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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

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(R) FURNITURE DEVELOPMENT, TESTING, STANDARDIZATION AND QUALITY CONTROL.

TS/IND/76/006.

INDIA.

Prepared for the Government of India by the
United Nations Industrial Development Organization

Based on the work of Pietro Borretti, woodworking consultant

id.78-2827

Explanatory notes

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

The monetary unit in India is the rupee (Rs). During the period covered by the report, the value of the rupee in relation to the United States dollar was $US 1 = Rs 8.00.

In the same period, the value of the Saudi riyal (SR1) in relation to the United States dollar was $US 1 = SR1s 3.47.

A slash between dates (e.g. 1975/76) indicates a financial year. The financial year in India is from April 1 to March 31.

Use of a hyphen between dates (e.g. 1974-1976) indicates the full period involved, including the beginning and end years.

The following forms have been used in tables:

Three dots (...) indicate that data are not available or are not separately reported

A dash (-) indicates that the amount is nil or negligible.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

IPIRI	Indian Plywood Industries Research Institute, Bangalore
NSIC	National Small Industries Corporation
GT & TC	Government Toolroom and Training Centre
CMTI	Central Machine Tool Institute, Bangalore
ISI	Indian Standard Institution

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ABSTRACT

On 12 October 1976 the Government of India requested assistance from the United Nations Industrial Development Organization (UNIDO) with the drafting of a major project to develop the large-scale furniture industry. A woodworking consultant was sent on mission to India on project "Furniture Development, Testing, Standardization and Quality Control" (TS/IND/76/006) on 26 March 1978 for one month.

The consultant was attached for the duration of the mission to the Indian Plywood Industries Research Institute (IPIRI), Bangalore. The Director of the Institute provided overall guidance during the mission and accompanied the consultant on some of the most important field trips. One of the assistant directors of the Institute was assigned to work full time with the consultant. A close working relationship was also maintained with the other officers of the Institute.

The consultant was given the opportunity of visiting typical woodworking plants of various sizes in Delhi, Bangalore, Mysore, Cannanore and Calcutta in an endeavour to obtain as representative a picture of the industry as possible. During the field trips, assistance was provided by the consultant concerning the use of equipment, the selection of cutting tools and product engineering.

Visits to various handicraft centres resulted in the identification of a wealth of traditional handicraft techniques, some of which, in the opinion of the consultant, could be utilized in combination with modern technology to produce furniture for export. Also visited were a plant for the manufacture of woodworking equipment; government agencies involved in the development and manufacture of machinery and tools; government departments involved in activities concerning the development of the industry such as the Indian Standard Institution (ISI), the Small Industries Service Institute, and the National Small Industries Corporation (NSIC).

The findings of the mission, and a tentative development programme, were discussed at length with the Director of IPIRI and his senior staff. A Work Plan was drafted outlining a schedule of activities concerning fields where foreign technical assistance would be required for the establishment of a furniture development centre.

The tentative Work Plan was again reviewed at the debriefing sessions at New Delhi with the UNDP resident representative and the Under Secretary of State for Industry, in which a representative of the IPIRI Director also participated.

CONTENTS

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The report has been organized to combine in each chapter assessment and recommendations concerning the particular topic under review; the first chapter gives an overall picture of findings and recommendations.

I. FINDINGS AND RECOMMENDATIONS

The furniture industry in India can be geared to generate additional employment provided that the necessary steps are taken, particularly towards the modernization of machinery and equipment, in the sense of identification and use of low-cost technology, consistent with economy, efficiency and quality, and towards the development of appropriate furniture designs for both local and export markets.

The aim is not only to increase employment in the "modern" sector of the furniture industry, but also to boost the dwindling employment of cottage handicraft industry in rural areas, thus contributing to two additional social benefits, i.e., the preservation of cultural identity, and checking, even if in a modest measure, the exodus of unemployed from rural to urban areas. The woodworking industry, both in developed and developing countries, is by its nature more labour-intensive than the average manufacturing industry.

The main assets of the industry are:

(a) The enormous reserve of management and engineering skills which can be easily transferred to the service of the furniture industry;

(b) The ability of labour to learn new skills quickly and to work under exacting conditions;

(c) The extraordinary wealth of handicraft techniques practiced in rural areas which could be utilized in combination with factory-made wood components to produce tradition-inspired Indian furniture for the European markets;

(d) The availability of internationally accepted timber species such as teak and rosewood;

(e) The possibility of utilizing short-cut veneer waste of valuable species for the production by plywood plants of panel furniture components for further processing by the small-scale furniture sector;

(f) The dynamism of the IPIRI and a nucleus of plywood manufacturers dedicated to innovation in the way of product and process development and utilization of secondary wood species;

(g) A nucleus of furniture-making entrepreneurs open to the challenge of innovation in design and technology;

(h) The capability of the engineering industry (backed by the excellent prototype facilities of NSIC, CMTI and GT & TC) to produce necessary new-generation woodworking machinery, thus enabling the small-scale industry to acquire appropriate technology with suitable and efficient equipment to ensure a low-cost economy as advocated by the Prime Minister;

(i) The closeness of Gulf States markets with an established and enormous export outlet.

The main drawbacks of the industry are:

(a) The absence of a coherent ad hoc programme for the utilization of secondary wood species with potential for the furniture industry;

(b) The lack of an organized effort for the production of furniture designs suitable for the utilization of short-cut veneer of valuable species;

(c) The lack of consistent, innovative product designing capable of utilizing traditional handicraft techniques and motifs for furniture for export;

(d) The lack of standardized furniture designs enabling the small-scale furniture industry to fully utilize the advantages of low-cost mechanization;

(e) The lack of ad hoc facilities for providing performance testing of furniture according to the stringent quality requirements of foreign buyers (Singapore has recently introduced a furniture Performance Testing programme to enhance its export competitiveness);

(f) The limited input of new-generation woodworking equipment which prevents the industry from achieving competitive levels of efficiency and quality;

(g) The lack of an up-to-date marketing survey of the Gulf States providing a detailed and systematic assessment of the wooden furniture trade prospects in that area.

The proposed strategy of development is to establish with the assistance of UNDP/UNIDO a Furniture Development Centre within IPIRI with the task of assisting the wooden furniture industry to become competitive in techniques, design and quality.

The Centre would serve as a basis for development of the furniture industry and disseminating know-how in technology, design and marketing. Its main objective would be to generate additional employment for the country by contributing towards expanding efficient production of furniture for the local and export markets.

The main tasks of the Centre would be to assist the industry in:

(a) Adoption of suitable furniture designs;

(b) Improvement of product engineering (choice of construction and materials);

(c) Improvement of process engineering (choice and development of processes, equipment and tools, processing organization);

(d) Improvement of quality (quality standards, performance testing, quality inspection during process, quality label);

(e) Improvement in marketing.

The main aims of this Furniture Development Programme would be for the Centre to combine development, production and training activities and undertake actual pilot batch production of selected furniture so as to provide the industry with effective guidance on product and process engineering.

By incorporating the Programme into the framework of IPIRI, a minimum of financial input would be required on the part of the Indian Government in that the necessary regular engineering staff (with the exception of a product designer), premises and national contribution in equipment would be allocated from the existing resources of IPIRI.

A complete set of pilot equipment for production of plywood, as well as tool room equipment, is already available at IPIRI.

The assistance of UNDP/UNIDO would cover only the first two years of operation of the Centre and would provide the necessary equipment and the services of top consultants on short-term missions.

The IPIRI would implement the Programme in close co-operation with other agencies whose scope of work is related to the objective set up for the Furniture Development Centre. The selection of the co-operating agencies, and the terms of reference of co-operation would be included in the preparatory phase of the project.

The guiding principles of the proposed Furniture Development Programme and related inputs were arrived at in consultation with the IPIRI Director and his senior staff, and a preliminary Work Plan of Project Activities was tentatively agreed upon, to serve as a basis for the subsequent preparation of a Project Document.

II. THE INDUSTRY

There are no systematic statistical data available on the Indian wooden furniture/joinery industry. A rough estimate for 16 states based on figures available for Karnataka State puts the total number of production units scattered all over India at about 3,200 with an average employment of 20 workers and an average total investment of about $13,000 per unit. Out of those, there are 322 large-scale furniture plants with an average of 36 workers and an investment of $51,320 per plant.

The furniture/joinery industry consists of private enterprises with the exception of a few plants that are under the partial control of the Department of Defence.

In general, the degree of mechanization of the industry is very low. Moreover, only a limited degree of efficiency and quality seems to be derived from the use of available machines since their capabilities are not properly and fully utilized.

The general approach to the manufacture of furniture appears to be that of the custom cabinet shop rather than of a production plant, with individual workers handling the full process of each furniture component from the preparation of the timber stock to final assembly.

There is hardly any standard furniture available on the market. Each piece is generally made to satisfy the needs and tastes of individual customers rather than for stock on the basis of standard designs and sizes.

The tremendous asset of the traditional handicraft system consisted of sophisticated woodworking skills passed down from fathers to sons within the framework of the Caste system. However, mainly because of social changes, and especially the urbanization process, such skills are becoming increasingly scarce and the attempt to regenerate them in the substitute environment of modern institutional training does not seem to have fully achieved the desired objective. The transition from woodworking artisan skills to factory skills for the benefit of the emerging small-scale woodworking industry is yet to be accomplished.

III. RAW MATERIALS

Approximately 73 million hectares (22.3%) of India's total land area consist of forests of which 62.8 million hectares (86.2%) are classified as production forest, that is, a source of timber for forest products.

There are some 248 commercial timbers available for various end uses, but only about 15 species are generally utilized in the furniture industry (annex I).

In the ISI classification the country is divided in 5 zones (annex II), with respect to the availability of timber, keeping in mind the principal timber-consuming centres and the forest areas that feeds them. However, timber grown in one zone is generally available in other zones. The main forest-bearing states are: Assam, Andhra Pradesh, Bihar, Kerala, M.P., Karnataka, Tamilnadu, Andaman and Nickobar Islands, Manipur, Arunachal Pradesh and Nagaland.

Teak is the most popular wood used in the furniture industry. It was estimated in 1960 that the use of teak species accounted for 60% of the total consumption of furniture wood. Considerable efforts have been made to renew forest resources of this particular species. The most valuable, however, among the furniture and veneer timber available is rosewood (Dalbergia latifolia)

In 1960, the share in the consumption of timber by the furniture industry was estimated at 3.3% of the total consumption of industrial wood (7,833,000 m^3 of roundwood), that is, about 260,000 m^3 of roundwood or 156,000 m^3 of sawn timber. With a similar output of production logs in 1976 (7,711,000 m^3 of roundwood) it has been estimated that the consumption of timber by the furniture industry would have reached a considerably higher ratio to an estimated consumption of as much as 500,000 m^3 of roundwood owing to the increasing rate of house construction, urbanization and the rise in per capita incomes.

In India, the demand for timber for cheap living quarters and school buildings was estimated at 4.8 million m^3 of logs in 1975 as opposed to 3.7 million m^3 in 1970. Rapid urbanization is increasing the demand for non-traditional types of housing that are intensive in the use of wood panels. Demand for wood for use in bodies of trucks and buses, fishing boats, agricultural implements and bobbins for jute and cotton mills can be expected to increase along with population growth and increasing economic development.

The increased demand for timber has contributed to the increase in the price of furniture timber and in turn to an increase in the price of furniture products, as materials take as much as 60% of the value of output.

Decorative plywood as a furniture material is becoming increasingly popular, especially for office furniture, in spite of its high selling price which is due to the high cost of urea formaldehyde glue. (Indian plywood and particle board manufacturers have to pay over three times the international price for their resins, which are produced locally.)

Plywood is generally available faced in some eight veneers (annex I). The most popular, both in the local and export markets, is teak while the most expensive and de luxe is rosewood veneer, which is in short supply and generally exported.

There seems not to be a sufficient supply of furniture-quality plywood, thus quality furniture incorporating this material is not always satisfactory - especially where glossy finishes are used which tend to magnify surface defects. Pre-finished plywood is available and mostly used for table tops.

Blockboard is used in table top components but, because of the short supply of quality board it seems difficult to produce a good finished surface when this material is used.

Hardboard, a recently introduced wood-based panel, is finding wider usage but has yet to find its place as a complementary material in furniture making. One common application of hardboard in Europe is in the form of drawer bottom where one-side coated hardboard is used.

The Committee on Building Material in India has anticipated a shortage of popular wood species because of the increased demand, and various steps have to be taken to obtain fuller utilization of those timbers and to encourage the increased use of secondary species, aiming, inter alia, at reserving a greater share of valuable species for wooden furniture for export. This can be achieved first, by upgrading the secondary species by means of processing methods such as kiln drying and wood preservation; secondly, by undertaking imaginative product development projects; and thirdly, by utilizing profitably the short-cut veneer and solid wood obtained in the manufacturing process.

There is a widespread awarness of these needs among the leading furniture and joinery plants. The treatment of secondary species will certainly be facilitated by the considerable level of know-how developed in India in this field. In fact, it has already been possible to utilize properly seasoned and preservative-treated secondary species for standard joinery products.

Use of secondary species can be further promoted by specific action by the government departments concerned. In Guyana, the Forest Department buys rough wet lumber of lesser-known species from sawmills and grades it, seasons it, and manufactures it into flooring and panelling of standard size. In Papua New Guinea, the high degree of preservative treatment of wood made compulsory by the Government has considerably increased the range of secondary species that can be used in construction. In Ghana, the Government reimburses the full cost of transporting secondary species by rail or road to the market or harbour.

Research in the use of secondary species has been undertaken in India for some time. For example, the properties and machinability characteristics of some secondary species have already been determined by the Forest Research Institute of Dehra Dun.

So far as the utilization of secondary species in furniture making is concerned, it is deemed necessary to launch into an ad hoc programme covering species with specific potential in furniture making to determine working specifications such as standard drying schedules, preservation materials and methods, machinability, and selection of appropriate wood joints.

Some interesting work is already taking place in the way of product development to utilize secondary species. An impressive variety of experiments have been carried out by the Western Indian Plywood Company, Kerala, with plywood and hardboard, such as plywood embossing to upgrade the appearance of secondary veneer species and pre-finishing of plywood with an original method of applying colour patterns.

With the aim of upgrading the appearance of veneers of secondary species the India Plywood Mfg Co. Ltd, Bombay, is introducing an advanced manufacturing process whereby veneers are bleached throughout the thickness of the material in attractive shades and colours.

The Indian Plywood Industries Researoh Institute (IPIRI) is developing an original technique whereby decorative veneer overlay can be replaced by facing plywood with a newly developed inexpensive non-woven jute fabric (developed by the Indian Jute Industries' Research Association) that can be pre-printed in any colour pattern. The IPIRI techniques allow the fabric to be bonded to the plywood and coated at the same time by using melamine resin. The result is extremely attractive and could provide expanded scope in the use of plywood as a furniture material.

Finally, the Central Handicraft Development Centre has developed a method for chemically etching solid wood - softwood and hardwood alike - giving relief to wood grain. The etched surfaces can be subsequently colour-ooated to provide a rich attractive appearance. The technique should prove valuable in the development of furniture design for export.

On the matter of utilizing short-cut wood material there seems to be a oonsiderable amount of decorative veneer short-cuts (mainly teak and rose-wood) which at present can not be profitably disposed of by the plywood factories, thus preventing full economic utilization of valuable veneer logs. This is due mainly to the lack of manufacturers of panel furniture in India. There is, therefore, a strong case for investigating the possiblity of manu-facturing knocked-down panel furniture for export to the Gulf States which currently import this type of furniture from Europe.

IV. EXPORT OF FURNITURE

The share of wooden furniture in India's expo t of timber products is rather low. The figures for the period April 1976 to March 1977 (annex III) are: furniture $1,063,564; sawlogs and veneer logs[1] $880,000; and sawnwood $14,800,000. However there has been an upward trend in the export value of furniture from $118,828 in 1970/71.

Some twelve manufacturers (annex IV) were involved in export in 1976/77.

The largest importers of Indian furniture for the period April 1975 to March 1976 (annex V) were: Muscat and Oman ($100,000); Dubai and Qatar ($96,000); United Kingdom ($82,000); Kuwait ($56,000); Abu Dhabi ($26,747); Nepal ($25,743); Bahrain ($16,666); and Iran ($14,756). The figures cover furniture as well as panel doors and wood panels.

With the exception of the United Kingdom and Nepal, the only existing export outlet of some relevance is the Persian Gulf states. The economy of this region is linked with rich oil resources and is growing at a very fast rate. Iran (the largest country in the region in terms of population, GNP and imports) seems to be the only country in the region where the export potential does not apply because of the ban on the importation of furniture.[2] The other countries in the Gulf area are small but their importation bills are relatively large in comparison to their population. In 1967, Kuwait had hardly half a million population and a per capita income of $3,500, but its annual importation bill was $593 million.

The demand for both domestic and office furniture in the Gulf countries is tremendous being associated, inter alia, with the high pace of building activities. In Saudi Arabia's capital, Riyadh, apartment buildings are going up at the rate of one storey every two days and the demand for housing is so great that rents have soared 600% in the last two years. Sixty per cent of the furniture demand is met by imports, which were estimated at SRI 135 million in 1975 with an expected increase of 15% each year up to 1986. However, the value of Indian furniture exported to Saudi Arabia in 1975/76 was only $2,000. The source of most of the imported furniture is the Federal Republic of Germany, Italy, the Scandinavian countries, the United Kingdom and Yugoslavia.

1/ January-December 1976 (FAO Year Book of Forest Products, Rome, 1976).

2/ Report on three Sales-cum-Study Missions to the Gulf States in 1975-1976. By R. Gopal, Featherlite Corp., Bangalore, 1977.

No systematic commodity survey has been done of furniture since the one carried out as a part of the study on India's Export Potential in Selected Countries by the National Council of Applied Economic Research in 1970. However the Chemical and Allied Products Export Promotion Council of the World Trade Centre in Calcutta, has been active in promoting the identification of export potentials for the furniture industry sector. Within this framework the Council has organized study tours of the furniture industry. The most recent group marketing mission to Europe was carried out in late 1977 as members of the Chemical and Allied Products Export Promotion Council, Calcutta. The two-week mission was sponsored by the Indian Institute of Foreign Trade under a UNDP programme (annex VI). The Council also liaises with visiting foreign missions concerned with trade of wooden furniture. For instance, in 1977, the Furniture Survey Mission of Japan visited India, while in early 1978 a market development expert from ESCAP undertook a survey in connection with the possibility of expanding export of furniture to Japan.

Three sales-cum-study missions sponsored by the Council were carried out in the Gulf States in 1975-1976. They revealed that in order to increase exports of Indian wooden furniture its quality and finish must be improved. This also applies to upholstered components; in order to compete with upholstered furniture exported by the European countries it is necessary to use the same type of upholstery materials offered by those countries. Gopal's[2/] findings emphasize that in the Gulf States there is a strong widespread preference for Western European type of furniture and consumers associate optimum standards of design, finish and construction with products from those countries. It is therefore absolutely necessary that Indian furniture duplicate those standards.

Recent information obtained by the Export Council from the Embassy of India at Doha (Qatar) reveals the enormous opportunity of that country for Indian furniture. Ninety per cent ($11,910,214) of the office and domestic furniture imported in 1976 was in finished form from such varied sources as: Bahrain, Dubai, the Federal Republic of Germany, Italy, Japan, Kuwait, the United Kingdom and Yugoslavia. The share of Indian furniture in that market in the same period was worth only $53,000.

Gopal's report further states that furniture packing should be considerably improved to withstand the rough conditions of handling and storage in open areas of cargoes at destination ports in the Gulf States. Due to port congestion,

cargoes are often discharged and left in the open for long periods; the goods should therefore be protected with polythene sheets and packed in properly designed heavy duty cases. There is a need for proper packing in order to withstand preshipping storage conditions at Indian ports and airports. A buyer of Indian handicrafts, for example, complained that brassware shipments had been left lying in the open at Bombay airport and were spoiled by rain (annex VI).

An up-to-date systematic study is now deemed necessary to present a fresh assessment of the wooden furniture trade prospects for India with special emphasis on the Gulf States area which in the meantime has developed into the closest, and possibly largest, export opportunity for the furniture industry sector.

The study would establish in detail consumption trends in the Gulf States and identify competitive aspects of European furniture which now dominates those markets. The task would include the purchase of typical samples of European wooden furniture popular in the Gulf States in order to provide Indian manufacturers with a true picture of requirements in terms of design, quality and construction details.

Sample collecting should be carried out on a periodic basis so as to keep Indian manufacturers posted on the changing needs and tastes of the Gulf States markets.

Specific recommendations would have to be made on how to stimulate new approaches to export promotion and the establishment of appropriate channels of distribution (now practically non-existent) in the export areas with major potential.

With respect to marketing in the Gulf States area it is suggested that the best local representative should be sought rather than relying exclusively on agents in the area of Indian descent.

Regarding the European market, it has been suggested by an exclusive furniture mart from the Federal Republic of Germany that the most efficient distribution system for central Europe might perhaps consist in creating a central warehouse in the Federal Republic of Germany, as has been done for Indian carpets, from which furniture could be delivered on short notice by truck to various markets, thus ensuring timely supply. The approach would, inter alia, simplify the packaging and freight aspects.

The ideal arrangement would indeed be to combine the warehousing, distribution and showrooms of both Indian carpets and traditional type of Indian furniture. A combined display setting of carpets and furniture would greatly enhance the presentation of both types of products.

Similarly, show-case centres could be established in selected market areas that serve as local points of international trade. High quality distribution services would be required to support the drive to create for Indian furniture an image of modernity combined with the attractive elements of Indian tradition.

V. PRODUCT DESIGN

There seems to be an absence in India of a consistent continuous and widespread development process in the furniture design field, both in conceptual and technological terms. There are hardly any signs of well-defined design trends which normally emerge, predominate over a period of time and are then gradually superseded by new ones.

For instance, Danish furniture design has been a universal taste for some twenty-five years, but little of its influence was felt in India. Nor has any substantial innovative furniture design trend developed on the basis of local traditional and cultural values. This situation seems to apply also to industrial design and interior design.

It appears that industrial design in India has yet to become a fully dynamic force in the development of the community, unlike countries where leading designers and manufacturing houses, in certain instances. actual influence taste in interaction with other socio-cultural factors.

On the domestic furniture side, the most attractive products are those made of rattan, that is, those rooted in the handicraft heritage, while wooden furniture, especially for the living room, partly reflects pre-independence trends.

The situation is different in the office desk field where significant visual development has taken place. A typical example in this respect is the products of Featherlite, Bangalore, who manufacture attractive and functional office furniture of mixed construction type in timber and aluminium tubing.

The most attractive, functional and popular chair available in the country is perhaps the "Mies Van de Rohe", a cantilevered chair made of bent-steel or bent-aluminium tubing with seat and back of canework on wooden frames.

Isolated efforts have been made by the more enterprising furniture manufacturers in introducing modern techniques and design concepts. For instance, Western Indian Plywood Ltd - one of the most dynamic woodworking set-ups in the country - experimented years ago with the production of laminated furniture chairs based on designs of famous Western designers (Alvar Alto, Charles Eames, Arne Jakobsen). No commercial outlet materialized for this type of chair except for a version of a one-piece compressed wood-shell which was adopted as standard seating in Calcutta trams.

The IPIRI itself has been a leader in experimenting with all-plywood furniture in knock-down form and has developed an attractive wall shelving system made entirely of plywood.

