carrying out a programme of staff training and giving at least one lecture;

(e) Making all arrangements necessary to enable the Ministry of Light Industry to prepare suitable plans for the re-equipment of the factories, as required.

B. Specific recommendations

At the end of each factory visit, a number of recommendations was given either as a result of what had been observed or in reply to queries raised by the management. These are listed below for each company, with a certain amount of inevitable overlapping. They are divided into two parts: "first aid", which covers aspects on which immediate action can be taken, and "long-term" recommendations, which require time to allow for the necessary modifications. Recommendations affecting broader aspects and future development are addressed to the Ministry.

Cardo Butorgyár

First aid

1. The grades of sanding paper in use are too coarse, leaving a surface adequate for polyester but not for a nitro finish. Hand-operated belt sanders do not leave a finish which is level enough to be coated by a roller coater. The veneers are so thin that it does not make sense to take too much away; only enough sanding should be used to level the surface and then to make it smooth with a fine grade of paper. Although a coarse grade of paper must be used to perform the final shaping of solid beech, it should be followed by a finer grade.

2. Sharper tools and better cutting techniques must be used in preparing the edging of panels to avoid splitting, open corners along the edge and ragged edges.

3. More attention must be paid to making the final thickness of the veneered panel uniform so as to obtain an equal coating by roller coater.

Long term

4. An attempt should be made to obtain from the machine manufacturer a modification incorporating a doctor blade for the roller coating machines to avoid uneven application.

5. Some means, such as a deceleration zone (a short piece of driven conveyor), should be fitted after the second curtain coater to avoid panels falling one upon the other.

6. Filtration should be fitted to the curtain coaters on the pipe returning material from the trough to avoid contamination by large pieces of dirt, chip etc.

7. The cylinders on the printer should be replaced.

8. The rubber offset roll on the printing machine should be resurfaced.

9. An inspection procedure for each operation should be established to enable information to be fed back to the point where an improvement is needed.

10. Oscillation should be restored on the shaft of the polyester burnishing machine.

11. Uniformity should be restored by spraying the edges of matt-coated panels with matt lacquer and glossy panels with glossy lacquer.

12. Consideration should be given to the use of a roller coater which can coat both sides of the panel, the lower side being burnished by a leather mop. A special type of conveyor is needed and the surface preparation must be first class.

Zala Butorgyár

First aid

1. Every attempt should be made to improve the surface sanding in order to leave a smooth surface thickness, since this is where the prospect of greatest improvement lies.

2. The sanding operation should be checked to determine whether the veneer is being torn at this stage or is delivered badly cut, and appropriate action should be taken.

3. It should be made certain that the Alberti/Stemag combination is set up as necessary to process each panel rather than relying on the use of the belt sander on repair.

4. An inspection system should be inaugurated, perhaps through the section leaders, to feed back information on faults to the places where the faults arise.

Long term

5. A system should be established for more frequent inspection of material on the machines, checking viscosity and coating weight by weighing an aluminium panel, in preparation for more sensitive high performance materials.

6. Consideration should be given to the use of double roller coaters to give double output on nitro finishes as in recommendation No. 12 to Cardo Butorgyár.

Kanizsa Butorgyár

First aid

1. The use of belt sanders should be avoided as far as possible for panels which are to be coated with nitro finish or gravure-printed. The contact sanders should be set up correctly to prepare a level and smooth surface.

2. The problems relating to bad adhesion on birch veneer, joints opening and glue spreading through the veneer should be taken up with the suppliers of the AMICOL M-50 glue. It is probable that more thickener would improve all three points, but the supplier should be asked for advice in this connexion.

3. It should be made certain that the paraffin wax solution does not contain crystals when added to the polyester by warming it to about 40°C in order to avoid craters.

4. All possible steps should be taken to avoid dust from the Gianida polishing machine falling on panels as they are being coated or assembled for coating.

Long term

5. The substitution of a paraffin wax with a higher melting point (up to 60°C) should be tried to assist development of a film on the surface and give easier sanding.

