Computer visualization in accident prevention in industry

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Summary

The paper presents results from the collaboration between Polish coal mines and the Geometry and Graphics Center at the Silesian University of Technology in Gliwice, concerning the application of computer visualization in accidents prevention. The collaboration consisted of making movies which reconstruct accidents which have happened in coal mines. These movies are shown to employees during their health and safety training and on multimedia screens located in the plant. Further work carried out in our center will be concerned withe the development of an interactive simulator with which the employees would be able to learn safe job procedures .

1. Introduction

For the last 5 years, the number of accidents in Polish mines has stayed on the same level. On average, the number of deadly accidents amounts to 25 annually, which is unacceptable for both social and economic reasons. The main reasons of these accidents are still man faults. The mines' management is currently looking for new ways of appealing to employees' consciousness as far as work safety is concerned. It is mainly done through a change in a form and methodology of employee trainings [ILO 1993].

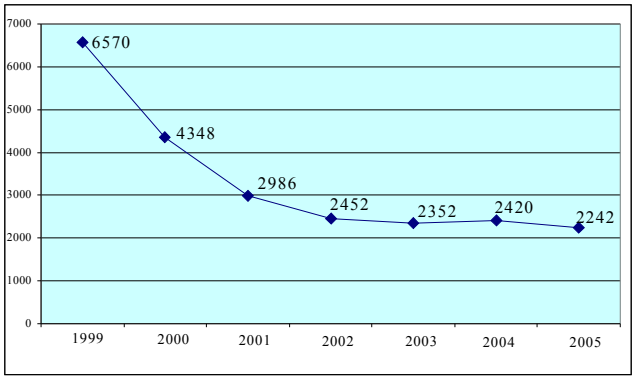


Fig. 1. The number of accidents in polish mines in last years.

For two years our center has been carried out work aimed at creating a series of animated movies which are use for training purposes and promoting safety among employees [Bogacki 2005].

Computer visualization is the best method for accident reconstruction due to the following reasons:

- High costs connected with employing actors and hiring TV equipment.
- Limited possibilities of using recording equipment (lighting, cameras) under ground, in coal mines.
- Reconstruction of the majority of the situations using traditional methods is not possible due to the high risk of the dangerous situations involved in an accident.
- It is impractical to make a video since work needs to be suspended at the location during the recording of the video.

The usage of computer visualization allows the reconstruction of even the most dangerous of situations. There is a possibility of modeling such events as tremors, inrush of water, methane or coal dust explosion.

The visualization will show the reaction of a crew. It is possible to reconstruct positions of their bodies and their actions. The scene can be watched from any direction so it is possible to simulate the field of view of each person involved in the accident. By using a computer generated visualization it is possible to determine what each person could see or even what he could not see. Observations done through the eyes of a casualty gives better understanding of the decision-action process which accompanied the analyzed events. Thanks to this feature of the computer generated visualization it is possible to use the visualization to verify the statements of witnesses to the accident .

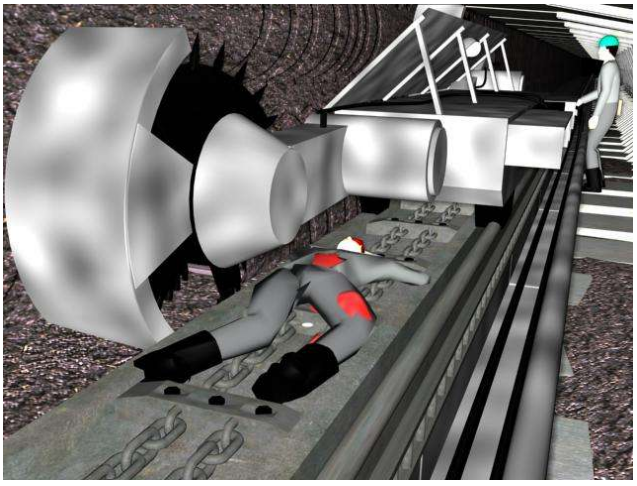


Fig. 2. Scene from movie, which reconstructed the accident in coal mine.

