HARDEXP - A STRATEGIC SUPPORT TOOL FOR HARDWARE EXPANSION

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ABSTRACT

This paper presents a system developed to design strategies for organizational expansion based on system dynamics and expert system methodologies. The tool was especially built to plan the expansion of a computing system network.

The prototype developed supports tasks related to strategies design, scenarios generation and system simulation. Examples are exhibited.

1. INTRODUCTION

The increase of computational facilities in an organization must be dimensioned and scheduled in such a way that maximum demand can be satisfied within pre-established parameters for service quality, maintaining the required reliability indexes.

For an adequate accomplishment of this aim it is required to plan strategically the most important resources such as: personnel and capital reserves. Large companies know the value of information resources but under the presumption of low hardware costs they do not doubt to invest in information technology beyond the present needs. For small enterprises and for some medium ones it is important to maintain the balance between the available budget and the actual needs. This, to avoid over-installation expenses.

The purpose of this work consists in developing an intelligent system which incorporates knowledge acquisition and organizational simulations specifically orientated to hardware expansion planning through a methodology that could be easily adopted to other problems.

2. PLANNING HARDWARE EXPANSION

The criterion for computer hardware expansion is mainly based on establishing reliable service levels. The installed computational capacity increments must be dimensioned and scheduled in such a way that demand is guaranteed within some quality service standards and with the desired reliability which must include: devices faults and system maintenance.

The computational expansion may have two alternatives to satisfy the demand increase:

- Expansion of the existing facilities.
- Incorporation of new technologies.

The previous alternatives oblige to carry out strategic planning with short horizons since technological obsolescence is a critical factor for decisions making in these matters. In this study, thirty six months are taken as a planning horizon.

The main factors that determine demand satisfaction are among others maximum time of system reply, CPU utilization, disks speed and I/O service.

A planning criterion that contemplates high service levels bears high costs of expansion and maintenance. It is important to take into account that the adoption of a very rigid criterion in terms of high satisfaction levels may be unfeasible from the economic stand point.

3. CONCEPTUAL MODEL

Nowadays there is a growing interest in developing decision support systems. There are developments that combine models based on knowledge with traditional simulation models or system dynamics models.

Levary and Chi (1988) integrates a discrete or continuous simulation model depending on the characteristics of the system being simulated and two expert systems: the entrance expert system verifies the compatibility of the entrance vector and the exit expert system makes recommendations on design.

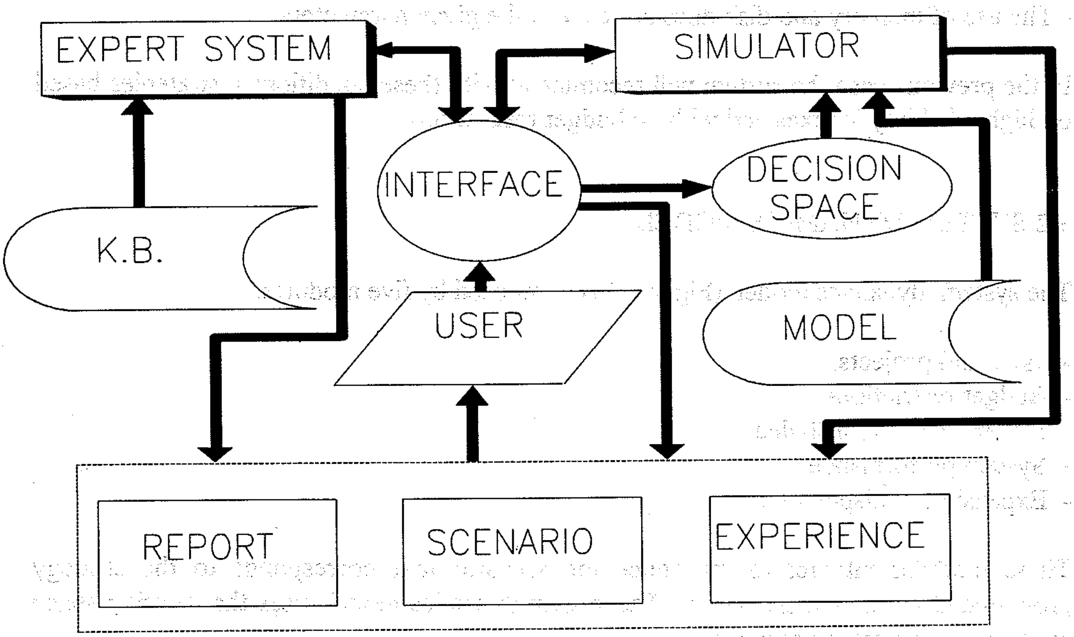
Markarian and Koziol (1991) presents a DSS based on system dynamics methods and expert systems. In this work the system dynamics model was used to simulate the production processes and to identify possible existing problems. The expert system diagnoses the possible causes of the problem as well as the possible solutions.