6. The addition of more paraffin wax to the third coating should be tried, so as to give better sanding as above; it may be possible to reduce the cobalt content.

7. A transparent shield should be fitted over the head of the curtain coater to stop ventilation draught from blowing the curtain to one side, and then the best height of the head above the panel should be found in order to reduce the carrying of lacquer over the edges and on to the backs of panels.

8. Only a machine fitted with a doctor blade (such as the Hymmen) should be used when applying coloured material by roller coater.

9. Transparent colours should be used over veneer before printing to allow the veneer to show, and the use of a veneer which has a pattern unlike that of the print should be avoided.

10. Consideration should be given to the use of a special double sided coating line as in recommendation No. 12 to Gardo Butorgyár.

11. Consideration should be given to the use of a roller conveyor in the assembly line incorporating fewer and simpler tasks for each worker in order to speed output and reduce damage due to excessive handling.

Ministry of Light Industry

1. The education of workers at all levels should be improved by instruction on the factory floor, in the secondary schools and in technical colleges, expanding existing facilities so as to ensure a more thorough appreciation of the requirements of modern machinery. A great deal of skill has already been developed in the various factories and by the SZKIV organization, and advantage should be taken of this by promoting visits between the factories by personnel who are able to recognize and appreciate improvements and then carry the improvement back to their own factory. An advisory body may be set up to correlate the work of the University, the Design Institute and the Quality Control Institute, and form a department dealing with furniture technology.

2. Great emphasis should be placed on the concept of intelligent inspection aimed at finding the cause of failure and correcting the fault. This is the best way of obtaining an improvement in quality and the only way to keep up to a standard once it has been reached.

3. Consideration should be given to the proposal for setting up a mobile team of engineers, specializing in modern woodworking and coating machinery, whose task would be to keep all the installations in first-class condition and to deal with any emergency which may arise.

4. A more uniform approach to the testing of raw materials by the factories should be adopted throughout the furniture industry. Specifications and testing methods could be agreed with the industry, the Quality Control Institute and Budalakk.

5. More information concerning both present difficulties and future plans should be given to Budalakk so that they may have a better opportunity of giving assistance.

6. No roller coater should be installed in future unless it is fitted with a doctor blade. The best type of machine at present is the Hymmen type LAC or LAX.

7. The staining of panels could best be performed by the use of a roller coating machine followed immediately by a brush. Such machines are available, and preference should be given to a machine using a non-absorbent roller to allow cleaning and a change of colours.

At the request of the Ministry, the names of the following two companies, both of which operate internationally and are capable of supplying either single machines or full-scale plants, are given solely for information purposes. Both are manufacturers of certain types of machines, but will supply any specified machine as required.

