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Technical Meeting on the Selection
of Woodworking Machinery

Vienna, Austria, 19 - 23 November 1973

GENERAL SELECTION GUIDELINES FOR WOODWORKING MACHINERY 1/

by

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SUMMARY

This paper covers cases where manufacturing facilities already exist which must be imporved or extended. Any decision to invest in new machinery should be based on reliable, objective studies which marshall all pertinent data on alternatives and present it in a form which will allow a decision.

Macroconditions involve availability of raw materials (sources and costs), development of infrastructure (transportation network, power, water etc), development trends in the industry (automation, specialization, new products and competition), the level of production techniques and the serviceability of machines.

The actual procedure for decision-making and/or weighing alternative solutions is discussed in terms of sequence of work phases, manufacturing programme (type, quality and volume of production) new requirements for raw material, waste disposal, electric power, heat, water, compressed

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air, transport and manpower, and finally a list of equipment for the production unit. Various means of economic evaluation are then explained.

The actual purchasing procedure is then discussed including what must be contained in invitations for binding quotations, and the step-by-step evaluation of offers - going into technical commercial and economic aspects in some detail.

The bibliography contains forty-five entries on this general subject, and two annexes supplement the paper with details of: 1) a checklist of points to consider when purchasing a woodworking machine which is extracted from a 1971 Furniture Industries Research Association (FIRA) publication by Mr. R. Stephenson; and, 2) a classification system used for machinery comparisons by the author's consultant firm.

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CONTENTS

A. PROBLEM IDENTIFICATION

I. Introduction

1. It must be borne in mind that the aims of this meeting do not cover the whole range of problems connected with the establishment and running of wood processing industries or plants in developing countries, and that the main objective is confined more or less to the selection of individual machines. The choice of production processes will be dealt with at another meeting organized by UNIDO at a later stage.

2. This paper covers therefore cases, where manufacturing facilities already exist, which have to be improved or extended.

3. As a general rule it has to be pointed out, that the industry - in order to remain competitive - must steadily offset rising costs, improve quality and productivity, replace inefficient machines and equipment, reduce waste and convert it into profitable byproducts, and also improve management control and marketing methods, regardless in which part of the world it is involved.

4. Whether the operation is big or small, every enterprise faces opportunities for worth-while improvements and accomplishments of its manufacturing facilities. The problem is to realize the changes in such a way as to enable the plant to meet the challenges and to convert them into profitable growth.

5. Whatever might have been the reasons for a decision to consider the possibility of purchasing a new machine or equipment, favourable economic results are to be expected in any case. In order to avoid a failure in this respect certain preconditions have to be thoroughly analysed and evaluated prior to any final decision. The extent of attention which is to be paid to such evaluation work depends naturally on the amount intended to be invested. On the other hand the amount of capital which an enterpreneur is willing to invest will be, no doubt, closely related to the expected profitability of such an investment.

6. In this respect the fact has to be taken into account that the efforts in mechanization and automation as well as the aim to specialize operations and to decrease the labour consumed for economic reasons had their influence on construction of machines and equipment resulting, during the last decades, in such a variety of machinery that it becomes difficult even for an experienced technician to cover all the manufacturing fields.

7. Any decision to invest in new machinery or equipment should be, therefore, based on a reliable basis which means that preliminary studies are essential; those studies should aim at solving all the questions influencing at a later stage the results to be expected as a follow up of the decision.

8. There may be different approaches or systems on how to proceed to come to the desired conclusion. Regardless of the procedure chosen it seems that two major areas of problems involved may be drawn up which deserve proper attention before any decision on purchasing new equipment should be taken. No exact dividing line exists between the two complexes of problems, as one group is closely interlinked with the other, but basically the following two viewpoints may be differentiated:

- macro conditions/exogenous or outside conditions/i.e. conditions influencing the decision from outside the plant such as the suitability of the site for further expansions, and
- microconditions/endogenous or inside conditions/inherent in the already existing manufacturing facilities.

9. After both fields of preliminary considerations have been evaluated the procedure for outlining the production programme and for selecting the proper equipment can be begun.

II. Macroconditions (outside conditions)

10. It would exceed the scope of this paper to analyze in detail macroconditions but for reasons of completeness the main conditions having a basic influence on any consideration for extending, changing or improving existing production facilities are here outlined in a very concise way.

11. Before allocating any additional investment to a certain production unit
- the suitability of the existing site in the light of expected development in raw material availability and in planned infrastructure must be checked,
- the general development trends in woodprocessing have to be evaluated in order to align the company's intentions to world trends,
- the type of the manufactured product has to be reconsidered in the light of raw materials, of construction and of manufacturing principles as well as its future marketing prospects on the home and foreign market.

12. The situation in individual developing countries vary to a great extent, each development case facing its own problems; therefore, the arguments and recommendations brought forward can be stated in very general terms only.

13. Some aspects of general validity for wood processing are listed hereunder, which - without claiming completeness - should create an incentive for undertaking more detailed reviews for the specific conditions of a given case.

i. Raw material

14. The availability of raw materials is obviously one of the critical factors when considering future expansion of manufacturing facilities. A further development of the production capacity or of the variety of products is evidently not justified where the raw material resources are inadequate.

15. It is therefore, necessary to check whether a long term supply of hitherto processed species and assortments of wood can be ensured for the required period of years.

16. In addition to this the possibilities of substituting traditional hardwoods by so far unused or less used so called secondary species have to be taken into account. It is well known that fine tropical hardwoods are often used for lower grade products - even for shutterings, or for items where their texture is covered by lacquers etc, while other species, technically suitable for the given purpose remain in many cases unused just because of alledged consumer resistance and for fear of not complying to usual utilization standards.

17. As it has been stressed on different occasions by the Food and Agriculture Organisation of the UN that the industrial utilization of world's forest reserves in tropical forests with their huge variety of species presents a big problem not only from the point of view of investments in infrastructure etc. but even for technological reasons. A number of papers presented at the Seventh World Forestry Congress in 1972 confirmed again the need of properly organized systematic research and development work as a precondition for solving this extremely important and complex task. (See Bibliography.)

18. Nevertheless, many minor steps leading towards an intensified utilisation of forest resources can be undertaken immediately, on a local scale, by processing and introducing on the market lesser used species which in certain cases are known to be suitable for a given purpose and where a certain reservation of the customer has to be overcome, e.g. by a reasonable price policy, etc.

19. A change-over to other species or dimensions may, of course, influence the selection of a machine or equipment to be introduced.

20. The selection of a machine may also be influenced by the expected quality (grade) of lumber to be processed. In order to get a certain amount of dimension stock, a larger volume of lower grade lumber or a smaller volume of higher grade lumber can be processed. It is evident that for lower grade quality the kerf losses and the processing costs are higher and the yield figures lower. Should the economic calculation - taking into account the price difference in raw material, the processing costs and the yield figures - be in favour of lower grade raw material, the impact on the manufacturing line has to be considered i.e. the higher number of cuts and the larger volume of material to be handled must be accounted for.

21. The same applies - even to a larger extent - to possible replacement of a part of the raw material processed by semi-products such as wood-based panels or by premachined components supplied by another manufacturer. Such a decision will effect a basic change in the set of operations and the machinery needed.

