SYSTEMS ENGINEERING RESEARCH CENTER

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

ART-016 Integrated Mission Equipment (IME) Architecture Process for Vertical Lift Systems

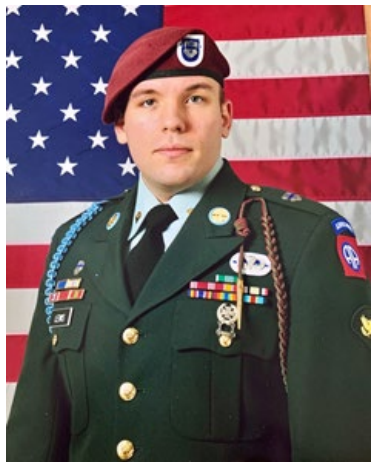
Dr. Bryan Mesmer, The University of Alabama in Huntsville

Research funded by U.S. Army Combat Capabilities Development Command Aviation and Missile Center (DEVCOM AvMC) under W15QKN-18-D-0040/W15QKN20F0091ART-016.

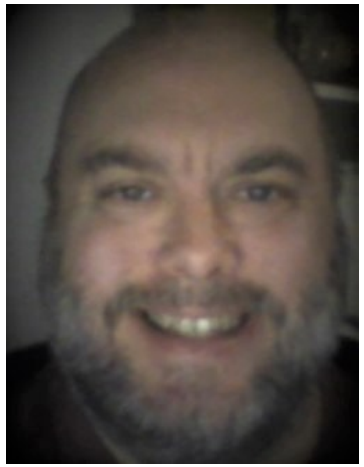
The Research Team












The Goal

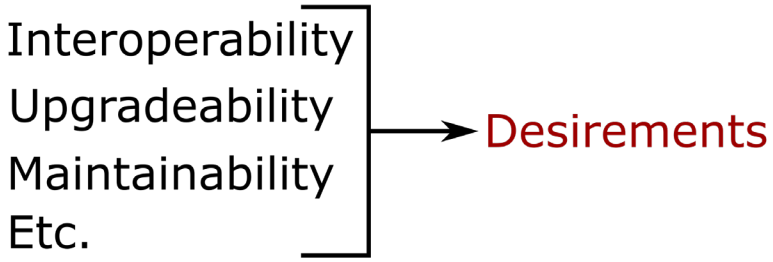
- Enable rapid integration of flight capable technology in a manner that is sustainable over the lifecycle of a platform, system, or component.

The Problem

- A Comprehensive Architecture is Needed
- "To a large extent, the Military Services develop military systems through independent procurements using a unique set of program requirements implemented by a single vendor." (Comprehensive Architecture Strategy)
- A process is needed that incorporates program business objectives

The Problem

- When program business objectives (which may vary from program to program) are identified as important they take the form of "desirements" or other weaker forms.
- Desirements are not treated as "equals" to performance requirements
  - Non-functional requirements are not included as normative requirements in typical requirements documents [Kazman 2000].
  - Desirements are often not defined in a common way
  - Leads to inconsistency between programs
  - Not verified/validated



