Safety and Reliability of Embedded Systems

(Sicherheit und Zuverlässigkeit eingebetteter Systeme)

Fault Tree Analysis
Selected Tools

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- Tool Selection
- Tool Overview
  - Faulttree+
  - Relex
  - BlockSim
  - Galileo
  - UWG3 / ESSaRel
- Other Tools

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Selection Criteria

- Purpose / Characteristics
  - Drawing Tool
  - Pure FT Analyzer
  - Integrated Analyzer (e.g. Markov, Event Tree Analyzer, FMEA)
- Expressiveness
  - Supported Types of Gates
  - Support of Repeated Events
- Analysis Capabilities
  - Fast Algorithm (BDD)
  - Limits (Number of Nodes etc.)
  - Useful and Justified Approximations
  - Minimal Cut-Set Listing
  - Importance Measures

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Selection Criteria

- Presentation of Results
  - Exportable Tables for Numerical Results and MCS Lists
  - Report Generation
  - Graphical Highlighting of Cut Sets etc.
- Handling / Ergonomics
  - Project Explorer / Structuring / Search Capabilities
  - Positioning and Routing Aids
  - Table Input for Large Amounts of Numerical Data
  - Reuse of Trees and Partial Trees from the Same / Other Projects
- Side Conditions
  - Licensing / Prices
  - Operating Systems
  - Required Hardware

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Tool Selection

Claim a (full) trial version!

Do a small example FTA that you prepared ahead.
Let the final users judge the usability!
Try some test cases (e.g. for repeated event correctness)

Tool Overview

- Faulttree+
- Relex
- BlockSim
- Galileo
- UWG3 / ESSaRel

... are shown in more detail as examples.

Others are listed at the end of the presentation

The features lists are based on material supplied by the vendors!

