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MANAGEMENT SYSTEMS IN THE FOREST INDUSTRY

Paavo Uronen

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INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

PREFACE

This paper is a survey discussing the present state and future trends of the management systems and other systems analytical tools in the Forest Industry at the corporate and mill level. The technological development has made the hierarchical distributed systems technically possible and economically attractive.

The benefits of these kind of hierarchical management systems are discussed.

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INTRODUCTION

The general objectives and tasks of management in a forest industry enterprise do not differ from those in any other business management; they are (Drucker 1974): economic performance, making work productive and the workers achieving and managing social impacts and social responsibilities. In other words, management must organize the purchasing, producing, marketing, investment, maintenance and other activities in the most economical way (or fulfilling some other objective function) under many constraints in a dynamic environment and at the same time the goals and wishes of many interest groups associated with the business in question should also be met. Some other classifications for the most important tasks of management include (Dale and Michelon 1974):

Planning		(set)	goals
Directing			
Organizing		(analyze)	means
Decision-Making	or	(select)	resources
Staffing			
Controlling		(decide)	action
Innovating		(measure)	results
Coordinating			
Representing		(maintain)	Human relations

In principle each decision-making process of management will include the following steps (Sage 1978):

1. Problem definition.
2. Value system decision.
3. Modeling and analysis.

4. Alternative ranking (optimization).
5. Decision.
6. Action.
7. Evaluation.

It is thus evident that in order to make right or proper decisions, management needs plenty of information and tools, especially in points 2, 3, and 4 in the above list. Management Science, Operations Research, or Systems Analysis are more or less meaning the same discipline studying these problems and providing tools for management.

The terms "Management Science," "Operations Research," or "Systems Analysis" appeared after the second world war. These new "hard science" tools, together with the development of digital computers, gave high expectations; and many initially feared that computers and operations research would soon replace managers. That has not been, and never will be, true. Systems Analysis and computers are just tools, nothing more. They are tools with high potential for contributing to decision-making, but so far many managers in the business think that systems analysis has been quite a big disappointment (Drucker 1974). Drucker further states:

> Managers complain that management scientists concern themselves with trivia and reinvent the wheel. Management scientists, in turn, tell horror stories of resistance by reactionary managers.

Systems analysis has, perhaps, put too much attention on the improvement and analysis of <u>functional</u> efforts (production, marketing, financing), but there has been too little emphasis on managing itself, on decision-making and on risk taking. The most important goal of these tools would be to improve the understanding of management and decision-making in business and enable managers to take the <u>right</u> risks. Or, putting it another way (Drucker 1974):

> Systems analysis should
> -- test assumptions,
> -- identify the right questions to ask,
> -- formulate alternatives rather than solutions,
> -- focus on understanding, not on formulae.

SYSTEMS ANALYTICAL TOOLS AND APPLICATIONS

There are many kinds of systems analytical tools and programs available for business management. The most important techniques and tools are listed in Table 1. Typical application areas of these methods are given in Table 2. The tendency here is to combine all these methods and applications into a management information system (MIS) or management system and the updating, maintenance and further development of these models and methods is the responsibility of the Systems Group or

OR-group of the company. Figures 1 and 2 show schematically two versions of MIS and Figure 3 represents a management system as proposed by Ackoff (1972).

One interesting feature in the development of these systems in the process industry has been demonstrated in Figure 4; at early stages in the 60's the approach was a centralized one, and then attempts were made to solve both the process control tasks and the management tasks through a big centralized system. These attempts were not successfull--the main reasons being insufficient reliability and capability of existing computer hardware, the difficult and complicated software, and lack of specialists. After this stage, the minicomputers were developed in the early 70's and then also the process control systems and the management systems were separated and even difficult organizations inside the company were reponsible for these tasks. Today we can see very clearly the tendency towards a total mill control and management system implemented with a distributed hardware.

To what extent the above mentioned tools and systems are used in each individual enterprise is highly dependent on many factors: the branch of industry, the size of business, the regional and national characteristics and the interest and attitude of top management.

MANAGEMENT PROBLEMS IN THE FOREST INDUSTRY

The forest industry is a typical process industry facing many problems and structural changes now and in the future. Figure 5 is a sketch of the problem "environment" of the manager in a forest industry enterprise. It is obvious that corporate management today cannot make the decisions by taking only the interests of the company and the technological aspects into account. More and more the social impacts, the goals of many interest groups (stock-holders, labor unions, government, environmentalists, forest owners, etc.) must also be taken into account and the development, both global and national, in this industry should also be forecasted and notified in decision-making. Figure 6 gives a schematic hierarchy of the problems in the forest industry.

For assisting management in these tasks in the forest industry, most of the methods mentioned in Table 1 could be, and to some extent are, used at the corporate and mill levels. The big problem is the lack of models and forecasts at the upper levels of hierarchy in Figure 6. Also decision-making under many constraints and trying to satisfy all the goals of the different interest groups will lead to a multicriteria optimization problem. The latest developments in multiobjective optimization (Wierzbicki 1979) and game theory may give useful tools for these problems in the future. These problems are closely connected to strategic planning, i.e., to long-term (time horizon: several years) management of the company. The manage-

Table 1. Management techniques and tools.

Data base techniques
Modeling techniques
Simulation techniques
Optimization techniques
-- LP
-- Integer programming
-- Non-linear programming
-- Dynamic programming
-- Multiobjective optimization
Forecasting methods
-- Linear time trend
-- Moving average
-- Exponential smoothing
-- Non-linear time trends
-- Adaptive forecasting
-- Box-Jenkins
Inventory control theory
Value analysis
Optimal control theory
Game theory
Critical path scheduling and other project control systems
Heuristics
Reporting systems

Table 2. Applications of systems analysis in management.

Corporate modeling
Strategic planning
Budgeting
Cash flow analysis
Financial forecasting
Financial analysis
Demand and sales forecasts
Profit planning
Marketing management and planning
Investment analysis
Production planning
Production coordination and control
Project control
Planning of transportations
Inventory control

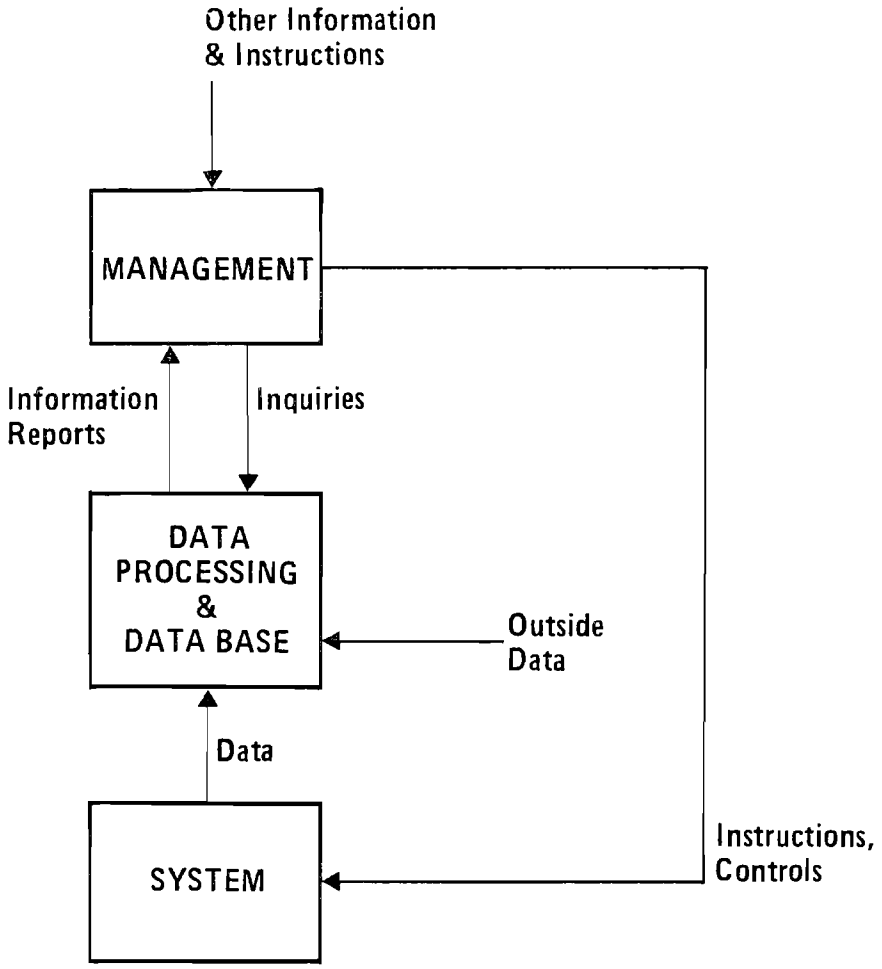

Figure 1. Management information system I.

