

ESD.84 Doctoral Seminar – Session 7 Notes

Guests Presenting: Earll Murman

Session Design:

- Welcome and Overview and Introductions (5-7 min.)
- Generating Key Questions from Readings (7-10 min.)
- The Aerospace Enterprise (60-75 min.)
 - Earll Murman and Sheila Widnall
- Student Presentation (15-20 min.):
 - The Role of the Skunk Works Operations in Extended Aerospace Systems – Troy Downen
- Break (7-10 min.)
- Student Presentation (15-20 min.):
 - Assembly Automation of Aerostructures – Tom Speller
- Book Reviews (5-7 min. each):
 - Earll Murman, Tom Allen, Kirkor Bozdogan, Joel Cutcher-Gershenfeld, Hugh McManus, Debbie Nightingale, Eric Rebentisch, Tom Shields, Fred Stahl Myles Walton, Joyce Warmkessel, Stanley Weiss, and Sheila Widnall. Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative, New York: Palgrave/Macmillan (2002) – Tom Speller
 - B.R. Rich and L. Janos, *Skunk Works* Boston: Little, Brown & Co. (1994) – Eun Suk Suh
 - Lessig on *Code* (1999) – Ben Koo
- Integrative Discussion (10-15 min.)
- Next Steps (3-5 min.)

Potential Discussion Questions:

- How much of the fear of automation is a social-political factor affecting commercial aircraft versus military aircraft?
- On procedures, process, players space – where would a systems architect sit, an engineer, and others?
- In the discussion of form follows function – to what degree do your engineering tools determine your degrees of freedom?
- What would be the development plan for an engineering systems faculty member – comparable to the plan for a systems engineer?
- What is the distinction between systems engineering and engineering systems – how can we make this clear?
- Say more about the three axes – technical, social and life-cycle – are they truly orthogonal and are they comprehensive? Also, where do economics fit in – linking the technical and the social?
- Where does re-designing the organizational structure fit into the overall engineering design process?

Student Presentation:

The Role of the Skunk Works Operations in Extended Aerospace Systems –
Troy Downen

Book Review:

B.R. Rich and L. Janos, *Skunk Works* Boston: Little, Brown & Co. (1994) – Eun
Suk Suh

Discussion:

- The barriers to “Skunk Works” in the current industry are many – how to address these barriers to implementation?
- Are we dependent on strong leaders? What does this say about the role of a systems architect? What does this say about strong technical skills and capabilities on the part of the leader?
- How do Skunk Works projects get chosen? Is it external “pull” or internal pioneering of capability? Where is the boundary between Skunk Works product development and advanced R & D on various technologies?
- Is this contrary to the current notion of “listening to the customer?”
- Consider the alternative model such as Cisco, Colgate and others – which involves purchasing a small entrepreneurial enterprise rather than setting up an internal Skunk Works (contrast in consequences of failure in an internal Skunk Works (fail soft) versus an external entrepreneurial initiative)
- Contrast between a fluid, specially set up Skunk Works and an ongoing institutional arrangement
- See the book “Inventing Accuracy” from a Scottish Sociologist about the Draper Labs – on the Apollo guidance system – pointing to issues of personal trust in establishing contracts
- To what degree are these types of systems dependent on four hard to fill capabilities:
 - Strong leadership skills
 - Deep technical engineering capabilities
 - Well-established networks with customers and other stakeholders
 - Systems architecture capabilities
- Tension between autonomous teams on specific products/platforms and integration with an enterprise
- Consider how engineering time is spent in development in a Skunk Works operation and a larger, higher volume program with more demanding requirements

Discussion with Earll Murman:

- Migration from deep technical expertise in aerodynamics to broad perspective on the aerospace industry
 - Selected in 1990 as Aero-Astro Department Head – prompted broader view
 - Berlin wall was coming down at the time – with basic questions on the ongoing need for an Aero-Astro dept. – which launched a strategic planning process
 - Strategic plan involved the key stakeholders associated with the dept. – which included junior faculty, industry and others in addition to senior faculty
 - Three questions – 20 year vision for aerospace (2010); technologies likely to be central to 20 year vision that should now be the subject of research; substance that should be covered in teaching so current graduates can be industry leaders in 20 years – with remarkably consistent answers across over 150 people consulted
 - A key consensus around the importance of being able to function at a systems level
 - Surfaced need to create a systems engineer – which ultimately became the SDM program
 - Engineering education – at undergraduate level, focus on fundamentals, which involved math, physics, communication skills/teamwork, and then other topics
 - “Customers” said that they looked to MIT to produce systems engineers
- Path to become a professor of engineering systems:
 - Need to be able to internalize a holistic approach to solving problems
 - There is a bias against this in the educational system – which is an issue
 - It is not sufficient to just attend class to develop this perspective – good judgment comes from experience and experience comes from bad judgment – industry or government experience is essential
 - Multiple domains of expertise are essential – making your mark as a scholar and then making your mark in industry and then coming back to a scholarly track – or sending junior faculty for a period of time (a year, for example) in industry
 - This contrasts with the traditional model of drilling deep within a narrow area of expertise – it requires instead establishing multi-disciplinary expertise
 - Key issues around the mix of government and industry sources of support for problem-centered work – with the balance shifting now toward industry
 - For industry the product has to be both research and students -- research, education and practical education are intertwined – a virtuous circle
 - A tension around dual appointments – can’t just have expectations of deep technical expertise in discipline and broad engineering systems output

- Student Presentation:
 - Assembly Automation of Aerostructures – Tom Speller
 - Challenges associated with new composite materials in aircraft and many emerging options for fastening technologies
 - Inter-woven evidence on the use of SDM tools, such as Object-process methods, design-structure matrices, system architecture team structure, etc.
 - Links to improved product development process and new organizational structure
- Discussion:
 - How to manage the phasing out of older technologies?
 - Environmental scanning on future products, materials and technologies – advantage of long time horizon in aerospace – five years or longer
 - There is a long time horizon for materials changes in any industry
 - The Sonic Cruiser at Boeing is not going to be aluminum so it is upsetting knowledge structures
- Book Review:
 - Lessig on *Code* (1999) – Ben Koo
- Discussion:
 - Connection between legal analysis and systems architecture approach
 - Complex terminology – things and modalities
 - Issues of “regulatability” or lack thereof
 - Steps in legal mindset with respect to cyberspace: What is controllable, controllable behavior, control mechanisms, and then latent ambiguity
 - Challenges of elegant architectural framework that does or doesn’t reinforce open or closed aspects of cyberspace – creating new freedom or restricting the same
 - Continuing issue of open source software
 - Note links to use of the book in ESD 10 – next M, W, and F
- Book Review:
 - Earl Murman, Tom Allen, Kirkor Bozdogan, Joel Cutcher-Gershenfeld, Hugh McManus, Debbie Nightingale, Eric Rebentisch, Tom Shields, Fred Stahl Myles Walton, Joyce Warmkessel, Stanley Weiss, and Sheila Widnall. Lean Enterprise Value: Insights from MIT’s Lean Aerospace Initiative, New York: Palgrave/Macmillan (2002) – Tom Speller
- Discussion:
 - Approached book with caution given the baggage that has emerged in aerospace around lean – but conclude that the book is valuable in addressing these very issues through a re-framing of the concept of lean taking into account “enterprise” and “value.”
 - Role of “monuments” enabling success in one era and being a barrier in the next
 - Role of “islands of success” as not diffusing
 - Need to better attend to the role of Jack Welch at GE and lean principles – power of Six Sigma in establishing cadence across an enterprise