22. In the field of raw materials attention is to be given to auxiliery materials as well. New developments in glues and finishing materials may influence the technological procedure hitherto used and may require adapting or renewing certain equipment.

ii. Infrastructure

23. A close interlinking exists between the successful running of an industrial plant and an investment into the necessary infrastructure of the given area. When considering an additional investment for a certain production unit the expected impact on the existing infrastructural facilities is to be analyzed i.e. whether they are adequate to meet the new tasks resulting from changed conditions.

24. New transport problems may arise in connexion with raw material procurement and product distribution while new technological procedures may necessitate changed technical requirements for auxiliary facilities in the plant itself such as power and heat supply, water availability, waste and effluent disposal, and general engineering works.

25. If proper attention to a correct evaluation of existing infrastructural facilities is not paid in due time i.e. before the decision on expanding the production has been taken, the operational running of the reconstructed plant under new technological conditions created may necessitate an additional investment into infrastructure at a later stage. Consequently, situations may develop where no other choice remains than to run the plant under technically and economically unfavourable conditions or to stop production.

26. In order to avoid such a haphazard process of development long-term investment plans have to be elaborated taking full account of the industrial development expected in a certain region.

iii. Development trends

27. When considering the possibility of purchasing a new machine or equipment the general trends of developments in the wood-working industry have to be borne in mind, which may have a more or less heavy impact on the decision, depending on the general economic conditions of a given country.

28. The main trends being realized in wood processing industry may be characterized as follows:

- extension of small and medium size production units working on craftman's principles into industrial enterprises with a higher level of mechanization where manufacturing processes are subdivided into a sequence of individual operations performed as far as possible on specialized machines.
- another trend becoming more and more evident is a specialization in production programmes e.g., general furniture shops with a variety of items produced are being gradually replaced by specialized manufacturing shops for kitchen furniture, bedroom furniture, chairs, school and office furniture, upholstered furniture, etc.

29. Yet another example may be mentioned. It calls for programme specialization; the manufacturing of pre-cut stock or ready-made semi-products, which are delivered for further processing, assembling and finishing to a separate production unit.

30. An important trend, which not only facilitates a switch-over to industrial production methods but at the same time may require entirely different machinery, is the increasing use of wood-based panels - blockboard, plywood, particle board and fibreboard. For certain products a combination or a partial replacement of solid wood by panel materials may be interesting for both manufacturing and cost reasons. It is self-evident that different machines will be used for manufacturing; e.g. a table-top on the basis of solid wood or from blockboard or particle board (since the latter will involve veneering, lipping of edges, etc).

31. For economic reasons specialized manufacturing lines are being combined into integrated plants with primary and secondary processing facilities (sawmilling joinery, wood-based panels, furniture, etc.) which make it possible:

- to achieve a fuller utilization of raw materials even of the hitherto less used species and dimensions (including waste being returned into production);
- to get higher conversion and yield figures;
- to install a higher level of auxiliary facilities at lower costs per unit produced (heat, electricity, maintenance, etc.);
- to create special services for future product development and marketing promotion.

32. As a logical follow-up of increasing specialization and co-operation a growing emphasise is given to standardization and to a higher degree of accuracy in terms of dimension tolerances.

iv. Level of production techniques

33. In the wood processing industries there are certain technological processes necessitating the installation of highly sophisticated equipment with a certain level of automation if competitive products of a uniform and a good quality are to be manufactured, as in the case of particle board or fibreboard. The performance of each piece of equipment in such a production line is chosen to match the output of the key investment, which is usually the press. But even in the case of such sophisticated production lines the question of purchasing a single machine may arise e.g. in replacing damaged or worn-out equipment of if new, more efficient equipment has been developed and brought to market (e.g. a new type of chipping machine producing better particles at lower cost, more efficient sifter, more up-to-date glue spreading equipment, etc.), or due to the introduction of changes in the raw material used.

34. Nevertheless, the majority of manufacturing technologies in wood processing can be realised at extremely different conditions as far as capacity, technical level and the variety of production programmes are concerned.

35. Sawnwood or simple items can be produced "under the tree" with the simplest hand tools while the same can be manufactured on an industrial scale on highly mechanized production lines, where not only the manufacturing operations but also handling and transport of material is mechanized or even automated. There is, of course, a difference in quality of the product, in the recovery figures, in productivity, etc., but in principle both ways of production are technically viable and in many developing countries realized side by side.

36. Compared with other branches of light or heavy industries the flexibility in scale and in range of production programme is one of the typical and very important advantages of wood processing especially for developing countries. Another specific advantage of special importance for less developed countries is the possibility of a gradual introduction of more sophisticated and hence more expensive machinery into a production line. A manufacturing unit can start operation without expensive mechanization, which means lower capital investment with higher requirements on unskilled or semi-skilled labour. As soon as macro-conditions grow more favourable the production techniques can be improved by additional investments step by step.

37. Summarizing it has to be pointed out that in wood processing there are technologies which have to be realized at a certain minimum capacity on a highly sophisticated production line, where a new machine has to suit the performance requirements within very narrow limits, while the majority of processing technologies allow for a very wide range in the performance of a new machine to be purchased and installed.

v. Serviceability of machinery

38. From the point of view of machinery serviceability a certain degree of differentiation may be drawn up for two groups of wood based industries. The group of primary wood conversion processes logs and roundwood into sawn timber of different dimensions, into veneer and plywood and into wood-based panels such as fibreboard or particle board, while the group of secondary wood processing industries uses products of the primary industry for manufacturing end products such as a furniture, doors and windows, etc.

39. As far as technology, production flow and types of basic equipment are concerned the first group i.e. the primary industry usually remains valid for a longer period of time based on the same principal layout not to mention, of course, certain improvements and innovations due to developments in the machinery industry.

40. The so-called secondary industries on the other hand are much more varied in their working operations. The requirements of customers keep changing, their claims and wishes being influenced by their standard of living, by general technical developments, by fashions, etc.

41. In this case the manufacturing facilities have to be more flexible in order to meet, as far as possible, changes which may be foreseen for the future.

42. In production units with a larger variety and flexibility in manufacturing programme a mechanized or automated linking up between individual machines is usually performed in partial sections only. In any case the mechanized sections have to be harmonized in their performance with the operation ahead and behind.

43. The serviceability of a machine depends, naturally, on the technical level of construction and manufacture. Up-to-date constructions of machines enable a higher performance in using arrangements for quicker exchange and setting of tools, in applying different speeds for idle running and for running under load, etc.

44. As far as tools are concerned it may be assumed that results of research and development work are generally incorporated in tools available on the market. Hence, the optimum serviceability of tools is a question of the right application and of their proper maintenance and use.

vi. Material handling and transport

45. When talking about purchasing new machines the whole field of handling and transport equipment within a production line deserves special attention.

46. Handling equipment and transport means within a manufacturing line are increasing in number and performance. Their level has to be, of course, adequate to the type of work, to the output figures and naturally to the economic standard of the region (wages, skill, underemployment, etc.). As an example, for an industrially developed country it may be mentioned for information that a modern finishing line for windows consists of about ¼ of "finishing applying technique", about ¼ of "drying technique" while about ½ is dedicated to transport means (proportions of investment costs).

47. There are certain factors encouraging mechanization of handling and of transport in underdeveloped areas as well. The increasing use of fork lift trucks, mobile cranes and other heavy equipment has raised the handling speed outside the main production line and has an impact on the mechanisation of the manufacturing line itself. Another promoting influence is to be seen in the steadily rising labour costs which may for certain specific cases reach a point where investment in mechanical handling equipment becomes a more economic proposition than in the past.