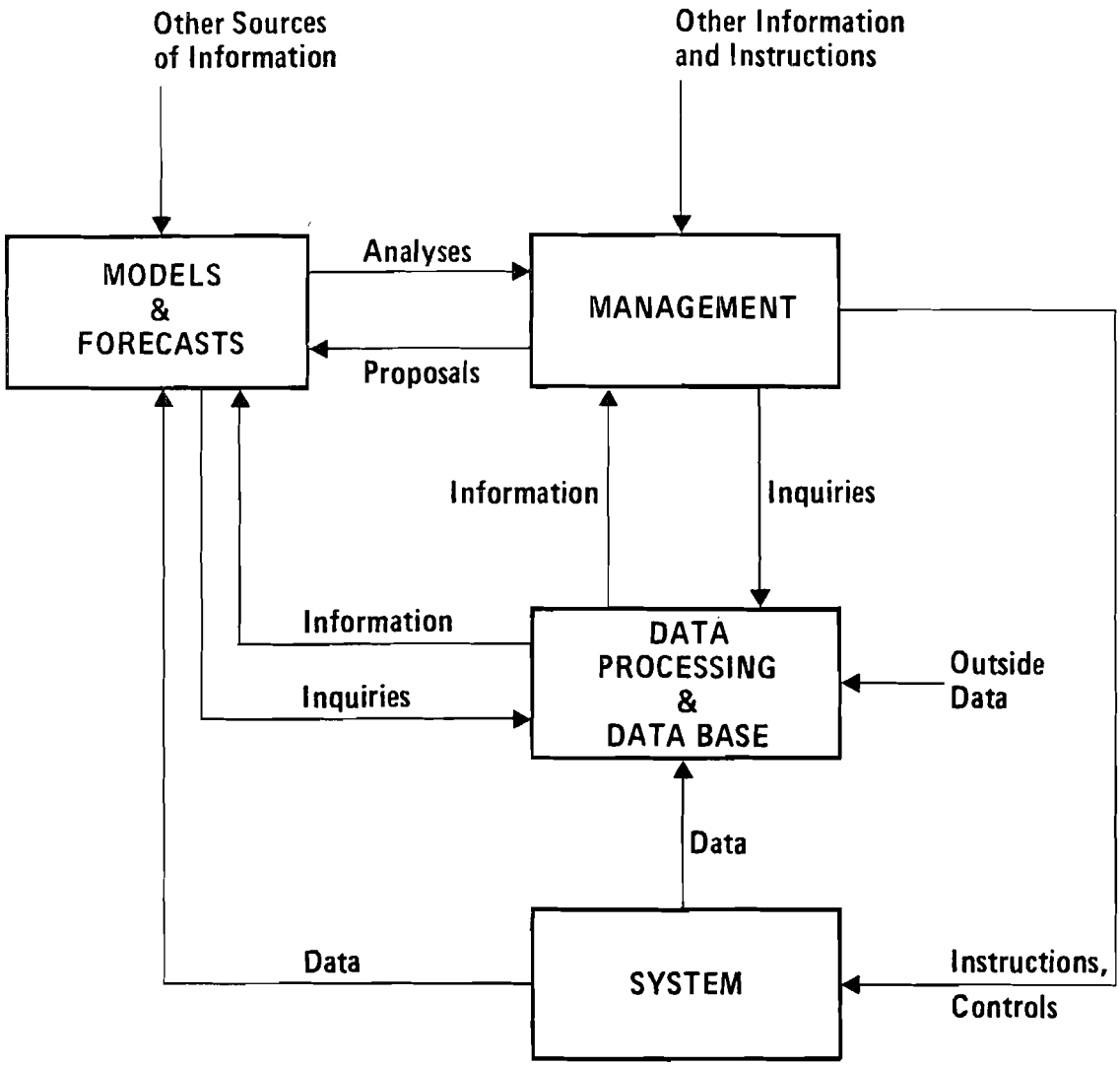

Figure 2. Management information system II.

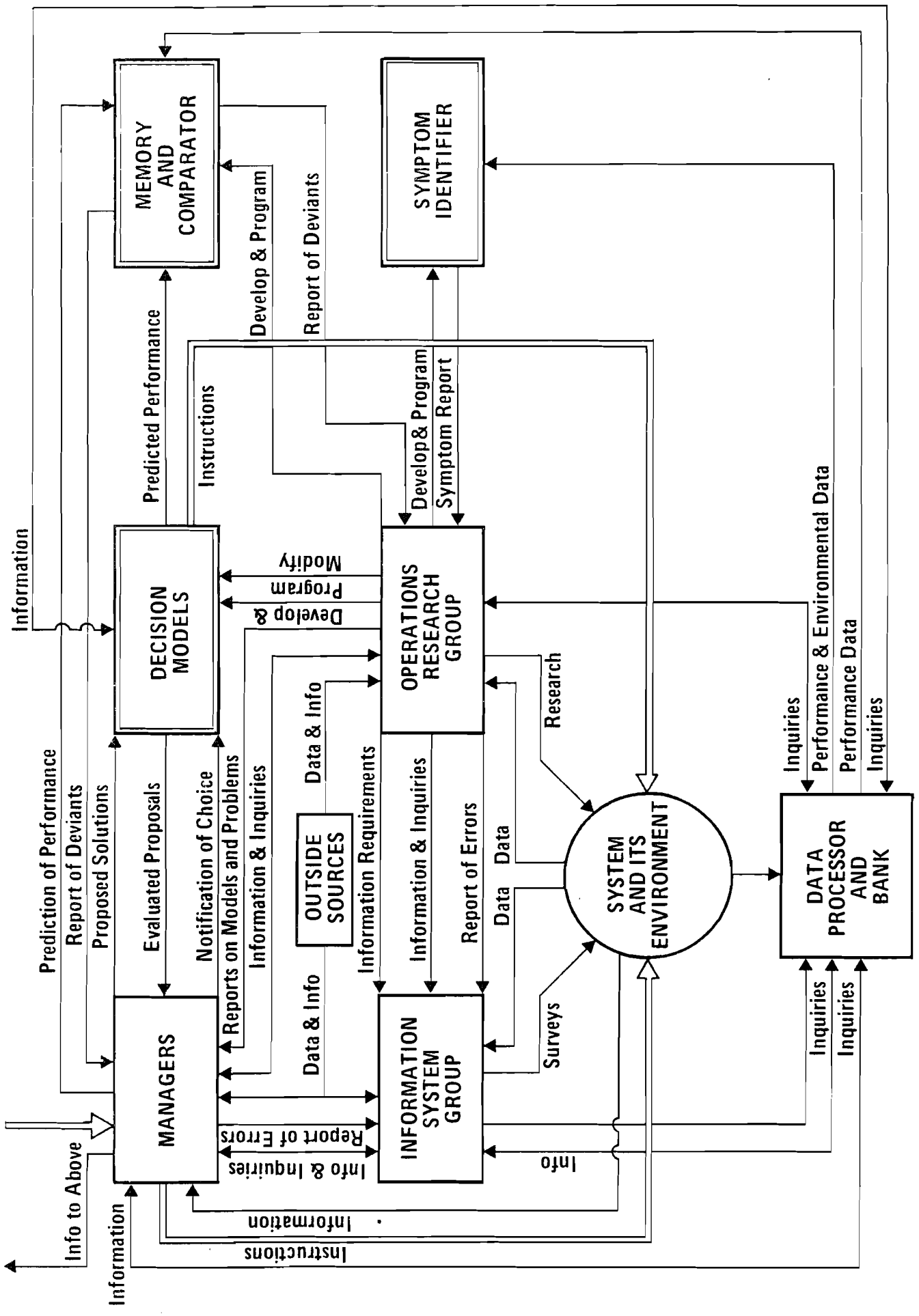

Figure 3. Management system suggested by Ackoff (1972).

