Training Method of Oil and Gas Industry Operators on the Example of the Automaton Simulation Usage

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Abstract. At the present time, in the oil and gas industries centers of operators training simulate situational problems likr alarm and pre-alarm events. Recent studies in this field allow us to consider only the most likely emergency scenarios. In order to identify unlikely and untypical situations the HAZOP-methodology is being used. Its usage is becoming problematic due to the significant growth of low-probability a *fault tree eaves*.
In this paper we propose to use the automaton approach with the use of advanced automaton cuts for the effective use of failures models in practice, training of operators working in emergency situations. This process simulation approach will allow taking into account highly unlikely and untypical situations.

Introduction

Accidents at various facilities in the oil and gas sector can be divided into three groups of interrelated causes that contribute to the emergence of the accident, as analyses have shown:

- equipment failures,
- human error,
- underexpanded external effects of natural and manmade.

Through training and recurrent training of operators, we can reduce the severity of the accidents. At the present time, in industrial centers of Operators training situational problems like typical alarm and pre-alarm events are considered.

1 Formulation of the Problem

According to the Pareto analysis only 20% of all incidents are responsible for 80% of damages. As situational problems 20% of the best reasons of accident scenarios are detected and considered. In this case consideration of these situational problems reduces the likelihood of emergency events up to 80%.

Thus it turns out that 80% of the scenarios fall out of consideration in the virtual training places, and operators are not prepared for 80% of theunlikely system failures causes. However, international experience indicates greater risk of unlikely and untypical situations which operators are not prepared to control.

Emergency situation in the oil industry can paralyze the work of the oil and gas facilities until the elimination of the causes, and if unsuccessful can result in fire, possible detonation, and others.

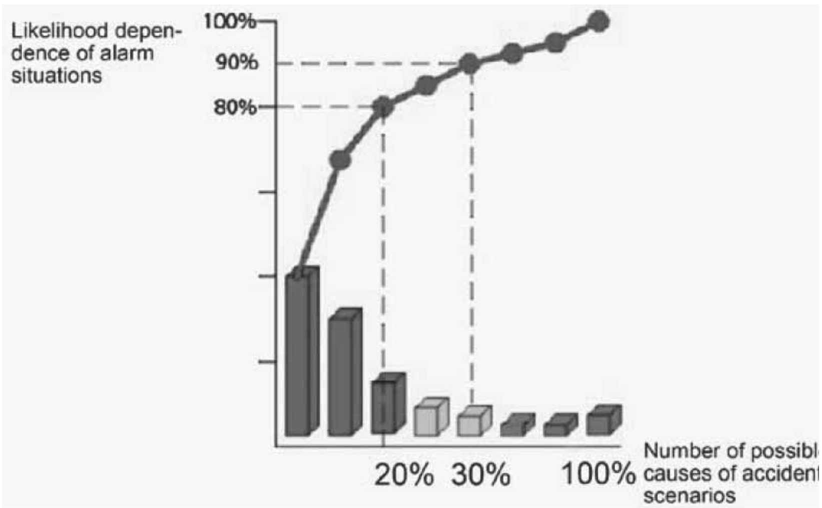

Figure 1. Likelihood of alarm situation, depending on the number of possible causes of the accident scenarios.

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That may lead to the death of more than one dozen people. Recent studies of the fault tree construction allow us to consider only the most likely emergency scenarios. That makes it necessary to develop the methods to detect more untypical events. It will allow operators to be ready to manage a lot of emergency events. Thereby it will significantly improve the quality of their training.

In Figure 1. there is the likelihood dependence of emergency situations, depending on the number of possible causes of the accident scenarios.

2 The Method of Finite Automaton as a Tool for Studying of a Typical Emergency Scenario

2.1 Disadvantages of the HAZOP-Methodology used to Identify Emergency Causes

In order to identify emergency causes at the present time the HAZOP-methodology is used. [1].

But the HAZOP-methodology considers only the most dangerous and most likely emergency situations. Its usage is becoming problematic to identify unlikely and untypical situations due to the significant growth of low-probability 'a fault tree leaves'. In addition, the HAZOPmethodology has a number of other shortcomings. In the process of the object analyzing on the availability of emergency situations consideration of relationships, regularities of accident scenarios, co-occurrence of multiple emergency scenarios are not included. [2].

2.2 Usage of the Extended Automaton Cuts

In the practice of operators training of working in emergency situations automaton approach is proposed using 'cuts' of 'the extended machine'. This approach will reduce costs for expensive prevention of emergency situations. Such an automaton approach allows creating virtual field automated place.

