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MEANS AND TECHNIQUES FOR OPTIMAL SECTORAL AND PROJECT PLANNING IN FOREST INDUSTRIES[1]

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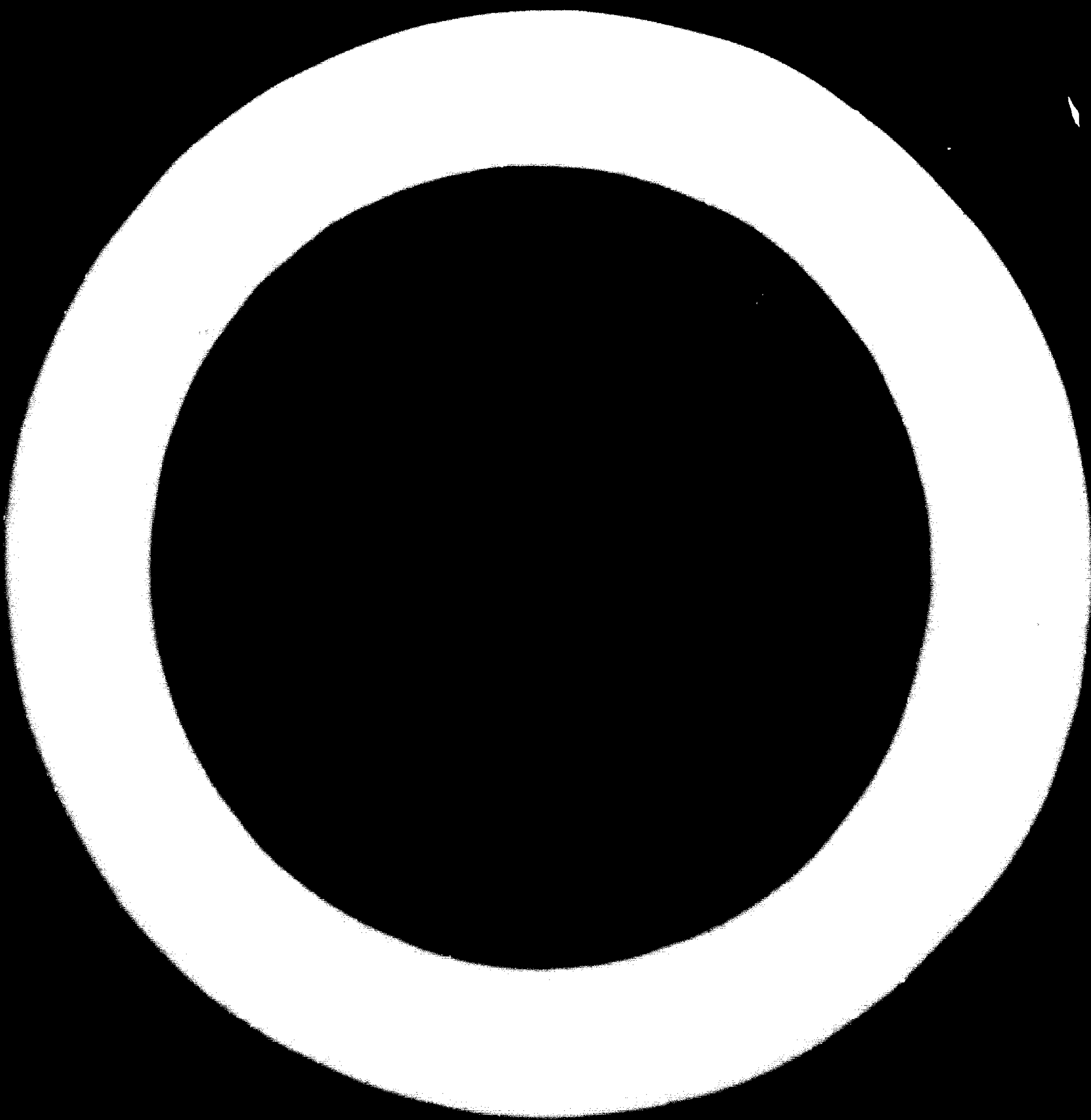


Sectoral and project planning in forest industries, compared to many other branches of industry, represents a very complicated area of planning, in which the optimization of planning decisions is extremely difficult, due to the many special features of this sector of industry.

The intention of this paper is to illuminate, by means of a general survey, certain planning methods and the planning techniques applied in them, with the help of which more optimal solutions have been arrived at in sectoral and project planning in forest industries.

Special features of forest industries from the point of view of sectoral and project planning

Forest industries have a number of special features which have to be taken into account in sectoral and project planning in this field. Above all, the source of basic raw materials used by this industry - i.e. the forest - for reasons of its area of growth, age structure, growing stock and wood species, is unhomogeneous as an object of planning and difficult to treat statistically. The renewable nat re of forest resources and the problems caused in many cases by forest ownership also cause difficulties in planned forest utilization.

