



TOGETHER
for a sustainable future

OCCASION

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



TOGETHER
for a sustainable future

DISCLAIMER

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

FAIR USE POLICY

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

CONTACT

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

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

19347

RESTRICTED

DP/ID/SER.A/1530
17 December 1991
ORIGINAL: ENGLISH

ii, 22 p.
English
original
date: 1991

STRENGTHENING THE TECHNICAL AND MANAGERIAL CAPACITIES
OF THE CARPENTRY COOPERATIVES IN MUKALLA AND SEIYUN

SM/PDY/87/005

THE REPUBLIC OF YEMEN

Technical report: Training Manual on Product Development
in the Secondary Wood Processing Industries*

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

Based on the work of: Radmilo Malis
Expert in Furniture and Joinery Production

Backstopping officer: Antoine V. Bassili
Agro-based Industries Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

TABLE OF CONTENTS

INTRODUCTION	1
PRODUCT DEVELOPMENT IN THE SECONDARY WOOD PROCESSING INDUSTRY	1
1. A strategic approach to product development	1
2. Product life cycle	2
3. Steps in product development	3
4. Analysis of market demand and factory capabilities	6
(a) Location of production units	6
(b) Equipment	6
(c) Capacities	6
(d) Raw materials	7
(e) Auxiliary materials	7
(f) Tools and technical supply	7
(g) Skilled personnel	8
(h) Experience	8
(i) Quality of products	8
(j) Organization	8
(k) Maintenance	8
(l) Energy	8
(m) Motivation, responsibility and attitude	8
5. Analysis of the existing product line	9
6. Product design	10
(a) Division of space and areas	11
(b) Curved lines and elements	12
(c) Proportion	12
(d) Ornaments	12
(e) Colours	12
(f) Standardization and interchangeable parts	12
7. Making prototypes	13
8. Value analysis	13
9. Construction, detailed drawings and technical description of a new product	14
10. Recommendations on product development adapted to the situation in the Cooperatives	16
ANNEXES	
I Training programme for furniture and joinery production	18
II Product development in the secondary wood processing industry	22

INTRODUCTION

This training manual is one of a series prepared by a UNIDO expert while serving as Chief Technical Adviser on a UNDP financed and UNIDO executed project in the Republic of Yemen, to strengthen the Technical and Managerial Capacities of the Carpentry Cooperatives in Mukalla and Seiyun (project No. SM/PDY/87/005).

The entire scope of the training envisaged to be given, with the intended audience for each topic is given in Annex I.

The syllabus, namely the topics, the duration of lectures (theory) and practical work and the level of competence attained after completion of the course on this topic is given in Annex II.

PRODUCT DEVELOPMENT IN THE SECONDARY WOOD PROCESSING INDUSTRY.

In any manufacturing company, production programme is the most important factor of a successful business. It predetermines raw materials, technology and customers. In a secondary wood processing industry oriented to a competitive market there is a permanent need for innovation of the product line and product development must be carried out as a permanent task. This training manual is aimed at training the technical staff of the Carpentry Cooperatives in Mukalla and Seiyun, Yemen, on the basic procedures and techniques of product development. Product development is a complex work divided in many steps. The complete methodology of product development is explained.

1. A strategic approach to product development.

Every manufacturing company has to analyze its product strategy from time to time in order to strengthen its competitive position in the market. By making strategic decisions about the main characteristics of a product line the future orientation of the company is established.

The general level of the product line which a company wishes to achieve is determined by certain requirements regarding the:

- Originality of the product.
- Quality of products.
- Production expenses.
- Reliability.
- Length of the production cycle.
- Flexibility.
- Speed of delivery etc.

Therefore, the key task of every production is to define a level of the requirements for each single product. These are strategic decisions which should be made by the top level of management. Many factors ought to be analyzed in choosing the right strategy, but the most important are:

- customers' requirements.
- factory's own capabilities.
- resources available.
- skill of its staff.
- experience.
- its position in the market.

Some of the key strategic considerations are: specialization, cooperation, diversification and balance between these. Specialization of individual production units and cooperation among them can result in a higher degree of diversification, a higher productivity and better quality products. Any product strategy requires a specific type of organization, structure of management, quality control and marketing performance. The product development strategy is a part of the company's strategy focused on the development of a product line, harmonized with marketing criteria and the factory's own capabilities. Strategic plans should be recorded in a written form, otherwise they will be ignored.

Regarding the establishment of a product development strategy in the Carpentry Cooperatives in Mukalla and Seiyun, the lack of a competitive market and other current limitations must be considered as a temporary situation which will be changed with the growth of production and market supply. At present, all production units within these Cooperatives follow a strategy which is known as "Follow the crowd". This strategy does not give any chance for prosperity and should be gradually changed, accepting a "product innovation" strategy.

2. Product life cycle.

The product life cycle is an approach to recognize distinct stages in the product life history in order to formulate better marketing plans. A product's life cycle is presented graphically as an S-shaped curve showing sales and profits (see Fig. 1).