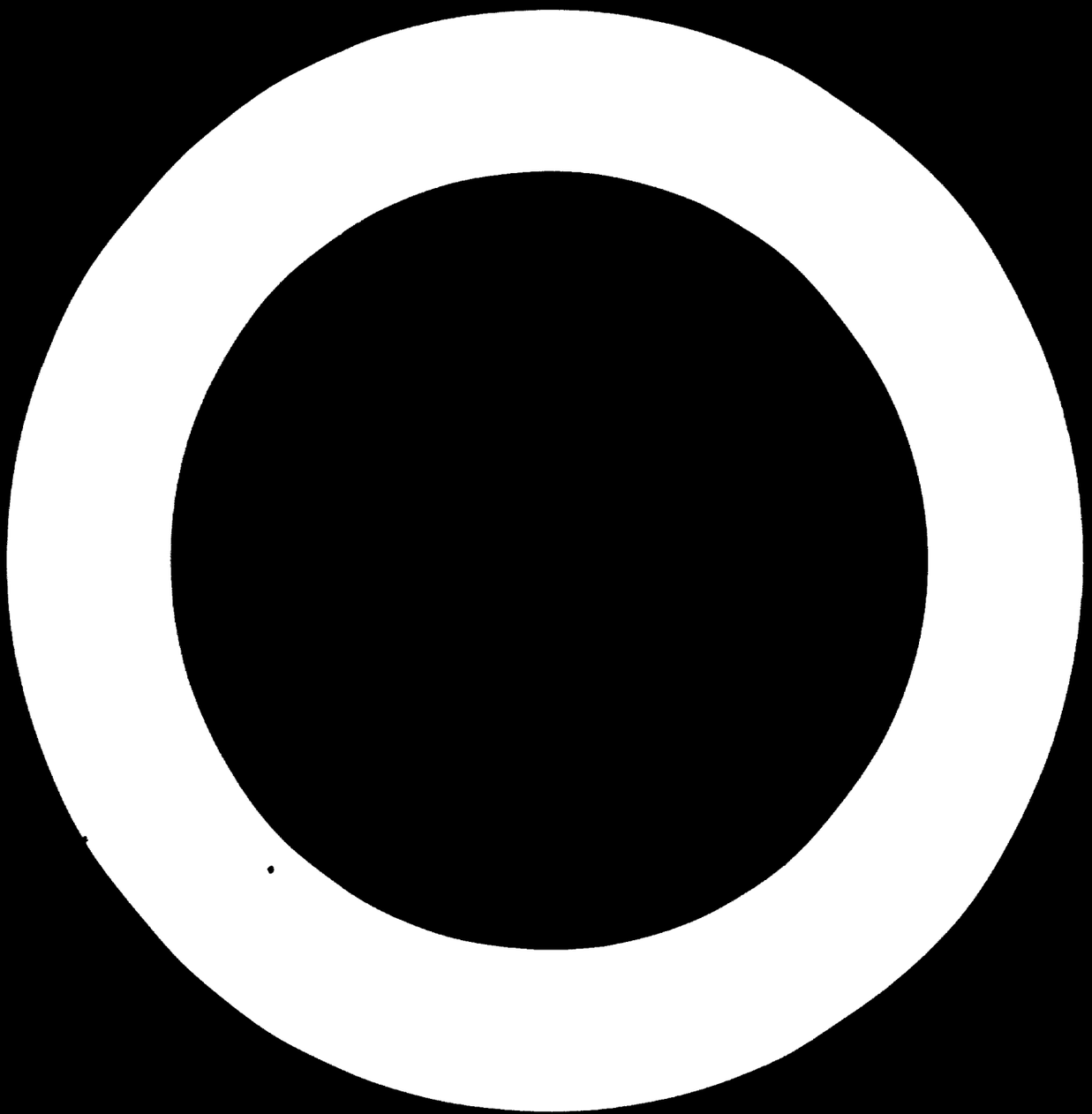
Superfici
Viale Elvezia
Monza, Italy

Wemhohner GmbH
Postfach 598
Herford, Federal Republic of Germany

The following two companies, both of which supply coating materials for furniture coating installations and have a wide experience, are also mentioned strictly for information purposes.

Société des Vernis Bouvet
Tournus
Saône-et-Loire
France

The Donald Macpherson Group
Three Quays
Tower Hill
London
United Kingdom



Annex I

PROJECT PERSONNEL

A. Government counterpart: Ministry of Light Industry

Botka Zoltan, Head of Department
John Ede, Head of Section
Jancsó László, Senior Economic Adviser
Sopp László, Senior Economic Adviser

B. Officials and technicians met at establishments visited

Cardo Butorgyár (Györ)

Lovász László, Director
Simon Zoltán, Technical Director
Tóth József, Designer

Zala Butorgyár (Zalaegerzseg)

Bejczi József, Director
Szalay Ferenc, Chief Engineer
Koncsek János, Laboratory Leader
Király Tibor, Deputy Leader, Technical Department

Kanissa Butorgyár (Nagykanizsa)

Tollar József, Director
Gaál József, Deputy Director
Maráz Kálmán, Technical Director
Mr. Lackner, Chief of Technology
Mr. Vellak, Laboratory Leader

Quality Control Institute (Budapest)

Bakay Stephan, Director
Székelyhidi János, Section Head
Babos Zoltán, Scientific research worker

Annex II

PLANT LAYOUTS

A. Cardo Butorgyár

The sequence of machines and operations is shown with figures at the right hand side showing the time in seconds from the start of the line, either a single figure in the case of, for example, a roller coater, or two figures showing dwell time in a tunnel.