2. Assumptions

In order for a movie to fulfill its didactic purposes and for the employees to identify themselves with the presented situations the following issues must be included:

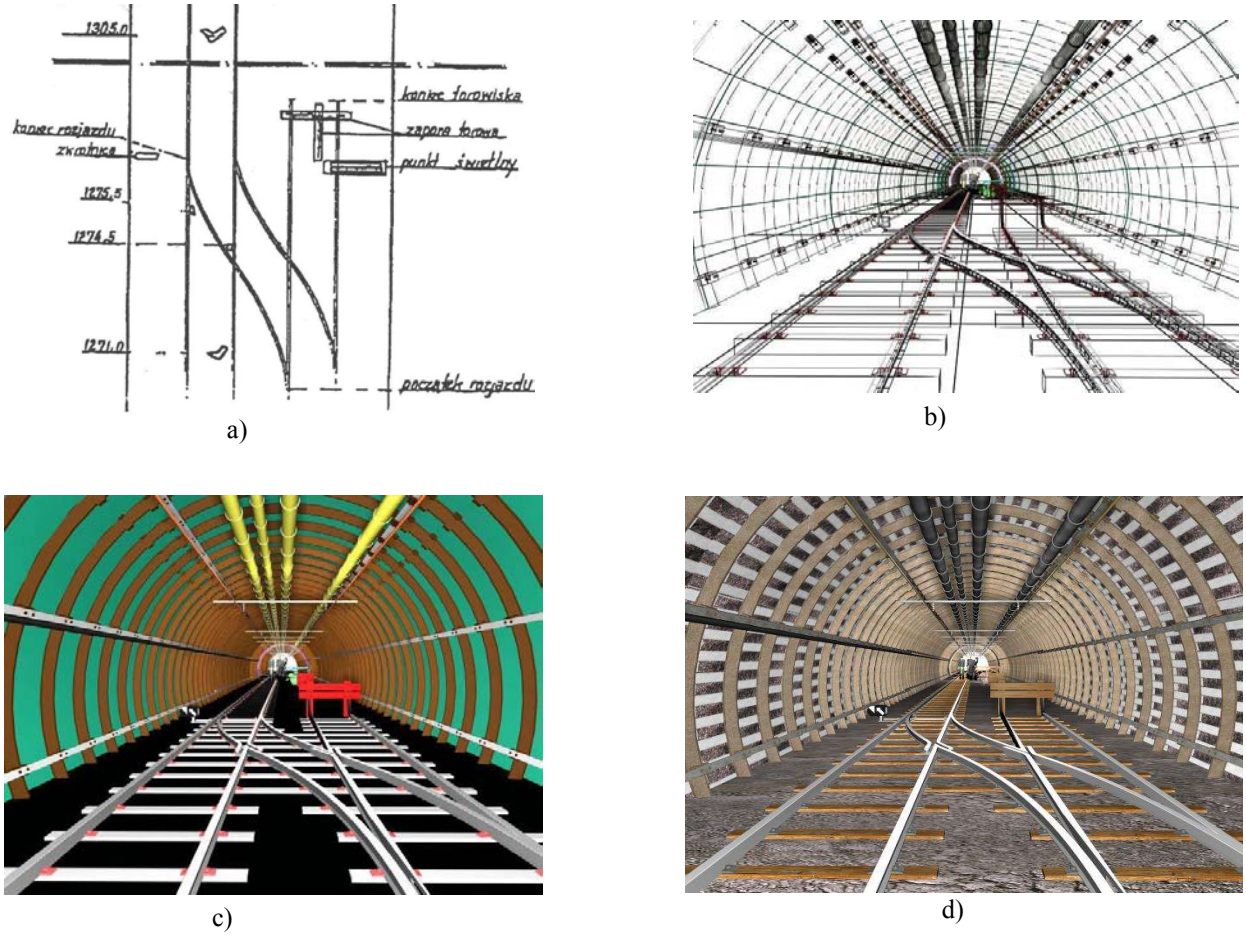
- A movie should realistically show the place where the accident happened, the machines, appliances and devices should look realistic, in a way known to the employees.
- The ambient conditions must be taken into account (lightning, dust).
- The movements of people and machines must correspond.
- Movie screenplay must be based on real events and the movie itself should focus on the error which was the main cause of the accident.

3. Production

The screenplay of the visualization needs to be based on the investigation that was carried out at the mine. Particular care is placed on witnesses' statements, what they witnessed and when, their location on the spot and their actions. The most convenient notation for the screenplay is storyboards since the plot of the visualization mainly consists of the movements of devices and people, and rarely features dialogues .

By means of visualization employees behavior is illustrated, their particular movements and activities. When each take is constructed, it must be cleary stated, minute by minute what movements the people and devices have made, including detailed information about their individual positions [Jacinto 2002].

The scene is reconstructed from of drawings and pictures of the location. All this data allows a detailed model to be constructed including all technical equipment involced in the situation. In order to simplify the creation of future visualizations, a set of 3d models have been created. These models represent machines and devices that are commonly used in polish mines. They are harvesters, transporting machines, as well as casing elements; however, for accidents reconstruction they do not have to be very detailed. In fact these machines are very complex and modeling of all their details would be a big drawback in scene operation and it would significantly increase the time of animation rendering. The immersion is increased when texturing and lighting of elements matches their real-world counterparts. This phase of the construction of visualizations has a big influence of the acceptance of the visulalization.

