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08646

DP/ID/SER.A/168
15 September 1978
English

ASSISTANCE TO THE WOOD PROCESSING INDUSTRIES*,
SI/PDY/77/804,
DEMOCRATIC YEMEN.

Technical report: Assistance to the Public Corporation
for Carpentry and Boat Building

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

Based on the work of Desmond P. Cody, expert in wood processing

United Nations Industrial Development Organisation
Vienna

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id. 78-5678

Explanatory notes

References to dollars (\$) are to United States dollars.

The monetary unit in Democratic Yemen is the Dinar (Din). During the period covered by the report the value of the dinar in relation to the United States dollars was \$US 1 = 0.343 Din.

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

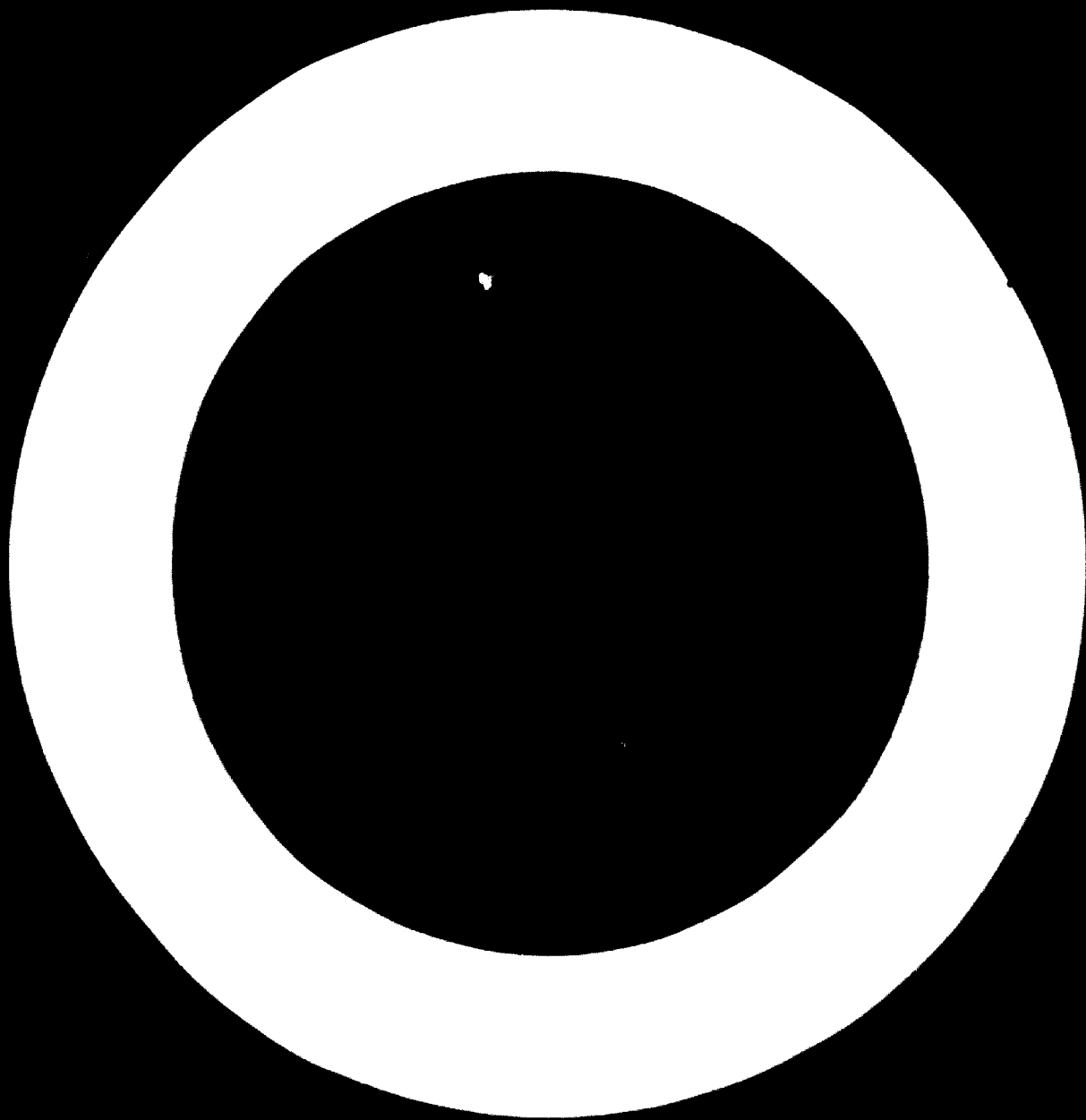
A coma (,) is used to distinguish thousands and millions.

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ABSTRACT

In response to a request by the Government of Democratic Yemen to the United Nations Development Programme (UNDP) an expert in wood processing was sent on a six weeks mission to advise the management of the Public Corporation for Carpentry and Boat Building attached to the Ministry of Construction, Aden, on the factors affecting the development of the secondary wood processing industries sector, assess its potential for development, and identify measures to be taken. His assignment began on 1 August 1978 and ended on 13 September 1978. The United Nations Industrial Development Organization (UNIDO) was the executing agency. The government agency co-ordinating the project was the Ministry of Industry.

The chief objective of the mission was to identify the major shortcomings of the Corporation's various enterprises in Aden, to recommend improvements where appropriate, and to prepare outline plans for further long-term development. Recommendations were made concerning product design, manufacturing facilities, production and productivity, management and labour, industrial training, finance and costing, factory development and future UNIDO assistance.



CONTENTS

<u>Chapter</u>	<u>Page</u>
Introduction	5
I. <u>Findings</u>	
General observations	7
Product design	8
Raw materials	9
Production	11
Management and labour	15
Development plans	21
Quality control	22
Future UNIDO/UNDP assistance	23
II. <u>Conclusions and recommendations</u>	
Conclusions	25
Recommendations	26
<u>Annexes</u>	
I Data on Public Corporation for Carpentry and Boat Building	31
II Job description	32
III Summary of major activities of project	33
IV Assessment of boat building industry	34
V Appraisal of wood carving and crafts section	38
VI Design and production programme	40
VII Summary analysis of requirements and projections for joinery production	41
VIII Literature on furniture	45
IX Programme of reorganisation	47
<u>Figures</u>	
1. Existing building's layout	51
2. Proposed building's layout	52
3. Production flow chart for solid timber products	53
4. Production flow chart for panel products	54
5. Organisation chart for furniture factory	55

	<u>Page</u>
6. - 15. New furniture designs	56
16. - 21. Technological details of new furniture designs	66
22. Typical cross-sections of fishing boat	72
23. Bar chart of proposed immediate development programme	73
24. Temporary layout of machine shop	74
 <u>Tables</u>	
1. Departmental area requirements	75
2. Analysis of existing machinery and equipment	76
3. Analysis of machinery and equipment recently purchased	77
4. Schedule of total machinery and equipment requirements	78
5. Specifications for additional machinery requirements for furniture production	87
6. New furniture designs - quantity analysis of raw material	89
7. Raw materials requisition sheet	92
8. Materials costs calculation	93
9. Labour costs calculation - solid wood flow	95
10. Labour costs calculation - panel flow	96
11. Labour costs calculation - surface treatment and upholstery	97

INTRODUCTION

The Public Corporation for Carpentry and Boat Building is attached to the Ministry of Construction and has its head office at Hai-al-Rowada, Maalla, Aden. The Corporation was established in November 1973, having been taken over from the Public Works Department. It comprises the main furniture factory at Maalla, a second furniture factory at Labourers Island, and a boat-building yard at Hedjuff, Aden. Data on the Corporation's manufacturing activities are given in Annex I.

A formal request was made by the Government of Democratic Yemen to the United Nations Development Programme (UNDP) for technical advice and assistance for the Corporation, and the project was subsequently approved. A wood processing expert began this work on 1 August 1978 and ended on 13 September 1978. The United Nations Industrial Development Organisation (UNIDO) was the executing agency. The government agency co-ordinating the project was the Ministry of Industry. The expert's job description is given in Annex II.

During a preliminary discussion which the expert had with senior officials of the Ministry of Industry and of the Corporation for Carpentry and Boat Building it was agreed that the following should be the objectives of the project:

- (a) the improvement of the existing manufacturing facilities in terms of buildings, machinery and equipment, and available skills;
- (b) the upgrading of existing designs and the introduction of new ones where appropriate;
- (c) standardisation of products and components;
- (d) improvement of production technology;
- (e) better materials utilisation;
- (f) improvement of quality;
- (g) introduction of procedures for management and supervision;
- (h) better productivity;
- (i) establishment of operative training procedures;
- (j) preparation of plans for future development.

A summary of the expert's major activities is given in annex III. The following personnel were concerned with the project: Mr. Kassem Hesson Mohamed, Assistant General Manager, Organisation for Carpentry and Boat Building; Mr. Abdul Rahman Abdul Walid, Manager of Finance and Administration; Mr. Mohamed Abdul Kader Ali Minse, Cost Accountant; Mr. Abdul Karim Abdul Rahim, Senior Production Supervisor; Mr. Abdul Rahman Turkey, Production Supervisor.

Also associated with the project were Mr. Mohamed Awad Daba, Deputy Minister, Ministry of Construction, Mr. Ahmed Hussein, Director of Production, Ministry of Industry and Mr. Ahmed Bashin, Programme Officer, United Nations Development Programme.

I. FINDINGS

General observations

The major proportion of the furniture produced by the Public Corporation for Carpentry and Boat Building (PCCB) is supplied to various government departments and official agencies. It is manufactured more or less to a specification originally prepared by the Office of Public Works in 1956 and has changed little since then, except perhaps in a lowering of quality. The remainder of the furniture is of a domestic nature and includes bedroom, living room, dining room, kitchen and upholstered furniture. They are usually made on the basis of a specification and design supplied by the customer and are produced almost always on a "one-off" or individual basis. The boats are produced for the Ministry of Fisheries and in accordance with its specifications. In addition there are two small craft workshops within the complex for musical instrument making (e.g. guitars) and wood carving. Assessments of the boat building and crafts activities are given in annex IV and V respectively. Regarding annex V it should be noted that this annex was prepared by ILO expert Maurice Fish, who was part of the team making the tour of the operations. This expert concurs fully with the comments made therein.

With the exception of the assistant general manager, who has over twenty years experience in furniture production, three of which were spent in the Federal Republic of Germany, the experience of all other employees in wood working (including carpentry and boat building) is confined to that obtained at the various enterprises in Aden. The work-force which is not particularly well disciplined in the production sense, is evidently poorly trained and, with the exception of perhaps half a dozen carpenters, has no idea of quality requirements. To this may be added inadequate manufacturing facilities, poor use of adequate space, and a lack of appreciation of good handling and storage arrangements especially for expensive hardwoods.

Despite these shortcomings, which can be overcome, there is considerable potential for the Corporation given the buoyant state of the current local market, as well as the markets of neighbouring countries. The plans envisaged for the Corporation, if brought to fruition, will provide it with every means to achieve this end. To this must be added a clear-out policy regarding its manufacturing activities and the determination and skilled management to carry it out.

Product design

It is important to define what is meant by design in relation to furniture. The elements that go into planning design are the production facilities of the plant, the skills of its work-force, an understanding of the nature and characteristics of the materials used, the form and colour of the article, its tactile beauty, its fitness for the purpose, and its acceptability to the consuming public.

Present day production depends, in a large measure, on prefabricated, as well as natural, materials and this has tended to remove both management and worker from an intimate knowledge of the materials used. The result is a loss of understanding of the qualities of the materials and their scope in design. For example, in the manufacture of cabinet goods - wardrobes, dressing tables, storage units, desks, etc. - veneered particle board and plywood have largely replaced solid wood. These are excellent materials in their own right, but the method of their treatment in terms of technology and design must differ fundamentally from that of treating traditional materials. Otherwise the resultant pieces of furniture will be a failure.

If the above criteria are applied to the furniture produced by the Corporation it is immediately clear that it cannot be rated highly, since it conforms to few, if any, of them. The remedy, therefore, is to raise the general standard of design. As there are no trained furniture designers in Democratic Yemen, however, nor any facilities for training designers, the provision of such facilities, or the training of a designer abroad, however impractical, could hardly produce worthwhile results in less than ten years.

In the meantime there exists a basis for improving the situation in the short and medium term by continuing to rely on outside technical assistance in the fields of design and technology. Initially, most of the effort will concentrate on improving the basic manufacturing techniques, as a precondition to undertaking more ambitious functions. As a first step, good draughting facilities should be set up at the Maalla factory, and while these should never be confused with design expertise, but are part of it, it would be possible to incorporate some element of design into them. A draughtsman should be recruited, trained locally and later sent on an appropriate design course abroad.

In addition, there should be good prototyping and product development facilities provided close by the draughting office so that the two can work together in developing design both from technology and production points of view, to the stage when it can be manufactured without difficulty and to the required standard. When the drawing office and prototyping workshop are fully equipped and staffed, they should be able to provide for the needs of all the enterprises owned by the Corporation.

As a further short-term means of solving the design problem, the Corporation should consider the importation of suitable designs from abroad. This can offer many advantages in terms of technical know-how, in addition to a well-developed product or product range. The same basic design criteria must, however, be applied in assessing and selecting suitable designs and should include production costs, likely sales and profit projections. At the same time, it must be stressed that such an arrangement should be regarded only as a short-term expedient; it is no real substitute for soundly based home design.

Annex VI provides details of the designs recommended to be produced instead of the existing ones. They conform to the criteria in the previous paragraphs and may be manufactured from most materials currently in use. Other considerations which influenced their choice included common structural elements, interchangeability of components and uniform standards of quality and performance. The expert wishes to stress, however, that this range should be regarded as the first of a number of design-integrated systems, which as they are being developed will reflect accurately an anticipated growth in skills, expertise and productivity.

Raw materials

Since raw materials may account for up to sixty per cent of the total cost of production of furniture and boats, they are of paramount importance in both design and production considerations. The most important materials used in the production of furniture are a hardwood species known as BENTEAK and plywood. Boats are manufactured from teak and these, and practically all other materials used, including fittings, adhesives, hardware, upholstery materials and surface coatings, are imported from India. There are limited supplies also from Italy and Japan.

As a basic raw material for carcass production, plywood, although suitable, tends to be expensive and should be replaced in part by particle board (chipboard) which is considerably cheaper and equally well suited to modern production. If it is to continue to be used, then the specification should insist on better quality and species for surface veneers. There are plans to install a veneering plant which would make the use of particle board essential and this means that carefully selected veneers would be included in the raw materials' requirements.

The expert has had previous experience of BENTEAK as a hardwood used in furniture production. In general he found it unsuitable for this purpose, being coarse grained and having a tendency to split and warp. There are no timber-drying facilities available in Aden and since it arrives at the enterprise almost saturated with moisture, the difficulties faced in working it satisfactorily are almost insuperable. There are large quantities of this timber presently in stock. It is thrown haphazardly about the timber yard, and is left exposed to the direct rays of an intensely hot sun. Consequently there is considerable degrade, resulting in substantial financial loss through unnecessary wastage. The situation requires to be dealt with urgently and before further losses are incurred. The timber yard should be redesigned so that the timber is stacked in accessible aisles according to length and sectional dimension. Each stack should be protected from direct sunlight, either by roofing in the timber yard or covering each stack with sheets of corrugated iron properly held down.

The expert further recommends that the use of BENTEAK should be discontinued when current stocks are depleted. There are many other suitable commercial species available in plentiful supply such as mahogany and teak which, if obtained in appropriate sizes and stored in the manner already described, would effect a dramatic improvement in utilization and quality of the end product. The timber will need to be air-dried, as well as kiln-dried, before being put into production and some form of timber-drying kiln should be installed. The expert provided details of solar and other types of timber-drying kilns to the management.

Further on in this report reference is made to the need for a more up-to-date finishing or surface-coating system and this should include modern synthetic lacquers and oils which nowadays have almost totally

replaced the inefficient French polishing process of bygone days. These would include wood fillers, matching stains, and various types of lacquers, and are described in some detail in the chapter dealing with production.

There remains furniture fittings and accessories for furniture and joinery production. Those currently being used are of Indian origin and, in general, are unsuited to the production and quality standards required of modern furniture. Suitable fittings must be imported, particularly from Denmark, the Federal Republic of Germany, Italy and the United Kingdom. They are available in abundance and are suited to every conceivable type of design and production. Details of such fittings have also been supplied by the expert to management.

Production

Productivity in the various plants, by any standards, is very low (see Annex I).

Output per worker hardly covers the basic costs of production, and should be increased five-fold before the current level of investment in the plant would be justified. This is not meant to suggest that workers are expected to work five times as hard, although far more effort on their part is certainly necessary. Of greater importance is the extent to which all the production facilities of the plant, i.e. buildings, machinery and equipment, and management and operative skills are exploited. The ways in which personnel are expected to contribute are dealt with in a later chapter. The technical aspects of production and productivity are dealt with here.

Buildings

The total area of the factory is 12,558 m² (182 m x 69 m). This is subdivided into various storage and production departments as illustrated in figure 1.

Some of the buildings, particularly the timber sheds, machine shop No. 1., machine shop No. 2, and the finished goods and sheet materials stores, are well built and in good condition. The remainder are more of the shed-type building evidently erected quickly and cheaply. However, given the general climatic conditions, they are probably suitable enough except when it rains, which is not often.

The general disposition of the existing layout of the buildings is shown in figure 1. This clearly indicates that the factory has grown piecemeal over the years. Buildings were added on from time to time as the need arose, without any reference to an appropriate work flow or logical sequence of operations. This has meant that the best use of available space has not been made and, no doubt contributed to the decision to resite the factory elsewhere. When to this is added the chaotic condition of the site as a whole, with raw timber and waste material strewn everywhere, it is difficult not to agree with such thinking. However, a careful analysis of the factory makes it clear how much better use could be made of available space. This is illustrated in figure 2 and shows that by more effective use of existing production and storage areas and the provision of some additions, the whole can be quickly and cheaply turned into an effective organisation. Table 1 compares the available areas for the existing departments with the proposed areas to be provided in this new layout. This would result in an additional 1,600 m² being made available and would, together with the existing, but reconstructed buildings, provide for the needs of the enterprise for at least the next ten years or more.

The major structural alterations envisaged would include doubling the size of the machine department, which would now be housed in one building, doubling the carpenter's assembly department, again confining it to one area, doubling the polishing department, providing a battery of three timber drying kilns, and building a new workshop for engineering and vehicle maintenance. The services to be provided would include additional power, compressed air and compressed airline system and waste extraction system. There would in consequence be a logical flow of work beginning with the timber yard and sheet materials stores, through machining, assembly, upholstering and wood finishing to dispatch, all proceeding in one direction.

It should not be necessary to carry more than two months stocks of raw timber, provided a continued supply at that interval is assured, consequently less space is required for timber storage and incidentally less working capital and less wastage.

In the case of fittings, adhesives and finishing materials, stocks should be extended to cover a six months period. Adequate and conveniently located storage has been provided for all raw materials.

The whole factory was subject to a thorough clearing out of all waste materials during the course of the project. Management should see to it that this accumulation of materials, as well as waste of valuable space should never occur again. Good housekeeping, especially in a wood working plant is an essential pre-requisite to efficiency and productivity.

Machinery and equipment

Table 2 provides an analysis of existing machinery and indicates that, in the main, it is mostly old and certainly past its best. This is particularly evident from the poor quality of machined components which add enormously to cost because this has to be "repaired" or amended subsequently by the carpenters. There was therefore every justification for the recent purchase of new machinery which has just arrived at the factory.

This machinery is analysed in table 3 and as can be seen, is much more suited to joinery production (doors, windows etc.) where the working of large sections requires heavy duty equipment. In the case of furniture production - the only one now carried out by the Corporation - all sections used are of light dimension and while the equipment referred to may be used, it is not really appropriate to furniture production needs. Some items undoubtedly will be used, but will only partly solve the production problems.

Table 4 provides a complete breakdown of the total machinery and equipment requirements for efficient furniture production. It also takes into account the labour requirements and the extent to which existing and recently purchased machinery may be used. There is still a considerable shortfall from total minimum requirements and these are listed in table 5. The expert strongly recommends that the machinery be purchased without delay since without it the furniture factory is heavily under-equipped. Here it should be emphasised that this recommendation is based on a radical departure from the methods currently used to produce furniture. As evidenced by the quality and structure of the end product, it is anything but acceptable, simply because neither the tools nor the skills of production are suitable or adequate. In future production will depend on accurate machining to close tolerances of all components, which will then be transported to the carpenters for assembly. Many of those machined parts will be interchangeable, and elements of the same model may be assembled independently of each other. The elements themselves may also be interchangeable and be stored in this form until required for final assembly

and dispatch.

The remainder of the machinery may be used for a separate joinery factory to be located possibly in the new building originally intended for furniture production (see annex VII).

When the proposed building programme is completed, every department will be required to be redesigned and outfitted according to a carefully prepared and pre-determined plan which neither time nor facilities permit at this stage. Details would also need to be worked out for power supply, the design of a compressed air-line system and the provision of internal transport systems. This layout should be in accordance with the production flow charts for solid timber products and panel products, shown in figures 3 and 4 respectively.

An essential adjunct to the efficient and accurate use of machines is the development of appropriate gauges, jigs and formers. These should be designed and made at the product development stage and should be the result of the combined expertise of the draughtsman and prototype makers. The new design programme has provided an opportunity to develop many of those. The designs themselves should be produced in accordance with the technological details described in figures 16 to 21. The expert recommends that the detailed production and work station layout and the production planning and control referred to should be among the subjects to be dealt with in any follow up envisaged as a result of this project.

Productivity

Productivity may be defined as output per worker per year. In the case of the Corporation's furniture plant this is abysmally low by any standards. The cause of this cannot be attributed to the workers alone who, after all, only do what they are asked and trained to do. In fact, the causes can be traced to a variety of circumstances including inexperienced management, poor production facilities, lack of essential technical know-how, the absence of in-plant operative training, unsuitable raw materials, inaccurate costing, poor design and quality of the end-product and lack of a carefully planned production programme.

Throughout this report it has been emphasised that a pre-condition for an acceptable level of productivity is the availability of all the requisite means of production. Those means are totally interdependent so that the plant cannot perform efficiently without any one of them.