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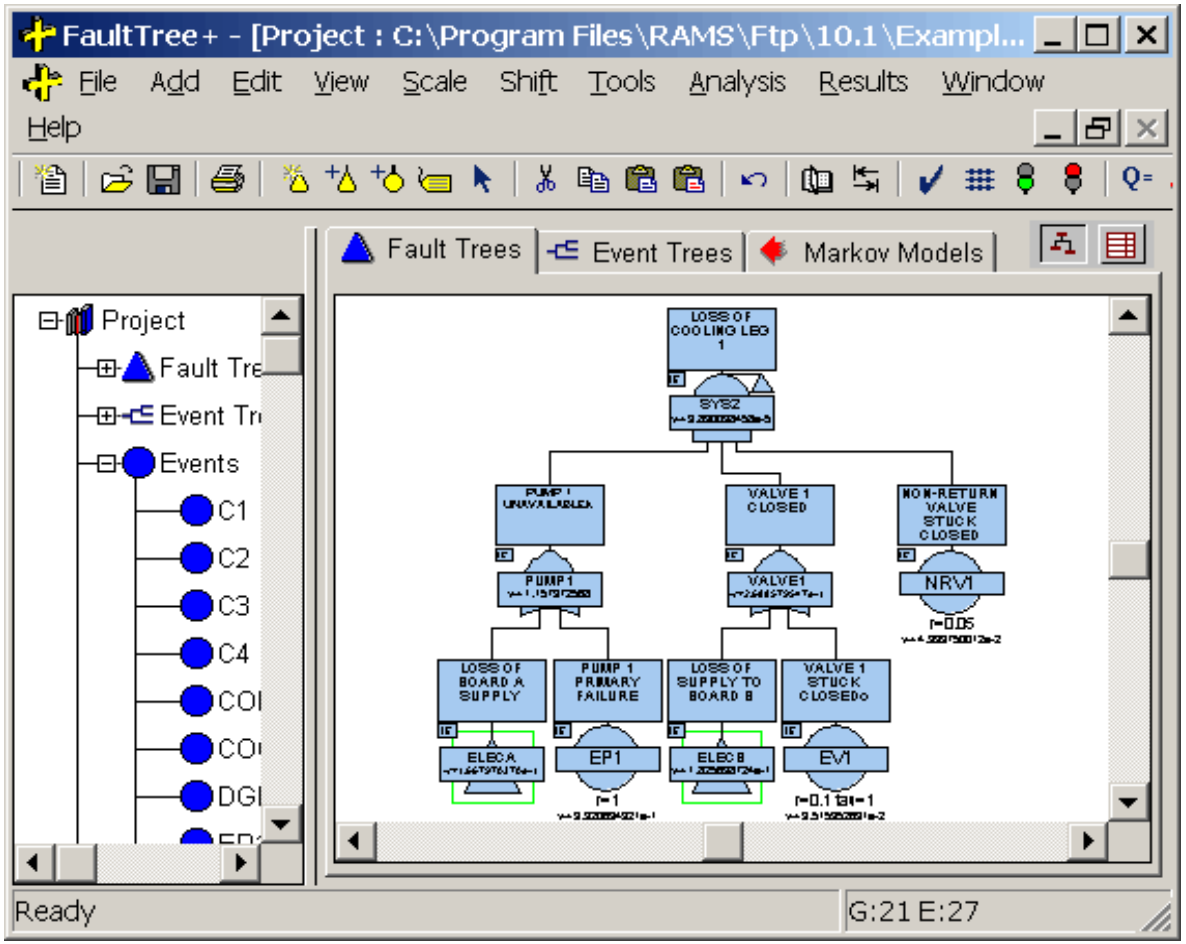
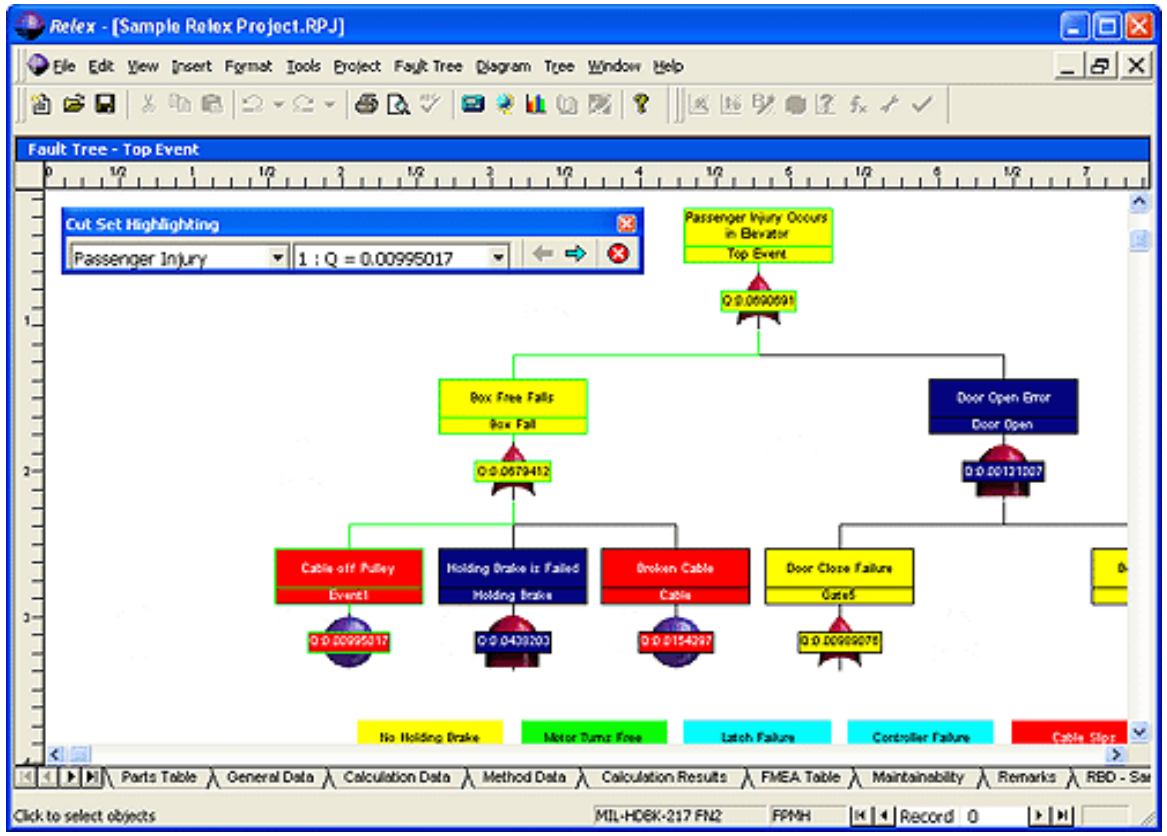
FaultTree+



