



# RT16 Experience Accelerator Progress and Future Plans

## SERC Sponsor Research Review

February 25, 2014

[www.sercuarc.org](http://www.sercuarc.org)

# Outline

- EA Overview
- Year end results
- Future work
- Demo



# Overview

# Hypothesis & Goals



***Hypothesis:*** *By using technology we can create a simulation that will put the learner in an experiential, emotional state and effectively compress time and greatly accelerate the learning of a systems engineer faster than would occur naturally on the job.*

**Goals:** To build insights and “wisdom” and hone decision making skills by:

- Creating a “safe”, but realistic environment for decision making where decisions have programmatic and technical consequences
- Exposing the participants to job-relevant scenarios and problems
- Providing rapid feedback by accelerating time and experiencing the downstream consequences of the decisions made

# SE Maturity

## Maturity in Systems Engineering requires:

- Viewing a program through the entire lifecycle
- Seeing the relationships between elements of the system, and the system developing the system
- Encountering the challenges faced in a complex system development
- Being able to navigate through the “gray” zone
- Creating mental templates which can be applied to similar future situations

# Learning Process

**Concrete Experience**  
(Experiencing)

Decision and Actions

Feedback on performance

Communication with team, and  
stakeholders

Profile building

After action reflection

**Active**  
**Experimentation**  
(Doing)

*Accelerated  
Development*

**Reflective**  
**Observation**  
(Reflecting)

Re-experiencing / testing of  
lessons learned

Synthesis of lessons learned

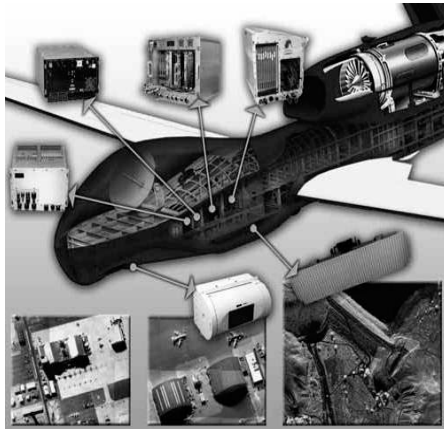
Developmental objective  
setting

**Abstract Conceptualization**  
(Theorizing)

# The Experience: A Day in the Life of a PSE

## UAV System:

- S0 – System
- S1 – Airframe and Propulsion
- S2 – Command and Control
- S3 – Ground Support



## UAV KPMs:

- Schedule
- Quality
- Range
- Cost

## Phases:

- EA Introduction
  - Phase 0: New Employee Orientation
- Experience Introduction
  - Phase 1: New Assignment Orientation
- Experience Body
  - Phase 2: Pre-integration system development -> CDR
  - Phase 3: Integration -> FRR
  - Phase 4: System Field Test -> PRR
  - Phase 5: Limited Production and Deployment
  - Phase 6: Experience End
- Experience Conclusion
  - Phase 7: Reflection
- Each session = 1 day

# Experience Accelerator Team

## Experience Design:

- Jon Wade, PI – Stevens
- Rich Turner, Stevens
- James Armstrong - Stevens
- Rick Abell – consultant
- John Griffin – consultant
- John McKeown – consultant

## Evaluation:

- Bill Watson, CoPI – Purdue
- Pete Dominick – Stevens (H1 Y2)
- Dick Reilly – Stevens (H1 Y2)
- Dana Ruggiero – Purdue (Y2)

## Technology & Tools:

- George Kamberov – Stevens
- Brent Cox – Stevens
- Hao Kang – Stevens (H2 Y3)
- Wang Yang – Stevens (Y2)
- Vinnie Simonetti – Stevens (H1 Y2)
- Yagiz Mungan – Purdue (H1 Y2)

## Simulation:

- Doug Bodner – Georgia Tech
- Anqi Zou – Georgia Tech (Y3)
- Arya Irani – GTRI (Y3)
- Subbu Ramanathan – Georgia Tech (Y2)
- Pradeep Jawahar – Georgia Tech (H1 Y2)
- Kyle Crawford – Georgia Tech (H1 Y2)





