

Computer Supported Complex Strategy Process: A Dynamic and Multicriteria Group Support System

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Abstract

We establish a versatile framework for building a strategic decision support system that integrates advances in a corporate-wide simulation, Group Support System, and hierarchical evaluation procedure. The ideas of the management team about organizational goals, objectives or strategies can be captured by the Group Support System. During the GSS sessions the mental models of the participants are shared among team members. The corporate-wide simulation model encourages the participants to establish long-term views of policy and strategic issues, to integrate the different functions of the company and to look at the company holistically.

Perhaps the most important advantage of the approach is that the system provides the strategic management with new opportunities for learning through conceptualization, discussion, and experimentation. The Group Support System supports the integration of the diverse knowledge, opinions, values, and judgments of the participants. Through the methodological integration the hierarchical evaluation procedure helps to find the effective solution in a simulation context. The contemporary views of organizational goals and objectives are balanced by a hierarchical evaluation procedure.

1. Introduction

Strategic management is regularly faced with new challenges from competitors, suppliers, changes in industry structure, mergers, etc. These challenges are characterized for example with a short response time, high turbulence and uncertainty, controversial goals, and global perspective. As an internal response to the challenges of strategic management, the strategy process has changed to a continuous, full time, participative, management process.

Fortunately, recent advances in information technology offer great opportunities to support strategic planning processes, particularly in the field of Group Support Systems (GSS), interactive simulation systems, and

Decision Support Systems (DSS) in general. A DSS is an information system that combines models and data in an attempt to solve even nonstructured problems with extensive user involvement (see for example [14]). Today it is possible to develop support systems that meet the diversified challenges of strategic management. A Group Support System is especially intended to support decision process in groups. It is possible to replicate the key characteristics and behavior of an object system by simulation. However, the developed systems seem to support only a particular phase of the strategy process, specially the initial information gathering phases. Intelligent agents [5], for example, can be used to support the scanning, filtering, and interpreting of strategic information that is then used in the strategy process. On the other hand, the Analytic Hierarchy Process [10] supports the choice phase of the strategy process. Although there are some attempts to integrate different tools [15] there is still a need for a conceptually sound, integrative framework and, specially, for concrete support systems based on that framework.

In this study, a general framework is presented for building a strategic decision support system that integrates advances in a corporate-wide simulation, group support systems, and hierarchical evaluation procedure. We have constructed and integrated a set of tools that supports the essential needs of the strategic management and supports all the phases of the strategy process. The forest industry is employed to illustrate the application of the approach.

Below we first discuss conceptually what to include in the strategic support system and how to support strategic management, and then we present a real forest industry case.

2. Supporting the Complex Strategy Process

The purpose of this chapter is to incorporate conceptually the strategic planning and analysis and the support systems intended to support those activities. The

logic behind our view of reasoning is summarized in Figure 1.

According to Figure 1 the Strategy schema and Support schema are tied by two routes: the needs and characteristics of the strategic management define what to include in the support systems, and the content of the strategy process defines how to support the strategy process. We will discuss the *What*-question first, and then the *How*-question.

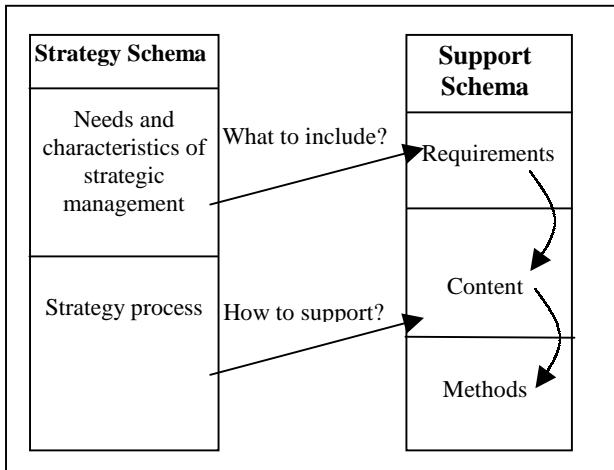


Figure 1. Conceptual map of the study

2.1. Strategic management and requirements for respective support systems

It is clear that the strategic management in a large, multinational corporation has a global perspective. In those corporations the strategic management exercises dynamic, long range planning, and it has multiple criteria for evaluating alternatives. The needs of strategic planning and analysis form a starting point for developing systems to support the tasks and work procedures of the strategic management. In Table 1 we summarize the most crucial needs and characteristics of strategic planning and analysis and the respective requirements for the supporting systems.

Strategic planning and analysis concern the whole company indicating that every function and department in a firm is understood as a part of the whole; not as an isolated entity. Because the strategic management covers the whole organization it means that the respective computerized support system also has to adopt a systemic, corporate-wide perspective. The system has to cover the whole company and all its functions, like finance, production, and marketing. This does not indicate, however, that massive, indivisible systems should be developed. On the contrary, the corporate-wide perspective can also be accomplished by combining for example functional models.

