A Constructivist Approach to Teaching Software Process

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Overview

- Why did we create the game?
  - Needed a more effective way of teaching software process models to undergraduate aerospace engineering students
  - Reflects our evolving research and teaching philosophy
- How we played the game
  - Context, Roles, Structure and Execution
- Lessons Learned

Teaching Software Process

- Lecture-based teaching of software processes is “dry”
  - “I have also found students glaze over on these topics” – Anonymous Reviewer

- Learning often **NOT** anchored in long term memory
  - Performance in concept questions compared to the final exam

Constructivism-based Game Design

- Seven Values
  - Collaboration
  - Active Engagement
  - Personal Relevance
  - Pluralism
  - Personal Autonomy
  - Generativity
  - Reflexivity

Multiple Stakeholders

Software Development as Problem Solving

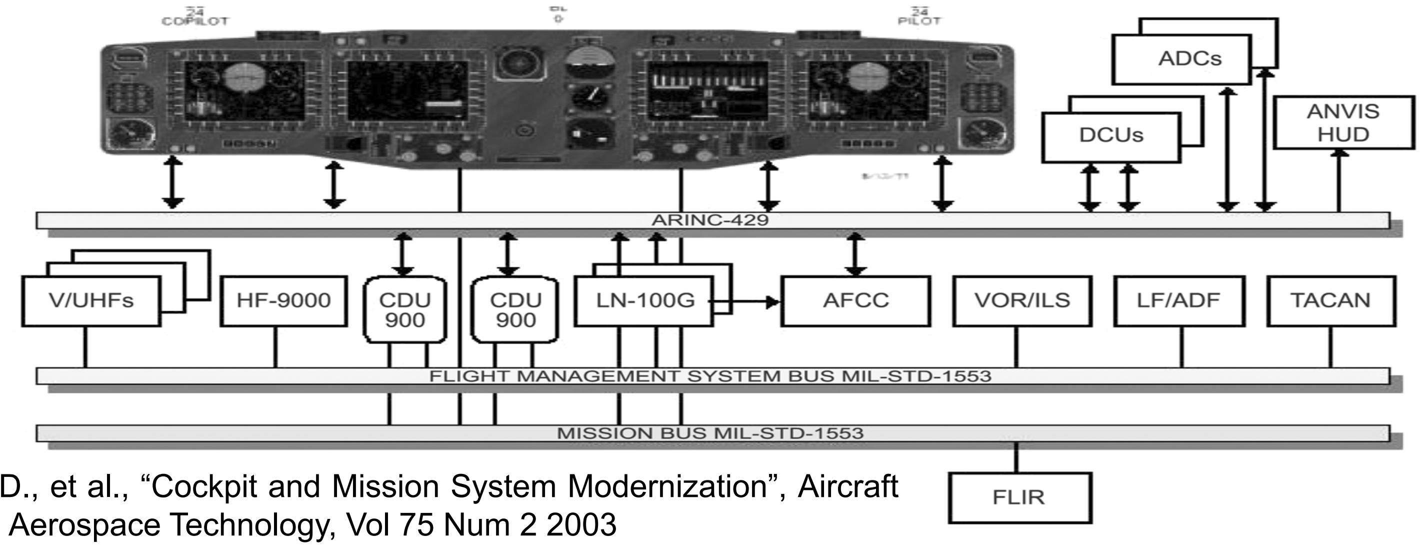
Game Design Philosophy

- Leveraged the 8 instructional principles created by Savery and Duffy

- Today's discussions focused on
  - Design an authentic task
  - Give learner ownership of the process used to develop a solution
  - Encourage the testing of ideas against alternative views and alternative contexts

Design an Authentic Task

S-70 Modernization Cockpit Architecture



Source: Anttila D., et al., “Cockpit and Mission System Modernization”, Aircraft Engineering and Aerospace Technology, Vol 75 Num 2 2003

Congratulations! Your team has been selected to upgrade the software for the glass cockpit of the Next_Generation-7 helicopter. The avionics system architecture for the helicopter exactly mirrors that of the S-70, as seen in the architecture diagram. A preliminary set of requirements have been generated by the technology feasibility study team, and will act as the starting point for your work. Given that our ***flight testing schedule has been moved forward, your delivery dates for software components have been moved up as well****. We have provided* ***additional funding to the program*** *to be dispensed at the discretion of the program manager.*

Game Roles

- Facilitator
  - Set up game
  - Active listening

- Requirements
  - Create a work package for downstream sub-teams

- Design
  - Refine work package

- Implementation
  - Eliminate all incorrect requirements

- Integration
  - Eliminate all ambiguous requirements

- Reserve
  - Manage reserve funds

Game Set up

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- Provide each team with instructions, stickers, set of timers and dice