# Year End Results

# Major Increment 2 Research Activities

- **Pilot System Development:**
  - Refinement based on evaluation findings
  - Architecture, Design, Technology and Tools for Flexibility & eventual Open Source
- **Develop Multi-Learner Technology**
- **Pilot System Evaluation:**
  - Plan Update
  - Learner Identification
  - Prototype Evaluation
- **Open Source Preparation and Deployment:**
  - Prototype Completion
  - Migration, Open Source Hosting & Development, and Ticketing
  - Tool Development
  - Design Flow
  - Documentation
- **External Developers Engagement**
- **Final Report**

# Pilot System Development

- **Experience Design**

- User interface and status visibility
- Dialog enhancement
- Instructor interaction in class environments

- **Technology**

- Multi-learner Capabilities
- Dialog system
- Stability: replication of state, communication and network improvements

- **Simulation**

- Execution engine & charting improvements
- Simulation model enhancements
- Simulation chart syntax supporting new features
- New output charts

- **Tools**

- Chatmapper translator and integration
- System dynamics GUI model building tool
- Simulator XML syntax for charts and code that generates charts
- Templates for recommendation forms and emails


# Dashboard Status

KPPs and TPMs	Range	Drag Coeff.	Propul. Effcy.	APS Weight	CCS Weight	Total Weight
	5315.49 ↑	2.58 →	1226.66 ↑	7371.14 ↓	2548.88 ↓	9920.02 ↓
Contract Performance EVM (\$M)	Cur. Burn Rate	BAC (Phase2)	EAC (Phase2)	Difference	Result (End of Phase 2)	
	6.59	195.00	232.57	37.57	Overrun	19%
	Sched(SV)	Sched(SPI ratio)		Budget(CV)	Budget(CPI ratio)	
Overall	-9.52 ↑	0.95 ↑		-35.77 ↓	0.84 ↓	
UAventure (Prime)	0.02 ↓	1.00 ↓		-9.07 ↓	0.82 ↓	
AirGo (Airframe and Propulsion)	-3.63 ↑	0.91 ↑		-12.54 ↓	0.74 ↓	
FlyWire (Command and Control)	-5.83 ↑	0.94 ↑		-10.84 ↓	0.90 ↓	
Terra Firma (Ground System, Launch/Retrieval)	0.00 ↓	1.00 ↓		-3.45 ↓	0.81 ↓	
CDR Requirements (% complete)	Test Reqts	Digital Data Files	SW Dsgn Descs	Struct. Lds.	SS Dsgn&Ver	V&V of SIL
	98%	88%	93%	92%	99%	99%
FlyWire SW Quality (# of Defects)	Outstanding	Detection Rate	Removal Rate	Projected Time To Remove		
Critical Defects	0 →	0.3 def/mon ↓	0.3 def/mon ↓	0.0 Months →		
Non-critical Defects	8 →	11.0 def/mon ↑	11.0 def/mon ↑	0.7 Months ↓		

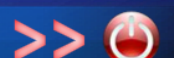
Red - beyond Threshold or > 15% worse than plan, Yellow - 10-15% worse than plan, Green - within 10% of plan  
 Change from last cycle: ↑-better →-same ↓-worse

### UAV Experience Status

- New User Orientation----- Complete
- New Experience Orientation----- Complete
- Pre-Integration System Development----- Active
- System Integration-----
- System Field Test-----
- Limited Production and Development-----
- Experience End-----
- Reflection-----



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# Recommendation Forms

client - Mozilla Firefox

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Search results - dr.jon.wade@gmail.c... x client x +

www.bcoxie.com/expacc/

tom mcdermott gtri

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### Recommendation Report Phase 2

This is a set of recommendations before the CDR.

