# Simulation and Multimedia in Chemical Engineering

by

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Abstract

*The use of computer simulation in training plant personnel and thus improving plant operational efficiency is presented in this paper. Traditional operator training methods are extremely costly. A microcomputer based simulator is a more cost effective option. A further benefit is that computer-based training (CBT) requires precise instructional objectives and criteria for mastery with appropriate remedial studies for trainees failing to achieve the required level.*

## 1.0 Introduction

Computer simulation has long been an established tool for the design and analysis of process systems. however, its use as an aid for plant operation is a much more recent development. the current rapid advance of computer technology has accelerated the use of computer based systems as plant operation simulators. One important aspect of process plant operation is the efficiency of the plant personnel, particularly with regards to their ability to diagnose potential equipment failures. Many process industries are beginning to realise the potential of computer-based training (CBT) in improving the knowledge and skill of plant personnel. This paper describes the simulation of some simple plant operations and the implimentation of these models on microcomputer which is used as basis for on-site plant operation training.

## 2.0 Computer in chemical engineering training

The use of computer aided design (CAD/CAE) is well established in process industries. Locally, industries such as the petrochemicals, fine-chemicals, petroleum and palm oil are using packages that are either bought from overseas or developed by foreign consultants. There is a need for research and development in this area to remedy the trend.

There is a universal trend in the recognition by universities of the fact that industry needs to rely on computer technique both in production and research and development to an increasing extent that education cannot avoid responding adequately to this challenge.

Computers are widely used in process industries in the areas of modeling of fundamental phenomena, process design, process operations and control and process engineering information management. More research works are needed in these areas because computing technology are growing very rapidly.

## 3.0 Simulation and Multimedia

Simulation can be defined as the representation of certain features of a real situation to achieve some specified objective. It follows that simulation for training must achieve a training objective. In the past, training simulator hardware has been dominated by hybrid analog computer driven control panels which are expensive and lack versatility. More recently, mimic control panels driven by a digital computer have been adopted. It appears that the considerable high cost has limited their use. The simulation package is usually included as part of major contracts only. Relatively inexpensive but highly interactive microcomputer based training simulators are therefore very attractive alternatives. These micro-based systems, though not as powerful as the larger simulators, can act as the tutor, exerciser, calculator, simulator and information resource all in one. They are more ideally suited for the simulation of individual plant units and process of moderate complexity.

A variety of training objectives can be achieved by means of computer simulation which should lead to significant improvement in the quality of training. One essential feature of CBT is to simulate actual plant behaviour to a sufficiently high degree of fidelity. The trainee is then able to learn by discovery under the guidance

of the simulator. Specifically, the CBT simulator can be used for a number of training tasks namely

- skill development
- knowledge of the plant
- decision making
- fault diagnosis

Skill development includes basic skills such as the reading of instruments, setting and tuning controllers. More complex skills involve the start-up and shut-down of process units. It is vital that operational personnel should appreciate and understand the operation of major equipments in the plant and also understand and even predict the effect of an action taken at one unit on the rest of the plant. Such plant knowledge is essential in decision making and fault dignosis.

Multimedia system is an integration and manipulation of text, video, audio and graphics. Simple graphics, video and audio could draw the attention of the brain and would make it easier for the students to retrieved the information stored. Therefore, when users see that they can understand better and remember more, their interest in the subject would automatically increased.

Comparing with the traditional methods of training being used, one can see the advantages of multimedia system. In traditional methods trainees get the opportunity to work with the actual unit operation only when they are exposed to the real situations later or when they work in plants. This could be dangerous as mistakes and mishaps could lead to disaster situations. Multimedia would overcome this problem by allowing the trainees to see the operations and effects of actions or changes done on the operation on the screen immediately.

