COMPLEX SYSTEMS ENGINEERING

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Large Engineering Failures

- Complex system development tends to fail when performed in the classical sense
  - Over 50% “Challenged”
  - Under 20% on time
  - Other 30% are abandoned
- Eg. FAA Advanced Automation System
- Due to inherent complexity

System Function – Responsible Organization	Years of Work (outcome)	Approx. Cost M=Million, B=Billion
Vehicle Registration, Drivers license – Calif. DMV [3,10,23,24,39,40]	1987-1994 (scrapped)	$44M
Automated reservations, ticketing, flight schedul-ing, fuel delivery, kitchens and general administration – United Air Lines [27]	Late 1960s–Earl y 1970s (scrapped)	$50M
State wide Automated Child Support System (SACSS) – California [12,37]	1991-1997 (scrapped)	$110M
Hotel reservations and flights – Hilton, Marriott, Budget, American Airlines [26]	1988-1992 (scrapped)	$125M
Advanced Logistics System – Air Force [38]	1968-1975 (scrapped)	$250M
Taurus Share trading system – British Stock Exchange [16]	1990-1993 (scrapped)	$100–$600M
IRS Tax Systems Modern-ization projects [34]	1989-1997 (scrapped)	$4B
FAA Advanced Automation System [35]	**1982-1994 (scrapped)**	**$3–$6B**
London Ambulance Service Computer Aided Dispatch System [30]	1991-1992 (scrapped)	$2.5M, 20 lives

Complex System Innovations

- The field of complex systems helps solve some problems with these failures

- Two answers are provided:
  - Change of objectives
  - Use of an evolutionary process

Evolution vs Incremental Engineering

- Evolution assumes many different systems exist at once, changing in parallel

- Testing is done “in the field”
  - Learning about effective solutions occurs through direct feedback with the environment

Enlightened Evolutionary Engineering

- Different strategies are introduced
- Most efficient strategies spread throughout the system
- Less efficient strategies are slowly abandoned

Application to Air Traffic Control

- Must keep the old system in place while using the new system for redundancy
  - Train new employees with the new system
  - The old employees may override using the old system in emergencies