Human-System Integration Scorecard Update to VB.Net

Blaze D. Sanders[1]
NASA, Johnson Space Center, Houston, TX, 77058

Mentor:
Mihriban Whitmore Ph.D., Johnson Space Center, Habitability and Human Factors Branch

Abstract

The purpose of this project was to create Human-System Integration (HSI) scorecard software, which could be utilized to validate that human factors have been considered early in hardware/system specifications and design. The HSI scorecard is partially based upon the revised Human Rating Requirements (HRR) intended for NASA's Constellation program. This software scorecard will allow for quick appraisal of HSI factors, by using visual aids to highlight low and rapidly changing scores. This project consisted of creating a user-friendly Visual Basic program that could be easily distributed and updated, to and by fellow colleagues. Updating the Microsoft Word version of the HSI scorecard to a computer application will allow for the addition of useful features, improved easy of use, and decreased completion time for user. One significant addition is the ability to create Microsoft Excel graphs automatically from scorecard data, to allow for clear presentation of problematic areas. The purpose of this paper is to describe the rational and benefits of creating the HSI scorecard software, the problems and goals of project, and future work that could be done.

[1] NASA Intern, Habitability and Human Factors Branch, Johnson Space Center, Johns Hopkins University.

I. Introduction

The first step in converting the Microsoft Word version of the HSI scorecard into computer software was choosing a programming language. C++, Java, and Visual Basic.Net (VB.Net) were considered. C++ program execution may have possibly been faster; however, development time would have been much longer. Java benefits include the ability to easily distribute program across many computer platforms and a shorter development time than C++. Conversely, because the HSI scorecard was to have an intricate graphical user interface (GUI) Java was not chosen. Ultimately Visual Basic.Net was chosen because of the following reasons: *One*, it can be distributed to any Windows computer where during installation process the .NET Common Language Runtime engine can be automatically installed from the web. And with the Mono Project framework, multi-platform distribution capability will be comparable to Java. *Two*, the Microsoft integrated development environment (IDE), is inherently designed to create complex GUI's with relative ease. Thus greatly decreasing development time. *Three*, with Visual Basic.Net being produced by Microsoft, automation and communication between programs such as Word and Excel with HSI scorecard software was straightforward, and used object oriented programming methods. *And Four*, The simplicity of the VB.Net programming language should allow many members of the Habitability and Human Factors branch at NASA to effectively update, maintain, distribute, and make suggestions about code.

The overall coding process was fairly straight forward and many new coding techniques pertinent to VB.Net were utilized. Techniques such as XML documentation, multi-control event handling sub procedures, and Window CE Registry control. XML documentation of code will permit future programmers to better debug and maintain the code, by producing a professional structured documentation library. Multi-control event handling sub procedures allow for quicker code execution and more concise code. This in turn will make debugging and maintaining code easier too. Windows CE Registry control enables sections of a finite state machine to be stored, even when program is terminated or computer turned off. This ability will enable users to score/rate the system under analysis, quicker and with less effort. The end software product created this summer was a Beta version, which is developed sufficiently for user testing and reevaluation. Future work will involve creating a Menu system, improving data import capabilities, and enhancing user usability by creating shortcut keys for all functions.

