

COMPUTER 3D TRAINING SYSTEMS FOR OIL-REFINING AND PETROCHEMICAL INDUSTRY

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Oil-refining and petrochemical industry is a sphere with high dangerous situation. This is due to high sophisticated level of technological processes, using of dangerously explosive products and high level of equipment deterioration. Occurring haphazards with emergency conditions as results of human element demand arrangements concerning with improving of personnel training using of all the latest technologies.

To decrease the quantities and consequences of emergency conditions it is recommended steady tuition of personnel of any positions, increasing of experience and testing of knowledge. The training systems correspond perfectly to deciding of these tasks. The ideal training simulator of any object is its replica, but it is not expedient due to some reasons concerning with finance and human safety. In the same time the training system without situation modeling and imitation of real actions can not give necessary skills. The closer the training system to the reality, imitating visual, acoustical, sensible feelings and taking into account a term factor, the better it is fulfill its functions. To the present day the most appropriate way to training system development with the best relation of functionality and cost price is the development of computer training systems with 3D environment and using the latest achievements in informational technology. The virtual training systems are the intermediate part between of deep academic knowledge and industrial experience. The main aim of such systems is increasing of practical skills of directions and personnel and safety ensuring during the working processes under cases of emergency or difficult parts of work and so on.

Hitherto 3d computer training systems were expensive end were used in medicine, space military spheres, where any mistake could lead death of many people. However increased requirements to the level of safety in oil-refining and petrochemical industry from one hand, and continuous development and reduction of prices of computers from other hand lead to appearance of real opportunity of creation of appropriate training simulators. There are several variants of creation of organizations devoting to this kind development. The ideal variant is creation of additional structure in the territory of plant the training system is development for. The benefit from it is the direct contact with environment as a base of simulator and with specialists and end users during the development. Though, absence of strict regulated technology of such a kind of development and particular specialization of authors make difficult such a creation. The second way is formation of third party organization which is not related to this industry. This make it more mobile. But negative feature is absence of appropriate basic technical education or experience what can lead to arising of plenty errors and inaccuracies during development. The third way as the most suitable is for formation of third party organization with attraction of specialist with common petroleum technological education. The most natural variant both for this creation and for staff training is forming the special laboratories on a base of petroleum technological universities.

Such a kind of group was formed in Ufa State Petroleum Technological University in Computer Graphics Studio in order to develop the computer 3d training simulator system devoting to service and control of a compressor unit of one of regional refineries.

As a basic data the technological schemes, regime scheme, description of technological parameters, photo and video data and personnel work nuances were granted.

Finally, on basis of granted data the computer training system has been developed. It consist of 3d model of necessary parts of compressor unit, 3d engine of this model in action style, mathematic model, partially describing the compressor operation, algorithm of compressor service, educational and testing systems. In the future the multiuser training system is planning to be developed for testing the mutual actions of personnel.

This simulator is intended for mechanical engineers who have direct contact with service and operation of compressor. The safety during processing and liquidation of emergency conditions entirely depends on accuracy and timeliness of their actions.

The technology of development computer training systems was elaborated which can be applied to create the training systems of similar kind.

The process of training simulator development can be divided into the next stages.

1. Elaboration of scenario and structure.
2. Analysis of reference documentation, technological regulations and other data.
3. Designing of graphical model of virtual environment and user interface.
4. Development of mathematical model.
5. Elaboration of educational system.
6. Elaboration of control system and checking system.
7. Testing and debugging.

Let's pay more attention to the each point.

ELABORATION OF SCENARIO AND STRUCTURE (1)

This stage is the main in development and defines its laboriousness. On this phase the most cooperation with customer is necessary because there are several main points of training system such as conception, level of detailed elaboration, mathematical model complexity, multiuser features, interface are determined. Thoroughly elaborated structure let avoid many errors and hence costs for their correction on the next stages. Level of detailed elaboration also depends on elaborating scenario that is on specific tasks needed to be solved in this training system. During modeling the main attention have to be paid to objects which directly take part in scenario. Interface has to be the simplest and friendliest for the user since user has to be concentrated on deciding of scenario tasks and not to spend his time on memorization of functional keys.