Managerial Support Systems (MSS) are suitable to support planning and decision processes where uncertainty, subjectivity, experience and different qualitative factors are considered to be relevant.

HARDEXP is a MSS characterized for being a decision making support tool which incorporates experience to formulate strategies, to build scenarios and to acquire new knowledge.

The system possesses three main components: an expert system, a system dynamics model and a manager interface between the components and the user (Figure 1).

Figure 1. CONCEPTUAL MODEL



3.1 THE EXPERT SYSTEM

The expert system provides elements of judgment in a systematized, controllable and reproducible form in order to design strategies on hardware expansion. The system extracts the necessary information and identifies the relevant factors to formulate the strategy.

Some defined strategies on the knowledge base depend on: minimum costs, system performance, control of disk space, control of main memory use, interactive and batch priorities and system reliability indexes.

The user is orientated systematically towards one of the strategies or to elaborate a strategy that does not possess an antecedent in the knowledge base. In the last case, the internal consistence is verify through simulations and then it could be incorporated to the knowledge base.

For example a strategy orientated towards a good system performance could be obtained through the following conditions:

- The user will wait at most ten seconds for a system reply.
- The visits of each interactive and batch task are inside of pre-established ranks.
- The use of memory and disk does not exceed the given parameters.

In the previous case the system will recommend with these conditions a strategies based on high reliability indexes and with no budget restrictions.

3.2 SYSTEM DYNAMICS MODEL

The system dynamics model (Figure 2) is composed by five modules:

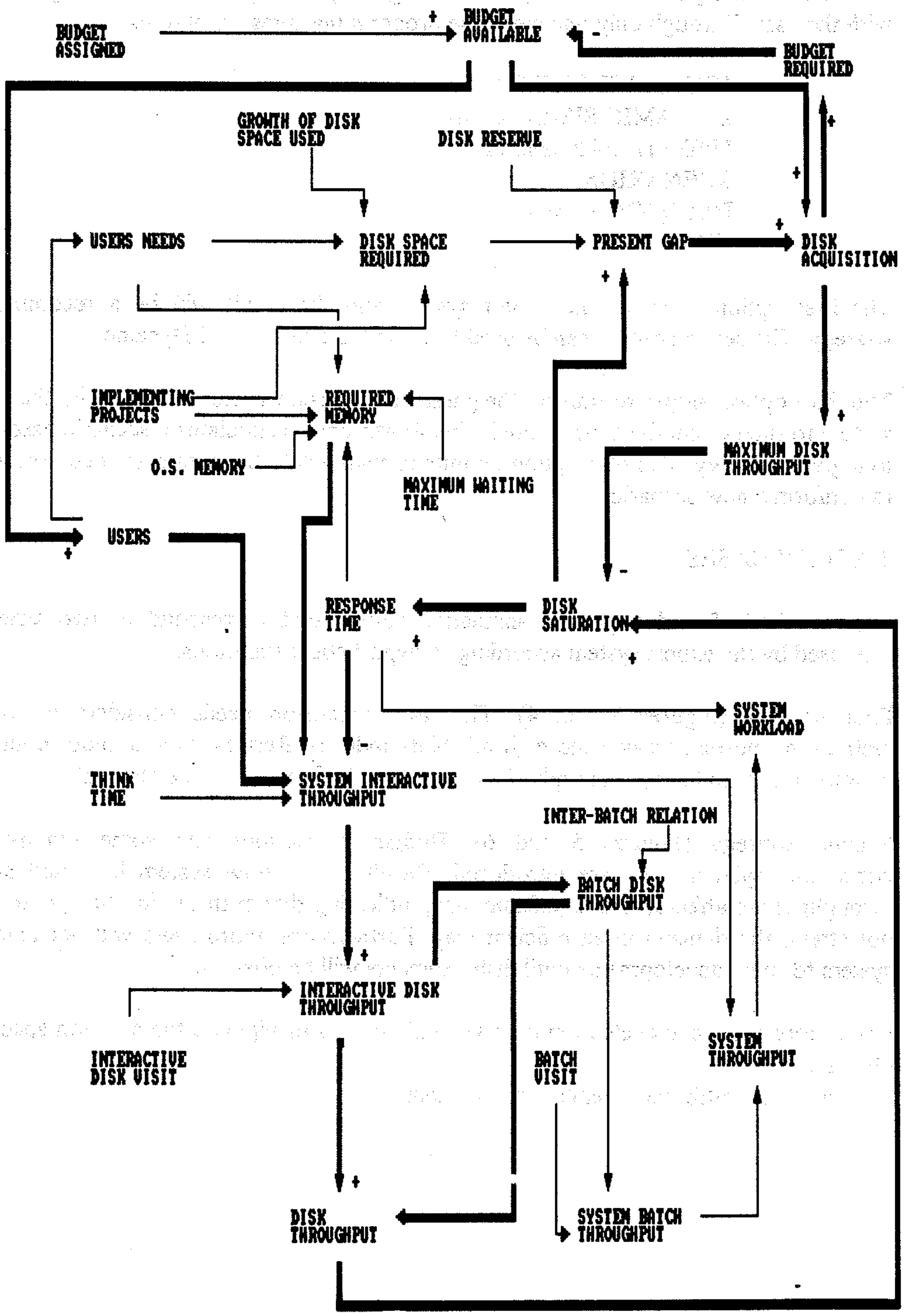
- Users and projects.
- Budget restrictions.
- Present capacity installed.
- System performance.
- Expansion of dispositive.

