INCOSE International Symposium (IS) 2022
Summary of Presentations

7/21/2022

Tony Williams, Anthony Bullion, Rey Climacosa

Ford's Connected-Agile, Model Based Systems Engineering and Simulation Journey….so far.

- Authors: Christopher Davey, Global R&A Senior Global Manager for Systems Engineering, System Safety, Modelling & Simulation and Senior Technical Leader in Software & Control Systems Engineering, Ford Motor Company
- Topic: How to employ systems engineering in projects where the project/company does not see the value of systems engineering
- Key takeaways:
  - Ford stole the show in the final plenary presentation - Davey presented a comprehensive discussion of the Ford Agile/DE/MBSE capability that is not a vision, but is in place today, and was instrumental in delivery of recent hi-tech Ford products like the all-Electric F-150 Lightning and the BlueLine self-driving capability.
  - Key elements
    - Continuous MBSE/Simulation & Modeling/Verification and Validation/Deployment
    - Millions of scenarios simulated to validate performance in diverse conditions weather/lighting/traffic/terrain/etc., using sim environments
    - Digital sims enable rapid exploration of design space without need for hardware
  - Key Takeaway – Ford is not doing DE and MBSE based on some governmental directive, but based on a motivation for profit, market share, and stockholder profit. While evolving the NASA culture towards this vision will take time and effort, JETS has the ability to position our system engineers to take advantage of opportunities to incrementally implement MBSE and DE, by doubling down that our staff are highly trained, and equipped with tools and MBSE methodologies. This will help our projects succeed and assist our partner in agency-wide adoption.

Tutorial: Building Really Big Systems with Lean-Agile Practices

- Authors: Harry Koehnemann, Scaled Agile, Inc.; Robin Yeman; Project & Team, Inc., Jeff Shupack
- Topic: How to employ systems engineering in projects where the project/company does not see the value of systems engineering
- Key takeaways:
  - Agile is about setting up and answering smaller questions, getting learning in smaller bites and continuously improving our Design-Build-Deliver capability
  - Products need to be designed to be updated and evolved.
  - Specs should capture only the knowns, and allow the team to work on filling in the rest, then revise the spec
  - DE is a major enabler
  - Design your development based on your acceptance testing, initial increments based on the tests that you plan
  - Organizing along value stream
  - Synchronize development cycles across team to maximize integration opportunities cycles

You Can't Touch This!: Logical Architectures in MBSE and the UAF

- Authors: Matt Hause, SSI
- Topic: Logical architectures can be defined using MBSE languages such as the systems modeling language (SysML) and is implicit in architecture frameworks such as DoDAF, MODAF, NAF and their implementation in UAF using SysML.
- Key takeaways:
  - While I worked with the DoD, I was familiar with the evolving architecture frameworks, including C4ISR and DODAF. At NASA, I had not previously understood the relevance to NASA system development. In The DoD, these frameworks are critical to implementation of large systems of systems (satellite sensor – fusion center – communications network – weapon system platform – for example), and the standardization of perspectives really helped in this integration.
  - The recently evolved Unified Architecture Framework (UAF), built on SysML, is used to define the overall goals, strategies, capabilities, interactions, standards, operational and systems architecture, systems patterns.
  - One negative about the typical MBSE framework is the lack of a 'standard methodology.' Different practitioners can follow totally different approaches and the resulting products are difficult or impossible to integrated. The UAF offers templated views that provide an intuitive and more standard approach.