That allows regularly training of operators for emergency scenarios and also gives intelligence prompts information of appropriate action.

This approach has considerable practical importance. Enterprises can get the simulation methods of technological processes to the workplace of the operators that will allow taking into account not unlikely typical situations. This account will allow a more carefully prepare operators of the oil and gas industry. This in turn will significantly reduce the probability of accidents and prevent them. That will reduce the costs of emergency response and resulting consequences.

It becomes cost effective to prepare the operators to the emergence of a larger number of alarm events, than to technically realize the lack of all contingencies. StateFlow is used as software package for automated device modeling. StateFlow is a simulation tool for event-driven systems, for designing of complex control systems.

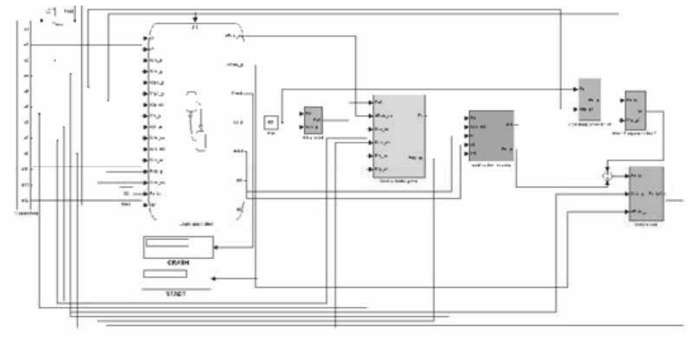

Figure 2. Finite state machine model of technological process section.

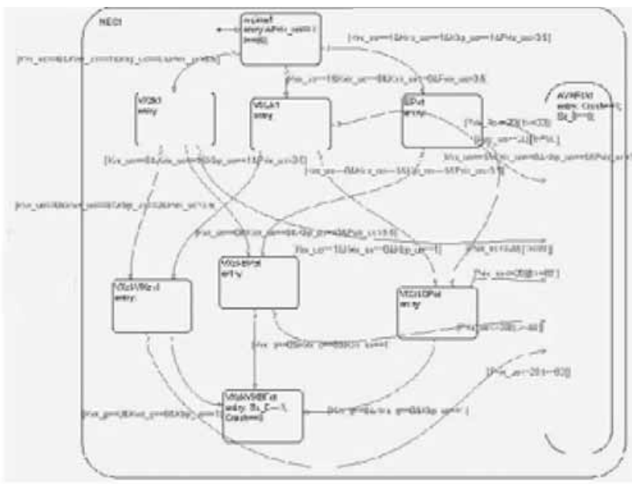

Figure 3. StateFlow-state model of the technological process

StateFlow allows to simulate the behavior of complex event-driven systems, based on the theory of finite automatons. The StateFlow diagram is a graphical representation of a finite automaton, where states and transitions form the basic building blocks of the system.

Figure 2 shows the finite state machine model of technological process section – the simulator of accidents processing. This model consists of a console, the control part (controller), the physical model of the reservoir and visualization tools displaying values of interest variables.

Figure 3 shows state model of the technological process. Here is a hierarchical method of model building for automaton programs of simulator's control system. This method is used in modern enterprises. In order to realize the most danger in terms of safety and security scenarios components and contained within them control objects are considered as the subsystems. Considered control objects are divided into several sub-systems of finite automaton.

Figure 4: Diagram of machines interaction

Each subsystem can be considered as finite state machines of the Moore-Mealy, arranged in a hierarchy. As a result, the logical part of the reservoir control system is given as a system of interacting automatons.

An automaton located higher in the hierarchy controls its imbedded automatons by events generating and transferring to them its control of the event. In addition, the automaton monitors the nested automatons, since its state transitions may depend on them also.

In Figure 4, there is a diagram of the interaction between machines.

3 Interface of simulation models

HMI LabVIEW is used as software package to create screen forms of the oil and gas facilities. It is the most suitable software to simulate the process of any physical nature. It has familiar human-machine interface to the operators of oil and gas facilities.

LabVIEW has a wide range of built-in functions that allow to interact the virtual control object with Simulink-diagram.

4 Conclusion

At the present stage of the oil and gas operators' training, carried out in training centers, only typical emergency situations are considered. The importance of playing out such scenarios is significant, but we thus disregard most of the causes of other accident scenarios. The usage of "advanced finite automaton" will help us to consider significantly more events. We will limit the amount of the low- robability "leaves" of the "fault tree" by the "cuts" usage of "extended automata".

Field automated virtual places will not only generate motor-reflex skills of action in dangerous situations, but also will demonstrate to the operators the processes taking place in the equipment during the technological processes and their interdependence.

References

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