

## **Development of Human System Integration at NASA**

Human Systems Integration seeks to design systems around the capabilities and limitations of the humans which use and interact with the system, ensuring greater efficiency of use, reduced error rates, and less rework in the design, manufacturing and operational deployment of hardware and software. One of the primary goals of HSI is to get the human factors practitioner involved early in the design process. In doing so, the aim is to reduce future budget costs and resources in redesign and training. By the preliminary design phase of a project nearly 80% of the total cost of the project is locked in. Potential design changes recommended by evaluations past this point will have little effect due to lack of funding or a huge cost in terms of resources to make changes.

Three key concepts define an effective HSI program. First, systems are comprised of hardware, software, and the human, all of which operate within an environment. Too often, engineers and developers fail to consider the human capacity or requirements as part of the system. This leads to poor task allocation within the system. To promote ideal task allocation, it is critical that the human element be considered early in system development. Poor design, or designs that do not adequately consider the human component, could negatively affect physical or mental performance, as well as, social behavior.

Second, successful HSI depends upon integration and collaboration of all the domains that represent acquisition efforts. Too often, these domains exist as independent disciplines due to the location of expertise within the service structure. Proper implementation of HSI through participation would help to integrate these domains and disciplines to leverage and apply their interdependencies to attain an optimal design. Via this process domain interests can be integrated to perform effective HSI through trade-offs and collaboration. This provides a common basis upon which to make knowledgeable decisions.

Finally, HSI must be considered early in the requirements development phase of system design and acquisition. This will provide the best opportunity to maximize return on investment (ROI) and system performance. HSI requirements must be developed in conjunction with capability-based requirements generation through functional. HSI requirements will drive HSI metrics and embed HSI issues within the system design. After a system is designed, implementation of HSI oversights can be very expensive.

An HSI program should be included as an integral part of a total system approach to vehicle and habitat development. This would include, but not limited to, workstation design, D&C development, volumetric analysis, training, operations, and human-robotic interaction. HSI is a necessary process for Human Space Flight programs to meet the Agency Human-System standards and thus mitigate human risks to acceptable levels.

NASA has been involved in HSI planning, procedures development, process, and implementation for many years, and has been building several internal and publically accessible products to facilitate HSI's inclusion in the NASA Systems Engineering Lifecycle. Some of these products include: NASA STD 3001 Volumes 1 and 2, Human Integration Design Handbook, NASA HSI Implementation Plan, NASA HSI Implementation Plan Templates, NASA HSI Implementation Handbook, and a 2-hour short course on HSI delivered as part of the NASA Space and Life Sciences Directorate Academy. These products have been created leveraging industry best practices and lessons learned from other Federal Government agencies.