Mobility and System Engineering Integration

Carla Bailo – CEO Center for Automotive Research

- Tuesday Keynote Speaker
- Abstract - The automotive and mobility industries have been experiencing undergoing dramatic shifts in the last decades. Emerging modern methodologies such as electrification, digitalization, artificial intelligence (AI), connectivity, automation, and shared mobility have collided with new ways to move people and goods. This technology is driving innovations such as mobility charging solutions, ride-hailing and sharing, and robotics. This is totally disrupting the mobility ecosystem of today and creating a much more equitable future. This presentation will review the industry and technology updates its systems engineering impact on product development, infrastructure, and more.
- Key Take-aways
  - The switch to electrification has changed how the automotive industry did business for the last 40 years, need to be ready and think differently
  - ACE – automated (data ownership, right to repair), connected (vehicle to vehicle/infrastructure/cloud) and electric. Newly added Mobility (ride-sharing, car-sharing, user-ship versus ownership)
  - Impacts to stakeholders – automakers, dealers, suppliers, end customers, and government regulations
  - System wide thinking is critical. Smart City Vision – livability, workability, sustainability

MBSE – The Natural Evolution of Systems Engineering

Jon Holt – Scarecrow Consultants

- Abstract - There are many myths and misconceptions concerning the use of Model-based Systems Engineering. Perhaps one of the biggest areas of misunderstanding is that MBSE is not a subset of System Engineering but is, in itself, Systems Engineering. In this presentation, Jon will discuss the main reasons why we need Systems Engineering and then go on to expound upon how this need, particularly with regards to complexity, as evolved over the last few decades. This presentation will point out that there is nothing wrong with a traditional approach to Systems Engineering which has, as people are not shy to point out, been used for decades quite successfully. However, as the complexity of our Systems evolves, so does the need for more rigorous practices and techniques to cope with this. The main statement of this presentation is, therefore, that MBSE is a natural evolution of a more-traditional document-based approach to Systems Engineering.

- Key Takeaways
  - From “how do we model effectively and efficiently?” to “how do we deploy this within our business?”
  - Need for SE – **complexity** (*essential and accidental*), communication, and lack of understanding across life cycle.
  - Model (noun) is about consistent information, model (verb) is about managing complexity, effective communication, and increasing understanding

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MBSE – The Natural Evolution of Systems Engineering

Jon Holt – Scarecrow Consultants

2. MBSE Evolution

Stage 1: Document-based

Stage 2: Document-centric

Stage 3: Model-enhanced

Stage 4: Model-centric

Stage 5: Model-based

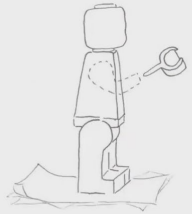
Stage 5: Model-based Systems Engineering - Outcomes

- Knowledge owned by Model

- People
  - MBSE competence
- Process
  - Mature ontologies, frameworks, process sets
  - Patterns, applications
  - Company roll-out
- Tools
  - Integrated toolsets
  - Profiles
  - Automation

Stage 4: Model-centric Systems Engineering - Outcomes

- Knowledge owned by Model and (few) documents



- People
  - MBSE competence
  - Tool competence
- Process
  - Initial ontology, framework, processes
  - Measurement and assessment of pilot
- Tools
  - Tool(s) selected

As the complexity of our Systems evolves over time…
….so must our approach to Systems Engineering…
…..MBSE is the natural evolution of Systems Engineering”

