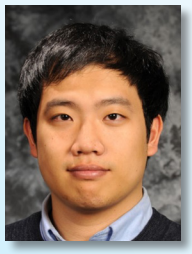
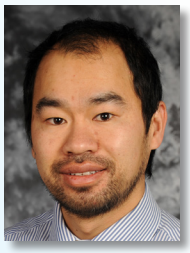
Better Together: EMRALD-HUNTER

LWRS Program Software Tools Linked for Better Modeling of Hardware and Human Risk



Ronald L. Boring, Thomas A. Ulrich, Stephen P. Prescott, Jooyoung Park
Risk-Informed Systems Analysis Pathway



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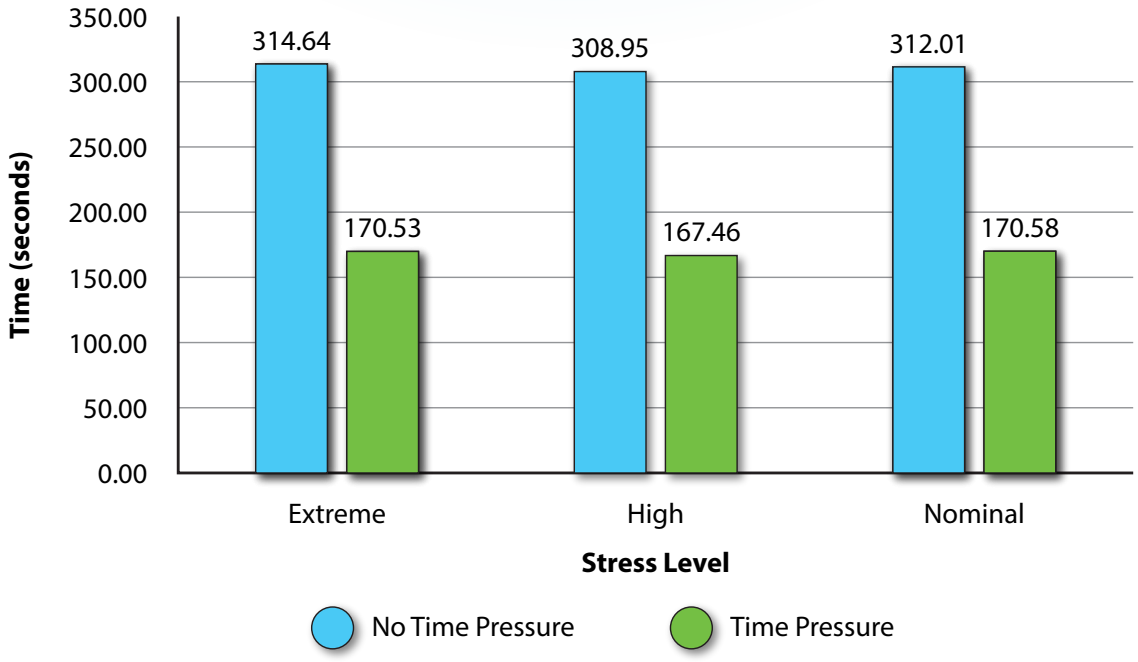
Legacy risk assessment methods are widely used in the nuclear industry to help ensure the overall safety and reliability of the U.S. commercial operating fleet of nuclear power plants. However, these methods are largely static approaches to risk, meaning they operate on a fixed or well understood set of plant and operational conditions. For example, static risk approaches might anticipate failure to initiate safety injection of coolant following a plant trip, but they might not fully consider risk changes resulting from delaying the injection. It is not an all-or-nothing condition with only a single success or failure outcome.

In contrast, dynamic risk assessment uses Monte Carlo techniques to explore a wider range of outcomes, enabling "what-if" modeling. Such modeling is especially important in the context of plant upgrades, novel plant strategies like hydrogen production, and advanced reactors. In those contexts, there is not yet a large base of operating experience to understand system interdependencies or new operational contexts. Dynamic risk assessment can provide this information.

LWRS Program Risk-Informed Systems Analysis (RISA) Pathway researchers have developed two tools that

Figure 9. Example EMRALD-HUNTER output in terms of overall time duration as a function of time pressure and stress.



support emerging needs for dynamic risk assessment:

- Event Modeling Risk Assessment using Linked Diagrams (EMRALD) is a dynamic probabilistic risk assessment (PRA) software tool to help model causes and mitigations for hardware failures .
- Human Unimodel for Nuclear Technology to Enhance Reliability (HUNTER) is a dynamic human reliability analysis (HRA) software tool to help model operator performance including human errors .

A recent RISA Pathway research effort integrated HUNTER into EMRALD to enable plant and human operational risk modeling in a single tool. This assists industry risk analysts to cover both hardware and operational risk, provides the existing wider user base for PRA with greater HRA functionality, and provides missing functions required for holistic risk modeling of hardware and human interactions.

The integration of HUNTER into EMRALD is informed by earlier efforts and the challenges that were incurred in modeling HRA without a specific human module in EMRALD. For example, many human actions are repeated across procedures, but repeated human actions had to be separately coded for each instance in EMRALD. To enable HUNTER integration, EMRALD's process, structure and interface were extended. This new functionality allows modeling operator procedures to include repeated human actions. The speed and choice of operator actions is determined by contextual events in the EMRALD simulation and human influences modeled within HUNTER, creating a realistic simulation of operator performance.

HUNTER benefits from dynamic PRA functions via EMRALD, while EMRALD acquires HRA support from HUNTER. This integration is more efficient than adding the redundant functions separately to HUNTER and EMRALD.

Integrating HUNTER into EMRALD is an effective way to handle routine dynamic PRA applications needing HRA. An example of one of the outputs for a steam generator tube rupture for 1,000 scenario runs in EMRALD-HUNTER is shown in Figure 9. Novel applications such as rare events or human factors design tasks to establish the risk of new human-machine interfaces may require a more in-depth understanding of human operational phenomena, and the standalone version of HUNTER remains available for such applications.

The initial implementation benchmarks successfully to previous standalone HUNTER simulations and to operator performance data . As such, EMRALD-HUNTER holds considerable promise to help industry model risk for novel plant applications.

Welcome Sue Goetz, the New Light Water Reactor Sustainability Federal Program Manager

Sujata (Sue) Goetz is the new Light Water Reactor Sustainability Program Federal Program Manager within the Reactor Optimization and Modernization Team. Sue brings a wealth of experience and knowledge to this role. Sue holds an undergraduate degree in Biology with an emphasis in Microbiology, from Virginia Tech, a master's degree in environmental science and policy from Johns Hopkins University, and certificate in National Environmental Policy Act from Duke University.

Throughout her career, Sue has consistently demonstrated a commitment to environmental stewardship and innovation within the energy sector. Sue began her career as a biologist, working in a laboratory doing research on carcinogens. Then she worked at the U.S. Department of the Air Force, Headquarters (HQ), Pentagon, where she was an intern, At Fort Belvoir, she began her federal service as the Environmental Program Manager for the installation. She was then promoted to the US Army HQ Pentagon, where she continued to serve as an Environmental Program Manager.

She left the Department of the Army to serve as a general engineer at the US Nuclear Regulatory Agency in the office of New Reactors, where she reviewed license applications for the construction and operation of new nuclear reactors, including Vogtle and VC Summer. She has also served as a regulator for operating reactors, where she issued amendments for nuclear power plants such as Comanche Peake, Fermi, Prairie Island, Susquehanna, Beaver Valley, and most recently, Calvert Cliffs.

Sue's diverse background and expertise will be invaluable as we work to advance the sustainability of light water reactors.