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ADVISORY SERVICES TO PREPARE A PROGRAMME FOR THE DEVELOPMENT OF
A WOOD PROCESSING INDUSTRY IN MATO GROSSO

SI/BRA/86/837/11-01

BRAZIL

Terminal report*

Prepared for the Government of Brazil
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of a UNIDO staff member

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I. INTRODUCTION

As a result of a request made by SENAI, UNIDO sent a staff member of its Agro-based Industries Branch, Antoine V. Bassili, Senior Industrial Development Officer, to Brazil on a three-week mission (from 7 to 26 October 1986).

His terms of reference were:

- 1) To evaluate the state of the art of the wood processing industries of Mato Grosso;
- 2) to evaluate technological and management needs, especially in furniture design and marketing;
- 3) to advise on the needs for international technical assistance, especially on those of UNIDO's competence (based on items 1 and 2);
- 4) to advise SENAI on the contents of training courses, bibliography, methodologies, equipment, etc.;
- 5) to participate in the three-day Round Table Meeting (15 - 17 October 1986);
- 6) to elaborate a report.

II. PRESENT STATE OF THE SECONDARY WOOD PROCESSING INDUSTRY IN MATO GROSSO

During his two-week stay in Cuiabá, the consultant visited three furniture showrooms, exhibiting and selling higher-priced furniture produced in other states of Brazil (Goiana, Rio de Janeiro and states to the South), as well as nine local furniture manufacturers and one joinery producer and a craft operation (which was representative of the majority of the producers of furniture and joinery in the State). He was assured that the furniture producers in Cuiabá were more advanced than those in other towns of Mato Grosso.

All better quality furniture was produced outside Mato Grosso. This appeared in the following aspects: better designs, higher quality inputs (for example upholstery materials, metal trimming); better designs (more innovative, better ergonomically, etc.); and last, but by no means least, higher quality of production (sanding of inside of drawers and inside rails, fitting of drawers, etc.) and of surface finishes.

Most of the production facilities seen in Cuiabá, with one exception, were not real industrial operations producing in series, but small plants operating at a 'mechanized craft' level of technology producing in small batches, hand finishing all the components and assembling and fitting by hand each and every item. The remaining firms visited were jobbing operations, producing to the client's designs on an one-off basis. Numerically, these firms are the minority, the vast majority being small craft enterprises producing using artisanal methods. Even the largest plant in Mato Grosso (the only one producing industrially) is considered to be a medium/small plant by Brazilian standards.

The level of knowledge of wood technology in all plants visited was very limited. All the firms but one (the only one producing industrially) used three most common - well known - species. The exception was using a 'lesser known' species.

With respect to wood drying, only two plants had their own drying kiln, three air dried their lumber, and some others were kiln drying it in a co-operatively owned kiln. It must be stated here that, except for one firm, none possessed electric moisture meters, and even the one who had a meter had not calibrated it over a long time.

All surface finishing except for one jobbing producer) was done with nitrocellulose finishes, and the existing facilities were by and large insufficient (cabins without water curtains and only with a suction fan, no separation between sanding, spraying and drying rooms, poor design of racks for drying, etc.). Sanding was all done by hand, with very little - quasi no - use of hand held pneumatic sanders.

Machines in all factories were locally made and were all of the traditional multi-purpose types. All plants had the same range of machines, only very few had the more advanced ones (eg. double-end tenoners). None of the plants visited had any routers. Multi-spindle boring machines (needed for lowel constructions) were also very rare.

Tool maintenance seemed to be good, poor quality could be attributed to the damp wood.

Jigs - for production and assembly - were used sparingly, and in many instances their precision and safety characteristics were lacking. Dust extraction was lacking in most plants and use of compressed air was more the exception than the rule.

Plant layout and internal transport (pallets) were also sorely lacking, only the larger plant meeting the expectations of modern plant layout. In some plants, the floor was in too poor a condition to permit the use of pallets and their transporter.

Waste was allowed to accumulate, and fire protection was lax.

In the eyes of the industrialists their major problem which they have to face and which hinders their rapid development (in the current sellers' market) is the lack of qualified manpower. Some claimed that the training provided by SENAI to its apprentices was not appropriate. The consultant does not share this opinion if one bears in mind that SENAI trains carpenters in craft operations. He feels that these shortcomings were due to the fact that these apprentices had no industrial experience and too much was expected of them. He felt nevertheless that the real shortcoming in manpower development was the lack of facilities for training machine woodworkers, and, more important, technicians who could assume responsibilities at the middle management level.

III. PRESENT ACTIVITIES OF SENAI IN MATO GROSSO

SENAI, the National Centre for Industrial Training, was founded in 1942 as a private sector body affiliated to the National Federation of Industry. It comprises a National Directorate (co-ordinating the activities of the Regional Directorates in each state), and International Directorate (co-ordinating the international activities) - both located in Brasilia - and Regional Directorates in practically all the states of Brazil.

Because industrial development in the State of Mato Grosso started only recently, the Regional Directorate of SENAI for Mato Grosso was only created in 1972.

It is active in several sectors (metalworking, electrical engineering, woodworking, automotive, graphics, etc.). Its activities in woodworking started in 1979 with the creation of the woodworking school in Cuiabá. This school currently caters to two groups of apprentices who receive a practical-cum-theoretical training as carpenters, together with some basic skills in the utilization of the basic woodworking machines. The course is of a modular concept, apprentices having to complete thirteen tasks, each one consisting of the production of an item of furniture, at increasing levels of sophistication (ranging from a chopping block to a desk with drawers) and involving the use of the complete range of woodworking machines available.

The school has some 25 youngsters attending the course, with three teachers and a headmaster. So far it has limited its activities to the training of apprentices, having offered no training to persons already employed - except for the rare case of paying for the training of individuals to attend special courses outside Mato Grosso.

The teaching material used (booklets) are quite appropriate to the level of the students, being clear and concise. However, SENAI only lends these to the students during the time necessary to produce the item being described, and they have to return them when proceeding with the production of the next item. The result is that the trainees have only whatever notes they have

taken when making those items and do not have any well prepared reference material for subsequent use in their career. It is of course realized that handing out a complete set of this material to each trainee would increase the cost of training to SENAI, but the consultant felt that this cost could be reduced if it were to be printed at the national level and distributed to all SENAI schools and would be a worthwhile investment. Also, no use was being made of material exhibits of the various raw materials and auxiliary products to open the eyes of the students on the existence of products not currently being used.

Among these shortcomings was a lack of information on the properties of species of timber which are presently not being used by the SENAI school in Mato Grosso, but which are currently in use or likely to be used by the furniture, joinery and construction industry in the state of Mato Grosso in the foreseeable future.