Project Objective

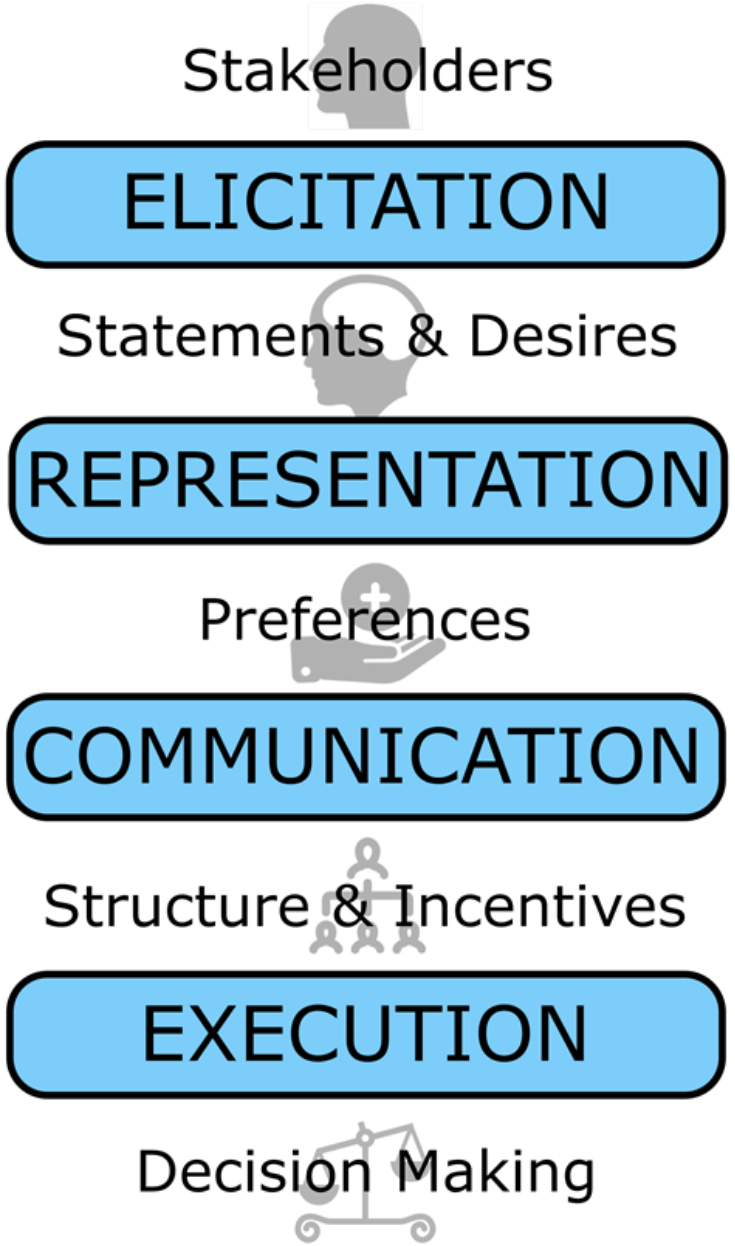
- Assist the Integrated Mission Equipment (IME) team in maturing the Comprehensive Architecture Strategy (CAS) approach by researching and developing methods for consistently applying CAS across multiple programs.
- Employ our expertise in systems engineering theory and practice, particularly the use of expressed preferences to guide decision making and mathematical alignment of contract incentives to carry this guidance across to industry.

Project Objective

- Long Term Goal: Provide a validated and rigorous systems architecture process based on evidence and theory from a broad collection of disciplines applied to a system of systems context.
  - Verify the intent of CAS.
  - Analyze CAS as a transformational system in a complex environment.
  - Make recommendations for improving the effectiveness of CAS itself.
  - Better integrate CAS with the acquisition and engineering environment.
  - Improve the transition of CAS into wider usage.