These modules interact to reproduce the scenario that corresponds to the strategy propounded by the expert system. The system dynamics model uses the decision space as an entrance vector parameter.

Simulation results show the evolution of the most important variables such as disk and memory needs and system load.

The user may then evaluate the proposed strategy through simulation results. At this stage a more adjusted scenario may be built making transformations on the decision space. Through this process more knowledge is acquired.

Figure 2. CAUSAL DIAGRAM



3.3 INTERFACE PROGRAM

The manager program was developed in C language, and it possesses a friendly interface with the user. Through only one menu the program manages six options:

EXPERT SYSTEM
DYNAMIC SIMULATOR
UPDATE PARAMETERS
SCENARIOS
DECISION SPACE
EXIT

The first option executes the expert system and the result will be a recommended strategy. The second option can be used to executed Professional Dynamo.

The third option allows to transfer the parameter decision vector produced by the expert system to the system dynamics model. The fourth option simulates a scenario associated to a given strategy. The fifth option permits to manipulate the parameter decision vector to conform a new scenario.

4. STUDY CASES

Figures 3, 4, 5 and 6 present simulation results that correspond to two strategies proposed by the expert system according to hypothetical situations.

First strategy (Figures 3 and 4). The user expansion needs considers no budget restrictions, normal service and high reliability indexes. Results show a uniform increase in system load and in system reply. Resources are distributed in time efficiently.

Second strategy (Figures 5 and 6). Budget restrictions and some requirements concerning system reply are introduced. Results show how system load and system throughput are affected in a significant way, indicating that at this point the system could not attend the demand in an efficient way. Furthermore, more users will not enter the system for new developments until disbursements will be possible.

For a more extensive evaluation the user will need to manipulate the decision space and obtain new
scenarios with different variables arrangements.