Finally, the apprentices do not seem to be taught the rudiments of wood technology and wood anatomy. Had this been included in the curriculum of the apprentices, it would have facilitated their subsequent understanding of what actually happens when wood dries, of attacks by fungi, interrelationship between the wood and the adhesives or the surface finishing material, etc. This could be due to the educational level of the teachers SENAI employed in its school in Mato Grosso, which, while being barely sufficient for the current curriculum, is inadequate for training of middle management.

IV. TEACHING OF MACHINE WOODWORKING BY SENAI IN MATO GROSSO

As indicated in chapter III of this report, SENAI currently only trains carpenters in craft operations.

The development of the industry is hampered by the lack of training facilities to train machine woodworkers and technicians to assume responsibilities at the middle management level.

SENAI should expand its school in Cuiabá to cover also this aspect. It is recommended to take as a basis for syllabus that of a developed country. A good example would be the United Kingdom's 'City and Guilds of London' Institute's programmes for the teaching of machine woodworking. There are two levels: the craft certificate (for machine operators) and the Advanced Craft certificate (for foremen and technicians).

The examination for the Craft Certificate in Machine Woodworking covers a two hour multiple choice paper to test achievement of objectives related to craft theory and associated subjects, as well as a course work assessment of assignments related to craft theory and industry studies and another one related to practical activities.

Advanced Craft certificates are awarded in the following fields of specialization:

- (a) Machine Woodworking and Toolroom Technology
- (b) Machine Woodworking and Materials Technology
- (c) Machine Woodworking and Construction of Machined components
- (d) Machine Woodworking and Production Planning for the Machine Shop.
- (e) Machine Woodworking and Plant Layout and Materials Handling.
- (f) Machine Woodworking Science
- (g) Numerically controlled/computer numerically controlled (NC/CNC) wood/machining processes.

All options except the last one (g) comprise a 2.5 hour examination in topics related to machine technology and processes, a 2.5 hour examination in the second topic and assessment of Course Work. For option (g), there is only a 2.5 hour exam in NC/CNC Woodmachining processes and the assessment of the course work.

It is recommended that at this stage SENAI only establish the courses leading to the obtention of the Machine Woodworking Craft Certificate; and, once a sufficiently large number of graduates exist, launch themselves in the advanced craft courses. The immediate needs of the middle management of existing furniture factories could best be provided through objectives 2 and 5 of Annex II.

In order to cover the topics for the Machine Woodworking Craft Certificate, training is to be provided on the following woodworking machines:

- table bandsawing machine;
- vertical band resawing machine;
- circular rip saw bench;
- dimension saw;
- universal travelling head crosscut sawing and trenching machine;
- straight line edger (single blade);
- panel saw (single blade);
- single end tenoning machine;
- overhead surface planing machine;
- thickness planing machine;
- combined surface planing and thicknessing machine;
- four sided planer-moulding machine;
- spindle moulding machine;
- disc and/or bobbin sanding machine;
- overhead narrow belt sanding machine;
- wide belt sanding machine;
- drum sander;
- single head boring machine;
- chain and chisel mortising machines;
- overhead router with template control of workpieces.

All these machines are produced in Brazil, so SENAI faces only financial limitations in acquiring them and installing them. It is recommended that 'state of the art' machines be purchased since they would be used for training purposes for at least the next 10 years and, in the recent past, developments in design and performance of woodworking machines have been rapid. It is expected that this development will continue at an ever increasing pace. In order that the SENAI Woodworking School may provide training of a level acceptable to industry, it is imperative that it be equipped with the type of equipment industry will be using - not only now but in ten years' time - hence the imperative need to buy the more advanced models of the above-mentioned machines.

It is also of utmost importance that these machines be placed in a logical sequence, that dust extraction and compressed air be installed and available whenever needed, and that some simple form of internal transport be used. It is also strongly recommended that the necessary corresponding tool maintenance equipment - suited for maintenance of carbide tipped blades - be acquired; together, whenever appropriate, will a full range of tools to enable the students to make full use of the machines. Money should also be invested to produce as wide a range of jigs as possible^{4/}. This will permit the students to get familiar with as wide a range of applications as possible and enhance their value to their first employers, who will have to spend less time in retraining them to comply with working conditions prevailing in industry.

The training of machine operators should not only cover technical grounds. The students should be trained to operate the machines under industrial (serial production) conditions. This would imply that the SENAI school establishes working relations with one or more furniture factories in Cuiabá and/or Varzea Grande to obtain orders for small, simple components to be produced in batches of a few hundred. Introducing the students to serial production and producing for industry improves their working discipline and also permits their practical training in quality control aspects.

Because of the relatively large number of machines on which the students for the wood machining certificate have to be familiar with, it would be logical to have classes large enough so that all machines are in use during a practical class. Classes could therefore have between 20 and 30 students. Also, since the practical sessions in the workshop only represent about half the time, the school could cater for about 50 students.

Demand for holders of the craft wood machining certificate would be created through the discussions with managers described under objective 5 of Annex II of this report.

^{4/} A wide range of jigs is described in the UNIDO 'Manual on Jigs for the Furniture Industry' (document ID/265)

The creation of the physical facilities for the teaching of machine woodworking should be preceded by the selection of the teachers and their training. It is recommended that teachers be selected from among middle-aged machine operators from industry, having a reasonably high education. They should be taught basic pedagogic skills in a special school (probably SENAI has such a school in some other state), and then give the first lessons under direct supervision of a trained teacher, so as to be able to benefit - in discussions after each lesson - from his experience. (It is more important to have a good technician, familiar with woodworking machines, and improve his skills as a teacher than to take a good teacher and try to teach him all about woodworking machines through a crash course.) Ideally, a study tour to modern furniture and joinery plants in Southern Brazil should be organized to serve as an eye opener to the teachers and expose them to modern industrial processes.

SENAI should encourage its teachers of machine woodworking to work as free-lance consultants with industry during the summer holidays because this will maintain (and even improve) their contacts with industry and their familiarity with industrial production. These teachers should also run special short, intensive courses for workers from industry on an ad hoc basis. This will enhance the image of the school in industry's eyes and strengthen its links with industry.

Finally, the teachers of machine woodworking should visit, as part of their duties, the specialized woodworking machinery exhibitions held in Sao Paulo, not only to keep abreast of recent developments, but also to establish contacts with the technicians from these firms and thus have direct access to new technologies.

The broad outline of a tentative syllabus for the teaching of machine woodworking is given in Annex III. It is based on the United Kingdom's City and Guilds requirements for its Craft Certificate.

Teaching for examinations equivalent to the Advanced Craft Certificate, also delivered by the City and Guilds Institute, should only be envisaged when a sufficient number of trainees have graduated to ensure a qualified teaching staff. Even then prospective teachers should be given scholarships to specialize further before being given the job.