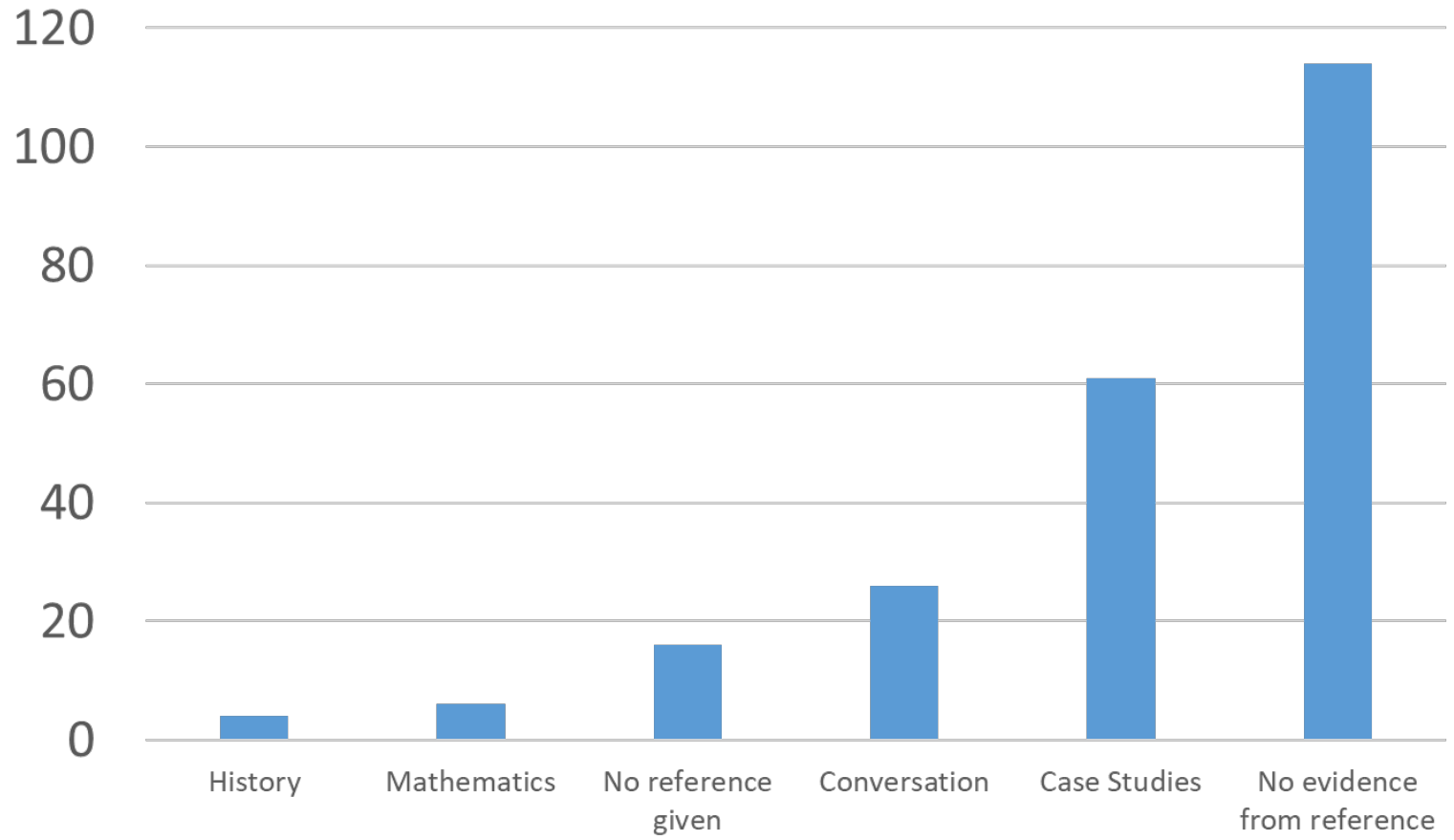
Research Structure

- Four key topics concerning preferences are investigated: Elicitation, Representation, Communication, and Execution.
- Approaches based on evidence and have been rigorously validated in their previous contexts will be implemented in CAS, with the approaches' theoretical and validation limitations characterized within this new context.



Why add more structure to architecting?

- Architecting is based on low or no evidence-based heuristics



Current Research Activities

- Documents improvements
  - Architecture Derivation Method (ADM)
  - Architecture Derivation Process (ADP)
- Training Workshop
  - Needs assessment survey
- Process Framework
  - Formation of ideal process
  - Identification of assumptions and challenges
  - Identification of recurring processes
  - Evaluation and selection of recommended processes

Documents Improvements

- Quantity
  - "Make your contribution as informative as required (for the purposes of the exchange)" (Grice)
  - "Do not make your contribution more informative than is required." (Grice)
- Quality (Truths)
  - Acknowledge when stand-in heuristics are being used and why
- Relevance
  - Ensure the specific document intent is being followed
- Manner
  - Avoid ambiguity, obscurity, etc.