The preference of the general public and government departments alike concerning non-residential furniture is clearly towards steel furniture on account of two main considerations on the part of the buyer: first, price - wooden furniture, being in most cases custom-made, is more expensive or at least equal in price to metal furniture; secondly, metal furniture is sturdier and it is mistakenly believed to be easier to maintain, possibly on account of the questionable standard of finishing of most wooden furniture available on the market. Low quality is thus believed to contribute substantially to the loss of market to substitute steel products and in particular to tubular steel chairs and steel desks.

There is a widespread lack of acceptance, both in the residential and public sectors, of standard furniture designs, with the exception of metal furniture. The established trend is for furniture to be tailored to the taste of individual buyers with respect to appearance as well as size. Perhaps the most notable single exception in this respect is the residential and office furniture produced for the requirements of the military services by the furniture plants of the Ex-servicemen Rehabilitation Association. In this case, designs were developed by one single source, that is the Army Architect Office, and are standardized in models and size although conservative in design and construction.

The problem of design in custom-made furniture is minimized by the prevalent practice of customers providing specifications of the design required. In standardized ready-made furniture there is a need for skilled personnel who can design styles which will meet with general market approval. However, with some exceptions, little originality is apparent in this field. This certainly adds to the difficulties of standard furniture penetrating the domestic market. For example, during the 1960s in the Philippines, some companies tried to shift away from custom-built furniture into standardized production. The poor success of these attempts was blamed on the fact that the ready-made furniture did not offer any substantial price advantage, nor did it show any creativity or originality in design. However a similar attempt conducted in the same period in Thailand proved that it was possible to introduce and popularize standard

furniture. The designs initially produced by the first mechanized furniture plant in the country were so successful that smaller plants gradually equipped themselves to reproduce the most successful of the standard models introduced.

There is scepticism among manufacturers of wooden furniture on the possibility of developing a favourable response on the part of the general public towards standardized products. There are however few entrepeneurs - the enlightened ones, those with the unmistakeable gift of community leaders - who are prepared to take up the challenge. What they badly need is the help of catalyst technical services to help start the innovating process in conceptual design and techniques and maintain it.

It has been established that the trend in the Gulf States, as regards furniture and general industrial design, is strongly Western-oriented. The highly competitive edge enjoyed by products from Western countries is provided by two main factors: first, they are top-designed and top-quality products mass-produced to stringent specifications with the aid of sophisticated technology and, secondly, they reflect the introduction of frequent new design concepts and new uses of materials.

In light of the above, types of furniture, both for domestic and public use, based on panel construction, might well prove to be the key for India's meaningful entry in the Gulf States markets.

By producing panel-based furniture it would be possible to combine capital intensive requirements of mass-produced furniture (together with the capability for rapid shift in design) with the established and mandatory government policy to reserve furniture manufacture to the small-scale industrial sector. The approach would consist in a selected number of plywood mills producing ready-veneered and cut-to-size furniture panels which could then be further processed (lipping, boring, fitting of knock-down hardware etc.) into furniture components by small-scale furniture manufacturing units.

The use of through-stained veneers being introduced by the Indian Plywood Company might prove to be an ideal material (together with de luxe veneers such as teak and rosewood) for the development of panel furniture products. Apart from its trend-setting aesthetic potential, through-stained veneers have the advantage of being easily finished without the risk presented by other staining agents, of re-exposing the natural shade of timber.

VI. TRADITIONAL PRODUCT DESIGN

Traditional Indian wooden furniture designs include the following main items: carved folding screens, round centre tables with brass tops, occasional tables with carved top and carved folding legs (which is possibly the single largest export item), occasional tables with veneer inlay tops.

It is significant that a recent on-the-spot market survey report of selected European countries should have revealed that the interest on the part of specific potential buyers - with the exception of Switzerland, where no export potential exists - is focused exclusively on the traditional type of Indian furniture with high added value.

The continued general recession in most overseas export markets, which has drastically affected housing activities, gives an additional justification for emphasis on de luxe exclusive furniture aimed at a selected buyer bracket.

Unfortunately, there has been no consistent effort so far to utilize traditional furniture design as a source of inspiration for innovative designs that would create export opportunities and secure expanded employment in rural areas.

In addition to the established traditional furniture design there is a tremendous reserve of various handicraft techniques that could be incorporated in machine-made furniture, thus preserving and extending handicraft heritage by combining it with the use of modern technology.

To give an indication of the tremendous potential in this respect the consultant developed during his four-week mission at the IPIRI, Bangalore, a furniture design based on traditional folding screens made of wooden frames and hand-crafted brass panels (annex VII). The design, a folding bookcase, consists of a back panel made of rosewood veneered plywood; two side panels of rosewood frame and brass panels that are hinged on the back panel; four free shelves of rosewood veneered plywood. The bookcase packs flat; to make it stand, the two side panels are opened out and the shelves are placed in position. No special hardware is used, only standard local-made brass hinges and brass door catches. In production, the back panel and shelves would be made by utilizing short-cut veneer and both components could be supplied in pre-cut form by the plywood industry to small-scale woodworking plants for lipping, finishing and final assembly.

VII. PRODUCT ENGINEERING

The single major factor for high cost and low quality of wooden furniture available for the general market is that the furniture made with the aid of machines is not designed having in mind the capabilities, characteristics, requirements and limitations of mechanized production.

For example it was observed in some of the mechanized plants visited that semi-skilled labour is utilized on the correct assumption that the performance of complex and critical woodworking operations can be transferred from man to machine; but, when it comes to the assembly of components, construction and design details are such as to require superior cabinet-making skills. As a result, the advantage of using equipment is drastically minimized and the production process becomes more cumbersome rather than streamlined.

Often, in an apparent attempt to become competitive with office metal furniture, wooden drawers are designed to be quickly assembled by nailing; by the use of a simple attachment on a standard spindle moulder (annex VIII) one could produce superbly dovetailed drawers.

On the other hand, design and construction details should also be thought out having in mind the limitations of machines. For example, radius of curves may be too short or the sweep too abrupt to permit easy machining, or they may create areas of weak cross grain that crack and break.

The ideal situation is for conceptual design and product engineering to develop as a whole and simultaneously during the creative design process; and the training of furniture designers should certainly be aimed towards the fulfilment of this critical objective. In any case a full awareness should be developed at the manufacturing level of product and process engineering consistent with the use of machines, even where equipment is utilized marginally as a complement to a hand-making process.

The new designs should be studied carefully for modifications that need not affect the overall appearance of the piece but that will provide strong construction with the most economical means of machining and assembly. Basic furniture construction should be engineered along the lines of minimum part sizes. Designs should be modified to standardize parts as much as is practical. Many parts can be of the same design or dimension to allow them to be interchanged among different types of furniture.

In transition from the original furniture design to its production, it is important to establish critical dimensions and tolerances, so that any part from one group of parts will fit with any part from another group of matching parts, unlike traditional hand-making practice where each part is made as it is required and is hand-shaped to fit with other parts making up the piece of furniture.

VIII. ORGANIZATION OF PRODUCTION AND MANPOWER

Unlike large-scale capital intensive industry, which seeks the highest possible degree of transfer of skills from man to machine, the small-scale furniture industry equipped with basic equipment can in fact expand substantially the employment opportunity of semi-skilled labour; but this can be achieved only if the Factory System, not the Handicraft one, is adopted in the manufacturing process, as it is in the case of larger Indian furniture factories and in other sectors of the small-scale industry.

The principle of the Handicraft System is to rely on highly-skilled craftsmen who carry out the entire fabrication of furniture from the raw material stage to completion. The basis, and the economics, of the Factory System is the division of labour whereby jobs are broken down into individual operations, most of which can be performed by semi-skilled workers rather than by master cabinet makers. By this method the quantity and quality of output, which is such a critical factor in the manufacture of furniture for export, is dependent more upon the machine process than on the worker.

Increasing capacity at lower production cost makes it also possible to lower selling prices and to stimulate the expansion of the small-scale furniture industry for the local market.

Division of labour entails a much higher degree of management skills in that all the jobs and operations within each job are planned, scheduled and controlled as a whole by the management in view of the full utilization of manpower, equipment and materials. But this requirement poses no problem as India has a tremendous reserve of management and engineering skills which have been widely utilized at home and abroad in the development of the industrial sector. These are the skills that have gained India an international reputation as a pioneer in the development of the small-scale industry. Unfortunately, as far as the furniture sector is concerned, conditions have prevented a widespread transition of the traditional Handicraft System into the Factory System.

IX. EQUIPMENT

The existing average level of mechanization of the furniture/joinery industry is very low. In smaller plants, including those newly established, even complex processing of furniture components is performed with the aid of very simple traditional tools. However, a relatively small number of larger plants are provided with machinery beyond the standard range of basic woodworking equipment.

Most of the equipment used by the sawmilling and the furniture/joinery industry is locally made in India by nine small plants (annex IX). Imports of many types of woodworking machines are banned so as to protect the local industry. This has somehow isolated the industry from exposure to technology of new-generation machines and to a certain degree from related technological development, although considerable technological adaption work has been carried out by two of the Prototype Centres of the National Small Industries Corporation (NSIC), which is equipped with most efficient facilities for the development of prototype machinery for the small-scale industry. In particular, the NSIC has produced prototypes and pilot batches of five woodworking machines: band resaw, spindle moulder, narrow blade bandsaw, turning lathe, belt and disk sander, and square chisel mortiser.

An estimated 481 pieces of woodworking machines were manufactured in India in 1976 with a value of $750,360, an increase of 47% compared to 1974. About 5% are exported to South-East Asian countries and Gulf States. Only 28 pieces of machinery were imported in 1976 and the value of imports, $4,556,410 indicates that most of the imported equipment is of high individual value, that is for use in the wood-based panel industry rather than the furniture/joinery sectors.

A few of the larger furniture plants are equipped almost exclusively with imported machinery, most of which seem to be of Eastern European origin.

The annual demand for new woodworking equipment is significant considering the vast number of existing woodworking units and this underscores the increasing difficulty encountered by the local manufacturers of woodworking machinery in operating at a profitable level and the need to seek complementary export outlets.

In general, locally-made woodworking equipment is sturdier and of better design than equivalent machinery manufactured in South-East Asia, which is mostly the reproduction of early models of European makes.

A typical small-scale equipment plant was visited during the mission. The plant was found to be run by a qualified engineer, a fact that in itself would be

an exception in South-East Asia. The workshop offered a choice of some sixteen types of basic woodworking machines. However, no machine is made for stock: they are fabricated one at a time when customer orders are placed. For example, the plant casting moulds of two types of thicknessing and jointing machines based on Wadkin and Zuckerman models. The customer would specify which of the two models is preferred when placing the order and on that basis the manufacturing process of one single machine starts. Despite the limited output, that particular workshop was equipped with original equipment for the dynamic balancing of cutterheads, an essential prerequisite for proper performance of planers.

In spite of the fact that woodworking machines are practically custom-made, they are selling at about half the price of the equivalent European equipment.

In seems evident that one of the main prerequisites for the furniture/joinery industry to improve quality of finished products to overseas standard, as well as to increase its competitivcs at homc, is to introduce low-cost protection and maintenance equipment, and a number of cutting tools and attachments that incorporate new-generation woodworking technology.

The main types of equipment whose introduction is desirable are detailed below. (The specimens shown in the annexes are representative samples and should not be taken as an endorsement of a specific make.)

Round-tenon machine (annex X)

This is one of the most innovative pieces of equipment developed in the 1960s which replaces, at least for the requirements of furniture making, the traditional single-end tenoner. The round tenoner is a most versatile piece of equipment in that, by means of a single cutterblock and in a single operation, it can produce a wide range of precision fully-shouldered tenons which could not be otherwise produced on the traditional single-end tenoner. The machine can be used either in conjunction with the traditional Slot Mortiser (of which a few pieces have already been imported) or alternatively, with the more advanced Oscillating Slot Mortiser.

Oscillating slot mortiser (annex XI)

This machine replaces in the furniture manufacture the obsolete traditional Square Chisel Mortiser and the Chain Mortiser. While in those traditional machines the cutting tools are very expensive, complicated and difficult to maintain, the Slot Mortiser operates with a very simple cutting tool which can also be sharpened by hand.

Multiple boring head units (with adjustable centres)(annex XII) complimented by the dowel machine (annex XIII)

The boring/dowel joint is hardly used in India although ideally suited for various furniture construction applications. The joint requires the minimum of capital investment and is very easy to produce. Boring heads make use of standard machine boring bits.

Copying machine (annex XIV)

This machine,of simple design, is for the precision multiple copying of shaped furniture parts, such as chair backs and chair legs. This type of machine was introduced in the early 1960s in Thailand and was soon acquired by several small woodworking units for sub-contract production of standardized components. A large type of copying machine can be manufactured on special order by the Jova Engineering Works but it is a complex, expensive piece of equipment not suitable for the requirements and budgets of the small-scale industry.

Dovetailing machine of simple type (annex XV) or, alternatively, a Dovetailing attachment to be used on the Spindle Moulder (annex VIII)

This is an essential piece of equipment when proper drawer construction is required in order to replace the widespread use of nailed drawers.

Spindle Moulder (with detachable spindle)

The Spindle Moulder is probably the most versatile type among basic woodworking machines provided it is designed and it is equipped to provide flexibility. The detachable spindle feature, for example, extends the usefulness of the machine for the small-scale industry, in that it allows, among other things, the performance of heavy routing work at a low tooling cost. With appropriate attachments the spindle moulder can be utilized for additional operations such as dovetailing and finger-jointing (annex VIII) which otherwise would have to be performed on separate machines.

Universal grinding machine (annex XVI)

This machine can take care of the entire range of cutting tools used by small production units. The introduction of this type of inexpensive grinding machine in the small-scale industry would contribute to overcoming the problem of the inferior quality of finished products and the uneconomical life of cutting tools.

One of the major drawbacks preventing the furniture industry from a full utilization of machinery is a critical lack in the market of a reasonable range

of standard cutting tools and ancillary attachments. For example, the availability of adjustable cutterblocks such as those illustrated in annex XVII would greatly increase, at low cost, the versatility of spindle moulders. Local machine manufacturers normally supply only the bare machine. With the exception of sawblades, mortice bits and one single type of spindle moulder cutterblock, no other machine cutting tool is ready available on the market. Moreover, information is not widely available on foreign suppliers, new developments, alternative tooling techniques and, indeed, working requirements of tools. For example, a metal milling cutter was seen being used on a high speed spindle moulder which resulted in a rubbing - rather than cutting - action due to the excessive number of cutting edges.

In another instance, it was observed that multiple rip-saws were operated with circular sawblades unevenly spring-set by hand, thus making it impossible to control ripping width of stock. Where carbide-tipped saws are used there is seldom any maintenance facility available resulting in those very expensive blades (average Rs 1,000) being simply discarded when badly damaged because the blades are not reground or broken carbide tips replaced.

There is also ample scope for fuller utilization of relatively inexpensive power tools for precision operations such as trimming and chamfering of formica and veneer edges (annex XVIII).

The foregoing shows that there is a need for substantial development work to be done in the field of woodworking equipment. The recommendations in this connection are:

(a) To acquire a representative set of new-generation woodworking machines and equipment as a basis for the development and manufacture of equivalent equipment suitable to Indian requirements as well as to the needs of potential South-East Asian markets. The demonstration equipment would also be utilized for training and production trial of furniture designs to be specially developed for the export markets;

(b) To acquire and develop a demonstration set of new-generation cutting tools and other production aids with the aims of ensuring the quality of finished products; improving machine productivity; and enhancing the versatility of woodworking equipment;

(c) To establish specific testing standards for the manufacture of woodworking equipment (annex XIX), and provide evaluation tests of Indian equipment such as assessment of rigidity, vibration levels and performance accuracy, etc.

The development programme outlined above should also contribute towards increasing the export potential of Indian woodworking machinery in the South-East Asia area.

X. QUALITY CONTROL

It is unanimously recognized that in order to develop export outlets for furniture products the industry must manufacture up to the stringest quality standards of overseas markets.

Quality is defined as degree of excellency: the degree of fitness to a purpose that is required of products. The process for achieving quality starts with the establishment of the wanted degree of fitness, i.e. of quality standards aimed at, in terms of function and durability of the product. Established standards serve as a guide for the manufacture of products and as a basis for judging quality and performance.

The second step consists in a durability test of the finished product at prototype status. Testing methods are used which subject furniture to stresses and conditions similar to those met in reality.

The third step is quality inspection during manufacture to assess the quality of components in process (conditions that must be prevented: wood cracks, faulty joints, poor finishes etc.) and the degree of precision components to ensure fit and interchangeability.

Finally, packing quality standards have to be observed in connection with the shipping of products to ensure that they resist moisture intake during harbour storage and shipping and are not damaged in transit.

Furniture quality standards are strictly observed in all major importing countries. In this respect, it is worth noting that a common convention, providing detailed specifications on quality standards for wooden furniture, has been prepared by the European Furniture Federation. The convention applies to furniture supplied and traded in all member countries.

The American National Standards Institute[3/] advises foreign manufacturers on any quality or construction standards related to the marketing of wooden household furniture in the United States of America. There are two particular quality requirements to which United States buyers assign special emphasis, i.e. proper wood drying and the use of proper gluing materials and techniques.

The packing of furniture is very strictly regulated in the United States by the railways and road-haulage companies; transport of furniture can be refused if goods are not properly packed according to standard specifications. The

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3/ 1430 Broadway, New York, New York 10018.

example given below illustrates the stringent packaging standards of one of the leading United States chair manufacturers:

(a) Each chair is packed in a manner that meets carrier acceptance and ensures safe arrival at destination;

(b) Each chair is wrapped in a plastic bag before being boxed;

(c) Each chair is packaged in a heavy fibre-board box provided with a stabilizer inside to eliminate any movement during transit;

(d) Each box is sealed with glue and a high-pressure staple gun.

In Japan, quality standards are laid down in the relevant Japanese Industrial Standards (JIS) and furniture marketed in Japan generally complies with these standards. There is also a law on quality labelling for household furniture which stipulates that the quality shall be indicated on each piece of furniture. When importing furniture the Japanese buyer expects that it complies with quality specifications and that appropriate quality control has been applied by the manufacturers.

A number of quality standards have been developed in India, under the leadership of the Indian Standard Institute, that apply to timber furniture and joinery products as well as to complementary woodworking materials such as glues and finishes. However, no facilities are available for performance testing with specific reference to furniture, such as durability of seats, backs and armrests; stability of tables and storage units; comparative structural strength of various types of joints including use of alternative types of glues; and surface resistance. Detailed descriptions of structural performance testing are given in annex XX and XXI.

At the manufacturing level, there is not much evidence of systematic and organized activities in the way of inspecting components in process for precision and quality. One major drawback in this respect is the lack of suitable measuring instruments.

As regards quality packing for export, much headway has yet to be made for lack of know-how of appropriate packaging techniques.

The most urgent need with regards to the improvement of quality standards of furniture products is the establishment of performance testing services for the benefit of the industry. As complementary activity a Quality Label programme should be introduced whereby furniture will be tested for durability by an independant organization and allowed to bear a Quality Label if found to fulfil the required standards. The Quality Label programme along the lines of the

Danish Møbelfakta, would be a key export promotion factor in that it would act as a guarantee to foreign and local buyers of the quality of Indian furniture.

It should be noted that even established leading furniture export countries, such as Denmark, Poland and Sweden, have found it necessary to establish centralized institutions for the development of the furniture industry, with the main task of determining and helping to maintain quality standards.

One of the recommendations contained in the report on the market study conducted in 1977 by a group of Indian furniture manufacturers (annex VI) concerns the possibility of establishing in India a centre similar to the Technological Institute (Furniture Department), Copenhagen, visited during the mission.

XI. FINISHING

Most of the furniture available on the market is finished by the shellac method known as French polishing. The method is elaborate and requires considerable skill, and, therefore, the end result is not always satisfactory. Polished furniture can only tolerate very brief exposures to heat, water or spirits, but the main disadvantage is that scratches and marks show very clearly and damage is difficult to repair.

Nitrocellulose lacquers of both matt and glossy types are used by leading furniture plants but do not seem to have a widespread application. Their use should be encouraged in that they are easier to apply than French polishing and provide a better surface wear. In addition, nitrocellulose lacquers can provide different end results as they can be applied either "thin" or "full". With the thin treatment the pores of the wood are only partly filled with lacquer and remain visible, while a full treatment closes the pores and covers the entire surface of the wood with lacquer.

Melamine finishes are used by some manufacturers of office furniture but difficulties are encountered in obtaining satisfactory results in their use, the limiting factor being that they should be applied in dust-free conditions.

It is surprising that very little apparent use is made in India of the Oil Finish type which was one of the key factors in the triumphant worldwide introduction of the teak furniture trend by the Danes in the 1940s.

To date, Oil Finish is still the most popular finishing method in overseas markets so far as teak and rosewood furniture is concerned. Therefore, any export drive by the Indian furniture industry would necessarily require the adoption of that particular finishing material.

One of the advantages of Oil Finishes is that oil-treated surfaces can be easily maintained and renewed by the user. This also means that minor surface damages which may occur on transit can be repaired by the foreign importers before distribution takes place.

Finally, the hand-rubbed feature exclusively of Oil Finishes would provide a main sales appeal attraction.

XII. GLUES

The most common type of glue used by the furniture industry is the animal-based one, followed by polyvinylacetate (PVAc) and urea formaldehyde (UF) adhesives.

Although animal glues are cheaper and easily available they are one of the main sources in the failure of wood joints when severe stresses are applied to furniture in use such as in joints of chair frames. Therefore, their use should be ruled out so far as furniture for export is concerned.

One of the main advantages of PVAc adhesives is their good gap-filling property and the resilient bond they provide. In addition, solvents that are often added to PVAo formulations (to promote the formation of a continuous glue film) have been found to minimize the action of natural extractives in teak that are believed to prevent the formation of an effective bond to the teak surface.

In view of the above, there would seem to be scope for research in identifying the most suitable solvents to be introduced in PVAc adhesives produced in India in connection with the manufacture of teak furniture.

XIII. PROPOSAL FOR THE ESTABLISHMENT OF A FURNITURE DEVELOPMENT CENTRE

Development of the furniture industry has an important role to play in the economic and social development of the country especially in terms of employment opportunities and utilization of forests.

With a view to accomplishing an optimum utilization of resources and market potential, the establishment is recommended of a Furniture Development Centre within the framework of the existing Indian Plywood Industry Research Institute (annex XXII).

In annex XXIII are some specialized furniture research institutes in other countries.

The development objective of the Centre

The Centre would act as a focal point for the development of the furniture industry towards increasing efficently quality and quantity of production.

The short-term objectives of the Centre

The Centre would assist the industry in:

(a) Adopting up-to-date appropriate technological processes;

(b) Utilizing suitable product engineering methods;

(c) Adopting standardized furniture designed for efficient and economic manufacture;

(d) Adopting furniture designs suitable for export markets;

(e) Applying suitable quality standards.

The activities of the Centre

The aims of the Programme would be achieved by carrying out the following activities:

(a) Applied research work for the selection and durability testing of furniture materials (wood, glues, finishes) and furniture structures;

(b) Introduction of a Quality Label programme;

(c) Development of standard furniture for local and export markets and undertaking related product and process engineering studies;

(d) Actual production of pilot batches of furniture;

(e) Training under actual production conditions;

(f) Standardization of machines, cutting tools and grinding techniques;

(g) Co-operating with concerned agencies in (i) conducting market research studies; and (ii) developing prototypes of new generation woodworking equipment;

(h) Adopting proper packing techniques and materials;

(i) Systematic dissemination of information to the industry;

(j) Production of reference and training manuals.

National personnel

With the exception of an industrial designer, a draughtsman, two drivers and four machine operators, all permanent staff required for the implementation of the Programme would be drawn from the existing personnel of IPIRI as agreed upon with the IPIRI Director during the mission. IPIRI has a wide departmental scope which would be utilized for the implementation of the Furniture Development Programme.