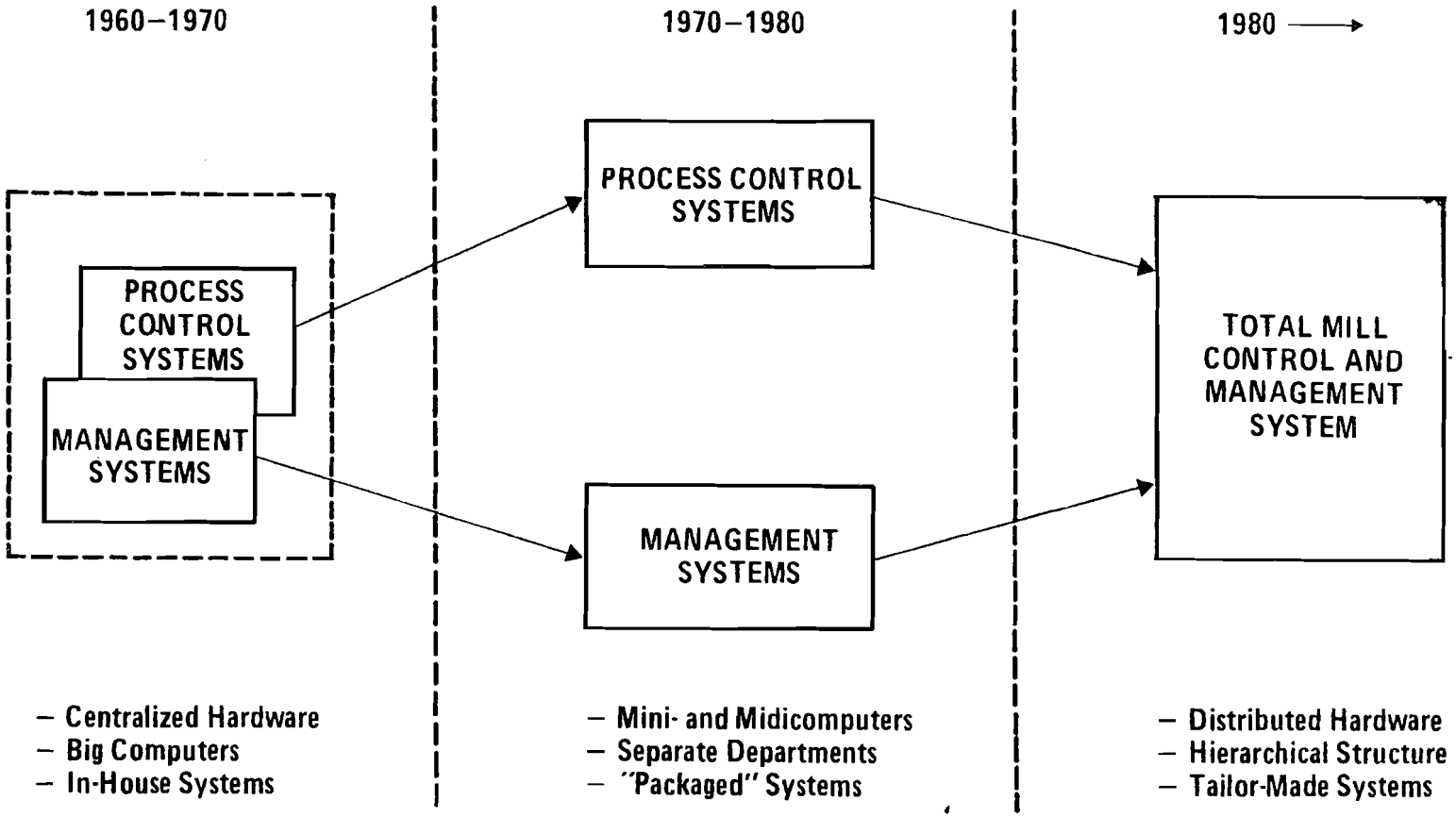

Figure 4. Development of control and management systems.