- Create preliminary requirements set
  - Three incorrect requirements
  - Six ambiguous requirements
  - Six correct requirements

Requirement Sheet

Type **A**	**Requirement** ***FLIR connects directly to the HUD***	**Weight** **-10**
Category **Incorrect**		

Place Red/Yellow/Blue does in the box for the phase

Design

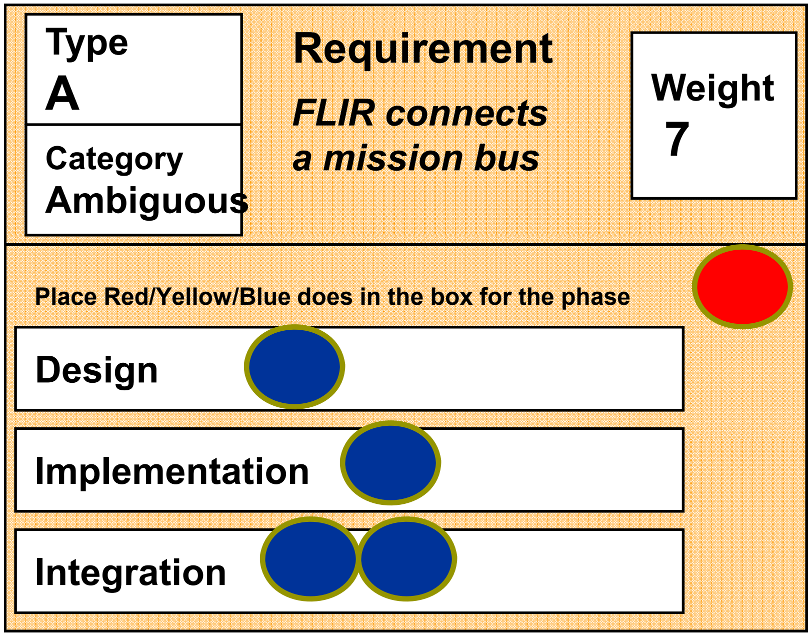
Implementation

Integration

Category	Type	Weight	Requirement
Incorrect	A	-10	1. The displays interface directly to the Arinc 629
Ambiguous	B	1	2.1. FLIR does not connect to the HUD

Exemplar Instruction

- Integration
  - Ensure there are no ambiguous requirements that have been implemented.