Even when all the physical aspects of production are present, there is still no guarantee of success without a skilled workforce and an informed and dynamic management. Then there must be set production targets in accordance with the projected annual output and these should be translated into a required daily output of units.

An essential adjunct to the efficient and accurate use of machines is the development of production aids such as measurement gauges, master parts, jigs, patterns and formers. These should be designed and made up at the product development stage and should be the result of the combined expertise of the drawing office and prototype workshop. The proposed new design programme provides an opportunity to develop many of these.

Management and labour

The quality of the management of the Corporation must be judged against the task set in making the various plants under its control efficient and profitable. This, as in any management situation, requires an acceptable level of experience and expertise in the areas of administration, finance, production, personnel and supervision. Without them, the plant will at best, struggle hopefully on without any clear idea of its ultimate goal, and even less chance of achieving it.

The acting general manager has the right kind of background for production management having had many years experience of production, including some years working in Europe. He is assisted by a financial controller and a production supervisor who, between them, are responsible for the day to day running of the Corporation. This is a good management team assuming that the appropriate level of experience is also present. A glance at the Corporation's present method of operation would indicate that this is hardly the case, but it should be remembered that tradition, established practices over the years, and a lack of contact with the development of modern production technology have taken their toll. The expert is, nevertheless, satisfied that the present management team has the capability of carrying through his proposals, and of acquiring the additional expertise already referred to. He does not wish to minimise the task facing them which will require a dedication and commitment which up

to now may not have been exercised. As a management team they must be strong and resolute in their determination to achieve the goal of an efficient and profitable organisation and above all they must have the authority and support in carrying it out. Accordingly, he recommends that the acting general manager be confirmed as manager and that the team be further strengthened by the appointment of a new production manager. The management structure should further be reorganized by adapting the organisation chart outlined in figure 5. In order to ensure complete co-ordination of effort it will be necessary to prepare job specifications for each of the management functions referred to so that performance is total and effective.

Costing

Chief among the techniques of production planning and control is the establishment of the principle of setting specific and periodic performance or output objectives, the attainment of which should be monitored daily. This would automatically take account of all management systems and procedures including product design, preparation of working drawings and specifications, machine loading, quality control and costing.

It is proposed to deal with these topics in detail during stage III of the project. For the present, particular emphasis is placed on the financial aspects of the business especially in relation to budgetary control and costing. The former should anticipate the projected turnover of production during a given period which, if achieved, will cover all charges and ensure an acceptable level of profitability. This figure must then be translated by production management into the total number of units (i.e. models) required in the same period and subsequently it must work out all materials, labour and other requirements. The total number of units should be directly related to the number of days of production available to management and in this way a daily output of units is arrived at which must be achieved. This pre-supposes the availability of all production facilities and the capability of the work force to carry them out. Only then may any kind of suitable incentive bonus scheme be seriously considered, otherwise it will defeat its own ends.

Tables 7 - 11 provide the basic data sheets on which a realistic costing system for woodworking production is built. The sheets are self-explanatory and if the information from production is accurately collected and recorded, not only is a satisfactory system arrived at, but also there is then in existence, permanent records upon which estimating and planning for the future can be built.

Technical control

Management is felt to be weakest in the area of technology, and this is probably one of the reasons why supervision is so ineffective. In giving technical or other directions to workers the supervisor should indicate his conviction that such procedures are appropriate and relevant. Any hesitancy on his part is quickly detected by the worker who, if he wishes, may turn the situation to his own advantage. Chief among the causes for this lack of technology lies in the absence of a training policy from the inception of the Corporation. Originally it was virgin territory without any tradition in manufacturing, much less in furniture production. Therefore, careful development with appropriate instruction and demonstration was required.

The nature of the training required should be related to the following:

- (a) Furniture plant layout and design. Problems in industrial plant design is applied to furniture manufacturing, building structures, equipment location, space utilization, power utilization, light, heat, ventilation, and safety are among the subjects covered as well as materials handling and maintenance;
- (b) Woodworking equipment. Study of production woodworking equipment, cutting, shaping, sanding, veneering and assembly operations; capabilities and limitations of machines; theory and practice of cutting and sanding wood; low-cost mechanization; pneumatics, electrics and hydraulics;
- (c) Wood processes. Processes of drying, gluing and finishing wood; reconstituting wood as fibreboard, hardboard and particle board;
- (d) Engineering economy. Study of criteria and techniques for management decisions in relation to economy of design, selection and operation; effects of depreciation policies and machine replacement;
- (e) Furniture design and construction. Detailed drawings and bills of materials from samples and designers' sketches. In construction, emphasis is placed on good performance under variable atmosphere moisture, on adequate strength and rigidity, and on low cost;
- (f) Furniture manufacturing and processing. Study of production methods in the furniture industry, including production procedures from the yard through all operations, and shipping;

(g) Manufacturing controls. Development of principles and procedures for control of materials, manpower and costs, with special attention to production and inventory control, equipment utilization, wage classification and cost reduction programmes;

(h) Quality control. Economic balance between cost of quality and value of quality; statistical theory and analysis as applied to sampling, control charts, tolerance determination, acceptance procedures and control of production.

Technical information

The other remaining and urgent need is for the provision of a good technical information system, which would enable management to remain abreast of technical and other developments in the industry. This could best be done by establishing a small technical information centre at the Corporation's Maalla factory, by furnishing it with appropriate books, journals and publications and by making this material available to the management and supervisory staff. Annex VIII provides a list of publications which are readily available at low cost and which could form the basis for this requirement.

Supervision

Many references have already been made to the need for informed and sustained supervision of the work force. This is a particular requisite for good productivity, and there is no substitute for it. Again it requires training in human relations, work allocation and quality control. Above all, it calls for personal qualities of leadership and integrity which alone will win and sustain the respect and loyalty of the workers, and encourage them to learn and to do their best. It should be manifest in fair-mindedness and have a meticulous observance of the regulations of the plant, whether these are concerned with discipline, punctuality or productivity.

Labour

The expert has formed a good impression of the work force. Whatever it lacks in skill is more than made up for in a friendly willingness to learn which promises well for the future. Despite the general inexperience and lack of technical know how, there are many evidences of latent skills which the Corporation would do well to foster and nurture.

These can best be brought to the surface by ensuring first of all, on the part of management, that a system of work is established to which everyone adheres, rather than at present when decisions are left to individual skills and judgements, often with disastrous results.

While taking into account the traditions and practices which have been established over the years, the understandable absence of industrial mindedness of the people, and the prevailing climatic conditions which inhibit a good production tempo, it must still be said that many improvements can and should be made. For example, during the period of the project, which coincided with that of Ramdan, the official working day was from 08.00 to 14.00, or a non-stop period of 6 hours production. In reality, work never really got under way before 08.15 and usually tapered off from 13.30 onwards. This is a serious loss of output in an already shortened day and if to this is added the wholesale and indiscriminate wanderings by almost everyone around the plant for one reason or another, the effective day is reduced at most to $4\frac{1}{2}$ hours. There is clearly confusion in peoples minds, including management, between being busy and being profitable.

The answer to this and many other similar problems is, as has already been pointed out, the continuing and consistent application of the principles of good management throughout the plant. Allied to this should be the adoption of a policy of upgrading staff skills through proper supervision and training. Additional help is also needed from outside the Corporation particularly in achieving, as quickly as possible, acceptable levels of skill and productivity. The expert, therefore, recommends that in addition to the input by him, two UNDP volunteers with appropriate experience in the machining and assembly aspects of modern wood processing should be recruited. Preferably they should come from one of the Scandinavian countries where there is a long and illustrious tradition in this field. The volunteers should remain at least one year. Regarding the question of plant discipline, it would be of considerable benefit if a special plant booklet were prepared and issued to each employee concerning his or her duties and responsibilities, as well as any other relevant information.

Training

Throughout this report, stress is laid repeatedly on the need for training if the efficiency of the work-force is to be raised to an acceptable standard. Training is an essential tool of management which, if planned

and implemented systematically, can reduce labour turnover, improve output and quality, reduce wastage, lower the number of accidents and improve morale and job satisfaction. Furthermore, use of the right method can reduce learning times drastically, enabling workers to improve earnings and increasing production capacity.

Training should be based on the commercial needs of the Corporation, thus helping it to become more efficient and profitable. This means that its overall effectiveness must be appraised and plans made for the future. To make these appraisals and planning processes more effective, it will be necessary to define specifically those areas in which effort must be concentrated. These may include finance and profitability, labour productivity, and sales. In this way training is linked closely to the whole business process. If it is to pay off, the Corporation must ask itself:

Howe well do we perform?

What are our main areas of weakness?

Howe well equipped are we to carry out our plans and achieve our targets?

Only then can it ask:

What training should we give individuals to carry out our plans and achieve our targets?

The first and essential stage in the establishment of a training programme is the appointment of a full-time training manager. The man chosen must have the qualifications and experience to carry out training within the Corporation effectively. Ideally, he will be found among the existing personnel, and since his task will be exacting, he will need to receive appropriate training himself. Excellent courses for training managers exist particularly in England where they are organized by the Furniture and Timber Industry Training Board. A course, which usually lasts for about three months, includes furniture and joinery in all its aspects. The manager will then identify precisely the training needs of the Corporation, draw up a training programme and supervise its implementation. What has to be taught will be found by comparing what the employee need to know for effective performance and the knowledge of the job they are likely to possess as potential trainees.

The basic steps of a training programme would be:

- (a) To describe the job, what it is and why it is done (job description);
- (b) To break the job down into suitable items of content for the purpose of instruction (job analysis);
- (c) To define the standards to be reached in each element of the job. At this stage a statement of the knowledge and skills required can be prepared (job specifications);
- (d) To prepare a detailed statement of what the trainee is to be taught and how (syllabus) by making a comparison between this specification and the existing knowledge and skills of the trainee;
- (e) To gauge the time required to cover each part of the syllabus;
- (f) To prepare a logical and progressive timetable;
- (g) To prepare the lesson plans.

At this stage the instructor is ready to teach his trainees and to maintain records of their progress.

Provision has been made in the new layout for a special section of the plant to be set aside for training particularly of new entrants and those whose skills need to be upgraded. This section should be properly outfitted and a specific course of lessons prepared which should be taught during an agreed period. The major aim of the training is to integrate trainee workers into full production as quickly as possible. Initially, much of their training will, therefore, be concerned with the simpler aspects of production and as their skills develop they will graduate to more difficult processes, and ultimately to full integration in production. The expert notes with satisfaction that the Corporation has arranged to send a total of twelve trainees to Budapest and three to Cairo for special training in all aspects of woodworking. They should, in particular, receive training in woodcutting machining, furniture and joinery production, machine setting-up and maintenance, technical drawing and wood finishing.

Development plans

Immediate plans for development covering a period from 1 September 1978 to 28 February 1979 are enumerated in bar-chart form in figure 23. They envisage two stages, the first being the implementation of the more immediate recommendations of the expert and the second, those that would

be carried out during a proposed follow-up mission early in 1979. The Corporation input during the first stage would be the carrying out of the structural alterations and the erection of the proposed extensions as already described. Meanwhile, and on the assumption of agreement from all concerned, including UNDP/UNIDO, the expert proposes that he should prepare detailed layout plans of the reconstituted factory, including the location of each machine, the design of compressed air-line and waste extraction systems, the preparation of detailed working drawings for the new designs programme and the location of alternate sources for the specification, selection and supply of essential raw materials, including adhesives, lacquers, fittings and veneers. He would also prepare similar plans for the proposed new joinery factory.

The return of the expert and the commencement of the follow-up mission should coincide with the completion of the building programme and the arrival of additional machinery, equipment and new raw materials. The work content of the follow-up mission would be items 13 to 20 of the bar chart. In order to assist the management in carrying out their plans, the expert has prepared a more detailed work programme including a temporary layout of the machine shop so that the recently purchased machines can be made use of as quickly as possible. These plans are described in annex IX.

Quality control

General

The quality of a product may be defined as the sum total of that product's essential characteristics which determine its degree of suitability for a concrete purpose. The quality of the efforts of each function should become part of measurable administrative entities.

Within this framework, the role of the quality control section of the Corporation is to provide and co-ordinate a system which ensures that it will produce an optimum quality at minimum product cost. The responsibilities of those charged with quality control are to define, plan, co-ordinate and measure the quality efforts of the Corporation, as well as to perform those activities normally associated with quality control. Quality itself cannot be ensured by inspecting a product, but should be designed and built

into it. Quality control entails not only inspection or testing for the acceptance or rejection of parts; it is also concerned with the provision of rapid, accurate and usable information about product and process quality which would give guidance for process control and control of product quality.

Quality control is effective if it is exercised in conjunction with standard specifications that apply to every aspect of the product. These standard specifications are now recognized internationally and are applied uniformly. Their application in terms of quality nearly always proves the decisive factor in successful export.

Those responsible should also realize that quality control begins and ends with the worker, whose responsibility to exercise it in terms of his craft cannot be transferred elsewhere.

It should also be remembered that quality control is best carried out in a well-organized and well-disciplined plant where everyone makes the right kind of contribution whether he is a cleaner or a production manager. It should be uniform and consistent in character because standards which fluctuate from time to time, whether in terms of raw materials, processes or finished goods, are no longer standards but further manifestations of poor management.

Future UNIDO/UNDP assistance

It is evident that the Corporation, in order to re-organize and develop its manufacturing activities satisfactorily, will need UNDP/UNIDO assistance for some time to come. Its immediate form should include the following:

1. Short-term consultancy

- 1.1. Two follow-up mission in 1979, each of two months duration and commencing in January and October respectively. The work content to be that enumerated in the bar chart, figure 23.
- 1.2. Commissioning of expert to prepare the detailed plans described in the previous chapter. The period required would be six weeks from mid-September to the end of October 1978.

2. Volunteer support programme (PDY-75-013)

- 2.1. Immediate appointment of two volunteers experienced in all aspects of furniture production to work for at least one year in the machining and assembly departments of the Maalla factory. Preferably they should be recruited from one of the Scandinavian countries.

Language: English

3. Fellowships

- 3.1. The attendance by the plant manager at the UNIDO Workshop on Wood Processing to be held in Cologne and Hanover in May 1979.

Language: English/German

- 3.2. The attendance of the newly appointed production manager at the UNIDO Seminar on Furniture to be held in Lahti, Finland in August 1979.

Language: English

- 3.3. The attendance by a selected trainee at a nine month's course in drawing and design at the London College of Furniture from October 1978 to June 1979.

Language: English

- 3.4. Provision of special training in wood carving and instrument making for the Corporation personnel engaged in this work.

II. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Plant facilities

1. The major furniture factory at Maalla and the second at Labourers Island have between them sufficient production and storage space to provide for their manufacturing needs for at least ten years.
2. There is not effective use of space in either location and at present over fifty per cent is wasted.
3. Location of production space, storage of raw materials, and work-in-progress, is far from satisfactory.
4. Layout of the machining, assembly, upholstery and finishing areas is poor and is not conducive to a logical flow of work nor good work planning.
5. Many of the existing machines are old and difficult to operate and maintain. New machines recently purchased will improve the situation but not satisfy all production requirements.
6. Additional machines are required for production; and equipment for assembly, wood finishing, and upholstery.

Design

7. The plant's deficiencies are most apparent in the field of design, the meaning and function of which are not fully understood.

Management

8. Production management is not sufficiently experienced in plant layout, production planning and control, staff supervision, quality control, materials handling, good housekeeping, purchasing, cost control and administration.
9. Design and product development are not sufficiently co-ordinated.
10. There are no draughting facilities available.

Raw materials

11. Essential raw materials are generally not appropriate to the needs of the end product nor its production technology.
12. There is enormous and totally unnecessary wastage of valuable raw materials through unsatisfactory selection, poor storage and low utilization.

Production technology

13. The technology of modern furniture and joinery production consistent with a plant of this scope and magnitude is largely unknown. This is particularly the case with regard to a satisfactory understanding and use of most materials used by the industry, the design and structural details of furniture construction, furniture finishing and upholstery.

Labour

14. There is no provision for in-plant training. This is urgently required for learners, unskilled workers, technicians and production foremen.
15. Productivity is very low. Causes other than a lack of suitable skills include absenteeism, chronically bad timekeeping, production indiscipline and lack of strict supervision.
16. Many of the workers lack the necessary skills to produce furniture to an acceptable standard.

Quality control

17. Quality control is not effective because its meaning in the context of furniture production is not fully understood.

Development plans

18. There are plans to transfer the entire operation to a new factory currently under construction about 20 miles from the present location.

Recommendations

Product design

1. The Corporation must evolve a design and product policy consistent with the needs of the market of Democratic Yemen and with the production capabilities of the plants under its control.
2. The design standards of all items manufactured need to be raised. In addition, new designs should be introduced as quickly as possible.
3. As there are no furniture designers in Democratic Yemen, the Corporation must ensure that it provides for its own needs in this respect. A beginning should be made by arranging for the attendance by a competent draughtsman with a flair for design, at an appropriate design course abroad, possibly with the aid of a UNIDO fellowship.
4. The Corporation should also consider, as an interim measure, the importation of suitable furniture models which would provide a guide to design development as well as setting standards of quality.

Product development

5. There should be a drawing office and prototype workshop attached to the main factory in order to provide suitable product development facilities prior to any model going into full production. This drawing office would also provide for the needs of the proposed joinery factory.

6. Prototyping should also include the design and production of all processing aids such as master parts, formers, machine jigs and patterns, measurement gauges and fixtures.

Raw materials

7. The raw materials selection and supply system for the Corporation requires much greater direction and co-ordination in order to ensure that adequate stock levels of appropriate quality shall be maintained at all times.

8. All materials, especially timber, should be properly stored and maintained on the basis of a good stock control system.

9. Use should be made of veneered particle board (chipboard) as well as plywood for the production of all types of drawer and storage units.

Most glueing operations should be done with a casein glue instead of the traditional animal glue.

10. The standard of metal and plastic fittings imported mainly from India is not sufficiently high for the production of modern furniture. They should also be imported from Denmark, the Federal Republic of Germany, and the United Kingdom, where there are established manufacturers of such fittings.

11. Management should maintain close contacts with manufacturers of other materials such as adhesives, wood finishes and upholstery materials. Their technical representatives should be encouraged to visit the plant regularly and to keep management informed of new technical developments.

Production and productivity

12. In order to advise on an acceptable level of productivity, specific production targets, based on capacity and known performance should be set monthly in advance and should be monitored daily.

13. Greater attention should be paid to work planning, layout, production flow, machine loading, production control and method study.

14. The entire factory should be redesigned in accordance with the general work flow. Department areas for storage, machining, assembly, upholstery, wood finishing and dispatch should be clearly designated, and arrangements made for ease of transport of raw materials, work-in-progress between each department.

15. Many woodworking machines are old and may be replaced by those recently purchased. Other essential machines require to be purchased immediately.

16. There should be a special machine shop for timber and board breakdown and a single machine shop for all other operations. Production in the machine shop should always be at least one week ahead of assembly so that the carpenters have plenty of work in hand. The size of this machine shop should be doubled.
17. Greater use should be made of such production aids as masterparts, measuring gauges, patterns, templates, jigs, formers, locating and boring aids. These should be made in the prototyping workshop.
18. A considerable increase in productivity, i e. output per worker, is necessary. This will be achieved only by the management's ensuring adequate production facilities (buildings, internal transport, raw materials, skilled workers, suitable machinery) appropriate production planning and control and strict and informed supervision throughout the plant.
19. All workers in the assembly or carpentry department should have a full set of hand tools, some power operated hand tools (e.g. electric drills and sanders) and a sturdy work bench, fitted with a woodworker's vice.
20. All assembled furniture should be loaded on flat rubber-wheeled trolleys for transfer to the finishing or polishing department.
21. The polishing department should be doubled in size and fitted with two spray booths with exhausts, for the spray finishing of furniture.
22. A new finishing system should be introduced incorporating the use of nitro-cellulose and acid-catalysed lacquers.
23. The finishing or polishing workers should be instructed in the use of spray guns and synthetic lacquers.
24. Good housekeeping requires to be maintained throughout the plant. Floors should always be kept clean, gangways kept clear and waste wood or other materials should never be allowed to accumulate anywhere.
25. The workshop at "Labourers Island" should be used for assembly purposes and for the manufacture of custom-built furniture only. It should be supplied with all machined components as well as other materials from the main factory at Maalla. It should also be provided with a spray booth and should concentrate on the assembly and finishing of solid wood furniture only, e.g. chairs, table frames etc.

Management

26. A management organisation chart should be drawn up indicating levels of responsibility and from which job specifications would be clearly defined for every level of management.
27. The present acting general manager should be confirmed in this post and a new assistant general manager appointed.
28. Before taking up a particular management or supervisory appointment, all personnel should undergo a period of induction and training.
29. Regulations regarding supervision and discipline should be uniform throughout the plant and all personnel should be made fully aware of them. A special document on this should be prepared and issued to every worker.
30. Management should understand and apply such management techniques as production planning, production controlling, quality control, work programme and machine loading.
31. Foremen and supervisors should realize that there is no substitute for direct and personal supervision. They should therefore spend the major part of their time in their own departments. This is particularly important when attempts are being made to improve production discipline.
32. The training programmes should be based largely on the needs of production and of achieving an acceptable level of quality.
33. A section of the factory should be set aside for this purpose and should be equipped with benches, hand tools and a universal woodworking machine for demonstration purposes.
34. Selected personnel should avail themselves of the various UNIDO-sponsored courses especially in Lahti, Finland, Ligna Hanover and Interzum, Cologne, Federal Republic of Germany.
35. The Corporation should arrange for the purchase of books, periodicals and other publications concerned with technology and production in the wood industries. UNDP assistance should be sought towards this end.

Quality control

36. Quality control should be substantially improved. Specific procedures and standard specifications for the establishment and maintenance of quality control should be laid down and strictly adhered to.

37. The staff directing quality control in the plant should be fully familiar with its requirements and applications.

38. Management should realise that quality control is everyone's responsibility and that it should be applied particularly by all craft workers.

Development plans

39. These should concentrate initially on the improvement of the present plant until the stage is reached where all its resources are fully utilised.

40. Plans to transfer the equipment and work force to another newly built factory should be reconsidered in the light of the experts findings and recommendations concerning the suitability of the present factory for at least the next ten years.