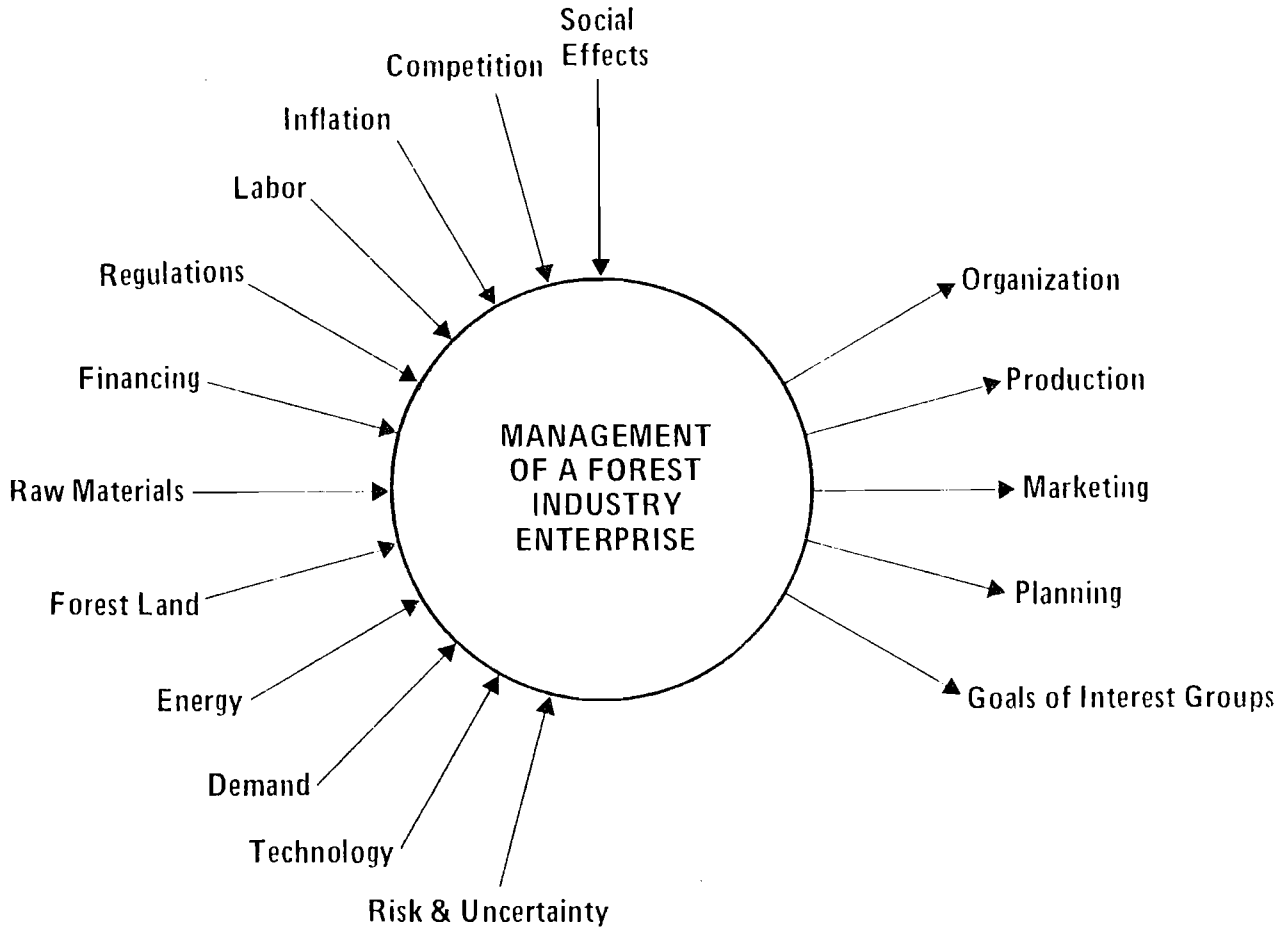

Figure 5. Management "environment" in a forest industry enterprise.

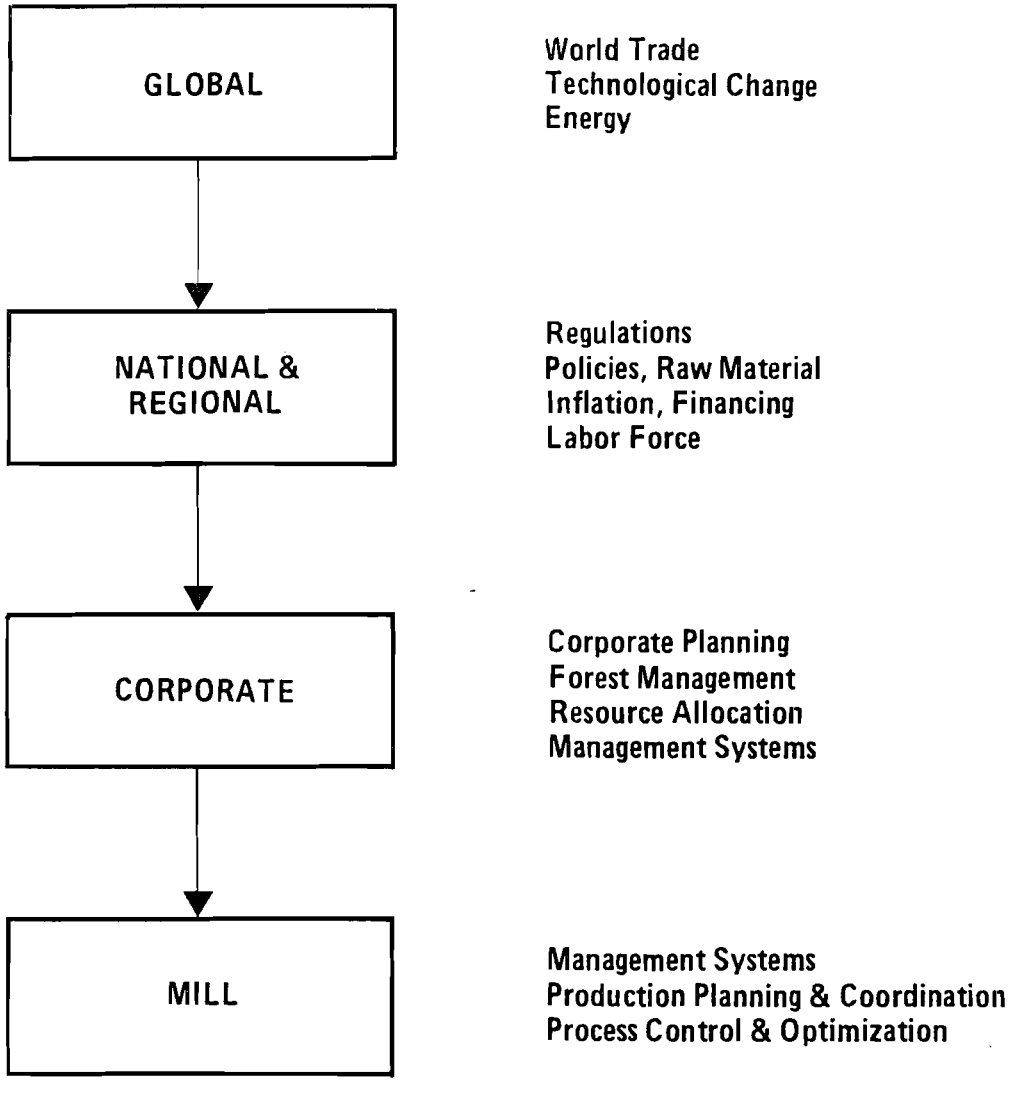

Figure 6. The hierarchy of management and planning problems.

ment tasks in a forest industry enterprise can be divided according to the time span as follows:

-- Strategic planning	time horizon:	years
-- Tactical planning	" "	months-year
-- Production planning	" "	1-7 days
-- Production coordination	" "	1-24 hours
-- Process optimization	" "	1-60 minutes
-- Process control	" "	0-1 minute

Another classification is:

Strategic management	long-term, (goals)
Tactical management	short-term, (means)
Operative management	real-time, (production)

For strategic management, typical systems analytical tools are corporate models and forecasts (Zackrisson, et al. 1977). The models needed are typical simulation models used to answer questions like: "What is the outcome if this decision or change will be made?"

For tactical management the most important tasks are budgeting and resource allocation; so budgeting and reporting systems, demand and sales forecasts, marketing and financial analyses are the tools needed.

The operative management of a mill is responsible for the fulfillment of the incoming order flow at the most efficient way taking several constraints and uncertainties into account. Figure 7 gives a diagram of the production planning system of a white paper mill. This kind of production planning system would be a part of a total mill information and management system as depicted in Figure 8.

Vital parts of this kind of system are several data bases which will draw data from the processes (via measurements) and from outside sources (via terminals). These data bases are updated and they are important data sources also for other management systems (tactical and strategic); thus all systems will be combined together.

Figure 9 presents two typical decision-making situations for operative management in the forest industry enterprise. The upper case represents a situation where the markets do not restrict, i.e., all what can be produced can be sold. In this situation management must decide the optimal product mix. The lower case represents a situation where the markets are limited and the orders coming in should be scheduled in production in the most economical way.