Multimedia packages can offer an opportunity through their varied and mutual supporting facilities, to provide an effective and efficient means of improving the quality, delivery and presentation of educational material. The many advantages they can offer are:

- presentation to suit a variety of learning
- attractive visual and auditory presentation, resulting in increased interest, higher retention and improved success.
- individual monitoring, assessment and feedback system which makes the package.
- non-threatening to those who are shy or who lack background or confidence.

self-paced, allowing the learner to attain mastery at each stage.

(Edgar and Docherty 1992, p568)

Therefore, CBT simulators can offer the trainee comprehensive experience of actual plant operation and eliminates human error on the part of the Training Officer. Training by CBT simulators has yet another significant advantage over on-the-job-training. The trainee, especially an inexperienced one, can be trained by computer simulation to master the intricacies of plant operation without risking possible loss of life or injury to other personnel. There will not be loss of production or damage to process equipment caused by the inexperience of the trainee. Plant efficiencies can be upgraded by training the operators to control the plant within tight limits.

## 4.0 Materials and Methods

Equipments used in the projects were, Macintosh II and LC, IBM PC compatible (80386 microprocessor), scanner and MacRecorder. These were then combined with a data projector with overhead projector for a lecture or a small group tutorial environment. The softwares used include HyperCard, Authorware Professional and MacroMind Director.

Two design concepts in the project are Integration and Interaction. The integration is at two levels, the physical and the pedagogical.The physical or technical level deals with the integration of the latest generation of hardwares and softwares.

The pedagogical or conceptual level involves the integration of the various disciplines and topics that combine within a field to produce a meaningful holistic view of the subject matter. The model used for the project was based on Gagne's (1979) instructional model.

The principles of interaction have been put into practice in the form of discovery learning such as alterability, relevance, validity, motivation, and friendliness. These principles are important for developing packages that are user friendly and can motivate, encourage and retain the attention of users.

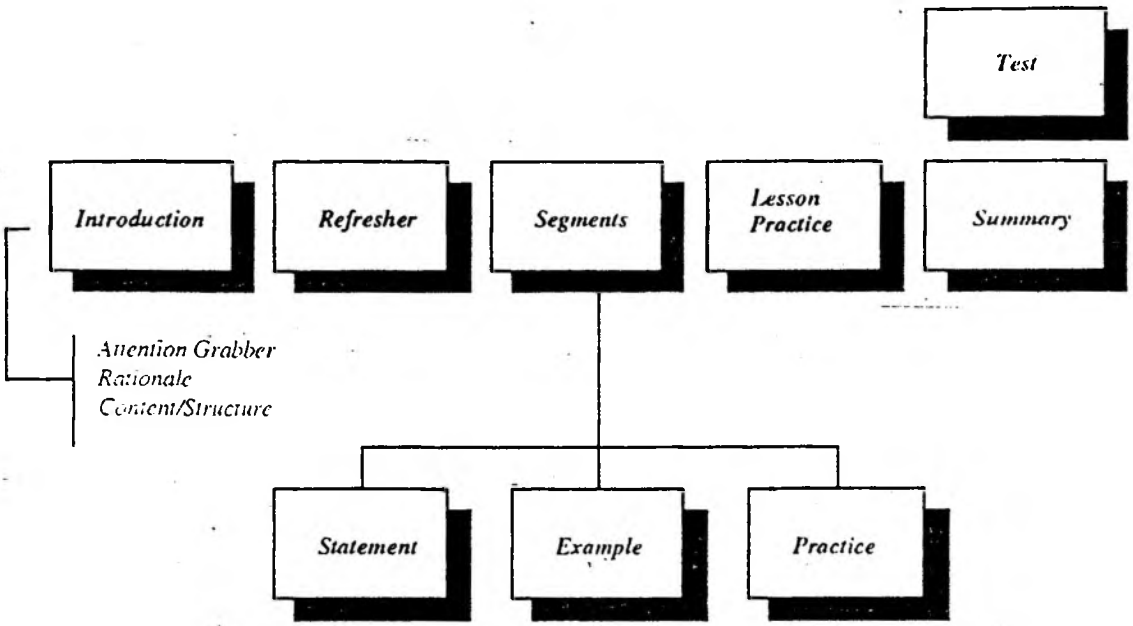


Figure 1. Gagne's Instructional Model

Modules identified for the project are the common unit operations in chemical industries such as distillation, evaporation, absorption and leaching. The multi-effect evaporation module is taken as an example in this paper. The package starts of by capturing the interest through attractive graphics, animation and good music and then asking users to type in their names. This allows the package to address the user by name as they progress, to bring in the personal touch. Users are then given an overview of the module before continuing the package. Option is given for those who need short revision on the subjects.