Another notable feature of planning of forest industries is the fact that many of the production processes in the wood-conversion industry use only part of the wood raw material, for example, residue from the sawmill and plywood industries forms a notable source of raw material for the pulp industry. This being the case, planning of raw material resources for the forest industries should cover not only the planning of forest resources but also the secondary raw material resources of the production sector. And this underlines the importance of integrated planning of the forest industries and forest resources.

The economy of transportation systems of wood raw materials is a further notable special feature of the forest industries from the point of view of sectoral and project planning. This has a decisive effect on the geographical location of industrial plants and on their size. Environmental protection, especially with regard to the pulp and paper industry, and supply of water and cheap power for the latter, should also be mentioned in this connection.

The bulky nature of raw materials and products of the forest industries combined with the wet processing methods used in the production of pulp, paper and board, means that modern plants, especially in chemical wood processing are very capital-intensive. The large capital investment requirements of the transportation systems needed for raw material and finished products means that the unit size of production units has a great effect on the size of specific investments calculated per production unit. Vertical integration (e.g. a sawmill integrated with a pulp and paper mill) can lead to considerable investment savings. Thus project and sectoral planning if carried out in the right interrelationship, can have a noticeable influence on the effectiveness of investments in the forest industries.

Criteria of sectoral and project planning in the forest industries

Sectoral planning in the forest industries can, in principle, be based on two contrasting situations as regards basic raw material:

a) a situation in which the scarcity of forest resources or their intensive use impose main limitations to be considered in sectoral and project planning

b) a situation in which the development of forest industries is not limited by scarcity of forest resources

The first situation is prevalent in many European countries and in the USA, where forest resources are scarce and forest industries well developed, and the latter situation prevails in countries rich in forest land such as the Soviet Union and Canada and many developing countries. It is natural that in the afore-mentioned contrasting situations different optimizing criteria in sectoral planning and in the national economy should be used, despite the fact that the feasible possibilities of utilizing forest resources are not always directly comparable to the amount of resources.

On the other hand, in the above-mentioned situations, the following goals can be set in sectoral planning, which at the same time reflect the quality level requirements of planning.

1. Satisfaction of home demand for finished and semifinished products of forest industries

2. Economic utilization of forest resources, satisfaction of home demand and acquisition of export income

3. Optimization of the structure of forest industries from the point of view of national economy

4. Integrated planning of forestry and forest industries in order to achieve an optimal result from the point of view both of the national economy and financial profitability

In principle, the same quality level requirements can be set in project planning as those mentioned for sector planning, in other words, the planning of forest industries can be handled by means of sectoral planning methods and derivated in the direction of project planning or started with project development and evaluated on the sectoral planning level.

In practice, these basic differences in planning system appear in the planning practices of so-called planned and market economies. If statewide sectoral planning is a decisive and guiding force in planned economies, then in market economies sectoral planning, at best, acts as a regulating and advisory factor in project planning. Sometimes, market economies try to include the planning aims characteristic for sectoral planning within the sphere of project planning, in which case also viewpoints of contribution to national economy are taken into account, in one way or another, in connection with project planning. This practice occurs especially in projects sponsored by international organizations and banks.

The classification of the quality and level of planning in forest industries presented (construed) above, at the same time presents the historical development of this type of planning in many countries. It also reflects the evolution from simple to more difficult objective of the level of planning.

If the planning problem of the first level - satisfaction of home demand for finished and semifinished products of the forest industries - can be solved by relatively simple means, solution of the planning problem of the second level - profitable use of forest resources, satisfaction of home demand and acquisition of export income - already requires a far-developed planning technique, including optimization methods and a firm statistical basis as regards both raw materials and marketing.

Effective sector and project planning in the forest industries, aiming at optimizing the structure of this industry from the point of view of national economy, and integrated planning of forestry economy and forest industries, have only become possible with the development of mathematical planning methods. These methods are best represented by mathematical models, with the help of which, in principle, a countless number of planning situations can be simulated and the planning problems of the third and fourth level can be solved in the light of selected optimizing criteria.

Mathematical models as a tool in sectoral planning

The model schematically presented in figure 1 can be treated as an example of the mathematical models used in investment planning in the forest industries. The principles of operation of this model are, briefly, as follows: calculations are based on a given annual amount of wood available to the industry. This raw material is classified according to wood species, grade and quality. The task can be, for example, to establish the most profitable product mix which can be manufactured from the amount of wood raw material in question. This product mix is called an optimum production program. Figure 2 presents a scheme which can be adapted when choosing an optimum production program. The final products to be analyzed are chosen, for example, on the basis of consumer forecasts or the market situation. The specific consumption of wood raw material and the manufacturing costs are calculated for each product. At the same time the price of the finished product is estimated.

The consumption of raw material is calculated taking into account that residue from certain production lines (e.g. sawmill chips) can be used as raw material for other products (e.g. pulp) and certain products (e.g. pulp) can be used as raw material for other products (e.g. paper).

