# Games for Systems Engineers

LETS MAKE A STRONG COMMUNITY

Where is everyone meeting?
Where is everyone publishing?

We need to impact multiple groups but also would be good to have a home



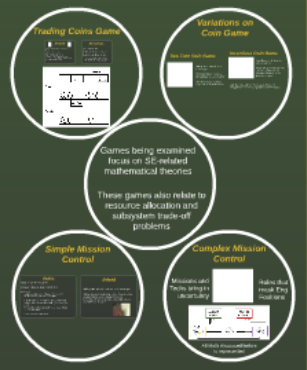

Why Games?

Why Now?

Why SE?

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

## Game-Based Learning for incentives and mechanism design




## Gamification of Systems Engineering

How to bring game elements into a real systems engineering process?

Dr. Bryan Mesmer

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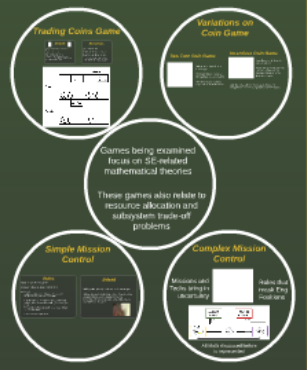


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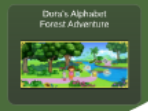
# Games and Gamification

## Game-Based Learning

Games that focus on teaching the player

Outcome: A skill or knowledge is gained by player


## Gamification

The use of game design elements in non-game contexts

Outcome: a product of the process being gamified


## Why Games?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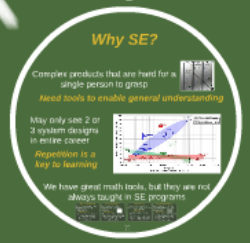
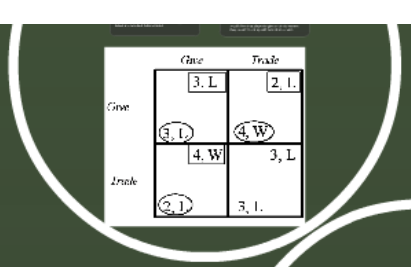
## Why SE?




Games being exami
focus on SE-relate
mathematical theor

These games also re
resource allocation
subsystem trade-
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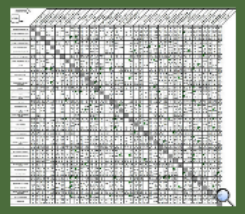
# Why SE?

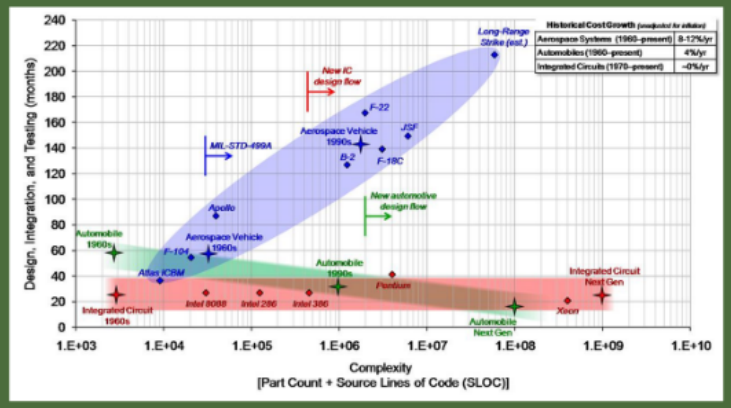
Complex products that are hard for a single person to grasp



***Need tools to enable general understanding***

May only see 2 or 3 system designs in entire career

***Repetition is a key to learning***




We have great math tools, but they are not always taught in SE programs

***Value Driven Design***
Enables the communication of preferences through value functions
***Who Cares?***
In games knowing your own and your opponents' preferences is crucial to success

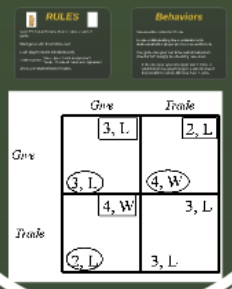
***Decision Analysis***
Examination of effective decision-making in a state of uncertainty
***Who Cares?***
Most games have uncertainty (otherwise it would not be fun)
Understanding value AND RISK is critical

