A Summary of SAE 550:

Systems Architecting and the Political Process

University of Southern California

Viterbi School of Engineering

Systems Architecture & Engineering (SAE)

Ken Cureton

cureton@usc.edu

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SAE-550-Summary.pptx

Mr. Kenneth Cureton

USC Viterbi School of Engineering
Systems Architecting and Engineering

- Instructor of SAE 550 from 1996 to 2014 & 2017 onward, SAE 574 from 2003 to 2013, SAE 599 in 2014 then SAE 546 in 2018, SAE 560 in 2020, SAE 549 in 2003 & 2017 through 2020
- Senior Systems Engineer (retired after 29 years) for The Boeing Company-- Boeing Defense, Space, & Security: Phantom Works (Get-To-Blue, Technical Lead Engineer)
  - Manned Space, Satellite Systems, Networked Systems, Cyber Security, and Defense Conversion
- Network-Centric Operations Industry Consortium (NCOIC) Technical Council Chair Emeritus
- Was employed as a Computer Hardware/Software and Systems Engineer for 46 years: Government, Small Business, & Aerospace Sectors
- Professional Societies: AIAA, INCOSE, IEEE
  - IEEE SMC former co-chair MBSE Working Group
  - INCOSE Resilient Systems Working Group (RSWG) chair
- Formal Education:
  - BS in High-Energy & Nuclear Physics
  - MS in Systems Architecting & Engineering

SAE 550 Objective

- **Part of Systems Architecting & Engineering (SAE) Series**
  - **Objective:**
    Analysis of risks inherent in managing high-tech/high-cost government-funded or corporate-funded engineering programs; tools and techniques for coping with the impacts of politically-driven budgets on the engineering design process.
  - **Elective Course in University of Southern California's Masters Program in Systems Architecting & Engineering**
    - **Class originated by Dr. Brenda Forman in the late 1980s**
    - **Class restarted in the Fall of 1996 to Fall 2014 by Ken Cureton, then Dr. Elliot Axelband for 2015-2016, Ken Cureton resuming in Spring of 2017**
  - **About 900 Students have completed the class**
  - **Student Demographics:**
    - **About ½ are employed by aerospace/defense companies**
    - **About 1 out of 20 are Air Force, Navy, or Army officers**
    - **Remainder are foreign students or those with more of a commercial background**

SAE 550 Value to Students

- **Not a Political Science Course!**
  - **Provides Political Risk Analysis and Mitigation Techniques**
    - **Supplements Classic Cost, Schedule, Performance & Programmatic Risk Management Systems Engineering Techniques**
- **Unique Class Emphasis: Impact on Systems Architecture**
  - **Other Courses Focus on Political Impact on Technologies**
- **On Completion of the Course, Students:**
  - **Grasp the Real-World Processes for Project Approvals, Funding, Budget Scheduling, and Regulatory Control**
  - **Understand the Necessity for Strong, Coherent Constituency and "Keeping the Program Sold"**
  - **Demonstrate Agility in Political Reasoning (Negotiation, Compromise & Appearance) to Supplement Engineering Logic**
- **Typical Student Feedback: *"I am now far more effective in project management and real-world systems architecting!"***

SAE 550 Class Format

- **Semester Class, 15 Weeks, One night/week**
  - **Weekly Lectures, 2 hours 40 minutes each**
  - **1 Final Exam week (scheduled but not used)**
- **Distance Learning Format via Distance Education Network (DEN)**
  - **Typically only a few students in the TV Studio, majority of students are scattered across the US**
  - **Class content webcasted for online/offline viewing**
  - **Class content in weekly reading materials (including 6 Case Studies), hosted on DEN Software for student preview**
  - **Class presentations in PowerPoint format, hosted on DEN Software for student preview**
  - **DEN Software provides for Chat or Voice Interaction online, Discussion Boards offline**
  - **Simultaneous Webex for real-time interaction**

SAE 550 Class Grading

- One Research Paper required of each student
  - In place of a Final Exam, 50% of class grade
  - Papers are typically 20 single-spaced pages, suitably formatted for publication in a technical journal
    - Student materials on "How to Write a Research Paper"
  - Students are encouraged to e-mail Instructor with questions, outlines, drafts, etc.
- Students choose research topic
  - Submit abstract for approval by Instructor
- 6 Case Studies, homework assignment for each
- Structured analysis required for paper, homework
  - Specific analyses required in each case to demonstrate student's ability to apply the class fundamentals:
  - Political Risk Mitigation Factors
    - Also known as the Political "Facts Of Life" or FOLs

SAE 550 "Political Facts of Life"
(as envisioned by Dr. Brenda Forman)