Manufacturing costs are calculated on the basis of specific consumption of labor, fuel, electricity and materials, paying special attention to their dependence on the capacity of the production lines. In this way a manufacturing cost calculation is arrived at, excluding the cost of the wood raw material.

The capital costs of investments are naturally also taken into account. On the basis of the prices of finished products, total sales income for different production alternatives can be calculated. The difference between total sales income and total manufacturing costs (excluding the price of wood raw material) divided by the total consumption of wood raw material, gives the highest wood price and represents the profitability level of the production program. From the tested production programs is chosen the one which gives the highest price for the amount of wood raw material available.

Within the framework of the model explained above, a sensitivity analysis can also be carried out to establish to what extent changes in the prices of products, manufacturing costs and marketing quantities affect the optimum production program. Also the effects of changes in wood raw material resources on the production program can be investigated.

Even if the model for investment planning in the forest industries has been developed for situations of limited forest resources, it can also be applied in the solution of planning problems when forest resources are not an important limiting factor in the development of forest industries. The most essential point in all the investment planning models for forest industries seems to be the use of the maximizing of the wood price as an optimizing criterion, which, interpreted in another way, means minimizing wood transportation costs.

An interesting application of mathematical models as a tool in sectoral planning on a national level was made in the Soviet Union in 1967. Optimum location of forest industries in the whole country was investigated with the help of mathematical models. The years 1975 and 1980 were used as points of prediction of the consumption of forest industries products. The product register of integrated forestry economy and forest industries comprises different species and dimensions of roundwood, sawn wood (export sawn wood separately), plywood, chipboard, wallboard, sleepers, various paper grades, various board grades, bleached sulfate pulp. viscose pulp and yeast produced from pre-hydrolization liquor (23 product groups altogether).

Various sectors of industry within the country as well as export needs were taken into account as consumers. Consumption was localized according to economic areas. Information on raw material resources was fed according to wood species and dimension grade. The investment and manufacturing costs of production were calculated according to standardized production lines in the Soviet Union. Thus, for example, in the case of bleached sulfate pulp production lines, the study covered the following production capacities: 125, 250, 500 thousand tons per year, and in the case of newsprint, 228 000 t/y and 456 000 t/y production units etc.

For the optimizing an expression was worked out which was assumed to take into account as fully as possible all the national economic cost factors such as manufacturing costs, investment cost including cost of establishing basic building production, community development costs, labor procurement costs and investments in forestry and forest operations. In order to find the optimal alternative, the sum of these costs was minimized. On the basis of results obtained, the basic outline of investment plans for forest industries for the next ten years was drawn up.

<u>Project planning process in forest industries</u>

Project planning in forest industries usually follows the same principles as project planning in other sectors of industry. Dividing the project planning in proper stages has perhaps greater importance in the forest industries than elsewhere, because of the capital-intensiveness of this industrial sector and because of the other special features mentioned earlier.

The most important stages of project planning and development and their basic components in market and planned economies are set out in figures 3 and 4. Despite the seeming differences, these project development models have many similar features. The development stage of the basic draft of the project which in planned economies is carried out by state central planning organs or ministries, is equivalent to the identification stage preliminary industrial survey of the project presented in figure 4. Drawing up of technical economic evaluations project study (figure 3) is equivalent to the pre-feasibility study stage in figure 4, and the feasibility study stage to the technical project in figure 3, although the extant of the latter can be greater than the feasibility study in figure 4. In a market economy the borderline between the different stages of project development cannot always be defined, because the type of project, financing and method of implementation affect the drawing of such a borderline. In planned economies, the borderlines of project stages are usually more clearly defined and less flexible due to the centralized financing system of projects and planning practice. A common feature of both the project development models presented above is also the requirement for gradually more precise planning, a successive elimination of project alternatives and getting the planning costs to agree with the result expected from the project development stage. Various eupilliary means used in project planning can be of great help in developing the methodology in question. These are dealt with below in the light of experiences gained by the engineering bureau I represent within the project planning field in forest industries.

The four main stages of project planning and implementation are the identification stage, the pre-feasibility study stage, the feasibility study stage and the implementation stage. The first three stages are considered to belong to the sphere of investment planning.

Project development stages

The identification stage of the project covers a wide field, but is based on rough estimates, whereas in the pre-feasibility study stage the number of alternatives has been eliminated and the basic material specified (figure 4). These two stages can be included in the strategic planning of the company.

During the stage of project identification, the aims of the company, its limitations and resources are mapped out. Attention is focused on production factors, above all on raw material resources, market prospects and factors of economic policy. During the identification, on the basis of market research, at least a rough prognosis of the marketing areas and volumes of different product alternatives is drawn up and products are chosen for more careful comparison. At this stage the actual processes are assumed to be "black box", standard elements, and an estimate is made of the size of the investments. A roughly defined product quality selection and production capacity is usually all that is available as source data. As a basis of evaluation can be used, for example, material gathered earlier on a project of the same type. This material can be handled either by computer or manually, using the graphs of specific investment of different production lines. A model of such a graph is presented in figure 5. A wealth of statistical material from investments which have already been realized is needed in the compilation of specific investment graphs for project planning, and their application requires critical analysis of the individual features of the project. The accuracy of this planning technique, however, is sufficient in the identification and pre-feasibility study phase, since at this stage it is more important to weigh the various project alternatives rather than to decide on the exact size of investments. The planning technique described above is a quick and easy method of comparing alternatives.