In addition, the Centre would utilize the services of visiting consultants from other co-operating agencies in fields such as industrial engineering, kiln drying and machine development marketing not covered in the present structure of IPIRI. Arrangements in this respect would be made in the preparatory phase of the project.

International personnel

The UNDP/UNIDO input would include the services of the following personnel for a total for 65 man/months whose task are outlined in the Work Plan (annex XXIV):

Senior adviser, 26 m/m
Four furniture design consultants, (annex XXV)
Marketing consultant, 3 m/m (annex XXV)
Sawdoctoring consultant 6 m/m (split mission)
Wood finishing consultant 6 m/m (split mission)
Quality control consultant 6 m/m (split mission)
Ad-hoc consultants 6 m/m

In addition to international personnel a project secretary and one secretary would be locally recruited.

The travel costs for the senior adviser are budgeted under Duty Travel (annex XXVII) and are broken down as follows:

		$
(a)	Travel to Europe on study tours with national counterparts	10,700 4/
(b)	Travel within country	2,000
(c)	Travel to Gulf States by marketing consultant	2,300
		15,000

Equipment

Part of the required production, testing and tool maintenance equipment is already available at IPIRI and would be utilized for the purpose of the Programme. The equipment includes:

(a) A complete set of pilot plywood-making equipment for the production of panel-furniture components;

(b) Testing equipment for wood-based panels and glues;

(c) Toolroom equipment.

4/ Calculated on the tentative basis of $50 per diem and $1,000 return air fare Europe-India.

The additional required equipment, which would be provided under UNDP/UNIDO contribution is as follows:

	($)
A complete set of demonstration machinery and cutting tools for the processing of solid wood components and final processing of panel components (boring, lipping etc.). The equipment would be utilized for actual pilot batch production of furniture	200,000
Testing equipment for finishes (wet and dry test, scrape test, impact test, cross-cut test, scratch test)	10,000
Performance testing equipment for semi-assembled (wood joints) and assembled furniture structures	20,000
Experimental dry kiln capable of handling stock for batch production of furniture	15,000
Measuring instrumentation for quality inspection of components in process	10,000
Office equipment and supplies and basic reproduction equipment needed for dissemination of information	20,000
Imported production supplies (special tools, sanding samples of and finishing materials etc.) and other expendable material	20,000
Furniture samples	6,000
One car and one pick up van	12,000
Total	313,000

Building facilities

Workshop and office facilities required for the operation of the Programme would be allocated from the IPIRI existing building area as indicated in the layout of the existing facilities (annex XXVI). The only addition required would be an open shed of about 10 x 15 m for the installation of the experimental dry kiln.

General services facilities

The Programme would share the existing general services facilities of IPIRI (library, meeting room etc.)

Machine prototypes

Prototype of new-generation woodworking machines and cutting tools would be developed as a joint programme with the following agencies:

(a) The National Small Industries Corporation Ltd., New Delhi, which has gained considerable experience in developing and producing prototypes of woodworking machinery;

(b) The Central Machine Tool Institute, Bangalore;

(c) The Government Toolroom and Training Centre, Bangalore.

The necessary operating arrangements in this respect would be negotiated in the preparatory stage of the project.

Raw materials and production supplies

All raw materials and production supplies are required for the manufacture of furniture prototypes as well as for trial batch production of products developed by the Centre would be part of the Indian Government's contribution to the project.

This would also apply to any cost involved in the development of prototype woodworking equipment.

Publications

A total of five training/reference manuals would be produced under the UNDP/UNIDO project. Periodical bi-monthly Newsletters would also be issued to keep the industry abreast of new developments in technology and product design. The project allocation required for this purpose is $20,000.

Study tours

Most of the national staff participating in the project would consist of senior officers with senior professional background. Therefore, for the purpose of the project, the conventional United Nations fellowship scheme will be replaced by overseas group study tours whereby personnel participating in the project would have the opportunity, as a group, of being directly exposed, during the formative period of the Furniture Development Programme, to sources and events that determine or influence relevant development aspects of the furniture industry. The method would allow the Furniture Development Programme, as a whole rather than for particular individuals, to benefit from exposure to the development process.

The first study tour of six-week duration would mainly serve to acquaint the IPIRI furniture development team with the work of the major European institutions involved in development work concerning the furniture industry. The selection of testing equipment would be made on the basis of the observations made during the tour.

The subsequent four study tours would be of a shorter duration - three weeks - and would coincide with the timing of major European exhibitions of woodworking equipment and furniture.

The five study tours are estimated to account for $74,900[4/] of the amount budgeted under Group Training; the remaining $3,000 budgeted under this heading is for travel within India (annex XXVII).

Annex I

WOOD SPECIES

Main veneer species

Teak (Tectoua grandis)
Rohini (Boymida febrifuga)
Rosewood (Dalbergia latifolia)
Paduak (Pterocarpus dalbergiodes)
Poon (Calophyllum)
White cedar (Dysoxylum halabaricum)
Chickrassy (Chukrasia tabularis)
Champ (Michelia champaca)

Main furniture species

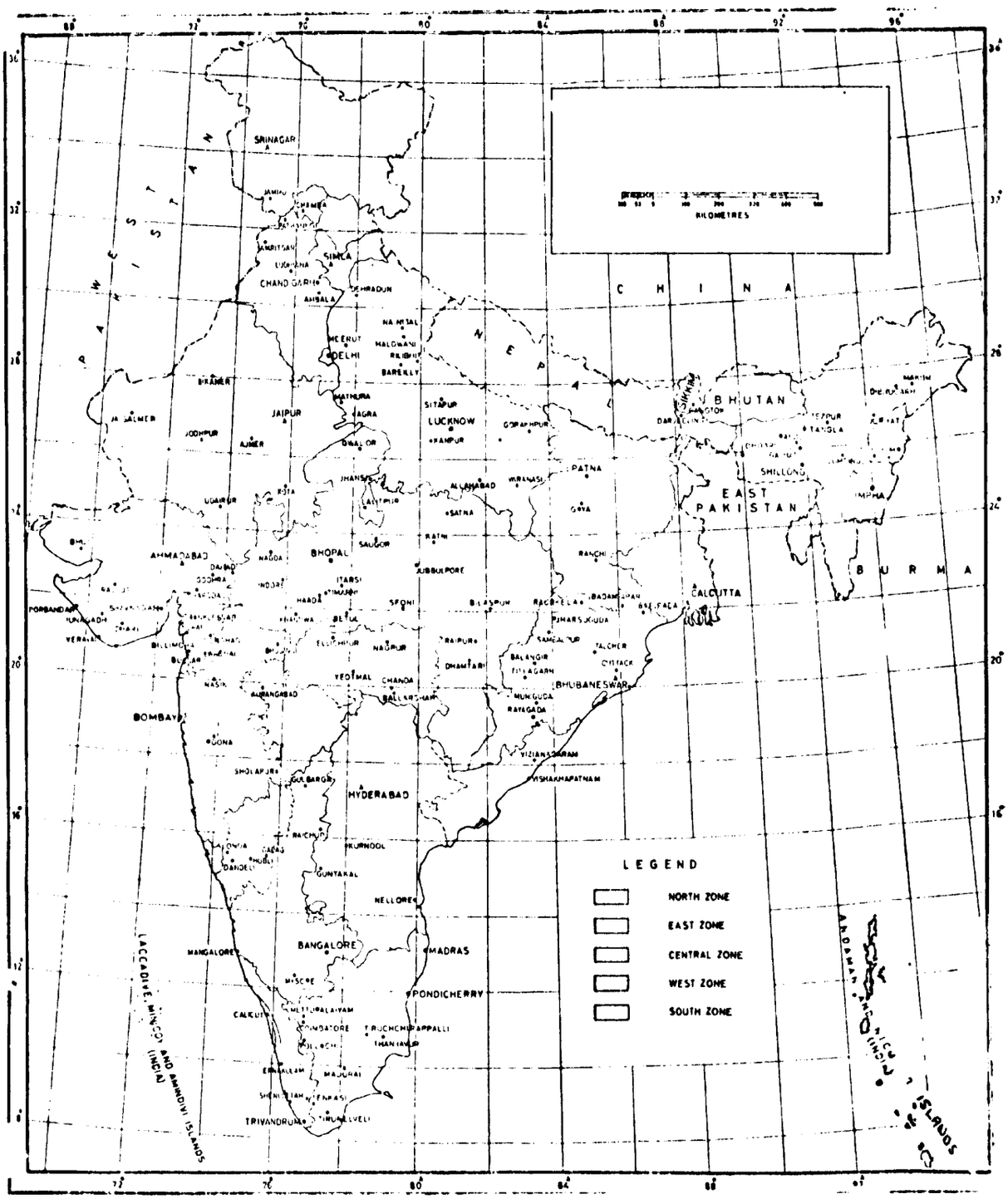
Badam (Therminalia cattapa)
Rosewood (Dalvergia latifolia)
Sissoc (Dalbergia sissoo)
Red cedar (Cedreila toona)
White cedar (Dysoxylum malabericum)
Padauk (pterocarpus dalberigiodes)
Teak (Tectona grandis)
Champa (Michelia champaka)
Palli (Dischopsis)
Velapine (Vateria indice)
Poon (Calophyllum)

Secondary furniture species

Indian birch (Betula alncides)
Chikrassy (Chukrasia tabularis)
Bonsum (Pheobe)
Haldu (Adinacordifolia)
Hollock (Terminalia myriocarpa)

Annex II

MAP OF INDIA SHOWING ZONES FOR CLASSIFYING COMMERCIAL TIMBERS



Annex III

EXPORT STATISTICS

A. Exports of wooden furniture, 1971/72 to 1975/76

(Thousands of Rs)

Importing country/area	1971/72	1972/73	1973/74	1974/75	1975/76
Abu Dhabi	66.6	1.3	2.7	-	206.5
Afghanistan	1.7	-	-	-	-
Australia	10.5	11.8	4.6	20.5	36.2
Bahrain	19.7	52.5	17.2	103.3	130.0
Bangladesh	-	109.0	340.3	13.4	-
Belgium	-	3.8	16.4	40.2	12.8
Bulgaria	-	-	-	-	5.0
Canada	1.7	3.3	2.4	38.4	21.0
Cyprus	-	0.1	-	-	-
Denmark	-	2.2	20.8	-	-
Dubai and Qatar	96.7	42.1	226.1	362.7	748.8
Egypt	-	-	-	14.7	-
Fiji	-	5.4	-	0.7	-
France	-	8.2	16.1	2.8	-
Germany, Federal Republic of	4.0	478.1	36.5	287.4	8.4
Gilbert Islands	-	-	-	48.0	-
Hong Kong	1.8	29.2	5.9	4.3	-
Iceland	-	6.5	-	-	-
Indonesia	3.4	-	-	17.0	-
Iran	18.9	3.4	4.1	40.9	115.1
Iraq	-	-	-	852.2	-
Israel	-	-	62.4	-	-
Italy	-	42.9	7.1	-	-
Japan	2.3	26.5	62.0	90.4	3.5
Kenya	25.2	-	-	-	-
Kuwait	25.9	5.9	258.4	442.0	437.3
Lebanon	-	-	-	-	6.6
Libyan Arab Jamahiriya	-	-	65.0	-	-
Malawi	0.6	-	-	-	-
Malaysia	21.1	2.3	-	-	-
Muscat	64.2	348.9	396.3	19.1	779.5
Mauritius	-	1.4	5.9	1.0	17.3

Importing country/area	1971/72	1972/73	1973/74	1974/75	1975/76
Mozambique	0.8	-	-	-	-
Nepal	157.2	98.0	33.7	45.2	200.8
Netherlands Antilles	-	-	-	1.4	-
Netherlands	-	-	-	-	7.5
Nigeria	-	-	-	4.4	-
Panama	-	-	1.6	-	-
People's Democratic Republic of Yemen	3.6	-	2.3	0.3	9.1
Saudi Arabia	3.0	0.1	-	13.0	15.5
Sri Lanka	-	4.3	3.6	11.5	37.3
Sweden	-	38.5	118.4	112.9	52.3
Switzerland	0.2	1.6	-	15.0	-
Singapore	0.5	7.6	-	5.5	1.4
Sudan	5.0	-	-	-	-
Trinidad and Tobago	-	-	2.2	-	-
United Kingdom	36.2	20.8	255.7	1,812.5	637.0
United States	48.6	58.2	141.1	161.6	64.1
Uganda	0.6	-	-	-	-
Zambia	-	-	11.1	-	-
Others	-	-	-	-	10.1
Total	620.0	1,414.8	2,119.9	4,582.3	3,563.1

Source: Chemical and Allied Products Export Promotion Council, 14/1-B, Ezra St., Calcutta, 700 001.

B. Exports of wooden products, 1971/72-1974/75

(Value in thousands of rupees, post devaluation)

	1971/72	1972/73	1973/74	1974/75
Plywood and plywood products	10,152.9	9,402.8	43,331.9	82,866.3
Hard board of wood fibre including insulation and particle boards	2,396.9	2,762.3	8,265.8	4,613.7
Wooden furniture	620.0	1,414.8	2,119.900	4,582.3
Wood products excluding wooden art ware	1,721.9	3,159.2	6,413.2	12,437.4

Annex IV

MANUFACTURERS/EXPORTERS OF WOODEN FURNITURE

C.G.G. Panicker
Management House
Trivandrum-I

Chippendale (Exports) Pvt. Ltd
C-20 Wagle Industrial Estate
Road-19, Thana, Maharashtra

Dodsal Pvt. Ltd
Mafatlal House
Backbay Reclamation
Bombay-4C0020

Kamdar Pvt. Ltd.
Industrial Assurance Building
Fort, Bombay-400001

Telecom Industries Pvt. Ltd
61 Dr. S.S. Rao Road
Parel, Bombay-400012

Modern Woodcrafts
Post Box No. 52
Tellicherry-I, Kerala

Alankrit Handicrafts Pvt. Ltd
208 Okhla Industrial Estate
New Delhi-110020

Featherlite Corporation
136 Mysore Road
Bangalore-560026

Goyal Industrial Corporation
Punjab & Sind Bank Bldg
3743 D.B. Cupta Road
New Delhi-110055

Indoors (Nagree & Co.)
50 Old Custom House Road
Bombay-400001

Interfurn Pvt. Ltd
361 Dr. D.N. Road
Bombay-400001

La-Kozy
La-Kozy Mansion
21 Chowpatty Seaface
Bombay-400007

N.R. Jasani
Jayant Mahal, D. Road
Churchgate, Bombay-400020

Vinoo Patterns & Furniture Industry
4 Industrial Area, Govindpura
Bhopal

Interwood Decorators Pvt. Ltd
C-201 Usha Nagar, Bhandup
Bombay-400078

Sri Aurobindo Ashram Wood Working Unit
3 & 5, Rue Depey
Pondicherry-605002

Western India Plywoods Ltd
P.O. Baliapatam,
Cannanore-670010, Kerala

Premier Woodcrafts Pvt. Ltd
1 Radha Kesto Sett St
Calcutta-700016

Republic Furnishers Ltd
4, Bakhar Shah Road
Calcutta-700033

Canton Carpentary Works (P) Ltd
14 Radhanath Chowdhury Road
Calcutta-700015

Joinery Manufacturing Co.
77/1 Christopher Road
Calcutta-700046

T.K. Jacob
Thamarapally
Thevars
Cochin-13

Mansfield & Sons
16 R.N. Choudhury Road
Calcutta-700015

Nexus Pvt. Ltd
76 Hazra Road
Calcutta-29

B.H. Smith & Co. Pvt. Ltd
46 Dharamtala Street
Calcutta-13

Annex V

MAIN COMPANIES EXPORTING WOODEN FURNITURE 1976/77 AND APRIL TO NOVEMBER 1977

(Thousands of Rs)

Company	1976/77	1977	Importing countries
Allansons Pvt. Ltd	-	174.6 (April-Nov.)	Abu Dhabi, Dubai and Qatar
Altaf Furnishers Bombay	-	391.5 (April-June)	Qatar and United States
Ahuja Furnishers Pvt. Ltd	-	69.2 (April-June)	Bahrain, Muscat and Sudan
Chippendale (Exports) Pvt. Ltd Bombay	2,260.5	704.1 (April-Aug.)	Bahrain, Dubai, United Kingdom, United States etc.
C.G.G. Panicker Trivandrum	1,120.5	1,923.9 (April-Oct.)	Canada, Denmark, Federal Republic of Germany, Japan, Singapore, Spain, Sweden, United States etc.
Interfurn Pvt. Ltd Bombay	2,104.1	95.5 (April-Oct.)	Dubai, Oman, United States
La-kozy Bombay	461.2 (April-Sept.)	...	Abudhabi, Dubai, Kuwait and United States
Kamdar Pvt. Ltd Bombay	297.3	- (Apri -Sept.)	Bahrain, Dubai, Canada and United States
N.R. Jasani Bombay	1,141.3	373.0 (April-June)	Oman
Indoors (Nagree and Co.) Bombay	161.1	3.2 (April-Nov.)	Bahrain, Dubai, Qatar and Oman
R.M. Gokul Associates Bombay	-	295.5 (April-Sept.)	United States
Vinoo Pattern and Furniture Industries Bhoopal	50.6	61.1 (April-Aug.)	United Kingdom
Western India Plywood Ltd Ballipatam	172.8	407.0 (April-Nov.)	Qatar, Sweden, United States etc.
Woods India Bombay	41.7	264.1 (April-Sept.)	Bahrain and Saudi Arabia
Others	484.7	1,729.2 (April-Nov.)	
Total	8,295.8	6,491.9	

Annex VI

EXTRACTS FROM A REPORT ON WOODEN FURNITURE IN DENMARK, FRANCE AND FEDERAL REPUBLIC OF GERMANY a/

Denmark

The Team had a useful talk with the authorities of the IFU b/. It was explained that they could contribute 20% of the investment with the Danish partner contributing another 20%. The Indian partner could have 60% of the share capital. The IFU also advances a loan to the Danish partner at a concessional rate with a 3 year grace period for preparation of a feasibility report and project report.

The above mentioned firms evinced great interest in having joint ventures of this kind in India. They are successfully running such ventures in Philippines, Thailand, Singapore, Ivory Coast and Ghana. IFU has assisted a number of furniture units of this kind.

Another important feature of the visit to Denmark was a visit to the Technological Institute (Wooden Furniture Section) and also to the Designs School. The Danish Technological Institute are willing to supply machines if approached at the Government level for testing not only wooden furniture, but also finishes, upholstery, etc. It is gathered from the members of the Team that although the Forest Research Institute is taking care of wood items, there is no Institute of this type anywhere in India. It may be worthwhile exploring the possibility for creation of such an Institute.

Mr. Ole Olsson of OLSON MOBLER confirmed that Danish dealers were also facing a tough competition from Ikea, but now they have revived their position. However, they were still facing tough competition from the low-priced furniture from East European countries. Mr. Olsson has 5 stores in Denmark. His store at the Imperial Hotel sells only high quality furniture on a 700 sq. meteres area. He showed special interest in traditional Indian furniture and it would be possible for his organization to promote these items.

At many places, importers wanted colour photgraphs or preferably colour catalogues which the Team was not able to provide. These catalogues make an indelible impact on the importer or consumer.

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a/ The report was prepared by a Team of Indian Furniture Manufacturers who undertook a two-week marketing mission to Europe late 1977. The mission was sponsored by the Indian Institute of Foreign Trade under the UNDP programme.

b/ Industrialized Fund for Developing Countries

1. M.K. Kruger & Co., Skodsborgvej, 188
   DK-2850 Nacrum (Near Copenhagen)
2. Nigaden Ltd, Bernstoffvej 104
   2900 Helirur, Copenhagen

France

In Paris, the big departmental stores like the Galerie Lafayette and Au Printemps did not evince much interest mainly because of the surge of numerous sellers to them. There is a separate person for each product. In other words, there is a man for traditional furniture, a man for Scandinavian furniture and another man for office furniture and an entirely different person for garden furniture, etc. Their buying department is a mini-secretariat.

M/s. Levitan showed general interest in modern home furniture. A visit to M/s. Mercier Freres, a classical style furniture shop, founded in 1828 was very useful for promoting traditional type of Indian furniture. A member of the Team gave samples to them. As this firm is one of the world famous in style furniture, selling also to the Middle East; this contact would indeed be very useful for exporting traditional type of furniture. A member of the Team has already sold directly to the Middle East from India. A tie-up proposal brought about with M/s. Mercier Freres will indeed mean a great market for Indian traditional furniture in France and also in other countries.

Federal Republic of Germany

The Team spent two weeks in West Germany visiting Frankfurt, Stuttgart, Berlin, Hanover and Hamburg.

The Team gathered from the representative of one of the Importers' Association covering 65 wholesale importers that there is great interest in Indian furniture, particularly of traditional type with Indian designs. They were also interested in certain items of modern furniture shown by the Team. They felt that price would not be a big problem for traditional type of furniture because only certain sections of the buying public with special taste would be interested in getting this type of furniture. On the contrary, modern type of furniture faces stiff competition from the Scandinavian countries and also from Yugoslavia, Romania and Poland. Apart from the price factor, designs are extremely important and people have a preference for Scandinavian type of designs.

Both traditional and modern type of furniture would be preferred in knocked-down conditions. It should be possible to assemble them easily as and when they are required.

Since the Scandinavian countries and the other neighbouring countries of West Germany are in a position to supply furniture at short notice by trucks, it would be advisable to create a warehouse as it has been done for Indian carpets. Perhaps packaging and freight problems could also be taken care of

by this arrangement of a warehouse located in a central place in West Germany. In fact, one of the exclusive furniture marts told the Team that the Indian carpets and traditional type of furniture would form a good ensemble and it would be advisable to have permanent exhibitions in big furniture stores.

The Team also felt that containerization will help export of furniture particularly upholstered furniture.

The members of the team were impressed by not only the display, but also by the excellence of attractively produced catalogues. The members felt that they should also have the means to produce such catalogues as a part of export promotion. The Marketing Development Fund of the Ministry of Commerce should also be able to provide liberal assistance in this regard.

Mr. Hartmut Martin of Hamburg knows India well. He is buying handicrafts from Jaipur. He emphasized that transport from India including air transport should improve. For instance, the handicraft items including brassware were lying in the open at Bombay airport and were spoiled in the rains. He sells only traditional type of furniture imported from United Kingdom, Italy, Romania and Yugoslavia. He has promised to consider traditional type of furniture during his next visit to India provided proper transport is ensured.

The Indian Consuls-General in Hamburg and Berlin felt that a lot of promotional efforts is required for selling furniture in the Federal Republic of Germany. The Indian furniture should be exhibited in well known furniture marts where space is quite expensive and also in the Indian offices.