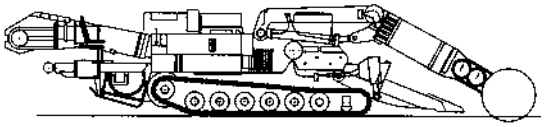


a) b)

c) d)

Fig. 3. Creation of spatial model of heading (railway crossover): a) sketch from accident's records, b) spatial mesh of heading, c) block model of heading, d) view of heading covered with textures.

a)



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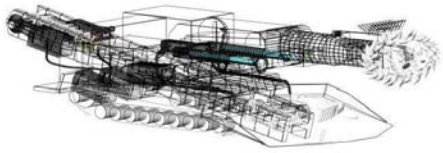
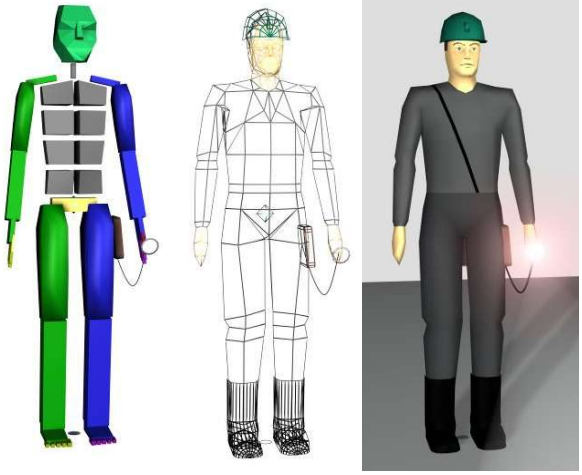


c)

Fig. 4 Creation model of harvester AM 50 a) side view, b) spatial mesh of harvester model, c) model of harvester covered with textures.

For the purpose of modeling, animation and rendering 3ds max program has been used. Animation of human figures has been done by means of 'biped' procedure from Character Studio module.



a) b) c)

Fig. 5. Stages of creation of miner profile a) skeleton of profile, used in movement generating, b) mesh of profile, c) profile covered with material.

Figures play the most important element in the movie but at the same time they cause the most troubles in animation. Other elements of equipment can be modeled with great realism whereas in case of human figures it is difficult to avoid superficiality, especially in the way they move. Nevertheless, for the purpose of events reconstruction some simplifications do not cause any obstacles. Further work on the visualizations will be required to increase the realism in the figures and movement of the employees .

The last phase of production is editing rendered material and adding sound corresponding to machines' noise. Narrator's commentaries are recorded separately, which describe particular situations. These commentaries are especially important when the movie is shown without a person leading the training.

4. Conclusions

From the experience of Health and Safety Departments it results that showing events reconstruction makes people realize how dangerous it is not to obey safety rules . It is especially appalling in case of dead bodies covered in blood.

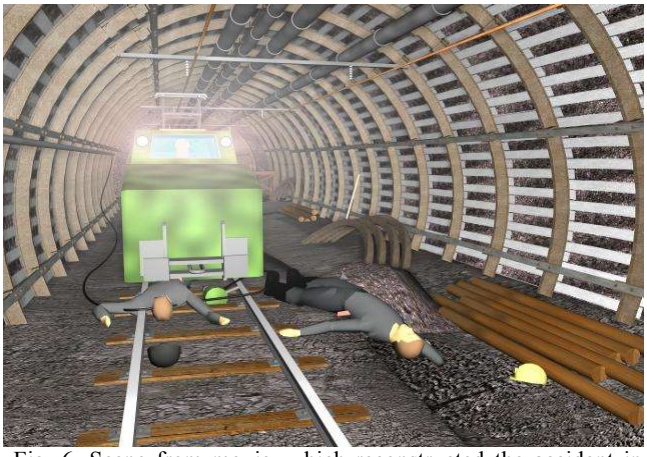


Fig. 6. Scene from movie, which reconstructed the accident in coal mine.

Accident prevention should not be limited to the presentation of error consequences but it should also show how to deal with job procedures correctly, this includes emergency situations. Further works connected with accidents prevention is aimed at creating interactive simulator of production processes whose principle of operation will be similar to 3D games. This simulator will be used for teaching how to deal with job procedures safely in both typical and unplanned situations. Currently, work is being carried out on the development of a module for the creation of 3d models for visualization of industry accidents. The rendering engine from the open source Blender Modeling [Roosendaal and Selleri 2004] system is being adapted to fit the needs of the simulator .

References

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