V. RECOMMENDATIONS

Addressed to SENAI's Woodworking School in Cuiabá

1. Use a wider range of species. Doing so will familiarize the students with the characteristics of species which will become more popular in the future, as supplies of the currently used ones will dwindle. It will also help popularize these 'lesser known' species.
2. The quality of the lumber given to the students for their work is above average. They should be taught to work on lower grade lumber having, for example, interlocked grain since it is more difficult to machine, etc.
3. Compile a set of samples (if possible tangential and radial sawn) of Brazilian species and have them mounted on a panel.
4. Information sheets on the properties of the Brazilian species compiled under (3) above should be prepared and a complete set made available to each student for study and as future reference material. It should comprise the common (local) as well as the botanical name, its geographic occurrence, a description of the wood (colour of heartwood and sapwood, growth rings, grain, texture, figure, luster and specific gravity), its main end-uses, strength, resistance to termite and fungal attack, shrinkage characteristics, ease of drying (including recommended drying schedule), ease of machining, ease of preservation - if appropriate, etc. (Such information could easily be obtained by SENAI from IBDF - LPF in Brasilia, IPT in Sao Paulo or INPA in Manaus).

5. Similarly, samples of the various types, surface finishes, etc. of the various wood based panels produced in Brazil should be displayed on a board indicating the dimensions and range of thicknesses commonly available.
6. A small set of samples of the various melamine ('Formica') sheets available should also be kept for reference purposes.
7. Two complete collections of the hardware fittings used for construction of furniture available in Brazil should be kept. One should be mounted in an appropriate way (so as to show how it functions) and the other kept for handling by the students.
8. Increased use should be made, whenever appropriate, of visual aids - slides and films for overhead projector. Teachers should be encouraged to prepare visual aids - overhead projector films - for each topic; and should be trained in preparing this audio visual material and using it.
9. SENAI should build up a set of slides showing equipment, jigs, layouts, products, etc. and use them for teaching purposes. Like with the exhibits of timber species, panels and hardware, one set could suffice for the State of Mato Grosso and arrangements made for its circulation to the various end-users, though ideally each school should have its own set.
10. Currently the lumber used by SENAI is barely dry (air dried, if time permits). The students are not made aware of the importance of using dry lumber, nor of all the various aspects related to wood drying (how and why wood dries, defects resulting from poor drying practices, air drying, various forms of artificial dryers, drying schedules and ways of measuring moisture content).

SENAI's management should make its teachers aware of the importance of this topic if Mato Grosso is to produce furniture and joinery products for other areas of Brazil, and eventually for export overseas. An opportunity should be given to them to follow a short course to understand the principles of drying wood and the existing drying methods.

Concurrently, SENAI should install a drying kiln to have access to kiln-dried lumber for its students. Because of the relatively small volumes needed and the relatively high cost of small conventional kilns, consideration should be given to building a solar kiln. This type of kiln can dry to a moisture content of 8 percent or lower, in about one third of the time needed for air drying. It calls for very small capital investments, and could be constructed by the school. Only the sheathing material - glass or a plastic foil - fans and small horsepower motors need be purchased, the rest would be constructed locally. Whereas glass is more apt to break due to mishandling the lumber, the plastic foil has the disadvantage that it deteriorates relatively quickly under the effect of the high ultra violet rays of the tropics and would probably be a more costly investment in the long run.

The installation of such a small (approximately 5 m³) solar kiln would permit the students to better understand the process of drying and the operation of any type of kiln since they could, as part of their training, be entrusted with the recording of results and the operation of the solar kiln. Once developed, such kilns would be very suitable for all the small craft woodworking operations in the State of Mato Grosso, and elsewhere in Brazil. SENAI should then make available the designs and train future operators. A series of 31 simple solar heated lumber dry kiln designs, explaining also the operation of such kilns, has been published recently 1/. (UNIDO is currently providing assistance to two countries in the Caribbean in the construction and operation of such kilns - with volumes of 7 to 20 m³ - and they have performed satisfactorily.)

1/ Wengert, Eugene M. and Luiz Carlos Oliviera, Solar Heated Lumber Dry Kiln Designs, 91 pp, undated, published by the Department of Forest Products, Brooks Forest Products Centre, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061, U. S. A.

11. For SENAI to be able to introduce changes in Mato Grosso's existing furniture and joinery industry, at a time of relative full employment and good sales, it is imperative that they motivate the small craft operators - who comprise the majority of the firms and generate also the majority of the employment opportunities in the sector - of the need to do so. This can best be done by inviting them to attend a series of lectures on various aspects of serial production of furniture to be given by Brazilian and foreign specialists at which modern production methods, production and quality control systems, layout and equipment selection, wood drying and surface finishing, tool and machine maintenance, etc. are covered.

Through such a series of lectures the smaller local furniture manufacturers will certainly realize their shortcomings when compared to producers in other parts of Brazil, and the potential they are letting go by producing goods inefficiently and of low quality thus permitting producers in other states, often over a thousand kilometers away to enter their home turf.

This action by SENAI will enable each entrepreneur attending the series of lectures to determine his own priorities for plant layout, additional equipment, better tool room, wood drying, better trained manpower, greater use of modern (eg. Tungsten carbide-tipped) tools, introduction of low cost automation, better design, etc.

The text of the lectures could be edited and published by SENAI and would serve as appropriate reference material for its students and also for industry. SENAI could recoup these costs by selling the publications.

12. As a result of this course of lectures, SENAI and the Federation of Industrialists of Mato Grosso could establish a longer range programme of training machine woodworkers. Such courses should be oriented towards adult education (i.e. training of the staff of existing plants)

as against training of youngsters (apprenticeships), since the existing industry will be more eager to upgrade the skills of its employees than to recruit new ones. These courses should be organized on a modular basis, i.e. they should aim at giving each trainee the additional skills needed for the introduction of a new technology and not serve as a general education to improve their overall knowledge. A tentative 'package' of topics, syllabuses and duration of such courses is given in Annex I. Expertise from outside SENAI: either Brazilian - such as IPT or FETEP - or expatriate - such as UNIDO or some bilateral donor of aid - should be sought for this programme. Here again, the course material should be published.

13. Industrialists in the State of Mato Grosso should be encouraged to show more interest in, and make fuller use of, SENAI and its work. Similar bodies in Europe have managed to improve their contacts with industry through a newsletter and/or maintaining close contacts between the teachers and their former students.

14. There is no doubt that in the foreseeable future SENAI will be called upon to train machine woodworkers. In order to achieve this, it would have to improve its equipment. This need not imply the purchase of a complete set of new machines, but would necessitate:

(a) The checking of the precision of the existing machines, one at a time. ^{2/}

(b) Improving the precision of the required standard by changing bearings, grinding axles, slides, etc. (This could be done easily at one of SENAI's metalworking facilities in Mato Grosso). The existing machines are robust enough to warrant their revision.