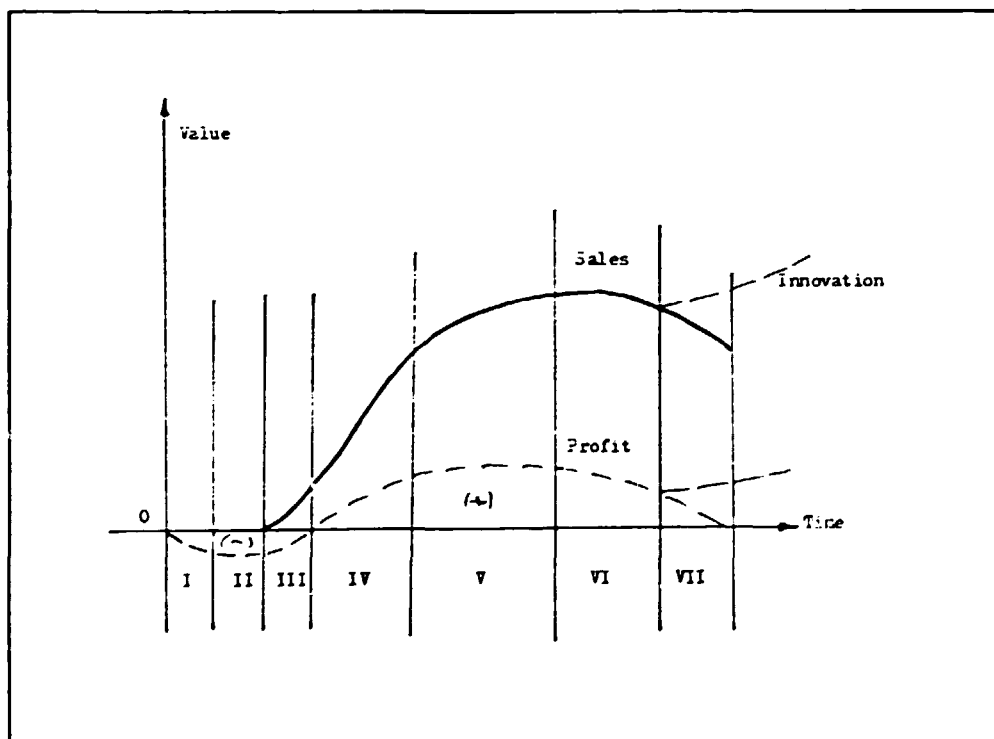


Fig. 1: Product Life Cycle Curve

The product life cycle can have seven different stages as follows:

- i. Market research,
- ii. Technical development of product.
- iii. Introduction into the market,
- iv. Growth of sales,
- v. Product maturity,
- vi. Market saturation,
- vii. Sales decline.

The actual time span of each stage must be estimated for every particular product, based on actual sales and profits. Market research (i) is a period when the company is looking for facts and ideas to formulate a future product. In the stage of the product's technical development (ii), design, construction, prototype and production documentation should be prepared. The introduction into the market stage (iii) is a period when first production starts (zero series) and the company pays special attention to promote and to test the product in the market. Quality control should be very strict in this stage.

In all three stages described above, profit does not yet exist, and investment in product development is shown as a negative profit. In the growth of sales stage (iv), an increasing number of customers buy the product, and production has to follow sales to be able to satisfy demand. With growth of sales, profits are also growing.

The product maturity stage (v) is a period when growth of sales is slowing and when profit reaches its maximum. Production is fully stabilized and expenses are reduced as much as possible.

The market saturation stage (vi) shows stable sales and profit and production reaches maximum efficiency.

The last stage, of declining sales (vii), is marked by the decline both of sales and profits. Profit is falling fast to zero when further production is unwarranted. The product's life cycle is strongly influenced by competition and fashion.

Knowledge of the product life cycle is very useful in planning when to start developing new products and their introduction in the product line.

3. Steps in product development.

It is most easy to get a new product developed up to the stage when it is ready for sale. Product development passes through different steps and it takes months of systematic work. In order to get a few good products a company has to develop a great number of new ideas. Most of these ideas are dropped during the initial selection, showing incompatibility with the company's objectives and resources. Next, selection continues through an evaluation of the profit potential. Some products will be disqualified during the first stage of commercialization testing the market. Finally, some good products prove themselves to be successful.

Top management must take full responsibility for the quality of new product development. It must define product categories and criteria for acceptance. It must also decide how much money to allocate to the product

development budget, establish product development procedures and find the right people to carry out the task of product development. In the case of a medium size factory, like those belonging to the Cooperatives, a product development model has been prepared which determined, in the form of a flow chart, all the steps to be followed in the stage of technical development of products (see fig. 2).

The need for a new product should be identified as a first step to satisfy the market demand and to utilize available capacities.

Based on the customers' needs and wishes, available raw materials and free capacities, a product to be developed should be identified and defined. This step is followed by the collection of ideas for the new product. The designer should visualize these ideas in the form of sketches, and, with a brief description and calculation of cost, propose them for evaluation. The evaluation team must be composed of specialists working in: sales, technical (production) department, purchase, quality control and the production units concerned. The evaluation should determine whether the idea fits the objectives, resources and profitability. At this stage of evaluation facts are still scarce and the experience of the team members is of great value. Products rejected by this evaluation are not retained for further consideration.

For the accepted products, the next step is the preparation of technical documents for a prototype. These documents are: drawings, technical description, specifications of materials and calculation of cost of materials.

When the prototype has been made, it is evaluated by the same team and, if possible, by more people dealing with marketing, quality control and even some customers. The evaluation of the prototype should answer whether the product satisfies criteria for: function, technology, materials, product exploitation, possibility of regeneration, etc. All these criteria must be determined in advance and cannot be a matter of guessing and bargaining. If necessary, the documentation for the prototype could be changed and all procedures repeated once more.