(1)	Orbital sander with brush and extraction, 220 grit	0
(2)	Agla single roller coat without doctor blade	13
(3)	Infra-red tunnel electric elements. Stated element temperature 80°-90°C	19-73
(4)	Olympic twin-cylinder printer: 1st head 2nd head	92 100
(5)	Agla roller coater without doctor blade	120
(6)	Stefani twin-head curtain coater	131
(7)	Steam-heated tunnel 30°C on polyester, 60°C on nitro	140-185
(8)	Lateral transfer unit (open)	193-211
(9)	Steam-heated tunnel 35°C on polyester, 72°C on nitro	211-?
(10)	Steam-heated tunnel 35°C on polyester, 60°C nitro	?-345
(11)	Cooling tunnel	345-390
(12)	Orbital sander Attilo Galli 220 grit	405
(13)	Stefani twin-head curtain coater	408
(14)	Hand transfer to steam-heated mobile rack tunnel taking about 24 minutes, depending on type of work, and operating at 50°C on polyester and 60°C on nitro.	
(15)	Unloading by hand after 24 minutes cooling in air at rear	

For dense veneers, such as beech, which are to be coated in nitro finish, the panels are fed to (4) for printing and (5) for application of basecoat, while (6) is inoperative, (12) sands the panel, and a single head of (13) applies 160 g/m^2 of topcoat which is dried in (14) and unloaded at (15).

For soft veneers, such as okoume, in the case of nitro finish, the panels are fed to (4) for printing as required, (5) is inoperative, and (6) applies 160 g/m^2 from one head. After drying, (12) sands the panel, and after a further coat of 160 g/m^2 is applied from a single head at (13), the panel is dried in (14) and unloaded at (15). When machine (2) has the roller replaced, it can be used to apply a coating of basecoat which is dried in (3), then a further basecoat is applied on (4) as above.

For polyester coating, panels are coated at (6), the first head of which applies the peroxide mixture (100 g/m^2), then the cobalt mixture (125 g/m^2), giving a total of 225 g/m^2. The sander (12) is not operating, since the film is still wet, and a further coat of 225 g/m^2 is applied by (13) in exactly the same way as before. Waxing and curing proceed in (14) and unloading takes place in (15). The panels are stabilized for at least 24 hours before sanding and burnishing.

When acid-cured materials are used, the same type of process is followed as for the nitro lacquer. Edges of panels are sprayed by pneumatic spray, in a stack, before entering the main coating shop. Solid beech framework is similarly sprayed and often, as in the case of divan legs, dipped singularly, as many as three coats being applied. The measured conveyor speed was 14 m/min.

Viscosities used on the machines

Polyester - in all four heads	24-28 sec DIN 4 at 20°C
Acid-cured lacquer	35 sec DIN 4 at 20°C
Roller coating basecoat for above	30-35 sec DIN 4 at 20°C
Nitro basecoat	45-60 sec DIN 4 at 20°C
Nitro topcoat	35 sec DIN 4 at 20°C

B. Zala Butorgyár

The sequence of machines and operations is shown with figures at the right hand side showing the time in seconds from the start of the line, either a single figure in the case of, for example, a roller coater or two figures showing dwell time in a tunnel.

(1)	Stemag double sander and brush	0
(2)	Agla roller coater without doctor blade	30
(3)	Cefla Infra-red tunnel 60°C	30-95
(4)	Olympic twin-cylinder printer: 1st cylinder 2nd cylinder	115 123
(5)	Agla roller coater without doctor blade	127
(6)	Stefani twin-head curtain coater	130
(7)	Cefla heated tunnel	130-225
(8)	Enclosed bend (unheated)	225-295
(9)	Heated tunnel (joined to 10)	295-?
(10)	Cooling tunnel	?-415
(11)	Lateral transfer unit	420
(12)	Agla sander and brush	423
(13)	Stefani twin-head curtain coater	427
(14)	Transfer by hand to mobile rack tunnel taking about 25 minutes, depending on work. Unloading after cooling at rear.	