^{2/} The methodology for checking the precision and minimum levels of accuracy of basic woodworking machines is given in Chapter 2 of the UNIDO publication 'Technical Criteria for the Selection of Woodworking Machines' (document ID/247).

(c) Build into the existing revised machines elements of low cost automation to increase their productivity and simulate conditions of the more modern machines found in industry ^{3/}. The existing machines are robust enough to warrant their improvement, once revised.

N. B. Recommendations given under (14) above should be implemented sequentially for each machine. Both the woodworking and metalworking departments of SENAI would benefit since it will enable the latter to provide a new form of practical training (in machine maintenance) which it otherwise could not do.

15. SENAI should embark on the immediate translation into Portuguese of UNIDO's documents on 'Furniture and Joinery Industries for Developing Countries' (document ID/108 Rev.1), covering aspects of industrial production of furniture and joinery; and the 'Manual on the Production of Jigs for the Furniture Industry' (document ID/265), for the time when it will be training machine woodworkers and supervisors. Authorization for such translation will be granted by UNIDO upon receipt of a written request to that effect.

16. The jigs shown in the latter publication should be manufactured for use in the training of the carpenters and of the future machine woodworkers. Special care should be applied in ensuring that these jigs are very precise; and they should only be manufactured after the precision of the machine they are intended for has been checked, if need be, improved, and meets the expected standard.

17. The introduction of lower quality lumber and/or of species that are more difficult to machine, together with the upgrading of the existing machinery through its reconditioning and subsequent addition of low cost automation, will call for the use of modern tooling, such as carbide-tipped moulders, inserted blade cutterheads, etc.

^{3/} Complete details for a series of such typical adaptations can be found in the UNIDO Manual on 'Low Cost Automation for the Furniture and Joinery Industries' (document ID/154 Rev.1).

18. The models of the furniture that the carpentry students are called upon to produce are appropriate for craft production methods. If and when machine woodworking will be taught, it will be necessary to redesign these items of furniture for serial production having, for example, a dowel (as against a mortise and tenon) construction; that can be produced and shipped knocked down, using veneered panels, etc.

19. The introduction of design adapted for serial production will necessitate the purchase by SENAI of additional equipment for its woodworking school. These, in a preliminary order of priority, are:

- A multi-spindle attachment, to be fitted to a mortiser or an existing pedestal drill so as to drill at least one pair of dowel holes at 32 mm centres;
- A feeding device for advancing wood components onto a spindle moulder or planer/jointer;
- a simple four-side planer-moulder;
- an overhead router (min. r.p.m. 15,000);
- a simple edge bander.
- Subsequently a multi-spindle borer will also be needed.

20. SENAI should establish a technical library for use by its teachers, trainees (apprentices and adult students) and eventually also the industry.

21. SENAI's teaching methods are quite well developed and deemed sufficient to meet the needs for the training of carpenters. Nevertheless it is recommended that the following additional material be introduced:

- (a) A set of theoretical lectures on wood structure be prepared by a wood technologist from a university. This text should then be simplified by SENAI's teachers to the level of comprehension of

their students, and the course be given using as much as possible visual aids. (This will facilitate the understanding, by the students, of many things they are now told to take for granted).

This material should be handed over to each student to serve him as reference material in future life.

(b) Similarly, a course should be developed on the characteristics and properties of the timber which could be used in furniture and joinery. Samples should be circulated and the students handed out sheets on the properties, characteristics, machinability, paintability, etc. of these species. These, again, would serve them as reference material in future life. It should be complemented by practical identification of these species by the students.

(c) A course should be given on moisture in wood: how and why wood dries, drying methods, defects, ways of measuring moisture content of wood and the basics of kiln operation. If and when SENAI will have its own (solar) kiln, a practical exercise of drying a load should complement this theoretical course.

22. SENAI's teachers are instructed to only demonstrate the correct ways of operating a machine, for example using only sharp tools and optimal rates of feed. This deprives the students of being able to judge when a tool is blunt, and realize what happens when really wet wood is machined, effects of too fast and/or too slow rates of feed, etc. It is therefore recommended that the teachers (and only the teachers) demonstrate to the students what happens when machines are run at non-optimal conditions.

A proposal for providing technical assistance to implement those recommendations which cannot be carried out using resources available to SENAI locally is given in Annex II.

ANNEX I

TENTATIVE PROGRAMME FOR TRAINING OF WORKERS FROM INDUSTRY

Scope of the Programme

If the existing furniture industry in Mato Grosso is to progress and improve its production technology, then new technologies, working methods and skills will have to be introduced. Existing companies will have to make do - to a large extent - with existing equipment and personnel, while the former will eventually be replaced, it is less likely to replace the men - be it only for humanitarian reasons. They will therefore have to be trained to acquire new skills.

SENAI should introduce, over as short a period of time as possible a complete overall programme of courses to cover the needs of the entire furniture and joinery sector. These should be designed on a modular basis and be exclusively destined to people from industry.

Each module should comprise a manual, written in a simple language, with many visual aids and simplified graphs and formulae, lectures, demonstrations, and also some practical work by the trainees.

The main objectives of this training programme are to enable workers not only to learn how to perform their jobs correctly, but also to understand industrial production requirements. The complete set of manuals could serve as an operational manual for a medium sized furniture factory.

The complete programme should comprise the following topics:

1. Wood as a raw material,
2. Wood and auxilliary products,
3. Wood supply,
4. Seasoning and kiln drying,
5. Machine shop,
6. Furniture product development,

7. Construction of furniture products,
8. Work preparation,
9. Cross-cutting,
10. Ripping,
11. Planing,
12. Turning,
13. Moulding,
14. Routing,
15. Tenoning and mortising,
16. Processing of boards,
17. Drilling and dowelling,
18. Sanding,
19. Assembling,
20. Surface finishing,
21. Upholstering,
22. Quality control,
23. Packing, making and delivering,
24. Production documents,
25. Safety and work protection,
26. Industrial behaviour
27. Economics of production,
28. Marketing.

Theoretical aspects, given in a classroom, should be kept down to a minimum since it keeps production staff away from work during regular hours.

The practical part of the training should be organized at the working areas of the respective operations. These areas must therefore be properly organized, including production documents, materials, tools, jigs, gauges, pallets, protective devices and everything that is necessary for productive, safe and good quality work. The teachers should explain and show how to check the machine, tools and jigs and, in the case of wrong adjustments, how to correct them and bring equipment to a good working condition.

Workers should start working using the present methods and their productivity should be recorded. Then the new method should be used and its advantages and benefits should be explained by the teachers who will show the correct way of working using the new method. Then workers will practice by themselves under the supervision of the teacher, who will correct eventual mistakes. At the end, differences between the two methods will be discussed, and conclusions reached.