Since strategic planning and analysis represent the highest planning level, one of the most crucial tasks of the management is to define the goals and objectives of the firm. This means that there is no single given goal or objective; different goals and objectives must be evaluated

Managerial need	Challenges and requirements for the supporting system
1. Concerns the whole organization	Systemic, corporate-wide approach Disseminate and coordinate decision making across functional areas and hierarchical areas Management of organizationally diversified users
2. Controversial goals and objectives	Multiple criteria decision making
3. Direct and indirect effects on multiple functions	Management of complicated causal relationships
4. Long time frame	Long planning horizon, extensive data volumes
5. Uncertainty	Subjective and objective input data
6. Short response time to environmental stimulus	Easy to adapt and use, high-quality user interface
7. Complex and unstructured problems	Support decisions, not substitute
8. Ad hoc, non-routine problems	Flexible system
9. Internal and external data	Tied to internal and external data bases
10. Remarkable sums of money tied	Significant undertaking, high system costs affordable

Table 1. Needs and characteristics of strategic management and requirements for strategic support systems

and weighed. Some goals and objectives have a direct value as such, while others have only intermediary value. At the support system level this feature of strategic management means that the system has to support multiple criteria decision making. This requirement can be satisfied at different levels by different means. At its simplest, the system can allow just using a number of evaluation criteria. For example, the system can report different financial ratios to support the decision makers. Another way to support multiple criteria decision making is that the system is not restricted only to a single user but supports also group or team work. When a group participates in the

decision making process they inevitably also carry multiple, conflicting goals and objectives. The system may also contain some multi-criteria decision-making algorithms that guide the search for efficient solutions.

Because the strategic management covers the whole organization, the decisions have direct or indirect effects all over the organization. Thus, the system supporting strategic management has to be capable of managing large and complicated sets of causal relationships. Actually, it is not enough that the system manages the causal relationships, it also has to help the decision makers to manage and understand them.

Strategic planning has long-term impacts. The rapid and sudden changes in the environment have made new demands on strategic planning and analysis. Organizations must adapt to changing circumstances quickly and flexibly. Further, they must be capable of changing their plans quickly and flexibly; these plans must have a longer horizon than previously. These needs introduce heavy requirements to the respective support system. The long time frame means inevitably long planning horizons for planning models, extensive data sets, and difficulties to get relevant data. The long time frame also increases uncertainty, and therefore more subjective data is needed. The requirement for extensive data sets on one hand and the requirement for subjective data on the other hand may be contradictory in some context and the support systems have to go beyond the scope of traditional information systems. To be able to adapt quickly to changing circumstances the system has to be flexible and easy to use. The system interface must be of the best quality to satisfy the demands of diverse users.

The above discussion of the *What*-question forms the requirements for an effective support system of strategic planning and analysis. In the next section we will discuss the strategy process, implementation phases, and respective support tools.

2.2. Strategy process and the content and methods of the support systems

In the literature of strategic management, planning and analysis, a number of process models are presented to describe the flow of the strategy process. According to [2], for example, a strategy process consists of the following phases:

- Strategy identification ... the assessment of current strategy and strategic components
- Environmental analysis ... to identify the major opportunities and threats
- Resource analysis ... principal skills and resources available to close the strategic gaps
- Gap analysis ... a comparison of an organization's objectives, strategy, and resources against the opportunities and threats in its environment
- Strategy alternatives ... the identification of the strategic options
- Strategic choice ... the selection of one or more of the strategic options for implementation.

Here we simply assume that the strategy process consists of the following five phases:

1. Review of the behavior of the present system
2. Identify goals and objectives
3. Formulate business strategies
4. Evaluate the outcomes of strategies
5. Prioritize strategies and selecting the best strategy

The first phase of the strategy process involves a holistic *review* of the present system and its processes. The analysis should be performed at the organizational level in order to build the first picture of the existing strategic behavior over the whole organization by diagnosing the perceived or underlying problems. This phase may include the traditional analyses of weaknesses, opportunities, and threats. The most important task is to provide the decision makers with shared understanding about the present organizational procedures, structures, information flows, etc.

The factual *identification* of the goals and objectives of the company forms the most fundamental premise for all subsequent activities in the entire strategy process. In a large organization there are individual goals, and small groups have their own objectives, as does the whole organization. The number of goals, objectives or evaluation criteria to be considered in the strategy evaluation can be enormous.

The organization can apply some generic strategies [8] or design its own, specific strategies. The strategy *formulation* is mostly an intellectual process limited by the organization's weaknesses, environmental opportunities and threats, and the resources at hand and available. Every organization should have some strategic alternatives to be considered during the strategy process.