48. Besides this there are machines necessitating a mechanized infeed with appropriate handling equipment in order to make use of the available capacity.

It is quite understandable that a highly efficient modern veneer peeling lathe where logs are brought in from the yard and lifted into the machine without any crane - as I saw it in a certain case - requires longer idle times than working times.

vii. Second-hand equipment

49. The tendency to cut down investment costs by purchasing second-hand, half worn-out, equipment would be in general a wrong approach; in less developed areas it is usually difficult to get the necessary spare parts and the level of experience in maintenance work is on the low side. Such a solution could be more expensive in operation costs than a new machine in spite of the lower depreciation costs.

50. Nevertheless, some specific cases may arise where second-hand equipment could be of interest. It may happen for example in a highly industrialized country that a quite modern manufacturing line has to close down and to stop production for purely economic reasons, e.g. that the existing capacity is too low to withstand the competition of other modern factories with a higher output and hence lower production costs and selling prices. Of course, each case has to be very carefully studied and evaluated as usually no performance guarantees can be given for the machinery. Any decision in this respect is, therefore, to be based on a very high level of technical knowledge and practical experience.

51. On the other hand the latest innovations with highly sensitive electronic systems and automation may for certain typical areas be just as inappropriate as old and inefficient equipment because of downtimes due to climatic conditions and lack of skill and experience in maintaining sophisticated equipment.

viii. Dust removal

52. As briefly mentioned under the item ii/ "Infrastructure" there are in each plant different auxiliary facilities, the performance of which are to be aligned in conformity with the new expected requirements. As a typical example the dust extraction system may be mentioned. As a result of a modification of the manufacturing equipment the question may arise of "retailoring" the existing system or of introducing a new one.

53. The technical problems to be solved when designing and installing a suction system are entirely different from all other technical and technological problems

usually met in manufacturing lines. Specific knowledge is, therefore, a precondition, if failure in technical and economic efficiency is to be avoided.

54. Removal of sawdust and of shavings may in certain cases be a question where economic pros and cons have to be thoroughly evaluated before a decision can be taken, namely, for simpler production lines and for areas where unskilled labour is available at low wages.

55. On the other hand the removal of dust from sanding machines and from finishing lines is a necessity for both technological and safety reasons. Separate extraction systems have to be installed for this kind of dust with separate ducts and separate collection devices because of the danger of explosion during conveying and disposal of fines.

56. It is obvious that the same applies for the saw doctoring shop, where sparks generated during tool grinding operation are to be separated from any combustible material.

57. In larger plants the whole extraction system may be broken down into several parallel systems for reasons of economy, flexibility and safety. First an efficient extraction at each of the waste generating points has to be guaranteed and the suction hoods, usually delivered with the machine, have to be checked in order to minimize the entrance of "false air" into the system and to guarantee a maximum intake of the waste.

58. The branches and bends of the suction system have to be properly calculated and designed, bearing in mind that an efficiently working system may be installed at the same investment costs as an insufficient, improvised system. If we take only the diameter of the ducts as an example, narrow ducts require an increased velocity and hence a higher consumption of energy. Larger diameters than necessary mean a decrease of air speed and depositing of transported waste in the ducts with an increased fire hazard. The performance of a fan with a low capacity can be improved by increasing its revolutions but at high costs only. To double the number of revolutions means to raise the energy consumption to a third power i.e. eight-fold.

59. In certain cases individual suction units may be used instead of central piping systems having the advantage of adaptibility to changes in production flow or capacity. Should a certain machine or a group of machines be out of operation, the respective suction unit can be stopped and energy saved.

ix. Product to be manufactured

60. Prior to taking a final decision on investment the product to be manufactured has to be re-evaluated from two main viewpoints:

- whether in the light of new developments the type and/or the construction of the products is likely to undergo changes which would influence the manufacturing operations;
- whether the marketing prospects for the product to be manufactured are reliable enough for the future on the home and/or on the foreign markets. In this respect the potential competition of plastics for a certain product deserves specific consideration. The production and use of plastics is growing rapidly on a world-wide scale and for some end-uses moulded plastics are competitive with wooden products even in underdeveloped areas (insulation materials, moulded crates for some uses, certain items for furniture, etc.).

61. When considering an additional investment, the principles outlined above have to be carefully investigated and different alternatives of potential solutions evaluated.

III. Microconditions (Inside conditions)

62. It is obvious that no decision about the future of a production unit can be taken without having a very clear and detailed picture of what is presently at disposal. Proper attention is, therefore, to be given to an analysis and evaluation of existing production facilities with the aim in mind to discover both bottlenecks and unused reserves in capacities and to find out solutions enabling an increase in capacity or an extension of the production programme with the smallest possible investment.

63. As far as the methods for achieving this goal are concerned a variety of techniques can be used, which are described in detail in different technical publications on production planning. (See attached Bibliography 5-14, 18, 19.) In general the methods applied have to be chosen adequate to the existing and to the expected level of production i.e. simpler methods may be used for less complicated manufacturing programmes and equipment, whereas more elaborate and refined methods are to be used for a more sophisticated production line.

64. The recording and analysing techniques vary according to conditions involved, mainly with the relationship of the production volume to the variety of produced

items. The type of graph or chart drawn up for investigating the findings may be different for a high volume of production at a low variety of items than for another case where a relatively low production volume is split amongst a great variety of products.

65. Irrespective of the technique chosen, the basic information for a critical examination of the existing facilities is to be created by a number of observations and by recording the findings for an individual operator and for the key machines. For each of the machines performing a certain operation a detailed break-down of time consumed is to be developed giving an exact picture in minutes or seconds on: setting of the machine and tools, preparation of work piece, feeding the work piece into the machine, removal of the work piece after the operation has been finished, etc.

66. With such evidence on hand, the degree of utilization of productive time and of basic equipment is obtained.

67. The next step of observation and of recording should be directed towards the sequence of machining operations - usually for the key products - starting from the material store through a certain department to be buffer stock for work in progress. Finally this type of activity is to be extended for the production unit as a whole in order to get the information necessary for evaluating the linking up of individual departments.

68. The results of the recordings are then plotted on graph paper with a drawing in a convenient scale, showing the relevant buildings, departments and machines as they are actually located.

69. A flow diagram for the existing production unit has to be drawn up stating in a schematic way the sequence of the main production phases e.g. storage of sawnwood, kiln drying, cutting into required dimensions, processing into work pieces, assembling, finishing and storing of finished goods.

70. The general diagramme should be further elaborated into details showing the follow-up of individual operations such as planing to thickness, cutting to final dimensions, dovetailing, grooving, gluing, sanding, spraying, drying, polishing, etc.

71. Bearing in mind the final target of optimizing the utilization of labour, equipment and space and of cutting down unproductive activities during which no value is added to the product, alterations of the lay-out have to be developed aiming at correct proportions between manufacturing operations, moving activities and stocking of work in progress.

72. After the whole production unit has been documented and illustrated in numerical tables and plotted in graphical sketches actual analysis and evaluation can be started with, the aim of which is namely:

73. For machinery:

- to find out whether the performance of a certain machine is hampered by e.g.
  - poor organization of work,
  - lack of skill of workers,
  - low maintenance level of machines and tools,
  - hoarding of waste,
  - inadequacy of storage space for work pieces, etc.
- to identify the amount of indirect labour at a machine which in many cases attains more than 50% of the total time available and which could and should be assigned to unskilled helpers in order to decrease idle time and to raise the output of the machine
- to state the actual working time of each machine, which in comparison with the total time available shows
  - the hitherto unused reserves which could be utilized in future,
  - the machines creating a bottleneck in production flow, which in case of extending the production programme should be either strengthened by additional machines or replaced by more efficient ones.