Based on the program performance this past review period and the feedback that I have received, I have the following recommendations for the Airframe and Propulsion, and Command and Control systems as noted in the table below to achieve a high level of confidence in the program:

Airframe and Propulsion Subsystem				
Schedule	No Recommendation Required for Schedule: <input checked="" type="checkbox"/>			Schedule Confidence Level: I (red) M (yellow) H (green)
Parameter	Current Target	Current Value	Recommendation	Rationale/Comments
Staffing	60.0 Sr. Staff	60.5 Sr. Staff	Set new Sr. Staff Target: <input type="text"/>	
	60.0 Jr. Staff	59.6 Jr. Staff	Set new Jr. Staff Target: <input type="text"/>	
Capabilities	No Recommendation Required for Capability: <input checked="" type="checkbox"/>			Capability Confidence Level: I (red) M (yellow) H (green)
Parameter	Alloc. / Target	Current Value	Recommendation	Rationale/Comments
Weight Allocation (lbs)	7500.0	7184.7	Set new Weight Alloc.: <input type="text"/>	
Propulsion Efficiency (Specific Impulses/sec)	0.00	1223.8	Set new Propulsion Effcy: <input type="text"/>	
Aerodynamic Drag (Kn)	0.00	2.56	Set new Drag Target: <input type="text"/>	

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# Multi-Learner

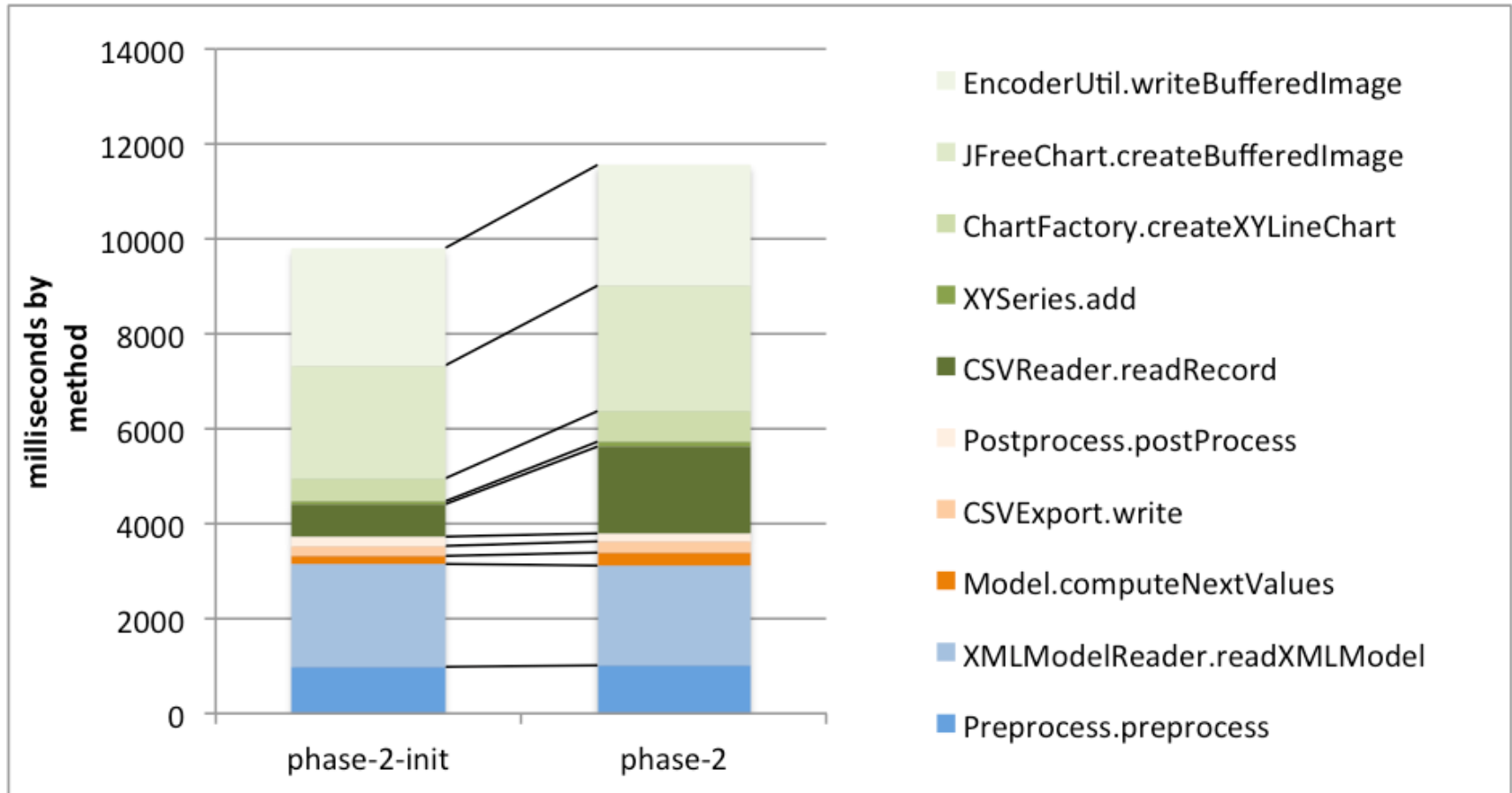
## Modes:

