



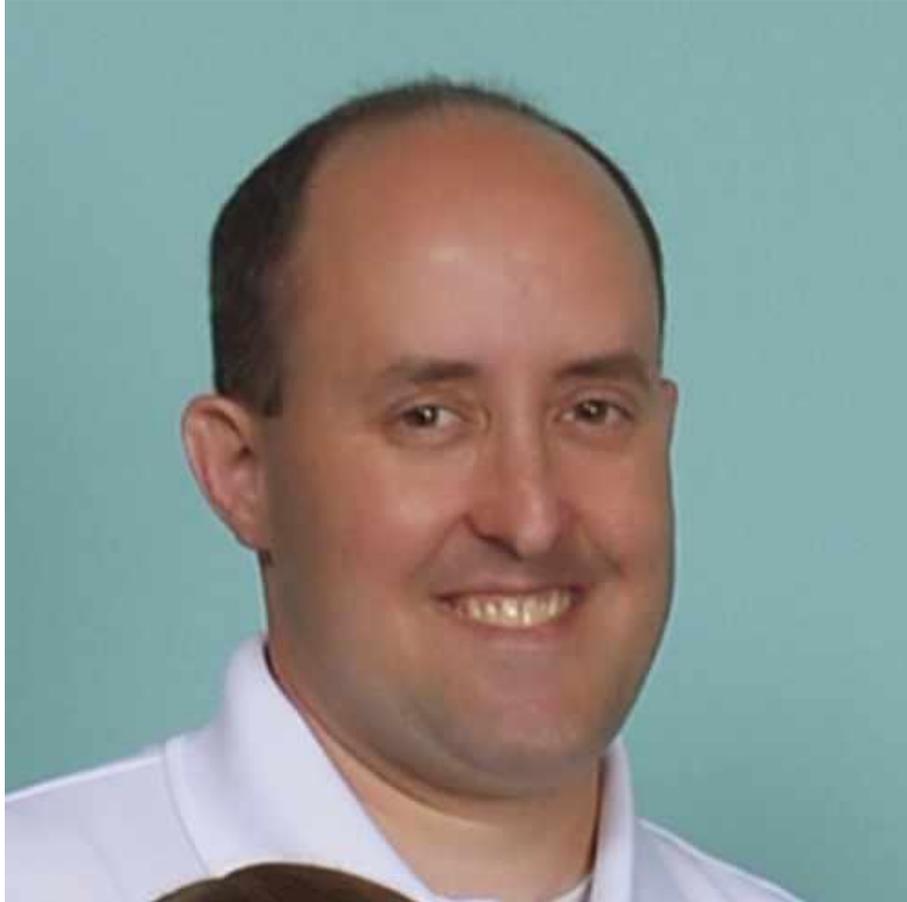
# Systems Engineering on Legacy Systems

Paul White

April 10, 2018



# Brief introduction about myself



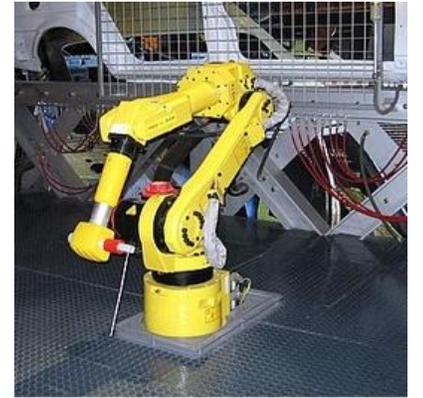
- Work Experience
  - 2015 – Present: KIHOMAC / BAE – Layton, UT
  - 2011 – 2015: Astronautics Corporation of America – Milwaukee, WI
  - 2001 – 2011: L-3 Communications – Greenville, TX
  - 2000 – 2001: Hynix – Eugene, OR
  - 1999 – 2000: Raytheon – Greenville, TX
  - 1996 – 1997: Southwest Research Institute – San Antonio, TX
- Education
  - 2011: Graduate Certification in Systems Engineering and Architecting – Stevens Institute of Technology
  - 1999 – 2004: M.S. Computer Science – Texas A&M University at Commerce
  - 1993 – 1998: B.S. Computer Science – Texas A&M University
- INCOSE
  - Chapters: Wasatch (2015 – Present), Chicagoland (2011 – 2015), North Texas (2007 – 2011)
  - Conferences: WSRC (2018), GLRCs (2012-2017)
  - CSEP: (2017 – Present)
- Recognition
  - 2018 Engineer of the Year Nominee (INCOSE) for Utah Engineers Council (UEC)
- Family
  - Married 13 years
  - Three daughters (16, 11, & 9)