The next step for an accepted product is the preparation of production documentation, as it is prescribed by the work preparation procedures.

When the production documentation is prepared, the first production should start as a "zero series". This is a minimal number of products needed to test both the documentation and the production process and to screen all hidden defects or weak points which have to be corrected before regular production starts. In working on product development, production capacity and possibilities cannot be ignored. Each workshop has a certain limitation which should be taken into account. The product line and every single product must be adjusted to the factory's capacity.

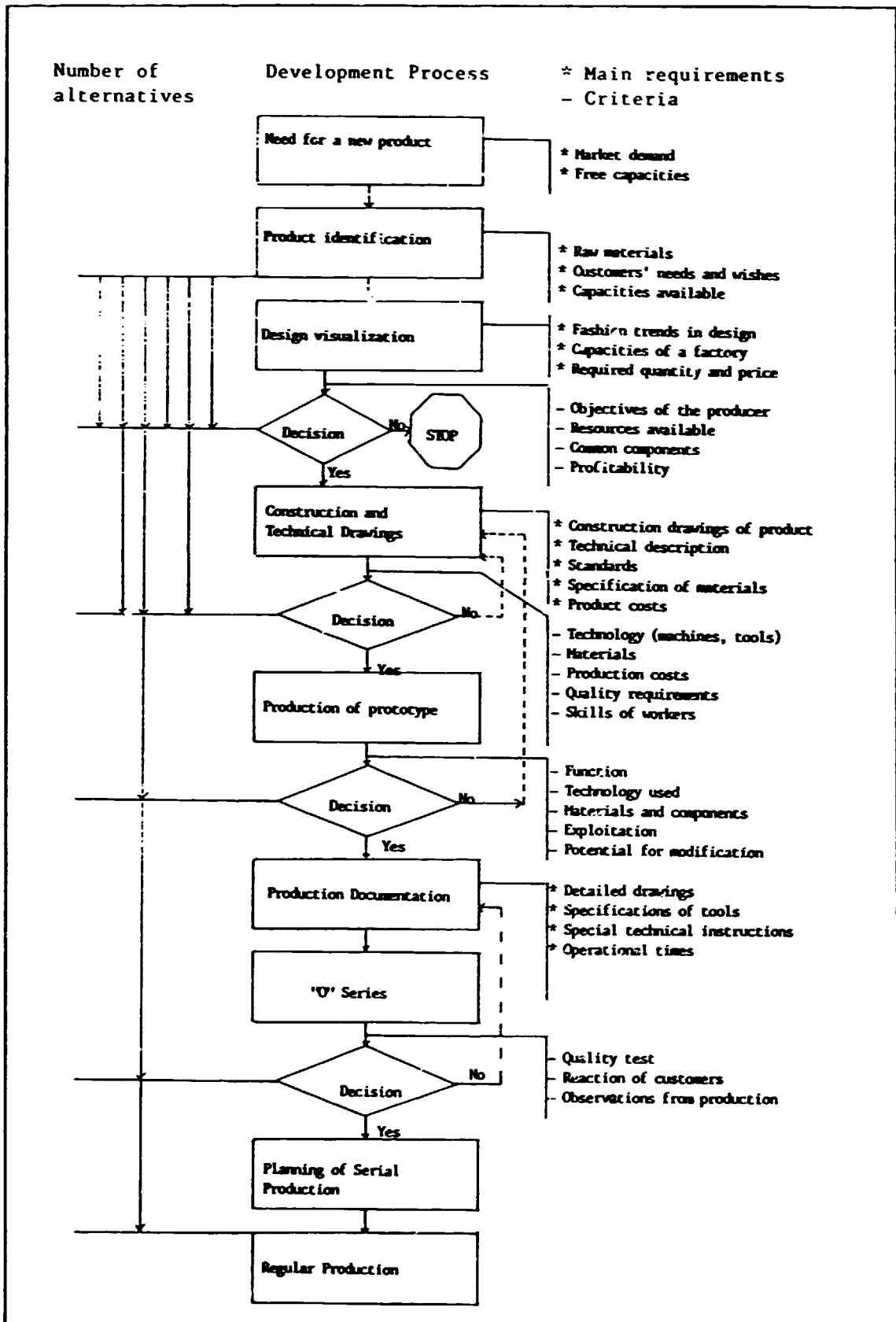


Fig. 2: Schematic representation of product development procedures.

4. Analysis of market demand and factory capabilities.

For the purpose of product development, the factory has to follow the sales of its existing products in order to decide when to replace them with new ones. If there are complaints regarding the quality of the products, a company should find out what is the cause and undertake corrective actions.

In order to develop new products, data about similar products in the market should be analyzed to estimate volume of sales, prices, quality, design, colours, sizes etc. First, the total market demand should be analyzed, who are the existing and potential future suppliers, is there an unfilled demand etc. A segment of the market should be chosen, distribution channels and quality requirements determined etc. In analyzing the factory's capacities, the following factors should be taken into consideration:

- (a) factory's location,
- (b) equipment,
- (c) capacities,
- (d) raw materials,
- (e) auxiliary materials and components,
- (f) tools and technical supply,
- (g) skills of personnel,
- (h) experience,
- (i) quality of products,
- (j) organization,
- (k) maintenance,
- (l) energy,
- (m) motivation, responsibility and attitude.

The above factors are analyzed hereunder for the Cooperatives and an example is given.