41. The production of joinery (mainly doors, windows, and timber-framed housing) should be begun by the Corporation possibly in the new factory planned for carpentry production.

Annex I

DATA ON PUBLIC CORPORATION FOR CARPENTRY AND BOAT BUILDING

<u>Total capital employed</u> (including buildings)	<u>Dinars</u>		
	330,700		
<u>Total turnover</u> (1977)	309,000		
<u>Total manufacturing Units</u>	<u>Number</u>		
Furniture	2		
Boat building	1		
	<u>Number of persons</u>		
	284		
<u>Total employment</u>			
	<u>Carpenters</u>	<u>Helpers</u>	<u>Labourers</u>
Maalla (furniture)	92	35	42
Hedjuff (boat building)	25	20	16
Labourers Island (furniture)	21	18	15
	<u>Value of production</u>		
	<u>Furniture</u>	<u>Dinars</u>	
		358,893	
	<u>Boats</u>	91,350	
<u>Productivity</u>	<u>Dinars/person</u>		
Furniture	1600		
Boats	1500		
<u>Exports</u>	Nil.		

Annex II

JOB DESCRIPTION

SI/PDY/77/80A/11-01/31.7.A

POST TITLE Wood Processing Expert

DURATION Six weeks

DATE REQUIRED As soon as possible

DUTY STATION Aden; with possibility of travel within the country.

PURPOSE OF PROJECT To study the factors affecting the development of the secondary wood processing industries sector in Aden, assess its potential for development, and identify measures to be taken.

DUTIES

The expert will be attached to the Ministry of Industry and will specifically be expected to;

1. Survey the present situation in the country's wood processing industry studying the following factors;
 - a) structure of the industry
 - b) raw material supply
 - c) markets
 - d) equipment
 - e) processing technology used
 - f) training requirements.
2. Draw up development possibilities in the various fields based on the above survey.
3. Recommend measures to be taken by the industry and by relevant authorities in the various fields (e.g. those enumerated under 1. above).
4. Assist the existing industry in the above fields.
5. Train counterpart personnel in the above field.

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

Annex III

SUMMARY OF MAJOR ACTIVITIES OF PROJECT

The following is a list of the main project activities:

- a) Plant's survey and preparation of work programme;
- b) Establishment of new design range and completion of some prototypes;
- c) Demonstration of method of striking out new designs;
- d) Preparation of materials specifications for new designs;
- d) Re-design of total storage and manufacturing areas;
- f) Preparation of detailed machinery and equipment specification;
- g) Introduction of more up-to-date production technology;
- h) Appraisal of boat building enterprise;
- i) Assessment of proposed joinery production enterprise;
- j) Preparation of on-going programme;
- k) Completion of technical report.

Annex IV

ASSESSMENT OF BOAT BUILDING INDUSTRY

Design

Traditionally built timber fishing boats, for use in the Gulf of Aden, which is a sheltered coastal water operation. The boats are approximately 40' - 45' long with a beam of 12' and a depth of 5'. The boats are shallow draft with a straight keel but having a maximum loaded draft of 3'. This is unusual for the conventional fishing boat but is a traditional design in this area. A particular characteristic is the angle of entry of the stem which provides a reduction in hull resistance but is also meant to ease construction difficulties. The hull shape is round bilge design with fore and after bodies resembling an efficient sailing yacht hull. The craft is flush-decked throughout with openings for access to fish hold, engine room and accommodation. There is a fairly shallow bulwarks at a constant height fore and aft.

Construction (see figure 22)

The craft is of robust construction. Planking, both hull and deck, is made from varying teaks; framing, floors, knees, stern post, apron and hog are a locally grown timber which it has not been possible to identify. Crown or natural frames, floors and knees are used in the main construction of the craft, but intermittent frames are made from odd lengths of material. Spacing centres of frames are about 10" to 12" which is very acceptable. A large number of springers are fitted between keel and gunnel. The hull planking width is unusually wide, but narrows at the turn of the bilge to enable the shape to be achieved. Planking is also reduced in width both fore and aft when running into the stem post. Stealers (filling pieces) are used in the bow and stem section planking. The method of scarfing of hull planking is by means of a diagonal butt scarf. Method of fastening is by what appears to be forged iron nails (dumps) with square shanks and round heads. These are manufactured in the boat yard. These fasteners are inserted in countersunk holes which are bored with a traditional bow drill. The nails are dipped in oil for ease of entry but would also act as a preservative. Before punching home the nail, caulking is wrapped around the shank below the head and as the nail is punched home it forms a seal. The nail is then turned over flat against the frame. Keel bolts

are used to connect the keel to the hog and floors, which are made from mild steel, round bar, threaded at both ends. The heads are stopped with a resin-based stopper. Deck beams are housed into the beam shelf (gunnel stringer) and nailed. Adhesives are not used anywhere. The hull is caulked in the traditional manner using cotton spun into long lengths rather like sisal which is caulked into the seam and into any splits, shakes and scarfs. The seams are then sealed with a plastic wood compound. The outside and inside of the hull is coated with a vegetable oil, possibly linseed oil, or an equivalent. The stem frame is hand bored from the inside to accept the stern tube (shaft) and the engine beds, which are large section hardwood, are bolted in position with mild steel bolts. The engine beds appear to be shorter than usual. The bulkhead is constructed between the engine compartment and the hold and is made from a softwood. The rudder is made of teak and fitted to the stem post by means of gudgeons and pintles (metal straps with pins for fixing). Each hull planking is pegged to the previous strake until the whole of the hull planking is completed. Only then is the planking attached to the frame. The life of the boat is approximately 20 years.

Production

Equipment consists of an 18" circular saw, a 30" bandsaw, a combined surfacer/thicknesser, bandsaw blade grinder, power cross-cut, electric drills, and hand tools. There are no work benches, and the shaping of the planking is done manually on the ground. The timber is not properly stored and is left lying haphazardly around the whole boat yard area. Much of the timber suffers from degrade as results of direct exposure to the hot sun and much of the local timber already referred to had evidence of woodworm. There are two partly covered slipways, each of which can accommodate two boats.

There are three boat-builders and four helpers per boat which is usually completed in six months. The selling price of the boat is 3,040 dinars without engine. This is a contract price covering a period of two years. The actual cost of production is now in excess of 5,000 dinars.

Comments

1. The design of this craft is outdated, and could be replaced by a contemporary designed, round bilge, displacement fishing boat, providing greater storage capacity for catch and gear, and a more stable craft. It should be remembered that this boat was originally for sail. Therefore, an efficient yacht type hull was evolved. No attempt has been made to amend this design to suit the introduction of a diesel-powered marine engine. Consequently the expected advantages in terms of increased capacity and greater stability are not availed of.
2. Choice of materials is satisfactory, but care should be taken in the selection and storage of the timber. Pest infested local timber should not be used. Non-ferrous materials should be used for all fastenings and fittings throughout the hull.
3. Construction methods are largely traditional, but there is not sufficient attention to detail. Hull planking is rough cut and poorly jointed; scarfs are technically not correct and should be stepped and halved or butt straps should be fitted behind each. The planks are not sufficiently carefully scalloped or dished to fit the frame, resulting in a lot of daylight. No bedding compound appears to be used when fitting hog, apron, floors, frames etc. They should also be leaded or painted. Crown frames are of poor quality and should be replaced with higher grade timbers. If they have to be used, defective parts should be chopped out and replaced with sound wood, accurately fitted and glued. All scarfs, deck beams, and other joints should be glued with a marine grade adhesive. External finish of planking is poor, and could be improved with more careful smoothing. The craft should be primed with a lead-based primer before stopping, and finished with a marine quality paint. Anti-fouling should be used below the water-line. To sum up, there is an evident lack of finesse in craftsmanship, but this could easily be remedied.
4. The boat yard should be tidied up and all waste material removed so that there is easy access to every part. Materials handling would be improved with the introduction of simple hand-lift trucks. There should be a small mobile crane or overhead gantry with chain blocks to facilitate

engine installation before shipping, and to transport heavy baulks of timber etc. A mechanical capstan or winder located at the land end of the yard for slipway operation would be a considerable advantage. Boats under construction should be built adjacent to the slipway in such a way that the slipway can be used for repair and maintenance purposes. This would provide valuable additional work and income for the yard. A band re-saw, and extra surface/thicknesser and bandsaw, especially for smaller work, would be a distinct advantage. Power tools should include 19 mm two-speed electric drills, circular saw with attachments, hand sur-facer and router. There should be elongated carpenters benches running the complete length of the construction shop and fitted with woodworking vices, stops etc. Other hand tools should include sash and cranes steel smoothing planes, spokshaves, hand drills and swing braces, twist bits, augers, rebate planes, paring chisels, gauges and adzes. In addition to the normal woodworking tools, there should also be a set of hard spanners and sockets.

5. To become abreast with current design and technological development the next logical step would be to build glass reinforced plastic (GRP) boats. This is how the current boat building industry throughout the world has developed. The main difficulties in this process would be the supply and storage of raw materials i.e. resins, catalysts and fillers, some of which have a limited pot life. The construction for the GRP laminate would need to be in a temperature and humidity-controlled workshop. These problems have been overcome in countries with a similar climate such as Bahrain, India and Saudi Arabia. Initially it would be advisable to negotiate a collaboration venture with an established and proven GRP production business. Initial construction could begin with the fitting-out of hulls, decks and superstructures supplied by the associate company, and later graduate to total home production. This should generate additional industry for the production of stern gear, fuel tankers, deck fittings, steering systems etc., as well as GRP water tanks, external facings for buildings etc.

Annex V

APPRAISAL OF WOOD CARVING AND CRAFTS SECTION

By Maurice Fish, International Labour Office
Consultant, expert rural crafts

Visit to and appraisal of the Corporation for furniture and
boat building (Wood Carving and Musical Instrument Section)

12 August 1978

A short tour of the two workshops concerned (musical instruments and wood carving) was undertaken with Mr. Abdul Karim, General Foreman, and Mr. Desmond P. Cody, UNIDO consultant. Products were inspected, tools and equipment noted and a short discussion held with the workers in each section.

A. Points noted on site

- (1) Two small sections of the factory are set up for:
 1. Musical instrument making
 2. Wood carving
- (2) The number of people employed are:
Musical instruments: 2 males, 1 female
Wood carving: 2 males
- (3) Products produced:
One model of Yemen guitar
A number of relief carvings of Arab scenes
- (4) Tools and equipment used:
Musical instruments: Chisels, tenon saw, knives, portable sander. Use of wood lathe in another section of the factory.
Wood carvers: chisels, hand-carving tools of poor quality, tenon saw.
- (5) Timbers: Mainly off-cuts and waste from other parts of the factory. A small amount of imported beach for guitar stocks

B. Possible lines of action that can be taken for improving these sections, consideration being taken of:

- (i) Cost
- (ii) Time involved for prototype production
- (iii) Training involved
- (1) Tools and equipment to be acquired:
 - (i) Musical Instrument Section:
Hand-carving tool set (2 off)
Veneer marquetry knives (2 sets)
Disc sander (vertical disc type)
Portable drill $\frac{1}{2}$ " with stand
Small wood-turning lathe with tools

- (1i) Wood-carving section:
 - Hand-carving tools (3 sets)
 - Veneer/marquetry knives (3 sets)
 - Portable sander
- (2) Timber to be available:
 - Supply of veneers
 - Beach for guitars
- (3) Products that can be introduced:
 - Musical Instruments Section: Other types of guitars from around Democratic Yemen, Bedouin guitar/sittar can be purchased or taken from models in Seyun museum of crafts

Wood carving section: Marquetry depicting scenes for tray bases, stool tops, coffee table tops etc.

The carving of full models of buildings, Arab dhows, minarets etc. This can be done from photography or sketching of various places and items of interest. Variety of timbers to be introduced to give colour variation and emphasis of depth etc.,

- (4) Training of local personnel:
 - (a) Each section could in the very near future take two teenage trainees, male or female, to follow a type of "apprenticeship"
 - (b) One craftsman from each of the two sections to be considered for an overseas training course. Probably Kenya, as a suitable choice for carving, and India for musical instruments
 - (c) A general up-grading of the work already being produced. Symmetry to be observed, squareness of frames is necessary, glued joints to be cramped, finish to be smoother, cleanliness to be observed. All minor points but which when put together produce a better finished product.

Comments

These two small workshops will not make a significant contribution to the income of the factory for at least twelve months.

If however they are looked upon as experimental workshops and products are designed and developed during the first twelve months, thereafter production could be planned and income generated.

The investment in adequate tools and a small amount of machinery would be worthwhile.

The two sections should be housed together or in close proximity to one another if this is possible. It would create interest in each others work and possibly competition.

Annex VI

DESIGN AND PRODUCTION PROGRAMME

The design programme illustrated in figures 1 - 9 is aimed at providing a basis for the establishment of a sound product policy on which further and more sophisticated designs can be built as production facilities, management and labour expertise improve. Factors which influenced the choice of this range of models are enumerated in chapter I. Those include methods of construction suited to skills and equipment, common structural elements, rationalized range of dimensions and a high degree of component interchangeability.

The programme covers the manufacture of the following types of furniture:

Living and dining-room chairs and seating, storage units for bedroom, dining room and kitchen; range of office desks and tables.

The raw materials to be used are as follows:

<u>Item</u>	<u>Raw materials</u>
Chairs, table frames, seating	Mahogany, teak or equivalent
Storage units	Veneered particle board and plywood
Office desks	Veneered particle board and plywood
Upholstery	Urethane and latex foams Nosag and resilient webbing
Lacquers	Nitro-cellulose and acid catalysed lacquers, teak oil
Fittings and accessories	Standard metal and plastic, imported mainly from Europe

The main forms of construction include the use of dowels, mortise and tenon, dovetail and housing joints. Methods of assembly are simple and uncomplicated and suited to the current levels of skill in the factory. Elements of the same model may be worked independently of each other and later assembled to the finished stage. This means that the more difficult work may be given to the highly skilled carpenters and the simple work to those who have less experience and skill. It is also intended that there will be a greater machine shop input in order to increase productivity, accuracy, and over-all quality. Figures 16 - 21 provide additional dimensional and structural details of the range.

Annex VII

SUMMARY ANALYSIS OF REQUIREMENTS AND PROJECTIONS FOR JOINERY PRODUCTION

1. Definition

Joinery is defined as "an assembly of wood components manufactured for incorporation in a building structure from which it shall receive support, but no load."

2. Products

Doors: external and internal, flush and other;
Windows: simple and specialized, fixed and openings;
Stairs: open and closed, straight and geometrical;
Shutters and balustrades;
Partitioning; bench framing;
Wall panels, door frames;
Prefabricated low-cost timber-framed housing.

3. Raw materials

Timbers From published data the physical characteristics of practically all species can be found. The particular features which concern suitability for joinery include the following:

Ease of kiln drying without degrade.
Machineability.
Stability and moisture movement.
Strength.
Acceptance of nailing, screwing and gluing.
Reaction to surface finishes.
Durability under all service conditions.
Permeability to preservatives if non-durable.

Wood-based panel products: These include notably plywood, particle board and hardboard.

Other sheet materials: These include materials such as asbestos cement, plaster-board and laminated plastics.

Other materials: Adhesives, fixings, ironmongery and joinery furniture, primers and finishes.

4. Product design

This will take into consideration the following factors:

- Local traditions and requirements.
- Degree of standardisation and dimensional co-ordination.
- Avoidance of excessive variety.
- Satisfactory performance in use.
- Ease of manufacture with equipment available.

5. Recommended size

Medium, employing up to 200 workers, mainly engaged on batch production of good quantities of a wide range of joinery, with the use of modern machinery and limited handwork, but not making for stock.

6. Manufacturing facilities

Storage: Preferably enclosed, ventilated, buildings should be provided to keep timber and other ancillary materials in good condition. Handling equipment for loading and unloading must be provided. A minimum height from floor to ceiling of 6 m is recommended.

Required floor area 1,000 m².

Offices, sanitary and social facilities: Single storey offices which can be readily expanded as needs grow. Required floor area 600 m².

Kiln drying of timber: This is to ensure further control of moisture content according to the ambient conditions prevailing in service, and a sufficient buffer stock for production.

Requirement is for a 4-chamber battery with a capacity of 20-25 m³ each. The kiln would be shared with the furniture factory.

Preservation treatment plant: This is required in order to meet exposure hazards in service. It should be an oil-borne formulation, and in the case of hardwoods should incorporate cylinders, pumps and control gear to withstand high pressure as well as low vacuum so that any species resistant to impregnation may be treated to a proper level of retention.

Wood-waste disposal: The capacity of the system is calculated on the basis of probable volume of woodwaste in the form of sawdust, chips, edgings and end trimmings as a daily output from the factory.

It should connect to every machine either directly or indirectly and should incorporate hoods, flexible and fixed ducting, air filters, fans and a cyclone with disposal bins.

Power: 500 kVA

Land and development: 15,000 m²

Production buildings: Permanent production buildings should be planned for operational flexibility and incorporation in any future expansion plans without excessive modification.

They should be single storey and of 6 m minimum height from floor to eaves. This will allow space for overhead suspended lifting and conveyor gear, exhaust ducting, and lighting.

Portal frame buildings of 20 m clear span, and those may be constructed of timber, steel or pre-cast concrete. Trunk distribution, electric power and compressed air.

Area required: 4,000 m²

Production machinery: A factory of this size justifies the installation of faster feed, more powerful, and more elaborate machinery to boost output. The degree of component completion will tend to reduce the amount of skilled handwork and call for more simple assembly operations by semi-skilled labour. Longer production runs and less variety are a corollary, with higher back-up in tool-room and machine setting.

Machinery requirements

N/C No.	Machine	Qty.	Availability		
			Ex	P	R.P.
1.	Circular saw	3	X	X	X
2.	Band re-saw	1		X	
3.	Panel saw	1			X
4.	Multihead moulder	1			X
5.	Spindle moulder	2		X	
6.	Surface planer	2		X	
7.	Thicknesser	2		X	
8.	Router	2			X
9.	Single-end tenoner	1		X	
10.	Double-end tenoner	1			X
11.	Single mortiser	2		X	
12.	Gang mortiser	1			X
13.	Belt sander	1		X	
14.	Drum sander	1			X
15.	Powered cramping table	1			X
16.	Veneer press	1			X
17.	Compressed-air line system	1			X
18.	Finishing equipment	1			X
19.	Compressor (high capacity)	1			X
20.	Tool room maintenance equipment	1		X	
21.	Exhaust system	1			X

Key: Ex. - existing; P. - recently purchased; R.P. - requires to be purchased.

6. Investment costs and trading finance

The various estimated capital expenditures associated with the sectors described in the previous chapter are brought together in the following table:

	<u>Dinars</u>
Land and development	N/A
Production buildings	90,000
Production machinery	78,000
Storage buildings	15,000
Offices, sanitary and social	30,000
Kiln drying facilities	15,000
Preservation plant	18,000
Waste-disposal plant	4,800
Power distribution	<u>3,000</u>
Total	<u>263,800</u> =====

Trading finance will be dependant upon the value of stocks of raw materials, work-in-progress and finished products, and the amount of credit given less than received. A desirable provision in the permanent capital would be an amount equal to two months average sales.

Output: It is impossible to state with any degree of accuracy the level of potential output measured in value terms. Raw materials costs can vary by a factor of two or more, according to their nature and source, and while labour costs may not reflect the level of skills, they do not operate on a proportional basis. It is, however, anticipated that the value of output would be between Din 510,000 and Din 600,000.

7. Management and administration

Provision must be made for buying, selling, estimating, costing, production planning, work study, book-keeping, designing, technical and management training, and all the other operations that do not function on the factory floor.

Annex VIII

LITERATURE ON FURNITURE

Journals

Furniture Manufacturer (monthly)

Magnum Publications Ltd, 110/112 Station Road East
Oxted, Surrey, England

Cabinetmaker (weekly)

Woodworking Industry (monthly)

Benn Brothers Ltd, 25 New Street Square
London EC4A 3JA, England

Wood and Equipment News (monthly)

Westbourne Journals Ltd, Crown House, London Road
Morden, Surrey SM4 5JR, England

Books and pamphlets published by the Furniture

Industry Research Association (FIRA)

Maxwell Road, Stenage, Hertfordshire, England

FIRA bulletins

FIRA research notes

FIRA technical reports

Furniture literature

Management accounting

Methods engineering

The furniture standards handbook

Publications issued by the United Nations

New York, N.Y. 10017, USA

Production of panels from agricultural residues,
Report of the expert working group meeting, Vienna, 14-18 Dec. 70
(ID/WG.83/15 - ID/79)

Sales No.: 72.11.B.4

Production of prefabricated wooden houses.

Sales No. ; 71.11.B.13

Production techniques for the use of wood in housing under conditions prevailing in developing countries. Report of study group, Vienna, 17-21 November 1969 (ID/WG.49/10-ID/10)

Sales No. ; 70.11.B.32

Wood as a packaging material in the developing countries (ID/72)

Sales No. ; 72.11.B.12

Publications issued by the United Nations Industrial Development Organisation

P.O. Box 707, A-1011 Vienna, Austria

Furniture and joinery industries for developing countries. (Raw material inputs, pt. 1; Processing technology, pt. 2; Management considerations, pt. 3) (ID/108/Rev. 1)

Information sources on the furniture and joinery industry (UNIDO/LIB/SER.D/4/Rev. 1)

Information sources on industrial quality control (UNIDO/LIB/SER.D/6)

Information sources on the building board industry based on wood and other fibrous materials (UNIDO/LIB/SER.D/9)

Information sources on the paint and varnish industry (UNIDO/LIB/SER.D/18 - ID/150)

Selection of woodworking machinery. Report of a technical meeting, Vienna, 18-23 November 1973 (ID/WG.151/38/Rev.1 - ID/133)

Low-cost automation for the furniture and joinery industry (ID/154)

Wood processing for developing countries. Report of a workshop, Vienna, 3-7 November 1975 (ID/WG.200/14/Rev.1 - ID/180)

Annex IX

PROGRAMME OF RE-ORGANIZATION

The immediate re-organisation programme to be carried out by the Corporation from September 1978 to March 1979 should be in conjunction with figure 2, which illustrates the proposed new layout. Despite the implementation of this programme and the consequent upheaval, production must still be maintained, hopefully at a higher rate but at least at the existing one. Therefore it will be necessary to appoint a specific person for this task on a full time basis and to provide him with the necessary workforce to carry it out. It is assumed that the Ministry of Construction will be responsible for effecting the structural alterations to various buildings.