74. For handling equipment:

- to verify the potential increase in performance by introducing new or additional handling equipment such as pallets, lifting tables, etc.

75. For auxiliary facilities:

- to check the technical capacities of auxiliary facilities (substation, boiler, water, compressed air, sewage, etc.) and to identify the rate of their utilization and the remaining reserves.

76. For the whole lay-out:

- to check the adequacy and the potential reserves in storage space and in available floor space,
- to evaluate the smoothness of the production flow from the view point of optimum utilization of equipment, manpower and space, aiming at discovering the general bottlenecks (manufacturing and auxiliary facilities, engineering network, etc.) which in case of future expansion plans deserve special attention.

77. When analysing the existing conditions of a certain production unit proper attention should be paid to methods for controlling quality of products and for reducing losses due to improper manufacture. The possibility of increasing the economic results without any new investment should not be overlooked.

78. Bearing in mind the increasing complexity of factors involved, a realistic solution can be obtained only if adequate new analytical methods are used. By applying for example statistical quality control methods variations in product due to causes inherent in equipment can be separated from assignable causes which may be eliminated. After removing assignable causes due to human failures or errors corrective action can be taken for machinery and equipment; in their maintenance, in redesigning their utilization and finally in their replacement by more efficient units.

79. Quality control in operation is quite simple and requires some measurements and recording and, of course, some professional ability and experience in their application.

IV. Procedure for deciding on additional investments

1. General considerations

80. The task of buying a machine adequate for the technical parameters required and for the level of local conditions seems to be quite simple but it may turn out to be complicated to find a solution as close as possible to the optimum.

81. It is assumed that as a result of an evaluation of macroconditions listed under the previous chapter a satisfactory answer has been found to the principal questions:

- whether and to what extent it pays to invest in the existing site,
- whether a dismantling of existing facilities and their re-erection in a modified and completed arrangement at a more convenient site would not be the better solution,
- whether principal changes in the production programme are to be considered and what are they.

82. If evidence is given in favour of investing in existing facilities an analysis and evaluation of the microconditions will show what are the unused reserves and what part of a new production task can be covered by improvements without a new investment.

83. As a general rule it should be anticipated that the incentive for an idea to undertake additional investment in existing production facilities in the search to improve economic results of the enterprises is:

- cutting down production costs,
- improving the quality of the product,
- increasing the productivity,
- increasing the output.

84. Different approaches may be used in selecting the most promising solution. In general the following aspects have to be taken into account and assessed:

- the assumed future production task in terms of type, quality and volume of product resulting from the evaluation of macroconditions,
- the requirements of the expected manufacturing programme on machinery, equipment and space,
- a comparison of the overall requirements with the existing production facilities with an assessment of the amount and equipment,
- an economical evaluation of the potential alternatives leading to the selection of the most suitable type of machine and equipment.

85. The main fields of consideration outlined above are elaborated in more detail under the following items. The proposed procedure may seem at first glance too complicated and time consuming, though it has to be borne in mind that evaluating different alternatives in the stage of planning and designing saves money and time during the whole period of operation, helps to avoid failure and creates the necessary prerequisites for achieving better economic returns in operating the production line.

ii. Sequence of work phases

86. The scope and volume of preparatory work before any decision on procurement or implementation can take place will depend on the expected amount of capital to be allocated. From the point of view of a logical sequence of work the following three major phases may be distinguished:

87. - The conceptual phase

The basic goals to be achieved are outlined taking into account the results of an evaluation of macroconditions and microconditions. Preliminary proposals as to the production programme and to basic facilities are drawn up in alternatives. A schematic flow-sheet and a layout prepared for each of the alternative proposals will serve as a basis for deriving

the expected raw material requirements for labour, energy, etc. The calculated results can be easily compared with the presently existing situation. From a preliminary economic comparison of pros and cons for individual alternatives the most feasible solution of capacities and of equipment is selected for further elaboration.

88. - The planning and designing phase

The solution agreed upon is to be reviewed, in detail, the objectives of the task clearly defined, the technological procedures finally selected, the most appropriate equipment chosen and the expected economic impact calculated.

89. The final layout drawing has to be elaborated with arrangement of equipment showing the position and the relationship of processing units to each other as well as the installations and connexions to auxiliary facilities.

90. From this, eventual alterations in the building may be deduced and specifications of additional building identified. The sequence of major activities for implementation are plotted in a time schedule.

91. - The implementation phase

Material and equipment are procured, erection and installation work executed and the reconstructed manufacturing unit is run-in. Due consideration is to be given that realisation complies with the defined goals and remains within the cost and time limits provided. It is evident that fewer delays or cost increases may be expected if the preceding planning phase was exact and reliable enough.

92. In order to enable the procedure as outlined above to be carried out, the following main background information is to be determined and gradually defined with more precision:

- manufacturing programme,
- engineering data sheet (chart of new requirements),
- equipment list,
- economic evaluation.

iii. Manufacturing programme

93. Generally, the idea of purchasing and incorporating new equipment into an existing production unit may arise

- without changing the manufacturing programme, or
- for a production programme extended in volume and/or variety of products.

94. The first example is to be understood as a result of a company's policy to replace machinery at economically justifiable intervals in order to remain competitive on the market. Well managed companies modernize from time to time their manufacturing facilities by purchasing new and up-to-date equipment, appropriate to their type of product and to the general level of production in the given area.

95. In the second case it is assumed that a new production programme has been outlined as a follow-up to marketing studies. Nevertheless, an investigation of home and foreign markets cannot by itself lead to a clear and final picture of exactly which product and what production volume should be manufactured. An optimum solution in this respect can be achieved only from an appraisal of different alternatives concerning

- the type of product,
- the quality of product,
- the production volume,

and from a confrontation of different manufacturing programmes with the necessary investments and calculated production costs.

96. It is evident that any alteration in the construction of the item manufactured will influence the kind and the sequence of manufacturing operations and hence the type of the machine to be purchased. The same applies for the quality (accuracy of work, different surface finishes, etc.) and for the volume of production. A higher number of items produced may allow installing single-purpose machines or expensive machines for combined machining operations which are economically justifiable only beyond a certain minimum output.

97. After a decision in principle has been taken during the conceptual phase of work, the exact picture of the manufacturing programme is finally developed during the phase of planning and designing the new plant.

iv. Chart of new requirements (Engineering data sheet)

98. Each alternative of the reviewed production programme has to be checked in the light of consumption figures. To this purpose the following schematic tables are to be prepared which should in a synoptical manner state the technical units per hour, per day, per month, per annum:

99. Raw material needed, subdivided into assortments for
- roundwood (by species)
- sawnwood
- dimension stock
- wood based panels
- auxiliary materials (glue, varnish, nails, etc.)

