Eventually, it will be possible to do evaluations of other specifications on several levels of the system, including new application programs, faster processor speeds, and other network configurations. But the real physical running on a large installation-- in the banking, administrative or financial environment-- will be the basis of permanent updating of the transaction model.

In fact, the correct use of these charts depends on the knowledge of the environment application to select the confident data.

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USE OF MODELLING IN PERFORMANCE EVALUATION OF COMPUTER SYSTEMS --- A CASE OF INSTALLATIONS IN THE TECHNICAL UNIVERSITY OF WROCLAW

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Summary

There is a number of models of user behaviour applied in modelling studies on computer system performance predictions.

The models in most cases can be called "resources-demands models", where users are only considered as resources consumers. Some authors build more sophisticated models - concerning user psychological features.

The paper discusses some of the users' models and their applicability in modelling and design of operating systems for computers. Some examples being the result of the research carried in the Technical University of Wroclaw, concerning complex users' model and performance evaluation of operating systems by simulation are presented.

Introduction

The aim of the paper is to define some levels of formulation of the needs and requirements of the computer system users. Every level is analysed taking into account its usefulness in operating system modelling and design process.

Problem formulation and classification

The basic task in operating system design process is to achieve proper behavioural properties of computer system fulfilling users' needs and requirements.

This problem can be taken into consideration in some levels according to the way of formulation of users' demands. General systems approach treats the computer system and its users as interconnected parts of an isolated system as it is shown on the Figure 1.

Figure 1.

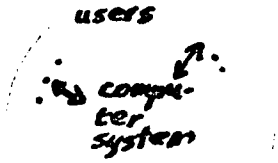


Fig.1 - Users and computer system-systems approach.

This approach requires to analyse users not only as a source of jobs, but in the more complex way including their psychological and motorial features. Since the user is treated as a basic component of the system- it is worthy for instance not to minimize response times but to optimize them in the sense that every user would need the optimal value not necessarily the minimal one.

Such a problem is by the time not easily solvable in general. However, there were trials to deal with psychological aspects of a man-computer interaction, the basic are Sackman's researchers. [6]

The main result of his work is, as one could expect, that system properties depend mostly on users. Also the researchers held in the Technical University of Wroclaw, have pointed out the principal importance of individual user features especially in timesharing systems utilization. [4]

Individual psychological features of users are very difficult to represent in a formal way which could be applied in models. However, trials of parametrization of users behaviour in that level are held and some results were achieved in our University. [4]

User model including psychological features

The approach tends to concern both the technical and psycho-physiological aspects of the user-computer communication and to develop such design methodology which allows taking into account this aspect in final product, viz. operating system. It is important to point out that commonly applied measures of system effectiveness do not hold here; for instance slower systems in the sense of response time, but with easy and individual user oriented communication, language can be more effective.

The following tasks are necessarily to be determined in the study:

- -the features of computer: hardware, software, man-computer communication tools,
- -the phases of human creative process applying computers, most commonly the final phase of problem solving,
- -the psycho-physiological users characteristics,
- -the characterisitics of problem solved by computers: time requirements, resources utilization etc.

Psycho-physiological features have the decisive impact on the other categories, namely they determine the thinking style, the way of problem formulation etc. This causes the need of more sophisticated users model taking into account both classical computer-oriented and psychological parameters.

The aim of the experimental researches being performed in the Technical University of Wroclaw was to determine the influence of users situation U, viz. classification of tasks and problems to be solved, the characteristics of problems P and system features C on the characteristics of problem solving process S. Problem solving characteristics can be considered in three aspects: functional structure characteristics S_1, time structure characteristics and S_2 and utilization of computer system S_3.

See Fig. 3 in Appendix

Thus, we have $S = (S_1, S_2, S_3) = F(U, P)\Big|_{M,C}$

where M Characteristics tested users by following parameters:

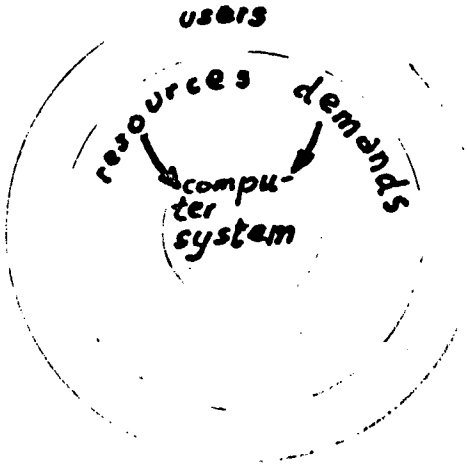
- -users' knowledge,
- -characteristics of the user central nervous system,
- -characteristics of the user cognitive process.

The results tend to formulate the user model in a more precise way. Such parametrization should be a helpful tool for operating system designers.