The programme will then be as follows:

Locations 1 and 2.

Stack timber as instructed, ensuring free access around each stack as well as the entries and exits, the engineering workshop and smithy. The timber stacks should be protected by sheets of corrugated iron pitched at an angle to enable the rain to flow off.

Location 3.

This is for the storage of plywood and particle board (chipboard) and should have a level floor area and partly enclosed frontage. There should be no leakage of rain through the roof.

Location 4.

Veneers should be stored here on the floor and on racks which should be clean and level. The store should be dry and well aired.

Location 5.

This is made up of three bays each of which should be provided with frontage and door. It will be the store for glues, adhesives and ironmongery with the exception of the furniture fittings.

Location 6.

This should be outfitted as an office for the timber yard foreman who will inspect all incoming materials and ensure they are stored properly.

Location 7.

This was originally occupied by the upholsterers, but should now be outfitted as a drawing office with appropriate full imperial drawing board and drawing equipment.

Location 8.

The electrical workshop should be doubled in size by incorporating the existing musical instruments craft workshop.

Location 9.

The wood carving and musical instrument crafts should be relocated in this area and each craft worker should have his own work bench vice, and hand tools (see annex VII).

Location 10.

This will be the location for the timber drying kilns, but nothing should be done about this area until a detailed drawing and specification has been prepared by the expert.

Location 11 and 12.

This area will house the blacksmiths and engineering workshops. The whole should be re-roofed and a pit provided for vehicle maintenance.

Location 13 and 14.

These will house the machine shop toolroom and prototype workshop. At the moment they are ramshackle structures which should be dismantled and replaced with a well-roofed permanent structure with access to each section and to the machine shop (see figure 25).

Location 15.

Machine shop No. 1 does not require any structural alternations but should be equipped with a replacement circular saw, a panel saw for cutting sheet material and a bandsaw. All these machines are available from those recently purchased.

Machine shop No. 2 will be provided with an extension of approximately 35m x 12m, and the structure itself should be similar to the existing one. It is not necessary to raise the floor level of this extension, but there should be an interconnecting ramp with an easy slope between the two sections. The whole roof area should be made leak-proof otherwise valuable machines and raw materials will be damaged irreparably. It should be noted that all solid wood machining will be carried out in the existing sections and that the new extensions will be used for veneering and panel production. Figure 25 gives a temporary layout of machines for this section, and the recently purchased machines should be sited in accordance with it. It will not be necessary to fix the machines to the floor by means of grouted bolts. This is now done by means of an adhesive pad which is easily fitted under the machine and to which it adheres, as well as to the floor. Power should be provided by overhead cable fed to

each machine by conduit. Care should be taken to ensure that the conduit should not interfere with the free and safe operation of the machine. A clearway, 1 metre wide should, as indicated on the layout, be painted, preferably with yellow paint, on the floor. This clearway should always be kept clear and will allow the uninterrupted flow of work from machine to machine.

When the extension is completed and before the arrival of the additional new machines on order, may be used to temporarily house any machines required from location 19.

Location 16.

All machined components will be stored here and used as buffer stock awaiting assembly by the carpenters. This area and location 17, which is part of the same building, should have the missing blockwork replaced, and the whole made rainproof. There should be easy access from this area to the machine shop.

Location 17.

All sub and final assembly will be carried out in this section but will be subdivided into two areas, one for frame assembly of solid wood (i.e. chairs, table frames etc.) and the other for panel assembly (i.e. Storage units such as wardrobes, dressing tables, chests of drawers etc.).

A new extension should be provided alongside the existing one and/ the same size. The roof of each should be made rainproof and an awning provided around the exterior of the whole at eaves level, which should be adjustable.

Location 18.

This will be for all in-plant operative training and requires no structural alternations apart from making the roof leak-proof.

Location 19.

All upholstery operations will be carried out here and the transfer should occur as soon as the extension to the machine shop has been completed and all the machines removed. It should then be renovated and decorated, the walls being distempered a light blue or cream colour. It should be outfitted with a proper cutting table, industrial sewing machines and upholsters assembly benches, details of which will be provided later. There should also be good internal lighting, a compressed-air line and electrical outlets.

Location 20.

This will be the furniture fittings store which should have island and wall shelving and a hatch connecting to the carpenters assembly workshops.

Locations 21 and 22.

The polishing shop should be extended to include the full width of the existing stores and have access at the end to final assembly. It will be fitted with two water-wash spray booths and should have work benches for sanding and de-nibbing. It is essential that this area be very well lighted preferably with flame - proof fluorescent tubing. Location 22 will be for the storage of all the polishing materials including stains and lacquers. Since these materials are highly inflammable, smoking in the vicinity should be strictly prohibited.

Location 23, 24 & 25.

These can be incorporated in the present store, and no structural alterations are necessary. The final assembly area A(23) should have 4 carpenters benches for final fitting-up before dispatch.

Finally, all administration should be carried out as far as possible in a central area. Thus the office directly across from reception should be re-located adjacent to it. The present structure would be an obstruction when the new layout is fully operative.

All new raw materials should be ordered as soon as details of specifications, quantities and sources have been supplied by the expert.

FIGURE 5. PRODUCTION FLOW CHART FOR SOLID WOOD PRODUCTS

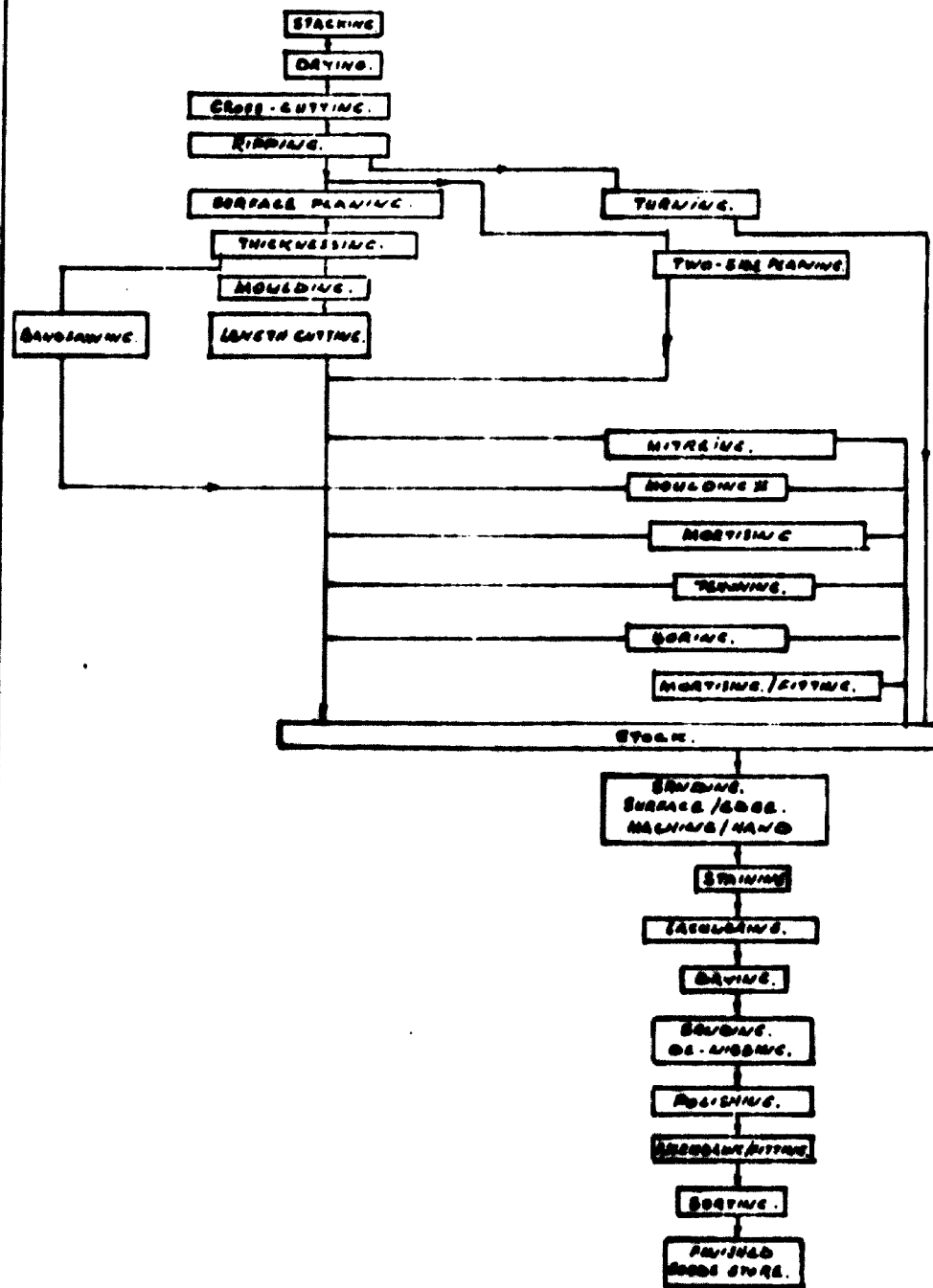
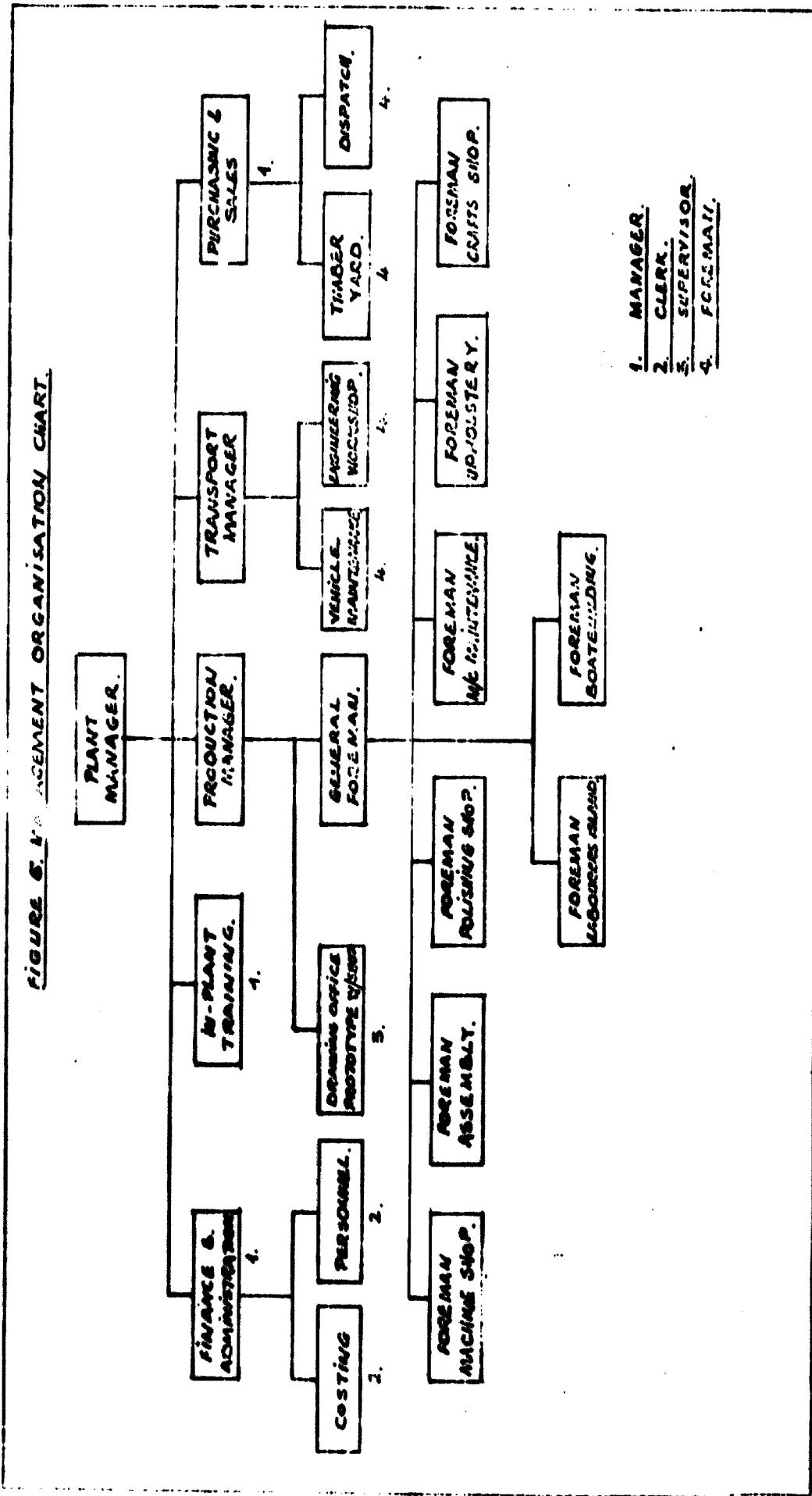


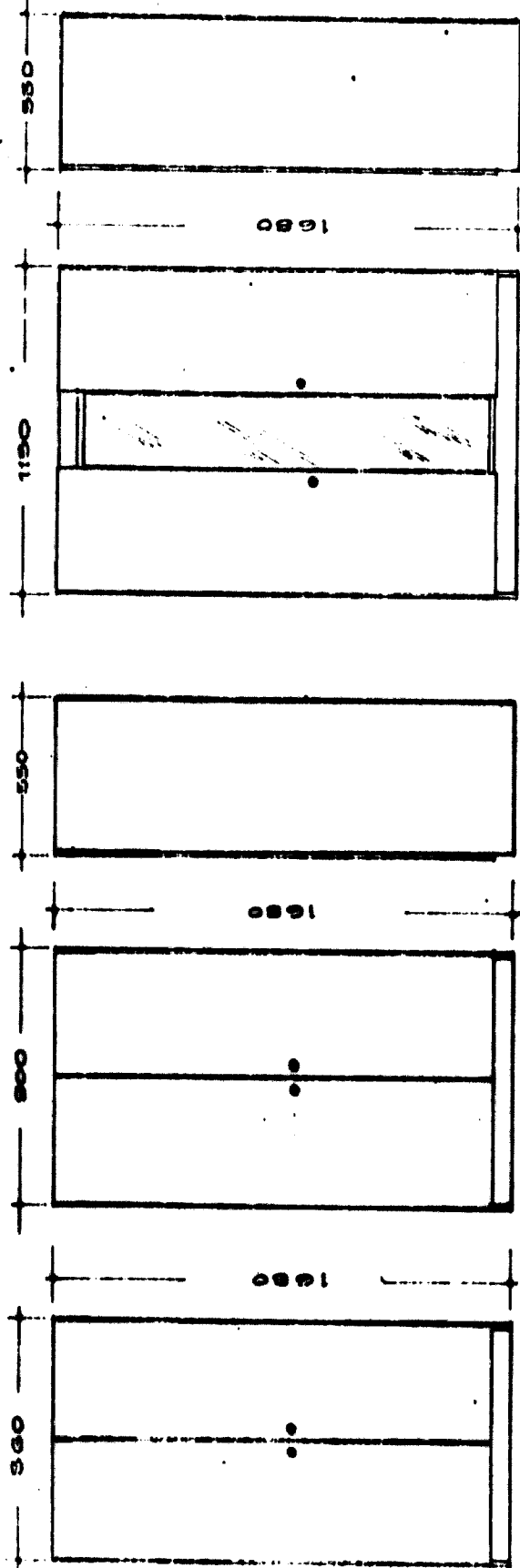
FIGURE 5. MANAGEMENT ORGANISATION CHART.



- 1. MANAGER.
- 2. CLERK.
- 3. SUPERVISOR.
- 4. FOREMAN.

Figure 6

WARDROBES



UNFITTED

FITTED

FITTED WITH MIRROR

ENDS, DOORS, TOPS, BOTTOMS AND
SHELVINGS:-

TOP AND BOTTOM RAILS:-

BACK:-

FINISH:-

VENEERED, EDGE-LIPPED PARTICLE BOARD.

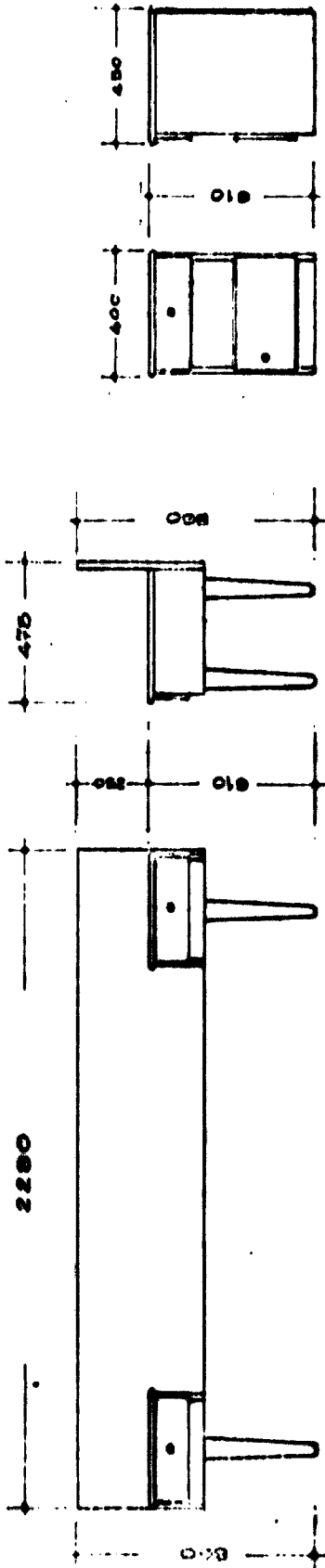
SOLID WOOD

PLYWOOD

ACID-CATALYSED AND NITRO-CELLULOSE LACQUIRE.

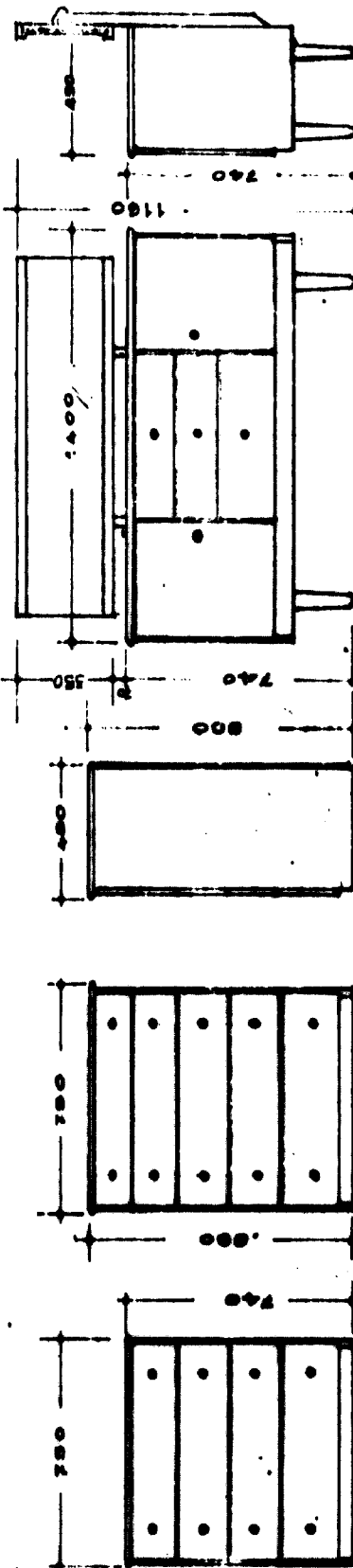
Figure 7

BEDROOM FURNITURE



DOUBLE BED WITH ATTACHED BEDSIDE CUPBOARDS

BEDSIDE CUPBOARD



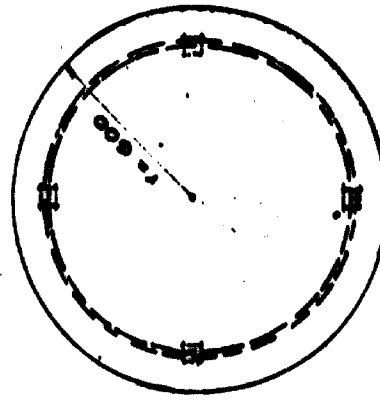
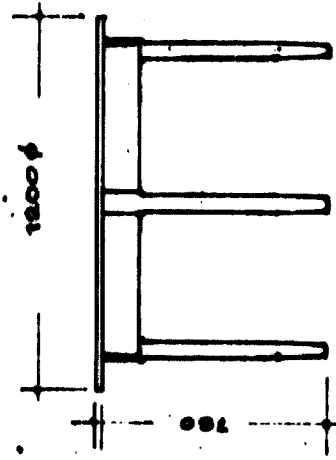
DRESSING TABLE

FIVE DRAWER UNIT

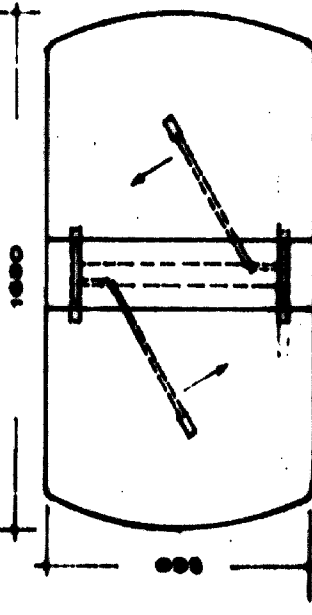
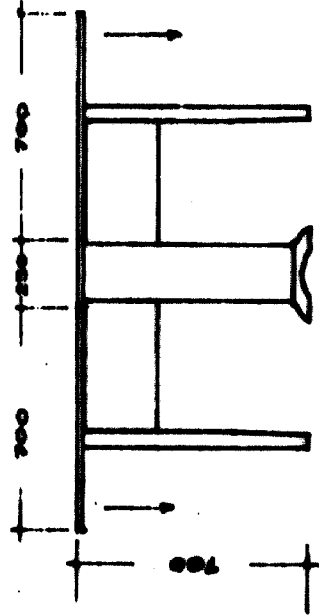
FOUR DRAWER UNIT