- Single Learner mode
- Single Learner with supervisor (PM & Mentor)
- Multiple Learner
- Multiple Learner with supervisor



Prototype multi-learner capabilities have been developed for the Experience Accelerator. The capabilities have been provided for multiple learners to create and join games asynchronously, share documents, communicate directly with one another, and make decisions that affect the outcome of the simulations.

# Performance Characterization



# Instructor Interaction

## Three specific ways of instructor interaction emerged:

- **Mentor** - This is the role that ended up being closest to the DAU traditional instructor role and was used in the pilot. It includes having the instructor watch over the student teams as they work. The instructor can provide guidance or answer questions, but is not directly involved in the scenario.
- **Passive Program Manager** - This is an extension of the Mentor role with an ability to accept or reject the recommendations by the team.
- **Active Program Manager** - This is the expected role for multi-player supported experiences. The instructor replaces the system NPC PM as an active player with the Program Manager's role. It is up to the instructor to receive and respond to the recommendations of the teams. Tools are provided that allow the instructor to view all of the experiences of the members of the team, communicate via chat, and accept or reject the team's recommendations.



# DAU Meetings & Milestones

Current Date	Description
Oct 16, 2012	Initial DAU Integration meeting
Mar 4, 2013	Logistics/Joint Competency Proposal meeting
Apr 15, 2013	EA Demo, DAU Integration meeting
Apr 23, 2013	DAU Integration meeting
May 5, 2013	DAU Integration meeting
Aug 13, 2013	DAU Instructor Familiarization meeting
Sep 4-5, 2013	DAU Instructor Pilot
Oct 15, 2013	DAU Pre-Student Pilot Review
Oct 29-30, 2013	DAU Student Pilot
Dec 31, 2013	Complete Final Report

# SYS302 Deployment Schedule

Time	Instructors	Students
<b>Tuesday</b>		
1400-1430	Introduce Exercise	Team formation, role clarification/alignment
1430-1530	Mentor and Support	Individuals complete EA Phase 0 and Phase 1
1530-1630	EA PM/Mentor/Control	Team completes Phase 2A Cycle 1
1630-1700	EA PM/Mentor/Control	Team completes Phase 2A Cycle 2
<b>Wednesday</b>		
0800-0830	EA PM/Mentor/Control	Team completes Phase 2A Cycle 3
0830-0900	EA PM/Mentor/Control	Team completes Phase 2A Cycle 4
0900-1000	Mentor and support	Presentation Development
1000-1100	View presentations & note items for reflection material	Teams deliver presentations
1100-1130	Monitor and support	Phase 2B (Receive & discuss CDR Results)
1130-1230	Lunch (develop reflection material?)	Lunch
1230-1315	Monitor and Support	Phase 3/Phase 4/Phase 5 speed through
1315-1430	Mentoring guidance	Individuals complete Phase 7 - Reflection
Homework	Review logged results after completion	Individuals replay experience