(a) Location of production units:

The production units are located in small cities with limited market and in the future they must count in the transportation of their products to distant places within the country or to neighbouring countries. Transportation costs could be reduced by shipping knock-down or semi-assembled products.

(b) Equipment:

The workshops are equipped with machines for processing solid wood components for joinery and simple furniture products, and for processing laminated panel components for carcass furniture (bedrooms, cupboards, cabinets, desks etc.). The majority of the existing machines are antiquated and have a very low precision. Some processing operations are done by using hand tools. Sanding and surface finishing have not yet been introduced.

At present, the workshops can manufacture only simple joinery and furniture products which must be assembled prior to shipment to customers.

(c) Capacities:

The average monthly number of units produced in the workshops in Mukalla and Seiyun in 1989 is given in table 1 hereunder.

	Furniture Products Units/month	Joinery products Units/month	Other Products Units/month	Total Units/month
Makalla	807	500	102	1409
Shahir	191	294	106	591
Ghail Bawazer	100	256	21	377
TOTAL CSCC	1098	1050	229	2377
Seiyun	89	165	126	380
Tarim	55	409	8	472
Shiban	2	153	--	155
Hauta	3	198	--	201
TOTAL SEIYUN COOPERATIVE	149	925	134	1208
TOTAL BOTH COOPERATIVES	1247	1975	363	3585

In case that the workshops improve the organization of the production and introduce serial production of standardized and well designed products, the production volumes can be doubled.

(d) **Raw materials:**

Sawnwood, plywood and melamine laminates are the basic raw materials used in the cooperatives. Blockboard and particle board are used in small quantities. The sawnwood used is of good quality and if it would have been selected by colour and properly stocked and seasoned it could meet requirement for high quality. Plywood is also of good quality and, if properly sanded and varnished, could be used as a face for furniture parts without veneering or laminating. All raw materials are imported from Singapore market from where other types of boards, like particle board or surface improved boards, could also be provided. Currently 18 mm plywood is used for manufacturing the laminated parts of carcass furniture. This could be considered to be too expensive. A better solution would be the use of cheaper blockboard or yet another cheaper alternative would be the use of surface improved particle board. From the product development point of view all raw materials are available through import under the same conditions.

(e) **Auxiliary materials:**

Almost all auxiliary materials are imported, with some restrictions caused by difficulties in obtaining foreign currencies and the import licence. In order to facilitate import, components should, as far as possible, be standardized and used for a wide range of products.

(f) **Tools and technical supply:**

The cooperatives rely completely on imported tools and other technical supplies (spare parts, instruments etc.). This calls for standardization of joints, profiles and other construction elements, so that the range of imported tools could be minimized.

(g) **Skilled personnel:**

Designers must know the skills that the workers in production have. This will determine the complexity of the products and quality criteria. It is always better to set lower criteria which can be achieved, than higher ones which cannot be fulfilled. Transition to more complex products should be achieved gradually.

(h) **Experience:**

The carpenters working in the cooperatives have long experience in the manufacture of products on an artisanal basis. There is a lack of experience in production using industrial methods. Designers of new products must try to adjust construction to the more productive industrial work.

(i) **Quality of products:**

The present production is of a rather low quality. To improve quality, design of new products must include strict quality standards, written and adhered to.

(j) **Organization:**

The existing production's major obstacle is the lack of proper work preparation. From the organizational point of view it is important that all details are drawn properly and that all production documents are completed. Proper work preparation and paperwork must be prepared for all new products.

(k) **Maintenance:**

The quality of maintenance has a big influence on both quality and productivity. Tolerances for new products must be set in accordance with the real (actual) precision of the woodworking machines.

(l) **Energy:**

Veneering and some other technological operations depend on proper heating. Compressed air is widely used for many wood processing and assembling operations, and some contemporary woodworking machines have built-in pneumatic components. Also, the working conditions as illumination, ventilation and dust exhaust are conditional upon various sources of energy. All these have a certain impact on the quality of the products, and the designer must take these into account.

(m) **Motivation, responsibility and attitude:**

If motivated, the people will always work above expectation and if not they will always accomplish less than is expected. This applies not only to the quantity, but mainly to the quality of products.

Closely related with the motivation is the responsibility towards success in general.

5. Analysis of the existing product line:

Under the word "product" we do not understand a physical object only, but a package of values offered to the customer. A customer buying a piece of furniture is not buying a wooden object, he is buying pleasure, comfort and satisfaction.

The product is always a compromise between desires of the customers and technical possibilities. So, both marketing and production desiderata (attractiveness) can be mentioned at the same time. For that purpose, the matrix shown in Fig. 3 can be used.

Production attractiveness ↑	MARKETING ATTRACTIVENESS ←		
	High	Medium	Low
High	A	A	B
Medium	A	B	C
Low	B	C	C

Fig. 3: Matrix of product attractiveness.

The product classified in a field "A" is attractive from both the marketing and production points of view. It means that customers like it, that the product fits all the sources and capacities available, that the quality required is achievable, and that the price of the product is reasonable and acceptable for both customers and the factory.

The products in a field "B" should be improved to become more attractive, and the products in a field "C" should be replaced by new ones.

Going back to existing production programme in the cooperatives we can state that it consists of some joinery products (doors and windows) and some furniture products (bedrooms, dressing tables, wardrobes, cupboards, office desks, school furniture, kitchen cabinets, bookshelves, chairs etc.). The joinery products are mainly of a repetitive nature, while the production of furniture is based on the customers' orders and design requirements.