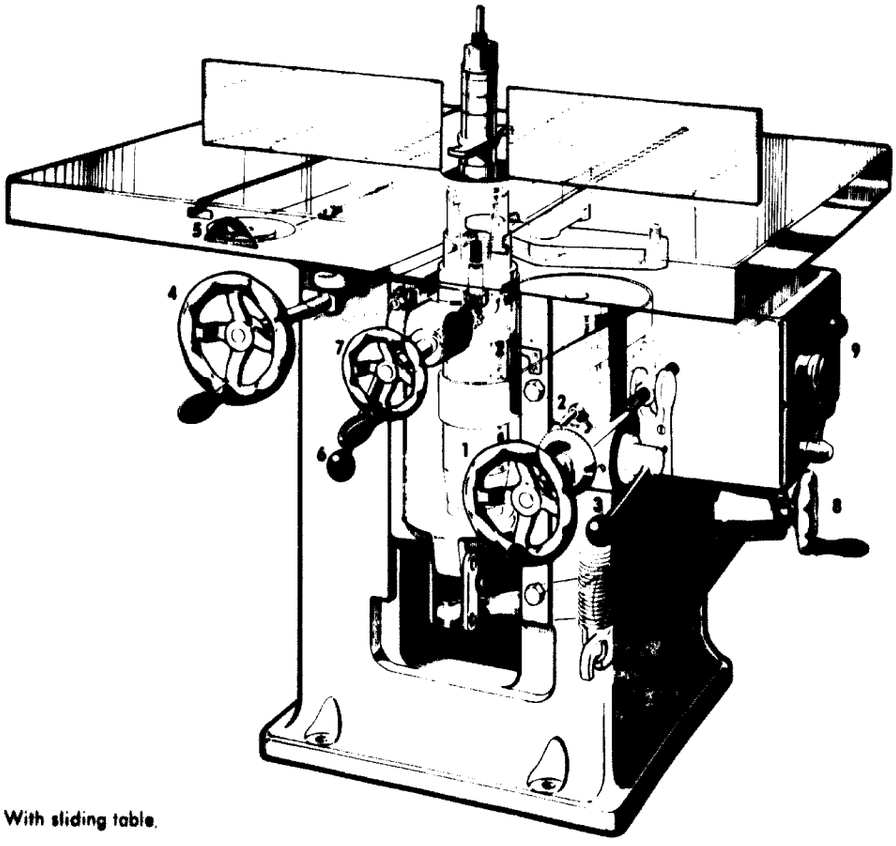
Annex VII

FOLDING BOOKCASE INCORPORATING TRADITIONAL BRASS-PANELLED SCREENS, DESIGNED BY THE CONSULTANT DURING THE ONE-MONTH MISSION AND MADE AT IPIRI, BANGALORE

The design is representative of the development concept outlined in the report, i.e., the promotion of functional cross-linking among three manufacturing sectors: the plywood industry, small-scale furniture industry and traditional handicraft cottage industry. In this particular case, the back panel and shelves would be supplied in pre-cut form by plywood plants. Further processing of these panel components and final assembly would be carried out by small-scale furniture plants, while the decorative brass panel inserts would be handcrafted and supplied by the cottage industry.

Annex VIII

SPINDLE MOULDERS

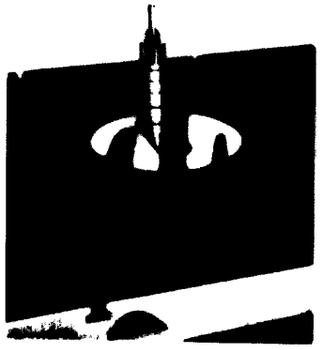


With sliding table.

1. Verticol adjustment of spindle
2. Vernier scale far vertical adjustment
3. Locking of spindle frame
4. Displacement of table inwards or outwards
5. Vernier scale far table movement
6. Brake lever
7. Clamping of spindle
8. Belt tightening
9. Start, motor protection, switch

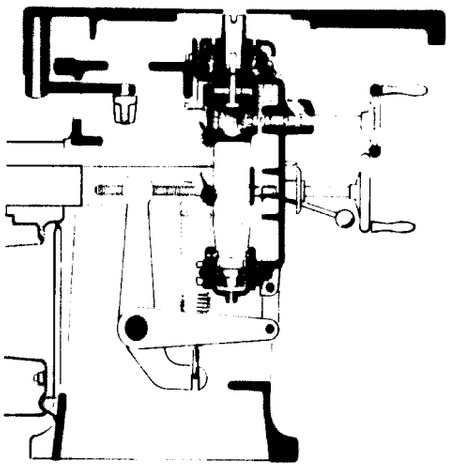
Sliding table with direct setting

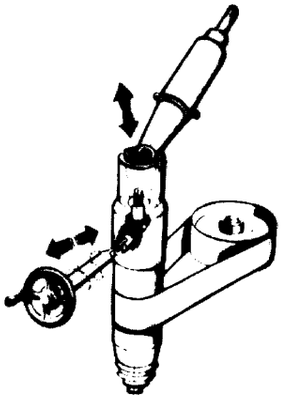
The table is adjustable for the types FM-PA. It can be moved through a maximum distance of 140 mm (5⅝") from the operator's side. Adjustment is made with a handwheel on the front. The displacement is read with 0.1 mm (0.025") accuracy on a vernier scale at the front edge of the table. This possibility of adjusting the table saves the tedious resetting of the fence, particulary for the fine adjustment in connectian with tool re-sharpening or replacement. The setting-up pracedure changes into a coarse setting, followed by a trial run on a work-piece to determine the necessary correction af the setting with the aid of the vernier.

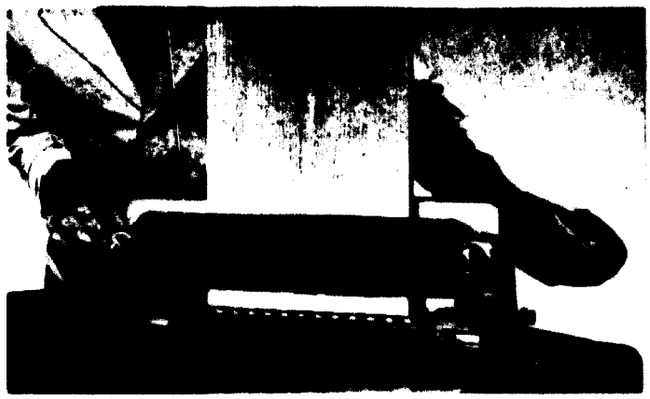


Detachable spindle with exact centering

A handwheel on the front operotes a screw at the bottom of the arbor shank, the wheel shoft acting simultaneously as a locking pin for the spindle. As the detachable spindles have a corresponding threaded hole, they can be locked and released with the handwheel. The arbor shaft is conical and ensures very accurote centering of the detachable spindle.







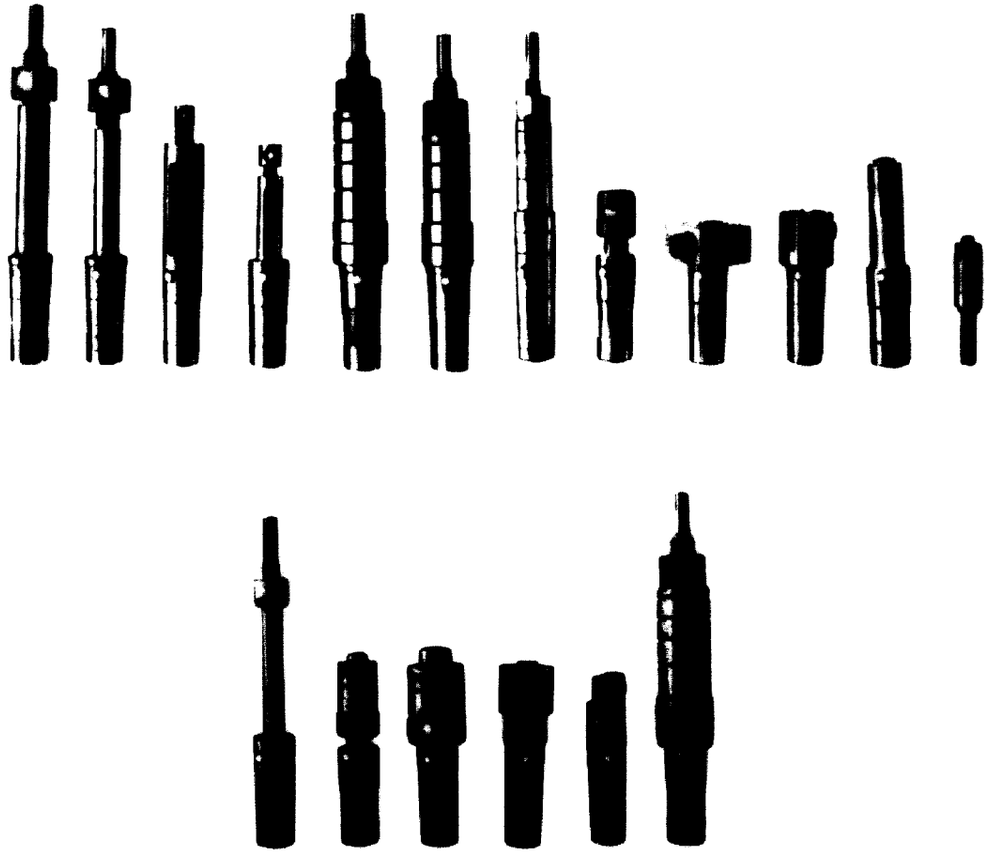
DOVETAILING ATTACHMENT E. E.

This attachment can also be supplied for use at 7,200 r. p. m. using comb plate and standard cutters.

CORNER LOCKING ATTACHMENT E. F.

Up to 3" maximum depth with top piece E. N. T. 28. Speed 4,500 r. p. m.

Detachable spindles



The illustration shows J- and K-type spindles. With heavy tools an overhead bearing should be used to avoid overloading the shaper.

Annex IX

MAIN INDIAN MANUFACTURERS OF WOODWORKING MACHINES

Atlas Works Ltd
119, Ripon Str., Caloutta

Baroda Machine Tools (BMT)
Dabhoi Road, Baroda

Beco Engineering Ltd
G.T. Road, Ballabgard, Haryana

Britannia Engineering Ltd
Titaghur, 24 Parganas, West Bengal

International Machine Tools Corporation
Botawala Building, 5 Bank Str., Bombay

Janta Machine Tools Ltd
Majiwade Village, Thana, Maharashtra

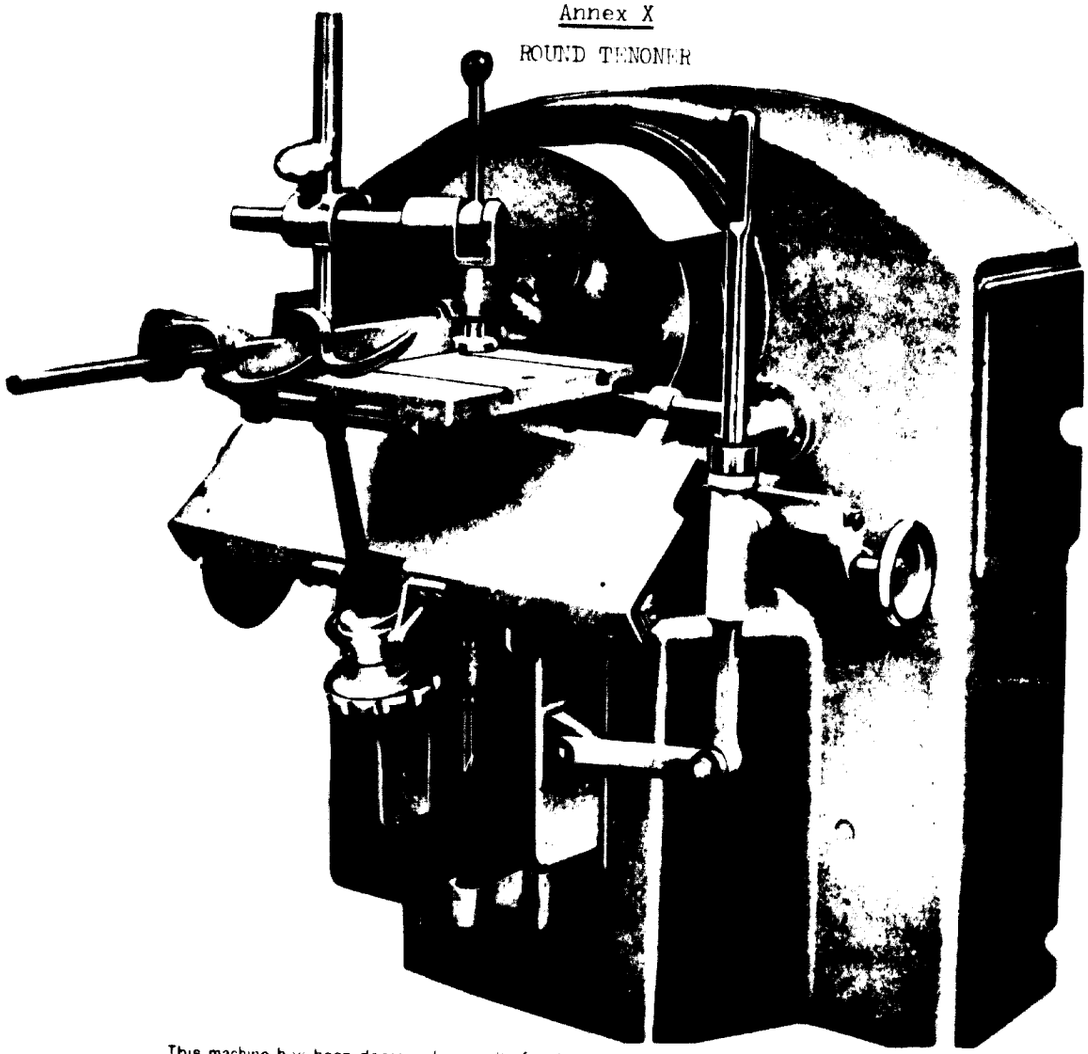
Java Engineering Work
Bangalore 560009

Kunda Machine Ltd
Civil Lines, Ludhiana, Punjab

Sonex Machine Tools
10, Industrial Estate, Rajkot, Gujarat

Annex X

ROUND TENONER

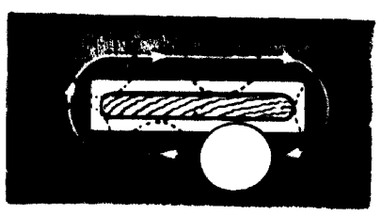


This machine has been designed specially for the furniture and chair manufacturers who produce quality articles.

All adjustments are easily made and read off the scales provided on the machine.

Constant accuracy is maintained as the settings are easily checked against the scales set in inches.

After clamping the stock the table is moved forward with hand lever (at right hand side from table and support). The under side of tenon is cut, and rounded at one side. The table comes against a stop, and the cutter head disc turns another half a stroke automatically and cuts the upper part of the tenon and rounds the tenon on the other side. The table is ready. Table can be tilted to [illegible]. The standard [illegible] can be easily adjusted from dials provided on the machine for setting [illegible] length is determined by the setting of the [illegible] saw on the cutterhead and turned by [illegible] top of the machine with scales which turn threaded spindles. The standard model will cut all types of tenons on any angle from approx. 3 1/2" long by approx. 7 1.16" thick, to perfectly round tenons.



Our tenoners do not operate on a copying process through masters for the size of tenon.

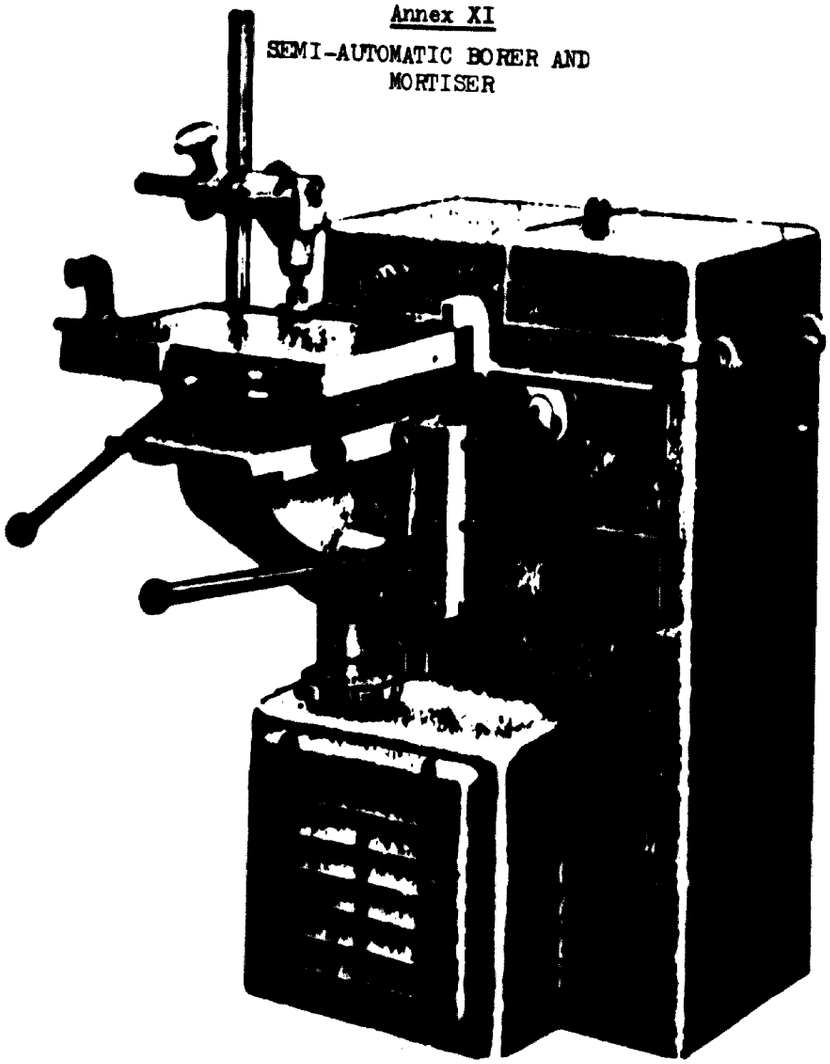
The cutting mechanism employs only a single cutterhead. The cutterhead is fitted to a round metal disc, which ingeniously carries the high speed cutters completely round the tenon.

As the disc is not overhung, there is no vibration or tearing of the material even on hard timbers. Cutterhead has 2 long knives for moulding tenons, 1 adjustable circular saw for cutting length of tenon (no bevel cutters!), 2 spur cutters for cutting shoulders of tenon to avoid splintering and 1 moulding cutter for chamfering tenon for fast insertion in the mortise.

The standard model RP 100 is supplied with eccentric holddown. Air pressure holddown by which the working piece is held automatically and released automatically can be supplied at a slightly higher price.

Annex XI

SEMI-AUTOMATIC BORER AND MORTISER



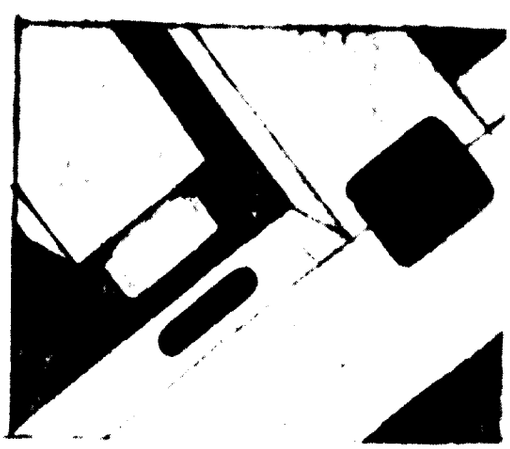
Model HL 120
(semi automatic

Drill automatic borer and mortiser, model HL 120
Ref.: Chair Upholstered Furniture and Furniture Factories

The high-speed machine has been specially designed for the production of mortises (round holes as well) and is therefore ideally suited to the chair and furniture industries. The entry of the cutter drill to a predetermined depth is actuated by a lever in a manner identical to the operation of a normal vertical drill. Automatically a lengthwise cut (for mortise) of set distance is made. Length of stroke varies from 0 (= round hole) to 6" (= mortise).

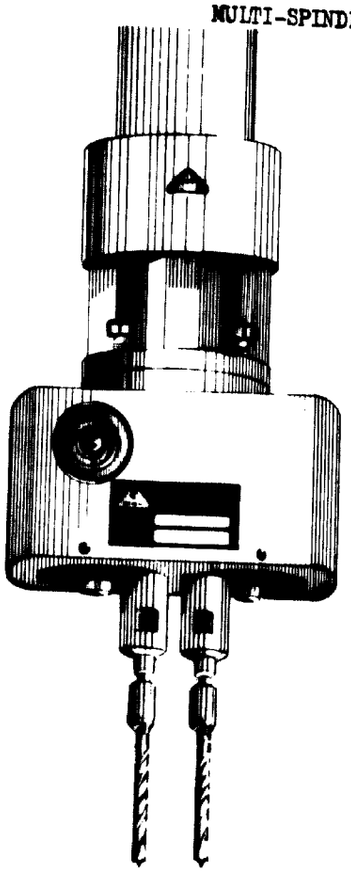
An identical adaption table is provided with a manual clamping device as illustrated. Against extra price table can be supplied with air-pressure holddown. Table is adjustable up to an angle of 20°. The table also has a length adjustment which can be set as required.

The machine is driven by a 3 HP electric motor (3 phases 50 or 60 cycles). The speed of the drill is approx. 11 500 rev./min. The whole mechanism is very well balanced and all moving and hinged points are on ball bearings. Maintenance as well as wear are therefore reduced to a minimum. The semi-automatic borer and mortiser effects a considerable saving of time by allowing the drilling of a mortise to be carried out in no more than the time needed to bore an ordinary round hole. Upon request the machine can be supplied with double action (= two tables).

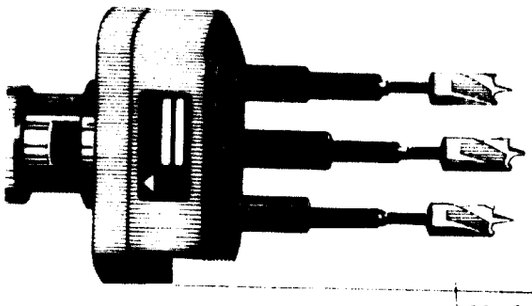


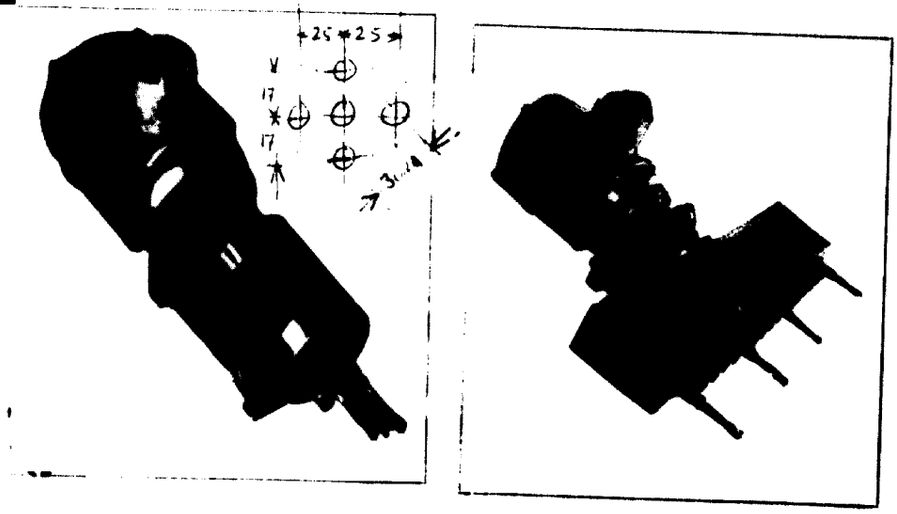
Annex XII

MULTI-SPINDLED DRILLING HEADS



Special multi-spindled drilling heads, fixed or adjustable





Annex XIII

DOWEL MILLING MACHINE

DOWELS AND THEIR USES

Dowels ere the most important elements for joining carcasses and frames in the woodworking industry. In the manufacture of prefabricated houses, doors and windows, dowel joints have become equally important. There exist three principal types of dowels: 1) plain dowels, 2) grooved dowels, 3) expansible dowels.
Plain dowels would make the best joint, unless the glue-applied to the dowel - was stripped while forcing the dowel into the dowel hole. If too much glue is applied in the dowel hole, this type of dowel provides no escape for the glue and thus involves the risk of tearing the wood.