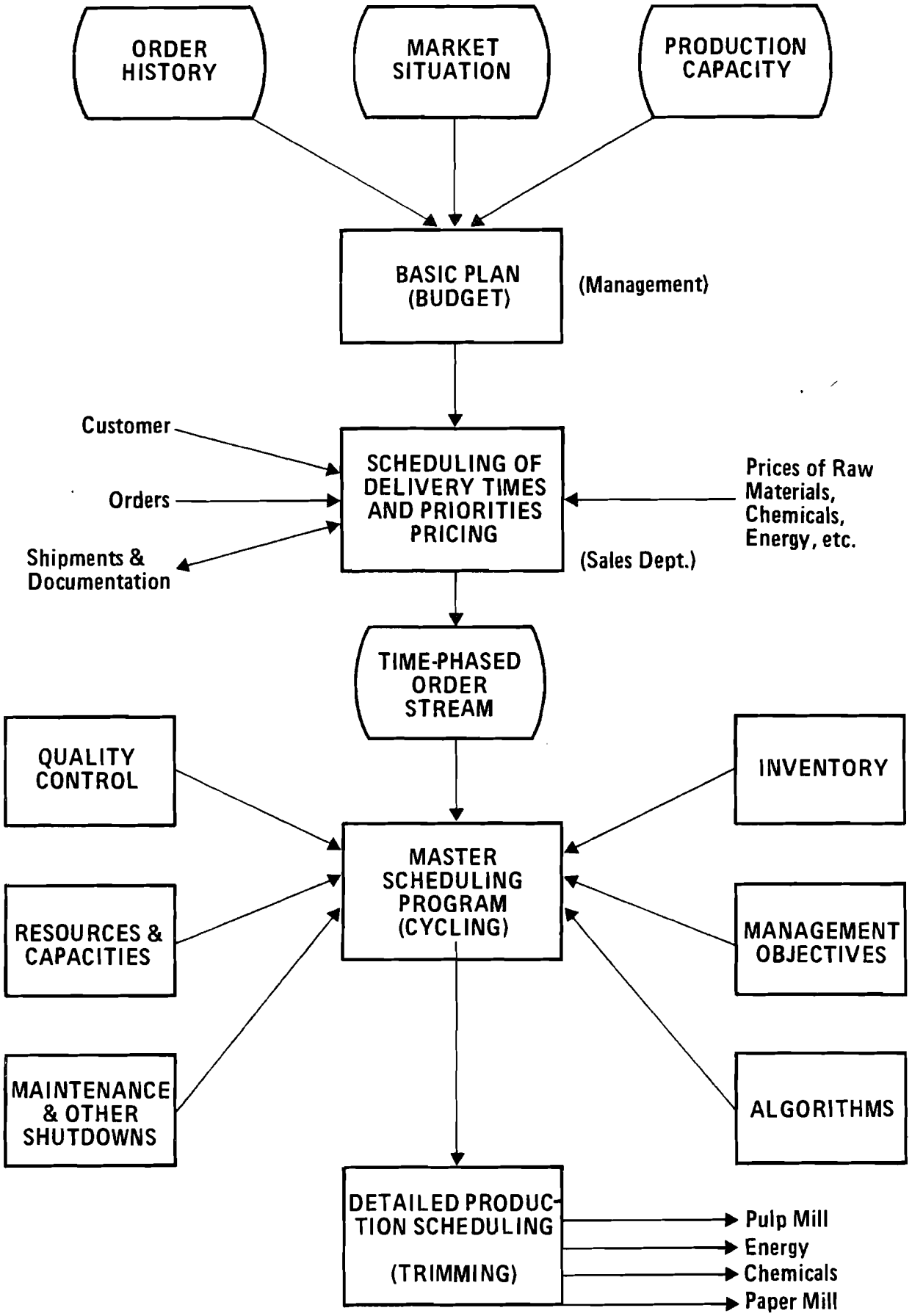

Figure 7. Master production scheduling process.

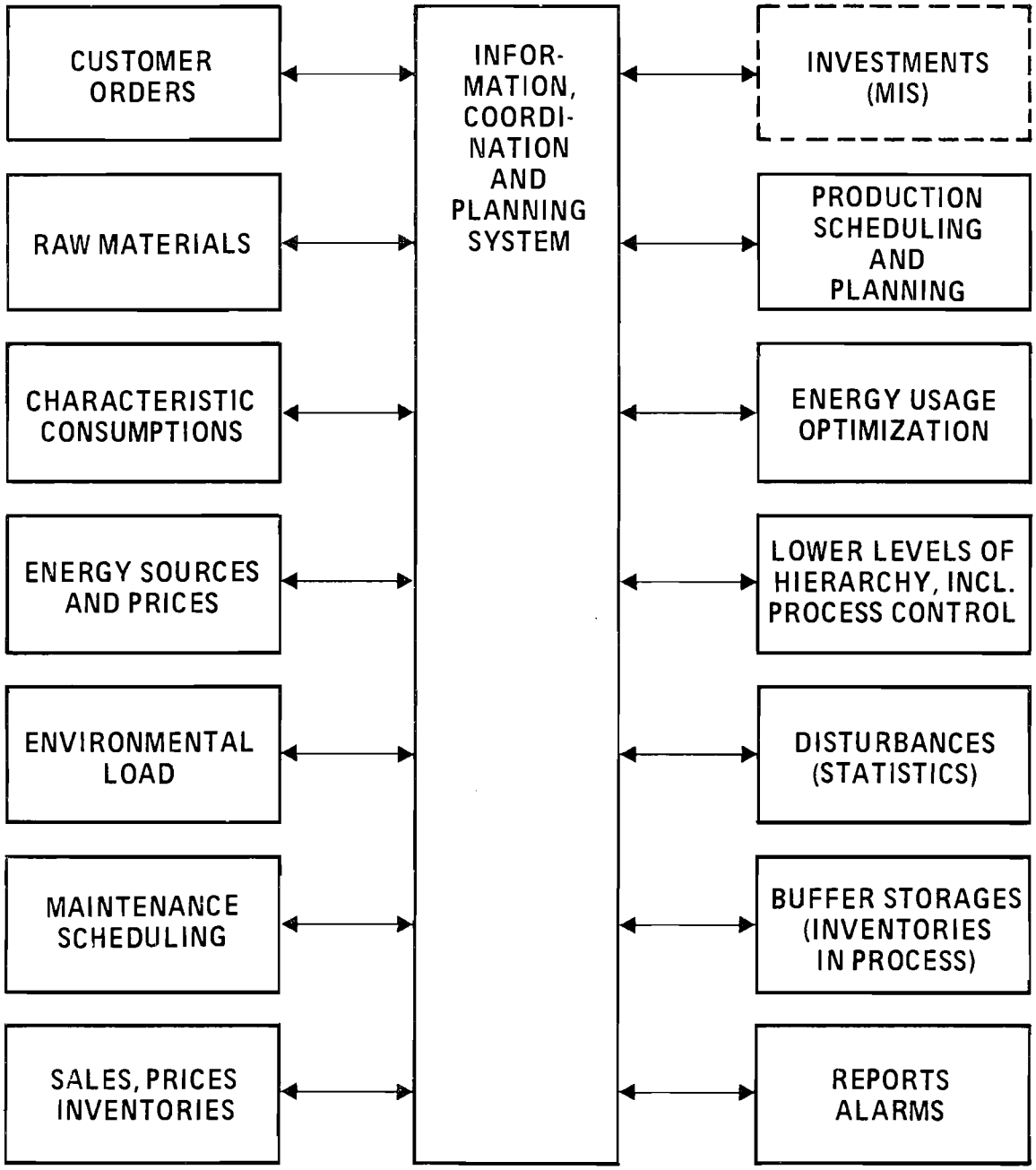

Figure 8. Tasks of total mill information and production planning system.