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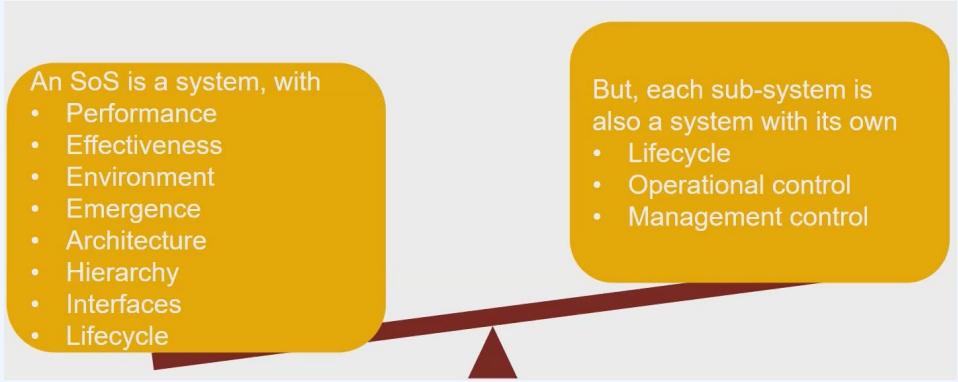
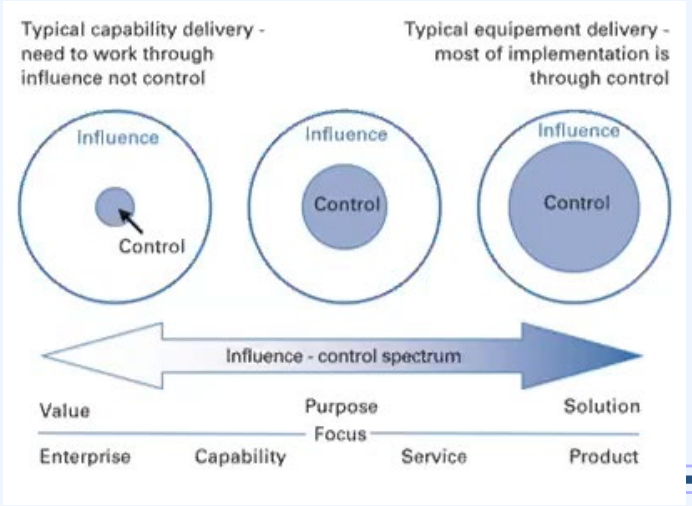
If you thought Systems Engineering was fun, wait until you try System of Systems Engineering

- Duncan Kemp – UK Ministry of Defence





System of Systems pain points

- Authority
- Constituent systems

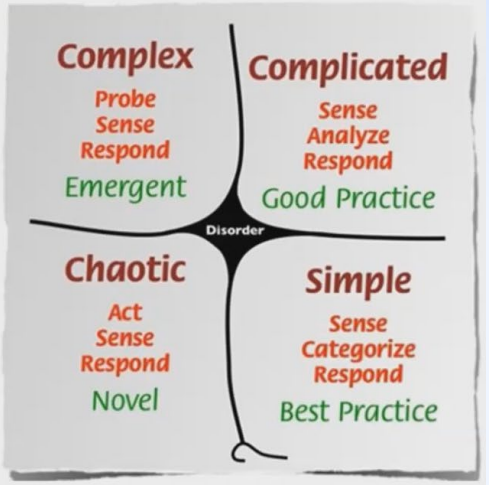
How to cope with no one 'in charge'

- Capabilities & Requirements
- Autonomy, Interdependencies & Emergence
- Testing, Validation & Learning