- By Isograph Software
- Popular Tool
- Tree Construction by Drag-and-Drop
- Includes Event Tree Analysis and Markov Analysis
- Different Failure Models
- Enabler / Initiator Events
- Common Cause Failures
- Can be integrated into a workbench

www.isograph-software.com

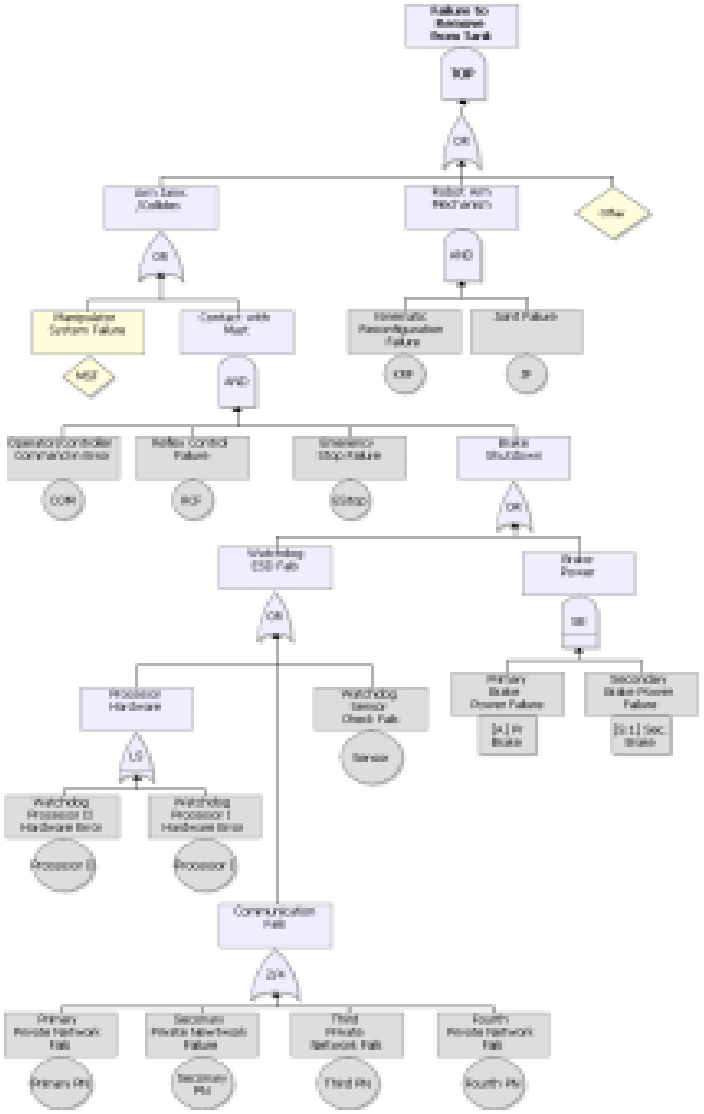
Relex



www.relexsoftware.com

- ☐ By Relex Software
- ☐ Popular Tool
- ☐ Extended Standard Gates Set (e.g. Priority AND, Spare, Sequence Enforcing...)
- ☐ Different Analysis Algorithms
- ☐ Fast MCS Algorithm
- ☐ MCS Highlighting
- ☐ Different Common Cause Failure Models
- ☐ Also for Event Trees

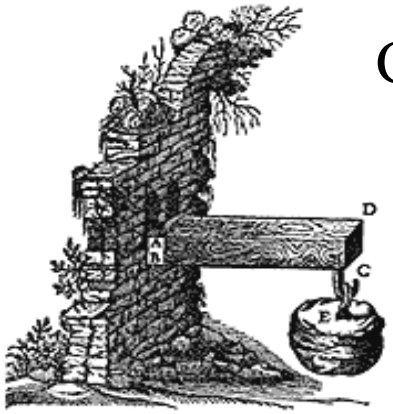
BlockSim 6 FTI Edition



- By Reliasoft
- Recent FTA extension for an existing RBD tool
- Can convert between both models
- Specific gates (Standby, Load Sharing)

