

A Summary of SAE 550:

Systems Architecting and the Political Process



**University of Southern California
Viterbi School of Engineering
Systems Architecture & Engineering (SAE)**



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SAE-550-Summary.pptx

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- Instructor of many Systems Architecting & Engineering (SAE) classes since Fall of 1996
- Senior Systems Engineer (Retired) for The Boeing Company Huntington Beach CA-- Boeing Defense, Space, & Security: Phantom Works
 - Manned Space, Launch Systems, Satellite Systems, Networked Systems, Cyber Security, and Defense Conversion
- Was employed as a Computer Hardware/Software and Systems Engineer for 46 years: Government, Small Business, & Aerospace Sectors
- Professional Societies (Senior Member): AIAA, INCOSE, IEEE
 - IEEE SMC former co-chair MBSE Working Group
 - INCOSE Resilient Systems Working Group (RSWG) chair
 - AIAA Space Settlement Technical Committee Member
 - Network-Centric Operations Industry Consortium (NCOIC) Technical Council Chair Emeritus
- 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 1,000 Students have completed the class**

- **Student Demographics:**

- **About 1/2 are employed by aerospace/defense companies**

- **About 1 out of 20 are Space Force, 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, 16 Weeks, One night/week**
 - **Weekly Lectures, 2 hours 40 minutes each**
 - **2 Final Exam weeks (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 9 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**
- ❑ **9 Case Studies, homework assignment for each**
 - **Lowest score not counted toward class grade**
- ❑ **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. Discretionary 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**
 - **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 Case Study #6

- ❑ **Case Study #6: Sardar Sarovar Dam (non-US topic)**
 - **Examines how Political Processes apply to *non-US* Systems? (India, in this case)**
 - **Also discusses application of Soft Sciences that impacts system architecture, systems engineering, design, and operations**

- ❑ **Case Study #6 Covers a non-US System that is:**
 - **A Development Project (like Case Studies #1 through #3)**
 - **An Infrastructure (like Case Study #5)**
 - **Flood & Drought Incident Management (like Case Study #4)**
 - **Water Management & Distribution**
 - **Electrical Power Generation**
 - **A Source of National Pride**

SAE 550 Case Study #7

- ❑ **Case Study #7: Superconducting Supercollider (basic research)**
 - **Examines how Political Processes apply to *Basic Research Systems***

- ❑ **Case Study #7 Covers a Basic Research System that is:**
 - **Supposedly a Development Project (like Case Studies #1 through #3)**
 - **Supposedly for eventual Operation & Use (like Case Study #4 & #6)**
 - **An example of *critical* need to develop & nurture Constituency (like Case Study #5)**
 - ***Extremely* difficult to explain the Practical applications to the Political System**
 - **How does one guarantee the Political Benefits of such a project, when (by definition) one doesn't know for sure what the Technical Benefits might be?**
 - **There might not be *any* Technical Benefits, other than lessons-learned from failed experimentation!**

SAE 550 Case Study #8

❑ Precision Navigation Systems

(GPS, GLONASS, Galileo, BeiDou, IRNSS, QZSS)

- Examines how Political Processes apply to Global, Multiple Use Systems (Both Military and Civilian, and of Multiple Countries!)
- Focuses on how the FOLs apply to Services (and not just to their Systems)
- Investigates if the 5 Primary Political FOLs always apply, or are there Counter-Examples
- Demonstrates how to discuss technical aspects of a Case Study

❑ Case Study #8 Covers Global Services that are:

- ***Extremely*** difficult to explain the potential applications to the Political System before first available for Use
 - How does one guarantee the Political Benefits of such a project, when one doesn't know for sure what all potential uses might be?
 - Many Global Services (e.g. Telecommunications) typically cause disruption of (and eventual replacement of) Legacy Systems and ***radically*** change Operations and Use via new/improved capabilities

SAE 550 Summary

- ❑ **Students Exposed to a Broad Range of Political Impacts on Actual Case Study System Architecture and Design**
 - **Research, Design & Development of Mission Systems**
 - **Operation & Use of Mission Systems**
 - **Mission Processes: Operations, Logistics, Sustainment**
 - **Infrastructure Systems**
 - **Non-US Systems**
- ❑ **Students Required to Demonstrate (for their chosen topic and for 9 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"**