ANALYSIS OF REFERENCE DOCUMENTATION, TECHNOLOGICAL REGULATIONS AND OTHER DATA (2)

This analysis is essential for the consecutive algorithm compilation, which in aggregate with mathematical model and elaborated structure constitutes the base of training system. Depending on scenario the algorithm involves both the main operations based on reference



Fig. 1

Screenshot #1

documentation and working nuances which are mainly not documented but are important and crucial in definite situations and which are determined by experience. These factors in aggregate give the reality to the algorithm. For example, some of emergency conditions can be eliminate passing over the documented rules and guidances. And such a successful experience has to be included in training system. In some cases the effective decision of particular task can be found during testing on the training system.

DESIGNING OF GRAPHICAL MODEL OF VIRTUAL ENVIRONMENT AND USER INTERFACE (3)

The main task in development of 3d environment of simulator is taking into account the computational capability of computer systems which has to be enough for processing of mathematical model in real time from one hand and rendering the environment with necessary level of detailed elaboration from the another hand. This stage is similar to technology development of 3d computer games and all the up to date means of visualization and computer graphic can be used. In this case the popular 3d game engine with OpenGL based on game Quake2 is used. The 3d environment was made using 3d modeling and editing program such 3dStudio Max and QRadiant.

DEVELOPMENT OF THE MATHEMATICAL MODEL (4)

The development of the mathematical model which is adequately describes the system behavior is global creative problem. If any of initial describing of input and output data, quantity of variables and another parts of mathematical model are incorrect then it may cancel all the advantages of training system. Even a slight change in scenario can lead to complete change of mathematical model. The adequacy of model defines reality of training system. If not, it may be harmful when user using simulator can develop incorrect skills. The mathematical model has to have the minimum of the parameters and variables enough for elaborated structure to avoid unnecessary errors. It has to be continuously checked and debugged to fulfill the real condition. It is desirable that modal is elaborated from the simple one to complex one. On the first step it has to be the simplest but adequate and after that being assured in its accuracy programmers can make it more complex step by step with continuously testing.



Fig. 2

Screenshot #2

ELABORATION OF EDUCATIONAL SYSTEM (5)

The educational system is divided into several phases. The first part is theoretical. All the theory essential for successful passing of training test is explained in easy manner using multimedia. Besides the principles of interface working are explained too. After the preliminary testing of the theory the user is immersed into training system environment, where he can not take any part. In this period of adaptation the scenario is played before him with audio and video comments. If possible, the reasons of main operations and consequences of crucial failures are explained. On the third part of education the user is allowed to repeat all

the operations but all his errors are blocked by the system with outputting on the screen the helping information.

ELABORATION OF CONTROL SYSTEM AND CHECKING SYSTEM (6)

In the processes of both education and testing the system controlling totally the user actions is very important. In case of education the control system forces the user to execute and memorize only the essential operations. In case of testing the user is allowed to do anything but each his step is analyzed and finally his work is evaluated. In case of multiuser training system the aggregate and timeliness of mutual operations of all the users is evaluated. Accuracy of actions is estimated by the build into system error data base, compounded after the reference documentation analysis. The errors are ranged depending on their level of significance and by the end this influences to the final assessment of test. At last, for the final analysis the record and following playing of all the user action is possible. The results of testing are gave out in text file with highlighting of all the errors and technical literature, essential for replenishment of missing knowledge.

TESTING AND DEBUGGING (7)

Testing and debugging is passing in several stages:

- Correction of program errors. This stage is executed by the programmers during all the process of development and checking of training system.
- Correction of technological errors. This stage is executed by the plant personnel. The imperfections of training system as a result of incorrect or unreal execution in training system of definite technological processes are found and mended
- Correction of scenario errors. This stage is executed by the customer after the fulfillment of previous stages.
- Testing of the interface by the finite users.
- Compiling the guidance.

The final debugging of system has to be carried out not sooner than two month of using of the training system on the plant.

In the end the using of training systems for oil-refining and petrochemical industry will allowed:

1. To teach the personnel to the practical skills.
2. To reduce to the minimum the period of adaptation for new workers.
3. To reduce the risk of mistakes during the phase of tuition.
4. To teach personnel to the new types of behavior, to improve the response and accuracy of taking decision in emergency conditions.
5. To improve coherency and efficiency of working in groups.
6. To test and control personnel knowledge.
7. To adapt the various industrial information and to lighten its perception.
8. To decrease the quantity of accidents caused due to improper or untimely actions of personnel.
9. To increase production and efficiency of enterprises.



Fig. 3

Screenshot #3