Scientific report

Introduction

After the nuclear accident of Chernobyl in 1986 the need for a system that supported the decision makers (DMs) in taking appropriate countermeasures was apparent. Up to then no program had existed that was able to comprehensively aid the responsible staff in decision making in such a catastrophe. To be prepared for future accidents the EU introduced a project that developed a program that dealt with the problem in a full manner: RODOS[1]. It was designed to collect all the important data, calculate and display the spread of the nuclear plume, propose appropriate countermeasures, and provide effective decision support for choosing possible countermeasures.

RODOS – as any other decision support system (DSS) – does not make the decision itself but it helps the DM to gain a better understanding of the problem and of his own value judgment. Since there are many stakeholders involved in a nuclear accident the system supports not just one DM but many. It guides the DMs through the whole process of multi-criteria decision analysis (MCDA) including the modeling of their preferences, different objectives and possible alternative actions. Even a single DM will often have to handle conflicting objectives. So the proposed alternatives have to be assessed in the context of various criteria.

In the previous releases of the system the parameters were considered to be deterministic. In a realistic environment this is not always sufficient: processes in nature are stochastic. An example is the weather conditions where it is only possible to calculate a distribution for the most likely future outcome. Here a DM has to cope with uncertain consequences of his actions. In this case a decision support system should aid him in such a way that he can “get a feel” for the risk he is taking when making a certain decision. Therefore it is not sufficient if he just receives information about what would happen in the most probable scenario. He should also see what the consequences of his alternatives would be in the worst and best cases.

During the EVATECH[2] project of the European Union, which dealt with the improvement of decision support methods, models and processes, the software package Web-HIPRE[3] has been integrated into RODOS in order to ensure a transparent and coherent evaluation of alternative countermeasure strategies whose potential benefits and disadvantages are

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[1] RODOS: Real-time Online DecisiOn Support System for Nuclear Emergency Management (http://www.rodos.fzk.de)

2 EVATECH: Information Requirements and Countermeasure Evaluation Techniques in Nuclear Emergency Management (http://www3.sckcen.be/samen/public/index_EVATECH.html)

[3] Web-HIPRE: HIerarchical PREference analysis in the World Wide Web (http://www.hipre.hut.fi)

calculated by RODOS. Web-HIPRE has been designed and programmed by Professor Raimo Hämäläinen and Jyri Mustajoki of the Helsinki University of Technology independently of RODOS in 1998 and therefore provides functionality in decision analytic problem structuring, multi-criteria evaluation and prioritization not only for nuclear emergency management but in all kinds of decision cases.

Purpose of my visit

The purpose of my visit to Helsinki was to add functions to the tool Web-HIPRE to handle uncertain consequences of the countermeasure strategies the DMs have to choose between. The previous version of Web-HIPRE could only deal with one scenario, so it could not supply the DM with decision aid in a practical manner in case of RODOS having produced many scenarios. This will be the case when the preliminary modules of RODOS will work with probability distributions for certain parameters instead of only deterministic values as in the previous version. The input into Web-HIPRE will then be a number of different scenarios of the consequences of the proposed countermeasure strategies.

Description of the work carried out

During my visit I programmed functions for Web-HIPRE to comprehensively process uncertain scenarios and to supply the DM with various possibilities to visualize the hazard of his decision. The new version of Web-HIPRE provides decision support for the modeling of the DM's judgment and preferences in the case of uncertain consequences.

Results obtained

In the new version the DM can import RODOS models containing any number of scenarios. Web-HIPRE can display the consequences in a clear way, and the DM is able to modify values and to add or delete a scenario. There is also the possibility to import the consequences from other programs or to export them. When assessing the value function to rate the alternatives the DM can view the 5%, 50%, and 95% quantiles of the consequences and the resulting values. This provides him with a way to set up a value function that describes his preferences, because he is able to observe what values he will most likely get and what values he will get in the worst and best case. The saved models of the new version are fully downward compatible so that models created in the previous version can still be used. This will add significantly to the acceptance of the new version among users who have created files in the previous version.

In order to model the DM's preferences, Web-HIPRE is able to display not only the medium score of all scenarios with respect to the DM's goal, but also the five percent worst and five percent best cases (5% and 95% quantiles). This allows him to select the alternative that reflects his attitude towards the risk he is willing to take. He has the option to view all

quantiles at the same time or just the 5%, 50%, or 95% one. The second option allows, for example, the pessimistic DM to select the alternative with the highest score in the worst case, which would correspond to a MaxiMin strategy. The restriction on the display of the three quantiles, which resemble key parameters of the scenarios, ensures that the DM concentrates on the important values of the scores and is not overtaxed with useless information. The DM can also perform a sensitivity analysis, in which he can test changes in his preferences or changes in the consequences with respect to a goal. Here the standard is the display of average scores of the alternatives. The DM has the possibility to view the 5% and 95% quantiles for the alternatives which have the highest score so that he gets information about the changes of the scores also for the worst and best case.

In this work extreme care has been taken to ensure a quick and easy learning for the new users and for the users that have already used the previous version. This will be of vital importance, if the tool is employed in a nuclear accident scenario where the application has to be intuitive and must not be subject to long training. The new version is therefore user friendly, robust, and stable so that it meets the high requirements for a program that is to be used in emergency management. The proper functioning of the tool was checked in extensive tests.

Projected publications

I will publish my results and a detailed description of the new functions of Web-HIPRE in my diploma thesis at the Institute of Industrial Production (IIP) of the University of Karlsruhe (TH), Germany. The title is “Multi-criteria decision support and probabilistic risk analysis: Application in Web-HIPRE as part of the Real-time Online Decision Support System for Nuclear Emergency Management RODOS”.

Changes in the travel period and travel costs

Since my work went really well in Helsinki, I came back earlier than expected. My original travel period was from January 24th until April 20th. My actual travel period was from January 24th until April 1st. So I did not stay 13 weeks as expected but only 10.5 weeks. I still had to pay my accommodation in Helsinki the whole month of April though.

Professor Simon French suggested that I put in 4850€ for my actual travel costs. The calculation is as follows: 400€/week times 10.5 weeks plus 420 € for the flight plus 230€ for the accommodation in April.

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