Figure 8

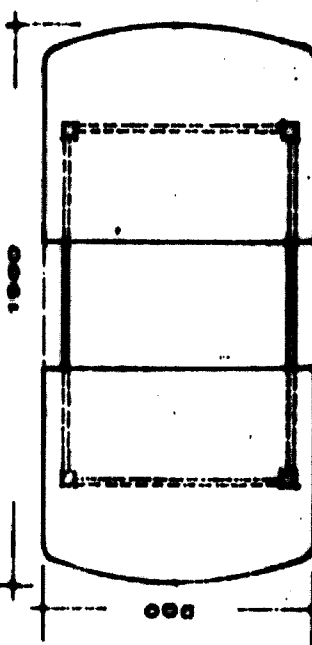
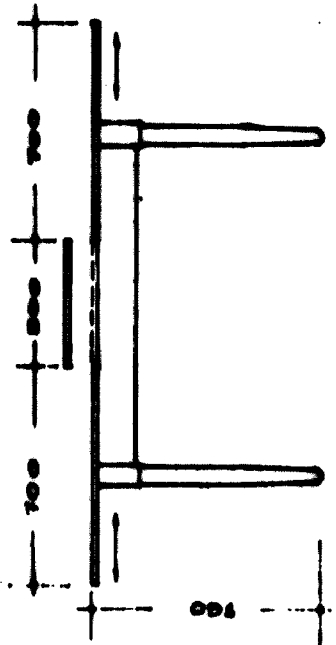
DINING ROOM FURNITURE



CIRCULAR TABLE



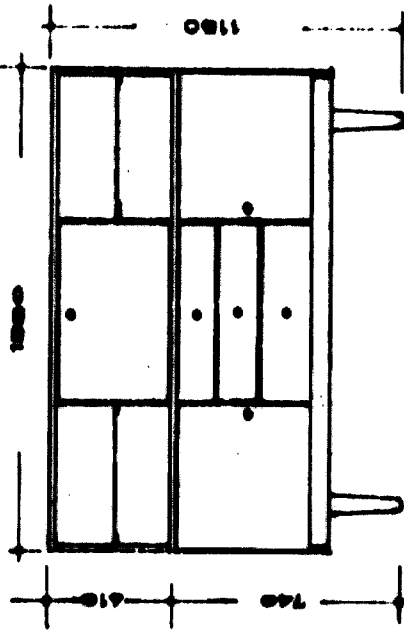
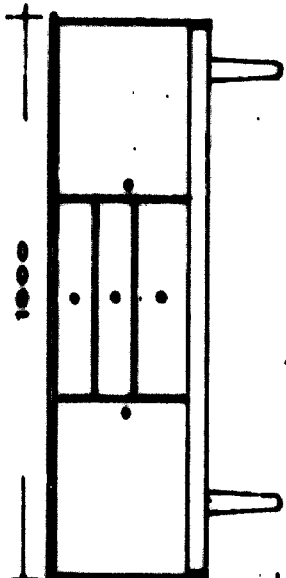
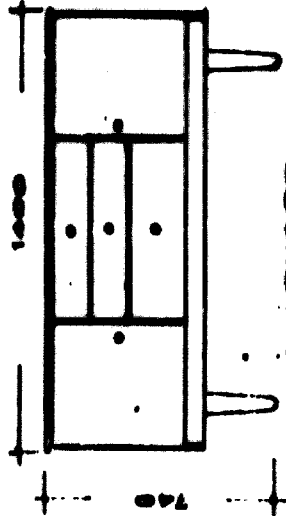
RECT. LEAF TABLE



EXTENSIBLE TABLE

TABLE 2

SIDE BOARDS



SHORT

LONG

TALL

- CARCASSES, DOORS, DRAWER FRONTS, TOPS, AND SHELVES :- VENEERED PARTICLE BOARD
- DRAWER SIDES AND BACK :- SOLID WOOD
- OPEN SHELVES :- PLATE GLASS
- CARCASE BACK, AND DRAWER BOTTOMS: PLYWOOD
- LEGS AND RAILS :- SOLID WOOD
- FINISH :- PU AND M.C. LACQUERS

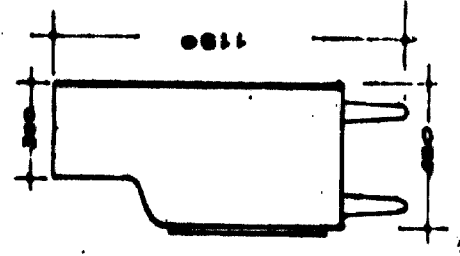
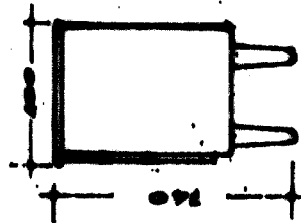
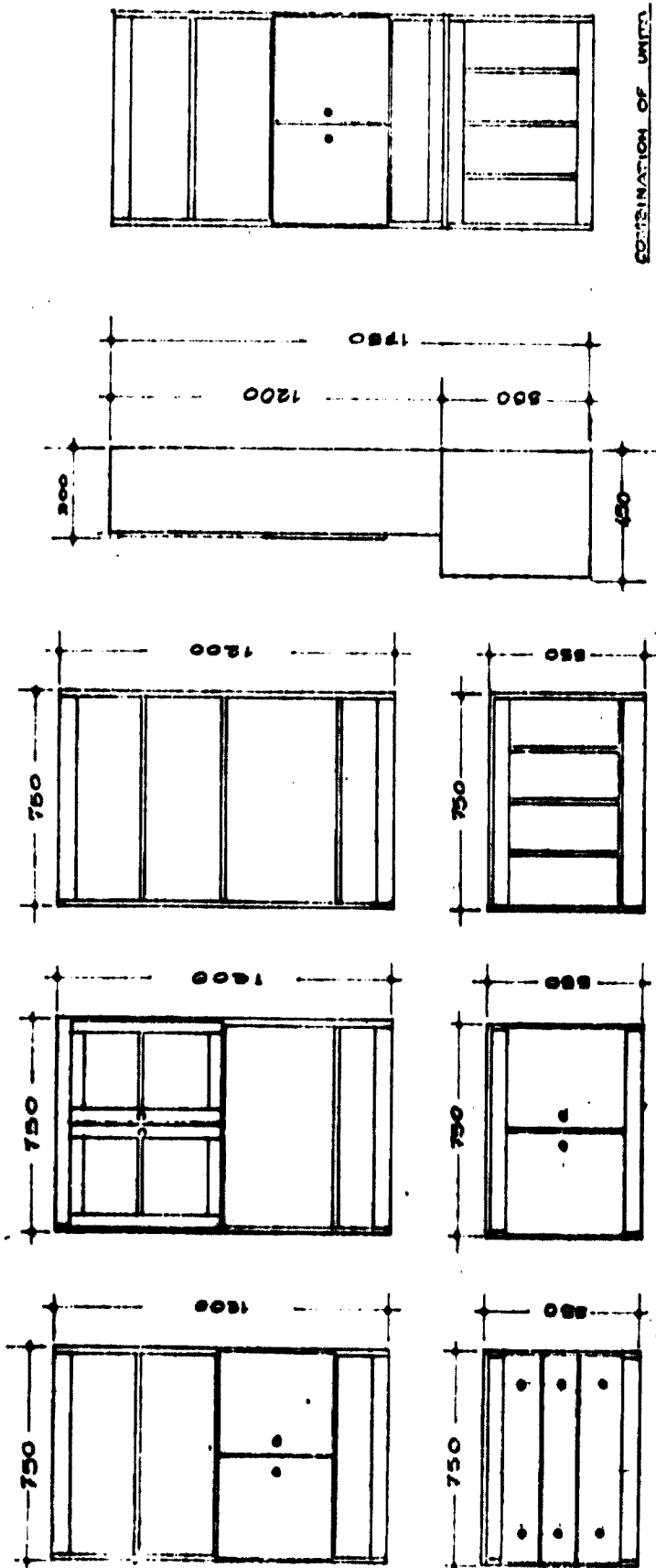


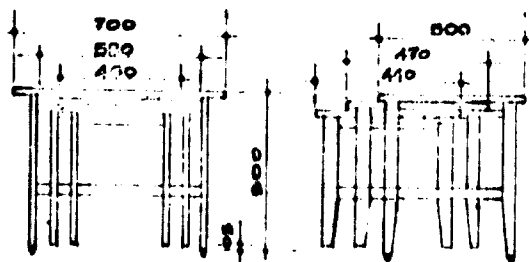
Figure 10

LIVING-ROOM STORAGE UNITS

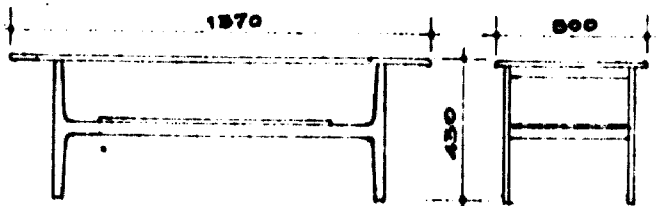


- CARCASSES, SHELVES, DOORS, DRAWERS, AND DRAWER FRONTS:- VENEERED PARTICLE BOARD.
- FRAMED DOORS, AND RAILS:- VENEERED PLY
- DOOR PANELS:- SOLID WOOD
- FINISH:- ACID-CATALYSED AND NITRO-CELLULUS LACQUIRE.

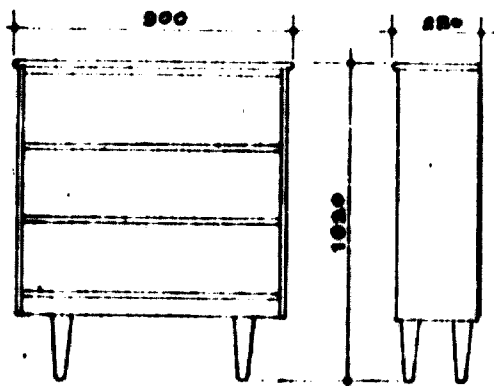
OCCASIONAL FURNITURES



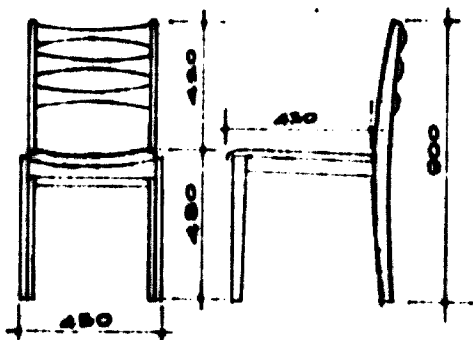
NEST OF TABLES



COFFEE TABLE



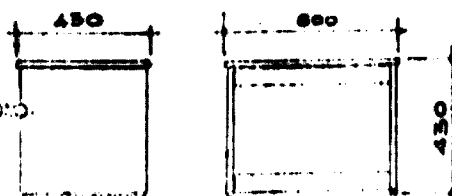
BOOK CASE



DINING CHAIR.

FRAMES-
TOPS & CHELVINGS
FINISH-

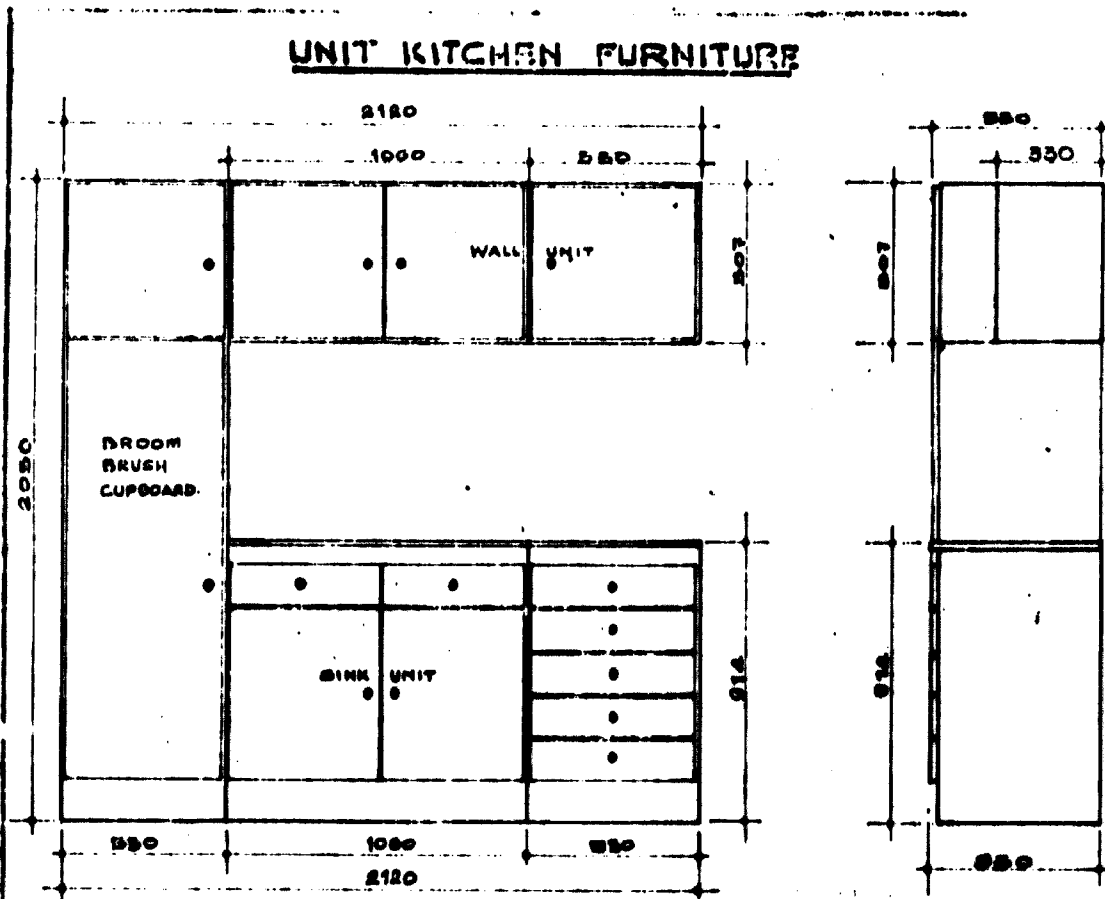
SOLID WOOD
VENEERED BENT LIPPED PLY.
WAX AND PU LACURES.



DRESSING STOOL

Plate 17

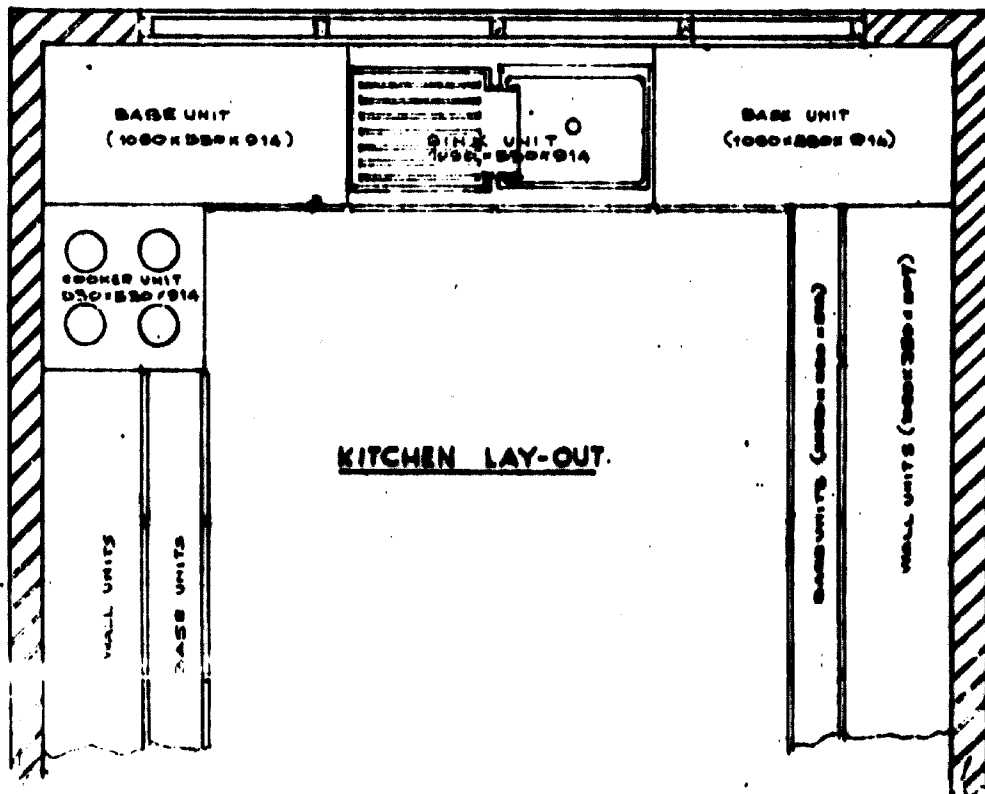
UNIT KITCHEN FURNITURE



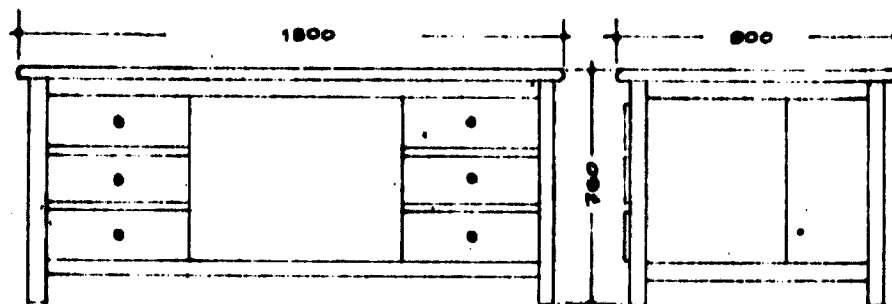
CARCASSES, DOORS, DRAWER FRONTS,
BOTTOMS, BACK AND SHELVES :-
DRAWER SIDES/BACKS AND RAILS:-
TOPS:-
FINISH:-

PLY WOOD.
SOLID WOOD.
PLASTIC LAMINATES.
PIGMENTED PU/LACURE.

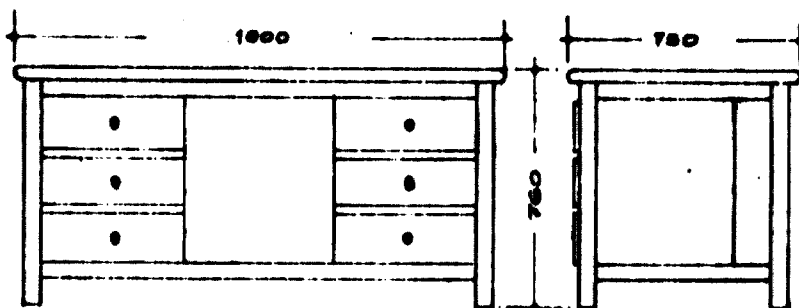
Figure 12



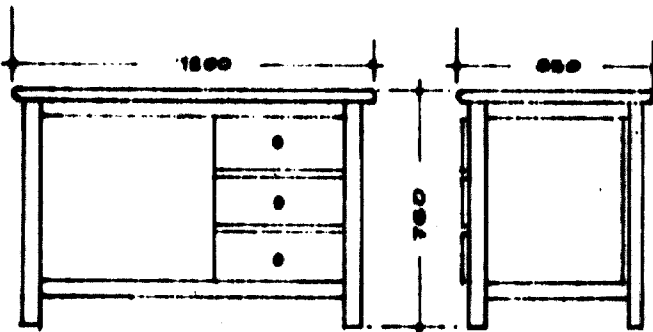
OFFICE DESKS.



SENIOR EXECUTIVE DESK.



JUNIOR EXECUTIVE DESK.



CLERK'S DESK.

Figure 13

FRAMES, DRAWER SIDE/BACK:-

SOLID WOOD.

CARCASSES, TOPS, DRAWER FRONTS:-

VENERED PARTICAL BOARD.

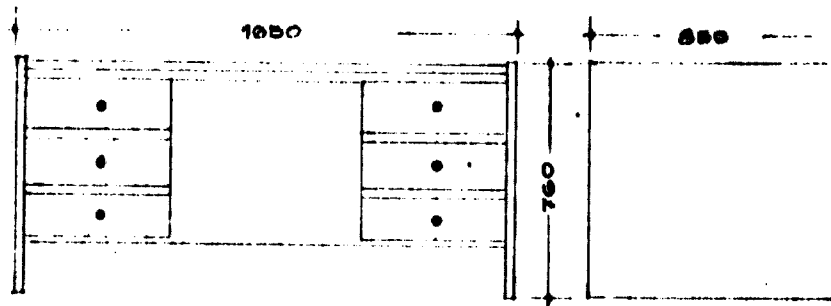
DRAWER BOTTOMS AND CARCASS BACK:-

PLYWOOD.

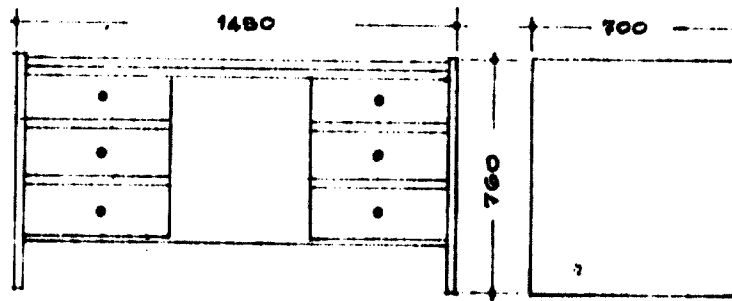
FINISH:-

A.C. LACURE.

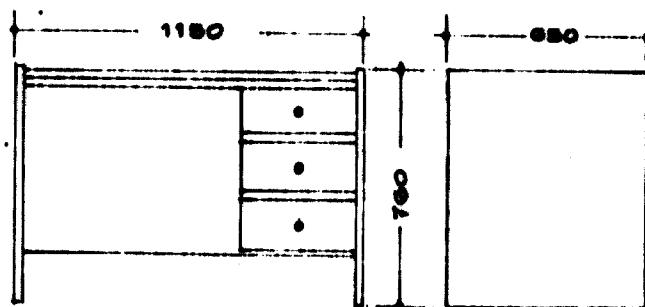
OFFICE DESK.



SENIOR EXECUTIVE DESK.



JUNIOR EXECUTIVE DESK.



