UNIRAM:
Unit RAM Methodology

The UNIRAM Methodology

Aptech Engineering Services, Inc.'s (APTECH's) Unit RAM Methodology (UNIRAM) is a well-established software application and analytical process that has been developed to address a wide range of system reliability, availability, and maintainability (RAM) issues. Originally developed for the Electric Power Research Institute (EPRI) to address baseloaded (full-cycle) power plant operations, it has since been expanded and modified to address systems undergoing fixed or random cycle operation, as well as full-cycle operation. It has also been applied to a number of systems other than power plants, including chemical processing plants, petroleum refineries, water supply pumping facilities, manufacturing production facilities, rail systems, and ship propulsion systems.

As Table 1 indicates, not only has UNIRAM been applied to a number of varied systems, it has been used during every phase of the system life cycle to address many system RAM-related issues. In the time the UNIRAM has been available, it is conservatively estimated that application of UNIRAM over the range of systems indicated has resulted in savings in excess of $100 million. In one case, the design of coal gasification process was evaluated. The result of that evaluation indicated the need for an additional gasifier to be available in the event that the main gasifier failed during operation. The acquisition of the additional gasifier required the investment of additional tens of millions of dollars. However, during the first year of operation of the coal gasification plant, the main gasifier failed, the standby gasifier was brought on-line, and gas production continued. Without the second gasifier, the plant would have been out of commission for months, resulting in the loss of millions of dollars in revenue because of lost production.

Table 1 — Typical UNIRAM Applications

Candidate Technologies:	■ Aircraft ■ Chemical Plants ■ Combined-Cycle Power Generating Units ■ Fossil Steam Power Generating Units ■ Fuel Cell Power Generating Units ■ Gasification Plants ■ Gasification Combined-Cycle Liquefaction Plants ■ Water Pumping Plants	■ Geothermal Power Generating Units ■ HVDC Transmission Systems ■ MHD Systems ■ Nuclear Power Generating Units ■ Oil Refineries ■ Photovoltaic Power Generating Systems ■ Rail Systems ■ Ship Systems
Objectives:	■ Assess New Technologies ■ Assist in Equipment Selection ■ Analyze Reliability Centered Maintenance Issues ■ Determine Cost Effective Sparing Levels ■ Enhance Maintenance Productivity	■ Evaluate Alternative System Configurations ■ Evaluate Component Criticalities ■ Evaluate System Design RAM Goals ■ Project System RAM Measures ■ Support Investigation of Regulatory Requirements
Plant Life Cycle Phases:	■ Planning and Design ■ System Startup ■ Operational ■ Fuel Conversion	■ Life Extension ■ Availability Improvement ■ Environmental System Retrofit ■ Debottlenecking

In another application of UNIRAM, the design of a generating plant incorporating new technology was evaluated. It was found that many of the auxiliary systems supporting the design had been over-designed and specified. As result of the UNIRAM study, the design was simplified resulting in significant savings in hardware procurement costs. In yet another application, the design of a chemical conversion process that had been proposed to replace an existing process was evaluated with UNIRAM. The results of that evaluation indicated that the productivity gains from the proposed design were marginal at best, and the proposed replacement activity was terminated.

Evaluation of a system with UNIRAM is based on the development of a logic dependency model that relates the impact of the loss a single component or group of components on total system productivity using a combination of block diagraming and fault tree techniques. Development of a UNIRAM model, which is accomplished interactively through the use of a graphical user interface, reflects the effect that the operation of components in all main process and support subsystems have on total system performance, taking into account each component's contribution to total system production capacity.

Evaluation of a UNIRAM model results in more than the calculation of the probability that a system will be working or failed. The evaluation of a system through the use of UNIRAM results in the calculation of four primary system performance indices. Those indices are: Availability (A), Equivalent Availability (EA), Forced Outage Rate (FOR), and Equivalent Forced Outage Rate (EFOR). It is the calculation of EA and EFOR that sets UNIRAM apart from other reliability models. These two indices not only indicate the average time a system is operational, they also indicate the average level of production the system will achieve when it is operational. In determining system indices, UNIRAM uses the component capacity contribution, and component reliability and maintainability measures to determine all the possible states in which the system will operate and the probability of being in each of those states. In contrast to UNIRAM, other approaches to modeling system availability either do not determine the effects of system-level shutdowns resulting from concurrent component outages or provide an excessive number of failure combinations such that the problem becomes too large to evaluate properly the total unit failure probability resulting from the failure of every component.