The conveyor speed is 12 m/min but, in practical terms this is limited to 10 m/min.

The sequence of operating the machines for coating with nitro is 1-2-3-4 (optional) -5-7-8-9-10-11-12-13-14, with a curtain coating weight of 120 g/m^2. Alternatively, it may be 1-4 (optional) -6-7-8-9-10-11-12-13-14, with a curtain coating weight in both heads of 120 g/m^2.

For polyester, the sequence is 1-6-7-8-9-10-11-13-14, the total coating weight of 516 g/m^2 being applied in the proportion of 40% on the first machine in equal parts, and 60% on the second, for the outside face. In the same way, 430 g/m^2 are applied for the inside face.

Viscosities of the materials used

Both Budalakk and Stolllack polyester are used at 30-35 sec DIN 4 at 20°C for cobalt and peroxide mixtures. For the roller coating basecoat, 60 parts of 010

are mixed with 30 parts of thinners, and viscosity is about 30 sec DIN 4 at 20°C. For the topcoat, 90 to 95 parts of 012 are mixed with 45 to 50 parts thinners, and viscosity is 20 sec DIN 4 at 20°C. The thinner is Celloxin 102-es.

Tunnel temperatures

On nitro-based materials	45°C
On polyester	55°C

C. Kanizsa Butorgyár

The sequence of machines and operations is shown with figures at the right hand side showing the time in seconds from the start of the line, either a single figure in the case of, for example, a roller coater or two figures showing the dwell time in a tunnel.

(1)	Rotary brush with extraction	0
(2)	Ferre dual roller coater	17
(3)	Infra-red tunnel rising from 40° to 80°C	40-?
(4)	Steam-heated tunnel, 64°C	?-73
(5)	Ernst drum sander, 280 grit	87
(6)	Hymmen Lac single roller coater with doctor blade	108
(7)	Short flash-off then steam heated tunnel, 30°-40°C	114-200
(8)	Open return bend conveyor	200-260
(9)	Schmutz two colour printer: 1st cylinder 2nd cylinder	263 270
(10)	Burkle twin head curtain coater	279
(11)	Steam-heated tunnel, 40°C on nitro	300-?
(12)	Steam-heated tunnel, 75°C on nitro	?-414
(13)	Covered unheated return bend	414-462
(14)	Steam heated tunnel, 45°C on nitro, 35°C on polyester	4[illegible]-?
(15)	Steam heated tunnel, 35°C on nitro, 25°C on polyester	? —?

(16)	Steam heated tunnel, cold on nitro, 20°-25°C on polyester	?-600
(17)	Twin-head Burkle curtain coater	612
(18)	Open conveyor with bend to off-loading point	616
(19)	Panels are transferred in the case of polyester to a travelling rack oven with three zones of approximately equal length operating at 40°C, then 60°C, then 30°C, and unloaded after returning along the outside of the tunnel. The dwell time in the tunnel is approximately 30-40 minutes.	
	Air velocity in sections 13, 14 and 15 is 7 m/sec for nitro coatings, and 3-4 m/sec for polyester.	