100. Waste with information on type (piece, saw dust, shavings, dust, etc.) place of generation and way of disposal.

101. Electric power with data for:
- input per machine
- load factor
- consumption in kwh

102. Heat energy with data for each consuming unit
- heat requirements with technical parameters
- fuel requirements

103. Water subdivided for
- drinking water
- water needed for the process

104. Compressed air stating volume per hour and pressure

105. Transport requirements with data on volume or weight to be moved over certain distances
- outside the plant
- inside the plant

106. Manpower requirements subdivided into:
- skilled
- unskilled
- maintenance staff

107. The information calculated and compiled in the proposed way enables a confrontation of the adequacy of auxiliary facilities (storage, energy and water resources, main handling equipment, etc.) whereby a conclusion can be reached whether existing reserves can meet the increased requirements or whether new facilities have to be provided. For the alternative selected within the conceptual phase all figures have to be reviewed in detail during the planning phase of work.

v. Equipment list

107. One of the substantial parts of the preparatory work is the development of a complete list of machinery and equipment for the production unit. The equipment list will, of course, undergo changes during the whole evaluation work. At the beginning preliminary information will be stated on machines and equipment which may come into consideration as possible solutions, while at the end of evaluation and of negotiations an approved detailed list of individual items will be developed subdivided into already existing items and those to be purchased, showing:

- short description of the type,
- performance parameters,
- requirement parameters (energy consumption, etc.),
- auxiliary equipment for the machine,
- necessary spare parts,
- weight,
- estimated costs in foreign and local currency.

vi. Economic evaluation

108. Investing in new machinery or handling equipment must be justified from an economic standpoint either by the amount and costs of labour saved or by the additional production volume achieved with the same labour force while improving or at least maintaining the quality of product. Larger investments allow, of course, for improvements both in production volume and labour productivity.

109. For each industrial development project usually a number of alternative technical solutions exist for achieving an objective as far as quantity and quality are concerned. Nevertheless, the final decision on realization should definitely rely on the expected calculated efficiency of the investment under the given conditions.

110. To this purpose an economic analysis of individual technical solutions is essential. The scope and depth of analytical work will depend, naturally, on the type and extent of the reconstruction in mind.

111. The basic features for such an analysis are created by calculating and compiling specifications for different types of costs such as for materials, wages and salaries, energy, overheads, sales costs, interests, insurance, etc. Special emphasis is to be given to a realistic estimation of purchasing and sales prices. Should a new product be introduced on the market, usually CIF costs for foreign-made similar products are considered as a basis.

112. With these costs specifications on hand, the main economic criteria for a production unit as a whole are developed for each of the alternatives considered. From a comparison it is possible to deduce the advantages and disadvantages of installing machines of different performances, the merits of different levels of mechanization with reference to wages and depreciation, the rate of return on the investment, etc. Such aspects as the effect on cost of increases in degree of accuracy and capacity must be considered in relation to market requirements.

113. The alternative which has shown the highest rentability and the shortest pay-back period is usually considered as the basis for further study. The results of an evaluation of short-listed offers (see part B, item IV, iii.), the expected erection costs, the training costs for key personnel and labour, restrictions in foreign trade, and other details are taken into account.

114. After new costs, prices and profits have been calculated, the efficiency of an investment into the reconstruction of a production line can be finally evaluated using different criteria such as:

- profitability of sales i.e. $\frac{\text{profit}}{\text{sales}} \times 100$
- profitability of capital invested i.e. $\frac{\text{profit}}{\text{total investment costs}} \times 100$
- pay-back period for capital invested i.e.
  $\frac{\text{total investment costs}}{\text{profit + depreciation}} \times 100$ (in the 4th or 5th year of operation)
- break-even point analysis usually based on values plotted in graphs for sales, fixed costs and variable costs
- cash flow table for selected alternatives.

B. PROCEDURE FOR SELECTING AND PURCHASING NEW EQUIPMENT

I. Introduction

115. The foregoing part A. was directed towards an explanation of the main interlinking conditions which have to be taken into account before making a decision on additional investment. The main fields of conditions have been enumerated and stressed and advice of general validity was given on how to proceed for achieving a viable and substantiated result.

116. For this second part of the paper it is assumed that the feasibility of the planned investment has been assured and the financial resources have been made available.

117. The Furniture Industry Research Association (FIRA), in the United Kingdom have published a report by Mr. R. Stephenson entitled "Purchasing a woodworking machine: Some factors to be considered." In it is listed a set of questions on component analysis and existing resources. These are relevant in the purchase of any machine and have been reproduced as Annex 1.

118. As a guideline for the procedure the following topics are summarised under separate headings:

- possibilities of acquiring preliminary information
- approaching potential short-listed deliverers for submitting binding quotations
- evaluation of offers received, bearing in mind technical, commercial and economic aspects.

II. Preliminary information

119. During the conceptual phase of preparatory work general information is to be suitable for performing the operation requested. A first orientation in this respect may be obtained e.g. from catalogues issued by International Fairs especially those dedicated to woodworking machinery and ancillary equipment.

120. Manufacturers listed in the catalogue are classified according to their fields of activity, a fact which makes it easier to get a general picture on what equipment of the kind needed is being produced. The next step should consist of gathering more information on equipment which seems to suit the requirements. Any manufacturer of equipment will be pleased to submit on request:

- his recommendation or proposal stating which of his makes could solve the processing or machining operation in question
- technical leaflets and descriptions of the main performance parameters of piece of equipment
- an informative price quotation

121. With such data on hand, preliminary proposals can be developed for the conceptual evaluation of alternative solutions for achieving the production goal. It is obvious that there is never only one technical solution for a given problem. Within this phase of work a wider variety of modalities has to be studied leading to a conclusion on which type of equipment will be:

- technically suitable and
- economically viable.

122. Thus the type of equipment can be identified and the potential manufacturers short-listed, who should be approached for submitting a final binding quotation.

III. Invitation for binding quotations

123. It is to be stressed that for planning and designing reconstruction of a production unit it is necessary to rely on detailed and binding information for technical data as well as for costs.

124. Manufacturers short-listed in the preceding phase of work are, therefore, requested to elaborate and to submit within a certain time a final offer.

125. The inviting letter must specify:

- the operations to be carried out
- the material to be processed (usually by species)
- the dimensions of raw material (average dimensions as well as maximum and minimum limits)
- accuracy of work required
- number of shifts assumed
- working hours per day, per week, per annum
- input and/or output per year, per day, per shift, per hour (average and peak values)
- characteristics of existing current (e.g. 415V, 50 cycles, AC)
- existing heat resources (if necessary)
- characteristics of compressed air available (if necessary)

and request data for:

- compliance with the technological purpose
- minimum and maximum speeds of operation
- minimum and maximum output
- energy consumption (average and peak values)
- auxiliary equipment necessary or recommended (feeding devices, handling facilities, etc.)
- quality of tools and their availability
- service life of tools
- whether special equipment for maintenance is necessary
- spare parts for one or two years operation
- dimensions and weight of the machine
- foundation plan if necessary
- price quotation FOB or CIF with a break-down for the main machine, auxiliary equipment, tools and spare parts
- terms of payment
- validity of quotation
- whether and where equipment quoted can be seen in operation

IV. Evaluation of offers

126. It is assumed that the first selection of the most feasible alternative has been performed within the conceptual phase of work and that it remains to evaluate short-listed quotations specified during planning work for which final quotations were requested.