The programme should be launched by SENAI by inviting owners and managers of furniture and joinery plants to attend a four hour (half day) course, covering three hours of lecture and one hour of selected demonstrations. The points to be covered in this introduction to the programme are:

- Aims and objectives of the training programme,
- Methodology of the training programme,
- Selection of participants (by the employers),
- Generalities about furniture production,
- Types of furniture production,
- Differences between handicraft and industrial production,
- Standardization and standardized production,
- Prerequisites for the production of furniture,
- Production systems, their establishment and maintenance,
- Knowledge and experience in furniture production.

Topic 1: Wood as a raw material:

(8 hours lecturing, 1 hour demonstrations)

- Forestry as a source of wood,
- Genetics and anatomy of wood,
- Growth process of a tree,
- Classification of wood species,
- Major wood species used in our production process,
- Climatic defects,
- Mechanical characteristics of wood,
- Moisture content and shrinkage of wood,
- Wood preservation.

Topic 2: Wood and auxilliary products

(6 hours lecturing, 2 hours demonstrations)

- Sawnwood,
- Veneer,
- Plywood,
- Blockboards,
- Particle boards,
- Fibreboards (hardboard, MDF insulation board),
- Surface improved boards (with melamine plastic foils),
- Adhesives,
- Finishing materials,
- Metal components,
- Textiles,
- Foams,
- Other auxilliary products.

Topic 3: Wood supply

(4 hours lecturing, 1 hour demonstration)

- Quality standards and grading of lumber,
- Wood specifications for production needs,
- Ordering,
- Purchasing,
- Grading rules,
- Receiving the goods (qualitative and quantitative aspects),
- Internal transportation and storage of lumber,

Topic 4: Air seasoning and kiln drying

(6 hours lecturing, 6 hours demonstrations and practice)

- Wood drying theory,
- Air seasoning,
- Kiln drying,

- Structure of dry kilns,
- Drying process,
- Control of kiln drying process,
- Conditioning the wood,
- Measurement of moisture content,
- Operation and maintenance of drying kilns,
- Operation and maintenance of moisture meters.

Topic 5: Machine shop

(6 hours lecturing, 2 hours demonstration and practice)

- Layout of machine shop,
- Classification of machines,
- Basic elements of machines,
- Wood processing tools,
- Jigs and gauges used in furniture production,
- Maintenance,
- Internal transport,
- Dust exhaust system,
- Energy distribution networks,
- Compressed air,
- Safety, protection and fire prevention.

Topic 6: Product development for furniture

(10 hours lecturing, 2 hours demonstrations and practice)

- Strategic approach to product development,
- Steps in product development,
- Life cycle of products,
- Market research,
- Analysis of marketing information,
- Analysis of factory capabilities,
- Analysis of existing product lines,
- Collection and selection of new ideas,
- Design of products,

- Standardization and interchangeability of parts,
- Production of prototypes,
- Value analysis,
- Construction details,
- Technical drawings.

Topic 7: Work preparation

(10 hours lecturing, 20 hours demonstration and practice)

- Objective of work preparation,
- Organization of the production planning department,
- Duties of the production planning department,
- Standardization of constructions, materials, tools, working time, quality, etc.,
- Preparation of production documents,
- Issuing and authorization of job orders with relevant documents,
- Analysis and processing of information on production,
- Improvement of production,
- Value analysis of products,
- Preparation of work instructions,
- Management information systems.

Topic 8: construction of furniture

(8 hours lecturing, 2 hours demonstration and practice)

- Classification of products,
- Basic principles of furniture construction,
- Review of joints,
- Fixed constructions,
- Knock down constructions,
- Fittings in furniture construction,
- Tolerances in furniture constructions,
- Working drawings.

Topic 9: Cross-cutting

(4 hours lecturing, 4 hours demonstrations and practice)

- Importance of optimal utilization of wood raw material,
- Wood characteristics important for cross-cutting (structure, defects, etc.),
- Cross-cutting saws,
- Saw blades for cross-cutting,
- Cross cutting operations,
- Organization of the working area,
- Safety measures,
- Maintenance of tools and machines,
- Quality grading of product parts,
- Cutting lists (documentation).

Topic 10: Ripping

(4 hours lecturing, 4 hours demonstrations and practice)

- Characteristics important for ripping (wood structure, shape, defects, etc.),
- Ripping saws,
- Sawblades for ripping,
- Jigs and gauges,
- Methods of ripping and wood utilization,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 11: Planing

(4 hours lecturing, 4 hours demonstrations and practice)

- Wood characteristics important for planing,
- Planing machines (jointers and thicknessers,

- Planer knives,
- Jigs and gauges,
- Methods of planing,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 12: Turning

(4 hours lecturing, 4 hours demonstrations and practice)

- Wood characteristics important for turning,
- Wood lathes,
- Tools used,
- Jigs and gauges,
- Machine setting,
- Methods of turning,
- Copy turning,
- Dowel making,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 13: Moulding

(8 hours lecturing, 8 hours demonstrations and practice)

- Wood characteristics important for moulding,
- Typical operations,
- Moulding machines,
- Tools used for moulding,
- Jigs and gauges,
- Methods of moulding,
- Safety measures,

- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 14: Routing

(8 hours lecturing, 8 hours demonstrations and practice)

- Wood characteristics important for routing,
- Typical operations,
- Routing machines,
- Tools used for routing,
- Jigs and gauges,
- Methods of routing,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 15: Tenoning and mortising

(4 hours lecturing, 4 hours demonstrations and practice)

- Wood characteristics important for tenoning and mortising,
- Types of tenons and mortises,
- Tenoning machines,
- Mortising machines,
- Tools used for tenoning and mortising,
- Tenoning and mortising methods,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 16: Processing boards

(8 hours lecturing, 8 hours demonstration and practice)

- Basic characteristics of wood based panels:
 - plywood,
 - blockboards,
 - particle boards,
 - fibreboards,
- Comparison with solid wood,
- Machines for processing boards,
- Tools used for processing boards,
- Jigs and gauges used,
- Cutting patterns,
- Processing methods,
- Veneering and edge lipping,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 17: Drilling and dowelling

(2 hours lecturing, 4 hours demonstrations and practice)

- Drilling machines,
- Dowelling machines,
- Tools used for drilling and dowelling,
- Drilling and dowelling methods,
- Safety measures,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 18: Sanding

(4 hours lecturing, 10 hours demonstrations and practice)

- Purpose of sanding wood,
- Sanding of solid wood,
- Sanding of boards,
- Sanding machines,
- Sanding papers and abrasive cloths,
- Classification and selection of sanding papers and emery cloths,
- Jigs and gauges used for sanding,
- Sanding methods,
- Safety measures,
- Care and maintenance of machines and sanding papers,
- Organization of the working area,
- Documentation.