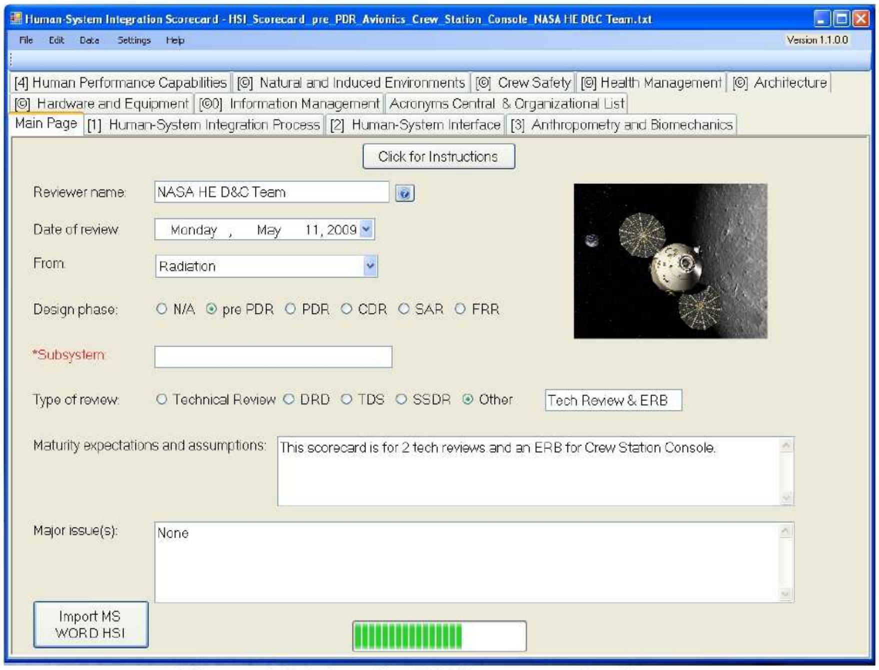
II. Goals and Purpose

The optimization of the human-machine system will be of great important as NASA continues its Exploration System Mission Directorate. The combination of human ingenuity and computer hardware speed and reliability is what enabled Apollo. Human factors should be on the mind of every human space flight engineer, yet that isn't always the case. As of today, incorporation of HSI practices are not formally mandated at NASA. The overall goal of this project was to improve interdisciplinary collaboration by designing a clearly defined, unified, and repeatable HSI process. The HSI scorecard can be used in baseline, preliminary and critical design reviews; allowing for tracking and assessment of specific systems and subsystems with respect to time in a consistent manner. The hope is that the HSI scorecard will benefit NASA by accelerating system design lifecycles and limiting modifications after system deployment, therefore reducing cost across the board. To do this a tool encompassing all segments of Human-System integration is needed. My role in this project was to convert the fantastic idea conceptualized by Dr. Mihriban Whitmore, Dr. Anikó Sándor, Debbie Berdich, Elkin Romero, Kritina Holden, and Kerry McGuire into software. Their Microsoft Word version was a great initial step; however, to fully exploit the increased productivity, decreased development cost, and increased collaboration triggered by a HSI tool a better deployment method was needed. With moderate updates to the Beta version of code, a fully functional HSI tool can be created in the very near future. What follows are the basic features and benefits of the HSI scorecard at this point in time (Aug 2, 09).

Main Tab:

- Red error labels are displayed if user forgets to enter data.
- Reviewer name, date, and from fields automatically fill in after user runs program once.
- Program instructions are accessible with one button click.
- When importing data from MS Word HSI scorecard progress bar is displayed.

All these features keep user informed of program status and ensure that scorecard data will be complete when review occur. Program also includes an adjustable auto-save feature which allows work to be automatically saved at user defined intervals.


Human-System Integration Scorecard - HSI_Scorecard_pre_PDR_Avionics_Crew_Station_Console_NASA HE D&C Team.txt

File
Edit
Data
Settings
Help
Version 1.1.0.0
[4] Human Performance Capabilities
[©] Natural and Induced Environments
[©] Crew Safety
[©] Health Management
[©] Architecture
[©] Hardware and Equipment
[©0] Information Management
Acronyms Central & Organizational List
Main Page
[1] Human-System Integration Process
[2] Human-System Interface
[3] Anthropometry and Biomechanics
Click for Instructions
Import MS WORD HSI

Reviewer name: NASA HE D&C Team

Date of review: Monday , May 11, 2009

From: Radiation

Design phase: ○ N/A ● pre PDR ○ PDR ○ CDR ○ SAR ○ FRR

*Subsystem:

Type of review: ○ Technical Review ○ DRD ○ TDS ○ SSDR ● Other Tech Review & ERB

Maturity expectations and assumptions: This scorecard is for 2 tech reviews and an ERB for Crew Station Console.

Major issue(s): None

Figure 1. Main tab of HSI scorecard software.

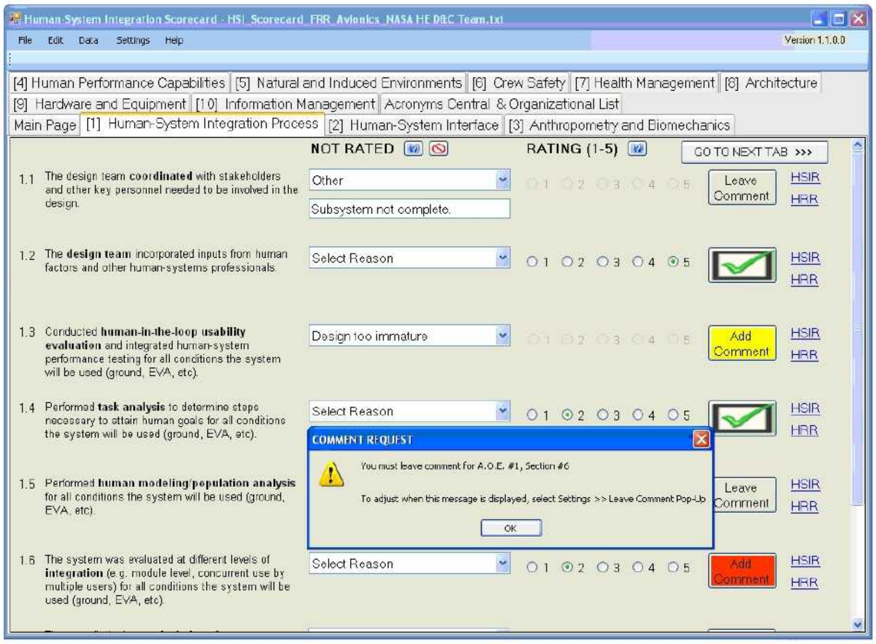
Question Tabs: (Tabs #1 thru #10):

- Status of question rating & comment completion is visually displayed on buttons to remind user of information entered. (See figure 2.)