This risk is absent with grooved or channeled dowels. However, only the area between the grooves comes in direct contact with the interior surface of the hole. If the glue is carefully applied, the grooves will be filled with glue. But glue contracts as it dries, and this will leave hollow spaces in the grooves. With heavily grooved dowels only about fifty per cent, of the total gluing area will thus at best be used, and this is not sufficient for heavily stressed parts such as chair frames.

THE ADVANTAGES OF THE EXPANSIBLE DOWEL

The ideal dowel to cope with heavy stresses is the expansible dowel. The grooves are impressed into the milled dowel and will expand again under the influence of the glue moisture. This assures a very strong joint, the strength of which is further increased by the tight mechanical fit resulting from the swelling of the dowel grooves. Moreover, the glue is evenly distributed over the entire dowel area when the dowel is driven into the dowel hole. Gluing tests have shown that the strength of such dowel joints is far greater than that of any other dowel joint.

METHOD OF OPERATION

The GNOM DK 110 Dowel Milling Machine was developed with a view to permitting joiners to use their waste wood for making much needed joining elements. Properly prepared square strips are fed to the cutterhead by means of an adjustable guide. A special cutterhead makes round dowel pins out of the square stock, impresses the spiral channels into the pin with a diametral reduction of 8 mils, and at the same time, assures feeding of the dowel pins. The GNOM DK 110 dowel milling machine takes strip lengths from 9 inches upwards.

Plain dowel rods can also be made in the place of spiral-grooved dowel pins. A separate cutterhead is needed for each type of dowel and each diameter. For making plain dowel rods, an additional holding device is required. Slight differences of about 8 to 12 mils as may be caused by inaccurate drills or machinery can be compensated by adjusting a cam at the cutterhead. The GNOM DK 110 dowel milling machine can thus be adjusted for making dowels to fit the dowel hole.
Since it has always been a little difficult to cut the square strips to correct size, an adjustable guide has been developed to assure trouble-free operation even with inaccurately squared blanks.

For serrating and thus compressing tenons as used for the production of chairs and tables, special heads have been developed to permit economical use of the machine for that type of works as well.

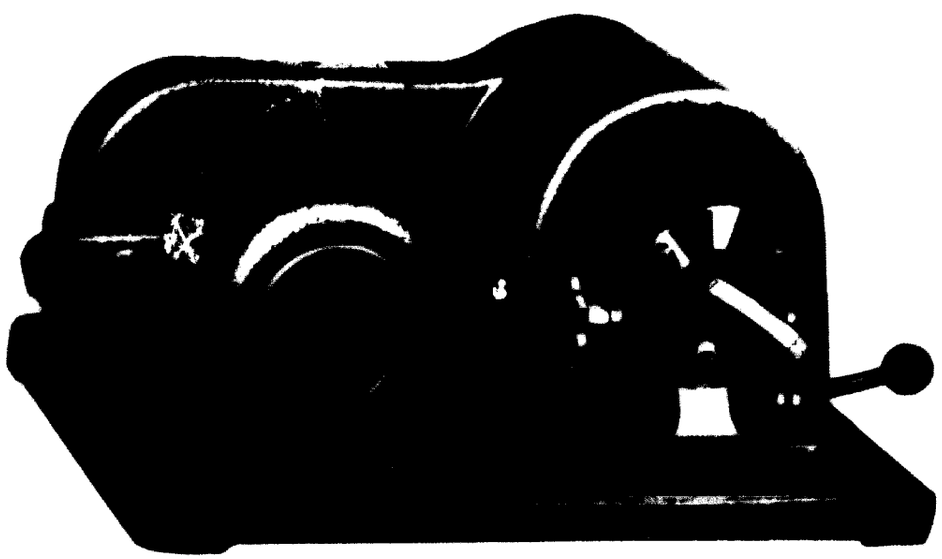
SPECIFICATIONS

Diametral capacity:	6-18 mm Ø
Feed rate:	epprox. 6-7 m per minute
Minimum length of square strip:	22 cm
Motor output:	0,75 Kw
Net weight	approx. 48 kgs
Gross weight:	approx. 58 kgs
Case dimensions:	approx. 67 x 51 x 35 cm

(The right is reserved to make alterations as required.)

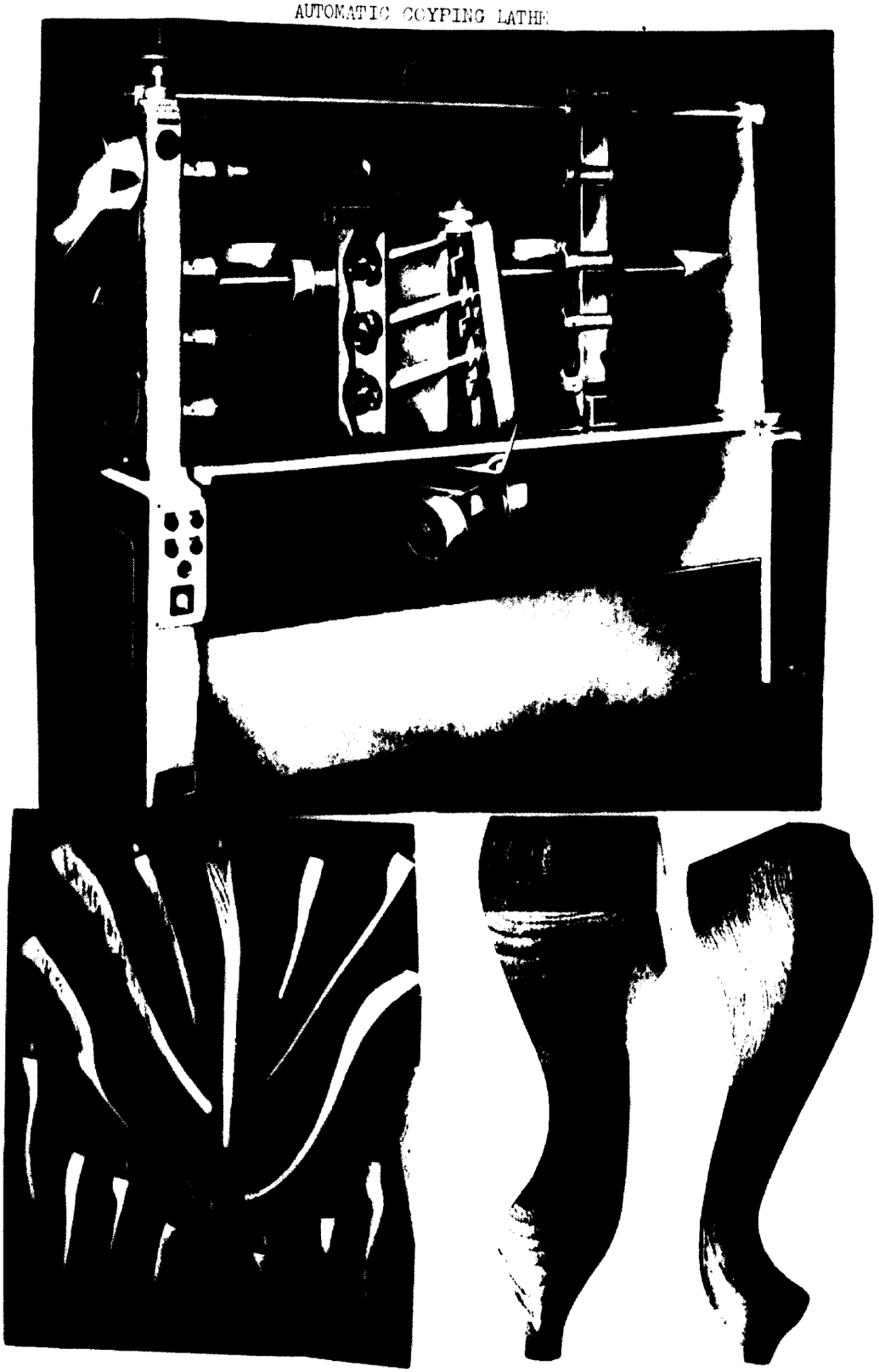
In addition to the DK 110 machine, we make the RF 411 rod milling machine for dowels 10-20 mm diameter, feed rate 15-18 m per minute. A machine of higher capacity is our VF 120 multiple head moulder for dowels 3-28 mm diameter, feed rate 5-25 m/min.

For chamfering the dowel rods and cutting the dowel plugs to length, we make our AA-200 and AA-220 dowel cross-cut and chamfering machines. For the production of round rods, we recommend our RF 410, RF 411, RF 420 and RF 430 rod milling machines and our RS 340 rod sanding machine.



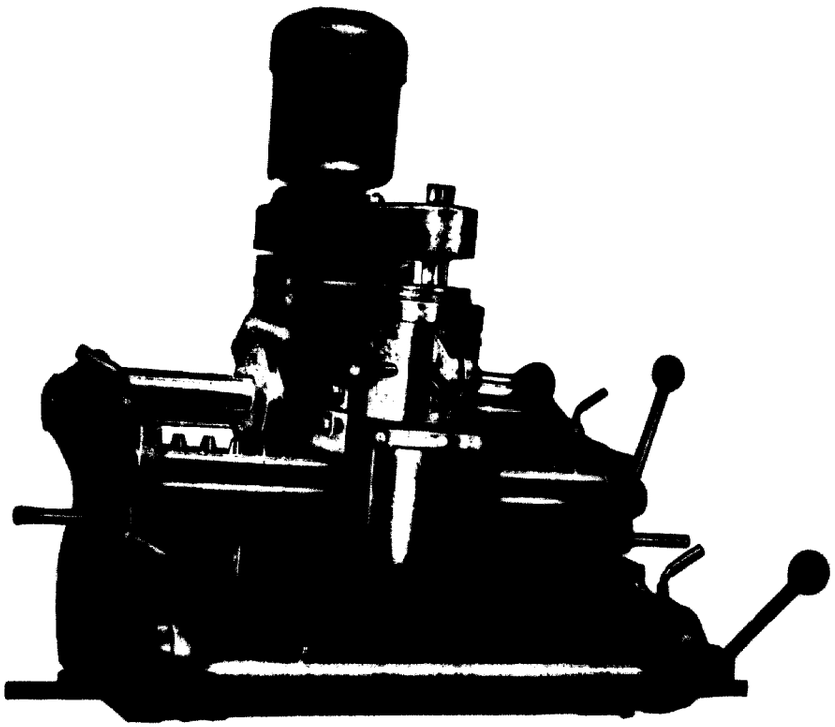
Annex XIV

AUTOMATIC COYPING LATHE



Annex XV

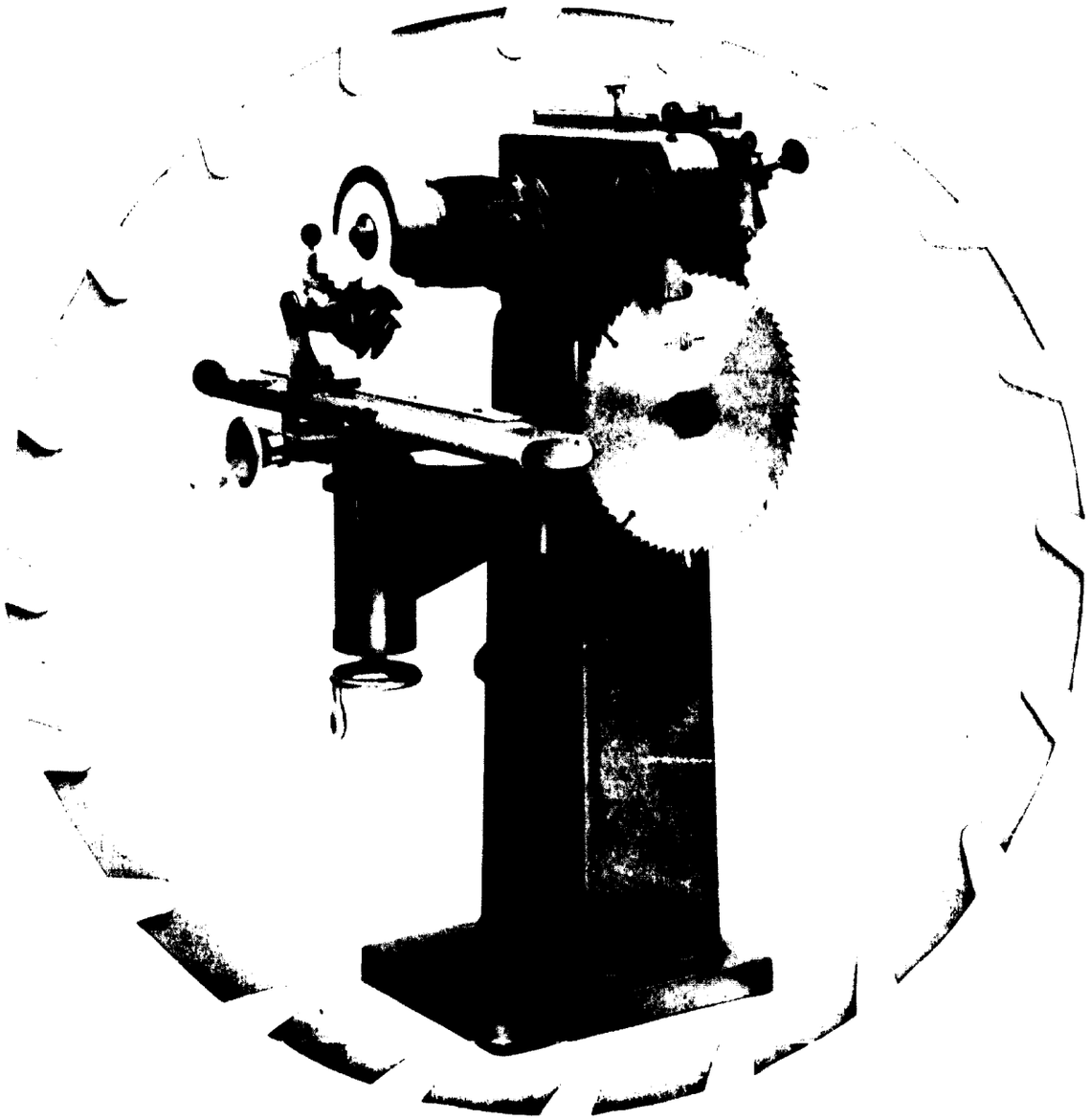
DOVETAILING MACHINE



Annex XVI

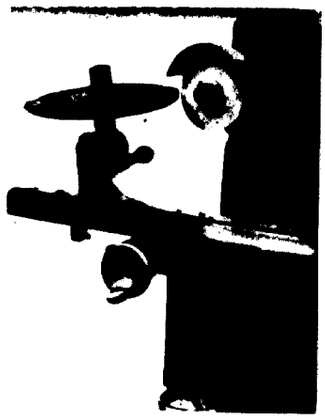
GENERAL-PURPOSE SHARPENING MACHINE

for sharpening plane irons, milling tools, circular saw blades, bandsaw blades
simple operation - maximum pitch accuracy

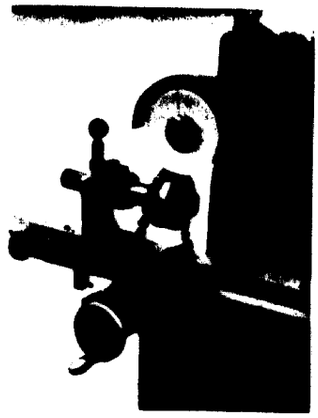


Grinding plane irons

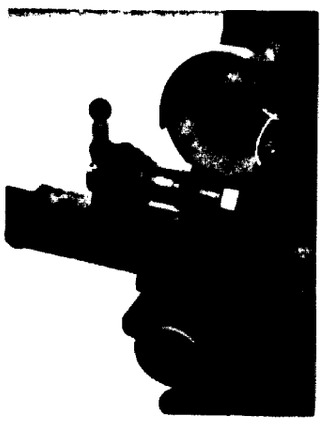
Progressive design allows the simultaneous incorporation of up to four tooth profiles. Adjustment is simple and can be performed whilst the machine is running. A notable feature is that all profiles, even WIGO-RS circular saw blades, may be sharpened in one working operation.



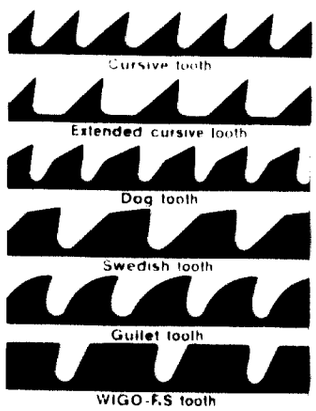
Grinding slotted discs



Grinding chain cutters



Grinding milling tools



Tooth profiles available

Technical data

	from	to
Circular saw blades	diam. 120	600 mm
Bandsaw blades	5	60 mm
Tooth pitch MFS I	2	40 mm
Tooth pitch MFS II	1	100 mm
Tooth depth: cursive tooth	3	20 mm
Tooth depth: dog and Swedish teeth	5	25 mm
Pitch for milling tools 2 3 4 6 12	diam. 200 mm	
Slotted discs	diam. 450 mm	
Plane irons	630 mm long	
additional extra	from 730 to 840 mm long	
Feed speed, normal	65 teeth/min	
two speeds, additional extra	30/65 teeth/min	
Required for WIGO-RS	15/30/65 teeth/min	

Accessories

3 Grinding wheels
Spanners 10/14/19/22/32
1 Dressing stone

Dimensions

Length 1000 mm, width 900 mm, depth 1300 mm
Weight 210 kg

Annex XVII

ADJUSTABLE CUTTERBLOCK

Tool No. 511 BG

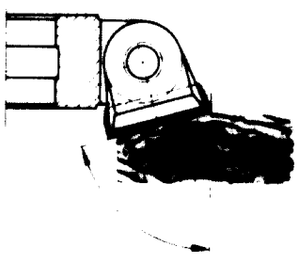
Multi-Purpose cutter head with 1° adjustment of bevelling feature

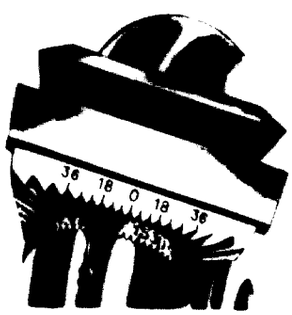
Applications:

Rabbeting, facing and every angle of bevelling from 60° top to 60° bottom.

Design:

A serrated disc between blade section and cutter body enables the fine adjustment of bevelling in 1° steps. Blade sections available with HSS and carbide tipped.





Tool No. 517 BG

Glue joint cutter head

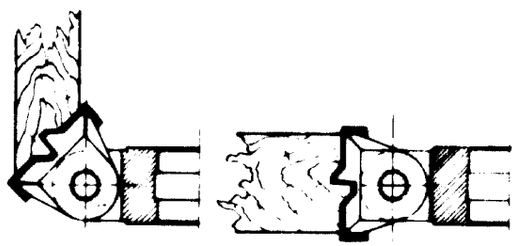
BG-TEST
ZU-472?

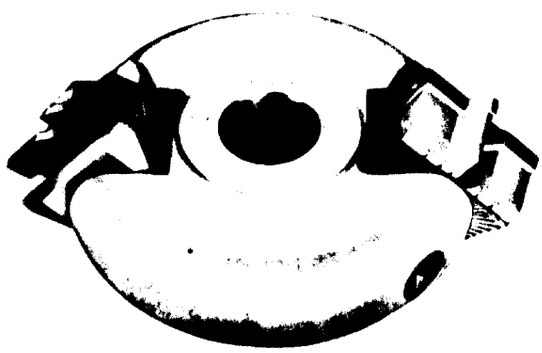
Applications:

Adjustable for straight as well as mitre locking glue joint.

Design:

Two profiled HSS or carbide tipped blade sections mounted with precision serrations in a dynamically shaped and balanced cutter body; swiveling 45° to each side in 5° steps. Profiled blade sections for locking joints can also be mounted in cutter bodies no. 510 BG or no. 515 BG.

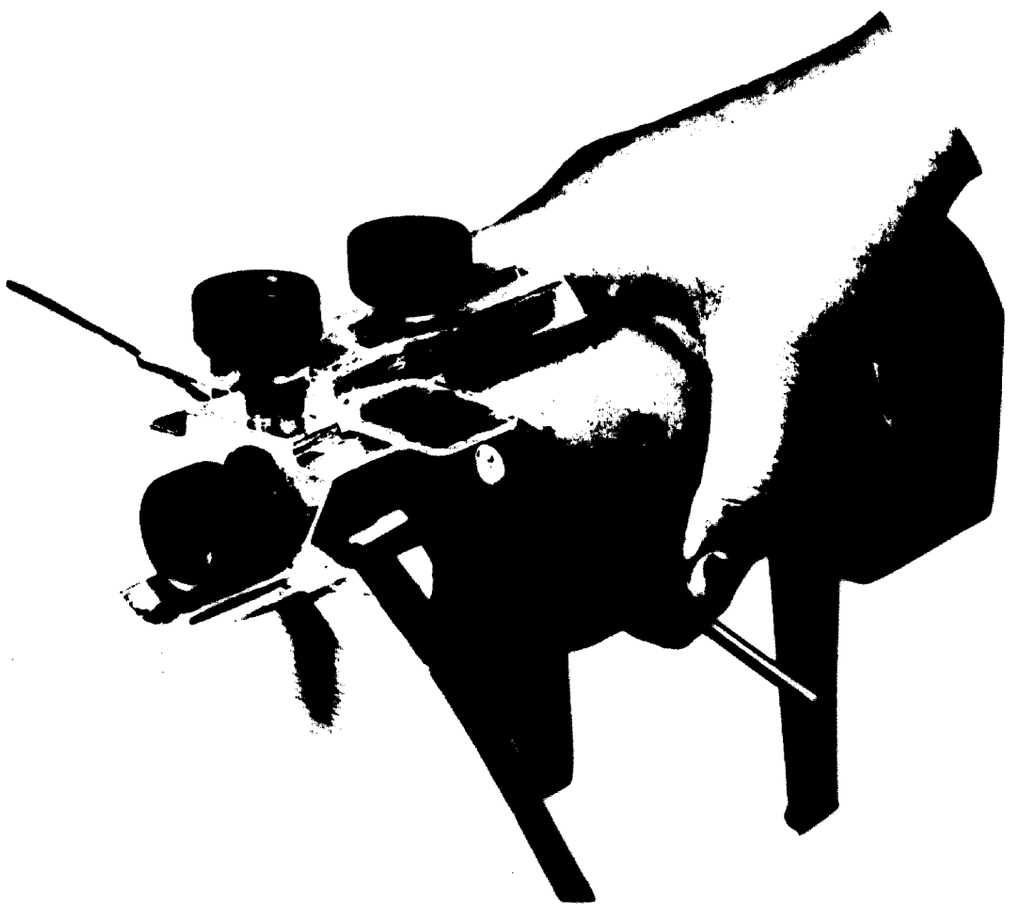




Tool No.	Diameter (closest metric equivalent to:)	Cutting width (closest metric equivalent to:)	Bore	No. of teeth	Tool No.	Diameter (closest metric equivalent to:)	Cutting width (closest metric equivalent to:)	Bore	No. of blades	Material thickness range: Straight locking joint	Material thickness range: Mitre locking joint
511	5"	1 9/16"	1 1/4"	2	517	5 1/2"	1 9/16"	1 1/4"	2	3/4"–1 1/2"	5/8"–1 1/16"
511	5 1/2"	2"	1 1/4"	2	517	6 5/16"	2"	1 1/4"	2	55/64"–2"	3/4"–1 3/8"
511	6 5/16"	2 9/16"	1 1/4"	2	517	7 1/8"	2"	1 1/4"	2	55/64"–2"	3/4"–1 3/8"

Annex XVIII

EDGE TRIMMING POWER TOOL



Annex XIX

SPECIFICATIONS FOR THE PRECISION OF THICKNESSING MACHINES

Number	Purpose of the test	Tolerances (mm)	Remarks and recommendations
1	2	3	4
	A. Geometrical checks		
A1.	Flatness of the work surface of the table in the following three directions:		Straight-edge greater in length than the length (or, in the case of (b), the width) of the table. Feeler gauge, plane-parallel block gauges.
	(a) Longitudinal	(a) $\frac{0.2}{1,000}$	
	(b) Transverse	(b) $\frac{0.15}{1,000}$	
	(c) Diagonal	(c) $\frac{0.2}{1,000}$	
A2.	Parallelism of the cutter block to the work surface of the table:		Dial gauge graduated in units of 0.01mm placed on the edge of the table in such a way that the plunger touches the lower generatrix of the cutter block. The gauge should be moved along the width of the table. The maximum readings should be taken. The test should be carried out first for the highest position of the table and then for the lowest one.
	(a) For work-piece widths up to 400 mm	(a) 0.15	
	(b) Same, more than 400 mm	(b) 0.25	
A3.	Run out of the cutter block	0.05	Dial gauge graduated in units of 0.002mm placed as in A2. The cutter block should be turned slowly and the maximum and minimum readings on the gauge taken.
A4.	Run out of the feed rollers	0.05	Same (See A3)
A5.	Parallelism of the feed rollers to the work surface of the table	$\frac{0.25}{1,000}$	Dial gauge; same (See A2)
	B. Tests for machining precision		
	(Samples from straight-grain soft wood species with a moisture content of 10 per cent should be used; dimensions: 30 x 150 x 1,000)		
B1.	Parallelism of machined surfaces of samples	$\frac{0.2}{1,000}$	Slide callipers

Source: V. Radulescu Criteria for the acceptance and ascertainment of the technical standard of machine tools for woodworking operating by removal of chips or particles. ID/WG. 151/25, 1973, p.50.