Producing to meet the customers' orders has created many difficulties with regards to the purchase of materials and the organization of production.

6. Product design.

Gathering ideas is the first activity in the technical development of a new product. Many sources can be used for the generation of new ideas. The present and potential customers are the logical starting point in the search for new product ideas. Customers should be asked not to give new product ideas directly, but to describe their problems with the current products and what household problems they have not yet solved. The staff of the sales department have the best exposure to customers' needs and complaints, and therefore they could be a good source of new product ideas.

Top management is a major source of new product ideas. Having a wide range of information at its disposal, top management is in the position and has the responsibility of generating new ideas.

Professional literature, periodicals, commercial publications, consultants and visits of international furniture exhibitions should be used as sources for generating new ideas.

The purpose of generating and collecting ideas is to create a large number of ideas, but the group selecting new ideas has the task of reducing their number and eliminating those ideas which are not compatible with the company's capabilities. Two types of errors are possible: to drop out a good idea or to accept a bad one. Those ideas surviving the selection must undergo further development. The next task, to visualize the ideas selected, is assigned to a designer.

As an orientation guide, the designer must have a written brief which expresses a product policy. For instance: "design an office desk with filing cabinets on both sides, in the medium price range, with a solid hardwood frame and plywood. Surface finishing is to be transparent NC lacquer stained to a mahogany colour. The desk's top is to be laminated with a melamine laminate having a matching colour".

The first step is making a number of sketches in the form of axonometric pictures, rather than orthogonal technical drawings. It is important to make many proposals and variations. It is not advisable to start detailed construction at this stage because it creates resistance to changes.

The proposals should be discussed by a team having the cooperatives' best knowledge of the market, processing technology and economics.

The proposals should be discussed in a positive manner, and even if a proposal is not accepted it may contain details or ideas that could be used in other products.

The main criteria for evaluation at this stage are connected with company objectives, resources and profitability. That means that the new product has to follow the company's marketing strategy, that the company has available materials and equipment to produce it, and that the expected price could assure the expected profitability. Products which cannot satisfy these criteria must be rejected, and those passing this selection are the subject of further development.

In order to help both the designer and the team working on product development, some of the facts important for a successful design will be considered hereunder.

Customers expect a purposeful design at an acceptable price. A designer has thus to be involved in economic considerations when working on new designs. Design has the strongest influence on the economics of furniture and joinery production. Nowadays the task is not to produce luxurious furniture for high society, but simple social furniture for the majority of the population.

Design is demanded for the improvement of our life environment. Design factors are closely connected with the factors determining production expenses. But it is hard to establish an appropriate connection, because the designer sees only aesthetic components, while the production men see only the cost of manufacturing. It is very important to build a bridge of reciprocal understanding between the designer and the production people, that is between design factors and factors determining product cost.

The design factors are certain conditions, influences and requirements that the product is subjected to, determined by the use and production. There are two groups of design factors: objective and subjective factors.

The objective design factors are equally valued by all customers. They cover: purpose of products, function, reliability, durability, ergonomics etc.

The subjective design factors correspond to individual desires of customers and they cover: form, comfort, size, compatibility to related products, material, assembling, nationality, correspondence to the style of customer's age etc. The subjective factors are the subject of a market research.

Production design factors are limited by law, standards, government regulations, patents, etc.

Norms and standards are mandatory and they determine sizes, quality, health protection and so on.

A degree of uniformity and number of interchangeable and different parts and components are design production factors, having considerable influence on the level of production costs.

A designer should respect some rules and principles of design. The most important ones are briefly mentioned hereunder:

(a) **Division of space and areas:**

Every product has a primary volume composed of major and minor volumes or areas, and these are composed of subdivisions which may or may not be of equal size and importance. Vertical primary volume dominant lines should lead the eyes in a vertical direction, and horizontal primary volume dominant lines in a horizontal direction. When a mass has to be divided vertically into two parts, one part should be greater than the other but balanced. If the mass is divided into three parts the lowest should be the greatest, with each succeeding one smaller in size.

When a volume is to be divided into two parts horizontally, the parts may be of equal size or one greater than the other, but balanced. A mass may be divided horizontally into three equal areas or with greater central area placed between two smaller areas equal in size. When more than three horizontal areas are necessary, they may be equal in size and importance or be symmetric.

(b) Curved lines and elements:

A designer can use curved lines and elements to round corners, relieve their mechanical severity or produce quaint effects. A beautiful one direction curve has no straight line in its composition. The reverse curve is always more beautiful if the curve is sharper at one bend than the other, and has no straight lines in its composition. Curves in turning and mouldings should connect with fillets close to right angles.

(c) Proportion:

The division of volumes, the planning of curved lines and determinations of proper proportions are closely related problems and should be solved simultaneously. To secure good proportions the contrast between the length and width of a volume should not be too great. Appropriate proportions are 2 to 3, 3 to 5, 5 to 8 and so on. The starting point in working out proportions is a fixed, standardized element which the designer cannot change.

(d) Ornaments:

Furniture ornaments could be chosen among abstract forms, motifs from nature and artificial objects. Outlines, borders, panels and moulded surfaces are well suited for ornaments. Ornaments must not destroy but emphasize the logical structure of a product and must be a harmonized part of a unified whole. The ornament on the borders should strengthen and support this outline. Ornaments should be placed on a major centre of interest, taking symmetry into account.