The point of the pre-feasibility study is to obtain, at relatively low cost, sufficient supplementary information in order to be able to compare alternative projects and to find the best alternative among them. During the pre-feasibility study planning of the production process is begun and the "black boxes" of the identification stage are clarified in terms of process technique. The general rule at this stage of project planning is to utilize customary project solutions and standard figures. The investment estimate is based on process descriptions, the accuracy of which is sufficient to make clear the essential differences in cost of the production program. The pre-feasibility study can also include an extensive economic calculation i.e. optimization of the production program, which was discussed earlier (figure 2). The optimization of the production program is a typical application of the mathematical model in planning. The profitability of the alternatives is calculated and the profitability figures evaluated by means of sensitivity analysis.

The accuracy of the pre-feasibility study is usually sufficient to enable a tentative decision to be made. The pre-feasibility studies containing basic cost benefit analysis and technical evaluations are normally used by international organizations and banks as main documents for the promotion of new projects. A more precise and accurate feasibility study is, however, needed, before a decision to implement the project can be taken: the time lag between the pre-feasibility study and project implementation is usually rather long, due, mainly, to the study of possibilities of financing and to making economic plans more accurate.

The production process planning of the feasibility study differs fundamentally from the standardized planning of the stages discussed earlier. The aim of this stage of process planning is to develop detailed processes and process alternatives to deal with the individual technical requirements of projects.

The project is usually at this stage closely bound up with the plant site under study. The investment estimate during the feasibility study stage is made in detail according to machines and equipment, using the offers made for the main machinery. Estimates of the cost of smaller lots of equipment and the indirect costs of the project are usually based on evaluation models and utilization of normative price information which has been corrected according to the index. The feasibility study stage also includes a considerable amount of technical planning which is called preliminary engineering.

In planned economies the stage corresponding to the feasibility study i.e. the preparation of the technical project, generally comprises considerably more technical planning than the former, because on the basis of the approved technical project, the final financial material and labor resources of the project are confirmed and the requirements of the project reflected to other industrial sectors.

Conclusion

In sectoral and project planning in the forest industries it is of utmost importance to clarify the profitability factors on both a national economy and business economy scale and to stress in a proper way their interrelationship. Project development can be approached from project planning through financial profitability "filter" towards sectoral planning, as has traditionally been done in market economies. On the other hand the same goal can be approached starting with sectoral planning taking into consideration national economic planning criteria and derivating individual projects from these requirements. Which road is followed depends on the economic system and political decision-making methods of the country in question. Intermediate forms of the afore-mentioned extreme cases can also, naturally, be used. Application of financial profitability cannot be considered as exclusive criteria for project planning in market economies. Against a background of diminishing raw material resources, the need also for effective centralized sectoral planning, especially in the forest industries, is admitted in many market economy countries. On the other hand, in planned economies, which have traditionally operated according to criteria of national profitability, there is an increasing tendency to thorough study of the profitability of forest industry projects during the planning process from the point of view of business economy methods applied in market economies, and as a rule the sectoral planning approach should be checked by the individual planning approach. Generally, it can be stated that there is a trend towards the comprehensive planning concept in forest industries which the sectoral and project planning techniques of today, with their mathematical models and computer applications, make possible. The level and reliability of planning has continuously improved with the development of planning methods, and planning system and practice have no decisive effect on the result of planning when the goals of the planning are specified and the optimisation criteria clearly defined.