Topic 19: Assembling

(6 hours lecturing, 20 hours demonstrations and practice)

- Quality control of parts to be assembled,
- Machines used for assembling,
- Jigs and gauges used for assembling,
- Tools for assembling,
- Pre-assembling,
- Assembling of frames,
- Assembling of case elements,
- Assembling of fittings,
- Final assembling and control,
- Safety measures,
- Maintenance of equipment,
- Organization of the working area,
- Documentation.

Topic 20: Surface finishing

(16 hours lecturing, 40 hours demonstrations and practice)

- Preparation of surfaces for finishing,
- Finishing materials,
- Formulation and quality control,
- Storage of finishing materials,
- Spraying guns and cabins,
- Staining,
- Tools used for finishing,
- Jigs, gauges and transportation systems used,
- Types and processes of finishing,
- Drying of lacquers,
- Sanding finished surfaces,
- Safety measures and fire prevention,
- Maintenance of equipment,
- Organization of the working area,
- Documentation,
- Testing of surfaces.

Topic 21: Upholstering

(4 hours lecturing, 4 hours demonstrations and practice)

- Upholstery materials:
 - frames and shells,
 - fabrics,
 - foams,
 - tension springs,
 - rubber webbing,
 - other materials,
- Production equipment,
 - cutters,
 - sewing machines,
 - assembling presses,
 - other equipment,

- Production technology,
 - Material handling and inspection,
 - cutting,
 - sewing,
 - assembling,
 - quilting and buttoning,
- Safety,
- Maintenance of tools and machines,
- Organization of the working area,
- Documentation.

Topic 22: Quality control

(8 hours lecturing, 8 hours demonstrations and practice)

- Definition of quality of products,
- Quality and customer satisfaction,
- Quality in production of furniture,
- Quality and reliability,
- Quality standards,
- Methods of quality control,
- Measurement of quality,
- Statistical quality control,
- Management of quality,
- Reporting about quality,
- Improvement of quality,
- Organization of quality control in furniture production,
- Tools and gauges used for quality control,
- Testing of furniture products,
- Quality and cost of production,
- Quality and warranty,
- Quality and company's name and image,
- Quality and prices of products.

Topic 23: Packing, Marking and deliveries

(8 hours lecturing, 8 hours demonstrations and practice)

- Production information systems,
- Purpose of production information systems,
- Basic documents for production,
 - Design of products,
 - Working drawings (details),
 - Monthly plan for production,
 - Job orders,
 - Materials lists,
 - Cutting lists,
 - Tool lists,
 - Construction of jigs and gauges,
 - Operation lists,
 - Scheduling (timing),
 - Machine loading,
 - Daily, weekly and monthly production reports,
 - Quality control report,
 - Documentation concerning working hours of labour,
- Basic guidelines for the creation of new documents,
- Feed-back systems and their roles.

Topic 25: Safety and work protection

(4 hours lecturing, 4 hours demonstrations and practice)

- Generalities on prevention of accidents in wood processing factories,
- Danger in using wood working machines and corresponding precautions,
- Work protection measures,
- Precautions against danger from electrical sources,
- Protection against noise,
- Protection against dust,
- Protection against evaporating chemicals,
- Types of fires and types of extinguishers,

- Fire prevention,
- Safety and productivity,
- Protection and quality,
- Working conditions and motivation,
- Responsibility for safety and prevention of accidents,
- Company's rules on safety and protection.

Topic 26: Industrial behaviour

(4 hours lecturing)

- Attendance,
- Duties at beginning of a work,
- Respecting working schedules,
- Respecting job orders,
- Using protective devices,
- Breaks for rest and smoking,
- Duties at end of work,
- Leaving the factory,
- Relationships with colleagues,
- Relationships with management,
- Sound factory environment as a crucial factor of job satisfaction and high productivity,
- Responsibility for meeting deadlines and quality standards.

Topic 27: Production economics

(6 hours lecturing)

- Inputs and outputs in furniture production,
- Production costs,
 - fixed costs,
 - variable costs,
- Total production costs,
- Pricing,
- Profitability,

- Break-even point,
- Production economics aspects,
 - Productivity and size of series,
 - Quality and size of series,
 - Materials utilization and size of series,
 - Work organization and size of series,
- Incentives,
- Production economics and well being and motivation of staff.

Topic 29: Marketing

(5 hours lecturing)

- Pricing,
- Promotion,
- Entering market,
- Penetrating market,
- After sales service,
- Defending the market,
- Review of procedures for product development.

ANNEX II

Proposed assistance to SENAI for development of Mato Grosso's
secondary wood processing industries

Introduction

The following material is drafted for use by SENAI and/or the Brazilian authorities in drafting the project document for the technical assistance to be financed by UNDP from the IPF.

Objective 1

To expose the owners and managers of the furniture and joinery industries in Mato Grosso to modern methods of industrial (serial) production and help them determine priorities for their own firms.

Output 1

- (a) Some 20 to 30 owners and managers of furniture and joinery plants in Mato Grosso will have attended a three week seminar that will have exposed them to the benefits of and prerequisites for the serial production of furniture and joinery.
- (b) Improvements in the operation of the factories of the participants of the seminar in product design, quality and productivity.

Activity 1

- (a) A three week seminar, held in the afternoons at SENAI's headquarters and woodworking school in Cuiabá to cover all technical and managerial aspects related to the serial production of furniture and joinery.

- (b) Ad hoc technical assistance (provided in the mornings) to the factories of the participants in fields related to the topics covered in the Seminar.

(SENAI will translate into Portuguese and publish relevant UNIDO publications to serve in the seminar and in its work.)

Input 1

- (a) A team of four internationally recruited consultants will be recruited for one month to cover activities (a) and (b). Tentatively, their fields of specialization will be: furniture production technology, furniture design, equipment selection and low cost automation and surface finishing.

They will be complemented by a number of Brazilian specialists in such fields as wood technology, wood drying, tool and machine maintenance, adhesives, marketing and industrial engineering.

- (b) Visual aids and teaching material (to be kept by SENAI) that have to be imported.

(SENAI's budget will cover costs of teaching material, samples, etc. available in Brazil.)

Cost of UNDP input 1

(a)	11-50 Consultants (4m/m)	US\$ 32.000
(b)	41-00 Teaching aids, samples, etc.	US\$ 2.500
	51-00 Miscellaneous (reporting costs)	US\$ 500
	Total for Objective 1:	US\$ 35.000

Work programme 1

<u>Activity</u>	<u>Location</u>	<u>Months ___ after approval ___ of objective</u>
1. Finalization of programme (by correspondence & telex)	UNIDO Vienna SENAI Cuiabá	1
2. Recruitment of consultants (international & Brazilian)	UNIDO Vienna SENAI Cuiabá	2-5
3. Purchase of teaching aids (international & Brazilian)	UNIDO Vienna SENAI Cuiabá	2-5
4. Translation of existing UNIDO documents in Portuguese	SENAI Cuiabá	2-5
5. Convening seminar (p.m.) and provision of ad hoc technical assistance (a.m.)	SENAI Cuiabá	6
6. Submission of report on Seminar	UNIDO Vienna	8

Objective 2

To introduce new technologies at shop floor level in the furniture and joinery industry of Mato Grosso through short (maximum two weeks) specialized courses for personnel from industry. (Possible fields: surface finishing, production planning and control, design and production of jigs, etc.)