(e) Colours:

Colours used in furniture production must be harmonious. It is essential for a certain scheme of furnishing. The greater the area to be coloured, the less intense the colours should be. Harmony by analogy is secured by relating all the colours in a scheme to one major colour.

(f) Standardization and interchangeable parts:

Standardization is a very important factor in product development and design. Its purpose is to rationalize production and to simplify work organization. This factor is related to the standardization and the reduction of different furniture parts and sizes to the most rational and reasonable number. It refers also to the standardization of materials, joints, tools, jigs, documents etc.

Company policy should determine how far it can go with standardization so as not to reduce its assortment below an acceptable level. Though the danger of excessive uniformity always exists, a professional approach can eliminate such fears by creating a modular system of products or extending a product line by using parts common with another product.

The sizes of furniture pieces, as well as angles and other ergonomic characteristics, must be based on the average size of the human body and its physiological requirements.

7. Making prototypes.

Though visualization is the most important part of the designer's work, he should follow product development all through to the market.

The next stage in the development of an accepted product is making the basic technical documents for the production of a prototype. These are:

- parts list,
- technical drawings of the product,
- specification, standards, and
- calculation of production costs.

At this stage, it is not necessary to finalize details in the drawings because further corrections are possible, after evaluation of the prototype. The next step, based on the technical drawings prepared, is making a prototype of the new product. The finished prototype is subject to a new evaluation by the same team. This time the main criteria are in connection with: function, technology, materials and end-use of the product.

During the first discussions, an idea was expressed in words and analyzed. The second time, the designs are evaluated by viewing sketches (pictures), and finally the evaluation of the prototype as a physical object takes place, and many new arguments, both for and against it, might arise. This is the last and most important decision, and accepted products - whether good or bad - go immediately into production.

If the prototype is not acceptable, the technical documents must be changed and a new prototype should be made according to the new documentation.

There are other purposes for producing a prototype. Defects in construction are discovered, dimensions are checked, as well as the strength, the appearance and function. Therefore, the prototype must be made to look identical to the products expected to be obtained in the regular production.

8. Value analysis.

The value analysis method was developed in order to ensure the continuous development of products and to find out the most suitable materials and methods of production. The best results are obtained on new products, during their development, studying parallel designs, materials and production methods. Value analysis methods should be an integral part of product development procedures, carried out by the team working on product development.

Value analysis is a systematic, function oriented method, seeking to find out an optimal combination of function and cost.

In value analysis, value is defined as function divided by cost.

In the analysis of the function, the product is split into components and functions, the value of each component is estimated and compared with its

cost. The cost can be reduced either by retaining the same function or improving the function by retaining the same cost. All other combinations are also possible.

The basic things to be analyzed are:

- completeness of construction,
- function of product,
- cost of materials used, and
- cost of processing.

The cost of material is often higher than necessary because of wrong specifications of materials, and insufficient knowledge concerning quality, prices and construction possibilities. The same applies to the cost of processing. With small adjustments in the design or construction some processing operations can be simplified or even omitted, combined with other operations or handwork substituted by machine work.

Since value analysis can only be done as a team work, the creation of the team is the first step in introducing it.

9. Construction, detailed drawings and technical description of a new product.

The main aim of product construction is to enable the rational establishment of the technological process and a maximal utilization of materials.

Furniture and joinery construction calls for adequate methods of joining parts of a product, their mutual positioning, taking into consideration: strength (both product and parts), function, economy, production possibilities and specific characteristics of wooden materials.

Several basic elements of furniture and joinery constructions are distinguished:

- frame elements,
- flat elements,
- combination of frame and flat elements,
- case elements,
- upholstered elements.

Very often products have one prevailing type of construction, but other types of elements are also used.

With respect to the assembling of elements into a final product, the following can be distinguished:

- fixed, permanent constructions, mostly glued, and
- knock-down, separable constructions, joined with fittings and other separable joints.

To ensure the adequate strength of the product, dimensions and directions of constructive elements must correspond to the maximum load during use.

Best solutions are obtained when the construction of wooden products is carried out by a specialized technologist. They should respect some basic rules such as:

- The wooden product must be constructed so as to enable unavoidable changes of dimensions, caused by changes of moisture content, without affecting the form and strength of the product.
- Since details of a product must be constructed so as to minimize dimensional changes.
- All details of a product should be designed and constructed so that all joints can be made on available machines.
- All details of a product should be constructed based on nominal sizes of standard dimensions of the material used.
- Furniture and joinery products must be designed and constructed to have rational forms and sizes, to correspond to the purpose of the product and to satisfy technical, sanitary, hygienic and aesthetic criteria.

Selecting and proper dimensioning of joints is of utmost importance. There are several major groups of joints:

- glued joints,
- carpentry joints,
- screwed joints,
- metal hardware connectors, and
- joints using staples and nails.

Mortise and tenon joints, dowel joints, tongue-and-groove and corner-lock joints are the ones most often used for fixed constructions, while screws and different types of fasteners are predominantly used for joining knock-down components.

It is recommendable to prefer joints which allow a better utilization of raw materials and use of multi-purpose machines, without the need for manual work or hand fitting during assembling operations.

Construction drawings ought to be made to a given scale. The 1:10 scale is very practical, but for small details it could be 1:5 or for important details 1:1.