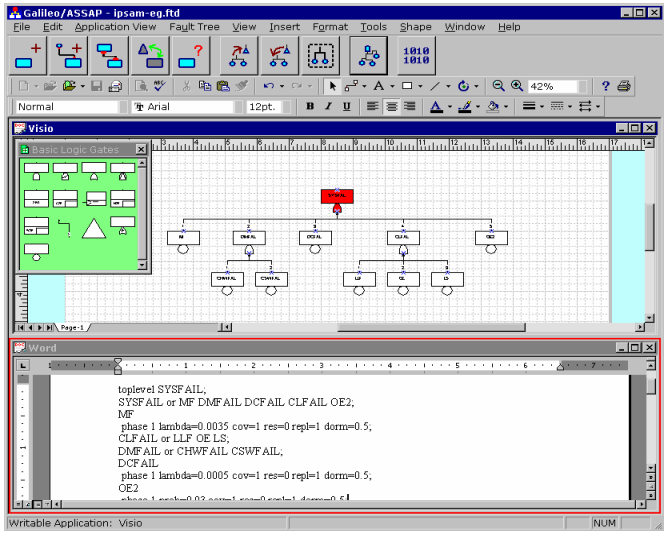
www.reliasoft.com

Galileo/ASSAP Dynamic Fault Tree Analysis Tool



Fault Trees

- Versatile mathematical reliability models
- A graphical representation of a logical function
- Can model both static or dynamic failure criteria
- Provides a logical framework for:
  - Combinations of component failures leading to system failure
  - Showing relationship between an event (failure) and its causes



Dynamic Fault Tree Methodology

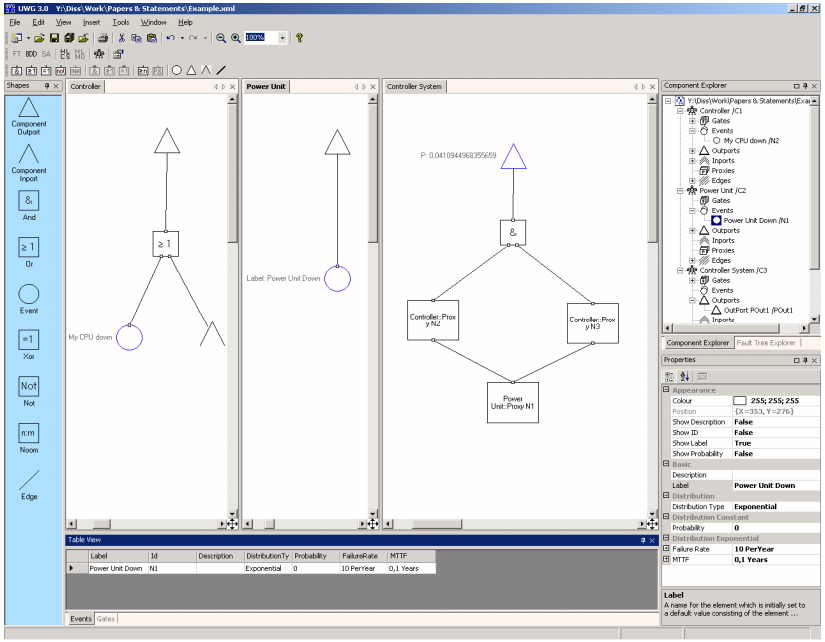
- Automatic modularization of fault trees &
- Independent solution of modules
- Efficient solution for
  - Static fault tree modules using binary decision diagrams
  - Dynamic fault tree modules using Markov-based techniques
- Multiple time-to-failure distributions
- Static and dynamic coverage modeling
- Sensitivity analysis and uncertainty analysis of basic events
- Special gates for modeling sequential behavior
  - Conversion of DFT into a Markov chain for solution
  - Modularization of complex fault trees
- Modeling and analysis of phased missions
- Diagnostic map to help determine cause of failure and optimize repair

Package Oriented Programming (POP)

- COTS-based user interface *i.e.* built from widely used components
  - MS Word Editor interface
  - MS Visio Graphical interface
- Capability to edit fault tree in either textual or graphical representation
- Automatic rendering from textual view to graphical view, or vice-versa.
- Fault trees spanning multiple pages
- Enhanced graphical editing capability

www.cs.virginia.edu/~ftree/

UWG3 / ESSaRel



www.essarel.de

- Windows based GUI Tools under .NET
  - Intuitive Use (Drag&Drop, Project Explorer...)
  - XML File-Format for Collaboration and Reuse
- **UWG3**
  - Supports Component Fault Trees
  - First Version in 2003
  - Successful Evaluation in Industry Projects
- **ESSaRel** (Embedded Systems Safety and Reliability Analyser)
  - Available Spring 2005
  - Integrates State-Event-Fault-Trees, Markov Chains and State Diagrams
  - Analysis by Translation to Petri Nets (DSPNs)

Other Tools

- CAFTA
- FaulttrEASE
- CARA
- CARE
- SAPHIRE
- Item
- TTREE
- Risk Spectrum Fault Tree
- Tree Master
- Formal-FTA
- Logan

Good Overview: http://www.enre.umd.edu/ftap.htm