UNDERSTANDING AND DEVELOPING STRATEGIES FOR

Human Factors to Increase Safety, Efficiency, and Overall Performance

Advancing fundamental knowledge at the intersection of people, technology, and work environments

Pacific Northwest
NATIONAL LABORATORY

U.S. DEPARTMENT OF
ENERGY

Understanding the human-machine interface is essential to increase safety, quality, and overall efficiency while decreasing risk and potential for error.

Many industries need performance oversight, tools, and techniques to identify and reduce the potential for human error. Understanding factors that shape performance can ultimately increase safety, quality, and overall efficiency while decreasing risk and potential for error.

With nearly three decades of experience delivering human-centered metrics, methodologies, and products, Pacific Northwest National Laboratory (PNNL) has a demonstrated history of advancing human factor strategies at the organizational, system, and individual levels. Our multidisciplinary expertise spans social, behavioral, and computational science, engineering, and analysis in nearly every domain necessary within human factors. Our experts address the nation's energy, national security, and environmental challenges where humans play a vital and impactful role now and into the future.

Rich Expertise, Advanced and Innovative Methods

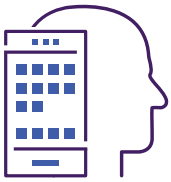
Our work incorporates tools, solutions, and strategies to meet the needs of project sponsors, with the goal of empowering individuals to take full advantage of the benefits of automation to optimize mission completion.

- Cognitive systems engineering
- Human reliability analysis
- Interactive visual analysis
- Automated and decision analysis to improve performance
- Enhanced human–machine interaction and teaming
- Computational modeling of complex social and organizational behavior
- Human performance assessment

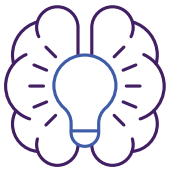
Proven Solutions and Core Capabilities

Human Performance Reliability Modeling and Analysis: Better understanding and improving human reliability in complex systems having machine–human interfaces. Our team includes the ideal partnership of experts in mathematical modeling, human factors analysis, and engineering. We have over 30 years of applied experience in human reliability analysis and probabilistic risk assessment modeling of nuclear power plants that supports the U.S. Nuclear Regulatory Commission in nuclear reactor research and licensing.

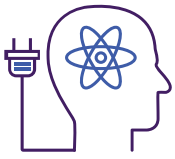
Human–Machine Teaming: Development of a new generation of smarter machines to support the human as a teammate. These cutting-edge machines can capture knowledge from interacting with expert users. They can learn and adapt to the human teammate's work patterns and provide explanations for the human's behavior, when needed, to help foster trust.



Cognitive Modeling: Advancing adaptive systems that integrate cognitive models with machine intelligence. One goal is to translate human thinking—conscious and unconscious— into a mathematical model that can be used by an artificial teammate for a variety of tasks. PNNL's Human Performance Assessment and Modeling Laboratory offers a dedicated facility for conducting cognitive modeling assessments.



Fitness for Duty: Bringing current scientific evidence to bear on understanding emerging issues affecting human operators' fitness for duties and informing policy making, including workplace drug and alcohol testing, worker impairment, substance use and abuse, worker fatigue management, and fitness for duty program performance assessment. PNNL develops and provides training to domestic and international regulatory inspectors related to access authorization requirements, fitness for duty, and fatigue.



Human Learning and Training: Systematic evaluation of the human factors influencing performance of complex technical tasks, identification of highest-priority human factors with the greatest performance impact, and development of targeted training to enhance human reliability and inform industry best practices.

Clients

U.S. Nuclear Regulatory Commission

U.S. Department of Energy National Nuclear Security Administration (NNSA)

U.S. Department of Defense

Environmental Factors: Assessing Impact of the Environment on Operator Performance

Environmental factors, such as those accompanying flooding events at nuclear power plants, can affect operator performance. PNNL offers a framework to assess the impacts of environmental factors on plant operator performance of flood protection and mitigation actions outside the control room. This work also includes estimating task performance times, which can be affected by cognitive loads, time pressures, rare scenarios, and environmental factors.

Human–Machine Teaming: Machine Analytic Assistant

Teammate is a research and design effort to build a machine analytic assistant that functions more like a teammate than a tool. This work provides guidance for human–machine teaming in an analytic environment. The iterative research and design effort is informed by PNNL's heuristics for machine teammate design and human subjects research.

Cognitive Modeling: Cognitive Depletion

Continuous decision-making over extended time periods leads to mental fatigue. This increases impulsiveness and errors, slows evaluation of new information, and decreases memory retention. We use cognitive models to create adaptive systems that can extend peak performance. The models predict the state of the users and recommend when they should take a break or increase the use of automated systems to avoid performance degradation.

Power Grid: New Digital Tech Tools to Support Operations

The evolving power grid infrastructure is changing the functional roles of power grid engineers and operators and requires that the tools used by control room personnel accommodate new data sources and operator workflows. PNNL is developing new machine learning tools to aid operators and engineers and the methodologies to understand human factors surrounding use, reliance, and adoption of these tools. Through human factors studies with utilities staff, PNNL is gaining a complete view of what tools are useful and how those tools will affect operator workflows.

Human Learning and Training: Human Factors in Nondestructive Examination

Nondestructive examination is an important method for inspecting the conditions of systems, structures, and components that are important to safety and reliability. The PNNL team, with its experience in nondestructive evaluation and human factors, conducted a multi-phase evaluation of the human factors that affect performance of nondestructive examination in nuclear power plants. Through task analysis and manual conventional ultrasonic testing, the team developed a model of functions, tasks, and subtasks characterizing manual ultrasonic testing. Interviews and focus groups offered operating experience insight to illustrate potential errors, precipitating factors, and consequences within the manual ultrasonic examination process.

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