Type
A

Category
Ambiguous

Requirement

FLIR connects a mission bus

Weight
7

Place Red/Yellow/Blue does in the box for the phase

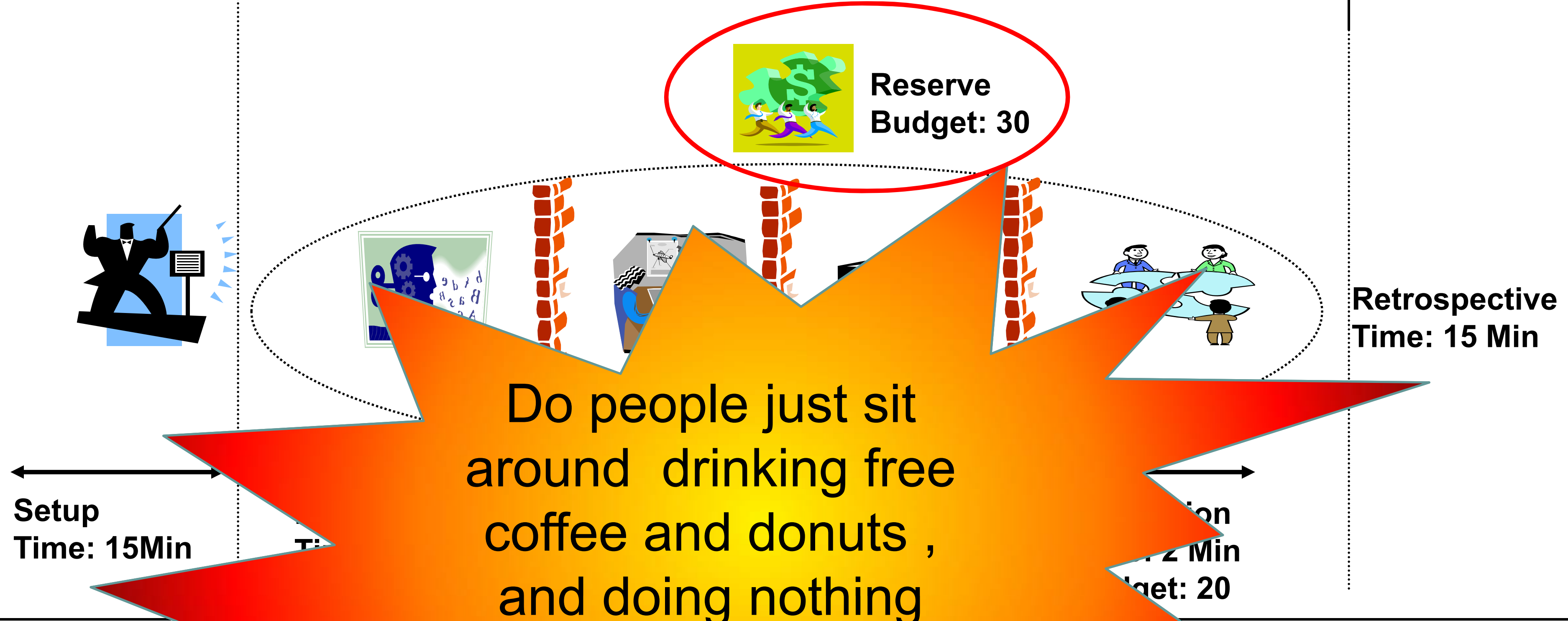
Design ●

Implementation ●

Integration ● ●

```
If Total_Blue = 0, PROJECT SUCCESSFUL
Set Dice_Total to zero

Loop Total_Blue Times,
  1. Throw a pair of dice
  2. Add the dice value to Dice_Total

If Dice_Total < 6, Set **Total_Blue to zero**, and
    **restart**

If 6<=Dice_Total<= 12, you have two options
    Spend 10 units, Reduce Total_Blue by
        1, **restart**
                  **OR**
    Start the black timer, when it expires,
        Reduce Total_Blue by 1 **restart**

If 12 < Dice_Total, **Spend 10 units** and Start
    the black timer, **restart**
```

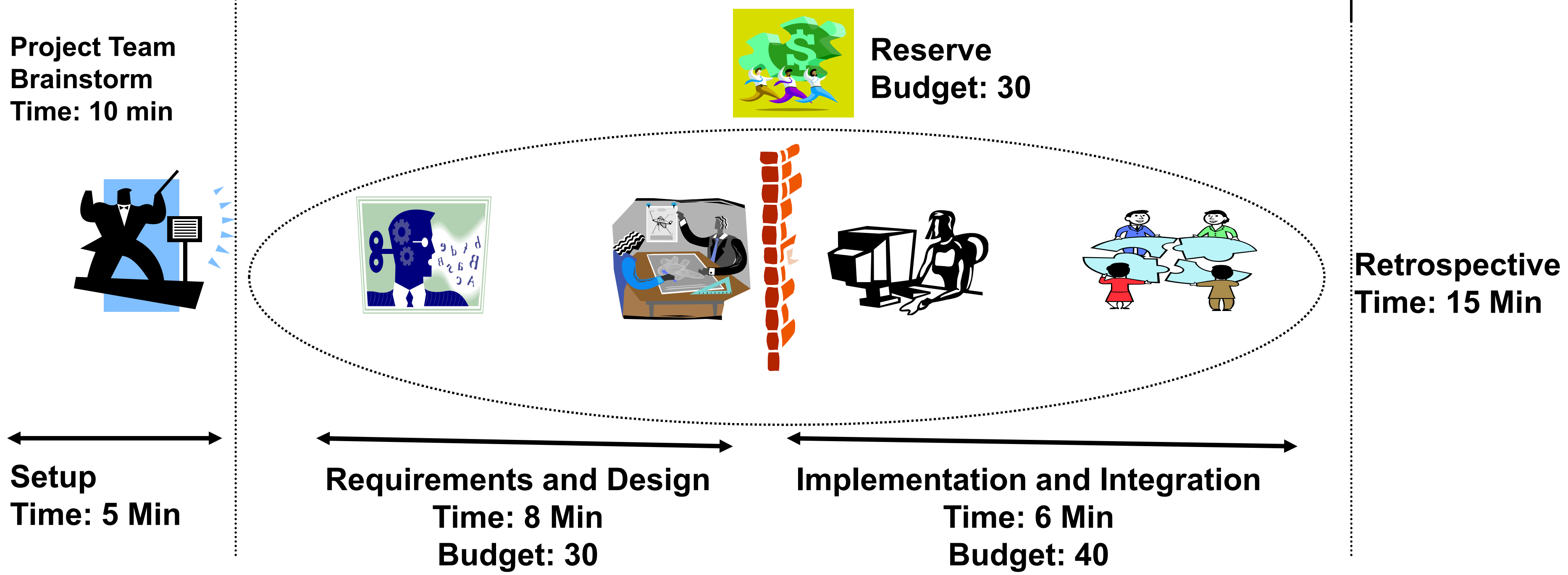
First Round: Structured Flow



Do people just sit around drinking free coffee and donuts , and doing nothing while they wait?