Regardless of how the strategies are generated the next phase in the strategy process is to *evaluate* them. Of course the goals and objectives of the organization serve as the evaluation base. "Whether formally or incrementally derived, strategies should be at least intellectually tested against the proper criteria" [7]. Finally, the strategies are *prioritized* and the best strategy chosen.

The above description of the strategy process is, of course, highly simplistic and serves only for conceptual purposes. For example iterations may exist during the strategy process. However, an open question remains: How to support the strategy process? The main principle for the system development would be that the whole strategic decision making process should be supported [13].

One potential way to meet the requirements and to support the review phase is to build a *corporate-wide simulation model* to describe the structure, processes, key relations and environment of the whole company. The purpose of the simulation is to gather understanding of the original object by studying the behavior in the simulation. Generally, corporate models aim to integrate the different functions of a company and to look at the company holistically (beginning from [6]).

As the methodology guiding the modeling process including model validation we have applied the principles of Systems Thinking. Systems Thinking offers a holistic view of the object system, emphasizes the feed-back relations among system items, and provides a structured way of shaping complex problems [12]. "Systems Thinking is the art and science of making reliable inferences about

Phases of strategy process	Review of the behavior of the present system	Identify goals and objectives		Formulate business strategies	Evaluate the outcomes of strategies	Prioritize strategies and selecting the best strategy
Support content	Development of corporate-wide simulation model	Searching of goals and objectives	Criteria evaluation	Defining business strategies	Strategy simulation by the corporate-wide model	Choice of the best strategy
Methods	Systems thinking	Group DSS	AHP	Group DSS	Systems thinking	AHP
Software	Ithink, Dynamo	Group-Systems	Expert Choice, LDW	Group-Systems	Ithink, Dynamo	Expert Choice, LDW

Table 2. Strategy process, contents of the support systems, and the respective methods

behavior by developing an increasingly deep understanding of underlying structure” [9]. According to the principles of Systems Thinking it is possible to construct ‘microworlds’ [11] which in some aspects resemble the real organizational environment. In those microworlds, if realism is required then complexity is needed.

In order to support the *searching of strategic goals and objectives* (performance indicators) we have applied the principles of Group (Decision) Support Systems (GSS). A group decision support system is an interactive computer-based system that facilitates the solution of unstructured problems by a set of decision makers working together as a group [1]. It is clear that a group has more ideas, information, knowledge, opinions, judgments, and values than any individual member. The Group Support System can help to combine that knowledge and create common goals and objectives to which the group is committed. The goal-sessions consist of the top managers and experts that are responsible for the organizational strategies.

The result of the strategic goal-sessions may be a long list of more or less important goals and objectives which the organization should strive for, and therefore the goals and objectives need to be weighed somehow in the *criteria evaluation* phase. (Because the strategies are later evaluated against these goals and objectives we can call these goals and objectives ‘criteria’.) The Analytic Hierarchy Process (AHP) is a multicriteria methodology to support selection problems [10]. It starts by decomposing a complex decision situation into a goal hierarchy. Each level consists of a few manageable goals and each goal is, in turn, decomposed into another set of goals. At the top of the hierarchy lies the most general objective of the organization. Structuring any decision situation hierarchically is a useful way of dealing with complexity and identifying the major components of the problem.

The Group Support System is an efficient method to *define business strategies*, too. The strategy ideas of the management team can be captured by the Group Support System. During the strategy-sessions the participants’ mental models and their knowledge are stimulated and shared to generate strategic alternatives, to organize them, to discuss their contents, and differences, etc. As a result of this phase there exist a number of potential strategies, strategies which the key managers of the organization are accountable for.

In the next phase, the corporate-wide model can be used to *simulate the strategies* concretely. This model, developed in the first phase, allows a risk-free experimentation with the strategic alternatives. It provides a concrete reference point for testing the different implications and validity of ideas created during the previous phase. The direct and linked implications of each strategy can be dynamically simulated.

Finally, the strategies should be prioritized and the *best strategy chosen*. In this phase the outputs of the strategy simulations are evaluated against the AHP hierarchy constructed in the second phase. This phase combines the results of all the earlier phases and puts the strategies into a proper order.

In Table 2, our view of the contents of the support process and the respective methods are presented with the phases of the strategy process. This table forms the answer to the *How*-question posed in the beginning of this chapter.

3. Descriptive case: supporting the strategy process in a forest industry corporation

In this chapter we describe a real case where the support process described in the previous chapter is fully adopted. The presented approach was implemented in a large Finnish, multinational forest industry corporation. For the details of the case setting see [4].

In Finland, and many other countries, forest industry plays a significant role in production, export, employment, investments, and other indicators of the national economy. It has held its position even today when rapid movements within industries are generally taking place, specially during the information technology and communication boom. Forest industry is a cyclical, capital intensive industry where large production units are typical, in the leading companies production technology is highly developed and automated, and mergers and acquisitions shape the industry structure. Dynamics within the industry, environmental turbulence, and global competition are shaping the operations within the industry.