# Pilot System Evaluation

The instructor familiarization, instructor and student pilots:

- generated 140+ action items for EA enhancements,
- proved the need for stability and performance improvements,
- provided feedback affirming the potential of the EA with students in a classroom

# Targeted Lessons

- **Problem solving and recovery**
  - Identify weight and drag problems, remediate with TPM targets and allocation changes
  - Identify schedule problem, remediate with additional staff and a small schedule delay
  - Identify software quality problem, remediate with increased software design review frequency
- **Product integration**
  - All sub-systems need to be done at the same time ideally for integration to begin. Adding resources to airframe/propulsion (AP) and command/control (CC) sub-systems brings their schedule more in line with the other sub-system and the systems integrator, who are not having schedule issues.
  - The solution could be improved by not hiring as many AP senior staff and reducing staff for the systems integrator and ground station sub-contractor so that they meet their targets at the three-month delay, instead of the original CDR schedule. This is left as an exercise for the learner and/or instructor.
  - Transferring weight allocation from AP to CC illustrates the relationships between these two sub-systems and how a win-win can be achieved (or at least a win and no-loss).
- **Cutting corners to make short term goals while ignoring long term outcomes**
  - Make decisions early, even though they have negative cost implications initially. This is better than facing the bigger problems later on of schedule delays that make the cost overruns worse.

# Lessons Learned: Team 1

“What would we do differently?”

- Over correcting the Aerodynamic Drag target
  - The error was made during the 3rd and 4th cycles where another change was made to the drag target from 2.5 to 2.45, attempting to further optimize the range. During the 4th cycle no change was made to the drag target and thus we spent a lot more money on decreasing the drag and increasing the range when it was not necessary. This partially contributed to our cost overrun of 9%.
- Hire more staff early in the project to ensure there won't be a schedule slip to integration testing”

# Lessons Learned: Team 2

## “Conclusions

- Based on current trends, CDR readiness NOT likely - No progress goals have been met.
- Suspect that Cycle 1 changes were not dramatic enough, in enough areas

## What to do differently:

- More dramatic changes to staffing
- Leave weight targets as-is
- Identify changes more directly linked to C2 progress”

## “Lessons Learned

- Shift staffing earlier to improve quality/test
- Reduce FTE from better performing sub-systems
- Pay closer attention to CDR entry criteria”

# Lessons Learned: Team 4

## “Hindsight is 20/20

- Early software emphasis worked
- Focus on KPP early
- Maintain focus on CDR entrance criteria
- Airframe/Propulsion subsystem CPI suffered because we spent extra resources to maintain range KPP
- Our initial top 3 issues were not the main issues we encountered
- KPP was in good shape
- We got FIRED! Don't slip CDR!”



## “Lessons Learned

- Ramped up staff quicker
- Taken staff away from Ground Control to save money
- Raised weight limit prematurely
- Focused on drag coefficient earlier”

# Learning Results

These examples demonstrate that for two targeted learning outcomes in particular, nearly all of the teams learned the outcomes as they very clearly highlighted them in their presentations as the lessons they had learned. Other learning objectives were also highlighted by the different teams.

- These lessons were learned despite the fact that the learners only fully completed the first two phases of the experience before speeding through the remaining phases in order to see their results.
- Furthermore, the EA was designed to be played multiple times by learners, so these results are indicative of impressive learning gains given the limited implementation of the experience.