***Game Theory***
Considers the interaction of individuals. Mechanism Design examines the designer's influence on a game
***Who Cares?***
Many games, and SE specifically, involves other players. 100% for SE
Understanding how the game designer can change the game to drive behaviors he desires is critical to incentives

***Organization Theory***
Examination of the structure and path information follows in large groups
***Who Cares?***
Its important to know how your decision (or game moves) outcomes will be impacted by the path it takes

# Game-Based Learning for incentives and mechanism design

## Trading Coins Game




## Variations on Coin Game

### Two Turn Coin Game

Brings in concept of past knowledge

Changing beliefs captured through Bayesian probability

Mixed Strategies become important as mixed NE exist

### Incentives Coin Game

Incentives can be used to drive a behavior

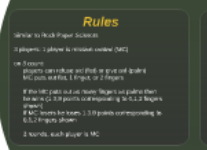
Game designer will give two cents to a player if they perform a trade (after the trade is complete)

Now Trade weakly dominates Give, the game designer has modified the game to drive behaviors

Games being examined focus on SE-related mathematical theories

These games also relate to resource allocation and subsystem trade-off problems

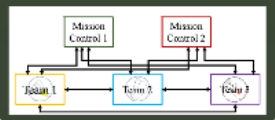
## Simple Mission Control




## Complex Mission Control

Missions and Techs bring in uncertainty

Roles that mask Eng Positions

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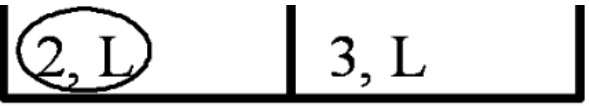


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Complex M

# Simple Mission Control

## Rules

Similar to Rock Paper Scissors

3 players: 1 player is mission control (MC)

on 3 count:
players can refuse aid (fist) or give aid (palm)
MC puts out fist, 1 finger, or 2 fingers

If the MC puts out as many fingers as palms then he wins (1,3,9 points corresponding to 0,1,2 fingers shown)
If MC losers he loses 1,3,9 points corresponding to 0,1,2 fingers shown

3 rounds, each player is MC

## Intent

Bribing (with points) is allowed and encouraged

Drives players to delve into a form of mechanism design where they are trying to alter the behaviors of their opponents by manipulating the outcomes of the game

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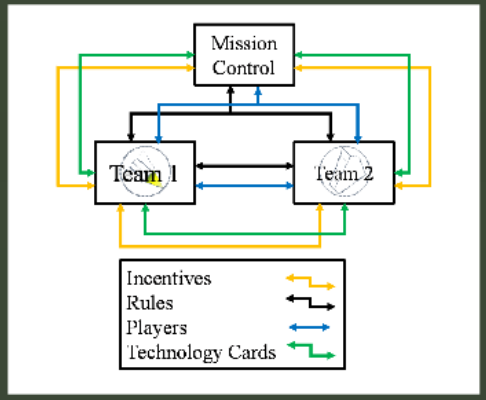


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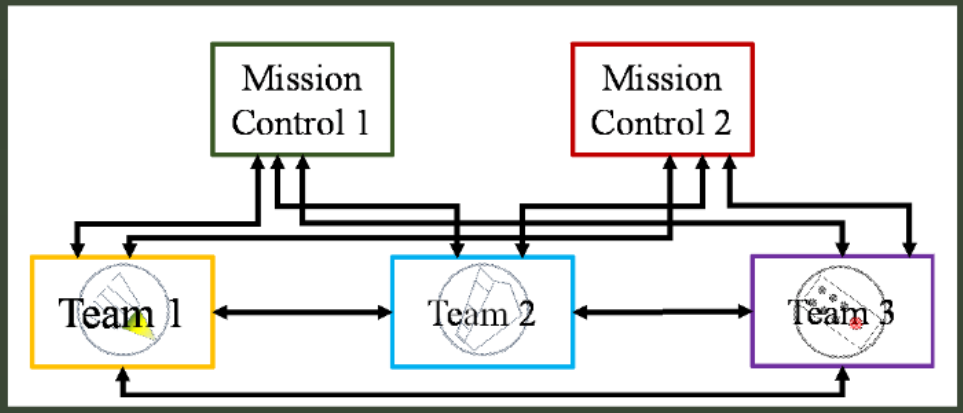