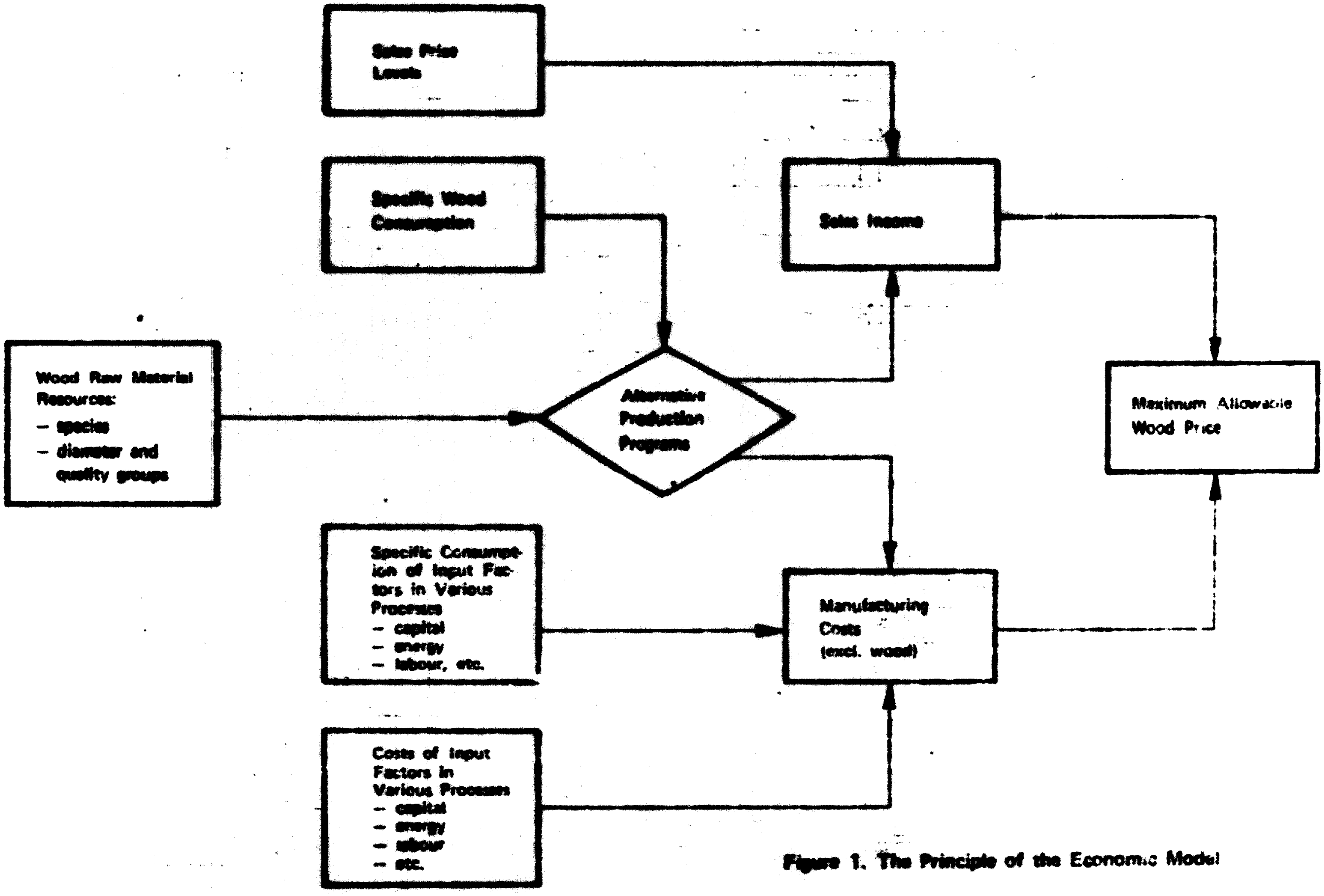
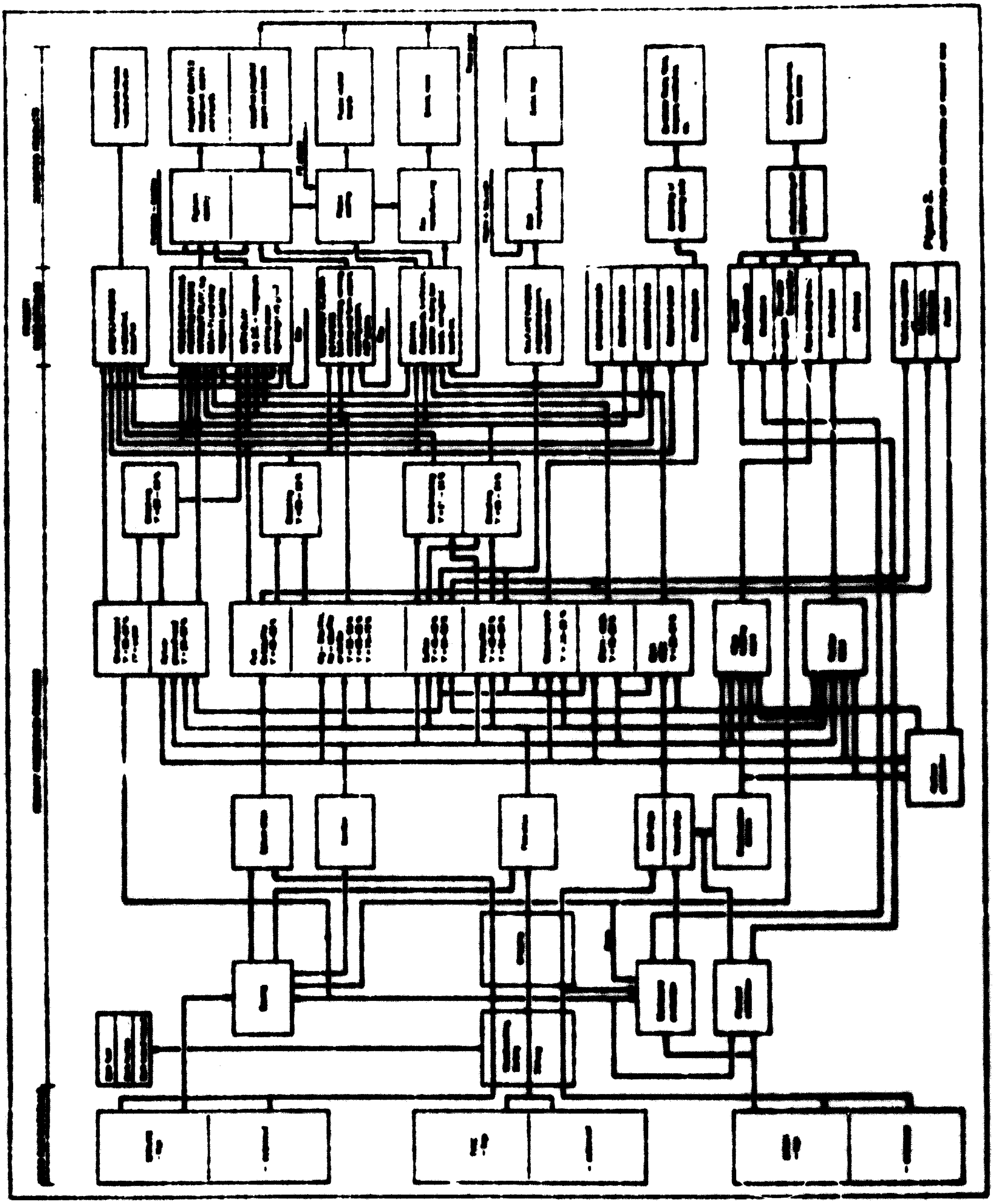