Resource-demand user model and its application

The way to omit the difficulties of the users' parameterization is to apply models which represent users behaviour only in terms of resource requirements during time passage.

Fig.2 -
Resources-demand model of the user.



Individual behavioural differentiation in the terms of resources requirements.

Such approach is used in most of the performance evaluation studies. [1,2,3,5,8,9]

In the case using simulation as the method of model investigation in performance prediction it is easy to map real differentiable multi-dimentional demands, at the considered level. This method was applied in testing and optimization of ICL operating systems MINIMOP and GEORGE-3 being used in the Technical University of Wroclaw.[1,2,3]

The objectives for establishing the research were concerned with two classes of users in our University as we found from previous tests. The first came from didactic process the second one mapped research activities. The didactic process is characterized by prefixed computing needs (programs for computer-aided teaching), the other one generates a very wild range of demands.

Performance predictions were thus based on two simulation models. The simple one, state-transition, written in Fortran model of Minimop system controlling computer aided instruction allowed for testing dependency of the number of users on system efficiency.[1]

The other model is mapping job processing under general purpose operating system GEORGE-3. Its philosophy was based on terms of CSL language: objects, states and events. The model allowed for system tuning, here the choice of installation parameters providing minimization of weighted reply times for inter-active and batch jobs. It is particularly important in the systems, which properties can be extremely changed from interactive to batch usage. The proper equilibrium between these two types of load is the basic task for the installation manager (see Appendix).

In the studies users' needs were mapped by means of random number generators according to ampirical distributions of resources demands measured by a special program in the running system.

The next possible level of considering users needs is group differentiation - within the group, resource requirements are of the same type - further no differentiation: every user is statistically the same.

Especially, it is possible to map user behaviour as one - dimentional demand distribution, e.g. processing time.

The above simplifications are required by most of analytic technicques. [5,7]

Models of users' behaviour which can be easily applied in evaluation studies by modelling have the basic importance in the design of operating systems. By resource demand models the designer can achieve most of the needed information: performance properties, fulfilling users computation needs, proper organization of computation process. More refined tasks as adjusting system properties to users' psychological features need more sophisticated models and more effort.

The above considerations can be illustrated as in Table 1.

Conclusion

In the paper the problem of representing users requirements in computer system has been analysed. Some models-the most sophisticated- containing psychological aspects, and the simplest, one-dimentional resource-demand, model were discussed from the standpoint of their suitability in modelling and design of an operating systems.

Design is the very time-consuming task based mainly on trial-and-error method and experimenting with models, and so designers need effective and adequate methods to evaluate different possibilities. Adequacy causes concerning more detailed information and thus complicated models, simple models are effective but loose many objectives. The prudent choice should be made by the designer with respect to his goal.

Classical performance evaluation studies apply resource-demand models, and their suitability in operating systems design is widely known. Now we have to answer the question how the psychological categories influence the effectiveness and the form of man-computer communication and how the knowledge of this influence can help system designer.

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Appendix

Table 1

level of formulation of users' needs	area of problem solution	usefulness in modelling
individual psychological differentiation	adjusting system properties to user individual psychological and computing needs	very sophisticated models, difficult to formalize
individual differentiation in terms of multidimentional resources requirements	adjusting system properties to individual computing needs, choice of proper computer power, proper organization of computation process	easy to apply in analizing models of computer systems by simulatia techniques
group differentiation	performance prediction as the function of users behaviour and computer power, estimation of needed computer power, proper organization of computation process	easy to apply in analyzing models of computer system by simulatia and analitical techniques
no differentiation	"	"
one-dimentional resource demands	rough estimation and prediction	very simple to apply