DATA SHEET

Machine: Multiple blade circular sawing machines, for ripping, mechanical feed

Basic parameter: Maximum width of workpiece

Specifications	Units	Current technology
Maximum width of workpiece	mm	400
Maximum distance between two circular blades	mm	120 - 320
Maximum cutting height	mm	100 - 120
Number of circular blades	pieces	6 - 15
Cutting speed	m/s	60 - 70
Feed rate (continuously variable)	m/min.	15 - 30
Power requirement	kW	15 - 30

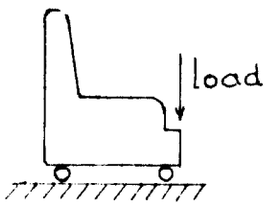
Annex XXX

PERFORMANCE TESTS FOR CHAIRS AND SETTEES

Stability tests

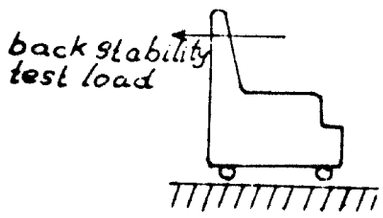
Forwards overbalancing

A vertical force of 1,000 N shall be applied by means of a suitable loading pad of 200 mm diameter, placed with its centre on the back-to-front centre line of the seat at a point 100 mm behind the front edge. It shall be noted whether the article overbalances.



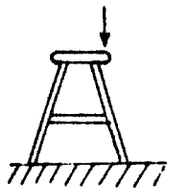
Rearwards overbalancing

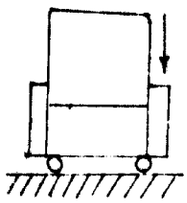
Rearwards movement of the article shall be prevented by suitable supports placed behind its rear feet or castors. A horizontal rearwards force of 60 N shall be applied to the back 350 mm above the intersection point of the centre lines of the seat and back surfaces or 100 mm below the top of the back, whichever is the lower. It shall be noted whether the article overbalances.



Sideways overbalancing

A vertical downwards force of 200 N shall be applied at different points along the length of the arm by means of a 200 mm diameter pad. It shall be noted whether the chair overbalances. If the arms of the chair are not identical and the chair is therefore not symmetrical the test load shall be applied to each arm in turn.





Strength tests

Checking of moisture content

The procedure described in annex I, under the heading "Checking of moisture content" shall be followed.

Initial inspection

The chairs shall be thoroughly inspected, removing as much of the cover on the bottom as is necessary to perform a thorough inspection of the joints and the construction. Any apparent defects shall be noted.

Number of seating units for settees

If for settees and similar articles the number of "seating units" is not obvious from inspection, the article shall be regarded as consisting of a number of equal units, each of a maximum width of 560 mm at the front and a minimum width of 360 mm at the rear of the seat.

Order of tests

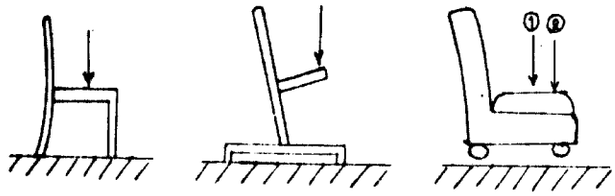
The article to be tested shall be submitted in turn to each of the tests described below.

Test 1 - Seat static load test

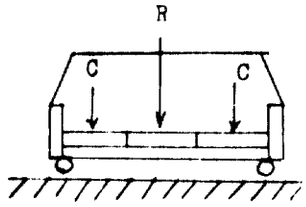
A downwards force shall be applied 150 times, at a rate of 40 times a minute, by means of a loading pad of 200 mm diameter, faced with a 25 mm thick

layer of hard, polyether foam, at right angles to the surface of the seam to any position along the fore and rear centre line of the seat most likely to cause failure. Such possible positions shall be loaded an equal proportion of the total number of applications. The applied load shall be 1,000 N for domestic chairs and 1,500 N for contract chairs.

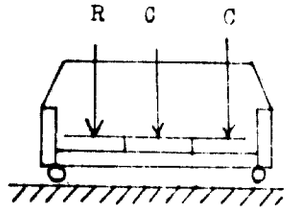
For settees the loading test shall be applied in turn to one end position and one central position, while each of the other seat units supports a constant weight of 75 kg.



Possible positions likely to cause failure



Seat static loading - central position



Seat static loading - end position

Key:

R = Repeated load

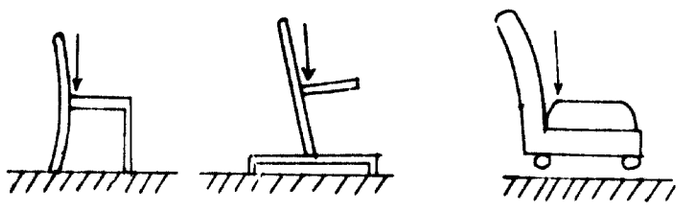
C = Constant load

Figure II. Seat static load test

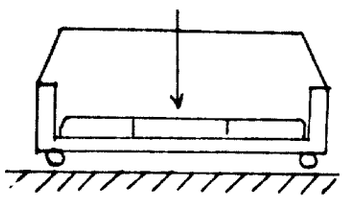
Test 2 - Seat fatigue test

The test shall be carried out as test 1, except that the seat fatigue load shall be 950 N, the number of applications 25,000 for domestic and 100,000 for contract chairs and the centre of the seat loading pad applied 175 mm forward from the intersection point of the centre lines of the seat and back surfaces (see also test 5 regarding the application of the load).

For settees, half the specified number of applications shall be made first to a central position and then to an end position (see figure III).

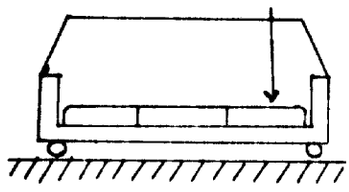


$\frac{1}{2}$ n times



Seat loading - central position

$\frac{1}{2}$ n times



Seat loading - end position

Key: n = number of applications

Figure III. Seat fatigue test

Test 3 - Seat impact test

The seat impact load shall be applied by allowing a seat impact pad to fall freely 10 times from a height of 75 mm for domestic chairs and 200 mm for contract chairs (see figure IV). The pad shall have a leather striking

surface of 200 mm diameter and weigh 25 kg (fine, dried sand filling). The impact load shall be applied anywhere a person is likely to sit, at the position most likely to cause a failure.

For settees this test shall be applied to an end position only.

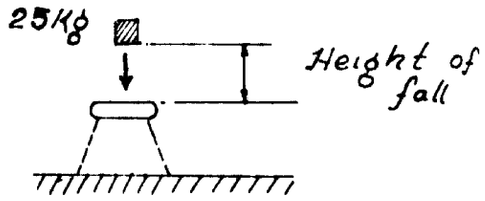


Figure IV. Seat impact test

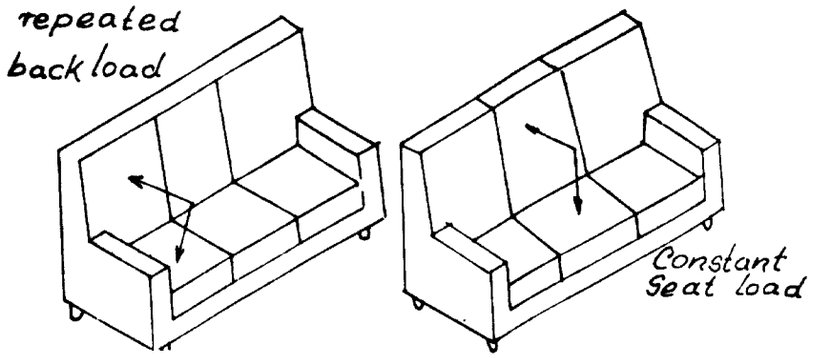
Test 4 - Back static load test

The load, a rectangular pad of 200 mm height, 250 mm width and faced with a 25 mm thick layer of hard, polyether foam, shall be applied 150 times, at a rate of 40 times per minute, at right angles to the surface of the back, with its centre 350 mm above the intersection point of the centre lines of the seat and back surfaces, or 100 mm below the top of the back, whichever is the lower. The chair shall be prevented from rearwards movement by stops placed behind the rear feet or castors. During this test the seat shall be loaded by a constant force, a pad of 200 mm diameter applied at right angles to the seat surface at the most forward position possible, along the centre line of the seat. The seat load shall be 1,000 N for domestic chairs and 1,500 N for contract chairs and the back load shall not be so high as to cause overbalancing rearwards and, if the chair does not overbalance, shall not exceed 500 N for domestic chairs and 750 N for contract chairs.

For settees the load shall be applied in turn to one end position and one central position. In addition, a double loading shall be applied simultaneously to a central pair of seating units (see figure V).

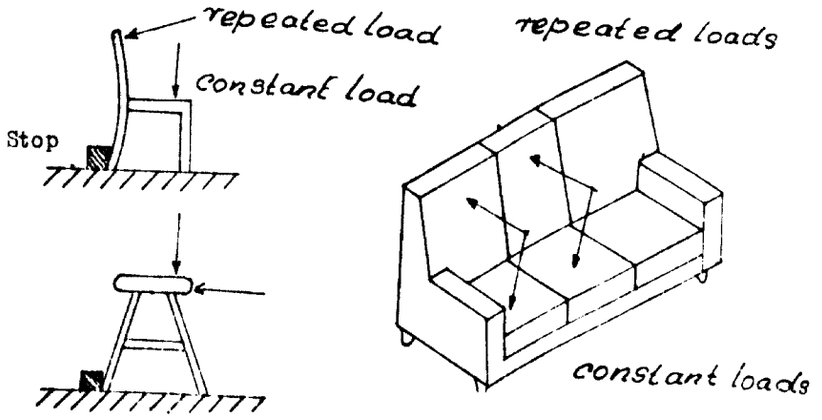
When this test is applied to chairs fitted with spring rocking-action bases which have a tension adjustment, the adjustment shall be tightened so that the least possible rocking movement is obtained during the test.

When testing without back rest, the back load shall be applied horizontally to the front edge of the seat. The restrictions given above regarding the magnitude of the back load shall also apply to stools.



Back loading - end position

Back loading - central position



Central double back loading

Figure V. Back static load test

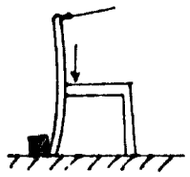
Test 5 - Back fatigue test

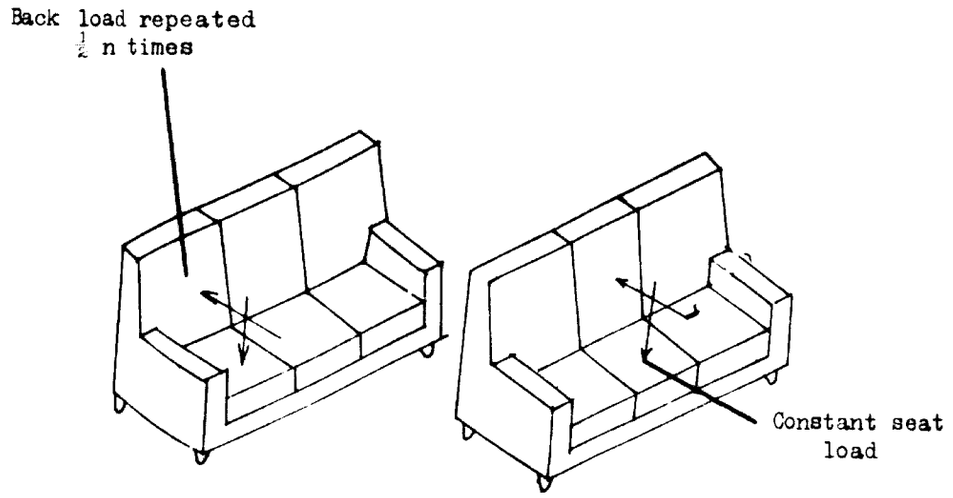
The test shall be carried out as test 4, with the following changes: 250 N shall be applied to the back 4,000 times for domestic chairs and 100,000 for contract chairs, and the centre of the seat loading pad shall be 175 mm forward of the intersection point of the centre lines of the seat and back surfaces (see figure VI).

The seat and back fatigue load tests (tests 2 and 5) may be applied separately, using a constant seat load and a repeated on/off back load in test 5, or may be applied together in a representative cycle of seat load on, back load on, back load off and seat load off.

The restrictions given in test 4 regarding the magnitude of the back load shall apply in this test too, as shall the remarks regarding stools without back rests.

For settees half the specified number of applications shall be made to a central position and the other half to one end position.





Back fatigue loading - end position

Back fatigue loading - central position

Key: n = number of applications

Figure VI. Back fatigue test

Test 6 - Back impact test

The chair shall be placed in its normal position with its back feet secured to the floor by hinges, or prevented from moving rearwards by means of stops. A weight of 6 kg shall be allowed to strike the centre of the top of the inside of the back or, when there is no back, the centre of the front seat edge. The weight shall have a striking surface of 100 mm diameter, shall

be suitably padded so as not to damage the chair surface, and shall strike the chair horizontally at a speed of 0.75 m/sec for domestic chairs and of 3.0 m/sec for contract chairs.

The chair shall be allowed to swing freely backwards about the hinged, rear feet until the top of the bar hits a firm concrete block arranged at floor level and covered with a 3 mm thick rubber sheet of a hardness of 90 to 97 degrees as defined in British Standard 903 "Methods for testing vulcanized rubber, part A 26:1969, determination of hardness". The test shall be carried out 10 times at a rate of 10 times per minute.

For this test a device consisting of a 1 m long, light rigid bar with one end pivoted immediately above the article to be tested and the lower end carrying an object of a mass of 6 kg, may be used. The pivot shall be in such a position that, when the weight at the other end of the bar strikes the article, it is travelling horizontally and falls at the specified point on the concrete block. The severity of the impact depends upon the height of drop, i.e. the angle to which the lever is lifted from the vertical (see figure VII).

The height of drop shall be 30 mm for domestic and 500 mm for contract chairs; the angle (θ) from vertical position shall be 14° for domestic and 60° for contract chairs.

For settees this test shall be applied to an end position only.

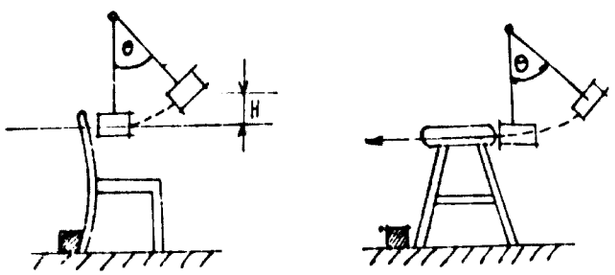


Figure VII. Back impact test

Test 7 - Disideways arm static load test

A pair of horizontal outward loads (see figure VIII) of 400 N for domestic and 600 N for contract chairs shall be applied, by means of load pads of 100 mm diameter, 50 times to any position along the inside of the uppermost part of the arms most likely to cause a failure. Such positions will depend on the construction of the chair and it may be that there are several such positions, in which case each position shall be loaded an equal proportion of the 50 applications.

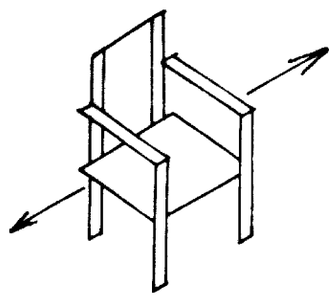


Figure VIII. Disideways arm static load test

Test 8 - Sideways arm fatigue test

The test shall be carried out as test 7, except that the magnitude of the load shall be 250 N, the number of applications 4,000 for domestic and 100,000 for contract chairs, and the point of application of the load shall be the most forward and uppermost possible on the arm.

Test 9 - Sideways arm impact test

The test shall be carried out in the same manner as test 6, with the following changes: the blow shall be applied in an inwards direction to the outside face of the arm, at any position most likely to cause a failure (see figure IX); a pair of side feet secured to the floor by hinges, or prevented from moving sideways by means of a stop; the height of drop shall be 29 mm for domestic and 463 mm for contract chairs and the angle θ from the vertical position 14° for domestic and 47° for contract chairs.

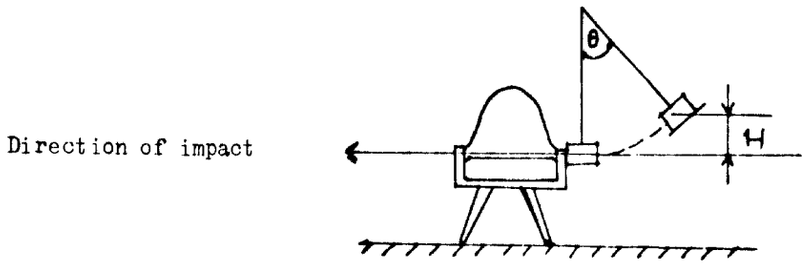


Figure IX. Sideways arm impact test

Test 10 - Downwards arm static load test

A vertical, downwards force of 500 N for domestic and 750 N for contract chairs shall be applied 50 times to the upper surface of each arm by means of a pad of 200 mm diameter to any point along the arm most likely to cause a failure.

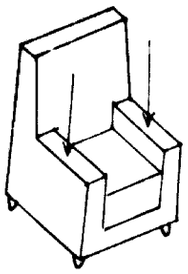


Figure X. Downwards arm static load test

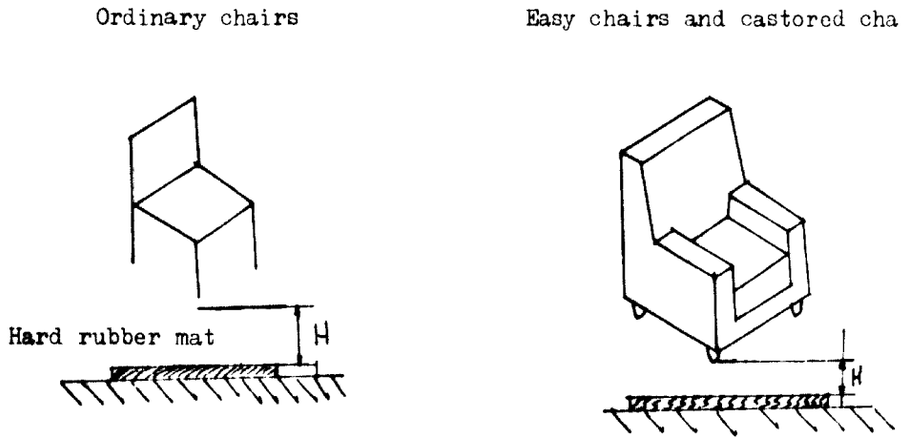
Test 11 - Chair drop test

(a) Chairs other than easy chairs and castored chairs. The chair shall be supported e.g. by three lifting cords attached to suitable points on the chair, so that the impact is on one foot and the line joining the foot to the diagonally opposite foot is inclined at 10° to the horizontal, whilst the line joining the remaining feet is horizontal.

The chair shall be allowed to fall freely onto a 3 mm thick sheet of rubber placed on a concrete floor. The hardness of the rubber shall be 90 to 97 degrees, as defined in British Standard 903 "Methods for testing vulcanized rubber, part A 26:1969, determination of hardness". The height of fall shall be 300 mm for domestic and 600 mm for contract chairs. The chair shall be dropped in this way 10 times onto a front leg and 10 times onto a rear leg.

(b) Easy chairs and castored chairs. The test shall be carried out as described above, except that the heights of fall shall be 150 mm for domestic and 300 mm for contract chairs.

(c) Settees. The settee shall be lifted up at one end and allowed to fall freely so that the impacting feet or castors strike a 3 mm thick sheet of rubber of a hardness of 90 to 97 degrees, placed on a concrete floor, at the same level as the non-lifted feet or castors. The respective heights of fall shall be 150 mm for domestic and 300 mm for contract settees. The settee shall be dropped in this way 10 times (see figure XI).



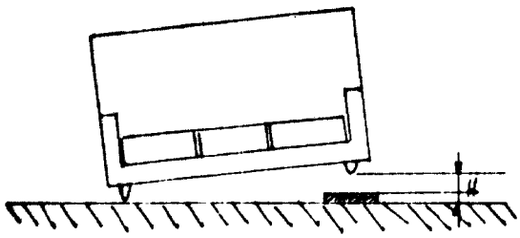


Figure XI. Chair drop test

Test 12 - Diagonal base load test for easy chairs and settees

Two opposing forces of 250 N for domestic and 500 N for contract articles shall be applied simultaneously to diagonally opposite legs or corners of the article, as near as possible to the lowest point. Application of these forces shall be made in an inwards direction 50 times at a rate of 20 times per minute (see figure XII).

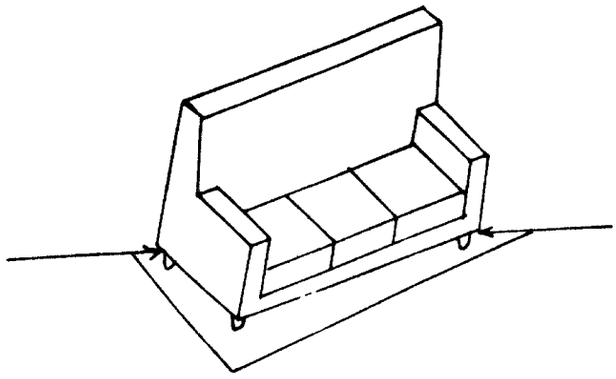


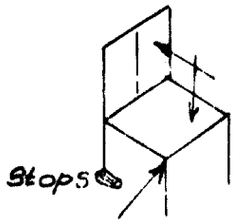
Figure XII. Diagonal base load test for easy chairs and settees

Test 13 - Chair racking test

The chair shall be subjected to a constant seat load of 1,000 N applied 250 mm forward of the intersection point of the centre lines of the seat and back surfaces. A single cycle of racking of the chair shall be achieved by applying a back load, on and off, first to the left hand part of the back, followed by a back load, on and off, to the right hand part of the back. The rear feet of the chair shall be restrained from front and back movements by suitable stops on the floor. These back loads shall be applied by means of two rectangular pads, 200 mm high by 125 mm wide, each faced with a 25 mm thick layer of hard polyether foam; their centre points shall be 350 mm above the back seat intersection point or 100 mm down from the top of the back, whichever is the lower, and 100 mm to either side of the centre line of the back.