Figure 1. The Principle of the Economic Model



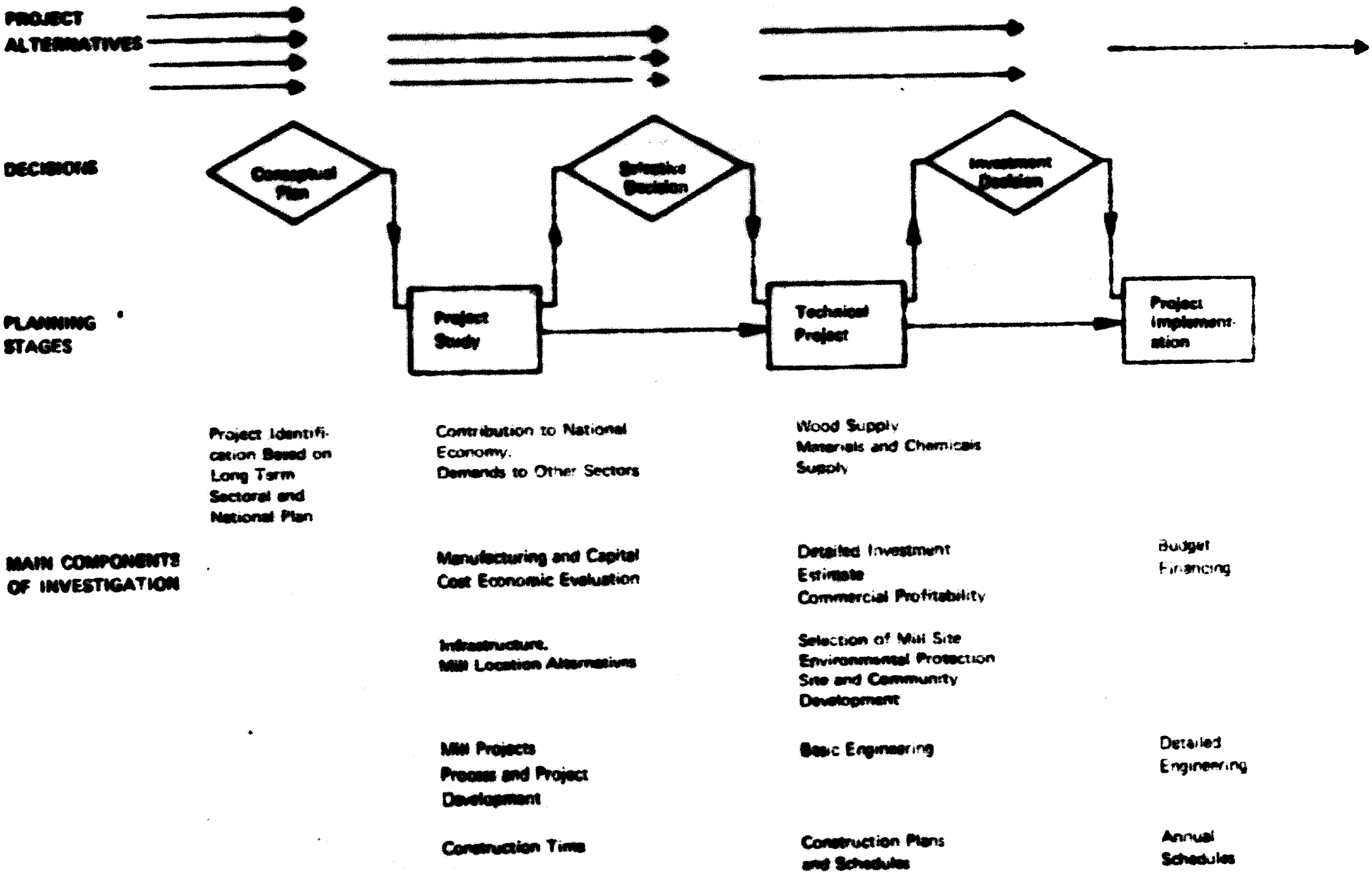


Figure 3. Project Planning and Development Stages in Planned Economy.

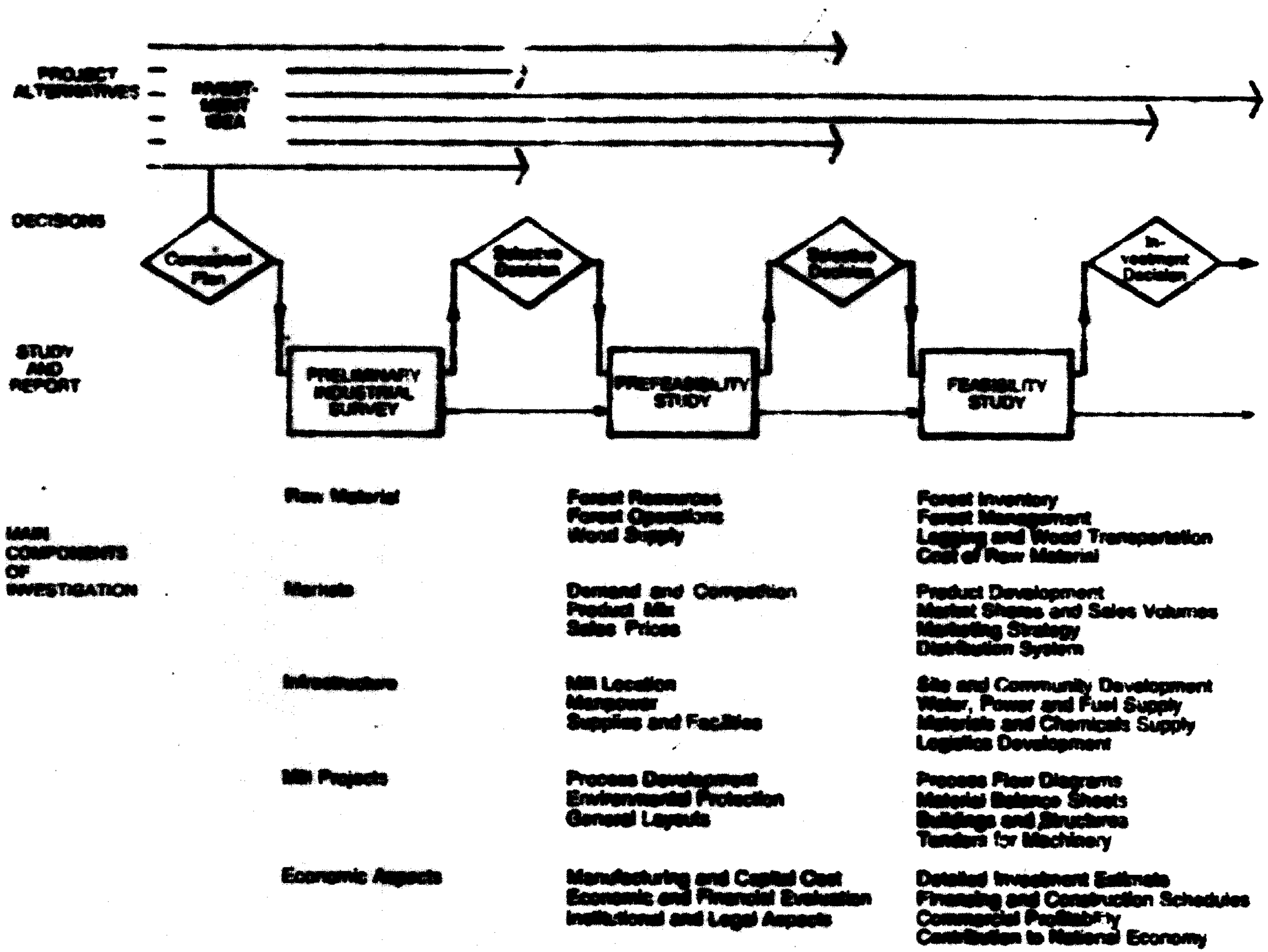
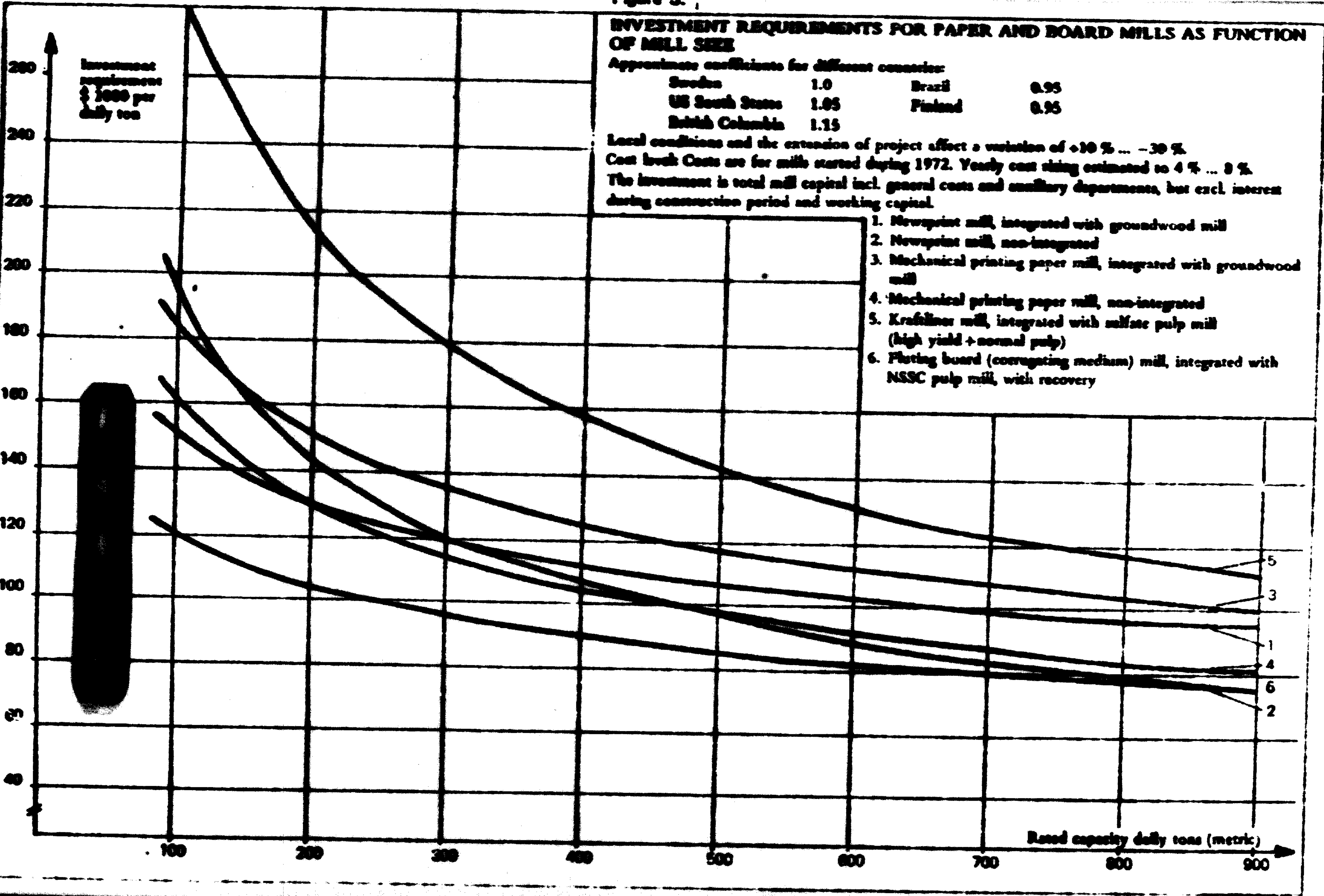


Figure 4. Project Planning and Development Stages in Market Economy.

Figure 5.


INVESTMENT REQUIREMENTS FOR PAPER AND BOARD MILLS AS FUNCTION OF MILL SIZE
Approximate coefficients for different countries:
Sweden 1.0 Brazil 0.95
US South States 1.05 Finland 0.95
British Columbia 1.15
Local conditions and the extension of project affect a variation of +10 % ... −30 %.
Cost level Costs are for mills started during 1972. Yearly cost rising estimated to 4 % ... 8 %.
The investment is total mill capital incl. general costs and auxiliary departments, but excl. interest during construction period and working capital.
1. Newsprint mill, integrated with groundwood mill
2. Newsprint mill, non-integrated
3. Mechanical printing paper mill, integrated with groundwood mill
4. Mechanical printing paper mill, non-integrated
5. Kraftliner mill, integrated with sulfate pulp mill (high yield + normal pulp)
6. Fluting board (corrugating medium) mill, integrated with NSSC pulp mill, with recovery
Investment requirement $ 1000 per daily ton
280
240
220
200
180
160
140
120
100
80
60
40
Rated capacity daily tons (metric)
100
200
300
400
500
600
700
800
900
5
3
1
4
6
2

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