In the globalizing world the companies in the forest industry are forced to reconsider their strategies concerning their production and marketing, growth, core competence, structural changes within the industry, customer relations, profitability, environmental issues, etc. The challenges the forest industry is facing have increased the requirements for strategic, long range planning of the companies within the industry. It is easy to see that there are several characteristics in the present turbulent business environment of forest industry which call for new kinds of decision tools.

The purpose of the project behind this research report was to identify the strategic challenges and their implications met in a Finnish forest industry corporation, to analyze them, and to develop appropriate decision support tools to manage the most critical problem areas. In order to meet the strategic requirements, ever-increasing uncertainty, turbulence and changing environmental conditions, a versatile set of integrated decision support systems was developed.

3.1. Corporate-wide simulation model

According to the framework presented in the previous chapter, the first step to support the strategy process is to build a corporate-wide simulation model. The corporate-wide simulation model can be static, including only a single period of time, or a dynamic, multiperiod model, but usually a corporate model describes the activities of a company over a number of periods. In the case company, a dynamic corporate model was developed in cooperation with modelers and other experts in the organization.

The structure of a corporate model is always analogically related to that of the object organization. The corporate model developed in this project is divided into two main modules: production and finance. In addition, some factors in the model are determined to be external and they are given as environmental factors. The production module includes some variables concerning marketing, too. The production module is further divided into four similar sub-modules: sawing, pulp, paper, and plywood. Each subsector has an almost identical structure.

The production modules include the following items defined for each main product group: production capacity, capacity utilization, inventories, shipments, raw-material inventories, raw-material purchasing, production, production costs, inventory costs, customer orders, pricing, market shares, and order backlog. The production modules have some interrelationships between each other. For

example, the by-products (chips) of saw and plywood industries are used in the production of pulp, which is further used in paper production.

Within the financial module the following items are defined: balance sheet, income statement, financial ratios, financial policies, borrowing, desired cash, dividends, and equity issues.

Production and finance have a lot of relationships with each other. The revenues from sales depend on the quantity of shipped products and their unit prices, investments depends on the financial conditions of the company, depreciations depend on production capacity, etc.

The basic demand of the products, which affects the sales, is considered to be external and is included in the environment of the model. Other environmental factors are the prices of raw material, fixed costs and some items of variable costs (salaries, energy costs, etc.). The seasonal and other fluctuations that have a significant influence on the behavior of the model are also given in the environmental sector of the model. The whole structure of the developed corporate model is described in Figure 2.

As Figure 2 indicates, the variables are dynamically interrelated or interdependent. A well-known approach to the model phenomenon including feed-back relations is Systems Thinking, the principles of which are applied in this project. By Systems Thinking it is possible to learn the reactive and proactive nature of strategic decision making.

In the forest industry, the planning horizon is usually long. For example, the life-cycle of production capacity is several decades and the technical solutions are long lasting. Therefore the planning horizon in the model is defined to be 30 years where the first five years with historical data are used for the model validation.

3.2. Searching and evaluating decision criteria

In searching for decision criteria, we use a GSS laboratory with GroupSystems software [14]. It includes different activities: idea generation (electronic brainstorming), idea organization (categorizing), prioritizing, and policy development.

Electronic Brainstorming is designed to gather ideas and comments from the management team of the company in an unstructured manner. The participants respond to a question and to the comments of the others in a divergent process that helps the groups to generate a free flow of ideas rapidly. The participants contribute simultaneously and anonymously to a discussion that can be used as such or sorted by keywords. In addition, the comments are imported into other GroupSystems tools, where they are categorized.

The Categorizer allows the group to generate a list of ideas and supporting comments. Categories are created for the ideas, and the participants can drag the ideas into the desired category.

Figure 3 shows a sample of the Categorizer screen, which contains long-range objectives: Profitability, Scope and level of activity, Finance, Growth, Customers and markets, Public relations, Production technology, Personnel, and Investors.