Button Visual	Meaning
Gray background	Question hasn't been rated or received rating above two with no user comment left.
Red background	Informs user that question received rating of 2 or less and needs commenting.
Yellow background	User changed a rated question to "Not Rated", and didn't update comment. Or user clicked "Leave Comment" button and left no comment.
Green Checkmark	Rating and commenting of question is complete.

Table 1. Leave Comment Button State

- Entire tab can be Not Rated with single click of button, decreasing completion time.
- User can’t move to next tab until all “Leave Comment” buttons are green or gray.


Human-System Integration Scorecard - HSI_Scorecard_FRR_Avionics_NASA HE D&C Team.txt
File
Edit
Data
Settings
Help
Version 1.1.0.0
[4] Human Performance Capabilities
[5] Natural and Induced Environments
[6] Crew Safety
[7] Health Management
[8] Architecture
[9] Hardware and Equipment
[10] Information Management
Acronyms Central & Organizational List
Main Page
[1] Human-System Integration Process
[2] Human-System Interface
[3] Anthropometry and Biomechanics
NOT RATED
RATING (1-5)
GO TO NEXT TAB >>>
Leave Comment
Add Comment
HSIR
HRR
OK

		NOT RATED	RATING (1-5)
1.1	The design team **coordinated** with stakeholders and other key personnel needed to be involved in the design.	Other Subsystem not complete.	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
1.2	The **design team** incorporated inputs from human factors and other human-systems professionals.	Select Reason	○ 1 ○ 2 ○ 3 ○ 4 ● 5
1.3	Conducted **human-in-the-loop usability evaluation** and integrated human-system performance testing for all conditions the system will be used (ground, EVA, etc).	Design too immature	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
1.4	Performed **task analysis** to determine steps necessary to attain human goals for all conditions the system will be used (ground, EVA, etc).	Select Reason	○ 1 ● 2 ○ 3 ○ 4 ○ 5
1.5	Performed **human modeling/population analysis** for all conditions the system will be used (ground, EVA, etc).		
1.6	The system was evaluated at different levels of **integration** (e.g. module level, concurrent use by multiple users) for all conditions the system will be used (ground, EVA, etc).	Select Reason	○ 1 ● 2 ○ 3 ○ 4 ○ 5

COMMENT REQUEST

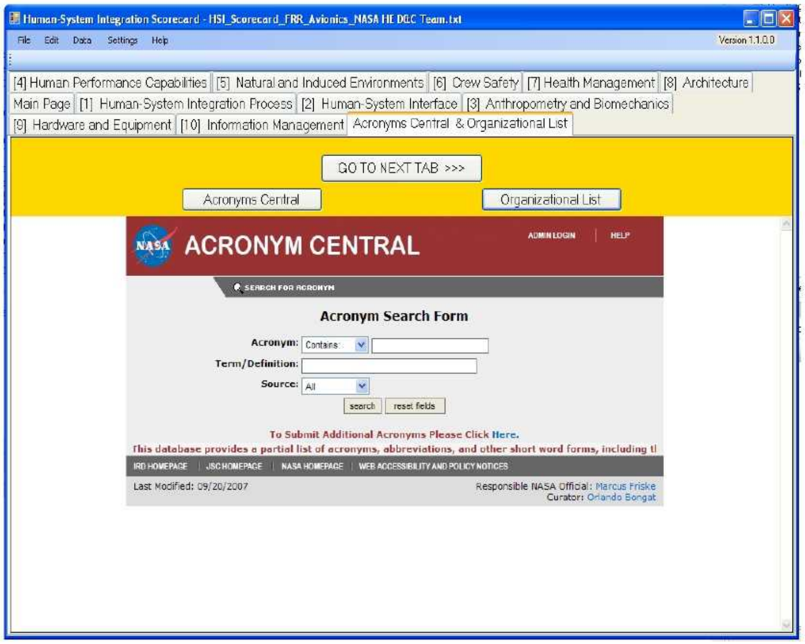
You must leave comment for A.O.E. #1, Section #6

To adjust when this message is displayed, select Settings >> Leave Comment Pop-Up

Figure 2. A question tab in HSI scorecard software.