127. By pre-selecting the type of equipment during the preparatory work a general common denominator has been obtained, making a comparison of offers submitted easier. In spite of a certain narrowing of the problem a true evaluation of offers is very exacting and requires an intensive assessment of many details in the light of the following aspects.

i. Technical aspects

128. Among the technical aspects due consideration is to be given to particular conditions listed below:

- suitability of the equipment offered for the required technological function
- versatility of the equipment (whether it can be used for other purposes, and/or adapted to changes in production programme)

- the adequacy of the level of mechanization offered, with respect to the existing conditions of work
- the adequacy of performance criteria
- the guaranteed accuracy and quality of work,
- the assumed operational reliability
- the level of skill required for operators
- the requirements for maintenance work (ease of maintenance)
- maintenance of tools (whether additional equipment is needed)
- interchangeability of tools with other existing machines
- quality of the construction of the machine (design standardization, robustness of main frame, type of drive, lubrication system, etc.)
- electrics (circuits, failsafe considerations, etc.)
- energy consumption
- dimensions and weight
- what kind of accessories are offered
- what additional work is assumed to be provided by the customer (piping, structural work, connexions to auxiliary facilities, etc.)
- whether, and what kind of spare parts are available on stock in the country or region
- whether maintenance or repair service can be assured by a local agency
- particulars influencing the environment (effluent, dust, noise, etc.)
- floor space requirements for the machine with necessary accessories and area required for buffer stocks of work pieces in process
- safety considerations (protective guards, safety devices and precautions, etc.)
- references on the manufacturer and equipment offered (experience in production, where the equipment can be seen in operation, etc.)

129. Note: In Annex 2 and example of a classification system is attached as it was used in an actual case for technical and technological comparison of individual machines and equipment for particle board production.

ii. Commercial aspects

130. In negotiating the delivery conditions, the following aspects deserve special attention:

Scope of delivery with an exact description of

- machines
- accessories

- spare and consumable parts
- installation material
- technical documentation and drawings
- after sales services (e.g. in erection, supervision, training, running-in etc.)

Final prices with specification what is included and what is not included in the delivery e.g.

- packaging for oversea transport
- transport
- insurance
- custom duties
- landing charges
- transport to site
- training (if offered)
- erection and running-in

In case that the deliverer offers the erection of the machine it is to specify:

- the buyers obligations in preparing the conditions for the erection
- the sellers obligations in performing the erection.

Date of delivery is usually closely related to terms of payment.

Terms of payment must state the amounts to be paid:

- in cash as a down payment
- in cash against shipping documents or
- on credit terms specifying bank guarantees and the rate of interest (any advantageous result is considered under economic aspects);

Guarantees covering:

- completness and time of delivery
- technically perfect manufacture according to certain regulations and standards e.g. BS or DIN

- reaching the output in quality and quantity
- control and supervision of erection (if offered);

Penalties for:
- delay in delivery
- non-conformity to specifications;

Force majeure clause;

Law and place of jurisdiction to be applied in case of disputes. The commercial aspects may become more complicated where preference is given by the buyer for a combined investment consisting partly of an external delivery and partly of locally provided items. Under certain conditions it may be preferable to purchase only the main machine from outside and to complete it by locally manufactured items (mechanization devices, transport means, piping, dust extraction, etc.). The impact of such an arrangement on seller's guarantees has to be negotiated very carefully.

iii/ Economic aspects

Quotations from individual suppliers usually show differences in the extent of items offered and have, therefore, to be adjusted first to a comparable basis mainly from the viewpoint of completness. It is self evident that such a comparison and correction is made easier, if quotations are requested with a breakdown of prices for each of the items offered.

For reasons of comparison and to simplify the ensuing evaluation procedure each of the offers is to be corrected
- to exactly the same scope of items (e.g. by estimating the cost of missing items)
- to the same level of delivery conditions(e.g. FOB or CIF)

* The results of such an exercise should be summarized in a table stating the total costs of the additional investment subdivided for:

- main machine (in foreign currency)
- accessories and spare parts (in foreign currency)
- accessories available on the local market
- estimate for accessories to be manufactured locally
- estimate for erection and installation costs including material
- estimate for structural work (if necessary).

It is evident that no final decision in selection can be reached from an appraisal of prices and of figures for technical performance only. A machine may seem to be economically promising from the viewpoint of investment costs and of output figures, but may turn out to be economically unfavourable if e.g. structural work or an extension of auxiliary facilities are involved.

An optimum solution can be identified only in the context of the production line as a whole i.e. in the light of interlinking with other machinery, floor space available, capacities of auxiliary facilities, etc. The resulting summary table is therefore, to be considered as background information for the final economic evaluation as outlined under item A,IV,vi. The expected operating costs for items to be produced are then calculated in the light of different offers.

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PURCHASING A WOODWORKING MACHINE: SOME FACTORS TO BE CONSIDERED

(Extract from a publication of the Furniture Industry Research Association, Maxwell Road, Stevenage, Hertfordshire, SG1 2EW)

1. COMPONENT ANALYSIS

(A) Function

(1) Is the component really necessary or can it be eliminated?

(2) If required, does it have to be machined in its existing form? Perhaps a small change in design would simplify machining operations.

(3) Would any design alteration affect another component in the sub-assembly unit?

(4) Is the cost of producing the component proportionate to its function in the final assembly?

(5) Can a 'standard' item be substituted?
It may be that a standard component can be bought from specialist suppliers which would remove the necessity for manufacture in the works.

(6) Is the part being made in the best way considering the quantities involved?

(B) Material

(1) Is the right type of wood being used?
Perhaps a cheaper grade and quality would suffice.

(2) Before reducing the quality, however, would this have an effect on strength properties or final appearance?

(3) Is the finished size of the component the most economical from a wastage point of view?
If a dimensional reduction can be made, it may be possible to obtain the part from a smaller section of rough material.

(4) Can waste be reduced in other ways?
In some cases the profile of the component may be altered so that previous wastage content can be used for making another smaller component. If so, it may even be a better proposition to use the next highest section of rough material.

(5) Could a lighter timber be used to ease handling problems?

(6) Can any pre-machining operations be done by the timber suppliers that would effectively reduce machining times in the works? ie, planing or sawing to length.

(7) What would be the cost of this service compared with existing methods of conversion from rough material?

(C) **Simplification**

(1) Are too many different sizes of similar components being used?

(2) Can some form of standard size be adopted as a result of a reduction in size variation?

(3) The conversion of timber sizes from imperial to metric measurements should be used to reduce the quantity of varying sections used, by raising or lowering the overall dimensions in imperial sizes to conform with the nearest metric equivalent.

(4) If alterations to component lengths are necessary as a result of a reduction in the number of items, what effect will this have on machining operations?
Distances between feed rollers and hopper feed capacities may have to be adjusted.

(5) Will a reduction in the variety of components result in the possibility of larger batch sizes?

(6) How will this affect existing machines in any particular department?

(7) Would it also have an influence on maximum feed speeds selected for the new machine?

(8) How are machine setting up times affected by a reduction in component variety?

(9) Can finished sizes of panel items be adjusted to make maximum use of suppliers' dimensions? It may be possible to alter a panel component size so that machining of all four sides could be replaced by a simple cutting to length operation only.

(D) **Machining requirements**

(1) What is the degree of accuracy required for the component in terms of tolerances?

(2) Are these tolerances too fine for the part in question?
Too close a tolerance often necessitates a more expensive machine to obtain the degree of accuracy required.

(3) Will, however, components machined to close tolerances, have increased benefits at the assembly stage of manufacture?

(4) What grade of finish is required?
Would a planed as opposed to a sanded finish be acceptable?

(5) Should each individual component be inspected or is periodic batch inspection sufficient?