The racking cycle shall be applied 150 times and the magnitudes of the back loads shall be 375 N for domestic and 550 N for contract chairs.

Back load - first half of cycle



Back load - second half of cycle

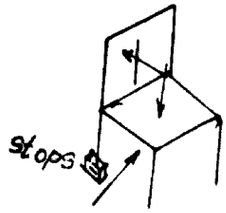


Figure XIII. Chair racking test

Final inspection

Immediately after the completion of the above tests the chair or settee shall again be thoroughly inspected; in the case of upholstered furniture, as much as possible of the covers shall be removed from the outside of the back, bottom and arms. Any apparent defect and any change that has taken place since the initial inspection shall be noted.

Annex XXI

STRUCTURAL PERFORMANCE TESTING

by D.P.Hart, B Sc (Eng), FIRA Research Division

Structural performance testing involves applying loads in suitable directions to various parts of the item on test of such magnitudes, number and rates of application and, possibly, duration of application, as will reproduce in the laboratory what actually occurs in use and which will allow predictions of whether in service the item will break or distort too much to fulfil its functions, produce discomfort or show unacceptable surface marks or irregularities.

It is evidently important that the loadings which come on to furniture are known, on the one hand so that the item can be made strong and stiff enough to withstand them without failure or undue distortion and on the other hand so that suitable tests may be applied to the item to check that it is strong enough. Both these requirements are of economic concern with most materials because of the high cost of the manufacturing process, if not of the material itself. If the loadings and the strength of the material are known then it may be possible to design the item by calculation, so that it is reasonably certain the item will be strong enough to support the loads. In any case it is better to subject the item to a realistic and representative set of performance tests than to make thousands and chance whether experience of actual use proves the design to be structurally weak. The performance tests should be capable of revealing weaknesses that can be remedied in the prototype stage.

Environment also plays its part; variation in temperature and humidity can affect properties and produce internal stress, while solar irradiation and chemical attack (eg, ozone and salt attack) can affect the strength properties. Dust and lack of lubrication can affect mechanical functioning and may lead to a structural failure.

Loadings on furniture

The loads that come on to furniture can be divided into functional and non-functional loads and these may occur under static, fatigue or impact conditions. By functional use is meant the use for which an item is designed and not the misuse which it inevitably experiences due either to improper use or handling.

For example, a chair is intended to support the human body in a comfortable position and experiences functional loading when a person sits down on the seat, leans against the back and presses down on the arms in order to rise out of the chair. The magnitudes of the seat, back and arm loads will vary according to how the person sits down, and different magnitudes of the seat back and arms will occur with varying frequency.

The static loads mentioned above will be the highest that occur infrequently while the fatigue loads will be the more normal levels that occur most frequently, both static and fatigue loads being applied at reasonable time rates of loading. Some loadings may occur at much higher time rates of loading and the performance of the material under such impact conditions may be very different from when loaded to the same stress but at a lower time rate.

The non-functional loadings mostly cover impact conditions, eg, an item knocked over or dropped, but can also cover accidental over-loading under static conditions, eg two people sitting simultaneously into a chair or a person standing on a table or cabinet.

Structural failures can occur under different conditions of loading. The term static loading often refers to conditions where loads are not applied quickly or repeatedly, but maybe sustained for some time and are large or, possibly, the largest that can occur. Thus in the first case, a big, heavy man leans against the back of a chair and stretches, creating a slowly applied and large back load, which does not often occur. The second case arises when a number of heavy books are placed on a long, thin shelf which gradually bends continuously with time to a greater extent than when initially loaded.

The second condition occurs under repeated application of a load which is less than that required to cause failure on a single application but which can, if applied often enough, cause an unexpected and sudden failure. Generally a small crack appears on the surface after a number of applications without causing failure, but gradually, under further application of load the crack extends in length on the surface and in depth into the material until a fracture suddenly occurs. This is an example of a fatigue failure under repeated load application. The number of applications to failure will depend on the mean load and on the variation in load about the mean, as well as on the material and environmental conditions. All materials exhibit fatigue failure and there is, for most materials, a stress below which fatigue failure will not accur no matter how many times, this stress is applied.

This is the fatigue endurance stress and it might be thought that an item should be proportioned so that the maximum stress is below the fatigue endurance stress. However, such a structure is likely to be uneconomical in the use of material or to be too heavy, and moreover the item may never be loaded as many times as required to approach the endurance limit, which is around 10×10^6 cycles, but is probably only to be subjected to 10^5 cycles.

The fluctuations of minimum and maximum load with time may be complex and the effect of their combinations has to be taken into account. A rough rule is to take the 'damage' ratio n/N between the number, n, of cycles at one load level, say L, actually applied to the number N, to cause fatigue failure at that load level. If this is equal to unity, ie, $n/N = 1$, then a fatigue failure will occur, but if it is less than unity the item still has some useful life left. If different load levels (L_1, L_2, L_3) are applied for different numbers of cycles n_1, n_2, n_3, . . . while N_1, N_2, N_3 . . . are the numbers of cycles to failure at those load levels, then the total damage or cumulative damage

$$D = \frac{n_1}{N_1} + \frac{n_2}{N_2} + \frac{n_3}{N_3} + \ldots$$

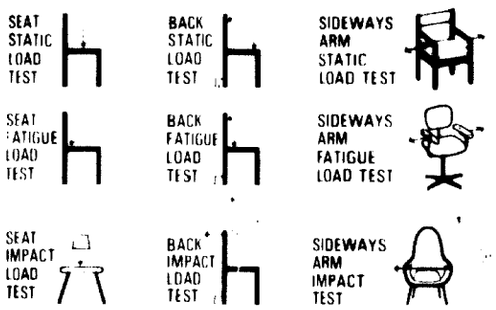


Fig. 1

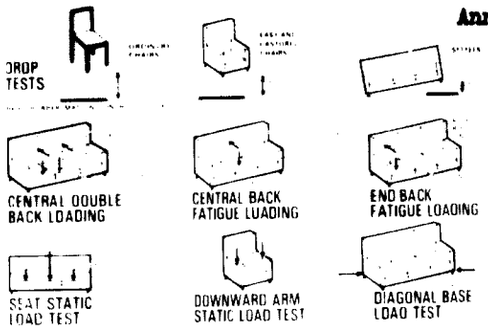


Fig. 2

must not exceed unity or else a fatigue failure will occur. This rule is generally approximately correct but has been known to be wrong in both directions, ie, fatigue failures have occurred when D is less than or greater than unity. Research by workers in other fields than furniture has shown that this relationship can be affected by the order in which these different load levels occur and that low load levels, producing stresses less than the fatigue endurance stress, when mixed with loads producing stresses greater than this fatigue endurance stress can cause different results. It is because of such features that the determination of valid performance tests must be carefully investigated.

A third loading condition is that of impact loading, in which the rate of loading is much higher, and under such conditions some materials exhibit brittle fractures at a lower stress than would occur under a slower, more normal, rate of loading. Such impact loadings occur either when an item is hit by a moving object or is knocked against a fixed object or when the item is dropped on to the floor.

The magnitudes and numbers of application of these static, fatigue and impact loads will vary with the type of use experienced by the item. It is reasonable to expect that different types of use can be covered in performance testing – and in design – by altering the magnitudes and the numbers of applications of the loads, increasing them on a graded scale for increasing severity of use.

The length of time a load acts on a structure can be an important consideration and is especially so with some plastics materials, which tend to deform continuously with time under a sustained load, to a greater or less extent depending on the temperature. This creep effect can also occur under intermittent, repeated loading. The tendency to creep must be avoided in shelving which is under sustained loading and with chairs under intermittent loading.

Let us consider the three main types of furniture and the loadings experienced by them.

1 Chairs

In ordinary functional use, the seat, back and arms of a chair, settee or other form of seating are loaded by the sitter and transmit the loads through to the base of the chair and so to the ground.

The magnitudes of these loads will depend on the weight and stature of the sitter, on the way in which he moves, ie, whether violently or gently, on his postural habits and on the flexibility of the chair. The non-functional loads may arise from more than one person using a chair, a person using the chair in an unconventional way or standing on the chair, which are, in effect, static loads; knocking it over or dropping the chair while moving it from one place to another, or unstacking it, which are impact loadings.

Connections between a chair shell and its base can cause problems due to stress concentrations or to high local internal loadings caused by small localized regions of load input. These can be overcome by localized reinforcements, such as inserts of a stiffer material or by integral bosses and ribs, or by avoiding localized changes of sectron and load inputs, achieved for example by distributing load inputs over large glue areas. Performance testing under representative loadings is extremely useful in revealing the presence of such points of local weakness.

2 Tables

Table tops are sometimes sat on and so must support the weight of at least one heavy man, unless a tendency to over-balance prevents this. A table is also subjected to horizontal loads arising from a person drawing his chair to or away from the table top, or leaning against the top or pushing the table across the floor. It seems unlikely that fatigue is a serious problem for tables but should be considered, while static and impact loads are obviously important. Impacts can occur from dropping an object on to the top, knocking against the top or kicking the legs and dropping the table on to its legs.

A prime requirement for a table is that it is firm and steady and does not distort or vibrate unduly. Where thick tops and stout legs are used there should be little difficulty. Another requirement is surface hardness, or resistance to penetration

3 Cabinets

Functional loadings on cabinets mostly arise from the weights to be supported by the horizontal surfaces such as the top, shelves, drawers or flaps. These weights must generally be sustained for long periods and the stresses developed in the material must be low enough to avoid creep.

Horizontal loads occur on cabinets from opening and closing of drawers and doors, and the impact load developed on slamming shut a heavily loaded drawer freely mounted on runners can be considerable. Although such loads can damage the carcase, the front

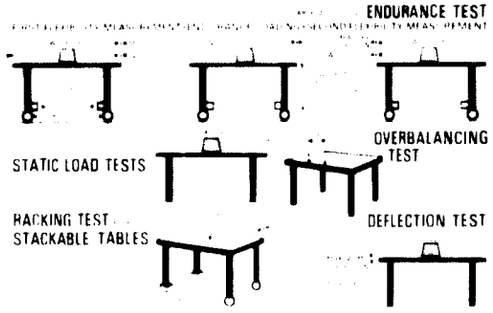


Fig. 3

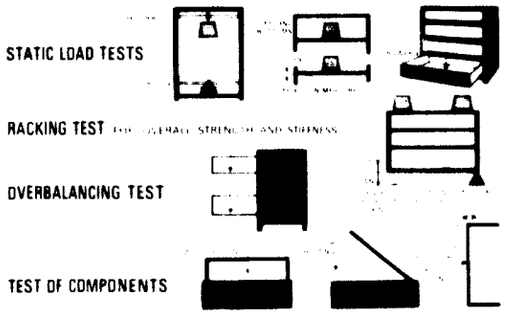


Fig. 4

of a drawer is most likely to be knocked off. The impact of a sliding door can also cause high shearing loads on the carcase end joints, which are not likely to exist with an integrally moulded plastics carcase.

Injection moulded plastics drawers often have timber fronts screwed to them and continual opening and shutting of a drawer can cause a bending fatigue fracture in the front of the plastics carcase where the screws connect it to the timber front. This can be overcome by using ribbing, a thicker wall or by moving the screws closer to the slides of the drawer.

Impact and penetration loads may occur on the top and the vertical faces of the carcase, on the drawer bottoms and perhaps on the shelves. Sliding parts of movable components of cabinets such as doors, flaps and drawers may wear and should be made of wear resistance materials. A drawer is subjected to varying reaction forces at the runners and these forces can be quite large, especially for large filing drawers, although they do not usually damage the carcase or drawer so much as the runners.

Performance tests currently used

CHAIRS and other forms of seating. A tentative specification of graded performance tests has been drawn up for all types of seating, small and easy chairs, settees, stools, suitable for all types of use in homes, schools, offices, etc. This tentative specification has to be proved by current research at FIRA, but it is believed that the methods of test are substantially correct according to research and experience to date, although the load magnitudes and numbers of application may be altered by the research results. One thing is certain, that the tests under static, fatigue and impact conditions are necessary for metal and plastics furniture – simple static tests alone are not sufficient.

The tests are graded to enable a chair to be selected as suitable for more or less severe use. The exact correspondence between grade and severity of use cannot at present be stated precisely, only correlation between test results for various chairs and their known performance in field use can give this information, which will take time to accumulate. At least these tests provide a rational set of tests which can be applied to chairs made in various materials and classify them into convenient strength grades. An important point is that the lowest strength grade does not imply poor quality of manufacture, only that an item has not got strength properties suitable for more severe use without greater risk of failures. Conversely, it is quite possible for a 'cheap and nasty' item to be of the highest strength grade.

The test methods are fairly well illustrated in figures one and two which were drawn with all types of chair constructions and materials in mind. There is a very important point about testing thin walled, uncushioned plastics chairs concerning the shape and flexibility of the load pads. These pads should be reasonably representative of the human body with its natural 'upholstery', otherwise unrealistic distortions and stresses will occur in the shell. This requirement can generally be met if the loading pads have a face curvature to suit as large a number of different chairs as possible and covered with a fairly hard, polyether foam cushion. It will be noticed that in the fatigue loading on the seat and back the seat load is closer to the back, corresponding to a person supporting himself against the back rest.

TABLES. The performance tests currently used at FIRA for tables, trolleys and desks are shown pictorially in figure three. These methods methods, which are due for revision into a graded system, are still valid in themselves but it is probable that other tests will be added for the revised specification.

To cover the strength requirements mentioned under the section above on loadings the following extra tests may be required:

A vertical fatigue load test, especially for pedestal tables; a vertical impact test; a horizontal fatigue load test, possibly applied only at right angles to the long edge of a rectangular table; a horizontal impact test, the impact load being applied to the top; a drop test, similar to the drop test for chairs; a leg foot impact test, an impact load, being applied in a similar way to the back or arm impact test for chairs, but to the foot of a leg; a penetration test anywhere on the surface.

CABINETS. The performance tests currently used at FIRA for cabinets are shown pictorially in figure four. As with the tests for tables, these tests will soon be due for revision and will probably require the following additional tests:

Vertical impact tests on top, shelves, horizontal flaps; static, sustained load test on the whole unit, especially for wall-attached units; sideways horizontal load test, especially for cabinets without back panels, such as room dividers; horizontal impact tests on vertical end panels and doors; drop tests; a penetration test anywhere on the surface; a sliding door impact on opening or closing test.

Annex XXII

INDIAN PLYWOOD INDUSTRIES RESEARCH INSTITUTE

THE main function of the institute is to study the science and technology of plywood, particle board, fibre board and other allied materials. The institute also functions as an advisory body to the plywood industry.

The activities of IPIRI are organized under eight main heads: Chemical technology; Physics, mechanics and testing; Biology and wood anatomy; Mechanical technology; Products application and development; Statistics; Information, liaison, publication and training; and Extension.

A major project under way at the institute is the development of adhesives for wood and wood products. New adhesives, particularly from non-petroleum based materials, are developed to meet the changing requirements of the industry, and several of these have found wide application in the industry. Development of particle boards based on agro-industrial wastes and suitable for tropical climates is in progress.

IPIRI has facilities to study the physical and mechanical properties of wood, plywood and other wood-based panel materials. Test procedures are rationalized and new test methods are developed. Non-destructive test methods are developed for strength and quality control in timber and timber products. Considerable effort is devoted to the development of instruments, some of which have been put to use in factories.

Wood anatomy is studied to identify timber species. Mycological and entomological investigations are aimed at the protection of wood and wood-based materials. Considerable work on the prophylactic treatment of veneer logs has been done and the results are being used by the industry to eliminate end cracks and staining of logs in transit and storage.

Studies on the peeling characteristics of different timber species, plant layout, development of new machines, and improvement of the existing ones constitute the main lines of work of the Mechanical Technology Division.

Considerable attention is paid to the development of engineering uses of plywood and other lignocellulosic panel materials. Design and fabrication of bins for storage of food grains and design and construction of low-cost houses, industrial structures and other useful mini-structures from plywood form the main activities of the Products Application Division. Knockdown-type furniture is designed and produced from plywood.

The institute assists the industry in the implementation of quality control, and advises on how to get maximum yield from the resources by reducing wastage. Other activities include organizing (1) periodical get-togethers with personnel from industry, (2) training courses in plywood technology, and (3) giving demonstrations of the processes developed by the institute for implementation by the industry. The institute publishes a half-yearly entitled *IPIRI Journal*.

The institute has facilities for trial production of panel materials in an experimental plywood plant. The institute has two field stations, located one each in Calcutta and Tinsukia.

FIELD STATIONS

1. **IPIRI Field Station**
   2/2 Biren Roy Road
   West Sarsuna
   Calcutta 700 061

2. **IPIRI Field Station**
   Parbatia Road
   Tinsukia 786 125
   Assam

Annex XXIII

SPECIALIZED FURNITURE RESEARCH INSTITUTES

Denmark

Teknologisk Institut (Technological institute)
Traeteknik (Wood-technology department)
Gregersenvej
2630 Taestrup

France

Centre Technique du Bois (CTB)
Division Ameublemen
10, avenue de Saint-Mandé
75012 Paris

Poland

Furniture Development Centre
Ul. Launa 1
Poznan

Romania

Institutul de Cercetari si Projectari Pentru Industria Lemnului (ICPIL)
(Institute for wood-industry research and projects)
Soseaua Pipera 46, sectorul 2
Bucharest 30

Sweden

Moebelinstitutet (Furniture institute)
Box 27198
Valhallavägen 191
102 32 Stockholm

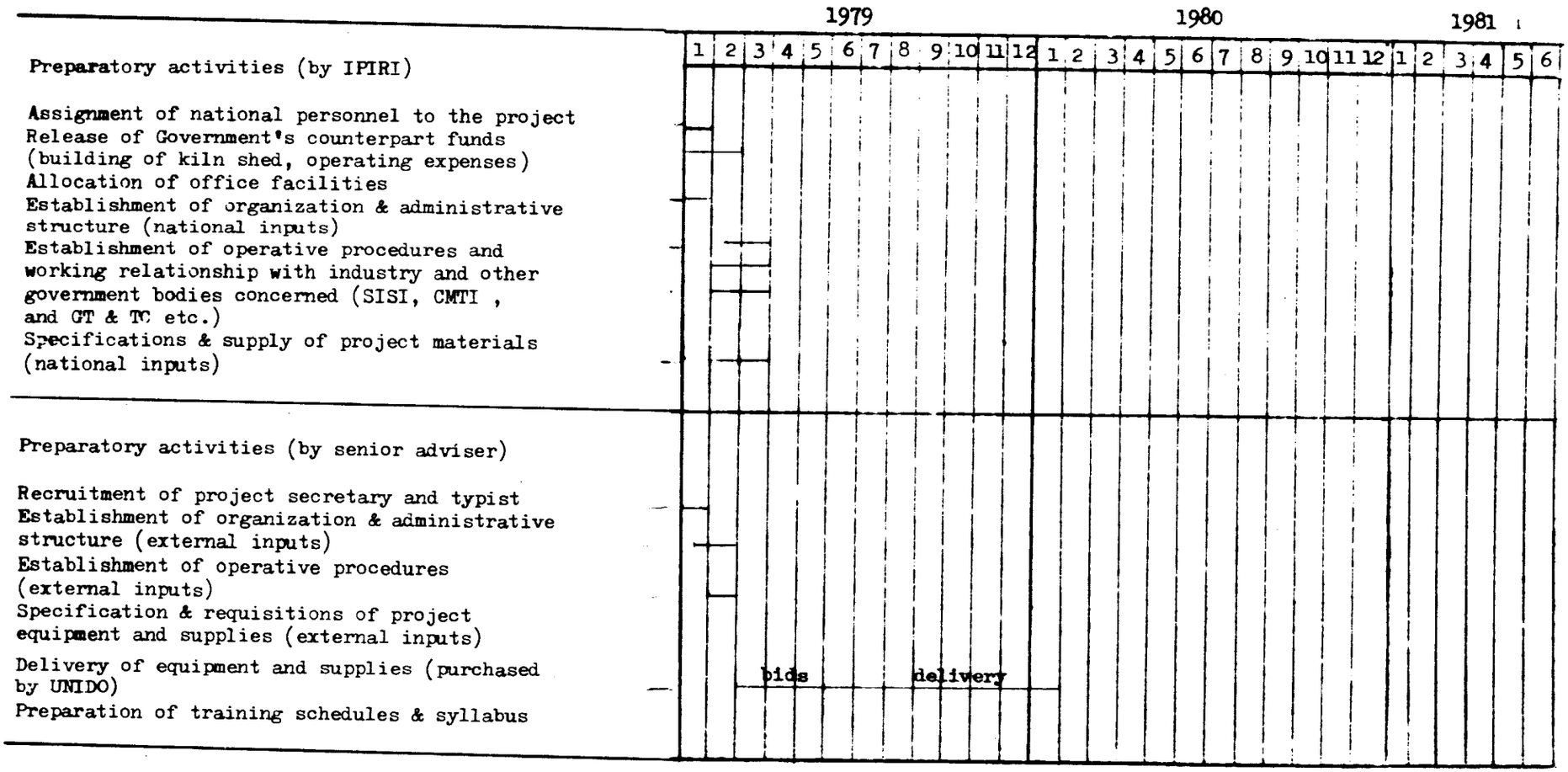
United Kingdom of Great Britain and Northern Ireland