Figure 3. **SYSTEM PERFORMANCE**
Strategy with no budget restrictions

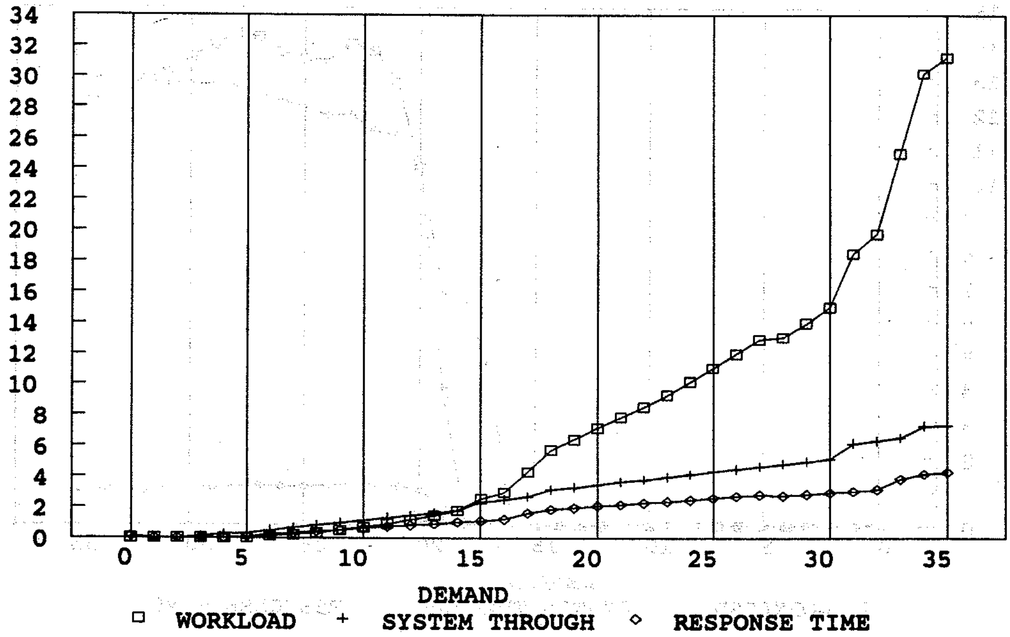


Figure 4. **RESOURCES REQUIRED**
Strategy with no budget restrictions

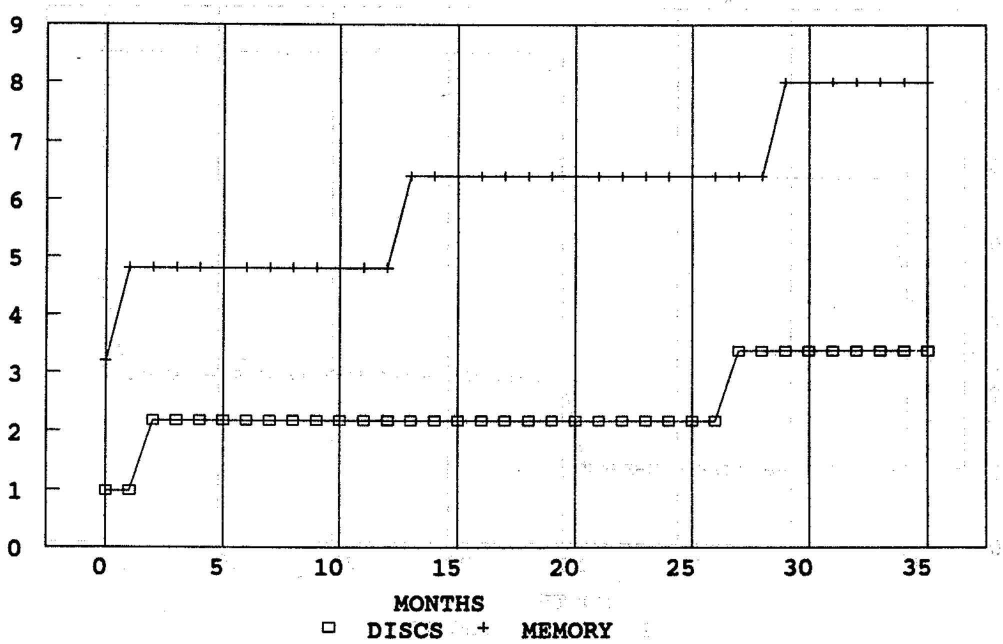


Figure 5. **SYSTEM PERFORMANCE**
Strategy with restrictions

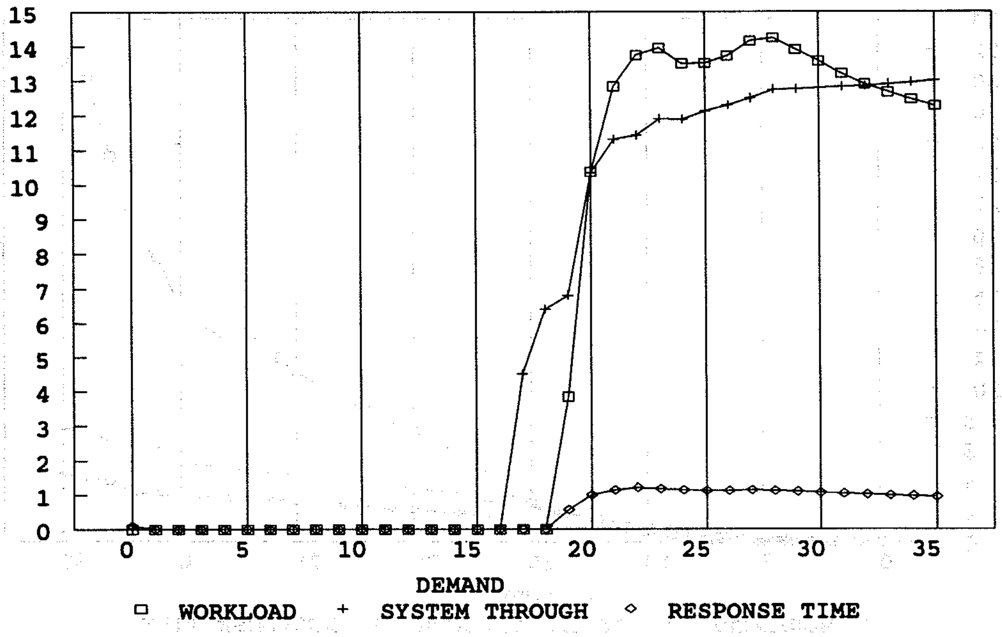
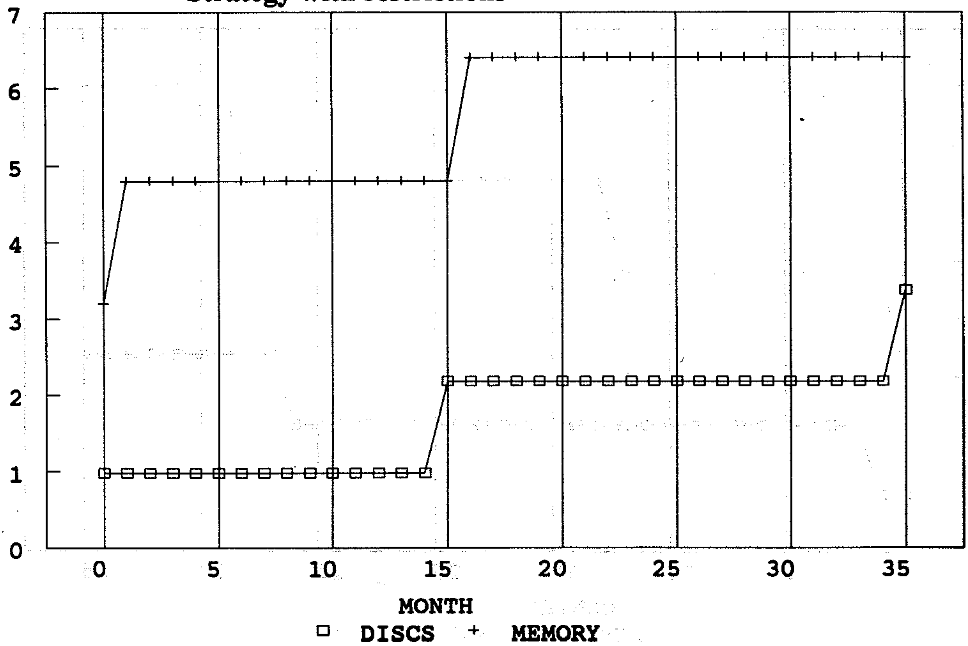


Figure 6. **RESOURCES REQUIRED**
Strategy with restrictions



5. CONCLUSION

Based on the methodology and on the developed tool, it is possible to assert that:

The interaction of models based on knowledge and system dynamics methods produce powerful MSS tools.

It is possible the integration of the superficial and deep knowledges in order to help more efficiently the decision maker.

The problem of the strategical planning of computational recourses is possible to be solved through
MSS tools.

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