Acronym and Organization List Tab:

- A simple web browser was inserted into the HSI scorecard to quickly view two important JSC websites; Acronym Central and JSC Organization List, without the need to open a full internet browser such as Mozilla Firefox, Internet Explorer, or Google Chrome.


Human-System Integration Scorecard - HSI_Scorecard_FRR_Avionics_NASA HE D&C Team.txt
File
Edit
Data
Settings
Help
Version 1.1.0.0
[4] Human Performance Capabilities
[5] Natural and Induced Environments
[6] Crew Safety
[7] Health Management
[8] Architecture
Main Page
[1] Human-System Integration Process
[2] Human-System Interface
[3] Anthropometry and Biomechanics
[9] Hardware and Equipment
[10] Information Management
Acronyms Central & Organizational List
GO TO NEXT TAB >>>
Acronyms Central
Organizational List
ADMIN LOGIN
HELP
SEARCH FOR ACRONYM
search
reset fields
IRD HOMEPAGE
JSC HOMEPAGE
NASA HOMEPAGE
WEB ACCESSIBILITY AND POLICY NOTICES

ACRONYM CENTRAL

Acronym Search Form

Acronym: Contains

Term/Definition:

Source: All

To Submit Additional Acronyms Please Click Here.

This database provides a partial list of acronyms, abbreviations, and other short word forms, including tl

Last Modified: 09/20/2007

Responsible NASA Official: Marcus Friske
Curator: Orlando Bongat

Figure 3. Tab Acronym and Organization List Tab HSI scorecard screenshot.

III. Impact of the MUST Internship on My Career Goals

The opportunity to work at Johnson Space Center and work on such an interesting and relevant project has no comparable metaphor. This summer has done nothing but strengthen my commitment to human exploration and reveal the multitude of ways an engineer can become involved in human space flight. Seeing the level of commitment, differing view points, and skills each JSC employee has intensified my wish to have multiple degrees in a variety of engineering and science fields. From computer science and chemical engineering to electrical engineering and geology. With extensive schooling and additional internship experiences I will understand an array of specific engineering details, and become a better JSC team member and thus a more competent Martian astronaut.

This paper can't do justice, the amount of new knowledge I have gained, but I will try. In a general knowledge sense I have discovered that one way human exploration of Mars solves much of the engineering challenges involved in such a trip. Imagine the exquisite spacecraft that could be built if the equipment used only for the return voyage didn't have to be transported around for 2 ½ years. Struggling through portions of this project allowed me to retain new engineering concepts much better, because challenges require thought, while memorizing knowledge at school is useful but has its limits in producing a useful engineer. From a computer science/engineering approach I can say that I have discovered many new tools and methods for approaching problems, and that computer programming outside of school is much less stressful and something that I really enjoy doing. I described some computer science insight I gained in the introduction; however, there is so much more that I have learned. From creating backups of source code both locally and on a server, to the hidden automation of Microsoft Word and Excel within a program using COM communication. I have learned to control operating system variables such as time, date, kill process events, form control events, and useable workspace pixel resolution. I understand how to add spell check, timer, and web browser capabilities to the programs I write. Yet the most important thing I learned this summer was the idea of modular code design. As I begin to work on bigger and bigger software projects being able to easily and efficiently interconnect different fragments of code will be vital. My mentor Dr. Whitmore did a fantastic job this summer. She clearly defined the problem at beginning of internship and gave encouraging pressure when necessary. She encouraged me to attend as many presentations, team meetings, and lectures as possible. And to volunteer at the High School Aerospace Scholars program at JSC. Dr. Whitmore introduced me to other agency wide NASA employees, where I gain insightful knowledge through one-on-one communication. Computer programming is something that requires little guidance and Dr. Whitmore did a good job leaving me to work independently. Nonetheless I *always* had engaging, interesting work to perform. I never felt like the intern of the office. I'm incredibly thankful for the opportunity M.U.S.T has given me, and I hope this program continues far into the future. Hopefully one day a Martian M.U.S.T staff member will be encouraging and inspiring students to explore the moons of Jupiter and Saturn.

Acknowledgments

I would like to thank John Pace who was a great source of quick and relevant programming information, along with Anikó Sándor and Kerry McGuire who gave critical suggestions about usability of HSI software.

References

Whitmore, M., Sandor A., McGuire K., Berdich D. (2009). *Tools for Human-Systems Integration Assessment: HSI Scorecard.* Johnson Space Center Houston, TX.

Liberty, Jesse. *Programming Visual Basic.NET*. 2nd. Sebastopol, CA USA: O'Reilly & Associates. 2003.

Foxall, James. Sams teach yourself Visual Basic 2008 in 24 hours: Complete Starter Kit. Indianapolis, IN. Sams. 2008.