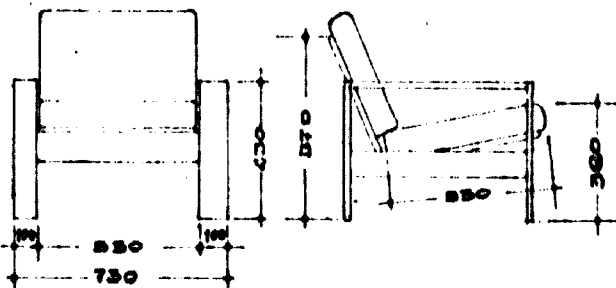
CLERK'S DESK.

FRAMES, DRAWER SIDES/BACK:-
CARCASSES, TOPS, DRAWER FRONTS:-
DRAWER BOTTOMS & CARCASS BACK:-
FINISH:-

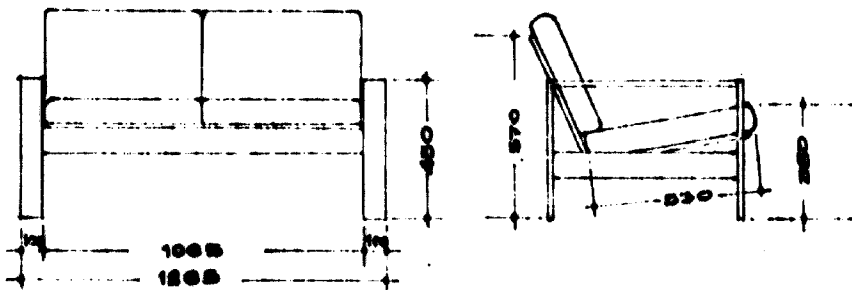
SOLID WOOD
VENEERED PARTICLE BOARD
PLYWOOD.
A.C. LACQURE.

Figure 14

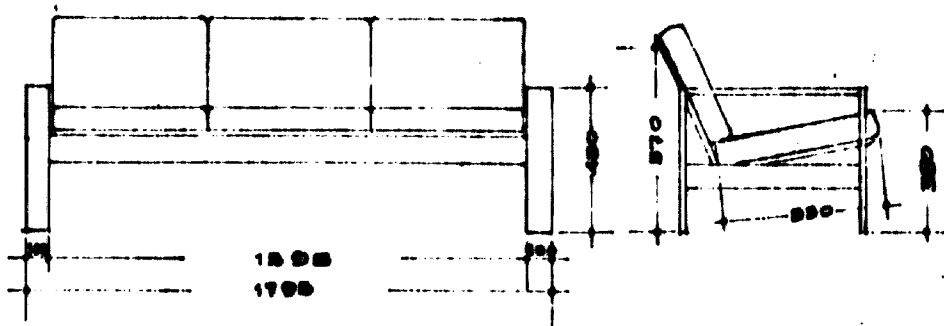
LIVING-ROOM SEATING UNITS



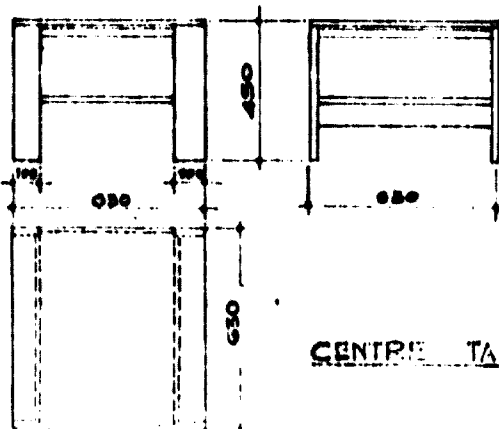
EASY CHAIR.



TWO SEATER SETTEE.



THREE SEATER SETTEE.

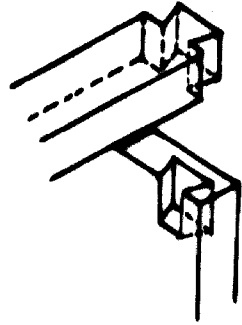


CENTRE TABLE.

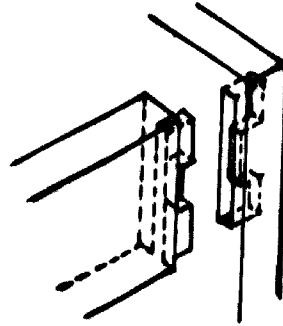
- | | |
|-------------|--------------|
| FRAMES:- | SOLIDWOOD |
| SEAT/BACK:- | RATTAN. |
| CUSHION:- | LATEX FOAM |
| COVER:- | FABRIC |
| FINISH:- | AC. LACQUER. |

Figure 15

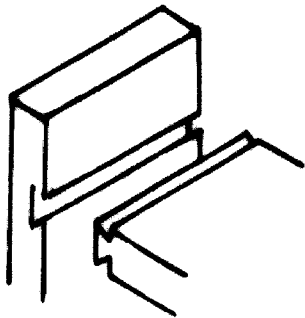
FIGURE 16. CONSTRUCTIONAL DETAILS.



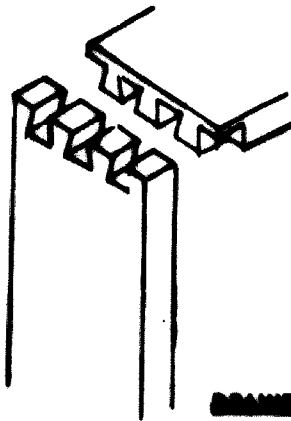
DOVETAILED



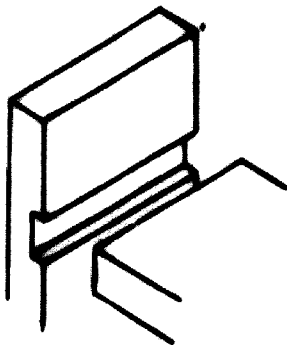
MORTISE & TENON



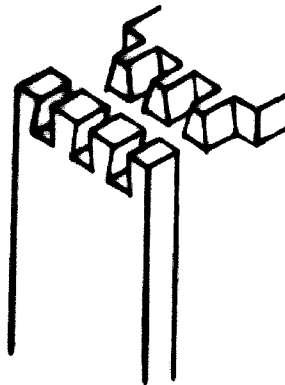
GENERAL HOUSING



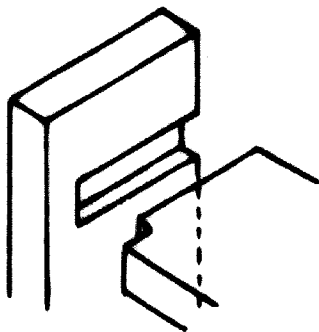
DRAWER ASSEMBLY



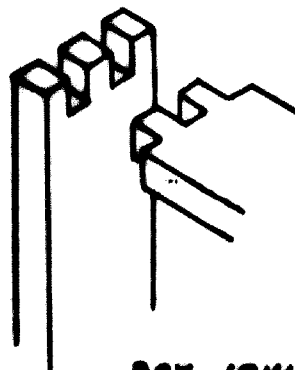
HOUSING



THROUGH DOVETAILED

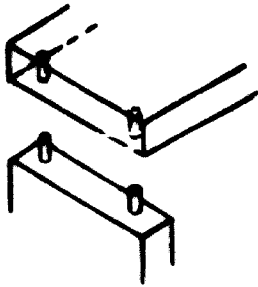


STOPPED HOUSING

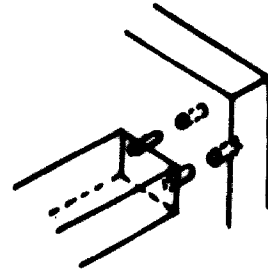


BOX JOINT

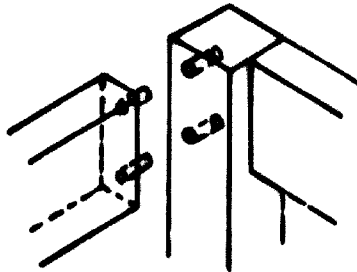
FIGURE 17. DOWEL JOINTS



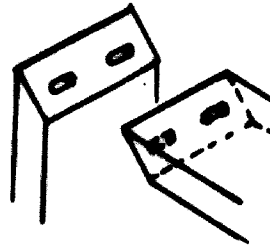
DOWEL SHELVES



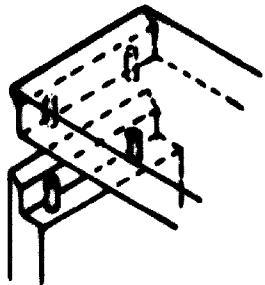
DOWEL BOX TO FRAME



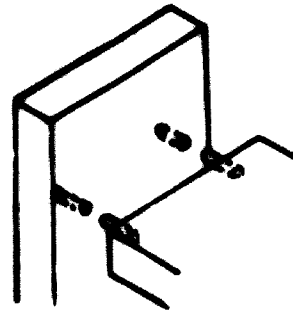
DOWEL BASE TO LEGS



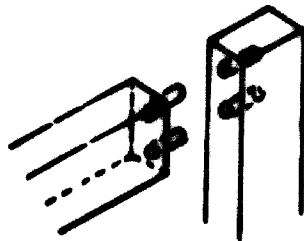
DOWEL MITER JOINT



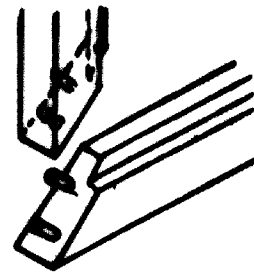
MITER AND SEAT BOARD



DOWEL MIDDLE FRAME

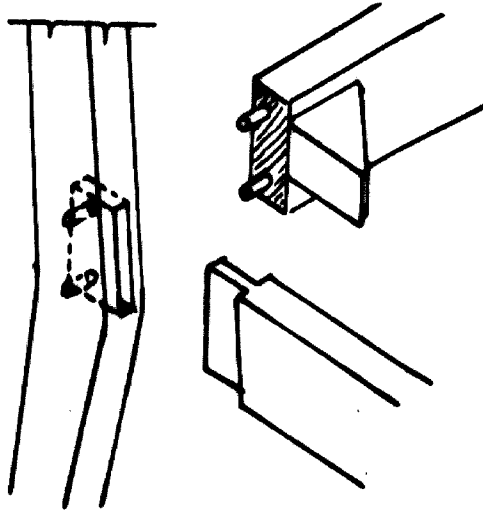


DOWEL BASE

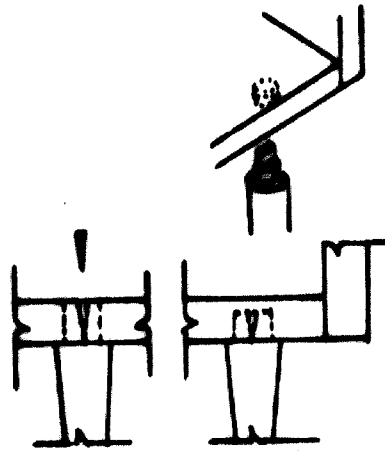


MITER SEAT BOARD

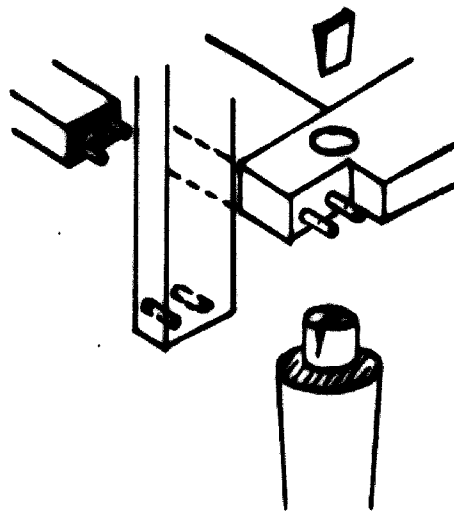
FIGURE 18. JOINING LEGS TO FURNITURE



2-WAY JOINT. CHAIR LEGS TO RAILS



WEDGE AND DOVETAIL JOINT.



JOINING LEGS TO UPHOLSTERED FURN.

FIGURE 19. DRAWER CONSTRUCTION.

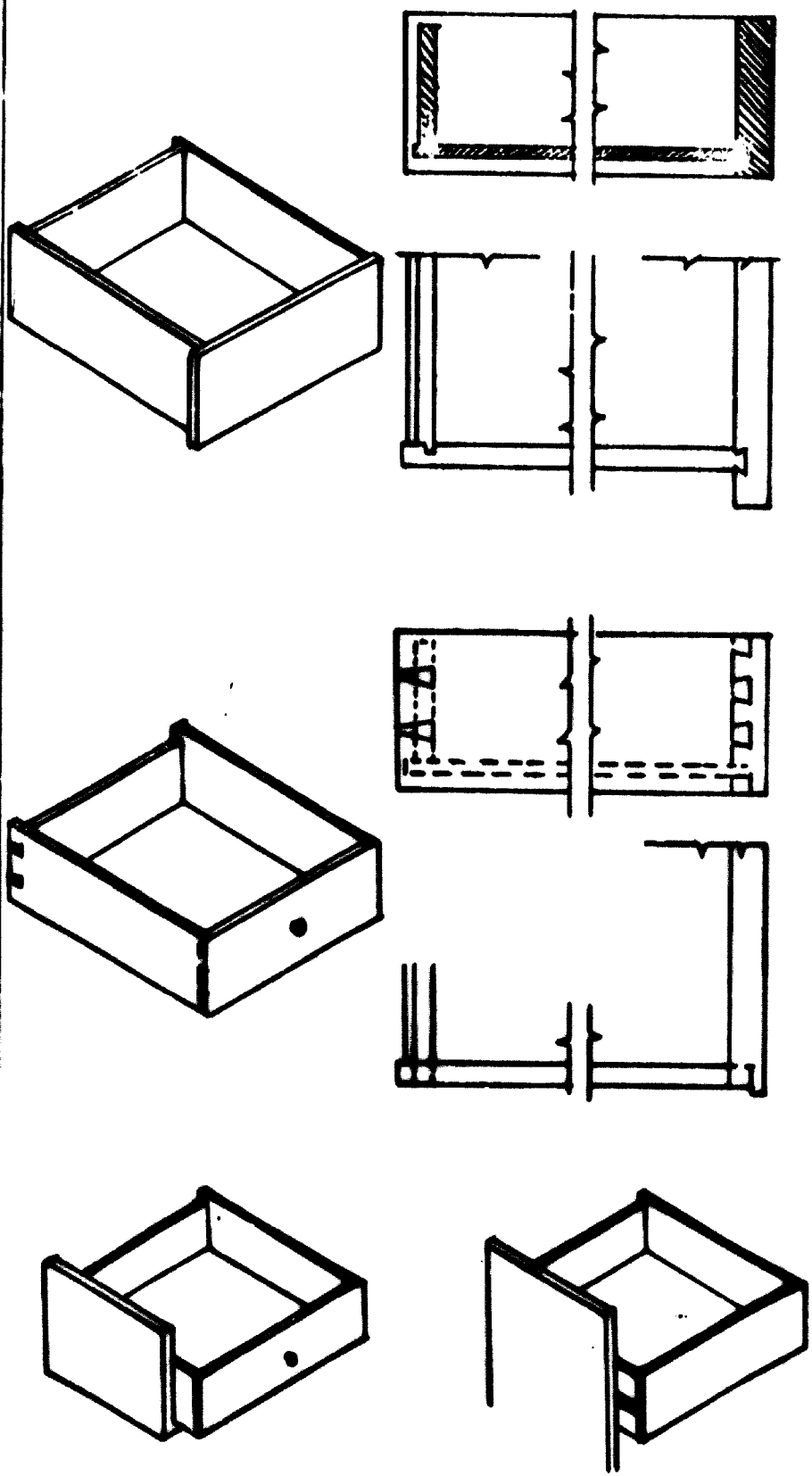
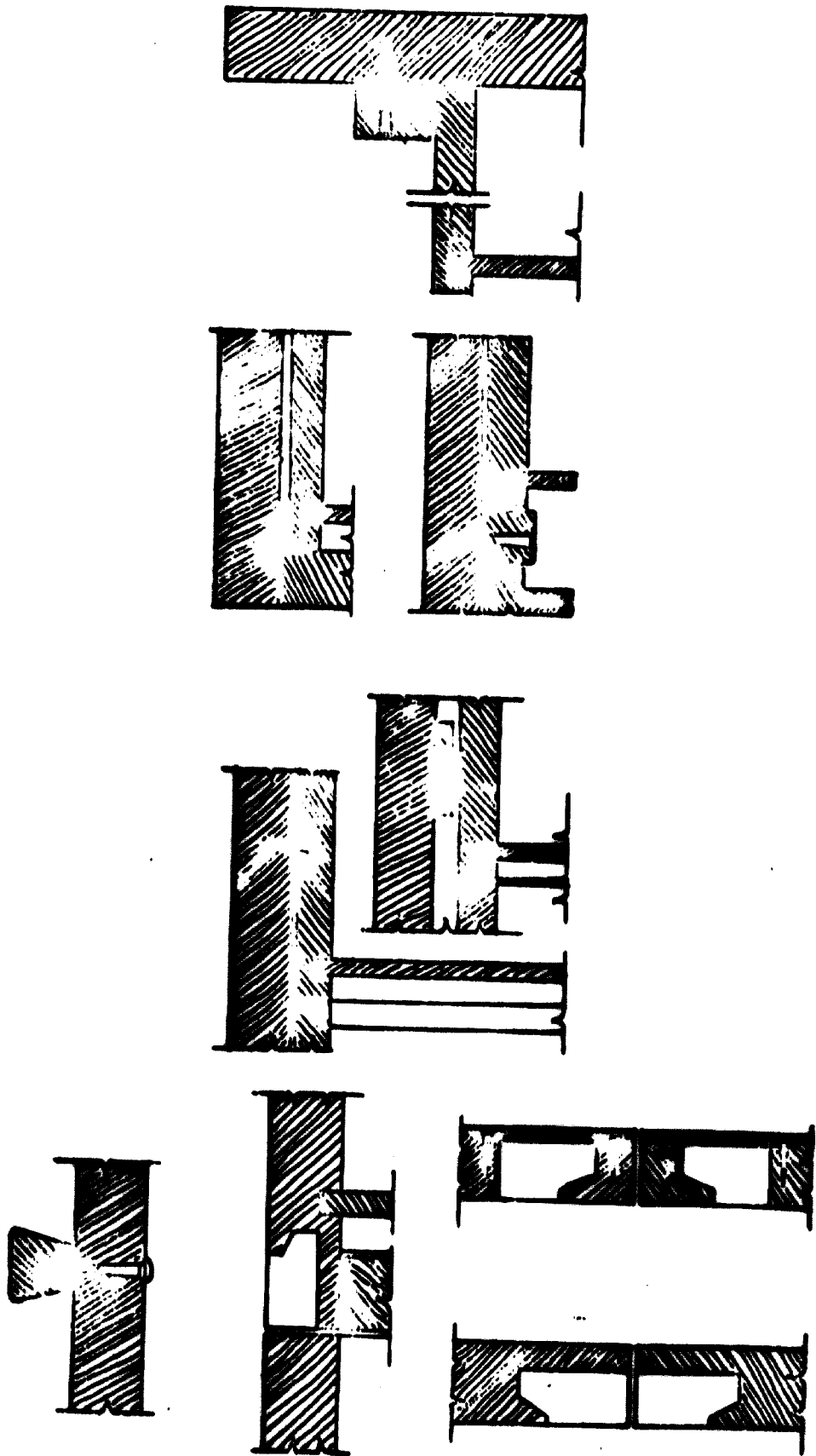


FIGURE 20. DRAWER DETAILS



DRAWER ASSEMBLY

FIGURE 24. EDGE TREATMENT



PAINTING.



VENEER BANDING.



SOLID EDGE.



TONGUED, FRAMED & GROOVED.



EDGE TONGUE.



BEVELLED EDGE & GROOVED FORM.



MITRED EDGE.



L. IN WOOD STRIP.



BACK TO BACK.

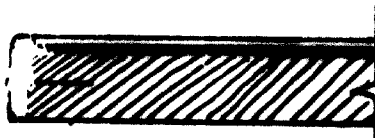


FABRIC STRETCHED
OVER FRAME.

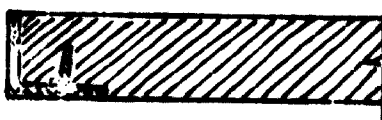
L.S. FASTENING FABRIC TO CORNER.



1.



2.



3.



4.

FIXING METAL OR PLASTIC CORNER.