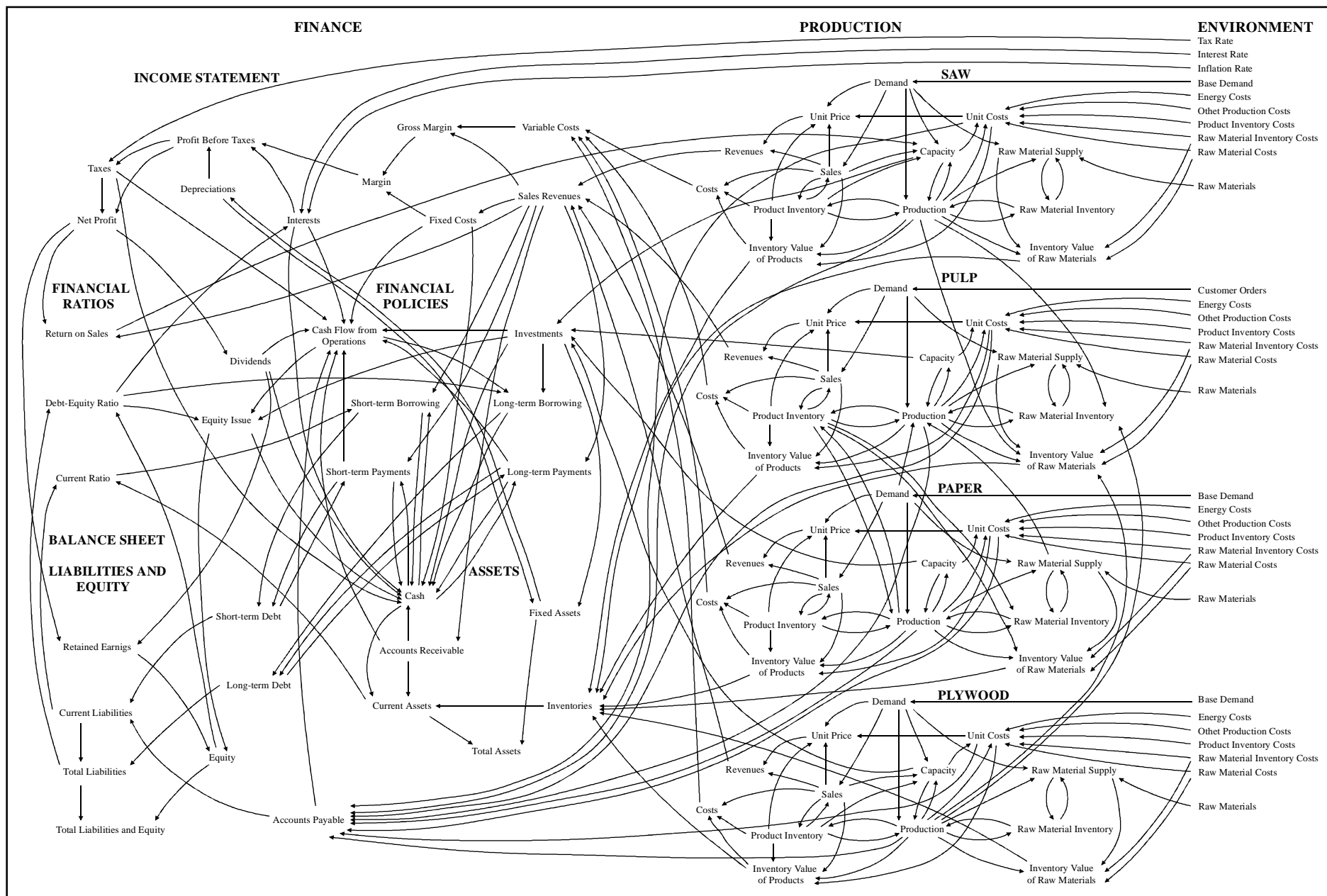


Figure 2. The structure of the corporation-wide simulation model

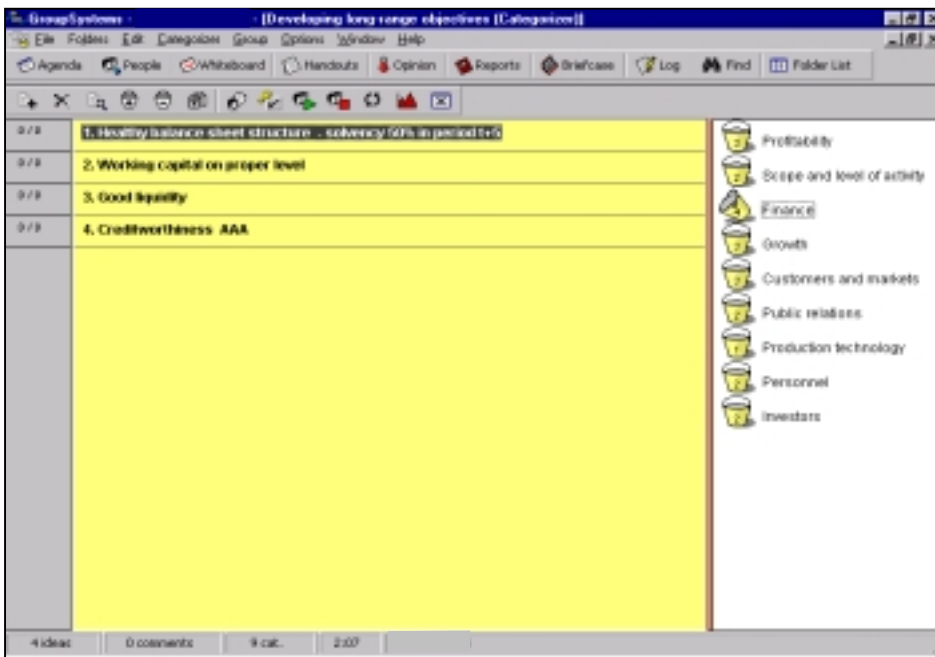


Figure 3. Categorizing goals and objectives

Next we use the AHP, which is designed to cope with both the rational and the intuitive information to select the best one from a number of alternatives evaluated with respect to several criteria. In this process, the decision makers (management team) carry out simple pairwise comparison judgments, which are then used to develop overall priorities for ranking the alternatives and criteria. The analytic hierarchy process both allows for inconsistency in the judgments and provides a means to improve consistency.