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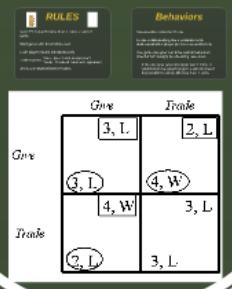


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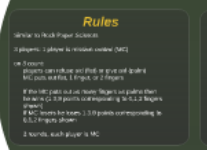


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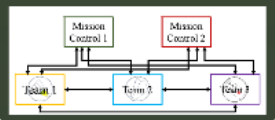


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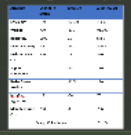
## How to bring game elements into a real systems engineering process?

### Scorecards in Value-Driven Design

Gives designers at different levels the impact of their decisions on system value

### ScoreBOARDS

By taking value impact (and accounting for the degree of impact from each group) can have groups competing for top place



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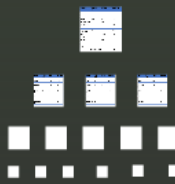

SCOREBOARD
1. Flight Controls 15468
2. Ground Support 12879
3. Structures 11588

This is all very preliminary work but we believe it to be a path that should be taken to align SE with the traits of future and current engineers and to address the teaching of topics that are not taught or are taught incorrectly in current SE programs

# *Scorecards in Value-Driven Design*

Gives designers at different levels the impact of their decisions on system value

| Attribute | Change in Status | Gradient | Value Impact |
|---|---|---|---|
| **Efficiency** | 10% | 150,000 | 15,000 |
| **Weight** | 700 | -130 | -91,000 |
| **Reliability** | 1500 | 2.3 | 3,450 |
| **Maintainability** | 7.8 | -340 | -2,652 |
| **Maintenance Cost** | 500 | -.5 | -250 |
| **Support Equipment** | 12 | -15 | -180 |
| **Radar Cross-Section** | .1 | -1200 | -120 |
| **InfraRed Signature** | 1.4 | -50 | -70 |
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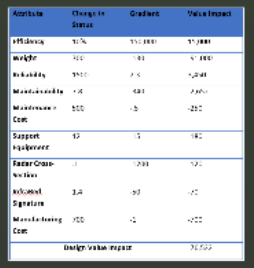

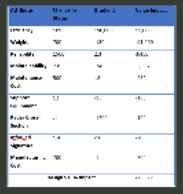

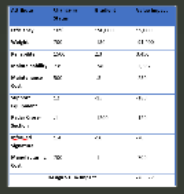

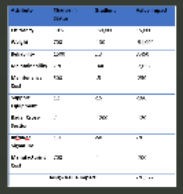

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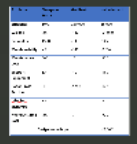

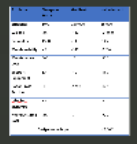

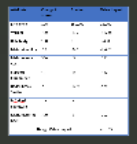

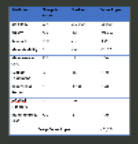

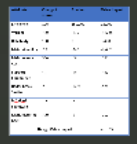

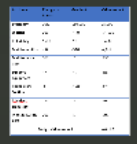

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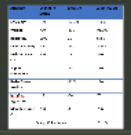

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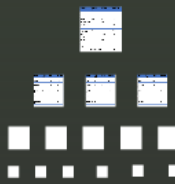

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Hexagon

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# Games in Engineering Feedback Panel

A collection of individuals exploring games

Provide constructive criticism and avoid repeating similiar mistakes

Useful on proposals (such as CAREER proposals) to demonstrate that this is an organized community and there has accepted practices/mathematics and we aren't just making games up without rigor

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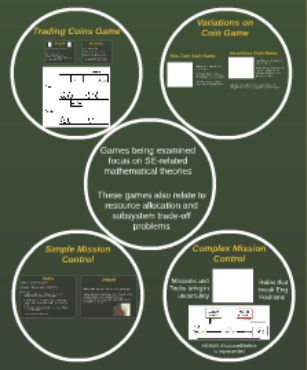


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