AREA 20. EXTENSIVE SHOWING TYPICAL CROSS SECTIONS OF
FINISH DRAW

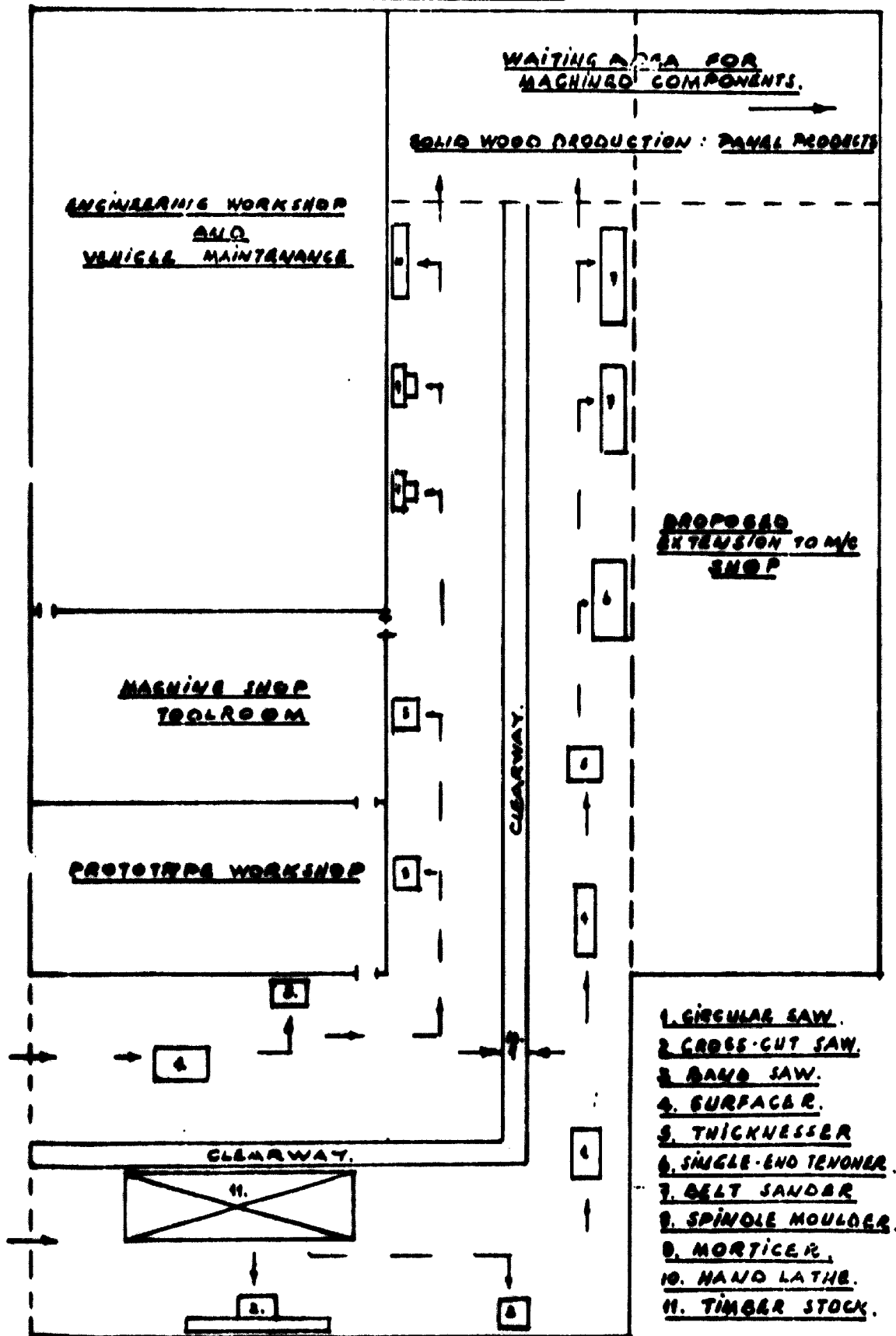


NOT TO SCALE

FIGURE 23. BAP STAFF OF WORK PROGRAMS, SEPT. 1978 - FEB. 1979

ACTIVITIES	MONTHS				
	SEP.	OCT.	NOV.	DEC.	JAN.
1. Implementation of expert's recommendations (C)					
2. Execution of structural alterations (C)					
3. Establishment of new management structure (C)					
4. Completion of selected new models (C)					
5. Temporary installation of some new machines (C)					
6. Providing benches and vices for carpenters (C)					
7. Placing orders for new machines (C)					
8. Preparation of detailed layout (E)					
9. Preparation of working drawings and specifications (E)					
10. Location of sources for new materials (E)					
11. Planning new joinery factory (E)					
12. Period of third stage of project					
13. Continuation of new product development (C,E)					
14. Establishment of management systems and procedures (C,E)					
15. Establishment of drawing office and prototype work shop (C,E)					
16. Establishment of plant training programs (C,E)					
17. Establishment of machine setting up and main prog. (C,E)					
18. Commissioning of new machines and equipment (C,E)					
19. Establishment of procedures for quality control & safety (C,E)					
20. Preparation of programs for stage IV of project (E)					
C: To be carried out by Corporation E: To be carried out by expert.					

FIGURE 24: TEMPORARY RE-LAYOUT OF
MACHINE SHOP NO. 2



SCALE 1:200

Table 1 DEPARTEMENTAL AREA REQUIREMENTS

No.	DEPARTMENT	Existing		Proposed	
		M ²	Sec.	M ²	Sec.
1	Timber storage	754	1	754	1
2	Timber storage	2846.50	1	1898	1
3	Plywood, particle board storage	200	2	326	1
4	Veneer store	-		81	1
5	Adhesives, nails, screws etc.	56.25	2	84.375	1
6	Timber yard office	-	-	72	1
7	Administrative offices	279.875	4	340.75	3
8	Electrical workshop	17.50	1	45	1
9	Crafts workshop	55.625	2	152	1
10	Timber drying kilns	-	-	75	1
11	Blacksmiths shop	50	1	116	1
12	Engineering workshop	79.625	1	181.25	1
13	Vehicle maintenance	-	-	181.25	1
14	Machine shop tool room	-	-	116	1
15	Prototype workshop	-	-	116	1
16	Machine shops	1159.25	3	1279	2
17	Machined components store	59.50	2	161.25	1
18	Carpenters workshops	977	3	1031	1
19	Trainee carpenter workshop	-	-	206.25	1
20	Upholstery workshop	253.50	3	337.5	1
21	Fittings store	56.25	2	35.625	1
22	Polishing shop	84.75	1	234.5	1
23	Lacquer and polishing materials store	81	1	44	1
24	Final assembly	-	-	132	1
25	Finished goods store and dispatch.	571.25	1	429	1
26	Upholstery materials store	100	1	100	1
Totals		6927.875	32	8529.5	29

Table 2 - ANALYSIS OF EXISTING MACHINERY & EQUIPMENT

M/U NO.	MACHINE	MAKE & ORIGINAL	LIGHT DUTY	HEAVY DUTY	CONDITION	SUITABLE FOR JOINERY FURN.	
1.	Circular saw	Smith, U.K.		X	Good	X	
2.	Wide table surface	Unknown	X		Good	X	X
3.	Manor table surfacer	Unknown	X		Poor		X
4.	Circular saw	Wadkin, U.K.		X	Fair	X	X
5.	Combined X-cut and surfacer	Dominion, U.K.		X	Fair	X	X
6.	Wide table surfacer	Unknown		X	Good	X	X
7.	Thickness planer	Unknown		X	Fair	X	
8.	Single end tenoner	Unknown		X	Fair	X	
9.	Combined surfacer/ thicknesser	Unknown		X	Poor	X	X
10.	Wide table surfacer	Unknown		X	Fair	X	
11.	Spindle moulder	Unknown		X	Good	X	X
12.	Band-saw	Dominion U.K.		X	Good	X	X
13.	Cutter grinder & sharpener	Bursgreen, U.K.		X	Poor	X	X
14.	Chisel morticer	Wadkin, U.K.		X	Good	X	
15.	Small surfacer	Dominion, U.K.	X		Good		X
16.	Thickness planer	Unknown		X	Fair		X
17.	Hand lathe	Wadkin, U.K.	X	X	Poor		X
18.	Bandsaw sharpener	Robinson U.K.		X	Fair		
19.	Chain and chisel morticer	Unknown		X	Good	X	
20.	Spindle moulder	Dominion, U.K.		X	Fair	X	
21.	Universal woodworker	Dominion, U.K.		X	Good	X	
22.	Combined surfacer and spindle moulder	I.M.A., Italy		X	Good	X	X
23.	Band-saw	Robinson		X	Good	X	X
24.	X-cut and surfacer	Unknown		X	Poor	X	
25.	Circular saw	Sagar, U.K.		X	Poor	X	
26.	Combined saw and surfacer	Wilson, U.K.		X	Poor	X	

Table 3 - ANALYSIS OF MACHINERY & EQUIPMENT RECENTLY PURCHASED

H/C No.	MACHINE	QTY.	MAKE	LIGHT DUTY	HEAVY DUTY	SUIT. JOINT.	FOR. FORN.	BOAT. BUTLD.
27.	26" circular saw	1	Kasto, Italy	X			X	X
28.	Vibrating head chisel mortiser	3	Wadkin, U.K.		X	X		
29.	Glus spreader	1	Amstrub, Denmark	X		X	X	
30.	Bandsaw welding units	2	Fulgor, U.K.			X	X	
31.	Automatic bandsaw grinder	2	Loroch, FRG		X	X	X	X
4.	Automatic hot press	1	Italy		X	X	X	
5.	Bandsaw	3	Wadkin, U.K.		X	X	X	X
6.	Dovetailing machine	1	Brookman, U.K.	X			X	
7.	Electro hydraulic frame press	1	Maweg, FRG		X	X		
8.	Tool grinder	2	Burgreen, U.K.		X	X	X	X
9.	E.C.A. single end tenoner	2	Wadkin, U.K.		X	X		
10.	Band resaw	1	Stenner, U.K.		X	X		X
11.	16" Radial arm saw	2	Wadkin, U.K.		X	X	X	X
12.	Vertical spindle moulder	2	Wadkin, U.K.		X	X	X	
13.	Corner locking attachment	2	Wadkin, U.K.		X	X	X	
14.	Thicknesser	3	Wadkin, U.K.		X	X	X	X
15.	24" radial arm saw	2	Wadkin, U.K.		X	X	X	X
16.	26" saw bend	1	Wadkin, U.K.		X	X	X	X
17.	20" saw bend	2	Wadkin, U.K.		X	X	X	
18.	Surfacer planers	3	Wadkin, U.K.		X	X	X	
19.	Belt sanding machines	3	Wadkin, U.K.		X	X	X	
20.	Universal cold press	1	Schubert, U.K.		X	X	X	

Table 4. Schedule of total machinery requirement for furniture factory

Key: L : Labourers; SK: Skilled Worker; SH: Semi-Skilled Worker; W: Wasting; R: Recently Purchased; P: Requires to be Purchased

Code	Operation	Machinery Requirements	Qty		Value	
			1	2	1	2
1	Timber stacking	Manually		3		
1.1	Timber drying and conditioning	Drying kiln Brick or concrete construction Automatic controls capacity 10 m ³ each	5	2	1	X
1.2	Cross-cutting	Overhead cross-cut saw Roller table with pneumatically controlled length stops	1	3	1	X
1.3	Edging	Circular saw Single-sided, with automatic feed	2	2	2	X X
1.4	Ripping	Saw bench with fence	1	1	1	X X
1.5	Band sawing (small)	Band saw Saw wheels ϕ 630 mm.	1		1	X X
1.6	Band sawing (large)	Band saw Saw wheels ϕ 800 mm.	1		1	X X
1.7	Planing and thicknessing	Surface Working width 510 mm.	1	1	1	X X

Code	Type of Production	Operations	Machinery Specifications	Qty	Labour				Availability		
					L	SK	S.SK	EM	F	RP	
1.9		Flaming and thickening	Circular saw Working width 630 mm.	1	1	1		X		X	
1.2		Length dimensioning	Circular saw Roller table Saw angle to 45°	2	2	2		X		X	
1.10		Wood turning	Wood-turning lathe semi-automatic controls working length 800 mm. Wood turning lathe manual controls working length 800 mm.	1	1	1					X
1.11		Shaping and moulding	Spindle moulder	2	1	1		X		X	
1.12		Dowel boring	Horizontal pneumatic dowel hole boring machine with multi-spindle head	2		1					X
1.13		Porticing and tenoning	Double-ided oscillating slot porticing machine	1		1					X
1.14		Dowel-making	Dowel making machine, capacity approx. 200 to 300 1/4 Dowel cross-cut and chamfering machine	1	1	1					X
1.15		Surface sanding	Over-belt sander Sliding table 2500 x 800 mm. Width of belt 150 mm. Length of belt 7200 mm Table belt sander Width of belt 400 mm. Length of belt 900 mm.	2		1				X	

Type of Construction	Code	Operations	Machinery Specifications	Qty	Labour				Availability				
					I	II	S.O.C.	SK	P	RP			
	1.16	Sanding edges and curves	Vertical belt sander width of belt 120 cm. Bobbin and brush sander	1		1							X
	2												
	2.1	Pre-assembly front and back components	Pneumatic jig and assembly table panel size 3000 x 15 mtr. 2 pressing points	2		2							X
	3												
	3.1	Panel cutting and squaring, plywood and chipboard	Dimension saw with built on wheeled table	1		1							
	3.2	Rolling press	Open stroke press for cold glueing	1		1							
	3.3	Glue lipping for table tops	Multiple edge-lipping machine edge grinding and chamfering, solid edge lipping, edge sanding.	1		1							
	3.4	Butting width and length	Double cross-cut saw saw cost to 450; width according to saws; capacity 2500 x 2500 mm.	1		1							
	3.5	Rebbiting and grooving	Vertical spindle moulder	1		1					X		

Production	Code	Operations	Machinery Specifications	Qty	Labor		Material	
					Man	Machine	Material	Machine
	3.6	Edge sanding	Single-sided edge belt-sanding machine, continuous feed	1		1		X
	3.7	Boring of construction and fitting holes	Heavy construction dowel boring machine. Unit adjustable vertically and horizontally	1	2			
	3.8	Dowel driving	Manually			1		
	3.9	Sanding flat surface (inside and outside)	Open-belt sander Table size 2500 x 600	1	1			X
	3.10	Checking	Work bench	1	1		X	
	4							
	4.1	Selection of veneer	Locally made table Rack Trolley	1	2	1	X	
	4.2	Cross-cutting	Over-head cross-cut with fine saw	1	1		X	
	4.3	Veneer jointing	Veneer clipper Cutting length 3100 mm. Double cutting device	1	1			X
	4.4	Veneer splicing	Veneer splicing machine, zig-zag method, outreach 1150.	1	1			X
	4.5	Checking	Locally-made checking table, illuminated	1	1		X	

Type of Production	code	Operations	Machinery Specifications	Qty	Labor			Availability		
					L	SK	OKK	SK	P	TP
<u>Surface Treatment</u>	5.1	Spraying base coat and finishing coat (flats and edges)	Water wash spray booth with turn-table, working width 2500 mm.	2	1	1				X
	5.2	Intermediate sanding	Manually. Work benches	2				X		
	5.3	Staining and drying	Manually. Work benches	2				X		
	5.4	De-rubbing	Manually. Work benches	2				X		
	5.5	Drying	Lacquar drying in rack type trolleys locally made	6				X		
	5.6	De-rubbing	Manually. Work benches	2				X		
<u>Full carcass assembly</u>	6.1	Pre-assembly carcass components: sides, bottom, s base and frames.	Locally made pre-assembly bench and hand tools Table size 2000 x 500 mm.	2	1	2			X	
	6.2	Glue application and carcass assembly press	Pneumatic carcass press, mechanized, adjustable glue application with glue gun size 2600 x 600 mm.	1	1	1				X
	6.3	Pre-assembly of drawers	Pneumatic glueing press and pre-assembly table and electric tools Table size 1600 x 500 mm.	1 1			2			X

Type of Production	Code	Operations	Machinery Specifications	Qty			Jobs			Specialization			
				1	2	3	1	2	3	1	2	3	
	6.4	Drawer fitting	Manually, with locally made assembly bench hand tools	1									
	6.5	Door pre-assembly	Manually with locally made pre-assembly bench hand tools Table size 2000 x 600 mm.	2	1			2					
	6.6	Door fitting	Manually, with locally made assembly bench hand tools and electric tools	2				2					
	6.7	Fitting of shelves and other components	Manually, with locally made assembly benches hand and electric tools	2				2				X	
	6.8	Inspection	Inspection table hand tools	1				1				X	
	7.1	Pre-assembly of carcass components: sides, bottoms, intermediate vertical members, shelves	Manually with locally made pre-assembly benches Electric tools and automatic screwdriver Table size 2400 x 900 mm.	2	1	1							X
7.2	Carcass Assembly	Manually on sliding bench made locally hand tools length of sliding assembly bench 10 m.	1	1									X

Carcass Assembly

Type of Production	Code	Operations	Machinery Specifications	Qty	Labour			Availability			
					M	HT	TL	SM	F	OT	
	7.3	Pre-Assembly of drawers	Pneumatic gluing press pre-assembly bench and electric tools Bench size 1000 x 600 mm.	2	1		2				
	7.4	Drawer Fitting	Manually on assembly bench Hand tools	1		1		X			
	7.5	Doors pre-assembly	Manually, with locally made assembly bench Hand tools Table size 2400 x 600 mm.	2		2		X			
	7.6	Door fitting	Manually, with locally made assembly bench	1		1		X			
	7.7	Fitting of shelves	Manually, with locally made assembly bench Hand tools	1		1		X			
	7.8	Inspection	Locally made assembly bench	1		1		X			
	3.										
	3.1	Assembly of chairs and other seating frames Glue application Chair levelling and trimming	Pneumatic chair cramp Plastic bottle Manually, and with small circular saw	1	1	1			X		X

Final assembly

Type of Production	Code	Operations	Machinery Specifications	Qty		Labour				Availability												
				I	II	I	II	III	IV	V	VI											
Subcontracting	9																					
	9.1												Fabric Storage	Locally made storage racks	10	1					X	
	9.2												Fabric Transport	Locally made trolleys	6	1					X	
	9.3												Fabric cutting	Locally made cutting table with roller type overhead fabric roll conveyor Area of table is 1.5m.	1						X	
	9.4												Foam Cutting	Foam cutting machine	1		1					
													Cushion rounding	Rounding disc or cutter	1		1					
													Foam Shredding	Foam shredding machine	1		1					
	9.5												Foam Glueing	Spary gun and exhaust hood	1		1					
	9.6												Fabric Sewing	Industrial Sewing machines with appropriate fittings	4		4					
	9.7												Upholstery assembly	Locally made upholstery benches Stapling guns Hand tools	6 8		8					X
Internal Transport	10	In-department and inter-department transport of raw materials work in progress and finished goods	Work lift truck Hand lift truck with pallets Flat bed trolleys with rubber wheeled castors Locally made trolleys	1 4 10 10																		
	10.1													X	X	X	X	X				

X - Masters only

Table 5 - Specification of additional machinery for furniture production

No.	MACHINE	QTY	SPECIFICATION
1.	Drying kiln	3	Brick or concrete construction automatic controls capacity 18 m ³ each
2.	Wood turning lathe	1	Semi automatic controls working length 800 mm
3.	Wood turning lathe	1	Manual controls Working length 800 mm
4.	Horizontal pneumatic dovell borer	1	With multi-spindle head 6 and 8 mm bits
5.	Double sided oscillating mortising machine	1	With 6 and 8 mm bits
6.	Single-end tenoning	1	Capable of rounding tenons with 6 and 8 mm
7.	Dowel-making machine	1	Capacity approximately 200 to 300n/hr
8.	Dovell cross out and chamfering machine	1	
9.	Table belt sander		Width of belt 400 mm Length of belt 900 mm
10.	Vertical belt sander	1	Width of belt 120 mm
11.	Bebbin and brush sander	1	
12.	Pneumatic jig and assembly table	2	Panel size 3000 X 15 mm 2 pressing points
13.	Dimension saw	1	Having built on wheeled-table
14.	Single sided edge lipping machine	1	Edge trimming and chamfering edge sanding solid edge lipping
15.	Double cross-out saw	1	Saw gant to 45° scoring saws capacity 2500 X 2500
16.	Single-sided edge belt sanding machine	1	Continuous feed
17.	Heavy construction dovell borer	2	Unit adjustable vertically & horizontally minus of spindle 19.

No	MACHINE	QTY	SPECIFICATION
18.	Veneer clipper	1	Cutting length 3100 mm Double cutting device
19.	Veneer splicer	1	Zig-sag method outreach 1150 mm
20.	Water-wash spray booth	2	With turn-table Working width 2500 mm - 6 spray guns
21.	Glue application and veneer assembly press	1	Mechanized Adjustable glue application with gun size 2600 X 600 mm
22.	Pneumatic glueing press	1	Pre-assembly table Table size 1600 X 600 mm
23.	Drawer assembly press	1	Pneumatic Adjustable
24.	Chair cramp	1	Pneumatic Adjustable
25.	Foam cutting machine	1	
26.	Foam rounding disc or cutter	1	
27.	Foam shredder	1	
28.	Glue application	1	Spray gun Exhaust wall
29.	Industrial sewing machines	4	Suitable for heavy and light duty upholstery fabrics appropriate attachments
30.	Fabric cutting knives	2	
31.	Fork lift truck	1	Suitable for furniture factory
32.	Hand lift truck	4	
33.	Dust extraction system		To exhaust all machines in supplied lay-out Fitted with ducting, exhaust fans & cyclone
34.	Compressor	2	To be specified after calculation of compressed air requirements
35.	Air tankers	6	
36.	Dust extraction system		Connections to each machine according to supplied lay out and fitted with ducting, exhaust fans and cyclone.