The structure of the decision problem consists of different levels: the goal of the decision at the top level, followed by further levels consisting of criteria by which the alternatives, located at the lowest level, will be evaluated. In Figure 4 the hierarchy for the criteria of the company is presented. It is adapted and developed from GroupSystems' brainstorming and categorizer. Now we can evaluate the main decision criteria and also the subcriteria by using AHP. The approach has similarities to the Balanced Scorecard [3], which includes financial measures that tell the results of an action already taken. It complements the financial measures with operational measures on customer satisfaction, internal processes, and the organization's innovation and improvement activities – operational measures that are the drivers of future financial performance.

3.3. Defining business strategies

We use also GroupSystems' electronic brainstorming and categorizer for defining the business strategies. The management team of the company produces idea generation and idea organization. Figure 5 shows the screen of the strategy groups (Financial, Growth, Sustainable development and environmental strategy, Core

businesses, Production, Investor, Marketing, and Resource strategies) and a raw list of the different strategies. In the figure, the raw list of growth strategies is opened.

3.4. Strategy simulation

Nine effective strategies are simulated by the corporate-wide simulation model. The strategy groups, strategies and respective symbols are presented in Table 3. In the status quo strategy the following assumptions hold:

- Stable salary and wages level
- Dividends tied to profits
- No stock issues
- Medium sized

inventories

- Market prices are followed in pricing decisions
- Investments are not constrained by profitability
- No environment-oriented technology is used

In our simulation experiments we get nine different simulation results. In each of them there are seventeen criteria. Because there is no strategy superior to all other strategies, the final selection is not clear or easy. The solution is that we have to use priorities of the goal variables. In the next section such a procedure is described.

In Appendix the behavior of the goal variables corresponding to the present system is presented.

3.5. Priorization of strategies

On the first level of the hierarchy, the analytic hierarchy process produces the importance of criteria. On the next level, we compare alternative strategies with respect to each criterion. The word preference describes the process. By using Figure 6, for example, we judge which is more preferable "Smaller inventory strategy" (blue) or "Dividends strategy" (green) with respect to the current ratio criterion, and how much preferable it is. After similar pairwise comparisons of all other strategies (Status quo, Personnel strategies, Pricing strategies, etc) respect to all criteria, the analytic hierarchy process calculates the results.

Finally, the total priorities of the strategies are synthesized, see Figure 7. Examining this figure, we see that the best strategy with respect to the well-being of the forest industry corporation is: The prices of paper and pine products are tied to the respective order backlogs and inventories -strategy (OBPRICE). The next best strategy is "Smooth dividends per share relationship" -strategy (SMDIVID). We can also study how sensitive the alternative strategies are to changes in the importance of the criteria.