Construction drawings show the product in all orthogonal projections, indicating dimensions. It must contain the specification of all parts with their dimensions and type of materials. Additional descriptions are desirable to avoid any ambiguity. The technical description contains a description of a product as a whole, including: functions, materials, special details, quality requirements, special technological processes, surface finishing, packaging, size and weight.

For the purpose of manufacturing or preparation of tools, jigs and setting the machine, all details should be drawn in three basic projections, showing all profiles, joints and other dimensions and characteristics.

Standardized details, once drawn, can be used at all times.

To conceal dimensional inaccuracies it is better to foresee overlaps, rabbets, or levellings on the joining ends of the parts. The description of the drawing should indicate: name, code number, material and requirements regarding quality or processing treatment.

Personnel producing working drawings must be familiar with the relevant technology.

10. Recommendations on product development adapted to the situation in the Cooperatives.

Product development is a highly professional work and must be carried out on a permanent basis by specialized persons and permanently. Each cooperative should have people specialized in the design and construction of products.

At least two men in each Cooperative should be assigned to work on product development: one a designer and the other a draughtsman. The task of the designer should be to study designs of products and work on their improvement, and to work on new designs. The designer should create a new product including: form, function, selection of materials and construction and should be able to estimate the approximate cost of the new product.

The draughtsman should be trained for all technical drawing tasks and be able to produce independently detailed drawings of parts.

The product development section should be a part of the production department and should also include two highly skilled craftsmen to work on production of prototypes and jigs. In case that these two craftsmen cannot be fully employed in production of prototypes they should be used for the production of special order products which are not included in the serial production.

In addition, each cooperative should nominate its product development team composed of the best professionals from various departments: sales, production, purchase, quality control, management and cost accounting.

Management should make strategic decisions on:

- type of the products to be developed,
- target market and segments of customers,
- raw materials to be used,
- type of surface finishing,
- quality and price level,
- profit goals,
- special request as: modular designs, interchangeable parts, level of standardization, assembly method etc.

The cooperatives must not delay the start of work on the development of a new product until the sales of these products has declined. New products must be developed in advance and be ready to be included in production as soon as the market shows signs of saturation with the existing products.

Designers and product development teams should follow the procedures recommended in this manual.

ANNEX I

TRAINING PROGRAMME FOR FURNITURE AND JOINERY PRODUCTION

This training programme is designed to achieve the objectives and outputs of the project entitled "Strengthening the Technical and Managerial Capacities of the Carpentry Cooperatives in Mukalla and Seiyun" (project No. SM/PDY/87/005).

After visiting all the production units of these Cooperatives, (the three units of the Coastal Strip Carpentry Cooperative and the four units of the Carpentry Cooperative, Seiyun), and after studying the present state of their production, it has been concluded that a thorough training of operators and managerial staff is a prerequisite for all improvement. Due to this conclusion, the training programme prepared and proposed hereunder is more comprehensive, and the training activities are more numerous than originally planned in the project document. It has been designed to meet the specific requirements of the cooperatives which are on the point of transiting from handicraft to industrial production. The topics for the training courses selected are:

COURSE NUMBER	TITLE OF COURSE	DESIGNED FOR:
1.	Production systems and types of production in the wood processing industry.	Management staff of the Cooperatives and their production units.
2.	Furniture products, classification, standards, design and construction	Production Department staff
3.	Joinery products, classification, standards, design and construction	Production Department staff
4.	Product development in the secondary wood processing industry	Staff of the production and sales departments.
5.	Organization and planning of production.	Production planning staff.
6.	Work allocation and control of production	Production planning staff, supervisors and foremen.
7.	Planning, cost accounting, pricing, cost control and optimization of a product line.	Accountants, salesmen and staff of the production department.
8.	Inventory control and purchasing techniques.	Purchasing unit's staff and staff of the production department concerned with material planning.
9.	Basic elements of marketing	Management, sales and production department staff.
10.	Modern industrial production management	Managerial staff.
11.	Information and documentation systems in the secondary wood processing industry.	Managerial staff, top and middle management of the cooperatives.
12.	Plant layout	Staff of the production department and production supervisors.

COURSE NUMBER	TITLE OF COURSE	DESIGNED FOR:
13.	Wood, affiliated products and other materials used in the production of furniture and joinery	The technical department's staff, supervisors, foremen and operators.
14.	Wood seasoning and preparation	The technical department's staff and people working in the timber yard.
15.	Crosscutting and trimming of sawwood	Operators of crosscutting and ripping machines, and foremen in the wood cutting area.
16.	Panel sizing.	Operators of panel sizing machines and their foremen.
17.	Veneering and laminating surfaces and edges of wood based panels.	Operators laminating surfaces and edges of panel furniture components.
18.	Surface planing and thicknessing of components	Operators of surface planers/jointers and thicknessers and their foremen.
19.	Tenoning, mortising and drilling	Operators of tenoning, mortising and drilling machines and their foremen.
20.	Moulding and routing	Operators of moulding and routing machines and their foremen.
21.	Sanding and surface finishing.	Operators of sanding and surface finishing machines and their foremen.
22.	Preassembling, assembling and packaging.	Assemblers, packagers and their foremen.
23.	Managing of quality and quality control	Managerial staff at all levels, foremen and quality controllers.
24.	Jigs, templates and fixtures in the secondary wood processing industry.	Production department's staff.
25.	Tool sharpening, maintenance and managing.	Tool sharpeners and persons in charge of ordering tools.
26.	Internal transport, receiving and storage of materials and shipping of products.	Persons working in storage and internal transport services.
27.	Maintenance of equipment	Maintenance personnel.
28.	Safety measures in the secondary wood processing industries.	Foremen and supervisors in workshops.
29.	Motivation of employees	Managerial staff at all levels.
30.	Innovation and development techniques and methods.	Managerial and production department staff.