# Future Work

# Program Goals

**Program Goal:** *Transform the education of SE by creating a new paradigm capable of halving the time to mature a senior SE while providing the skills necessary to address emerging system's challenges.*

- 1. Successfully integrate EA into DAU course SYS30X*
- 2. Create additional EA experiences deployed at multiple sites*
- 3. Create sustaining open source development community*

# 1. Integrate EA into SYS30x

- EA System Capabilities
  - Completion and stabilization of multi-learner mode
  - Provide means of informing learner of impact of recommendations
  - Ensure that dialog is synchronized with recommendations
  - Improve learner interface with status charts to eliminate need to page through entire set
- Tools
  - Create set of tools that allow the DAU to customize and create new Experiences
- Deployment Deliverables
  - Define explicit EA deliverables to support DAU deployment
- Hosting Requirements
  - Specify technical details of hosting requirements

# Program Goals

2. *Create additional EA experiences deployed at multiple sites*
  - *Develop joint competency to fill out EA experience through the life-cycle*
  - *Develop 2-3 other experiences for different domains*
  - *Trial tools through these experience development efforts*
  
3. *Create sustaining open source development community*
  - *Develop tool suite using SERC core funding*
  - *Release EA technology, tools and experiences to open-source community*
  - *Create consortia to provide long-term support*

# EA Tools

#	Limitation	Solution
1	Complex simulation models with limited reuse supported	<b>Sim Builder</b> - Simulation model builder utilizing libraries/templates
2	Complex simulation outputs dependent on hundreds of variables/parameters	<b>Sim Tuner</b> - Parameter tuner that automates the tuning of parameters to yield desired outputs via batch processing of different combinations
3	Manual nature of phase and cycle development	<b>Phase Editor</b> - GUI-based tool for phase, cycle and event specification with code generation
4	Manual nature of specifying events and their triggers in the Experience	<b>Event Editor</b> - GUI or text-based tool to specify events and their triggers with code generation
5	Manual nature of artifact integration involving re-linking and recompilation	<b>Artifact Integrator</b> - Artifact entry application that allows designer to take an artifact file and enter it into EA application with automatic recompilation and re-linking
6	Manual nature of assessment of learner performance	<b>Learning Assessor</b> - Assessment tool-suite that provides automated performance scoring, decision comparisons against proven baselines, etc.

# Funding & Joint Research

- Extended Capabilities
  - DAU: Option Year 3, Pilot + Multi-Learner Technology Support
  - SERC: Content Creation Tools funding
- New Experiences
  - DAU: Logistics Experience, proposal submitted
  - ONR: Team experience, white paper submitted
  - NSF: Learning in Formal and Informal Settings, proposal submitted
  - NRO: Spacecraft experience, will pilot SEEA
  - MITRE: Team experience, discussions
  - LMC: Interest
  - SI Corporation: Proposal interest
  - Sponsored doctoral research: 2 Stevens students





## Experience Accelerator

Welcome Jon Wade

Your Experience Awaits You!

Option Menu  
(please select choice below):

- UAV Experience
- Multiplayer
- Profile Update
- Logout

## UAV Experience Status

New User Orientation-----	Complete
New Experience Orientation-----	Complete
Pre-Integration System Development---	Active
System Integration-----	
System Field Test-----	
Limited Production and Development---	
Experience End-----	
Reflection-----	

? Help

● Abort Experience

# Join the Experience Accelerator Team!

## Contact for information:

**Jon Wade**

**[jon.wade@stevens.edu](mailto:jon.wade@stevens.edu)**

**Bill Watson**

**[brwatson@purdue.edu](mailto:brwatson@purdue.edu)**

**Doug Bodner**

**[doug.bodner@gatech.edu](mailto:doug.bodner@gatech.edu)**

This material is based upon work supported, in whole or in part, by the Defense Acquisition University through the Systems Engineering Research Center (SERC). SERC is a federally funded University Affiliated Research Center (UARC) managed by Stevens Institute of Technology in partnership with University of Southern California.

# Thoughts?





# Backup Slides

# Dialogue Enhancements

Initial dialogues tended to be based on a single thread of actions on the part of the learner, and only varied slightly from cycle to cycle.

**Temporality** - To maintain the information flow to support the learner, dialogues were developed for each subcycle. This involved tracking the current subcycle status and providing different conversation tree branches based solely on the temporal subcycle. This allowed dialogues to be based on time-critical issues and to adjust if recommendations about delays were made. It also allowed insertion of challenges based on external events (such as unexpected changes to requirements, resources or schedules).