1. ***Politics, Not Technology, Controls What Technology Is Allowed To Achieve***
   - **Budget Limitations (Amount of Money, Color-Of-Money)**
   - **Regulatory Constraints (Export/ITAR, "Fencing", Laws)**
   - **Schedule Deadlines (Not enough time to do it "Right")**
2. ***Cost Rules***
   - **Usually have to Overstate the Benefits and Understate the Costs just to get a Program Started**
   - **Program Funding has to be Re-Won each Year**
   - **Government Rarely Provides an Optimal Funding Profile (prefers reduced & level-loaded funding over a longer time)**
3. ***A Strong, Coherent Constituency Is Essential***
   - **Every Successful Program Must Serve Multiple Agendas**
   - **Government Loves to Dictate Multiple-Mission Systems**

SAE 550 "Political Facts of Life"
(as envisioned by Dr. Brenda Forman)

4. *Technical Problems Become Political Problems*

- **All Big-Budget High-Tech Government-Funded (or Corporate-Funded) Programs Operate in a Political Fishbowl**
  - **Ever-present Foes Looking For Excuses To Seize Funding**
  - **Valid Scientific Reports Will Be Misused for Political Purposes**

5. *The Best Engineering Solutions Are Not Necessarily The Best Political Solutions*

- **For Technical People: the Illogic of Negotiation, Compromise and Appearance in Politics**
  - **Programs That Create Jobs Are More Likely To Be Funded Than Programs With Theoretical Goals (Like Basic Research)**
- **For Political People: the Naiveté of Scientific Reasoning and Logical Choices in Engineering and Science**
  - **Most Politicians Have neither the Technical Background nor the Time to Understand Technical Implications of Their Choices**

SAE 550 Other "Political Facts of Life"

- **Timing Is Everything**
- **Political Problems Become Technical Problems (or Opportunities)**
- **Politics Prefers Immediate, Near-Term Gratification**
  - **Political Process Constantly Striving to Satisfy Immediate, Urgent Needs With Insufficient Resources (Money, Time) (*This Year* is More Important Than Out-Years)**
  - **Election "Event Horizon" Also Encourages Near-Term Focus (in USA: 2 Years for House, 4 Years for President, 6 Years for Senate)**
- **Politics Believes In Gurus And Heroes**
  - **And Once Tarnished, Forever Untrustworthy (Stink Sticks)**
- **A Catchy Slogan Is Essential To Getting Attention**
- **Perception Is Often More Important Than The Truth**
- **Staffers Shape Decision-Making**

SAE 550 Introductory Lecture

- **Syllabus**
  - **Homework Assignments**
  - **Research Paper**
- **Definitions**
  - **"The Political System"**
  - **Coping Skills for the Modern Design Engineer**
  - **Role of the System Architect in the Political Process**
- **Introduction to the Political Facts Of Life**
  - **Parallels in Our Personal Lives**
  - **Show Intimate Relationship Between Engineering Design Process And Pressures Of Political Process**
  - **Help Students To Understand That Political Process**
    - **To Give Confidence & Effectiveness In Future**
  - **Emphasis on Engineering and not on Political Science!**

SAE 550 Budget Processes Lecture

- **Description of the U.S. Federal Budget Process**
  - **Brief Overview of PPBE Process (including POM & FYDP)**
  - **President's Budget Request**
  - **Generation of the Congressional Budget Bills**
  - **Signing Into Law by President (or Threats of Veto)**
  - **Continuing Resolutions, Rescissions, Plus-Ups, Earmarks**
  - **PAYGO, Nunn-McCurdy Act, Clinger-Cohen Act**
  - **Mandatory (Entitlements) vs. Discretional Funding**
  - **Efforts to Balance the Federal Budget**
  - **Deficit Spending, Line-Item Veto, "Pork Barrel" Politics, Acquisition Reform, Budgetary Reform, Interest on the National Debt**
- **The Need for Political Risk Mitigation**
  - **Coping Skills and Defensive Engineering (Similar to Need for Performance/Cost/Schedule Risk Mitigation)**
- **Investigation of Difficulty in Reducing Governmental Budgets and Complexity**

SAE 550 Practice Case Study

- **Practice Case Study: A Realistic Program Scenario**
  - **Not a real Case Study!**
  - **A collection of real-world situations from past programs**
  - **A few parts are "made up" for ease of analysis**
  - **Assignment is "graded" but NOT included in class grade**
  - **Many "good" students struggle at first in analyzing the apparent illogic and technical insanity associated with Political impacts**

- **Guiding Students in Recognizing Symptoms of the FOLs**
  - **Recognition & categorization of Political events in terms of the FOLs**
  - **Emphasis on accurately expressing FOL occurrences**
  - **Focus on linking political events to resulting technical impacts**
  - **Insight into potential ways of dealing with consequences**