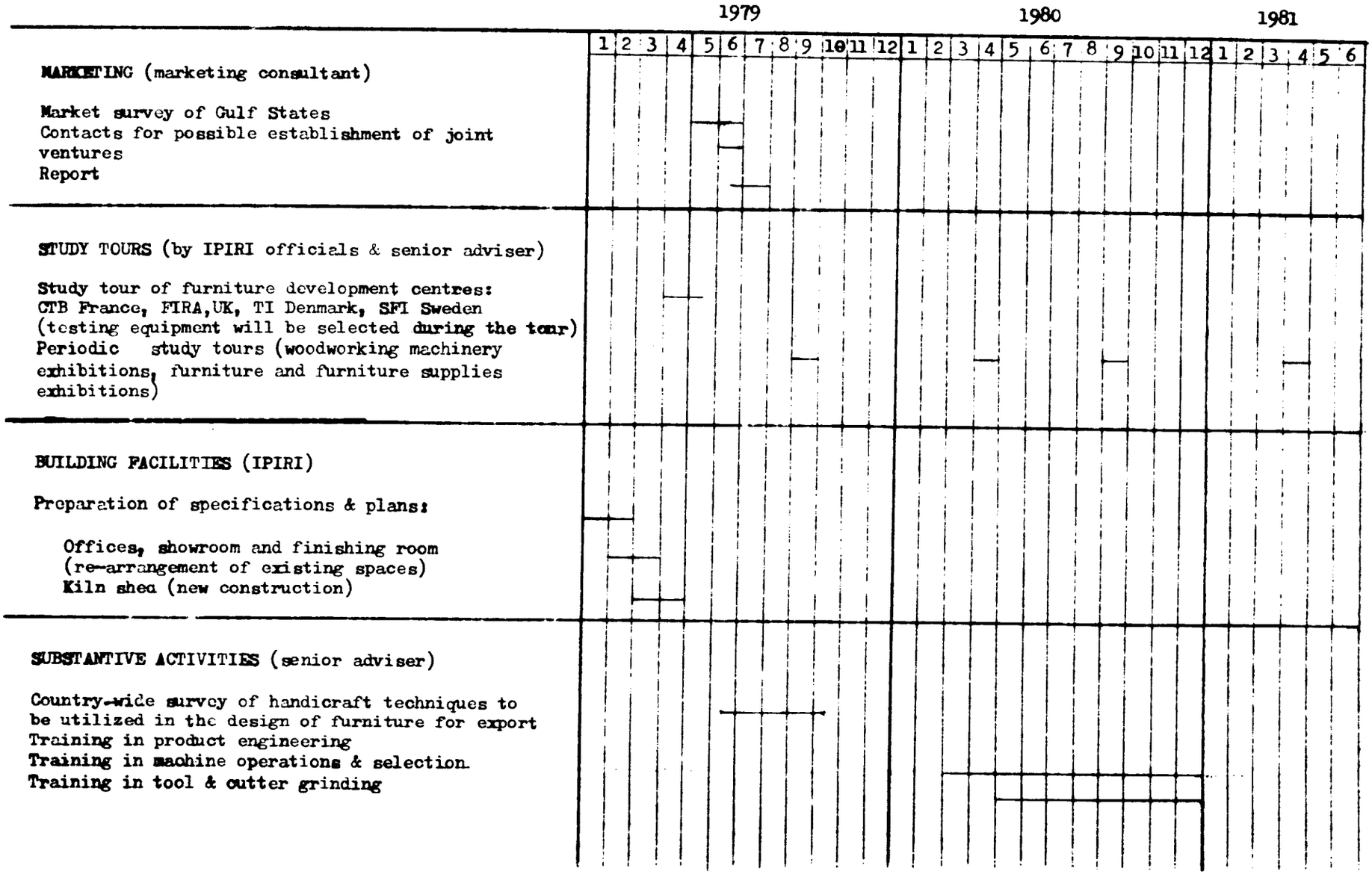
Furniture Industry Research Association
Maxwell Road
Stevenage
Hertfordshire SG1 2EW

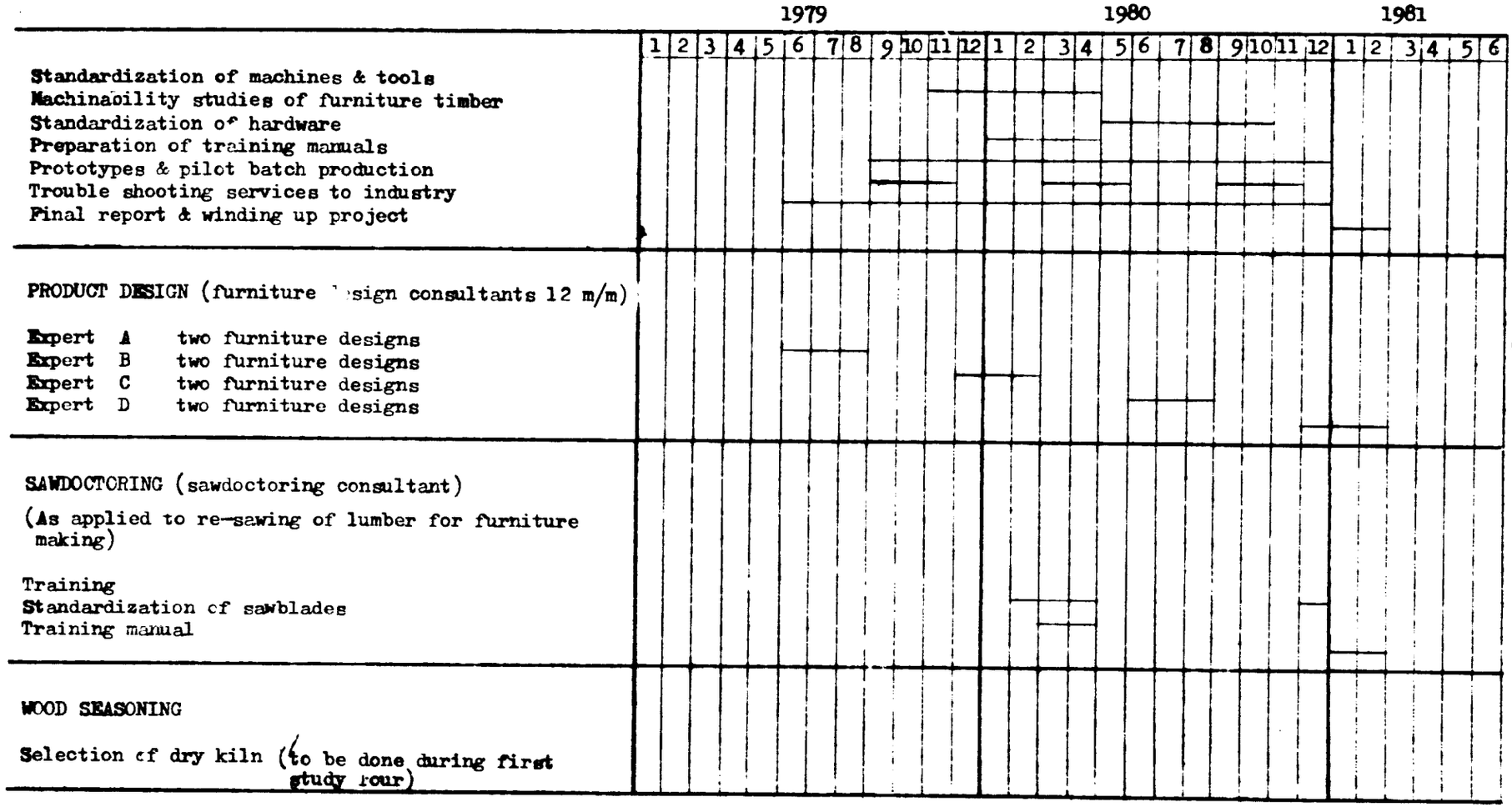
Annex XXIV

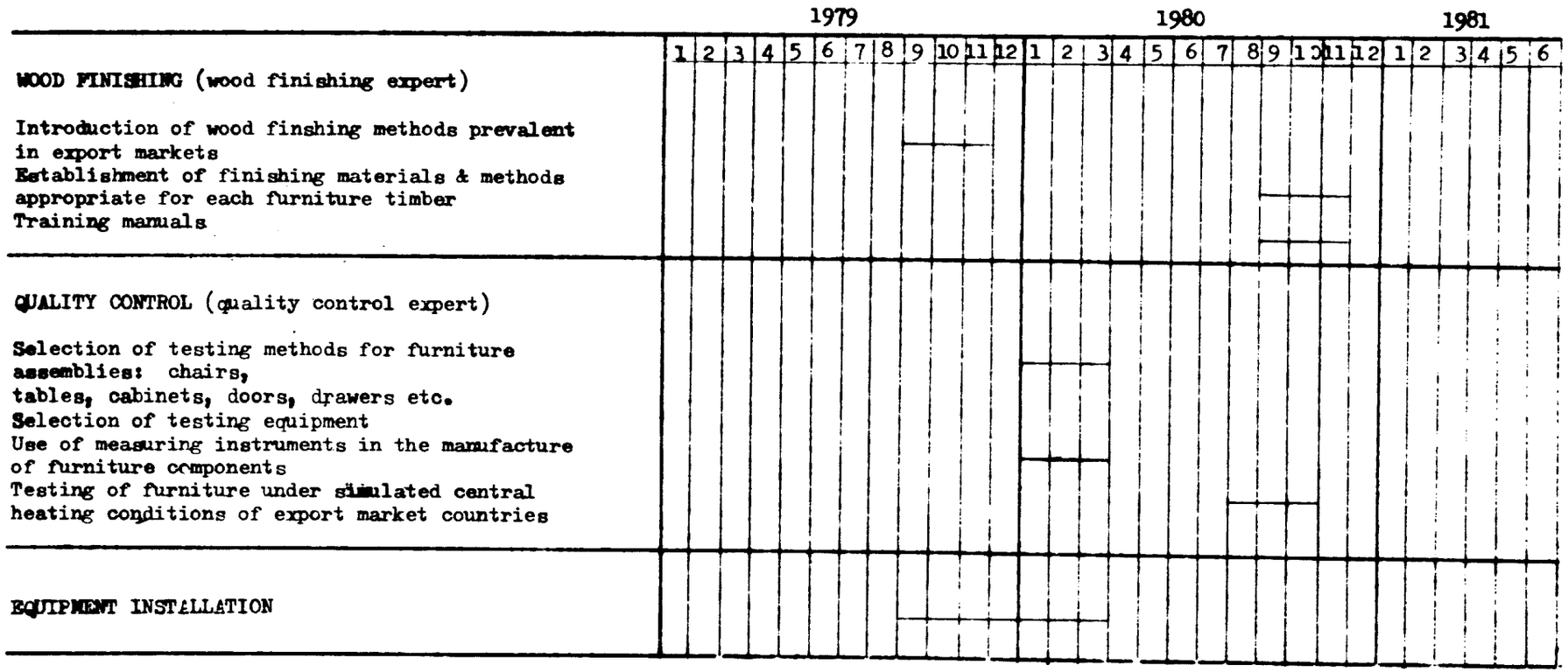
TECHNICAL ASSISTANCE PROGRAMME FOR THE ESTABLISHMENT WITHIN IPIRI OF A FURNITURE DEVELOPMENT CENTRE

Tentative work plan




1979
1980
1981
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6
MARKETING (marketing consultant)
Market survey of Gulf States
Contacts for possible establishment of joint ventures
Report
STUDY TOURS (by IPIRI officials & senior adviser)
Study tour of furniture development centres: CTB France, FIRA,UK, TI Denmark, SFI Sweden (testing equipment will be selected during the tour)
Periodic study tours (woodworking machinery exhibitions, furniture and furniture supplies exhibitions)
BUILDING FACILITIES (IPIRI)
Preparation of specifications & plans:
Offices, showroom and finishing room (re-arrangement of existing spaces)
Kiln shed (new construction)
SUBSTANTIVE ACTIVITIES (senior adviser)
Country-wide survey of handicraft techniques to be utilized in the design of furniture for export
Training in product engineering
Training in machine operations & selection
Training in tool & cutter grinding


1979
1980
1981
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6
Standardization of machines & tools
Machinability studies of furniture timber
Standardization of hardware
Preparation of training manuals
Prototypes & pilot batch production
Trouble shooting services to industry
Final report & winding up project
PRODUCT DESIGN (furniture design consultants 12 m/m)
Expert A two furniture designs
Expert B two furniture designs
Expert C two furniture designs
Expert D two furniture designs
SAWDOCTORING (sawdoctoring consultant)
(As applied to re-sawing of lumber for furniture making)
Training
Standardization of sawblades
Training manual
WOOD SEASONING
Selection of dry kiln (to be done during first study tour)


1979
1980
1981
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6
WOOD FINISHING (wood finishing expert)
Introduction of wood finshing methods prevalent in export markets
Establishment of finishing materials & methods appropriate for each furniture timber
Training manuals
QUALITY CONTROL (quality control expert)
Selection of testing methods for furniture assemblies: chairs, tables, cabinets, doors, drawers etc.
Selection of testing equipment
Use of measuring instruments in the manufacture of furniture components
Testing of furniture under simulated central heating conditions of export market countries
EQUIPMENT INSTALLATION

Annex XXV

SUGGESTED TERMS OF REFERENCE FOR CONSULTANTS

Furniture Design Consultants

Each consultant will be expected to actually produce, not just assist in producing, a set of furniture designs suitable for the prevalent tastes of potential foreign markets. This task will include the development of designs:

(a) Combining Indian traditional handicraft features and techniques with modern technology;

(b) Reflecting current requirements of Gulf States markets.

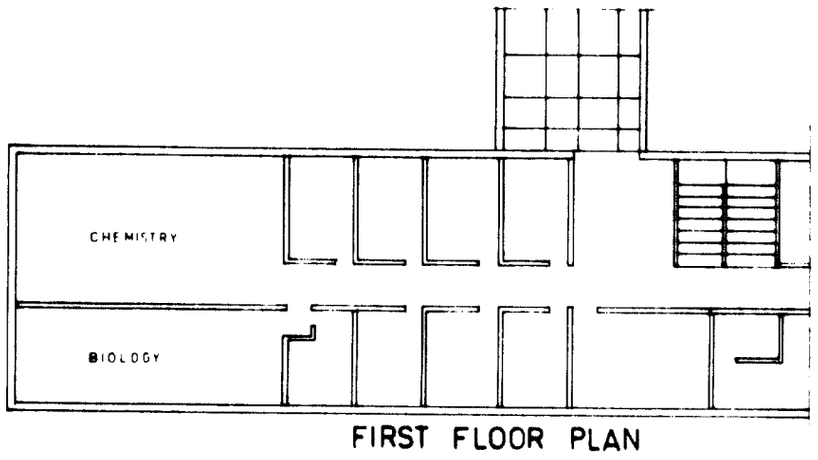
The four short-term missions will be spaced with a three-month period in between to allow trial manufacturing of designs produced by each consultant before the next design exercise begins.

Marketing Consultant

The consultant will be mainly concerned with making a fresh assessment of the wooden furniture trade prospect for India in the Gulf area. The marketing study shall establish consumption trends and the identification of competitive aspects of European Furniture in that area. Typical samples of European furniture marketed in the Gulf States will be purchased with funds allocated for the project.

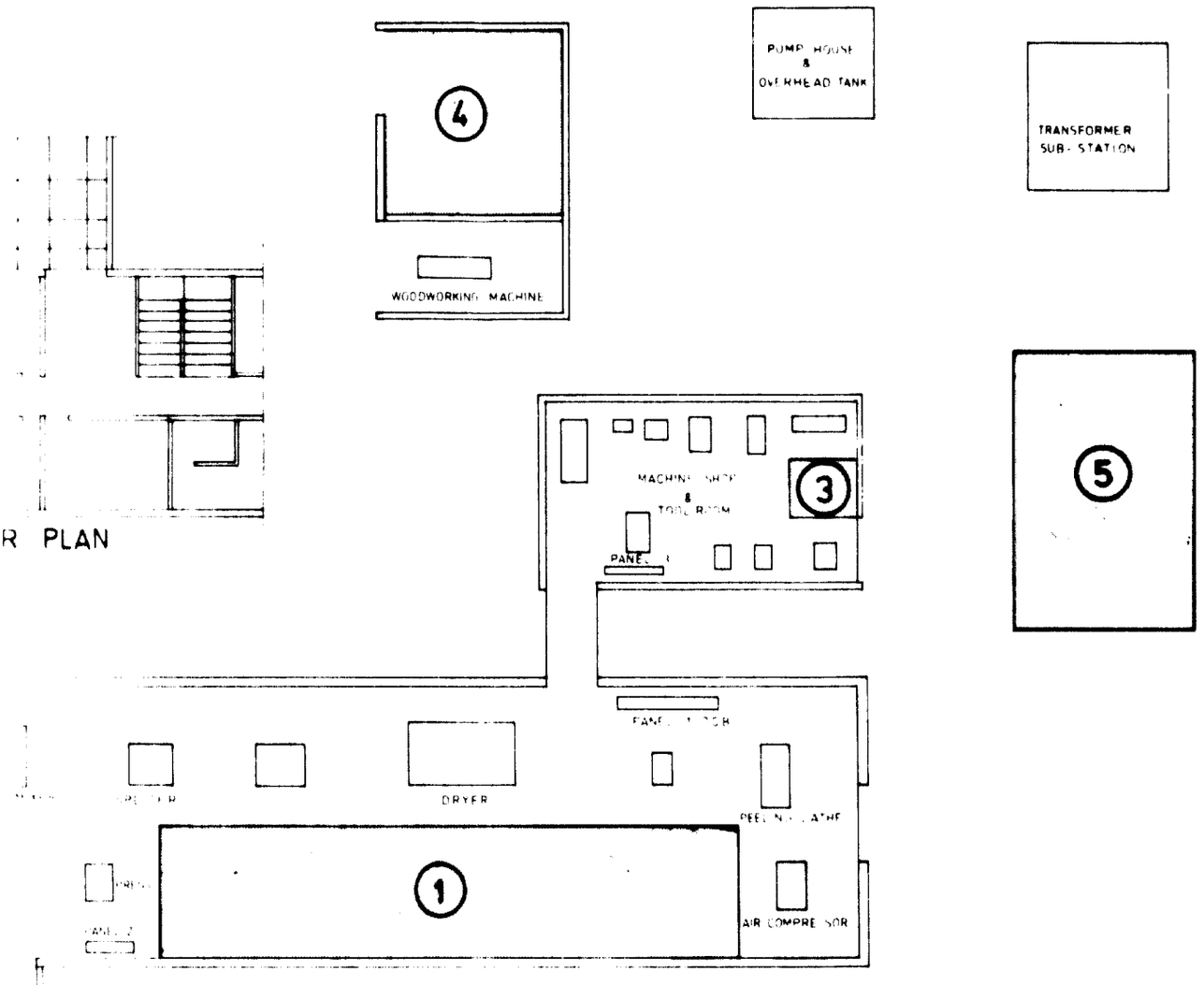
Annex XXVI

LAYOUT OF EXISTING BUILDING FACILITIES



FIRST FLOOR PLAN

GROUND FLOOR PLAN



R PLAN

NOTES

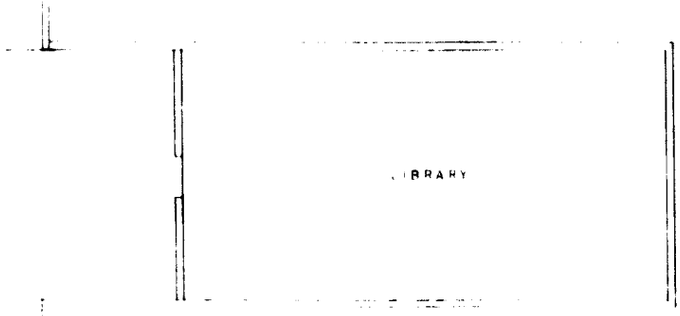
(1) Woodworking equipment 31,80m x 3,30m = 295,74 m²

(2) Offices and Finishing Room 13,80m x 3,9m = 135,52 m²

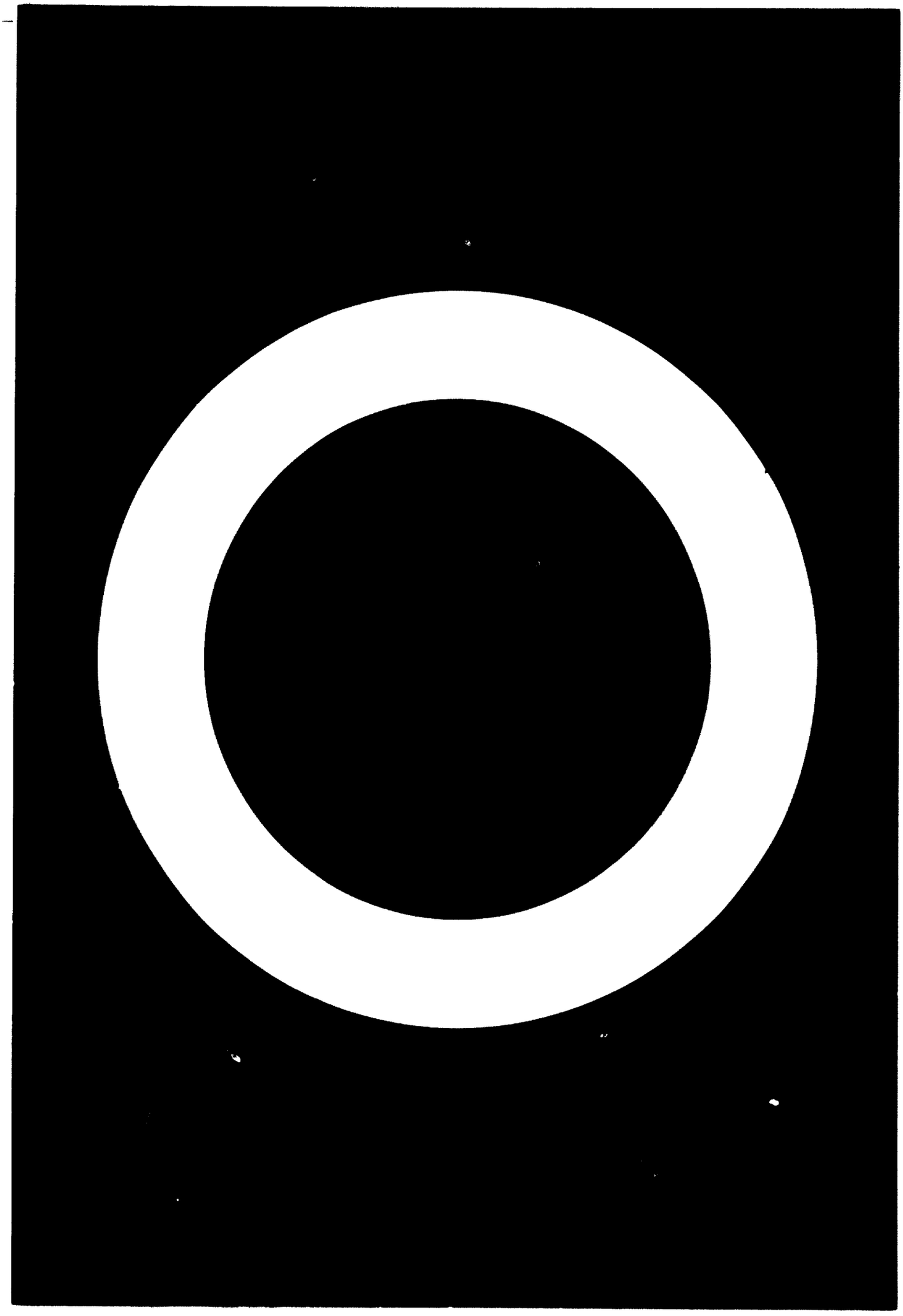
(3) Universal grinding Machine 3,50m x 3m = 10,80 m²

(4) Assembly Shop 10,20m x 9,9m = 100,98 m²

(5) Dry Kiln Shed 10m x 15m = 150,00 m²



GROUND FLOOR PLAN



Annex XXVII

PROJECT BUDGET COVERING THE UNDP CONTRIBUTION

	1979	1980	1981	Total
	man-months			
Project personnel				
Experts				
Senior adviser	12	12	2	26
Furniture design consultants	4	6	2	12
Marketing consultant	3	-	-	3
Sawdoctoring consultant	-	4	2	6
Wood finishing consultant	3	3	-	6
Quality control consultant	-	6	-	6
Ad-hoc consultants	2	4	-	6
Subtotal	24	35	6	65
Cost of project personnel	108,000	168,000	30,600	306,600
Support personnel				
Project secretary	1,200	1,200	200	2,600
Typist	1,200	1,200	200	2,600
Subtotal				
Duty travel	8,300	6,000	700	15,000
Other costs	-	2,000	-	2,000
Component total	118,700	178,400	31,700	328,800
Group training	39,000	38,900	-	77,900
Equipment	180,000	153,000	-	333,000
Operation and maintenance of equipment	2,500	3,000	500	6,000
Sundry	1,000	2,000	2,000	5,000
Reporting costs	1,400	1,400	200	300
Component total	4,900	6,400	2,700	14,000
Total	342,600	276,700	34,400	753,700

B-6

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