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Arthur D. Little, Inc.'s FaultrEASE™: Risk Analysis Modeling

FaultrEASE, one of Arthur D. Little's line of RiskWorks™ risk analysis software systems, built with Allegro CL® for Windows, is a new generation of large-scale fault tree analysis applications allowing users to dynamically perform CAD operations on-the-fly. Fault tree analysis, first invented by Boeing in the 1960's, was originally used in the nuclear power industry to assess the likelihood of power plant faults. These systems are now used to perform risk analysis in a variety of fields including medical device electronics, chemical processing, automobile, rail transit insurance and other industries requiring documented risk analysis.

The first generation of FTA programs focused mostly on the mathematics of fault trees. Although they could perform very sophisticated analyses, these programs could be difficult to use. They had no graphical user interface (GUI), and editing trees was cumbersome. In contrast, FaultrEASE is simple to master. "A user can learn the program in fifteen minutes," says Greg Wilcox who developed the system. "FaultrEASE is a Windows program written completely anew, in contrast to the first generation of programs that are quite complicated as a result of merely being modified for the Windows platform."

What is Fault Tree Analysis?

Fault tree analysis is a technique used by engineers, designers, and system safety professionals to assess the likelihood of a given event. A fault tree is a model that graphically displays all the scenarios in which that event could happen. "Anyone who needs to conduct risk analysis (to prevent a negative or cause a positive outcome)," says Wilcox, "would benefit from fault tree analysis. Typically, its current use is in the medical devices industry, such as heart pacemakers, catheters, respirators and the like because the FDA requires that risk analysis be documented for these kinds of mechanisms."

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>
> *Greg Wilcox*
> *Software Developer, Arthur D. Little*

Wilcox adds that major home, auto, and life insurance companies are also using the fault tree analysis to calculate risk percentages for various possible end outcomes.

Allegro CL for Windows and FaultrEASE

FaultrEASE is a graphics tool to create, edit, and compute fault trees. It lets the user quickly construct and edit trees as well as calculate statistics and cut sets. According to Wilcox, there are two aspects relative to using the FaultrEASE application: the graphical element and the mathematical component.

The chief benefit of the graphical portion of the program is easy layout and editing of the tree. The user can dynamically prune, clone and graft entire branches as he or she works, and the tree automatically re-balances itself in the process. Says Wilcox: "Today's users don't care a lot about how to lay out the tree. They just want to focus on the logic of the tree. They want to correctly model the scenario of the particular risk that they are trying to assess. What they most want to do is get a certain branch stuck into a certain place because it's the logical thing to do. With FaultrEASE, users needn't know or do CAD, the CAD operations are dynamically performed by the program in real time."

Key to enabling the dynamic fault tree layout is a placement algorithm developed in CLOS, the Common Lisp Object-Oriented programming language that powers Allegro CL. "It's easy to implement a tree structure in a recursive language such as Lisp," says Wilcox. "Using Lisp made implementing, testing, debugging, and fine-tuning the algorithm so easy." The placement algorithm allows for the placement of symbols as well as the annotation of those symbols. According to Wilcox, the automatic placement control frees users "from the mundane task of laying out their fault trees and lets them concentrate on constructing them."

Another aspect of the graphical portion of FaultrEASE is the graphical user interface. Here again Allegro CL was instrumental in developing this feature of the program. "All of the user interface elements are implemented using methods," says Wilcox. "This includes the fault tree display windows, which are defined as the class, FAULT TREE WINDOW. The program thus has a 'multiple document interface,' in which each window can have its own properties. In total, the program defines 80 classes and 495 methods."

The mathematical component of FaultrEASE consists of a direct evaluator built in Common Lisp and CLOS. The direct evaluator eliminates a problem in fault tree analysis known as repeated events. Says Wilcox: "If your fault tree has more than one symbol which represents the same event, that event is said to be repeated. A repeated event will cause the simple evaluator to produce wrong answers. This is because the event is included in the calculation more than once, although it should be included only once." According to Wilcox, the direct evaluator in FaultrEASE solves the repeated event issue. Direct evaluation is a top-down, recursive technique that is much faster than conventional methods since it does not need to produce a list of cut sets. Additionally, the results of direct evaluation are 'absolutely accurate.'" With other methods," says Wilcox, "some approximation may be involved. Worse, no confidence interval is provided, so users don't know how close their answers are to being correct. Direct evaluation involves no approximation, so the result is always exact."

"The best thing about Lisp is that it is a computer language that is both very powerful and flexible," says Wilcox. "Thanks to Lisp, I was able to write a large, complex application which might ordinarily require a whole team of programmers to complete. Also, Lisp is very easy to customize so that as users become more sophisticated, applications written in Lisp can grow along with those users."

For more information about FaultrEASE, please visit Arthur D. Little, Inc.'s web site at: http://www.riskworks.com.

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