Output 2

The head of the SENAI's woodworking school and two of his teachers will have been familiarized with contents of, and teaching methods used for, short intensive specialization courses for personnel from the furniture and joinery industry.

Activity 2

A two week study tour for three of SENAI's teaching personnel to France and the United Kingdom to visit:

- Ecole Boulle (furniture school), in Paris.
- Centre Technique du Bois et de l'Ameublement, in Paris.
- London School of Furniture, in London.
- Furniture Industry Research Association in Stevenage.

They will discuss range of topics covered, curricula, teaching methods, see demonstrations, teaching aids used, etc. to enable them to introduce similar methods in Mato Grosso.

(This study tour should be preceded by one to other SENAI schools in Brazil teaching woodworking, FETEP and IPT, to be familiar with what exists in the country and to enable SENAI in Mato Grosso to make fuller use of facilities existing in the country.)

Input 2

Travel and per diem for three persons for two weeks.

Cost of UNDP Input 2

Three transatlantic tickets	US\$ 7.500
Per diem for 45 days	US\$ 4.500
Total for Objective 2	US\$ 12.000

Work programme 2

<u>Activity</u>	<u>Location</u>	<u>Months after approval of objectives</u>
1. Submission of nomination forms	SENAI Cuiabá	1
2. Organization of study tour	UNIDO Vienna	2-3
3. Two week study tour for 3 persons	France & UK	3

Objective 3

- (a) To provide a facility in Mato Grosso that could test the quality (mainly rigidity) of furniture, its inputs and the quality of surface finishes.
- (b) To create a small documentation centre, specialized in the furniture and joinery industry that will cater for the needs of the industry in Mato Grosso.

Output 3

- (a) A facility for testing furniture and its inputs, as well as surface finishes, catering for the needs of the sector in Mato Grosso.
- (b) A documentation centre specialized in the needs of the furniture and joinery industry in Mato Grosso.

Activity 3

- (a) Purchase of quality control and testing equipment for furniture and surface finishes.
- (b) Purchase of textbooks, standards, catalogues, etc. relevant to the furniture and joinery industry.

(SENAI would have to undertake the following activities to complement the above, financed by UNDP:

- (a) Train one of its officials at FETEP in testing of furniture and surface finishes, interpretation of standards, etc.
- (b) Purchase locally available testing material.
- (c) Purchase all the documentation relevant to furniture and joinery available in Portuguese.
- (e) Train one of its staff in librarianship.)

Inputs financed by UNDP 3

Universal testing machine for furniture	US\$ 18.000
Quality control equipment for furniture	US\$ 2.000
Quality control equipment for surface finishes	US\$ 2.000
Documentation on furniture	US\$ 3.000
Total for Objective 3	US\$ 25.000

Work programme 3

<u>Activity</u>	<u>Location</u>	<u>Months after approval of objectives</u>
1. Purchase of quality control equipment	UNIDO Vienna	1
2. Purchase of textbooks, etc.	UNIDO Vienna	1
3. Purchase of universal furniture testing machine	UNIDO Vienna	1
4. Delivery and installation (by SENAI staff) of the above items	SENAI Cuiabá	3

Objective 4

- (a) To increase design consciousness for furniture (and quality of design).
- (b) To interest potential furniture designers in working in the furniture field and train them to design for serial production.
- (c) To popularize those commercially less accepted species of Mato Grosso suitable for furniture production.
- (d) To provide industry in Mato Grosso with a roster of competent furniture designers for subsequent collaboration with them.

Output 4

- (a) A national competition for the design of a range of furniture to be produced industrially that will use the commercially less accepted species of Mato Grosso.
- (b) Prototypes of this furniture which could be used for promotional purposes in national exhibitions as well as overseas.
- (c) A roster of qualified furniture designers who would be available to collaborate with the furniture industry in Mato Grosso.
- (d) Local designers trained in design of furniture for serial production.

Activity 4

A national design competition for solid wood furniture to be produced serially using commercially less accepted species from Mato Grosso will be organized by SENAI (in possible collaboration with CACEX, FETEP, etc.)

UNDP/UNIDO will provide the services of a well known designer to serve on the jury, assess the designs submitted from aesthetic, ergonomic and technical (ease of serial production) point of view and recommend the awards.

During his stay in Brazil, he will have discussions with each of the participants in the competition to provide ad hoc advice and answer queries.

He may also be called upon to advise factories in Mato Grosso on their design problems and to lecture on problems of design of solid wood furniture for serial production.

Inputs 4

A furniture designer, specialized in the design of solid wood furniture for industrial production will be made available for one month to participate in the jury of the national design competition for solid wood furniture.

Cost of UNDP input 4

11-50 Furniture design consultant (1 m/m)	US\$ 8.500	
51-00 Miscellaneous (reporting costs)		US\$ 500
Total for objective 4		US\$ 9.000

(SENAI's budget will cover the prize money, publicity costs, administrative costs and the honoraria of the Brazilian members of the jury.)

Work programme 4

<u>Activity</u>	<u>Location</u>	<u>Months after approval of objectives</u>
1. Organization of competition	SENAI Cuiabá	1
2. Publication of regulations, etc.	SENAI Cuiabá	2
3. Recruitment of UNIDO consultant	UNIDO Vienna	2
4. Recruitment of Brazilian jury	SENAI Cuiabá	2
5. Submission of projects and their assessment by Jury (including UNIDO consultant)	Cuiabá	3
6. Ad hoc technical assistance by UNIDO consultant	Cuiabá	3
7. Submission of report	UNIDO Vienna	5

Objective 5

To conduct a short (3 day) round table meeting grouping furniture and joinery producers in the state of Mato Grosso as well as representatives of SENAI and relevant government bodies, IBDF, CEBRAE, etc. - to introduce new ideas and identify problems, decide on ways and means to solve them.

In particular, they will finalize a long range programme of training of skilled workers from industry and middle management (supervisors) in new technologies used in serial production.

Output 5

A series of resolutions, decisions, etc. relating to the development of the secondary wood processing industries in the State of Mato Grosso, the most important of which will be a plan of action for future training addressed to skilled workers, technicians and middle managers from industry to be implemented by SENAI using locally available know how and, if not available, using UNDP/UNIDO technical assistance.

Activities 5

In the first week the consultant will help conduct the round table discussion, and conduct discussions with SENAI in Mato Grosso.