# Why Did You Become an Engineer?



**Applied Creativity**

**Solve Problems Using Technology**



# Career Path to Becoming an Engineer



Middle Schools

Explored possibilities



High Schools

Advanced Courses  
AP Exams  
College Applications  
Employment  
SATs/ACTs



Coursework  
Internships/Co-ops  
Networking  
“Spare” Time



B.S./M.S.  
Computer Science  
Computer Engineering  
Systems Engineering  
Electrical Engineering  
Aerospace Engineering

# Your First Job



Knowledge  
State-of-the-Art Technology  
Creativity  
Inventiveness  
Curiosity  
Competence  
Skill  
Intelligence



Aerospace Engineer  
Chemical Engineer  
Electrical Engineer  
Industrial Engineer  
Software Engineer  
Engineering Technician



# What is a Legacy System? (Pejoratives)

- **“Old”** ←
- “Obsolete”
- “Outdated”
- “Needs Replacement”
- “Past Its Prime”
- “Outlived Its Usefulness”
- “In Need of Replacement”
- “No one knows how to use it anymore.”
- “Why are we still using this?”
- “Older than \_\_\_\_\_ (me, my parents, my grandparents, ‘dirt’, etc.)”
- {Uncomfortable smiles, laughter, etc.}



# What is a Legacy System?

“A legacy system is an older system that is still in use.”

**Aerospace**

**Health Care**

**Construction**

**Manufacturing**

**Infrastructure**

**Computing**

# Examples

A-10



Older Buildings



Big Safari



Infrastructure



Intercontinental Ballistic Missiles (ICBMs)



Health Care



# Why Are We Still Using Legacy Systems?

- **They fulfill their missions better than anything else out there!**
- The cost of redesigning or replacing is impractical.
- The cost of retraining employees, customers, or users is very high.
- We cannot afford the down time (lack of availability) during transition.
- How would we replace the system (lack of understanding)?
- We replace the system later, and it should be pretty easy to do (complacency).
- Newer systems may be “better”, but they offer undesirable features or unneeded capability that we do not want at this time.
- Newer systems have uncertain deployment dates.

# Why Are We Still Using Legacy Systems?

- November 7, 2016 -- \$19.8 Trillion U.S. deficit
- Pressure to cut spending
- Pressure to stretch every dollar (tax-payer dollars ... your money)
- What about raising taxes for extra revenue?

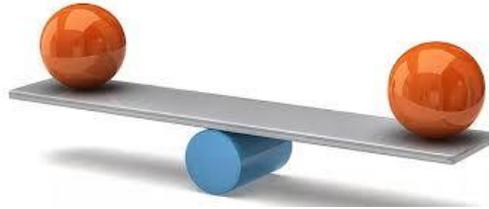


Jean-Baptiste Colbert – “The *art of taxation* consists in so *plucking the goose* as to procure the *largest quantity of feathers* with the least possible amount of hissing.” Quoted in: William Sharp McKechnie (1896). *The State & the Individual: An Introduction to Political Science, with Special Reference to Socialistic and Individualistic Theories.* p. 77

# Why Work on a Legacy System?



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Knowledge  
State-of-the-Art Technology  
Creativity  
Inventiveness  
Curiosity  
Competence  
Skill  
Intelligence

History  
Integration  
Budget  
Schedule  
Maintenance  
Security  
Shortages  
Constraints



# Younger Engineers & Legacy Systems

- Creativity – Think of how to apply to new missions and problem spaces
- Modernization – Chance to apply new technologies, methods to older system ... and keep it relevant ... make it better
- Established – System has been around for a long time, lots of history
- Mentoring – Lots of older engineers to mentor you
- Growth – System will be around for a while
- Respect – System has proven capabilities, good reputation, respect of community
- Pride – Service to country (“noble cause”), save lives, help people, save money, save time

# Older Engineers & Legacy Systems

- Creativity – Always new problems to solve
- Modernization – Can learn about newer technologies and how they can apply to your system
- Established – Lots of history, and you have played a key role in it
- Mentoring – Lots of younger engineers looking for guidance
- Growth – Plenty of growth opportunities still available
- Respect – People respect your contributions
- Pride – Service to country (“noble cause”), save lives, help people, save money, save time ... and you can leave behind a “legacy”.