The package is designed to be as friendly as possible to make it interactive. Users are given choices in the main menu and submenus so that they can choose any topic of their preferences without following any order or sequence(figure 2). This will help users who are familiar with the subjects to immediately go to their prefered topics or for any user who wants to repeat any topic can do it as many times as they like. Graphics, animation and music are included through out the package to retain the attention of users(figure 3). It is also designed as interactive as possible to motivate and to encourage users to use the package. Whenever necessary, graphics and animations are used as much as possible to enhance the presentation and for better description of the process.

To make the package interesting and a learning experience, the interactions are as meaningful as possible. The flow of the package follows "question-answer-information/dialogue" session like a normal tutorial class. Where possible,

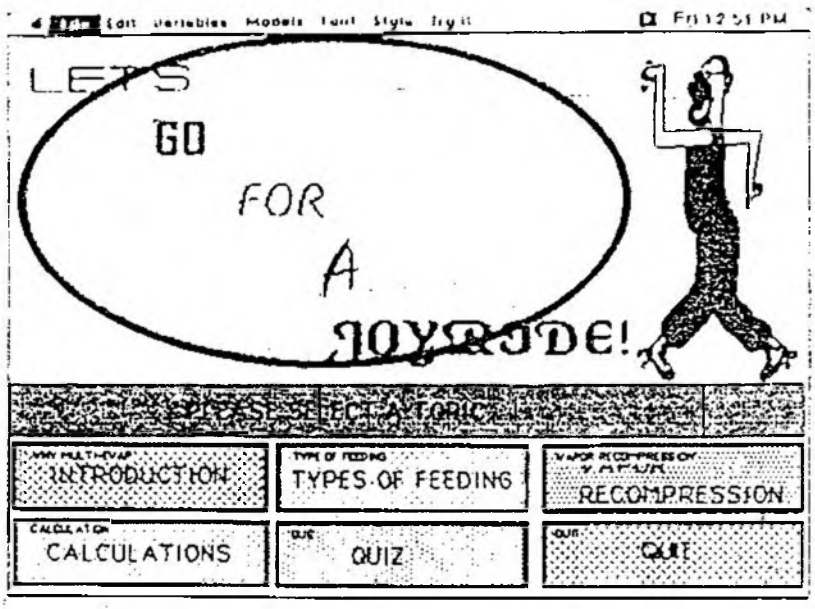



Figure 2. Menu Screen

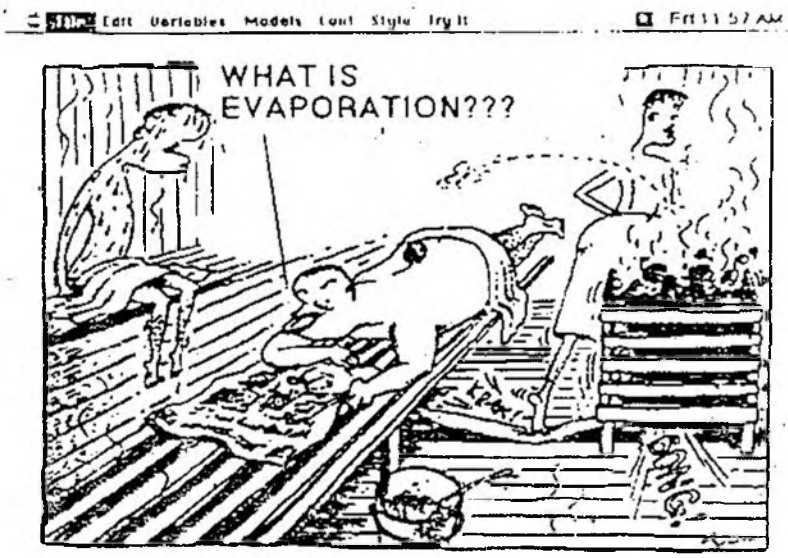



Figure 3. Attention Grabber

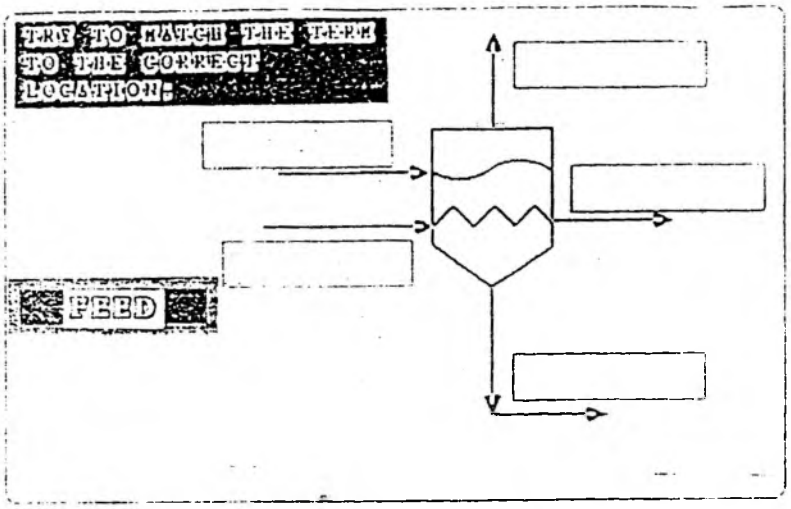
learners were provided with questions that were answerable in a short period of time, yet which required them to think (figure 4). Users were asked to answer questions relating to information presented to what they knew or what they were presented with. Feedbacks included were specifically related to the students responses. Correct answers were followed by compliments (figure 5). After a wrong answer, a hint or prompt was provided to allow users to try again (figure 6). If no correct answers after several trials, correct answer and an explanation were given. Repetitious patterns and consistent wording of feedback were avoided to produce higher levels of motivation. Scores are given at the end of the module for users' record and assesment.

Figure 7 shows the output for a change on the setting and tuning parameters of a binary distillation column. Users can immediately see the effects on the screen and this will enhance their understanding on the concepts and appreciate the effects of the process response. Using the package will allow users to feel and comprehend the dynamics of a process better.

## 5.0 Discussion

The package was evaluated by students, staff members and people from industries. The comfort and ease of use of the computer and the package have attracted all the users and the students were very excited about it. Most students found the package useful, interesting and motivating. It enabled them to understand the concepts and visualize the operation of the equipments better. Students felt that the package can be used in the tutorial class or as revision material because computer cannot clarify their doubts.

Most of the staff members also found the package interesting and suggested the use to complement lectures. One staff member felt that our society and more so the students were very passive and there were little interaction and questioning in the class. However, he believed that the package could be very beneficial to the majority of the students. Another commented that the package could be best used to enhance the main concepts and principles of chemical engineering. Graphics, animation and video can give better description and explanation compared to text books, he continued. One personnel from industry was commenting in the easiness of using the package(that was his first time working with Macintosh) and how useful it could be if operators in plant were given the computer training before going to the