Table 5. Production programme (see figure 6 - 15)

Model	Code No.	Batch size	Units/daily production
<u>Bedroom</u>			
Wardrobe 'A' (with mirror)	WRA	25	15
Wardrobe 'B' (fitted)	WRB	25	15
Wardrobe 'C' (unfitted)	WRC	25	15
Continental headboard	CHB	50	30
Dressing table 'B' (drawers & doors)	DTB	25	15
Dressing stool	DS	100	50
Dressing table 'A' (drawers only)	DTA	25	15
Five-drawer chest	OD 5	50	25
Four-drawer chest	OD 4	50	30
Beside cabinet	BC	100	30
<u>Dining-room</u>			
Dining table 'A'	DFA	25	10
Dining table 'B'	DFB	25	10
Dining table 'C'	DFC	25	10
Dining chair 'A'	DCA	100	50
Sideboard 'A'	SBA	25	15
Sideboard 'B'	SBB	25	15
Sideboard 'T'	SBT	25	12
<u>Living room</u>			
Three-seater settee	3S	50	20
Two-seater settee	2S	50	20
Easy chair	EC	100	20
Coffee table 'A'	CTA	50	25
Nest of tables	NT	50	15
Base unit 'A'	BUA	50	50
Base unit 'B'	BUB	50	50
Base unit 'C'	BUC	50	50

Model	Code No.	Batch size	Units/daily production
Top unit 'A'	TUA	50	50
Top Unit 'B'	TUB	50	50
Top unit 'C'	TUC	50	50
Bookcase	BC	50	25
Unit occasional table	UT	50	30
<u>Kitchen</u>			
Floor unit 42"	FU 42	50	25
Floor unit 21"	FU 21	50	25
Floor unit 63"	FU 63	50	20
Wall unit 42"	WU 42	50	30
Wall unit 21"	WU 21	50	40
Wall unit 63"	WU 63	50	25
Broom cupboard	BCU	25	20

Table 6. Furniture range - quantity analysis of raw material

Model	Thickness 12 mm (1/2 inch)			Solid wood - waste 60%			Chipboard - waste 12%			Veneer			waste 15%															
	19 mm (3/4 inch)			25 mm (1 inch)			50 mm (2 inch)			12 mm (1/2 inch)			16 mm (5/8 inch)			19 mm (3/4 inch)			Face			Back						
	Input net ₃	Input gross ₃	Input net ₃	Input gross ₃	Input net ₃	Input gross ₃	Input net ₃	Input gross ₃	Input net ₃	Input gross ₃	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂	Input net ₂	Input gross ₂		
1. (a) Chest of drawers/5 drawers	-	-	0.0264	0.0328	0.0084	0.0134	-	-	-	-	-	-	1.7524	1.9627	-	-	1.9000	2.1850	-	-	1.6000	1.8400	-	-	1.6000	1.8400		
(b) Chest of drawers/4 drawers	-	-	0.0123	0.0168	0.0076	0.0122	-	-	-	-	-	-	1.5196	1.7020	-	-	1.7020	1.9573	-	-	1.4331	1.6481	-	-	1.4331	1.6481		
2. Dressing table	-	-	0.0105	0.0168	0.0162	0.0163	0.0032	0.0051	-	-	-	-	2.6906	3.0135	-	-	2.2691	2.6095	-	-	1.9606	2.2547	-	-	1.9606	2.2547		
3. Wardrobe (18' fitted)	0.0013	0.0021	-	-	0.0037	0.0059	-	-	-	-	-	-	2.9957	3.3552	0.0479	0.0536	5.6948	6.5490	3.3105	3.8071	2.9868	3.4348	3.3105	3.8071	2.9868	3.4348		
4. LRF base/units	0.0007	0.0011	0.0097	0.0155	0.0070	0.0112	-	-	-	-	-	-	2.4748	2.7718	-	-	3.105	3.8071	3.105	3.8071	2.9868	3.4348	3.105	3.8071	2.9868	3.4348		
5. LRF top/units	0.0016	0.0028	0.0039	0.0062	0.0033	0.0053	-	-	-	-	-	-	1.8242	2.0431	-	-	2.2399	2.5759	2.2399	2.5759	2.0324	2.3371	2.2399	2.5759	2.0324	2.3371		
6. BRF/wardrobe	0.0024	0.0038	0.0002	0.0003	0.0067	0.0107	-	-	-	-	-	-	0.8216	0.9292	5.0370	5.6414	6.6988	7.7038	6.6988	7.7038	6.2244	7.1581	6.6988	7.7038	6.2244	7.1581		
7. BRF/bedside cupboard	-	-	0.0005	0.0008	0.0038	0.0061	-	-	-	-	-	-	1.8277	1.1510	-	-	1.0048	1.1555	1.0048	1.1555	0.9798	1.1268	1.0048	1.1555	0.9798	1.1268		
8. BRF/bed head with fixed cupboard	-	-	0.0033	0.0053	0.0009	0.0110	0.0023	0.0037	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
9. DRF/dining table extendable	-	-	0.0007	0.0011	0.0140	0.0224	0.0082	0.0131	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10. LRF/sideboard	-	-	0.011	0.0176	0.0145	0.0232	0.0027	0.0043	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
11. DRF/drop-leaf dining table	0.0004	0.0006	-	-	0.0055	0.0088	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12. DRF/circular dining table	-	-	0.0112	0.0179	0.0039	0.0062	0.0049	0.0078	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
13. LRF/tall sideboard	0.0011	0.0017	0.0007	0.0011	0.0022	0.0035	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
14. BRF/dressing stool	-	-	0.0006	0.0009	0.0046	0.0073	0.0026	0.0041	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
15. Bookcase	-	-	0.0009	0.0014	0.0071	0.0113	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
16. LRF/coffee table	-	-	0.0038	0.0060	0.0056	0.0089	0.0026	0.0041	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
17. Nest of tables	-	-	0.0008	0.0012	0.0025	0.0040	0.0110	0.0178	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
18. DRF/dining chair	-	-	0.0166	0.0265	0.0063	0.0100	0.0110	0.0178	0.0075	0.0049	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0078	0.0120	0.0078	0.0120	0.0088	0.0075	0.0120	0.0088	0.0075	0.0120	
19. KF/kitchen cupboards/model	0.0016	0.0025	0.0055	0.0088	0.0029	0.0048	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
20. KF/kitchen cupboard/model	0.0005	0.0008	0.0078	0.0121	0.0073	0.0116	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
21. KF/kitchen cupboards/model	-	-	0.0075	0.0120	0.0073	0.0116	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
22. KF/kitchen cupboards/model	-	-	0.0006	0.0009	0.0021	0.0033	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
23. FF/wall cupboards/model	-	-	0.0032	0.0051	0.0012	0.0019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
24. KF/brush, brush cupboard	-	-	-	-	0.0010	0.0016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
25. BRF/wardrobe with mirror	-	-	-	-	0.1180	0.1888	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
26. Easy chair, 2 and 3 seater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
total input (gross)		0.0152		0.2100		0.4211		0.0677		0.36410		50.4114		17.7195		82.0262		79.4954		885.8830		858.5503		885.8830		858.5503		
		Ft ³		Ft ³		Ft ³		Ft ³		Ft ²		Ft ²		Ft ²		Ft ²		Ft ²		Ft ²		Ft ²		Ft ²		Ft ²		
		9.5366		7.4130		14.8648		2.3898		39.3228		544.4431		191.3706		885.8830		858.5503		885.8830		858.5503		885.8830		858.5503		

Table 8. Material costs calculation sheet

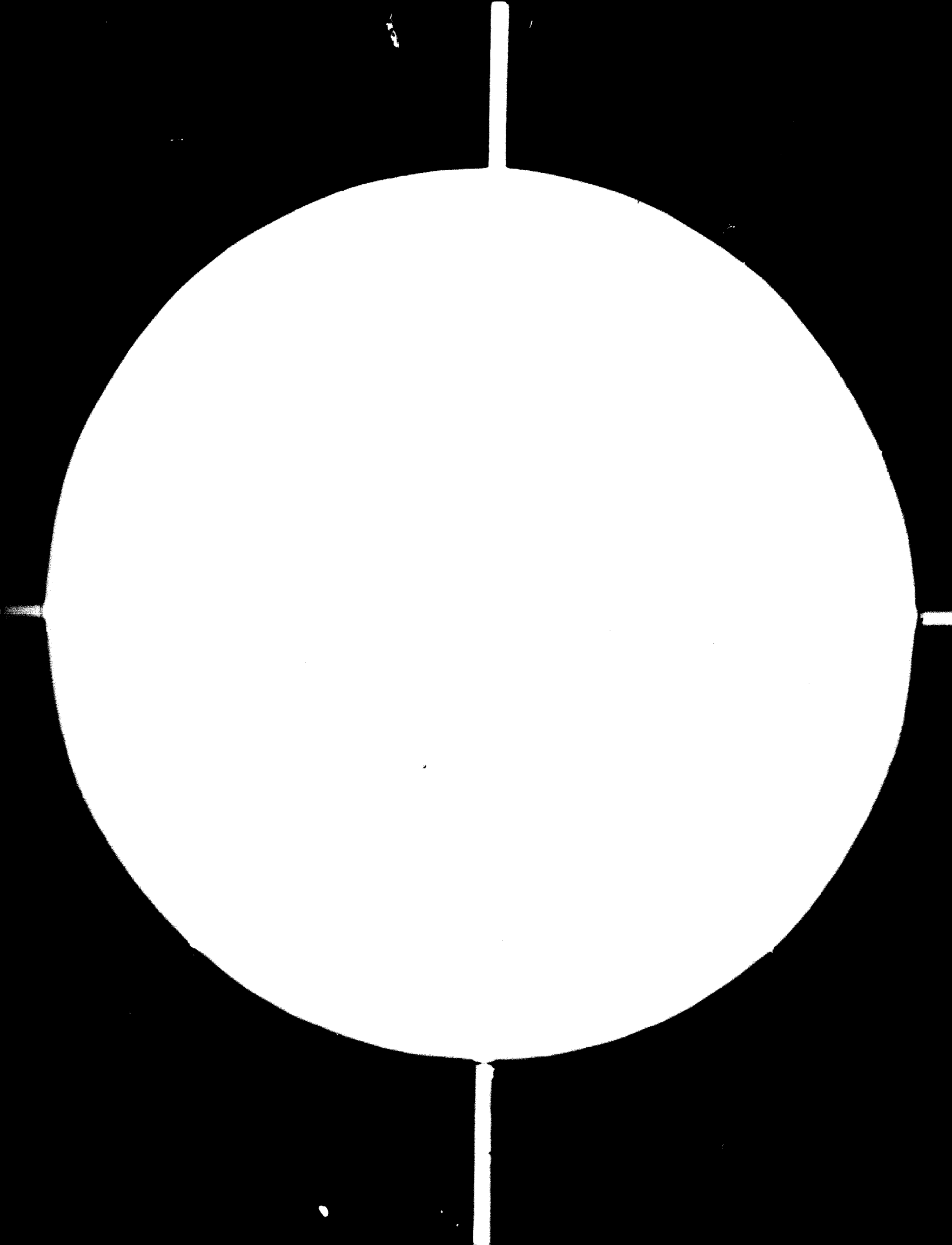
MODEL	DRAWING	CODE NO.	DATE

No.	MATERIAL	QUANTITY	DINAR UNIT PRICE	VALUE
1.	Solid wood 12 mm - class III 19 mm - class II 25 mm - class II			
2.	Composite boards particle board 16 mm " " 19 mm plywood - 3 ply 4 ply 6 ply hardboard			
3.	Veneers Face Back			
4.	Plastic laminates			
5.	Fittings Handles Hinges - 50 mm Locks - castors			
6.	Adhesives			
7.	Bezele 6 mm 8 mm			
8.	Screws 30 mm No.9 10 mm No.4			
9.	Nails 25 mm 40 mm			
10.	Pins			
11.	Staples			
12.	Foams			
13.	Springs			
14.	Velting			

B - 6

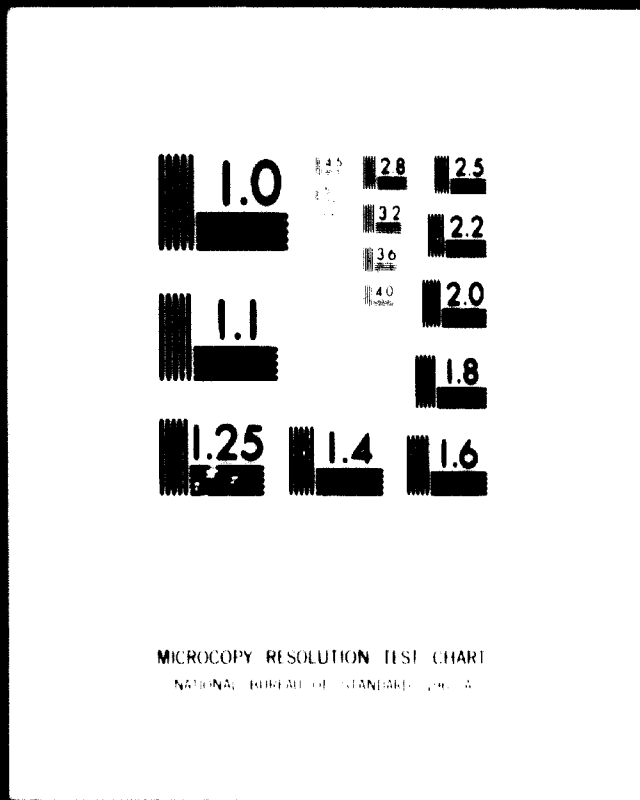


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2 OF 2

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No.	MATERIAL	QUANTITY	BIBAR UNIT PRICE	VALUE
15.	Upholstery covers			
16.	Stains			
17.	Sealers			
18.	Lacquers			
19.	Miscellaneous thinners			
20.	Oils			
21.	Belts			
	TOTAL MATERIALS COST			

Table 9e Labour cost calculation sheet - solid wood floor

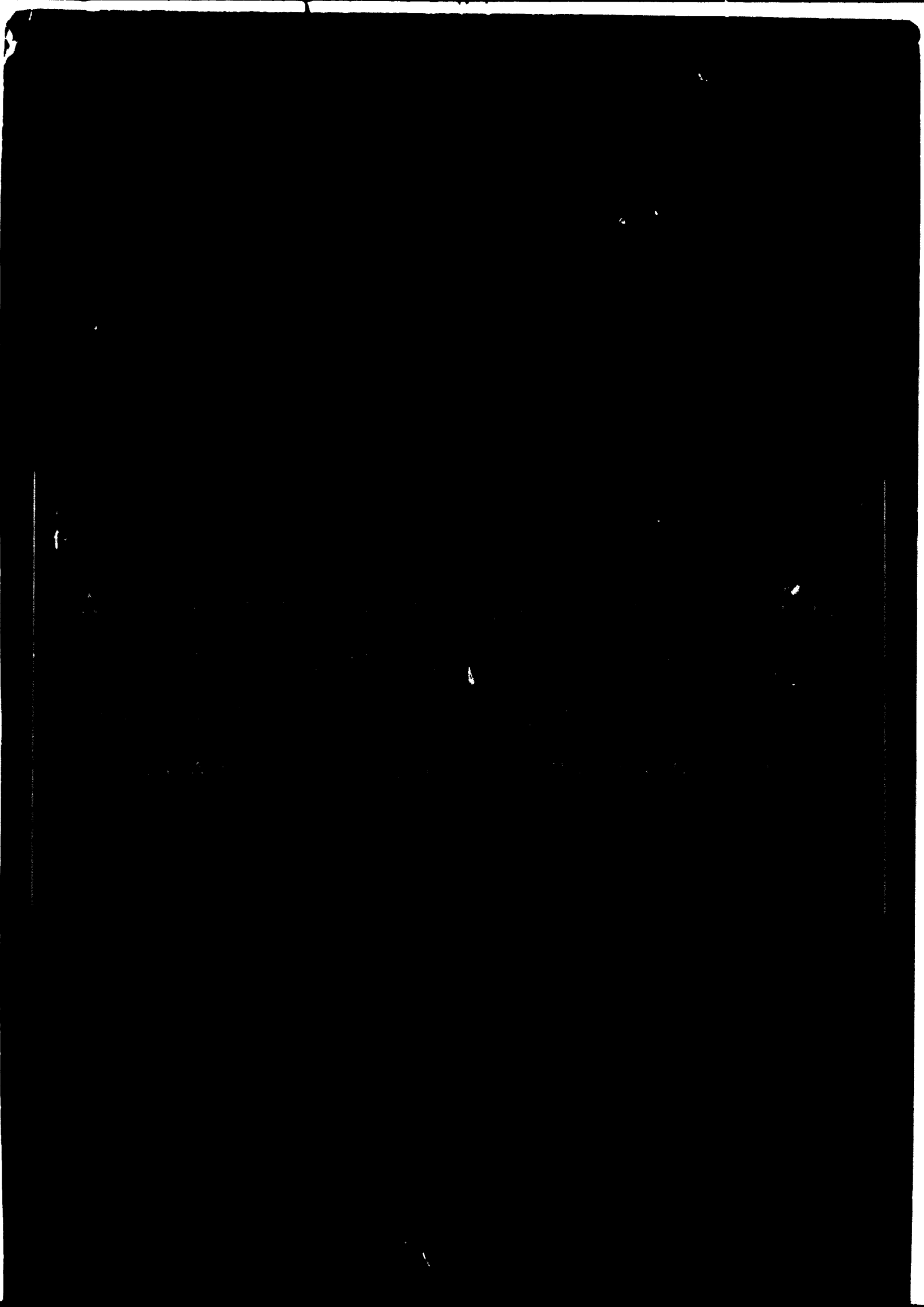
MODEL		DRAWING NO.	CODE NO.			DATE				
OP NO.	OPERATION	MACHINE	W/C NO.	MACHINE COSTS			LABOUR COSTS			TOTAL
				RATE/HR	QTY. HRS	COST	SK. RATE	S.S. RATE	COST	
1.	Kilning	Kiln								
2.	Cross-cutting	Cross-cut saw								
3.	Edging/splitting	Circular saw								
4.	Surfacing	Surfacer								
5.	Thicknessing	Thicknesser								
6.	Shaping	Shaper								
7.	Length	Double x/cut								
8.	Turning/sanding	Lathe No. 1								
9.	Turning/sanding	" " 2								
10.	Shaper / moulding	Spindle No.1								
11.	Tranching grooving	Spindle No.2								
12.	Mortising	Morticer								
13.	Tenoning	Tenoner								
14.	Dowel boring	Borer								
15.	Surface sanding	Belt sander								
16.	Edge profile sanding	Profile sander								
17.	Sub-assembly	Cramping table								
18.	Final-assembly	Cramping table								
19.	Inspection	Visual								

Table 10. Labour cost calculation sheet - panel floor

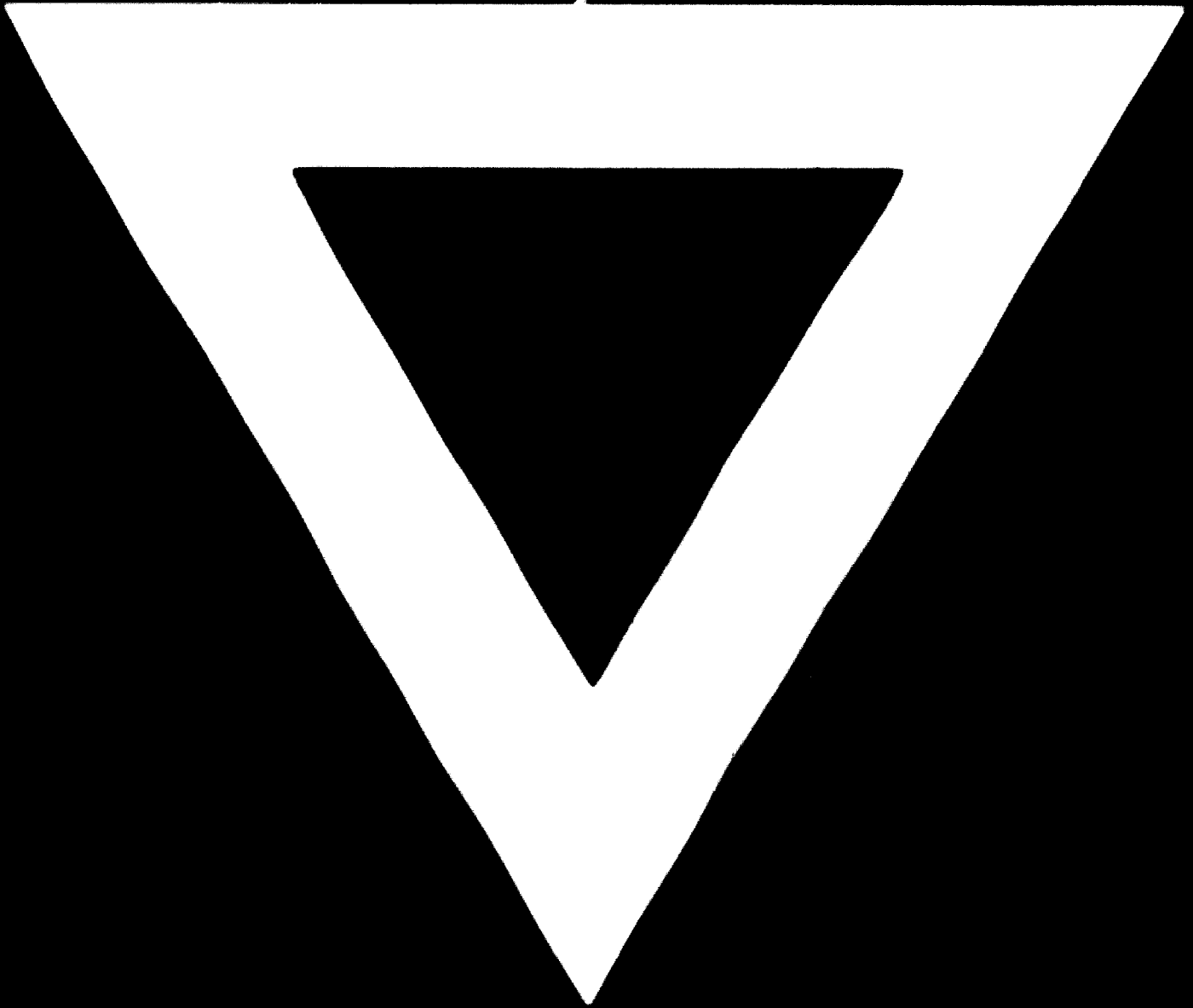
MODEL		DRAWING NO.	CODE NO.		DATE				
OP. NO.	OPERATION	MACHINE	N/C NO.	MACHINE COSTS			LABOUR COSTS		TOTAL
				RATE/HR	TOT. HRS	COST	SK. RATE	S. SK. RATE	
1.	Panel break-down	Panel saw							
2.	Veneering	Glue spreader Veneer press							
3.	Dimensioning	Double cut-off							
4.	Edge Veneering	Edge ripper							
5.	Dimensioning	Panel saw							
6.	Boring	Multiple borer							
7.	Dowelling	Manual							
8.	Sanding face	Belt sander							
9.	Sanding inside	Belt sander							
10.	Fittings insertion	Manually							
11.	Sub. assembly	Manually							
12.	Fine sanding	Manually							
13.	Final assembly	Manually							
14.	Drawer assembly	Pneumatic press							
15.	Door hingeing	Manually							
16.	Shelving	Manually							
17.	Minor fitting	Manually							
18.	Inspection	Visual							

Table 11. Labour cost calculation sheet - surface finishing and upholstery

Model		Drawing		Code No.		Date	
OP NO	Operation	Machine N/C NO	Machine costs		Labour costs		
			RATE/HR	TOT. HRS	COST	SK. RATE	S. SK. R.
<u>Surface finishing</u>							
1.	Sanding sealer	Spray guns					
2.	De-risbing	Manually					
3.	Staining	Spray guns manually					
	Dusting/Sanding	Manually					
5.	Base coat	Spray guns					
6.	Drying	Racks					
7.	De-risbing	Manually					
8.	Laquering	Spray guns					
9.	Drying	Racks					
10.	Inspection	Visual					
11.	Touching up	Manually					
<u>Upholstery</u>							
1.	Cover marking and cutting	Manually					
2.	Cover sewing	Sewing machines					
3.	Springing	Manually					
4.	Upholstery	Manually (Staple Gun)					
5.	Cushion filling	Manually					
6.	Cushion closing	Manually					
7.	Loose seat upholstery	Press and stapling gun					



B - 6



79.11.12