# Strategies for Legacy Systems

- Documentation
- Mentoring
- Architecture
- Modification Programs
- Sustainment
- Replacement

# Documentation



# Documentation



Paper Documents



Databases



Tribal Knowledge



Architectures



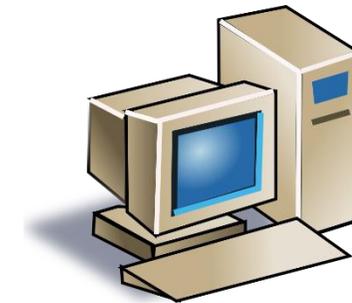
Expertise



CDs



Disks



Computers

# Mentoring

## Mentor

Guide  
Coach  
Advisor  
Counselor  
Advocate  
Role Model

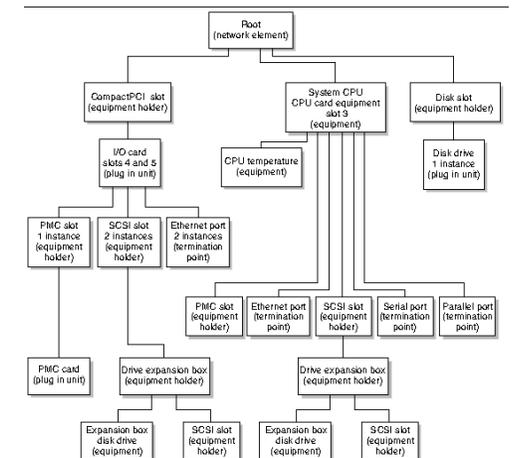
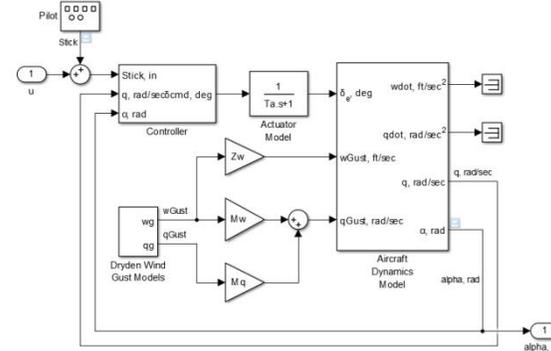
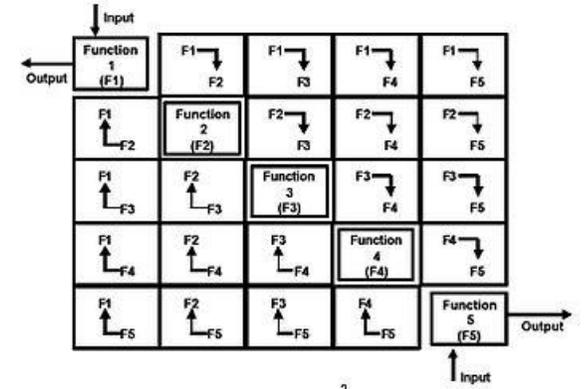
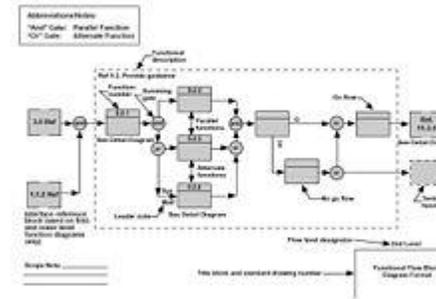


## Mentee

Driver of Relationship  
Development Planner  
Contributor  
Life-long Learner

# Architecture

- Lots of effort being put into documenting the architecture of legacy systems
- Purpose: To use as a reference for future modifications or proofs of concept
- Documenting
  - Mission
  - Capabilities & Requirements
  - Operational Architecture
  - Functional Architecture
  - Physical Architecture
- Gathering documents and external files



# Architecture

*“At the most fundamental level, systems are collections of different things that together produce results unachievable by the elements alone.*

For example, only when all elements are connected and working together do automobiles produce transportation, human organs produce life, and space produce information.