Having now made an assessment of the component to be machined, and what possible modifications may affect the type of machine to be finally installed, a review of the existing resources within the factory is desirable.

2. EXISTING RESOURCES

(A) Machinery

(1) When the new machine has been installed, will preceeding and succeeding existing machines be capable of keeping pace with it, if feed speed rates are increased?

(2) If not, what amount of extra equipment will have to be fitted to achieve this increased production rate?

(3) If it is impossible to increase output of adjacent machines, can the work be rerouted without a major change round of plant?

(4) What is the existing speed of production in terms of feet a minute?

(5) How many machines are hand fed as compared with those having hopper feeding devices?

(6) Would it be worthwhile when considering a new machine to fit as many machines as possible with hopper feed units?

(7) Are there any mobile stacking or feeding devices in use at present that could also be used for the new machine?
If so, this could simplify proposed machine requirements with a consequent reduction in purchase price.

(8) What is the working height of such a unit?
Is it fixed, or adjustable between certain limits?
This should be taken into consideration with regard to the working height of the new machine.

(9) Are the small tools such as cutterheads and saw units, etc, already in use, readily adaptable to the new machine or are they for use on particular machines?

(10) In the present period of changeover from imperial to metric measurement, will a new machine having provision for metric tooling cause duplication of existing imperial dimensioned cutterheads, etc.?

(11) If this is so, how will it affect existing sharpening, setting and gauging equipment in the toolroom?

(12) What other extra equipment will be required in the toolroom to cater for the new machine?

(B) Plant layout

(1) Has sufficient floor space been allocated for the new machine? Space must be provided adjacent to the machine for incoming raw materials and finished piece parts.

(2) Does the siting of a new machine involve moving existing machines?

(3) Are extensions or alterations to buildings necessary to cater for the new machine?

(4) Will lighting facilities have to be altered or added to?

(5) Has sufficient room been allocated for servicing the new machine? This is particularly important if the machine is to be positioned near a wall.

(C) Materials handling

(1) What kind of handling equipment is used at present - hoists, fork lift trucks, conveyors, etc.?

(2) Are these adequate to incorporate the requirements of the new machine?

(3) Can the new machine perform two or more operations either at the same time or in rapid progression in order to reduce handling times?

(4) Will additional handling equipment of a specialised type be required?

(5) Does the speed of material travel influence the rate of production, and will the new machine either increase or decrease this?

(6) How far do the components have to travel between different machining operations?

(7) If this is excessive, is it possible to provide simple conveyer equipment between the new and existing machines?

(8) Should special containers be made for protection of finished components?

(9) Are existing handling methods safe?

(10) Has sufficient room been allocated near the machine for spare pallets or small trucks?

(11) Can the new machine be linked into an existing line using automatic transfer equipment?

(12) If this is not possible, can the new machine be fitted with a device for the return of machined components to the operator? In this way, one operator can both feed the machine and stack completed components

(13) Are existing waste handling services adequate?

(14) Can the new machine be linked into an existing dust extraction unit?

(15) Is the extraction unit large enough to cater for additional materials necessitated by the new machine?

(16) If dust extraction is only a minor problem, can an existing small extractor unit be used for the new machine?

(D) Power

(1) Is existing electric power adequate for the new machine?

(2) Have allowances been made for bringing conduit piping to the new machine, and is it to be positioned underground or overhead?

(3) In addition to electric power, is any other form of power required - eg, pneumatic/hydraulic?

(4) Has an extension been considered for an air line to be brought to the site of the new machine for cleaning?

(E) Labour

(1) Have workshop personnel been told of the intention to purchase a new machine?

(2) Have the opinions and recommendations of the men most directly concerned with the new machine been obtained?

(3) What type of labour is available for the new machine - skilled, semi-skilled, or unskilled?
How will this affect the final choice of machine?

(4) If existing labour is unsuitable, will a new man be required or can existing personnel be trained?

(5) How many men are needed to operate the machine - one, two, three?

(6) Will the proposed operator object to being allocated to the new machine on safety, health or other grounds?

(7) Are working conditions good?
Poor lighting, dirty conditions, excessive humidity, and lack of adequate safety precautions can all contribute to the reduction of operator efficiency.

(8) How will the potential earnings of an existing operator be affected when he is transferred to the new machine?

(9) Will the operator be capable of setting up his machine and carrying out simple servicing operations if required?

(10) Can the plant layout be altered so that the operator of the new machine can work another machine at the same time?

Having asked relevant questions about the component to be produced, and having made a survey of existing resources, it should now be possible to concentrate on technical considerations that will finally decide the choice of the machine.

The following, therefore, is a list of desirable features and technical points that should be considered before making a final decision, and if a short list of machines has been obtained, will present a check list for comparison purposes.

ANNEX II

Classification system

used for technical and technological comparison of individual machines and equipment for particle board production

It has to be pointed out that the classification system outlined below is an attempt to express the technical level and the technological reliability of machinery and equipment offered. For each of the equipment groups three to four quality degrees are specified, taking into account the most up-to-date technological knowledge. The individual quality degrees are characterized by a certain number of points allotted. It is, of course, obvious that this system can be applied for comparison in the horizontal lines of the table only. In view of the fact that the system does not consider the proportionate weight of different equipment groups /e. g. pressing group contra silo/, a vertical addition of points would be misleading.

	Number of points
Raw material yard:	
fully mechanised	2
partially mechanised	1
not offered	0
Debarking station:	
Material losses:	
- low - drum debarker	3
- medium - ring debarker	2
- high - cutter debarker	1
- debarker not offered	0
Feeding to debarker:	
- mechanised, metal detector	2
- mechanised, no metal detector	1
- by hand	0
Capacity:	
- 1 shift for 3 shift production	3
- 2 shifts for 3 shift production	2
- 3 shifts for 3 shift production	1
- not offered	0

	Number of points
Bark removal:	
- mechanized incl. milling of bark	2
- mechanized	1
- not offered	0
Manufacture of particles:	
System proposed:	
- separate manufacturing lines for surface and for core particles and separate storing of sawdust, shavings and particles produced from hogged chips	3
- separate manufacturing lines for surface and for core layer particles but without separate storing of sawdust, shavings and of particles produced from hogged chips	2
- one manufacturing line for both surface and core particles without differentiated storing of sawdust, shavings and of particles produced from hogged chips	1
Capacities:	
- 1 shift for 3 shift production of boards	3
- 2 shifts for 3 shift production of boards	2
- 3 shifts for 3 shift production of boards	1
Removal of splinters	
- combination of air and mechanical sifting	3
- air sifting	2
- mechanical sifting	1
- not proposed	0
Silo for particles:	
- over 100 m^3	3
- medium, over 50 m^3	2
- small, below 50 m^3	1
Drying:	
Dryer:	
- fire protection device with automatic fire extinguishing equipment and automatic control of M. C. of particles	3
- the same but with manual control of M. C.	2
- hand operated fire extinguishing device only	0
Possibility of reusing dust from board production	
- combined reuse of dust in the production line as well as by burning in the dryer	2
- burning dust in the dryer or in the boiler	1
- no provision made	0