Table 2 — UNIRAM Execution Options

Execution Option	Summary of Results
Baseline	RAM measures for unit and subsystems
Baseline Run with Load Curve	Percentage of time product demand could be met or exceeded; expected annual makeup product required
Component Data Change	Baseline results as altered by changes to selected component mean time between failures (MTBF), mean down time (MDT), surge-time, and delay-time values
MTBF Scaling	Baseline results when all or specific component MTBF values are varied through a specified range of values
MDT Scaling	Baseline results when all or specific component MDT values are varied through a specified range of values
Component Ranking	Rank ordering of components according to unit sensitivity or criticality
Component Min/Max	Baseline results after changing all component MTBFs and MDTs to their maximum and minimum values (uses 3 from mean for max and min values when normal distribution parameters are used)
Component Redundancy	Baseline results as altered by addition of an identical component in parallel with existing component
Rolling Maintenance	Baseline results reflecting effects of rolling maintenance (or scheduled partial outages) of selected subsystems
Subsystem Sensitivity	Unit production loss variation as availability of each subsystem is varied from 0.80 to 1.00
Statistical Uncertainty Analysis	Sample means and 90 percent confidence levels of unit-level RAM measures
Time-Variant Availability	Unit effectiveness (1-productivity loss measure) as a function of time - includes repair
Time-Variant Reliability	Unit effectiveness (1-productivity loss measure) as a function of time - no repairs
Unit Data Change	Baseline results as altered by changes to unit reserved shutdown hours (RSH), scheduled shutdown hours (SOH), or period hours, or to selected subsystem throughput
Weibull	Unit RAM long-term performance using component time-dependent failure rates defined by the Weibull distribution

UNIRAM Software

The UNIRAM software system consists of the following software modules:

- A graphics-based preprocessor module that assists the user in creating and modifying UNIRAM models through the use of graphical symbols and interactive screen prompts.
- An execution module consisting of a number of run options that can be performed with any UNIRAM model under full, fixed, or random cycle operation.
- A utilities module that allows for viewing and analyzing outputs generated by the execution module.

The UNIRAM graphics-based preprocessor module contains programs that check UNIRAM files that may have been developed using an ASCII editor, assist in creating and modifying UNIRAM models, and convert UNIRAM models that have been developed for use with earlier versions of the UNIRAM software.

The UNIRAM execution module has a number of execution options which provide a number of useful outputs that may be used to support analytical objectives, such as determining component or system sensitivity, evaluating data uncertainty, analyzing improvement alternatives, or forecasting future unit production. The options available in UNIRAM are summarized in Table 2.

The UNIRAM Utilities module contains three options to permit on-line analysis of UNIRAM execution option outputs. One option is a graphics capability that enables the user to plot (to the screen or to hard copy) the results of various run analyses performed with the UNIRAM Execution module. Another option is a financial conversion program that converts changes in plant FOR, EFOR, A, and EA related to changes in component or system operation and design into an equivalent dollar value. With the third option, the user can print an output file or drawing from within UNIRAM for archiving or report generation purposes.

SYSTEM REQUIREMENTS

UNIRAM is currently designed to run on an IBM-compatible microprocessor as a DOS application (a Windows version will be available in the near future) with a minimum of 20 megabytes of hard disk storage. Because of the many calculations that occur during a UNIRAM evaluation, a computer with a 80486 microprocessor is recommended. UNIRAM requires the use of the MS-DOS, Version 2.0 or higher (MS-DOS Version 6.2 is recommended).

AVAILABILITY

To obtain additional information, please contact us in our Corporate Headquarters at:

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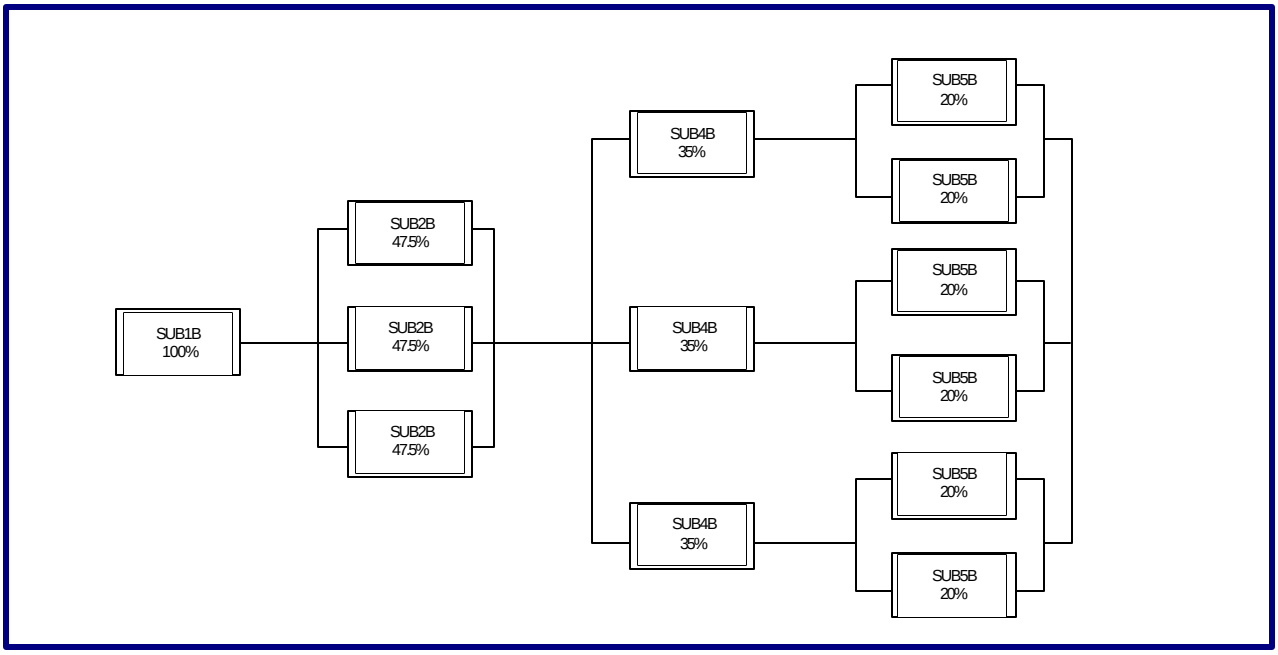
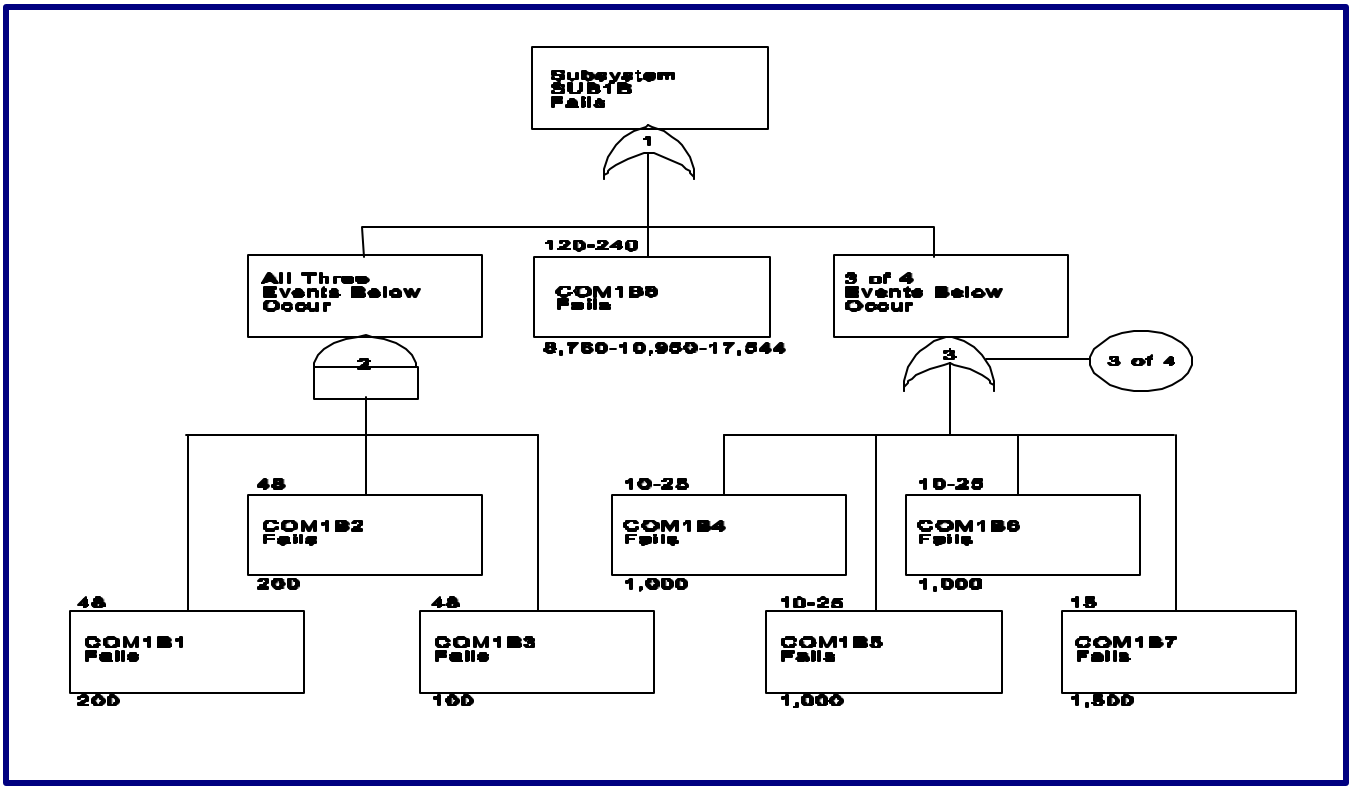


Block Diagram



Fault Tree