These system-produced results, or 'system functions', derive almost solely from the interrelationships among the elements, a fact that largely determines the technical role and principal responsibilities of the systems architect.”

-- Mark A. Maier

The Art of Systems Architecting, 3<sup>rd</sup> Edition

## “Systems Archaeology”

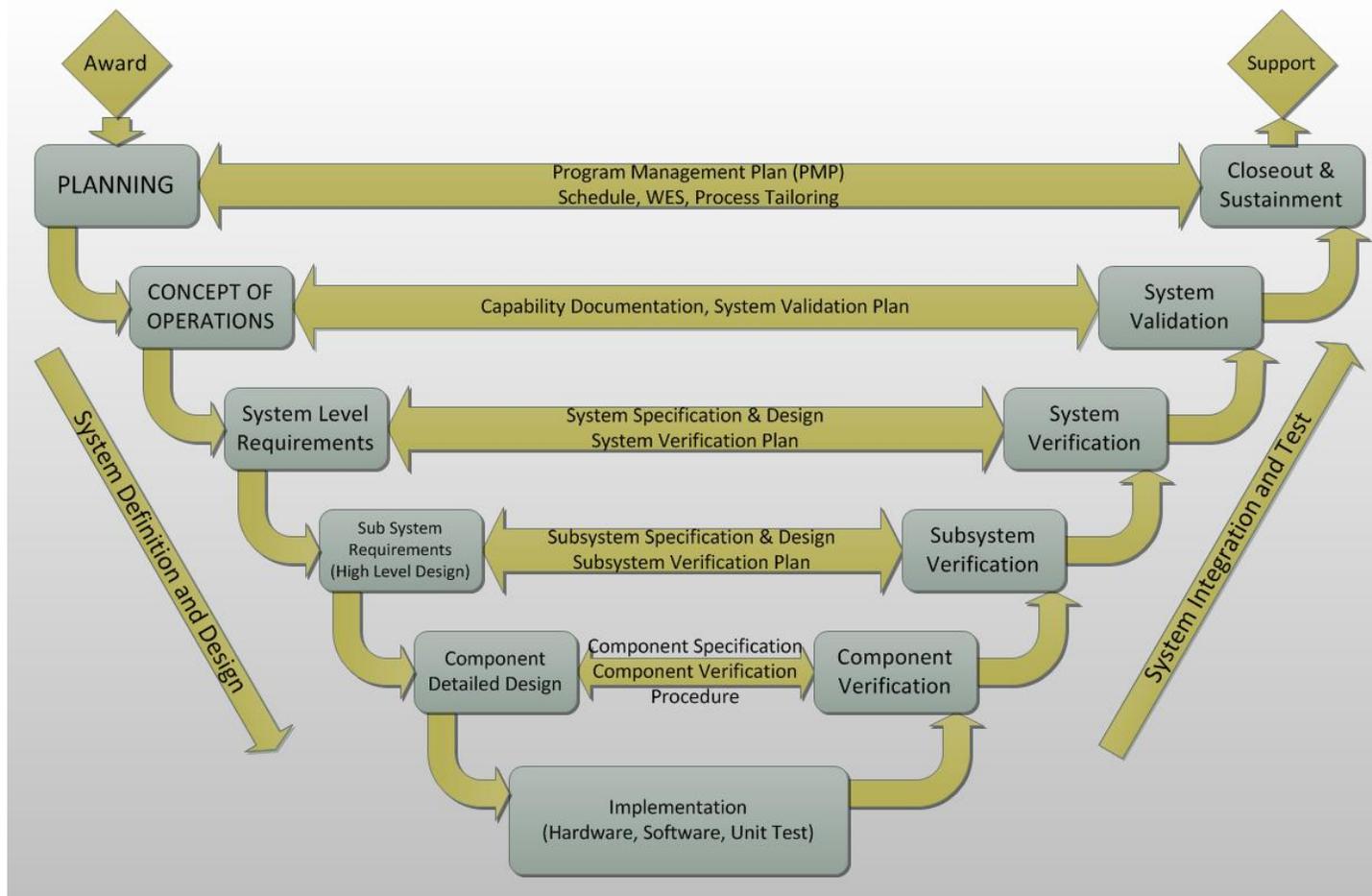


# Modification Programs

DAVID CUSH, CEO AT VIRGIN AMERICA

**“The biggest barriers to adopting employee social networks are legacy systems, legacy thought processes and legacy people.”**

