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**COMPUTER SUPPORT OF OPERATOR TRAINING BASED  
ON AN INSTRUCTION THEORY ABOUT PARALLELISM**  
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**Summary**

At the department of Education at the University of Twente, Enschede, The Netherlands some universal design systems have been developed in the period 1984-1989, with which a trained courseware designer can make computer simulation programs in the fields of physics, biology, medical science, and economics. Technical installations, processes or plants are also excellent subjects for this type of simulation. The educational computer simulation programs created with these systems, are characterised by a highly graphic interface. One of the design systems which was used was MacTHESIS and the design method which was used to develop computer simulation programs with this system was the so called 'MacTHESIS philosophy'. For the chemical company AKZO Hengelo, we developed a computer simulation program named BRINE PURIFICATION, based on this philosophy. These investigations led to a theory about parallelism.

**Introduction**

The simulation programs made with the MacTHESIS system link up completely with the Apple desktop publishing philosophy. The simulation programs themselves look like loose sheets of paper, which can be moved by means of the mouse. On the screen certain interesting visualized 'dynamic' processes take place. In this case a program is made about a complete chemical plant of the brine purification of the local mining industry. In the dynamic processes on the screen the trainee can intervene by clicking the mouse in special, so-called 'in-click regions' or else just with the help of pull-down menus. The computer simulation program BRINE PURIFICATION is tested on the plant. A stand-alone version, is being tested only with coached paper materials, and also a version with an integrated tutorial instruction shell built in HyperCard is tested. This type of learning environment, in which CBT-materials are used besides an educational computer simulation program, is developed at the University of Twente and is called: an 'integrated computer simulation support learning environment', by Van Schaick Zillesen.

## **The MacTHESIS philosophy and some instruction methods**

The MacTHESIS philosophy behind the computer simulation programs of Min et al. is described and showed in products on many conferences. The design environment, the teacher environment, and the learning environment, each have their own characteristics design parameters and a simple human-computer interaction.

From this point of view we developed and researched various instruction methods for use parallel to our simulation programs. Even the visualized conceptual mathematical model plays an important, special role in the instruction in the learning environment. We mark 6 important instruction methods for parallel use:

- a student manual (beside the program);
- loose papers and worksheets (beside the program);
- a (interactive) highly visualized conceptual scheme of the model (in a parallel window);
- a help system (in a parallel window);
- 'video messages' as intelligent feedback ('desktop video'; in a parallel window);
- an instruction program ('CBT materials'; as a parallel proces).

In a learning environment for computer simulation it is essential that the learner or trainee can see both the simulated world and the instruction materials. Because of this requirement it is necessary to furnish the computer simulation program in such a way that important information remains in view.

The earliest simulations had no more than a graphic output on a screen, the instruction in relation to the computer simulation program was given in a separate textbook with or without loose worksheets.

MacTHESIS, a computer simulation system developed at the University of Twente, partly solved this problem of paper materials by opening an extra window, parallel with the program on which a survey appeared of the visualized, underlying mathematical model, allowing for intervention at the same time. This rather simplified form of instruction required other paper materials as well.

## **Research**

We have tested a lot of hypotheses. One of the most important hypotheses being tested was: if parallel represented processes in windows are more effective than sequentially represented processes. The program BRINE PURIFICATION / PEKEL was used in that research. For the evaluation of this program a group of 9 employees from AKZO-Zout Chemie Hengelo were available. All subjects possessed advance knowledge about the structure of the simulated system (the brine purification installation) and about the relations within this system. One subject (process operator) was experienced in controlling the installation in practice, the other subjects had no practical experience in this respect. None of the subjects had ever worked with a program made by means of HyperCard and MacTHESIS software before. During the computer sessions the subjects were observed. Furthermore their interactions with the program (the simulation and the tutorial) were logged. We have proved that MacTHESIS is a good system for designing computer simulation program for education and training and in this case for a computer simulation program in color about brine purification. We developed a prototype in which information was transferred from the simulation program to the stack, enabling instructional feedback after the termination of the execution of

the simulation program, and vice versa, enabling the case and screen layout of the simulation program to be set from the HyperCard stack. We found that prototypes for CBT-materials can be developed in an extremely fast and highly interactive way using HyperCard. The philosophy behind the products made by this design method and these products were clear and useful in training situations. The general impressions of the subjects to the prototype were qualified as 'clear', 'instructive', 'pleasant' and 'interesting'. Furthermore according to the testees, the prototype can be used as a stand-alone learning tool and the guidance during the computer session is adequate. The subjects agree on the point that it was pleasant not to have separate paper materials. However, the statement that paper materials are more practical has not been rejected

### **The Parallel Instruction theory**

It turned out that for a large number of pupils and trainees everything in a learning environment should be within reach and crystal clear. This was already well known for simulations, but technically hard to realize by courseware writers or most of the educational software houses. With tutorial CBT materials it is known that certain pupils are annoyed by the disappearance of the subject matter which has been read. Technically speaking calling back text which has been read is for almost all tutorials still problematic or not common sense.

The problem with separate paper materials is that students and trainees think they can do without. Even teachers tend to think so. As a result beautiful computer simulations remain unused at schools, in spite of the perfect design, styling and user-interface. Our earlier learning environments are characterized by modern input and output techniques and a wide range of different kinds of visualizations, from abstract to concrete. In spite of all that it turned out that the Instruction method was the decisive factor. MultiMedia and HyperText techniques of in particular Macintosh computers, and the MacTHESIS system and philosophy, made it possible to prove our theories.

### **Conclusions**

The investigations with the MacTHESIS philosophy and our designing method has resulted in a new MacTHESIS system, version 5.0 with desk-top video output and in an theory about instruction, the PI theory. The design method based on this instruction theory for computersimulation we have called the 'Parallel Instructional Theory for Simulation' design method, the PITS design method. Students of the University of Twente can follow three courses in which they learn the 'PI theory', the 'MacTHESIS philosophy' and the 'PITS design method'. More than 30 experimental programs are made until 1992. So the basis of our ideas how to build new simulation environments, based on our methods, techniques and this instruction theory about parallelism, is large.

The design and some learning environments will be published on CD-ROM on the end of 1992.