FRAMEWORK ASSESSING NOTORIOUS CONTRIBUTING INFLUENCES FOR ERROR (FRANCIE): LOOKING TOWARD THE FUTURE

L.N. Haney
Idaho National Engineering and Environmental Laboratory (INEEL)

FRANCIE is a framework and methodology for the systematic analysis, characterization, and prediction of human performance and human errors. It was developed (for analysis of airline maintenance tasks) in a prior NASA Advanced Concepts Project by Idaho National Engineering & Environmental Laboratory (INEEL), NASA Ames Research Center, Boeing, and America West Airlines, with input from United Airlines and Idaho State University. The development method included ensuring that the approach addresses issues identified by project partners as important for future human error analysis. In the current Advanced Human Support Technology Project, FRANCIE was refined for analysis of ground based maintenance and assembly activities for spacecraft and launch vehicles, and then for activities performed in microgravity with focus on extra vehicular activities (EVA). INEEL, NASA Ames Research Center, University at Buffalo/State University of New York, and Idaho State University are participating in the current project, with project administration and support by Johnson Space Center. The framework is formed by a hierarchy of elements useful for the analysis of human errors. The core of the framework is formed by a hierarchy of Error Types, Generic Errors, and associated contributing influences to those errors called Performance Shaping Factors (PSFs). Each Generic Error is associated with a specific set of PSFs identified as important for that Generic Error. The PSFs are organized into eight General PSF categories: 1) Procedures, 2) Design, 3) Tools/Equipment, 4) Personnel, 5) Environment, 6) Organizational, 7) Work Group, and 8) Task Related. Human Factors-Based Countermeasures that support development of error reduction strategies are attached to each Specific PSF at the bottom of the framework. Human factors and domain subject matter expertise is captured in the content and structure of the framework, and in the linkages between items. Human error analyst expertise is captured in the way the framework is used, in linkages to error reduction strategies, and attachment sites for cognitive models, psychometrics, and ergonomic measures.

To perform human error analysis, items in the framework are selected and assembled by the user into a model of human performance for a specific activity. The analysis develops the logic of an error event tree to support easy visualization of the structure of a task including recovery actions, error chains, and error influencing dependencies. The modeling approach supports accurate depiction of the interactions of multiple individuals, including relevant support activities. A primary focus of FRANCIE is analysis of tasks to identify potential errors (or characterize observed errors), to identify and characterize the associated contributing influences to the errors, provide a level of prioritization, and to facilitate determination of appropriate countermeasures to reduce the occurrence and impact of the errors. User guidance includes procedure guides for task experts, procedure writers, incident investigators, designers, and error analysts with a supporting detailed written procedure, example analysis, and error event tree tutorial. A software application

is available that supports performance and documentation of analyses. FRANCIE is designed for use throughout system life cycle and contains a subset of PSFs identified as important for consideration during the design phase. FRANCIE is designed to expand to other domains of human activity (e.g. medicine, process control, transportation industries, etc.) through taxonomy refinement and development. The structure of the framework and the procedures for applying the framework (for human performance/error analyses) remain the same across domains. Expansion to other domains can be accomplished through actual use of the framework for performing analyses, or through sponsored efforts such as the current project. Expansion to other domains through actual use is demonstrated by application of FRANCIE for an aviation operations scenario for a new precision landing aid during Federal Aviation Administration certification of the new system.

A typical use of FRANCIE in support of space missions would include analysis of known scheduled or contingency tasks prior to a mission, as well as preview of tasks planned in response to unexpected occurrences (when time allows) prior to task performance. Many possible uses of FRANCIE have been suggested to support space missions in the near and distant future. FRANCIE is designed to mature and expand for future applications. Possible expanded use could include task tracking (e.g. during response to emergencies) in order to provide real-time warnings or cautions. A NASA EVA subject matter expert suggested that FRANCIE analyses could be useful during training and practice. Models of EVA tasks could be used to help familiarize task performers with planned tasks in terms of critical steps, important PSFs, and possible recovery actions. These models can incorporate lessons learned from prior similar tasks. The models can be updated and refined based on performance issues identified during pre-mission practice sessions. During NASA facilitated interactions with other Space Human Factors Engineering principal investigators and NASA human factors staff it has been suggested that FRANCIE could be implemented in an artificial intelligence application in conjunction with a neural net or holographic memory. Such implementation might allow the application to "learn" based on the input of new analyses and data to provide suggestions about possible new or previously unnoticed linkages between task contextual variables and human performance. A concept for 3D data visualization of the framework structure, content, and task models has been developed. Such a format would be useful in a collaborative design/analysis environment for interactive use by multi-disciplinary multi-geographical teams. Training modules included on long duration missions could allow selected crew members to become experts in the performance of FRANCIE analyses during the mission.

The PSFs currently in the framework address specific Critical Questions associated with the Human Performance and Behavior Risks identified in the NASA Critical Path Roadmap. Framework structure and organization supports logical refinements to more completely address these Risks. Future use and sharing of information between domains will facilitate further maturation of the framework. Because FRANCIE is compatible with other methods, and contains logical attachment points for cognitive models, psychometrics, and ergonomic measures, it will help organize and structure scientific

knowledge about human performance and error into a practical and easy to apply framework, as it is used in the future.