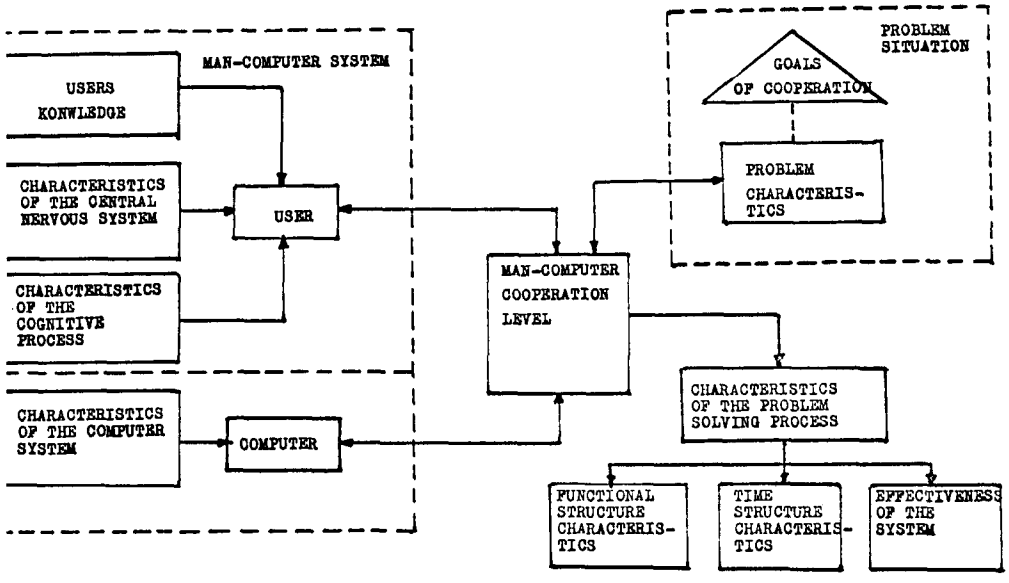

Fig.2. Relations between the factors describing the man-computer cooperation

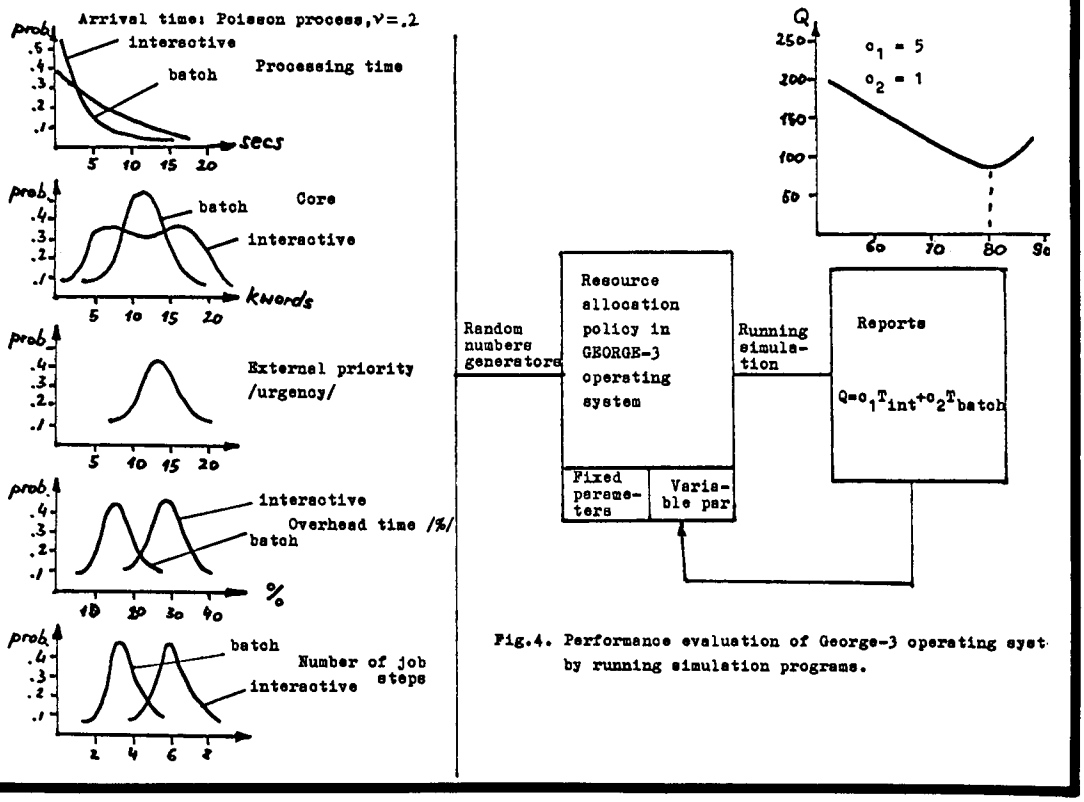

Fig.4. Performance evaluation of George-3 operating syst by running simulation programs.

FIXED PARAMETERS: workload, computer power /JOBLIMIT, MOPLIMIT, BACKGROUND, storage demands/

VARIABLE PARAMETERS: resources allocation policy /MOPCPI, SLOTTIME/

OPTIMIZED PARAMETER: computer power division among batch and interactive jobs /MOPCPI/

EVALUATION CRITERION: weighted sum of mean response times for batch and interactive jobs /$Q=c_1T_{int}+c_2T_{batch}$/

OPTIMIZATION: MOPCPI: Q = min.

INSTALATION PARAMETER	DESCRIPTION
MOPLIMIT	maximum number of cocurrently running interactive jobs
BACKGROUND	maximum number of concurrently running batch jobs
JOBLIMIT	maximum number of jobs controlled by system
MOPCPI	% of computer power for interactive jobs processing
SLOTTIME	relates the time-stol lenght with program core

Fig.5. The parameters considered in performance evaluation studies/2/