Training Workshop

- Being formed by an interdisciplinary collaboration
  - Systems Engineering
  - Systems Architecting
  - Psychology
  - Continuing Education
  - Theatre
  - Dance

Training Workshop

- Grounded in a Training Needs Assessment survey
  - Establish a baseline for participant knowledge
- Example questions:
  - What is the difference between architecture and architecting?
- Will enable more targeted workshop for maximum advancement

Training Workshop

- 3 days, material in morning and activities in afternoon
- Incorporate lessons learned from prior studies/research
  - Art-based SE education
  - Improv to elicit preferences
  - Architecting in dance
- Anticipating a focus on key architecture processes
  - Later workshops to focus more specifically on CAS

Training Workshop Next Steps

- Analyze survey responses
- Identify knowledge gaps
- Form morning material
- Form afternoon activities related to material
- Develop pre and post assessment

Process Framework

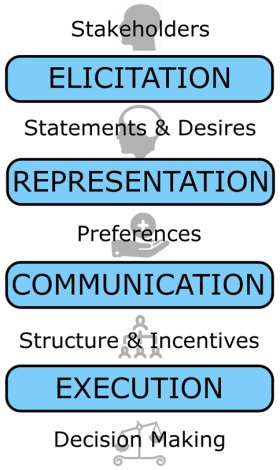
- A overview framework is needed for improved training and understanding
- Framework will be high-level and identify and link key processes that architects must perform