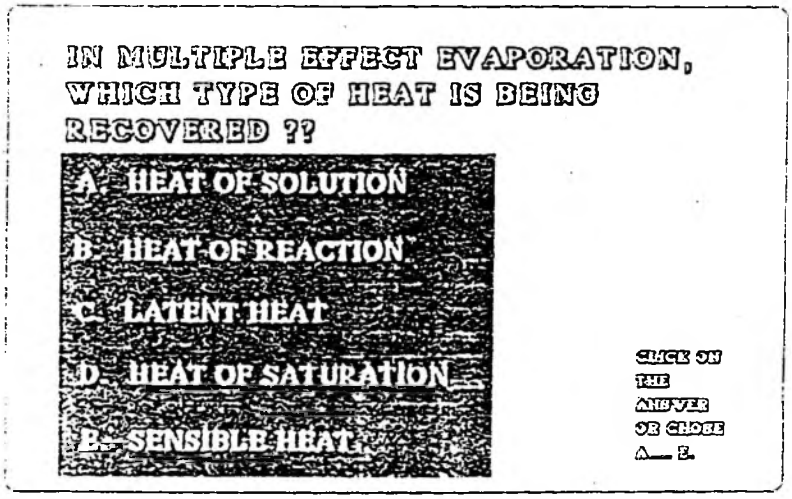




Figure 4. Samples of Question

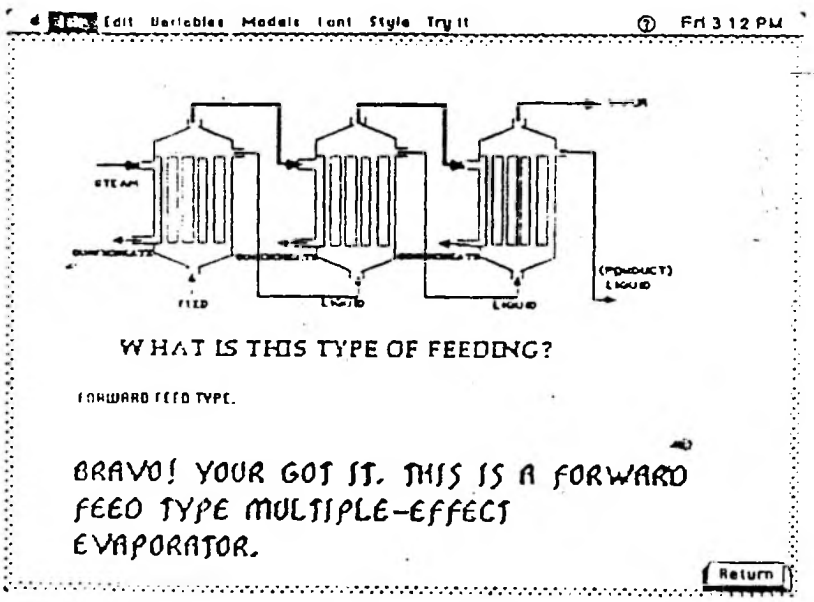



Figure 5. Response to Correct Answers

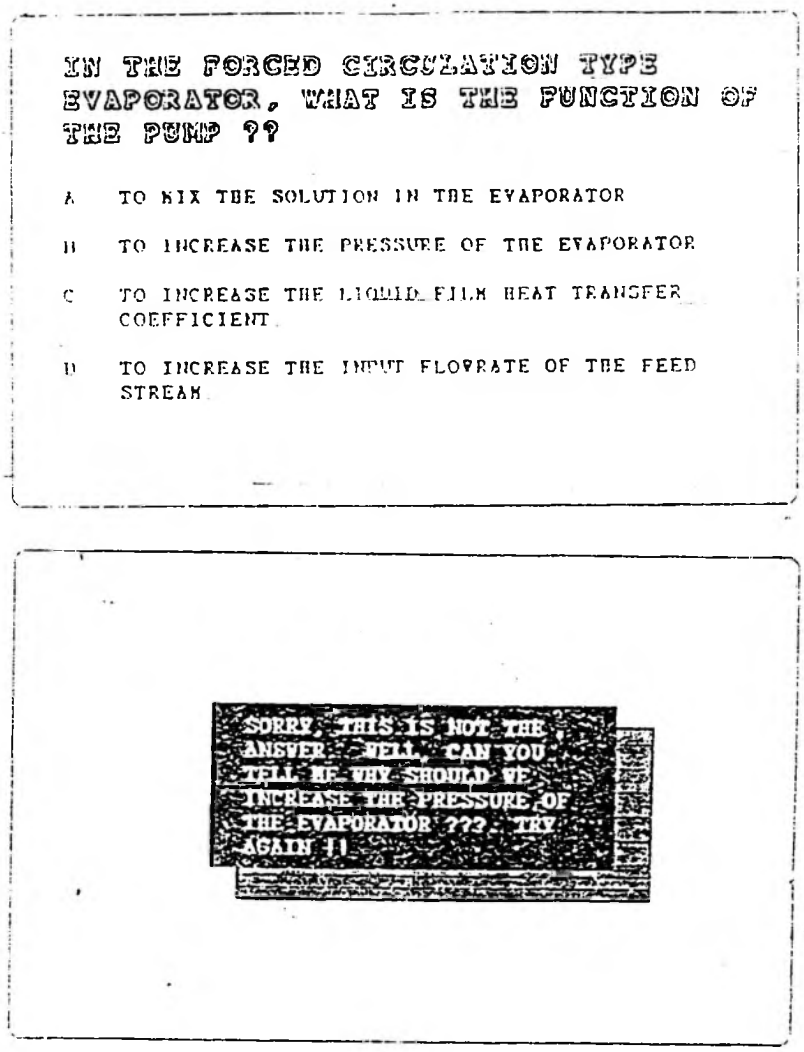



Figure 6. Response to Wrong Answers

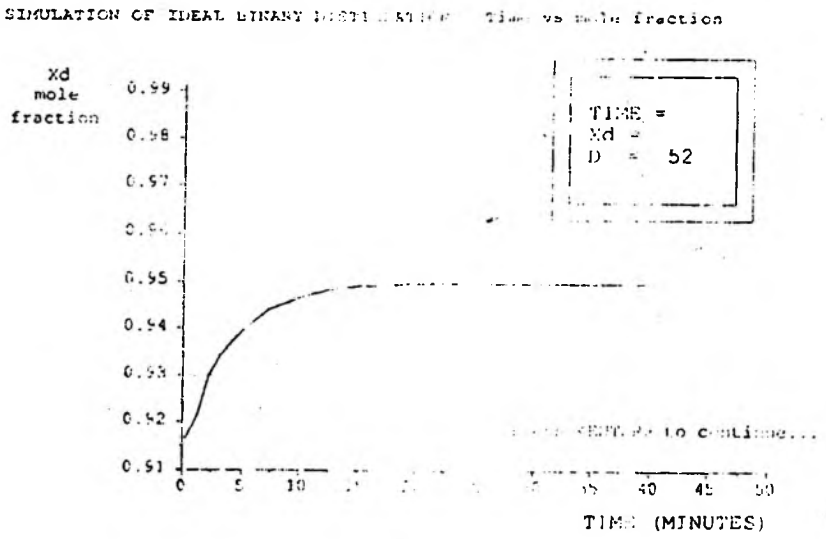



Figure 7. Step Change Output

plant. Another person who was so excited with the package even asked us to sell it to them.

## 6.0 Conclusion

CBT can be effectively used for training plant personnel. Modern training programmes are faced with the challenge of educating a wide range of employees. From dealing with experienced operators, who may need to learn new operating habits, to dealing with new employees who may not have scientific education, trainers must achieve a broad variety of objectives.

The rapid advances in hardware technology in the 70's and 80's have transported us from the mainframe era to the personal microcomputers which have the capabilities greater than the many of the original mainframes. With the latest technology of knowledge-based system, the personal computer is being transformed into a knowledge machine with artificial intelligence and expert systems. Full exploitation of these capabilities will only benefit the the whole nation and fulfil the requirement of Vision 2020. It is also relatively cheaper and more practical to use CBT on PC for training large number of trainees without having to take the risk of mistakes that can lead to disaster.

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