PURPOSE AND METHOD OF TRAINING

Training of employees is an integral part of production in modern industrial enterprises. Technical and technological developments offer new technical means and new production methods which make human work easier, safer and more productive. To be able to utilize such advancement, people working in industry have to learn and to train in order to achieve new knowledge and skills necessary for handling modern equipment and processes.

In developing countries, such training has decisive importance for the better utilization of new production techniques and for mastering new technological processes. To avoid unnecessary mistakes and gain indispensable skills, training courses are the most suitable way, because, in a short time, people can learn the best way of performing their duties in production.

The output of these training courses should be knowledge acquired by workers who will increase their abilities for effective production. To achieve this, the training method will rest on three steps as follows:

1. The lecturer will explain a new method.
2. The lecturer will demonstrate the new method.
3. The trainee will perform the new method under the lecturer's supervision.

Short manuals written in a simple language, understandable to the workers, will be prepared by lecturers for each course. Translated into Arabic and distributed to the trainees. All graphs, tables and formulas will be adjusted to the level understandable to the people to be trained.

Theoretical teaching will be conducted in a classroom and its duration will be adapted to the minimum of theory which has to be known for a certain job. This part of the training will be performed by the CTA, other experts in the project and by United Nations Volunteers assigned to the project.

The practical part of the training will be organized at the work areas of the respective production operations. This part of the training will be carried out jointly by the experts and the UN Volunteers. The working area must be organized in a proper way, including the prepared production documents, tools, jigs, gauges, protective devices, pallets, materials and everything that is necessary for safe, productive and good quality work. The lectures should explain and show how to check a machine, tools, jigs, and in the case of wrong adjustment, how to correct them and how to prepare correctly all that is needed for the production operation.

The lecturer will show the correct way of performing the operation and supervise the performance of the trainees until he concludes that their work is fully acceptable and that the quality of the products is satisfactory. The counterparts with higher skills and experience will also be engaged to train less qualified labourers and to supervise their practical work.

Most of the training courses conducted for the Coastal Strip Carpentry Cooperative will be repeated for the Carpentry Cooperative in Seiyun, while in some cases the trainees from Seiyun will be invited to come to Mukalla. Persons from the production units outside of Mukalla and Seiyun will be travelling to these two places. Some of the practical training could and should be carried out in the satellite units by the UN volunteers.

SELECTION OF TRAINEES

Trainees will be selected by the counterpart, according to their jobs and to the topics of the training programme. Besides workers who will directly perform particular production operations, all other people concerned with certain aspects of the production, such as: foremen, supervisors, management staff, maintenance personnel, etc. can be included in the training. The list of trainees is an integral part of the training programme and it determines the number of copies of the training manuals to be prepared and distributed for each course.

TIMING OF TRAINING COURSES

The training courses will be prepared and conducted mostly during the experts' missions, and those to be conducted by the volunteers will be scheduled in between those missions. The priority should be given to the courses which are a prerequisite for the better understanding of other topics.

The timetable of all courses is a part of this programme, though the exact schedule can be changed depending on the timing of the future missions by the experts.

Some of the courses are intentionally foreseen for the last mission, hoping that by that time the workshops will be the missing equipment, which is indispensable for a proper training of the operators.

SYLLABI OF COURSES

This programme contains syllabi of all courses planned to be conducted during the project execution. The courses are broken down into topics, and, for each topic, the training duration, both theoretical and practical, and the level of competence to be reached are given.

The selection of topics and the required level of competence is aimed to reach a minimum knowledge needed for successful manufacturing of furniture and joinery products in a medium-scale factory.

Each course has its number and topics are subdivided into a decimal classification following the numbers of the courses.

Once all the training courses are completed the training material can be compiled into a printed handbook to be used throughout the country.

ANNEX II

Product development in the secondary wood processing industry

This course is foreseen for the staff of the production and sales departments.

STAGE	TOPICS	TRAINING TIME (hours)		LEVEL OF COMPETENCE TO BE REACHED
		THEO- RY	PRAC- TICE	
4-1	Introduction.	0.25	--	Understanding the purpose of the course.
4-2	Strategic approach to product development.	0.25	--	Being able to make strategic decisions concerning product development.
4-3	Life cycle of products.	0.25	--	Understanding the necessity of permanent innovation of the product line.
4-4	Steps in product development.	0.50	--	Knowing about procedures of product development
4-5	Analysis of market demand and factory capabilities.	0.5	--	Being able to understand the importance of some of the factors of the product line.
4-6	Analysis of existing production.	0.5	--	Being able to analyze and improve products.
4-7	Design of products.	1	4	Knowing about the main design factors and rules.
4-8	Production of prototypes.	0.5	8	Being able to produce prototypes of new products.
4-9	Value analysis.	0.5	4	Being able to carry out a simple value analysis.
4-10	Construction, detailed drawings and technical description of a new product.	0.5	2	Being able to work out the construction, detailed drawings and the technical description of a product.
4-11	Recommendations for product development adapted to the Cooperatives' situation.	1	--	Understanding what changes are inevitable in order to develop a more appropriate product line for the Cooperatives.
	TOTAL	5.75	18	