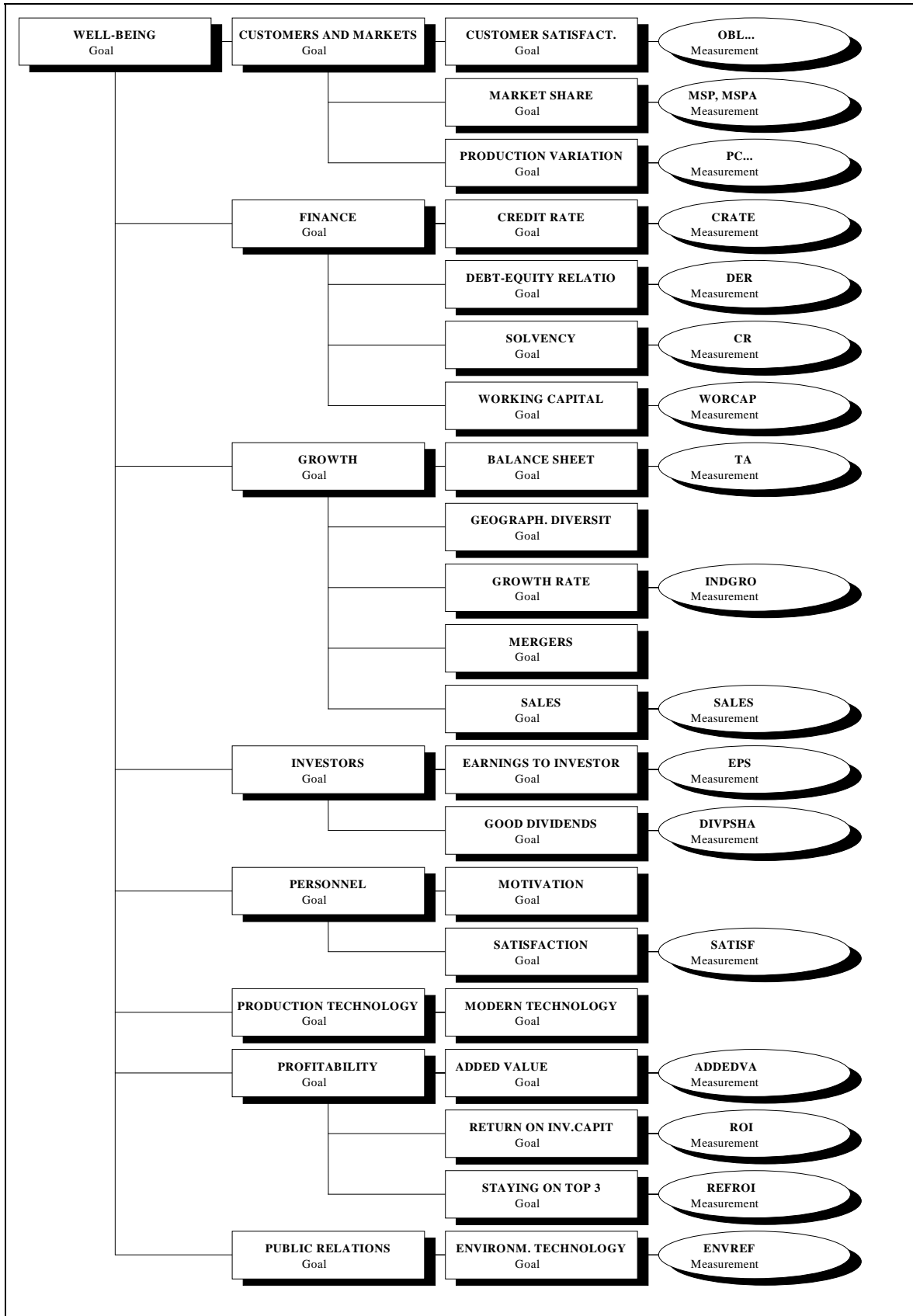


Figure 4. Hierarchy of goals and objectives

Strategy group	Strategy	Symbol
Status quo	1. Present system	PRESENT
Personnel strategies	2. Smooth growth in salary and wage levels	SMSALARY
	3. Salary and wage levels are tied to the profitability of the company	PRSALARY
Dividends strategy	4. Smooth dividends per share relationship	SMDIVID
Inventory strategies	5. Smaller inventories	SMAINV
Pricing strategy	6. The prices of paper and pine products are tied to the respective order backlogs and inventories	OBPRICE
Investment strategies	7. Investments are closely tied to return on sales	ROSINV
	8. Investments are not closely tied to return on sales	NROSINV
Environment strategies	9. Investing in environment-oriented technology	ENVTEC

