



Systems Engineering

MRA Education Day 2018

What did you have for lunch today?

 Respond at PollEv.com/timothylin280

Top



How the customer explained it



How the project leader understood it



How the engineer designed it



How the programmer wrote it



How the sales executive described it



How the project was documented



What operations installed



How the customer was billed



How the helpdesk supported it



What the customer really needed

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Timing

- **BROAD**
 - The whole robot
 - The entire process
- Requirements
- Design
- Interfaces
- Testing



Decision Cycle for Rapid Prototyping

- Base initial decisions on experience
- Prototype, prototype, prototype!
- Make decisions from
 - Research
 - Analysis
 - Prototypes

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Requirements

- USE CASE ANALYSIS
- Constraints
- Functional
- Performance
- Interface
- Programmatic

Use Case Analysis: FIRST Power UP

What are the different situations the robot might be in?

Based on these situations, what does our robot need to do?

 When poll is active, respond at **PollEv.com/timothylin280**

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Managing Design

Technical Budgets/Allocations

- Mass
- Power
- Cost
- Layout, Configuration, Volume, Alignment

What CAD software does your team currently use?

Solidworks

Onshape

Autodesk
Inventor

Autodesk
Fusion 360

Autodesk
AutoCAD

Onshape

Quick Plug for Onshape



Managing Design

Interfaces

- Mechanical
- Electrical
- Software

- Standards
 - Use a standard bolt size!
- Interface plates
- Document!



Risk

Analyzing Risk

- Likelihood vs. Consequence

Mitigating Risk

- Backup plans
- Relaxing requirements
- Reserves
- More resources

Some Final Thoughts on Design

[Akin's Laws of Spacecraft Design](#)

- At the start of any design effort, the person who most wants to be team leader is least likely to be capable of it.
- You can't make it better until you make it work.
- The ability to improve a design occurs primarily at the interfaces. This is also the prime location for screwing it up.
- ...and many more!

Testing & Verification

Progressive Testing

- Component
- Subsystem
- Fully Integrated System
- Field-Testing

Regressive Testing

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Testing & Verification

- Verify your interfaces
- Test performance. A lot. (If you have time.)

Overwhelming? Yes, it is.

- Don't do things too formally for robotics.
 - Just keep these things in mind.
 - Write things down.
- Don't get bogged down by the details.
 - Systems engineering is *BROAD*.
- Design doesn't happen alone.
 - Discussion is the most key.
- Always ask, “what do people need in order to succeed?”