Field Exam Question for Humans in Aerospace Part I January 2008

Human Factors Question: This is a spacecraft docking problem requiring manual control, loop closures and displays, and workload measurements:

Start with a simple case where your spacecraft is automatically lined up for straight-in docking with a space station and you have to manually drive into the docking port for a gentle contact. You have control over the thrust level (T) of a single rocket, and you can see only the distance from the contact point (d) as measured by a laser rangefinder.

1. Draw a block diagram of this situation

2. What is the transfer function of the controlled element?

3. What is the approximate transfer function of the operator? (Form and parameters).

4. What would be the advantage of adding another state variable – and what would be your choice for that variable?

5. If the rate of change of **d** (v) were available how would you display it as a quickened display?

6. How about as a predictor display?

7. If you now permit an automatic system to close and intermediate feedback loop, what loop do you close and how does this change the operator's task and transfer function?

8. Now suggest how to estimate the operator's workload in both situations (with and without an automatic loop closure) using each of the following three techniques:

   A. Subjective assessment
   B. Side task
   C. Physiological

9. For the side task measure, what statistical test would you apply to test the null hypothesis that the automatic loop closure task is no easier than the original, unaugmented, task?

Field Exam Question for Humans in Aerospace Part II January 2008
Space Biomedical Engineering Field Exam Question January 2008

1. (40% of Part II) Describe the skeletal physiological adaptive changes when exposed to long-term microgravity during human spaceflight. Include background, current scientific hypotheses, results, similarities/differences to aging, and comparisons to 1G)?

> **Note: illustrations, sketches, or models are encouraged for all answers in this Part II exam.**

2. (30% of Part II) During spaceflight, muscle atrophy of 30% and muscle strength loss of up to 40% have been measured. Please provide a description (narrative) with accompanying illustrations (when appropriate) of the following muscle mechanics and physiology (A-C below) and then comment on the specific nature of muscular deconditioning during spaceflight.

- **A. the size principle;**
- **B. illustrate $\alpha-\gamma$ coactivation (use a sketch with labels and some narrative);**
- **C. describe how muscle fiber types might adapt in long-duration spaceflight;**

3. (30% of Part II) Realizing the unified physiology of the musculoskeletal system, comment and/or illustrate how your answers for questions 1 and 2 above interact in a systems sense; and discuss possible spaceflight countermeasures for long-duration spaceflight.

Field Exam Question for Humans in Aerospace Part II **January 2008**
Human Supervisory Control Field Exam Question

In the Air Traffic Control (ATC) domain, currently planes flying transatlantic routes are not under positive radar control. As a consequence, controllers use non-radar procedures, which require that they do time/distance estimates with occasional updates from the planes about their estimated positions.

1. How and why could you implement and automated decision support tool to aid controllers in this task? Specifically discuss the advantages and disadvantages of automation, how much automation should be used, and what specific information processing elements the automation supports.

2. Discuss the human system engineering approach for the development of this decision support system. Be specific about what each stage entails and the methodologies/tools available for use in each stage.