SAFE-DIS : SAFE DESIGN OF URBAN DRAINAGE BY USE OF INFORMATION SYSTEMS

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Abstract

We present interim conclusions from a DTI/EPSRC funded study at the University of Surrey with Wallingford Software into the safety-critical aspects of modelling and rehabilitating sewerage networks. Of particular interest is the development of an information system leading to the inclusion of advisory and supervisory systems with simulation software. It is also recognised that facilities for sensitivity testing will be important, as well as the provision of measures for risk and failure. The more theoretical aspects of the project include investigations into the language used to communicate about safety related matters and the potential role of multi-agent architectures and neural networks in modelling.

Safe-DIS is a three year DTI / EPSRC project under the Safety-Critical Systems Programme. The objective of the Safe-DIS project is to emphasise the role of Information Systems in making safety-related information available to design engineers in a timely and effective manner. We are concerned with the hazards inherent when simulation software is used to produce computer models which are then taken as the basis for safety-critical designs. The final goal of the project is the production of an intelligent information system which will support the safe use of an existing software simulation package (eg Hydroworks produced by Wallingford Software). We have been focusing on how experienced engineers use such software packages, with the aim of archiving their knowledge. We have started to deploy this knowledge with a variety of information system mechanisms including marked-up texts, 'safety labels' and expert system modules.

Our talk at WaPUG will cover :-

i)   a brief history of the project to date, highlighting especially the role of the Safe-DIS Round Table

ii) an overview of the current Safe-DIS information system functionality

iii) details of future project activities

We plan to supplement the talk with a tutorial session during which the system will be demonstrated more thoroughly and responses from delegates will be solicited.

Proposed Approach – Acquiring Expert Knowledege for Safe Modelling

Our work starts from the premise that experienced engineers use simulation software well through the application of their experience/expert knowledge. The primary goal of the project thus became the elucidation of this knowledge from experts and its inclusion in an information system to support novice engineers.

The Safe-DIS Round Table

The Safe-DIS Round Table consists of representatives from three Water Companies and two Consultancies with a wide range of experience in the use of simulation software to produce models. To date, we have hosted six, day long meetings of the Round Table and engaged in a variety of knowledge elicitation activities concerning the safe use of simulation software for design. We have also had several meetings with individual members of the Round Table for more specialist discussions.

The Round Table has served three main purposes thus far in the project :-

- By identifying the hazards that can arise from the improper use of simulation software (See next section for a summary of our findings)
- By being a rich source for knowledge acquisition. A wide variety of knowledge acquisition activities have been performed with the Round Table – including brainstorming sessions and tape recorded interviews
- As a means for obtaining user-feedback. Throughout the course of the project the Round Table have been given demonstrations of on-going changes to the Safe-DIS system. Their comments have been invaluable in guiding its development.

Safety Issues in Modelling Drainage Networks

We have reached the conclusion that bad designs/plans for rehabilitating networks from the engineer either (i) treating a poor model as if it were good or (ii) extrapolating inappropriately from a good model. Here the word 'bad' implies either
  a) likely to lead to flooding or
  b) financially inefficient.

Particular attention must be paid to the following factors (identified by the Round Table) if these scenarios are to be avoided :

- relevance and accuracy of the asset and performance data
- accuracy of derived parameters
- uncertainty in estimated parameters
- adherence to procedures for building, calibrating & varifying a model
- sensitivity of results to key data and parameters
- the engineer's understanding of the equations which underlie the simulation process

Safe-DIS System Functionality

To address these and other hazards, the Safe-DIS system has been specified to act in both a supervisory and an advisory manner. In the former it responds to combinations of certain criteria, such as the current stage of the modelling process and the values of parameters in order to alert the user to possible dangers or block certain actions. In the latter, the system is prompted by the user to provide assistance in the form of guiding heuristics and expert system routines. The Safe-DIS workbench serves both as a research and development environment and as a prototype of the final system. The workbench facilitates the simultaneous acquisition, animation and validation of information. The mechanisms implemented thus far are :-

- Facilities for text retrieval and browsing to be accessible from all parts of the system – these allow the user to navigate the vast quantities of texts available including company guidelines, pertinent legal documents, transcripts of interviews with experts and articles from learned journals. (And exploiting the potential granted with the advent of the Internet, access to repositories of texts worldwide)

- Safety Labels – the system interjects with warnings or even intervenes to prevent hazardous use of the simulation software, in a manner sensitive to the experience of the user. These warnings are colour-coded to indicate degrees of severity.

- An Expert System module performing automated procedures – e.g. the simplification task where the system takes a network description file and makes suggestions for the merging and pruning of pipes in accordance with a protocol specified by expert engineers.

- Crystal Ball for risk analysis – the commercially available package Crystal Ball is applied in the workbench to show how an equation's parameters contribute to the calculated values and, how uncertainties about the values of these parameters propagate to the calculated values.

Future Directions and Further Information

Work is still on-going in the development of the prototype information system. Particular attention is being given now to its integration with simulation software. A number of visits to the companies of Round Table members are planned for the coming months to give demonstrations and to discuss the system with potential end users. The Round Table will be meeting next February 1996.

At the same time we will continue to explore our more theoretical interests in the language used to communicate about safety-related matters. the potential of neural networks for modelling complex functions and the applicability of multi-agent architectures for instantiating a framework of the design process.

A paper has been accepted for presentation at the International Conference of Urban Storm Drainage, Hannover 1996. Others are due for submission to the journals High Integrity Systems. AI and Engineering and Fachsprache (a special language journal). A paper given at the Safety-Critical Systems Symposium, Brighton 1995.

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