Table 3. Strategies in strategy simulation

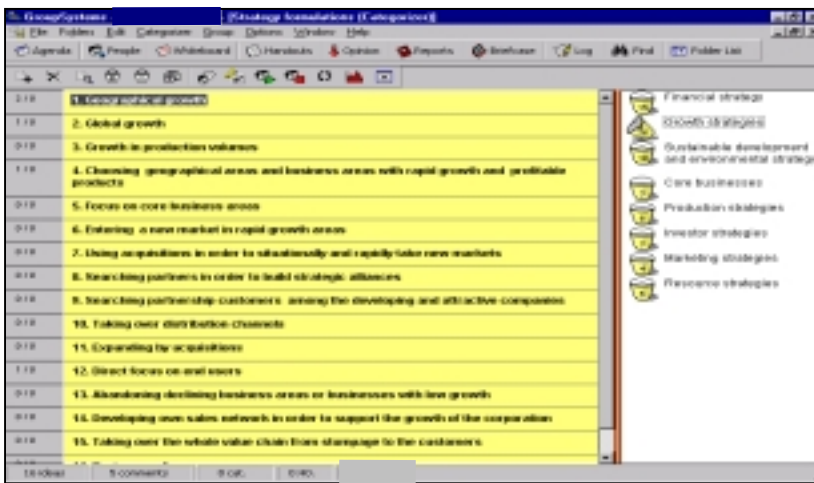


Figure 5. Strategy groups and a raw list of growth strategies

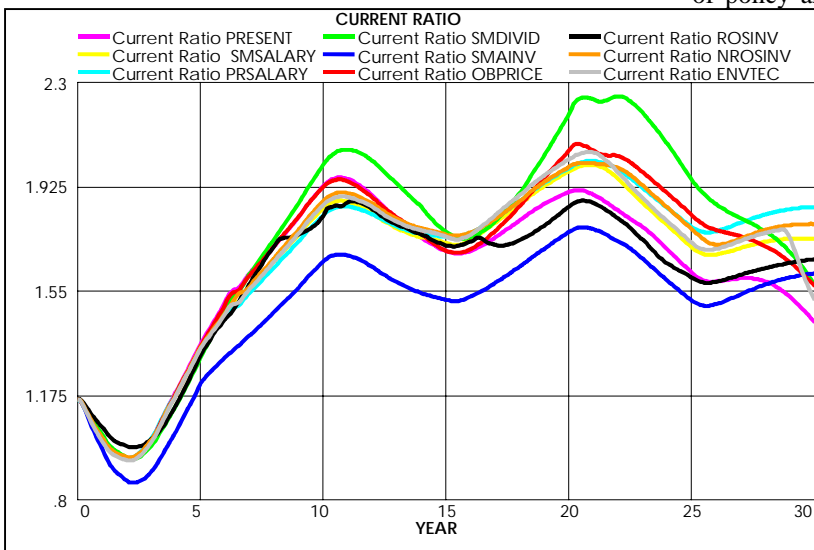


Figure 6. Strategy comparison with respect to current ratio criterion

4. Conclusions

In the research project behind this paper we have constructed and integrated a set of support tools that satisfy the essential needs of the strategic management and support all the phases of the strategy process. The whole structure of the developed system is presented in Figure 8.

In the developed system, hard and soft information has been integrated. The ideas of the management team about organizational goals, objectives or strategies can be captured by the GSS. During the sessions the mental models of the participants are shared among the team. The corporate-wide simulation model encourages the participants to establish long-term views of policy and strategic issues, to integrate the different functions of the company and to look at the company holistically.

Our experience with real cases highlights some obvious disadvantages and advantages of the approach. Building and validating a corporate-wide simulation model may be a time-consuming and expensive activity. However, the evident advantages go above the limitations clearly. Perhaps the most important advantage is that the system provides the strategic management with new opportunities for learning through conceptualization, discussion, and experimentation. GSS supports in integrating the diverse knowledge, opinions, values, and judgements of the participants.

members.

The corporate-wide simulation model encourages the participants to establish long-term views of policy and strategic issues, to integrate the different



Figure 7. Strategy prioritization

Through the methodological integration AHP helps to find the efficient solution in a simulation context. By a hierarchical evaluation procedure the contemporary views on organizational goals and objectives are balanced. On the other hand, from AHP point of view, the simulation provides long-felt dynamics to the static evaluation procedure. Typically, AHP evaluations are based only on subjective assessments. The simulation moves the evaluation toward a more factual and realistic basis. It is possible to utilize quantitative calculations behind the evaluations. When describing and simulating the dynamic behavior of a network of complicated business processes we have also established a more stable ground to evaluate the independence or dependence of the decision criteria.

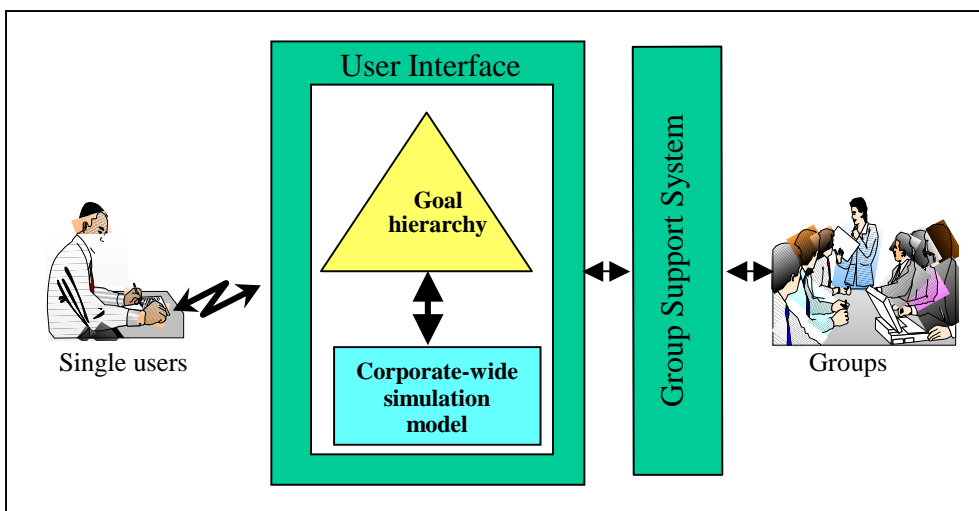


Figure 8. System structure

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Appendix The behavior of the goal variables in the present strategy