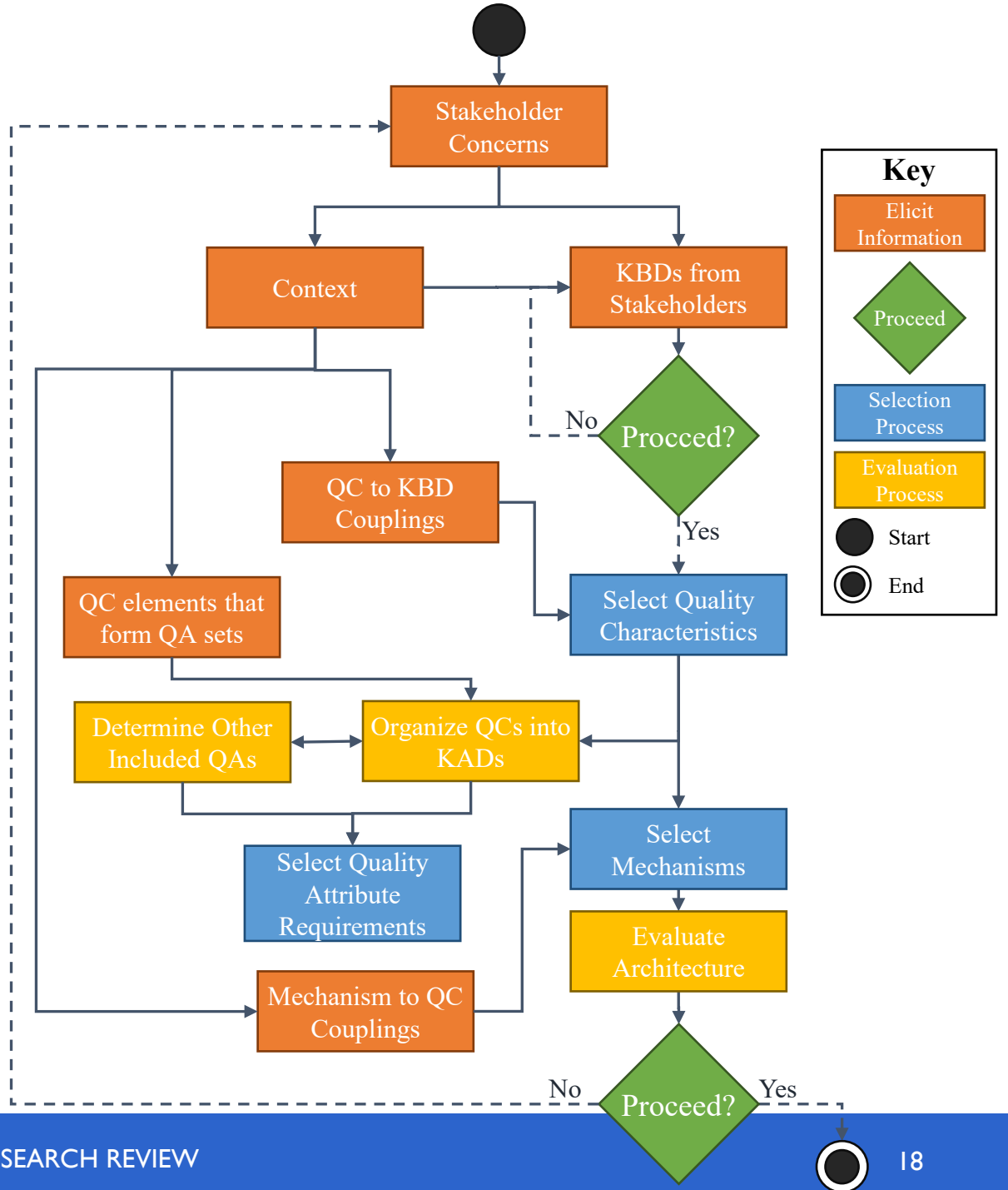
Process Framework

- Definitions agreed to by broad group:
  - Parameter- A measurable factor of a set that defines a mechanism
  - Rule- one of a set of principles governing the use of parameters to define mechanism
  - Mechanism Class- a group of mechanisms with the same set of parameters
  - Mechanism- result of applying rule set applied over a set of parameters
  - Operation-is a function which creates an effect using a mechanism in a specific context
  - Mechanism Effect- output of an operation applied to a mechanism
  - Quality Characteristic Value -a function of a mechanism effect
  - Quality Characteristic-a measurable factor of a set that defines a quality attribute
  - Quality Attribute - a name for a set of quality characteristics
  - Architecture Quality attributes – a class of qualities that describe the response of a system to internal and external changes over time

Process Framework

- Very Preliminary UAH Draft Framework
- Notice repeating processes
  - Elicitation
  - Selection
  - Evaluation





Process Framework

- Major Knowledge Assumptions:
  - Elicitation results in usable information
  - Quality characteristic to business driver coupling is known and available in a useable format
  - Mechanism to quality characteristic coupling is known and available in a useable format
  - Product specific attribute sets are known

Process Framework

- Challenges:
  - What does a value model for an architecture contain?
    - What must be there, what can be ignored?
  - What information can we expect to elicit to aid in forming the value model?
  - If attributes are sets of characteristics, then does it make sense to have attributes in a value decomposition?
  - What does improving a business concern focused value model result in if performance aspects are ignored?

Process Framework

- Challenges:
  - When should a decision be deferred?
    - How does uncertainty affect the processes?
  - What role does the envisioned products/systems impact the process?
  - What are the dials that the architect is able to turn?
    - Mechanisms?
  - How do we evaluate the goodness of an architecture?
    - Can you evaluate an architecture without system context?

Anticipated Impacts

- We expect this architectural process to transition what has been an ad hoc method that is very dependent on "heroic designers", into a more scientifically rigorous, repeatable, and reliable methodology.
- Prevent the "Vendor Lock" phenomena.
- Increase the reuse, upgradeability, expandability, and sustainability of developed and acquired systems
- Improve the interoperability of Army systems as a whole and with the Joint Force
- Increase the rate of innovation and the number of providers in the industrial base

Questions?

Bryan Mesmer

The University of Alabama in Huntsville

Bryan.Mesmer@uah.edu