# Modification Programs



- Backward compatibility
- Change management
- Integration into existing legacy structures
- Upgrades to portions of the system at a time
- Risk management
- Requirements
- Verification & Validation
- Process Modifications

# Sustainment

- Training
- Maintenance Depots
- Parts/Spares
- Staffing
- Metrics



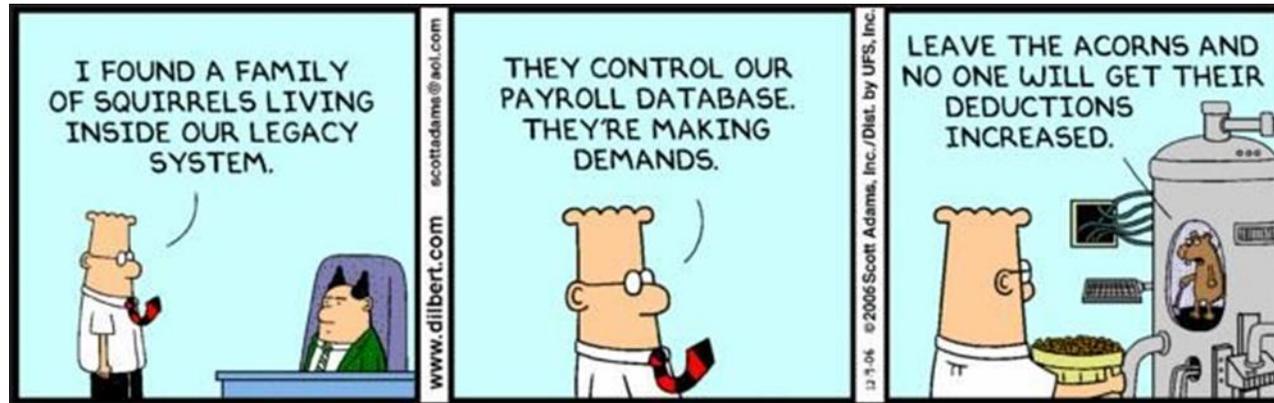
# Replacement

**I'd like to say that somebody [in an insurance company] at some point looks at the legacy system and says, 'Man, this is costing us a lot of money so we have to replace it. But that's pretty rare. Realistically it's when the old system prevents them from embarking on new initiatives that they start to think seriously about replacement.**

# Replacement

- I have never seen an entire legacy system replaced.
- Legacy systems live longer than people who worked on them.
- Things to consider ...
  - Capture knowledge.
  - Have well defined vision and goals.
  - Understand what you are replacing and why.
  - Start data conversion and cleanup. (Assume it will take longer than expected.)
  - Understand interface complexity.
  - Invest in organizational change.
  - Avoid arbitrary target dates ... unless attainable.
  - Request needed resources ... even if it may upset management or customers.
- Be realistic; you will never replace the whole thing at once!

# Concluding Thoughts



# Concluding Thoughts

- Working on a legacy system means using your engineering toolkit in a different way.
- Legacy Systems is a great career choice for younger and older engineers.
- You can build your entire career around legacy systems.
- Do not be surprised if a legacy system outlives you.
- Enjoy your work, and learn along the way.

My biggest thrill is when I plan something and it fails. My mind is then filled with ideas on how I can improve it. Engineering without personality doesn't have much value.

Soichiro Honda, Founder – Honda Motor Company

# WSRC

## Western States Regional Conference

September 20-22, 2018

Ogden, Utah

<https://incose-wsrc.eventbrite.com>

April 14 – Call for Proposals Deadline  
Satellite Sites Possible for SE PDD (September 21<sup>st</sup>)



# Contact Information

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