SAE 550 Case Study #1

- **Space Station *"FREEDOM"***
  - **America's Space Station Development circa 1984-1993**
  - **Brief Coverage of US Predecessors (MOL, Skylab)**
  - **Precursor to Today's *International Space Station* (ISS)**
- **Search For Constituency**
  - **Introduction to Battle of Manned vs. Unmanned Space**
  - **Need for (and Consequences of) Work Packages**
  - **International Contribution (Japanese *JEM*, ESA *Columbia*)**
- **The Historical Struggle of *"FREEDOM"***
  - **Watching the Basic Architecture Change Because of Political Pressures**
  - **Consequences of the Cessation of the Cold War:**
    - **Keeping Russian Space Scientists Employed**
- **Guiding Students in Proper Analysis via the FOLs**
  - **Emphasis on Difficulty of Funding Big-Budget, Long-Term, High-Tech Basic Research Programs**

SAE 550 Case Study #2

- **Launch Systems:**
  - **The Original Space Shuttle vs. Eventual Space Shuttle**
  - **Impact on Expendable Launch Vehicles (e.g. CELV)**
  - **Contrast of American vs. Russian Approaches**
- **Space Transportation Infrastructure Constituency**
  - **The Space Race: Sputnik - Apollo, recent resurgence**
    - **A View Into the Future: China, Japan, India, Europe, etc.**
  - **Intro to Struggle Between NASA and the DoD for Control of Space Funding**
    - **The Great Bureaucratic Space War**
  - **Impact of Challenger & Columbia Disasters**
    - **Augustine Committee, Rogers Report**
- **Investigation of Difficulty in Funding Big-Budget, Long-Term, High-Tech Space Infrastructure Programs**
  - **Like Basic Research: Hard to Predict Specific Practical Applications**

SAE 550 Case Study #3

- **The V-22 Tiltrotor "Osprey"**
  - **Example of the Development of a Mission System**
    - **Caught in Cross-Fire of Politics! (Congress vs. White House)**
    - **Political Impact of Technical Problems**
  - **Fixed-Wing vs. Helicopter: Which Is It? Both? Neither?**
    - **The Technical Challenges of a Convertiplane**
    - **The Challenge of FAA Certification for Civil Uses**
- **Department of Defense Constituency**
  - **Intro to Funding War Between the Forces: Air Force vs. Army vs. Navy (and Plight of Marine Corps Funding)**
  - **Multi-Role, Multi-Service, Multi-Mission Systems**
    - **Political Pressures to Develop; Resistance from the Forces**
- **Investigation of Difficulty in Funding Big-Budget, Long-Term, High-Tech Mission Systems Development & Construction**

SAE 550 Case Study #4

- The Federal Wildlands Fire-Fighting Process
  - Example of the Operation and Use of a Mission Process
    - Impact of FOLs on other than Military/Scientific Scenarios
  - USDA Forest Service; DOI BLM, NPS, BIA, FWS; Others
    - FEMA, Army Corps of Engineers, National Weather Service, DoD, NASA
  - Wildlands Fire-Fighting Technologies (Tankers, Helicopters, SuperScooper, Ground Crews & Equipment, Smoke-Jumpers, "Hot-Shot" Crews, GIS, Fire Simulations, SATCOM, Accounting)
- Civilian & Political Constituency
  - Intro to Struggle Between Mission Funding (FFFF) and Daily Operations & Maintenance (O&M) Funding
  - Fear of Fire vs. Acceptance of Fire as a Natural Part of the Ecosystem
- Investigation of Difficulty in Funding Big-Budget, Long-Term, High-Tech Mission/Operational Processes, Logistics, & Sustainment

SAE 550 Case Study #5

- **Ground Transportation Infrastructure (Roads, Autos, Trucks, Trains, etc.)**
  - **How Political Processes influence funding and approval of Public Infrastructures**
  - **Using the U.S. Ground Transportation Infrastructure as an example by examining the Historical Perspective of:**
    - **The Erie Canal Inland Waterways**
    - **The Transcontinental Railroad**
    - **U.S. Interstate Highway System**
- **Such Infrastructure Systems Suffer A Common Set Of Problems:**
  - **Require significant up-front investment & yield uncertain payback on that investment in the far future**
  - **The Key Any New Infrastructure is CONSTITUENCY**
    - **Everybody evaluates what the Political Process calls WIIFM: *What's In It For Me***
- **Investigation of Difficulty in Obtaining Funding and Approval for the Creation, Maintenance, and Upgrades of Infrastructures**

SAE 550 Summary

- **Students Exposed to a Broad Range of Political Impacts on Actual Case Study System Architecture and Design**
  - **Design & Development of Mission Systems**
  - **Operation & Use of Mission Systems**
  - **Mission Processes: Operations, Logistics, Sustainment**
  - **Infrastructure Systems**
- **Students Required to Demonstrate (for their chosen topic and for 6 Case Studies):**
  - **Political Impacts on System Architecture and Design**
- **Emphasis: Training Systems Architects & Systems Engineers in the Understanding and Application of Political Risk Mitigation Factors**
  - **Dr. Brenda Forman's "Political Facts Of Life"**