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"The Proposed Project's Objective is to Investigate Systems Engineering Research Topics using Rotocraft Simulators While Introducing an Undergraduate Student to All Aspects of Multidisciplinary (Systems Engineering, Aerospace System, Gaming, Simulation) University Research"

Bryan Mesmer
University of Alabama in Huntsville

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Faculty Research Mentor

Dr. Bryan Mesmer

Assistant Professor

College of Engineering, Industrial and Systems Engineering and Engineering Management
256-824-5620

Bryan.Mesmer@UAH.edu

Technology Hall N135

Project Summary

The proposed project's objective is to investigate systems engineering research topics using rotorcraft simulators while introducing an undergraduate student to all aspects of multidisciplinary (systems engineering, aerospace systems, gaming, simulation) university research. The rotorcraft simulators at UAH are the result of a collaboration between ISEEM, CMSA, and the Rotorcraft Systems Engineering and Simulation Center. A single-man simulator will soon be operational for research and a multi-man simulator is currently being developed. The simulators are designed to immerse the occupant in the rotorcraft environment, enabling studies on human behavior in extreme environments without danger to the user.

The primary research topic of the project will focus on the end-users of the rotorcraft system, a highly stochastic but highly influential input variable in performance models of rotorcrafts. A better understanding of the end-users will enable higher fidelity system models that in turn will enable improved rotorcraft design decisions throughout the system design process (conceptual, preliminary, and detailed design). In essence, an understanding of the decision processes of people interacting with the system will make the designing of the rotorcraft simpler, and it will allow the designer to make better products.

The research using the simulators focus on the behaviors of the end-users due to their decisions. The mathematically rigorous theories that form the basis for normative Decision Analysis will be used to define and investigate the decisions that lead to the end-users' behaviors. Utility Theory is used in Decision Analysis as a guide to assist an individual in selecting an action from a set of alternatives in the presence of uncertainty, using preferences, alternatives, and beliefs. Bayes Theorem provides a mathematical basis to update an individual's beliefs when new information is acquired. Game Theory is a method of Decision Analysis to examine scenarios where more than one individual is making a decision, and one or more of the individuals may make a decision that impacts the other individual(s) decisions. Mechanism Design explores how to construct the rules of a game to achieve a desired outcome, preferred by the designer. These theories will guide the researcher in developing studies that are founded in mathematically sound principles.

The following is a sampling of possible research topics that the RCEU can participate in related to the rotorcraft simulators and human decision modeling:

- Metrics on user interactions with rotorcraft systems
- Evaluation of different control mechanisms in rotorcraft simulators
- Eye tracking of rotorcraft simulator users
- Head tracking of rotorcraft simulator users
- Non-traditional user control mechanisms
- Non-traditional communication paths in rotorcraft systems

The above topics are a sampling of research topics that may be investigated by the RCEU participant. Students (including RCEU participants) will be encouraged to pursue new, creative

ideas related to rotorcraft simulators and end-user behaviors as they are revealed. In this sense, the rotorcraft simulator lab will be a dynamic environment, where multiple research paths will be pursued in parallel. RCEU participants will be encouraged to be flexible and multi-faceted researchers, able to incorporate knowledge from many different fields to perform systems level research.

Student Duties

During the 10-12 week work period, the RCEU participant will be introduced to the simulator, software, and primary mathematical principles that will form the foundation of the research. The student will then propose a research topic (that is a collaboration between the participant and the research mentor) to the research group involving simulator collaborators and ISEEM faculty and graduate students. The majority of the participant’s work period will involve performing research. Regular updates to the research group will be performed by the RCEU participant and involvement in weekly group meetings will be expected. The work period will conclude with a write-up of the research performed and a presentation to the research group. It is anticipated that the write-up will be the foundation of a future conference paper on the research topic or a conference paper itself.

Milestones / Week	1	2	3	4	5	6	7	8	9	10	11
Introduce Student to Sim and Soft											
Educate Student in Decision Analysis and Related Topics											
Student Proposes Research Topic											
Student Research Conducted											
Research Progress Presentation											
Write-up Results											
Final Presentation to Group											

The benefits of participating in the research project to the RCEU student are: involvement with vehicle simulators (a growing topic in industry and government); development and implementation of a research plan; education in various systems engineering and end-user modeling topics; learning presentation techniques and practicing in front of industry-experienced individuals; immersion in a research group examining aerospace science, gaming, system engineering and decision theory; and learning the process of writing a conference-ready manuscript. The specific disciplinary benefits of working on the rotorcraft simulator is partially dependent on the participant’s research interests. For example, a student preferring a software research topic will be exposed to such coding environments as Matlab, CPP, and VBA. Furthermore, a student with a research topic in non-traditional communication paths will receive a deeper understanding of mechanism design and psychological traits of end-users.

Mentor Supervision and Interaction

For this project the RCEU participant will be reporting to Dr. Bryan Mesmer. After an introductory period, the participant will be expected to give regular bi-weekly presentations to a research group on the project’s progress. A final presentation and write-up are expected from the participant at the end of the work period. Multiple meetings weekly will be held between the participant and Dr. Mesmer. The frequency of the meetings will be daily in the introductory period as the participant becomes familiar with the equipment and Dr. Mesmer educates the participant on the necessary discipline topics. The participant will be evaluated based on their contributions to the research group and the quality of their final report.