- All th blam he upstream process as a key allc
- Stories
  - Requireme ts team did nothing
  - Integration team could not integrate anything

Second Round: Integrated Teaming



Project Team Brainstorm
Time: 10 min

Reserve
Budget: 30

Retrospective
Time: 15 Min

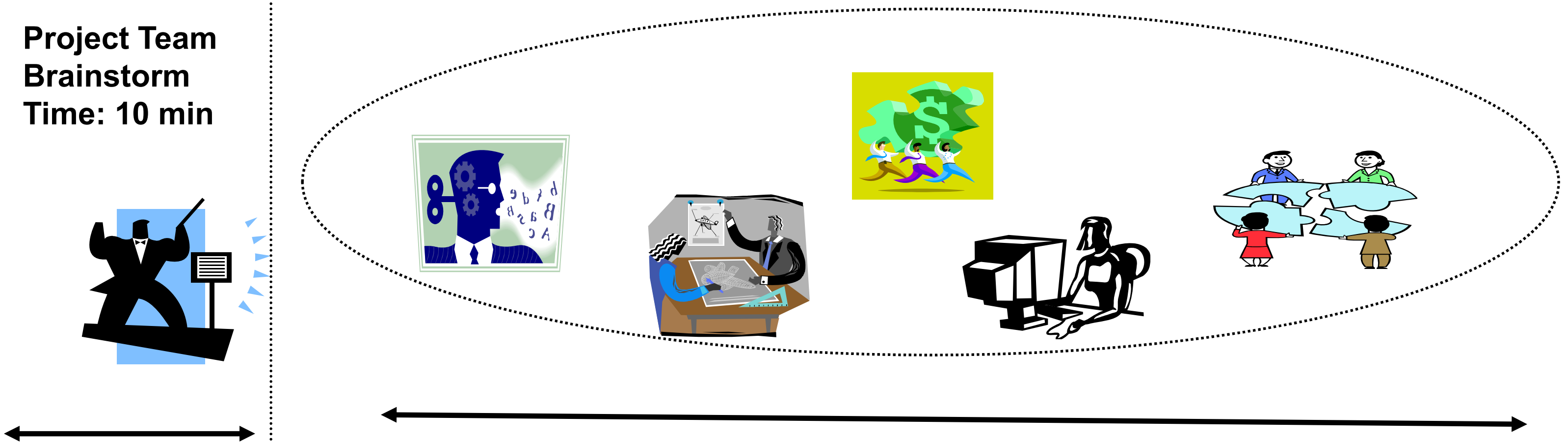
Setup
Time: 5 Min

Requirements and Design
Time: 8 Min
Budget: 30

Implementation and Integration
Time: 6 Min
Budget: 40

- Questions asked by the students
  - Can we all work together on both sub-teams so that we can maximize resource usage?
  - Can we start development and integrating activities earlier than the current handoff process?

Third Round: Value Stream



Project Team Brainstorm Time: 10 min

Setup Time: 5 Min

Single Team Time: 15 Min Budget: 70

Retrospective Time: 15 Min

- “We now know how to work together, now we want to see if we can do it as a complete group”
- Extremely flexible round based on progress of students
  - Seeded wrong requirements
  - Change the customer between rounds

Conclusions

- The Game
  - Created around constructivist values
  - Enables students to discover the strengths and weaknesses of software process models for themselves
  - Enables instructors to anchor learning in long term memory through concrete examples

- Future Work
  - Need to develop more detailed evidence on the effectiveness of the game
  - Develop agent based models that encapsulate decision rules captured through case studies
  - Support hypothesis testing and scenario analysis for process imrpovement

Acknowledgements

- Thanks to …
  - 16.35 Real-Time Systems and Software
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  - Funding support from LAI

- Game available via email

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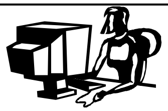
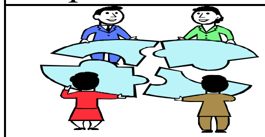
BACKUP

Example Rules

Role	Responsibility
Requirements	Create a work package where the total weight of requirements is >= 50
Design	Create a design that is in the worst case based on one incorrect requirement, and two ambiguous requirements.
 Implementation	Create an implementation that is in the worst case based on three ambiguous requirements
 Integration	Successfully integrate the system, ensuring that the implementation has no ambiguous requirements.
Revenue	Manage the funding for the project
Coordinator	Ensure that the game is being played by the rules, and observe team dynamics during the game, may also act as customer in later iterations

Rule for Integration Phase

If Total_Blue = 0, PROJECT SUCCESSFUL
Set Dice_Total to zero

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