In the second week, he will finalize the future programme of technical assistance to be provided by UNDP/UNIDO and discuss it with SENAI officials both in Cuiabá and Brasilia.

Inputs 5

The services of a UNIDO staff member, specialist in the furniture and joinery industries, or an outside consultant, will be provided for two weeks.

Cost of UNDP input 5

11-51 Specialist in furniture production 0.5 m:m	US\$ 5.500
51-00 Miscellaneous (reporting costs US\$ 500	
Total for Objective 5	US\$ 6.000

(SENAI will assume all local costs relating to the round table discussion.)

Objective 6

To develop and conduct a series of up to five short intensive courses ^{1/} for skilled workers and middle management from the furniture and joinery industry of Mato Grosso to upgrade their skills and introduce new technologies and management methods. The topics for these courses will be determined during the round table discussions referred to above (objective 5).

Outputs 6

- (a) A complete package of curricula, manuals, teaching aids (minor pieces of equipment), visual aids and a trained teacher for each of the topics (up to five) identified to be introduced in SENAI's training programme for training skilled workers technicians and middle management of Mato Grosso's furniture and joinery industries.
- (b) Up to five groups of 10 to 20 persons each from industry who would have attended a special course, acquired new skills and introduced them in their factories.

^{1/} These could cover topics such as: wood drying, surface finishing, design and production of jigs, design and installation of low cost automation circuits, production planning and control for serial production, product development for serial production, estimating material and labour requirements, maintenance of carbide tipped tools, etc.

Activities 6

For each of the topics - up to five:

Phase I (six weeks)

- (a) Short visits to a representative sample of factories to assess the current state of the art of the topic in Mato Grosso, current practices, equipment used, and level of skills and education of the employees.
- (b) Assessment of the relevant existing teaching skills at SENAI - including relevant teaching material and methods used by SENAI in its schools outside Mato Grosso.
- (c) Based on the above, recommend a curriculum for the topic, describing the demonstrations to be made and practical work of the students, identifying the equipment needs and drawing up technical specifications for the equipment to be purchased by SENAI to complement the existing equipment in Mato Grosso.
- (d) Together with the SENAI trainer, conceive and prepare all the visual aids that are needed to teach the subject.
- (e) Prepare the technical manual that will be used by SENAI to teach the topic.

(In the period between Phases I and II, SENAI will:

- (a) Order the equipment identified and install it.
- (b) Translate the manual into Portuguese.
- (c) Accept nominations from industry and screen the participants.)

Phase II (four weeks)

- (a) Train the trainer in the use of the visual aids and the correct and safe use of the equipment, pointing out possible errors and ways of overcoming them.
- (b) Be present and if necessary assist and complement the actual course given by the SENAI trainer to participants from the industry (one to two weeks).

- (c) Based on the response of the participants, their questions and the relative priority they have attributed to topics, correct, modify and if necessary expand the manual.
- (d) Recommend to SENAI a plan of action for future activities in his field of specialization
- (e) Prepare a technical report (which will include the manual).

Inputs 6

- (a) The services of a consultant, specialized in the specific field in which training is to be provided by SENAI, will be made available for a total of 2.5 months, in two phases (approximately 1.5 and 1 months respectively)
- (b) Teaching aids, visual aids, samples of products, etc. not existing in Brazil, but readily available elsewhere, will be made available.

Cost for UNDP Input 6

For each topic (maximum five topics)

11-50 Consultant in field to be determined under objective 5 (split mission (2.5 m/m)	US\$ 20.000
41-00 Expendable material (teaching aids)	US\$ 4.000
51-00 Miscellaneous (reporting costs)	US\$ 1.000
Total for one topic of Objective 6	US\$ 25.000

Work programme 6
for each topic (maximum five)

<u>Activity</u>	<u>Location</u>	<u>Months after approval of objectives</u>
1. Recruitment of consultant	UNIDO Vienna	2
2. Consultant mission, phase I	SENAI Cuiabá	4-5
3. Purchase of equipment	UNIDO Vienna	5
4. Purchase and installation of equipment	SENAI Cuiabá	5-6
5. Organization of the course	SENAI Cuiabá	5-6
6. Translation of manual into Portuguese	SENAI Cuiabá	5-6
7. Consultant & trainer conduct course (phase II)	SENAI Cuiabá	7
8. Submission of report	UNIDO Vienna	8

ANNEX III

TENTATIVE SYLLABUS FOR THE TEACHING OF MACHINE WOODWORKING

The student should be familiar with the following aspects for each of the twenty machines referred to on pages 15 and 16 of the text.

- Functions, capacity and limitations of each machine;
- main constructional parts and use of its ancillary facilities;
- factors affecting the selection of cutters;
- different types of cutting tools and their action;
- setting up operations;
- safety factors, including noise;
- holding, clamping and feeding during the machining process;
- use of jigs and fixtures;
- relationship between feed speed and quality of surface finish;
- waste extraction systems;
- routine maintenance.

The majority of the training is of a practical nature.

Furthermore, the student should be familiar with the following aspects of toolroom techniques for all the types of tools used by the machines covered in the syllabus:

- identifying dull cutters and defective holding devices;
- effects of use of dull cutters;
- storage of cutters;
- setting up procedures for maintenance of cutters and holding devices;
- need for balance and safety of rotating cutters;
- balancing of cutters and holding devices.

With respect to materials, the student should be familiar with the growth and structure of timber as well as with the properties and identification of a wide range of species available in the Brazilian forests. (These should not only comprise those species currently used, but also those species that have a potential role to play. IBDF's assistance should be sought in compiling this list, in obtaining samples of each, identifying possible end uses and in the compilation of data on their properties.)

The syllabus should also cover aspects of conversion: equipment available, how to eliminate defects; obtain certain properties - e.g. quarter-sawing, veneer slicing, peeling and eccentric peeling - and the importance of seasoning timber - e.g. what happens during seasoning, why timber needs to be seasoned, degrade in seasoning, etc.

The student should be familiar with veneer, plywood (including construction methods and various grades), blockboard, particle board, fibreboard (hardboard, MDF and insulation board). He should also be conversant with the various types of adhesives currently used (animal glue, polyvinyl acetate, urea formaldehyde, phenol formaldehyde and contact glue), glue mixing procedures and problems related to shelf life, pot life and curing time.

With respect to metals, the curriculum should familiarize the student with the properties and uses of various metals used in woodworking machines; while, with respect to electricity, he should be familiar with basic units of power and requirements of woodworking machines.

In the field of mechanical drawing the following aspects must be covered: orthographic, isometric full size and scaled drawings. Materials specifications and cutting lists. In the field of graphics, candidates should be able to develop geometrically cutter setting templates and cutter profiles for various cutter heads used in the machines for which training has been provided.

The function and use of various types of lubricants should be included in the syllabus. Candidates should also be familiar with the basic principles, applications and functions of component parts of woodwaste systems.