**Relevance** - The dialogues also needed to better track the information that was provided in the recommendations of the learner and the results they generated in the simulation. To support this, dialogue variables were provided for conditional branching in dialogues. This allowed the dialogue to change based on the recommendations and simulation results. The NPCs can now provide additional information based on the simulation as well as the story line. The dialogues can also now display subject values to the learner during the conversation. While not necessary because of the new dashboard and recommendations interfaces, being able to use values in the conversation adds to its verisimilitude.

## Simulation Tools:

- These two tools work interactively to allow the construction, test and tuning of systems dynamic models. Both the Sim Builder and Tuner tools have application outside of the Experience accelerator in the development of system simulation models, particularly those in systems dynamics.
- **Sim Builder** – This tool provides the ability for non-technical staff to build systems dynamics models based on existing templates in a GUI environment.
- **Sim Tuner** – This tune provides the ability to analyze the system, determine the sensitivity of various parameters, and aid in the tuning of the system to achieve desired behaviors.



# Tool Descriptions (cont.)

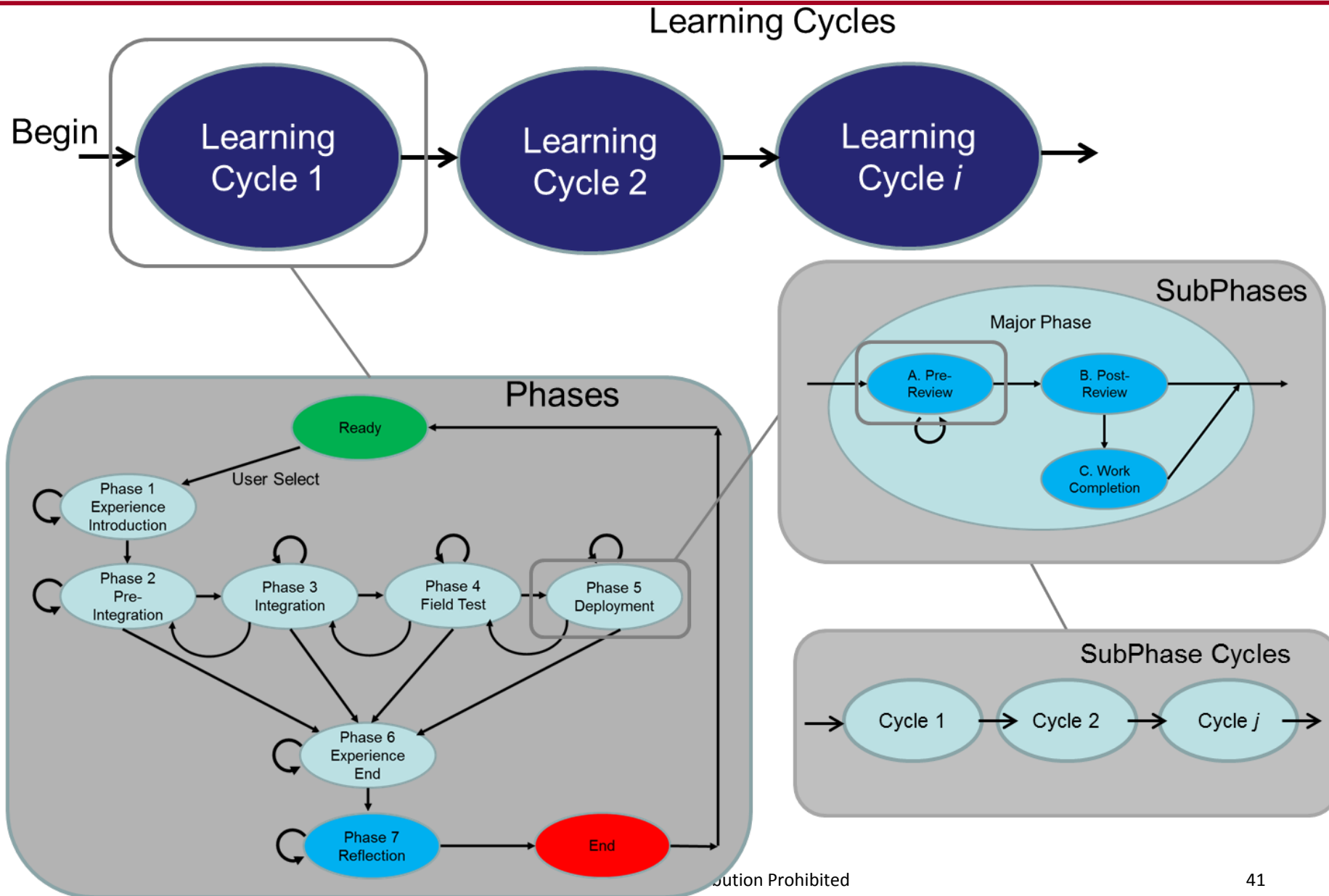
## Experience Building Tools:

