Systems Engineering Experience Accelerator
Accelerated Learning & Learning Assessment for Systems Engineering Education

Sponsor: DASD(SE)

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http://www.sercuarc.org/projects/system-engineering-experience-accelerator/
• A widening gap in industry between the need and the availability of systems engineering practitioners with the necessary experience to address these challenges

• Systems engineering educators are struggling to meet the growing educational demands for a workforce able to solve problems driven by accelerating technology, rapidly evolving needs, and increasing systems complexity
Increasing complexity, cumulative ambiguity, “lack of control”

Enterprise, Organizational, Governance (decentralized)

Network Intensive

Software Intensive

Electronic, isolated islands of Software

Mechanical and Electrical Elements

SERC Grand Challenge Research Areas: Enterprise Scale, Human Centered, supported by Technology based Tools

Classical Systems Engineering has this heritage. Much of the SE toolkit in use today has roots in such systems, and is best applicable to such systems
The Learning Experience

• An UAV acquisition program

• Learner assumes the role of lead program systems engineer

• Focused on developing the systems thinking, problem solving and recovery skills
### Phases of the XZ-5 UAV Experience

<table>
<thead>
<tr>
<th>Phase</th>
<th>Phase Activity Focus</th>
<th>Ending Event</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SEEA Introduction</td>
<td>Survey completion</td>
<td>The learner is introduced to the SEEA</td>
</tr>
<tr>
<td>1</td>
<td>Assignment to UAV Program</td>
<td>Submission of likely problems and actions</td>
<td>Introduction to the experience</td>
</tr>
<tr>
<td>2</td>
<td>System Pre-integration</td>
<td>Critical Design Review</td>
<td>Acts as LSE</td>
</tr>
<tr>
<td>3</td>
<td>System Integration</td>
<td>Flight Readiness Review</td>
<td>Acts as LSE</td>
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<tr>
<td>4</td>
<td>Flight Test</td>
<td>Production Readiness Review</td>
<td>Acts as LSE</td>
</tr>
<tr>
<td>5</td>
<td>Limited Production</td>
<td>Integrated System Review</td>
<td>Acts as LSE</td>
</tr>
<tr>
<td>6</td>
<td>End of Project</td>
<td>Success or Failure</td>
<td>Results are presented.</td>
</tr>
<tr>
<td>7</td>
<td>Reflection</td>
<td>End of experience</td>
<td>Receive information about their decisions and reflect on learning objectives.</td>
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Current Implementation of EA

Hosting on http://162.243.17.244
• The EA has been instrumented to record information as a learning laboratory.

• Research will be done to determine the requisite data that needs to be recorded and the EA will be updated accordingly.

• These data has been selected and will be collected from the EA:

  - Participant Identification:
    - Learner’s Name & demographic information
    - Team Name & other members
    - Instruction Name & Roles played in Experience

  - Experience Session Information:
    - Experience Name and Version
    - Date of Experience Start and End
    - login dates and duration of each session
    - Phases/cycles covered in each login session
    - Elapsed time & number of session per Phase/Cycle
    - Links to past experience information

  - Learner Experience Inputs & Actions:
    - Self-Assessment
    - Initial Recommendation Input
    - All subsequent Recommendation Inputs
    - Workflow sequence with each action recorded with a timestamp

  - Instructor Input
    - Feedback provided to Learners (dialog, email, etc.)
    - Recommendations accepted/rejected
    - Instructor’s observations

  - Simulation Output:
    - Last phase/cycle completed
    - Results of schedule, cost, range and quality
    - Final Status Charts
    - Final score

  - Reflection
    - Reflection feedback provided to the Learner
    - Learner’s reflection input
Pilot Use of the Learning Experience

• University of Alabama in Huntsville (UAH) used the SEEA during the 2016 and 2017 spring semester as a team project.

• UAH using the SEEA during the 2017 fall semester as an individual project

• AFIT using the SEEA during the 2017 fall semester as an optional individual final project


• Pilot Results
  — Performance data of the teams gathered and compared.
  — Performance measures include range, critical software defects, schedule, CDR artifact completion and budget overrun.
  — Students made different decisions resulting in a range of performances and different program results.
Range of the UAV is affected by weight, drag coefficient and thrust specific fuel consumption (TSFC).

There were early signs of a range problem caused by weight issues.

Team 2 performed very well with range, team 1, 5, 6 achieved the requirement.

Most of the teams reacted to the weight issues by reallocating the weight balance and adding more workforce to the airframe and propulsion team.
• Budget is an important measure to the success of the UAV program. Teams need to control the budget to be successful in the experience.

• Team 2 performed well in range, the recommendations they made caused significant budget overrun.

• All the successful teams managed the budget and had a budget overrun of less than 15 percent.
The XZ-5 UAV program has an original plan of 27 months between PDR and CDR. Any significant delay will potentially undermine the success of the program.

It is recommended by the experts that the schedule shall not be delayed over 20 while the delay within 10% of the period is considered good.

Team 3, 5, 6 and 7 managed the schedule well. Team 4 recommended to advance the CDR time by 5 months which resulted in incomplete work. Team 1 and 2 performed within acceptable range.

Teams that manages the schedule well are likely to pass CDR proceed with low risk.
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The CDR Readiness is affected by the staff mix, as well as the number of design and test plan reviews.

Includes STR, DDF, SDD, SLR, SSDV and VVSIL plans.

Team 1 and 6 did very well. While Team 2, 3 and 5 did ok.
- Software critical defects are affected by the mix of senior junior staff and the number of software reviews.

- It is recommended to have less than eight critical defects to pass CDR proceed with low risk.

- Team 1, 5, 6 and 7 kept the critical defects quite low, while Team 2 and Team 3 kept them within an acceptable range.
Pilot Results

From 2017 Spring UAH Individual Projects
Pilot Results

From 2017 Spring UAH Individual Projects
Pilot Results

From 2017 Spring UAH Individual Projects
• The use of Systems Engineering Experience Accelerator in the domain of Systems Engineering Education, its use for SE education and learning assessment.

• During the pilot application of the technology, data was gathered from students who participated the XZ-5 UAV learning experience.
Future Works

- Gathering performance data through pilot application with a number of systems engineering experts
- Calibrate the experience and scoring mechanism using data gathered from expert pilot usage
- Comparing students’ behavioral data and decision-making process with experts’
- Pilot applications with two separate runs of the SEEA before and after the learning, use the data gathered to assess the efficacy of the learning
- Improving the stability of the system using feedback
Acknowledgement

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Questions?

http://experience-accelerator.org
http://www.sercuarc.org/research/research-programs-and-projects/
se-experience-accelerator-task-16-125/