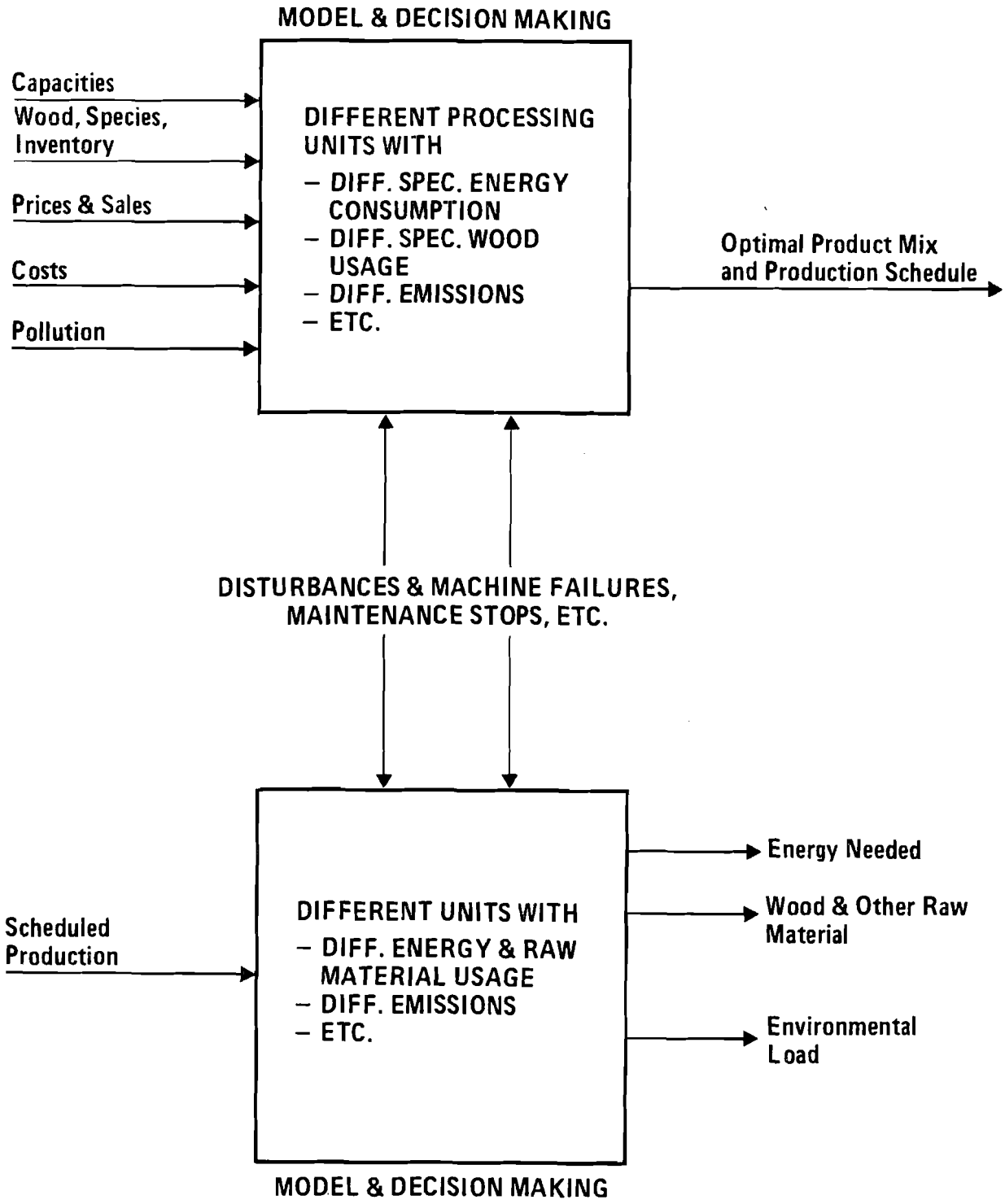

Figure 9. Typical problems to be solved in production planning.

Production planning should be done so that the use of equipment would be as even as possible, avoiding shut-downs, start-ups, rate changes, and overflowing, or emptying of in-process storages, etc., because there are several possible losses and disadvantages connected to all such changes as shown in Figure 10 (Uronen 1978). A real-time total mill information and management system, as depicted in Figures 7 and 8 can remarkably shorten the total control cycle time of the business thus preventing losses and improving the productivity as Figure 11 demonstrates (Uronen 1979). The development of computer hardware makes the implementation of these ideas in a hierarchical system with distributed hardware realistic and profitable. One possible structure of such a hierarchical system is proposed in Figure 12 (Uronen and Williams 1978).

STATE-OF-THE-ART IN THE FOREST INDUSTRY

No survey or state-of-the-art report concerning the use of systems analysis in the management of forest industry enterprises exists. One area, namely process control, is quite well covered in several surveys (Gee and Chamberlain 1977; Keyes 1975; Uronen and Williams 1978), and also the situation in recent years (Eriksson 1978; Uronen and Williams 1978). Thus a study of the applications and experiences concerning the use of the more "classical" type of systems analytical tools (corporate modeling, forecasts, etc.) in the forest industry would be necessary and useful giving feedback for research and development work in this area.

We can, however, assume that the situation concerning the use of these methods in the forest industry is far analogous to the situation in other branches of industry. Naylor and Schauland (1976) did a survey study in the US concerning the use of corporate planning models. The study concerned the situation in 1974-75 and they received answers to their questionnaire from 346 corporations representing 19% response. Some of their results are given in Tables 3-6. From Table 3 we can see that the response from the forest industry has been very limited, if any, and it has been included into group 'other'. Perhaps the most interesting is Table 6 which lists the benefits of corporate modeling; the main benefits are closely related to policy analysis and decision-making; the direct cost savings are mentioned only in 28% of the cases and only 4% of the answers do not indicate any benefits at all. We must, however, keep in mind that this study concerned only one application area of systems analysis, namely the corporate modeling. This is, of course, a central and important application but in order to be able to evaluate the whole range of applications, especially in the forest industries a survey study must be carried out.

Concerning the present situation in the area of hierarchical real-time management information and production planning systems, some existing systmes are in operation (Eriksson 1978; Uronen 1978). Figure 13 shows the functional levels of hierarchy installed at A. Ahlstrom's Paper Mill in Finland (Uronen 1978).

Table 3. Firms using corporate models classified by industry.

Industry	Number of Firms
Manufacturing	64
Banking and Finance	30
Regulated Industries (transportation, communications, utilities)	20
Service	15
Mining	7
Agriculture	5
Others	18
No response	54
TOTAL	213

Source: Naylor, Schauland, 1976

Table 4. Applications of corporate models

Applications	Percentage
Cash flow analysis	65
Financial forecasting	65
Balance sheet projections	64
Financial analysis	60
Proforma financial reports	55
Profit planning	53
Long-term forecasts	50
Budgeting	47
Sales forecasts	41
Investment analysis	35
Marketing planning	33
Short-term forecasts	33

Source: Naylor, Schauland, 1976

Table 5. How corporate models are used

Use	Percentage
Evaluation of Policy Alternatives	79
Financial Projections	75
Long-Term Planning	73
Decision-Making	58
Short-Term Planning	56
Preparation of Reports	47
Corporate Goal Setting	46
Analysis	39
Confirmation of Other Analysis	35

Source: Naylor, Schauland, 1976

Table 6. Benefits of corporate models

Benefits	Percentage
Able to Explore More Alternatives	78
Better Quality Decision-Making	72
More Effective Planning	65
Better Understanding of the Business	50
Faster Decision-Making	48
More Timely Information	44
More Accurate Forecasts	38
Cost Savings	28
No Benefits	4