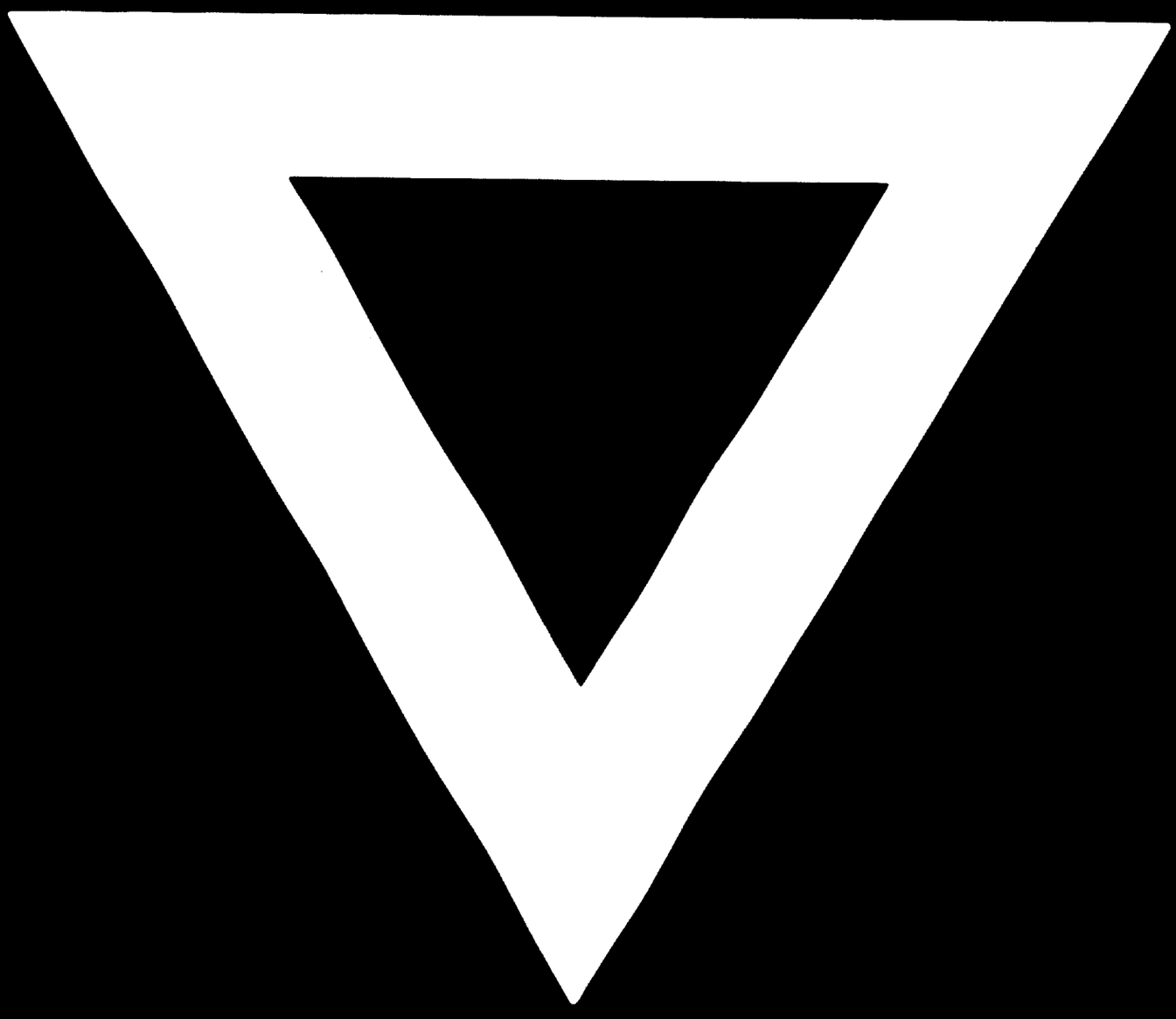
The conveyor operates at 4-5 m/min when using polyester, and 8-10 m/min using nitro; these times were recorded when a nitro finish was being applied. For a nitro coating, the machine operating sequence is 1-2-3-4-5-6-7-8-9 (optional) -10 (100 g/m^2) -11-12-13-14-15-16-18. For a polyester coating the machine operating sequence is 1-7-8-10-11-12-13-14-15-16-17-18-19.

Viscosities of the materials as used

Both Budalakk and Stolllack polyester, all mixtures are used at 35 sec DIN 4 at 20°C. Nitro materials are thinned with Celloxin thinners for spraying, rolling or pouring.

Material	Amount of celloxin added to 100 parts	Viscosity DIN 4 at 20°C	Process
010	30	35-40 sec	Roller coating
010	up to 100	20 sec	Airless spraying
011	50	28-30 sec	Curtain coating
011	60-100	20 sec	Spraying
004	0	20 sec	Airless spraying

G-343



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