These three tools are used together with Chatmapper to allow non-technical staff the ability to build and modify EA experiences without any programming. In most cases, this work will be accomplished through a GUI and a single workbench.

- **Phase Editor** – This tool provides the ability to change the finite state machine that changes the phases within an EA experience. For example, the project phases can be customized to new domains and environments and can be constructed to represent state changes that are not affiliated with formal project states.
- **Event Editor** – This tool provides the capability to create and edit events during an experience and the activities that may trigger them. For example, a phone call from the learner’s supervisor can be triggered based on a decision made by the learner or the state of the project.
- **Artifact Integrator** – This tool allows an experience builder the ability to quickly upload an experience change, be it a new artifact such as a new dialog or report, or a changed phase and or event, and test the results without having to do any programming.



# GUI Tool – Phase and Event Creator - Future



# Artifact Entry - Future

- Today:
  - Designer saves file in DropBox
  - Designer tells technical staff to load it into the design
  - File is moved to the correct location or handcoded
  - System is recompiled or linked
  - Designer is notified of the change
  - Designer tests changes
- Future:
  - Designer opens artifact entry client
  - Designer saves file into system sandbox
  - Designer tests changes

# Tool Descriptions (cont.)

## Learning Analysis Tools:

This tool has application outside of the Experience Accelerator and can be used as a tool for learning in a number of experiential environments.

- **Learning Assessor** – This tool will analyze the subject’s activities, decisions, project performance and self-assessments to determine the learning level achieved. This work will involve developing the logging ability to collect the necessary information, and an analysis tool for making the final predictions.

# EA Tool Year 1 Development

Phase	Simulation Tools	Experience Builder Tools	Learning Analysis Tools
<b>Specify</b>	3 months: a review of numerous existing tools will be required	1 month: basic concept already complete, needs to be reviewed by users	5 months: significant work is necessary in evaluating and advancing the state of the art
<b>Develop</b>	6 months: Complex simulation outputs dependent on hundreds of variables/parameters	8 months:	5+ months: This work will primarily consist of design work with some potential limited implementation. Implementation work will conclude in Phase 2 of this program.
<b>Evaluate</b>	1 month: Manual nature of phase and cycle development	1 month: The tool will be evaluated iteratively through its development culminating in this final evaluation	1 month: A final report will be written.

# EA Tool 3 Year Phasing

Time	Simulation Tools	Experience Builder Tools	Learning Analysis Tools	EA Infrastructure
<b>Year 1</b>	Develop prototype Sim Builder and Tuner tools	Develop prototype Phase and Event Editor, and Artifact Integrator tools	Research and create high level design of Learning Assessor tool	To be determined by need
<b>Year 2</b>	Refine Sim Builder and Tuner tools, make available open source. Determine new tools.	Refine Phase and Event Editor, and Artifact Integrator tools, make available open source. Determine new tools.	Develop prototype Learning Assessor tool	Develop plan for EA technology update, e.g., migration from FLASH to HTML5
<b>Year 3</b>	Develop new tools	Develop new tools	Refine Learning Assessor tool, make available open source	Update EA technology