	Number of points
Screening unit behind the dryer	
- combination of air and mechanical sifter	3
- air sifter	2
- mechanical sifter	1
- not proposed	0
Glue blending	
Bin for dry particles	
- capacity over 25 m^3 with level indicator on several points of the bin	3
- capacity below 25 m^3 with indicator for "full" or "empty"	2
- low capacity without level indicator	1
Dosing of particles	
- continuous quantity control	3
- discountinuous quantity control	2
- volume dosing	1
Construction of glue blender	
- stainless steel, cooling of drum, no compressed air	3
- steel, cooling of drum, no compressed air	2
- steel, cooling of drum, spraying with compressed air	1
- steel, no drum cooling, spraying of glue with compressed air	0
Dosing of glue and paraffin emulsion	
- interlinked with particle dosing, quantity control	3
- interlinked with particle dosing, no quantity control	2
- no interlinking with particle dosing	1
Mat forming station	
Type of forming station	
- stationary	2
- moving	1
Type of mat	
- sifting fine particles into outer layers, continuous quantity control	3
- sifting fine particles into outer layer, discontinuous quantity control	2
- sifting fine particles into outer layer, no quantity control	1

	Number of points
Prepressing of mat	
- included	1
- not offered	0
Returning of unduly formed mat	
- included	1
- not offered	0

Pressing:

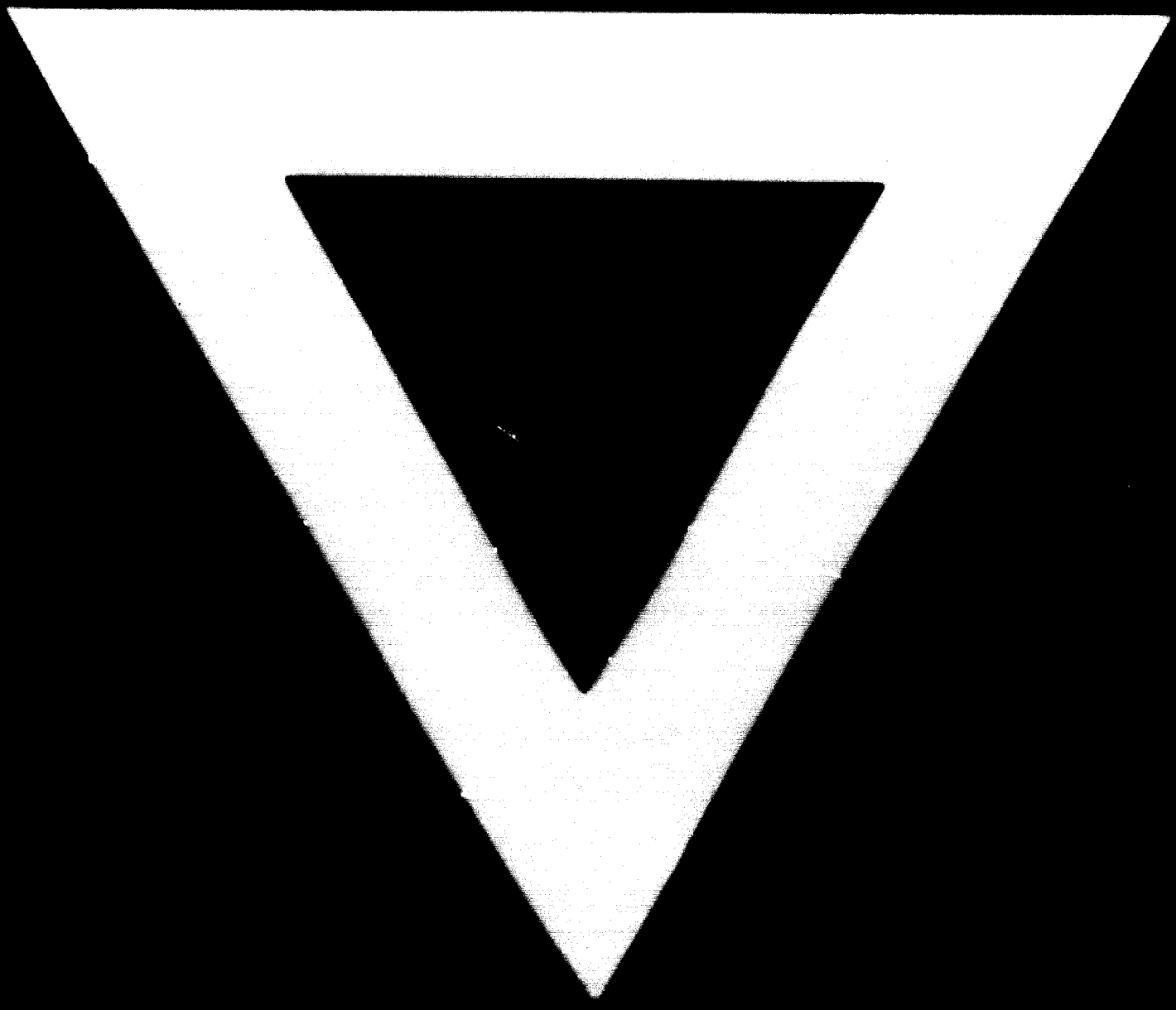
Type of press	
- single opening	3
- multi day-light with simultaneous closing	2
- multi day-light without simultaneous closing	1

Note: Preference is given to single opening press because of the heavier construction enabling to achieve lower thickness tolerances and equalised properties of the board. It has to be, of course, admitted that multi-opening press has a certain advantage in the potential possibility of increasing the capacity

Working pressure	
- min. 35 Kp/cm^2	3
- min. 30 Kp/cm^2	1
Accumulator station	
- pumps for each piston	3
- accumulator	2
- pumps	1
Feeding system	
- without supporting coils	3
- with transport coils or divided band	2
- transport band /for maintenance and cost reasons/	1
Position of press pistons	
- two rows situated above distance bars	2
- two rows closer to the center line of plates	1
- one row in the center line of press plates	0
Temperature regulation	
- included	1
- not offered	0

	Number of points
Temperature adjustment of pressing table	
- included	1
- not offered	0
Distance device	
- in press pistons	2
- on pressing plates	1
Sizing of pressed boards	
- with tools for simultaneous processing twice two sides	3
- with tools processing once two sides	2
- with tool processing one side only	1
Cooling of pressed boards	
- forced air stream	2
- natural air stream	1
- not offered	0
Volume/weight control behind the press	
- not necessary due to provisions in other equipment	3
- is necessary, measuring on several points	2
- is necessary, weighing of whole boards	1
- is necessary but not proposed	0
Thickness control of pressed boards	
- measuring the whole width of board	3
- measuring at several points	2
- measuring in one point	1
- not proposed	0
Board cutting	
- before the press	2
- behind the press	1
- not proposed	0
Sanding line	
Type of machine	
- processing on both sides with several tools	3
- processing on both sides with one tool	2

	Number of points
- processing on one side	1
Installation of equipment into a line	
- with automatic flow	3
- with mechanized flow	2
- with manual feeding and sorting	1
Sorting of sanded boards	
- into three places	3
- into two places	2
- into one place	1
Storing of ready-made products	
- handling by means of telescopic hoist	2
- handling by means of a lift truck	1
- not proposed	0
Storing and preparation of glue	
Raw material store	
- handling proposed including storing racks	2
- handling proposed without storing racks	1
- not proposed	0
Preparation of glue blend	
- mechanised, allowing for 1 worker to prepare the blend for 3 shifts	3
- not mechanised, 1 worker is provided for each shift	2
- simple, with more than 1 worker for a shift	1
Laboratory	
- offered	1
- not offered	0
Grinding shop	
- complete for grinding of all tools	2
- without the possibility of grinding special tools	1
- not proposed	0



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