Finding opportunities for commonality across complex systems: A study of unmanned aircraft systems

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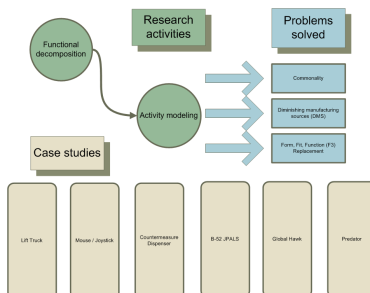Committee: Olivier deWeck, Missy Cummings, Eric Rebentisch

Motivation / Problem

- The DoD is making large investments in acquiring combat capability through acquisition of UASs

- In order to meet combatant commanders' requirements for The Long War (Global War on Terrorism), services have increased the quantities and types of UASs fielded
  - Many contractors and program offices have independently developed and fielded systems with overlapping functionality

- The GAO and OSD have directed that commonality be increased so that cost savings are realized

- As more systems are fielded, logistics tails for independent systems must be maintained at costs of inventory, transportation, training, repair, and more

- Literature focus is on developing commonality from "clean sheet" designs for product families instead of the case of increasing commonality across existing architectures and systems
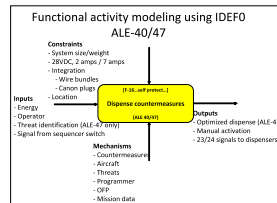
Key Question(s)

- How can opportunities for commonality be discovered across multiple systems?

- How can decisions be made to determine the technical applicability of a proposed system as a replacement for a current system?

- How do stakeholders impact the implementation of commonality across systems?

Methodology

The Research

Functional activity modeling using IDEF0
ALE-40/47

ALE-40/47

- Developed taxonomies for identifying functions across systems

- Functional decompositions of systems performed and multiple levels compared to find common modules

- Systems characterized through activity modeling using IDEF0

- Comparisons performed by calculating differences between activity model generated matrices and analyzing differences

- Stakeholders identified and mapped to their interests related to commonality

- Commonality solution developed by screening technically feasible solutions with stakeholder preferences

Hypothesis: Driving commonality across complex systems requires a rigorous process to implement and realize the benefits

Global Hawk: RQ-4A
Source: Janes.com

Predator: RQ-1A
Source: Air Force Link

Reaper: MQ-9
Source: Air Force Link

Fire Scout: RQ-8A
Source: Janes.com

Predator Ground Station
www.af.mil

Fire Scout Ground Station
www.irconnect.com

Global Hawk Ground Station
(Mission Control Element)
www.directionsmag.com

Preliminary Results

- Method for finding commonality opportunities has been developed and tested by the researcher in several domains

- The functional decompositions can be mapped to physical instantiations and compared across systems
  - Specifications can be compared to determine suitability of physical modules into another system

Collapsed Delta ICOMs		Category of Delta	Delta resolution	Primary Stakeholder	Cost estimate
Parameter(l)		Severe, Major, Minor, None	PM, EN, Prime and/or OEM		Future growth
Attribute	Metric	Value			
Operator	Automatic	Yes	Minor	All	Operator
	semi-automatic	Yes	Minor	All	Operator
Signal	Threat ID	Yes	Minor	All	Operator
	Sequencer to do	1	Minor	OEM	EN, Prime, OEM
Weight	Pounds	-8	Minor	EN	EN, Prime
Payload	Advanced CM	Yes, 0-60	Minor	All	Operator
Aircraft sequence	Group A wires	1	Major	Prime	Maintenance
	Group A Connec	12-pins	Severe	Prime	Maintenance
Dispense	Chaff	Optimized	Minor	All	Operator
	Flares	Optimized	Minor	All	Operator
	Advanced	Optimized 1, 2	Minor	All	Operator
	Automatic	Yes	Minor	All	Operator
Mission data	Adaptive	Yes	Minor	All	Maintenance

Remaining Research

- Transition from researcher-led method applications to practitioner-led studies
  - Evaluate method from observer status

- Future Research
  - Formalize cost estimating analysis to improve financial estimates
  - Automate comparisons of systems

Wrap Up

- Expected Contributions

- Process to allow DoD system program managers to identify opportunities for commonality with other complex systems
  - Areas for future consideration:
    - Communication systems
    - Ship management
    - Aircraft engines

Dave Long