Source: Naylor, Schauland, 1976

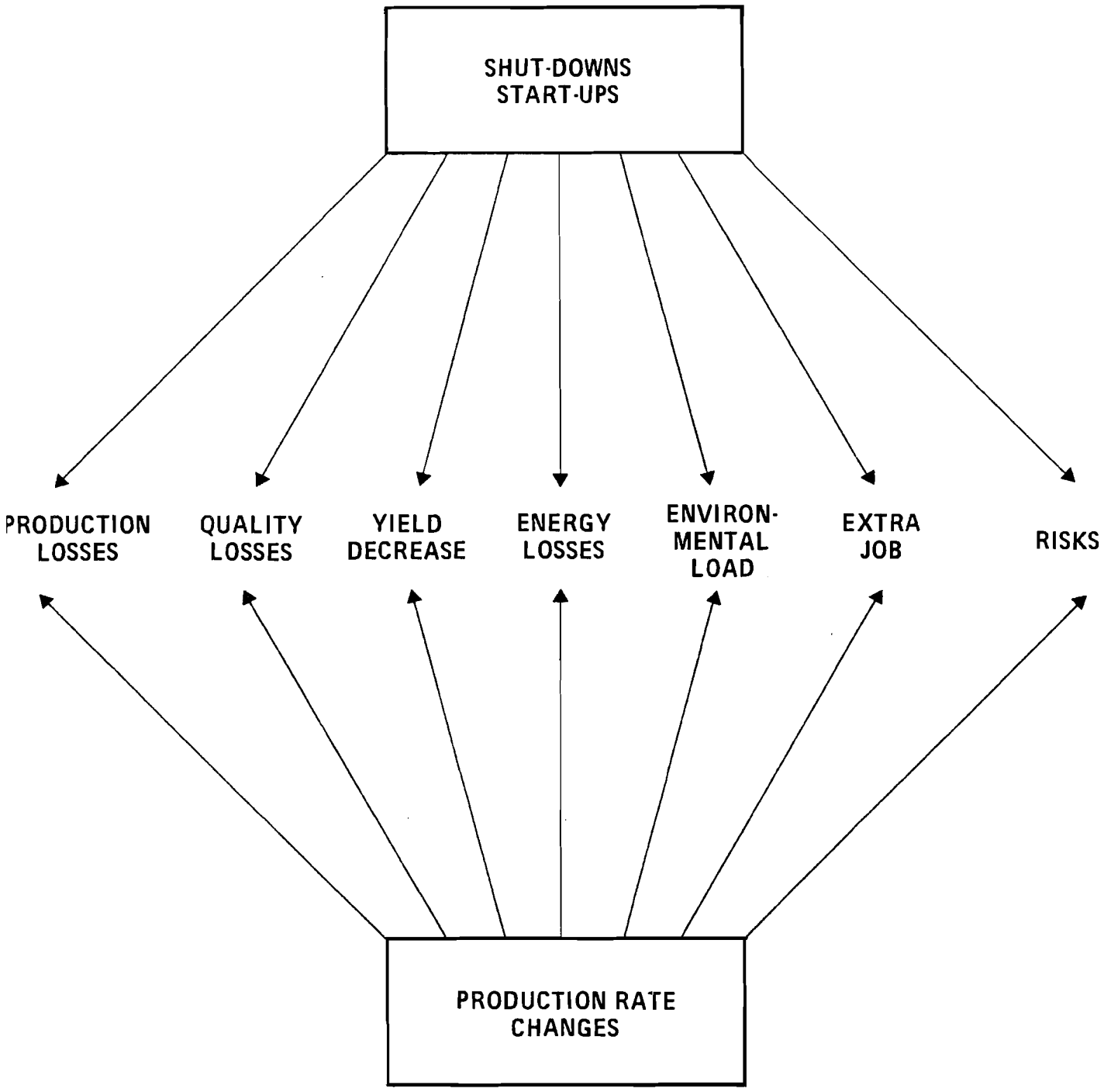

Figure 10. Some undesired effects of mill shut-downs and production rate changes. (Uronen 1978)

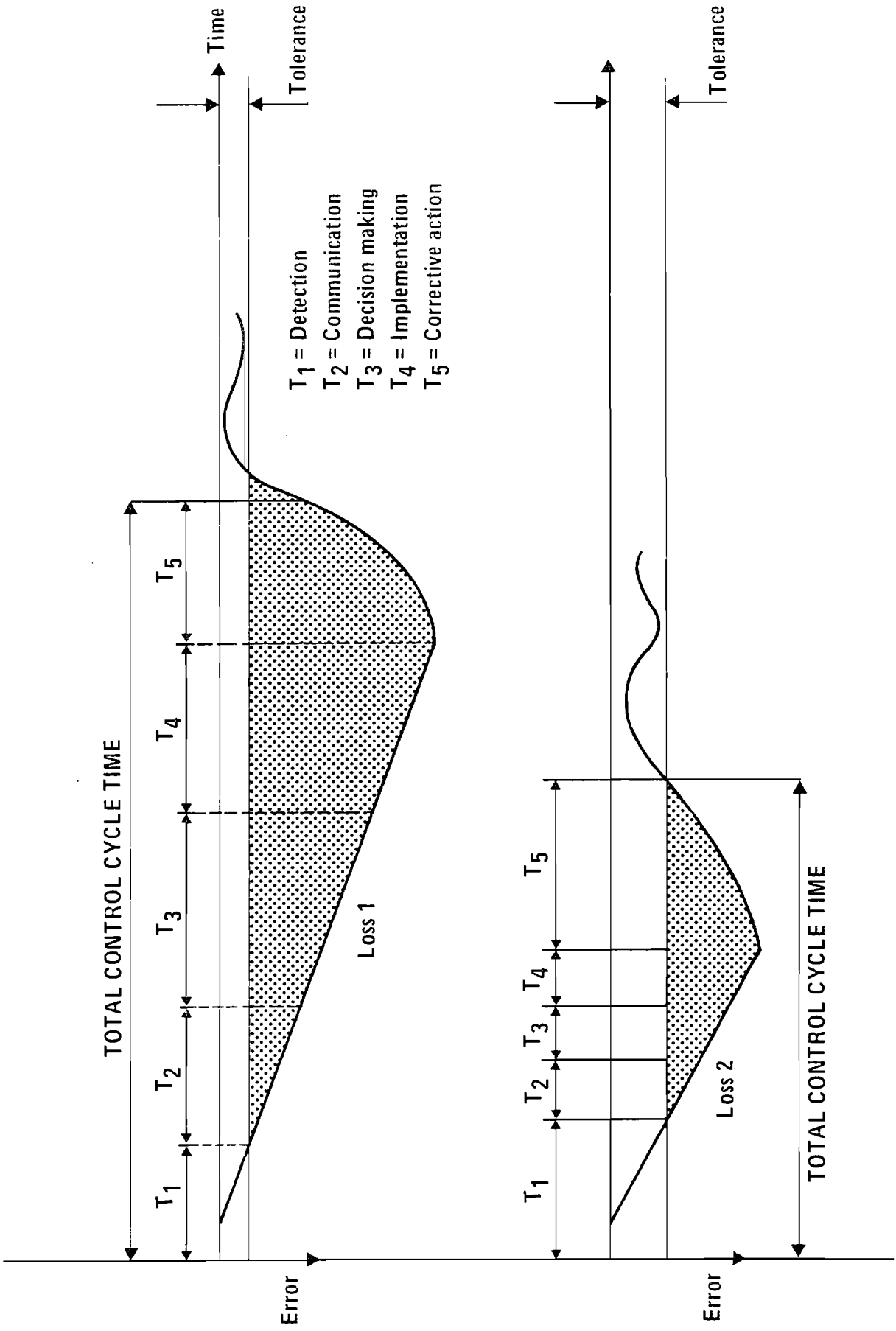

Figure 11. Real-time total mill information and control system can remarkably shorten the total cycle time thus improving profitability. (Uronen 1979)

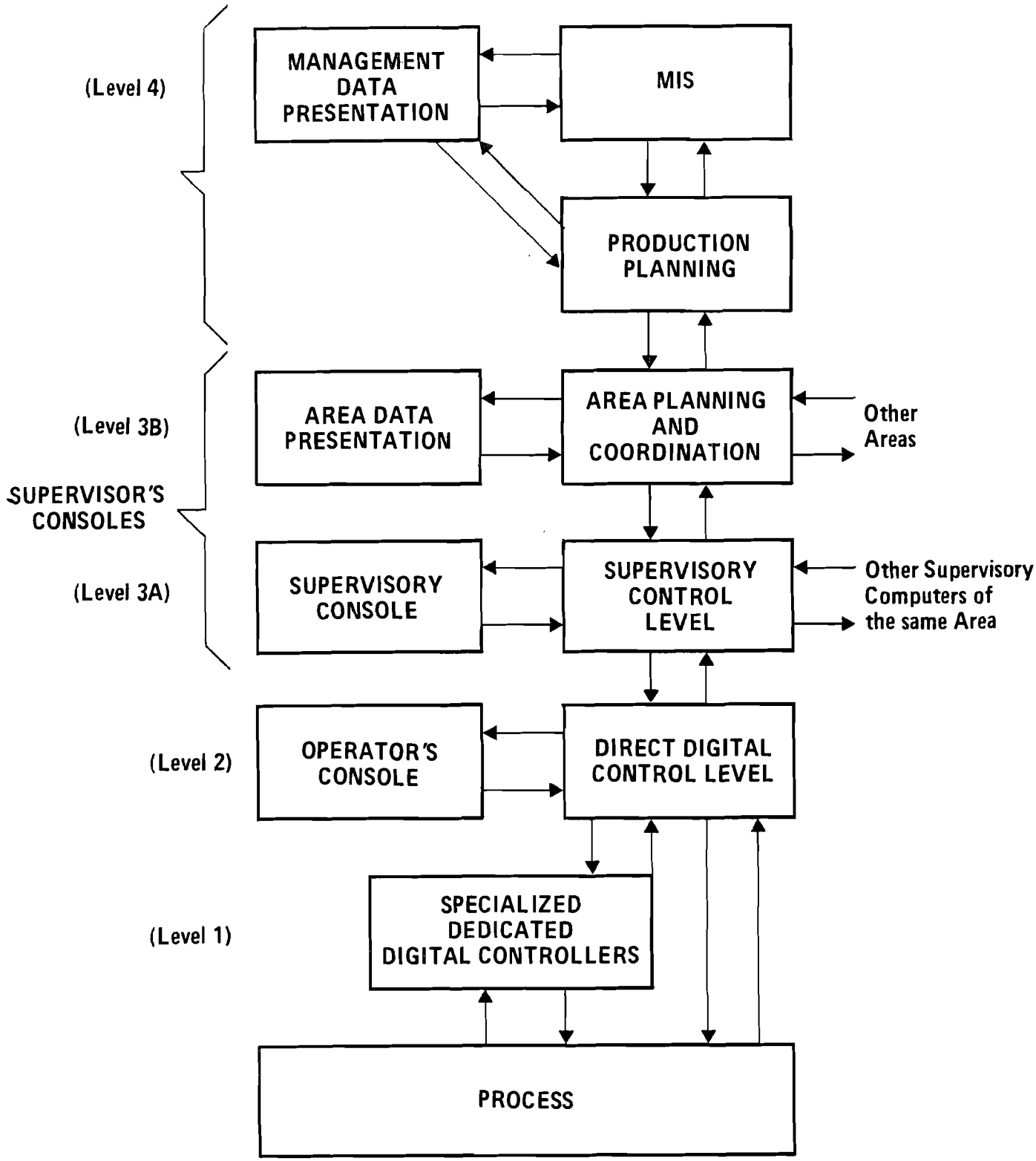

Figure 12. Proposed general hierarchy.
(Uronen and Williams 1978)

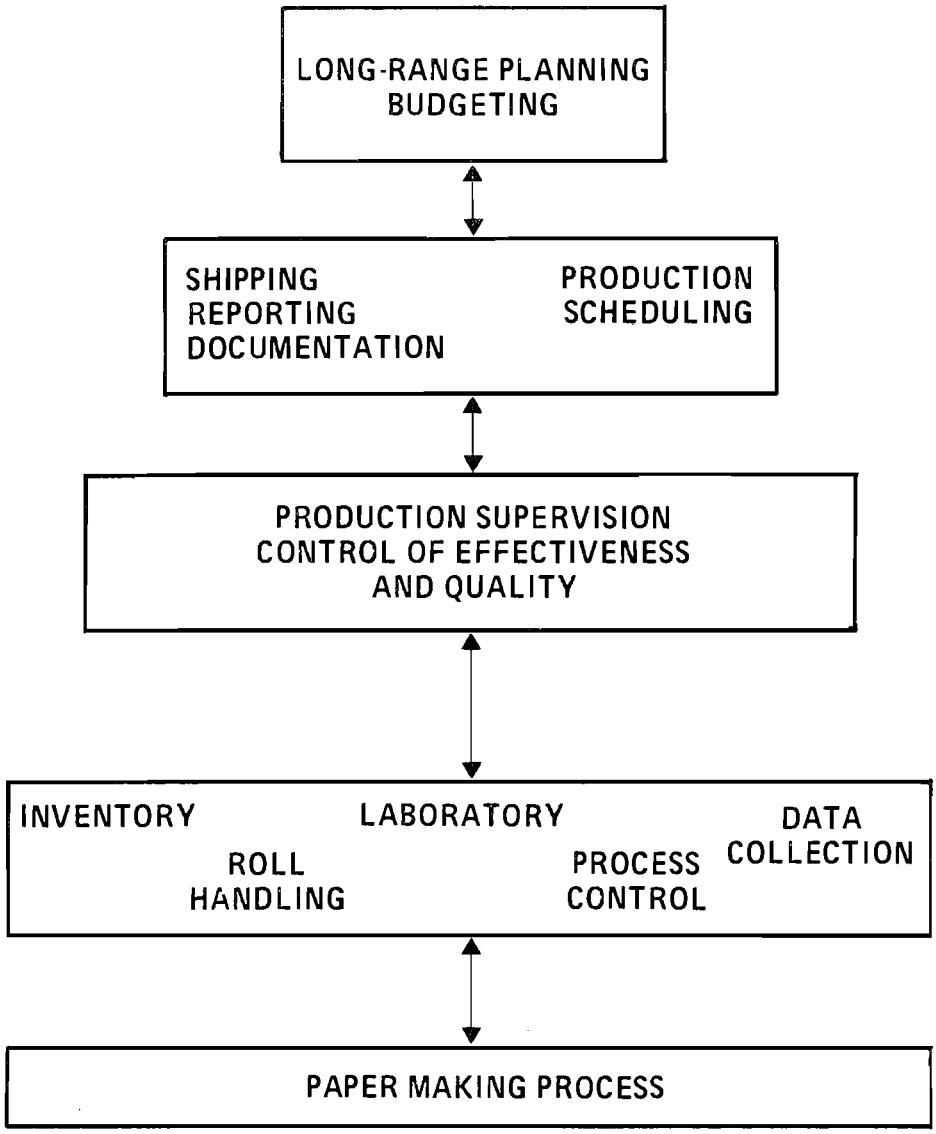

Figure 13. Hierarchical production planning and control at A. Ahlstrom's paper mill, Varkaus, Finland. (Uronen 1978)

The number of this kind of systems is expected to increase rapidly in the 80's and at the same time these systems will be combined more and more with corporate models and other management tools, thus forming a total management system for the company.

FUTURE DEVELOPMENT

It is obvious that despite disappointments and time lags the use of systems analytical tools in the forest industry, as well as in other industries, will increase continuously in the future. The following trends and needs can be seen:

-- the systems analytical models and tools will be more and more connected to production planning and control systems thus forming a hierarchical total mill management and information system. Then also the gaps and time lags between the planning, production, marketing and financing will be decreased and the overall control and decision-making will be faster and more integrated.

-- many companies are planning to build corporate models and management information systems. It is important that the needs of the users of these systems will be taken into account already in planning. Top management should also be involved in planning.

-- there is a need for the development of new user oriented programming languages, for example, for planning and budgeting.

-- the connection between corporate models and production planning systems will become more important.

-- most corporate planning systems do not, so far, include optimization procedures. It is probable that the use of optimization techniques in production planning and goal programming in resource allocation will increase rapidly.

-- new models are needed for external environment, i.e., for economic, regional, social, ecological and political problems connected with the forest industry enterprise.

-- a continuous dialogue between the systems analysts and the users of these tools is in essence.

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