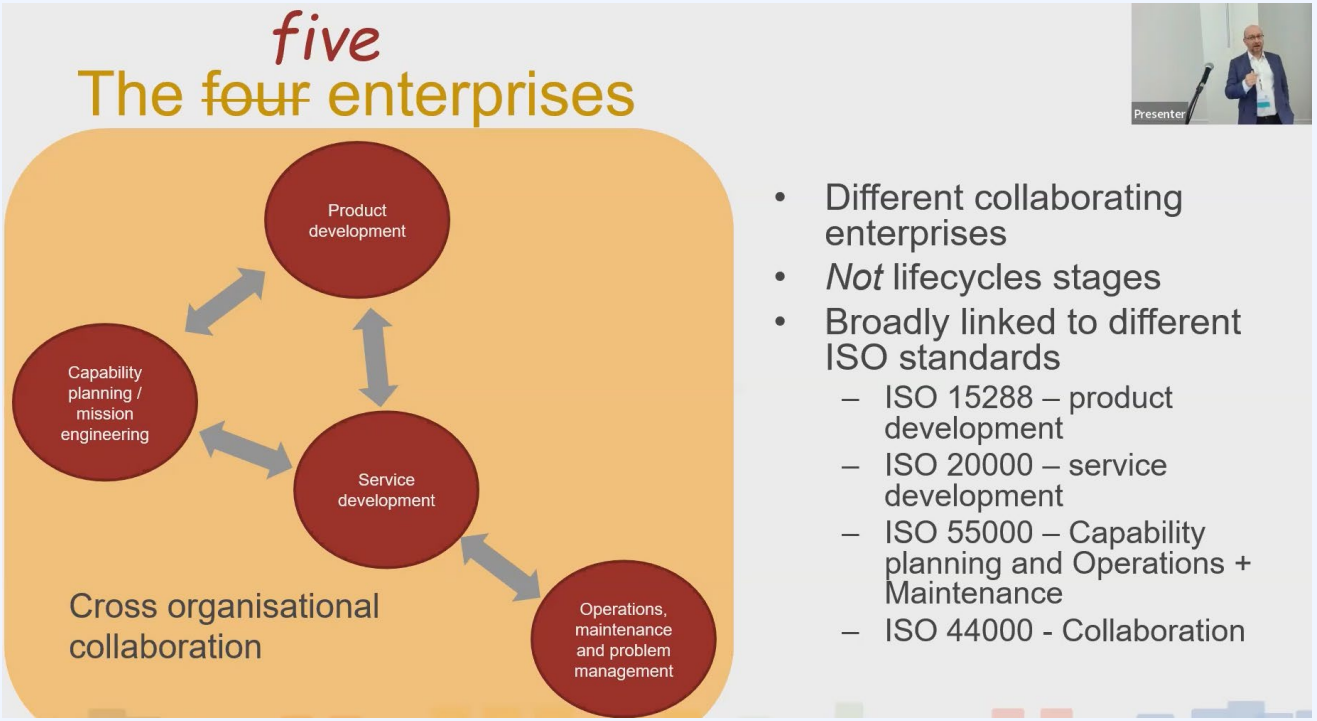
How to cope with a large complex system with 'uncontrolled' changes

- Leadership
- SoS Principles

How to lead and manage in this environment



If you thought Systems Engineering was fun, wait until you try System of Systems Engineering



Key Principles

- SoS comprise multiple systems, working to deliver multiple services. Team sport.
- Don't attempt to oversimplify, focus on sufficient consistent
- Develop integration architecture that describes functionality, performance, and commercial/organizational aspects of the SoS. More open, easier to evolve the SoS.
- Use different approaches for different enterprises, one size does not fit all.
- Integrate the different approaches. These are collaborating enterprises, not stages in a lifecycle.
- Balance cost and benefits for all
- Focus on easiest and highest value service to improve first.

By Any Other Name: Enabling Systems Engineering in an Unsupportive Environment Paper/Presentation

- Authors: Eileen Arnold and Dorothy McKinney
- Topic: How to employ systems engineering in projects where the project/company does not see the value of systems engineering
- Key takeaways:
  - Presentation is helpful for systems engineers that are in industries that are still not aware of the benefits of systems engineering in projects
  - In this environment, systems engineers are usually leading from the middle or from the back
  - Provided a matrix to determine the SE environment you are in
  - Provided a process for how to determine what SE concepts need to be applied to the project
  - Measure as you go, even the small wins. Will take time and may not get credit right away

By Any Other Name: Enabling Systems Engineering in an Unsupportive Environment Paper/Presentation

- **Recognized some cultural hinderances that were shown as examples (also in the Oil and Gas Industry)**
  - Develop knowing better than the customer
  - Leaping to point solutions
  - Lack of internal reviews
  - Fielding before testing
  - Ignoring interface concerns
  - Lack of resources
  - Lack of effective communication
- **Diagnosing the Organizational Environment and Choosing Actions to Take**
  - Characterize using 2 axes
    - Strength of top management belief in SE
      - Strong belief
      - Empty words (Lip service)
      - No belief
      - Counter belief
    - Supportiveness of cultural practices in the organization
      - Strong support
      - Weak support
      - No support
      - Opposition to SE approaches

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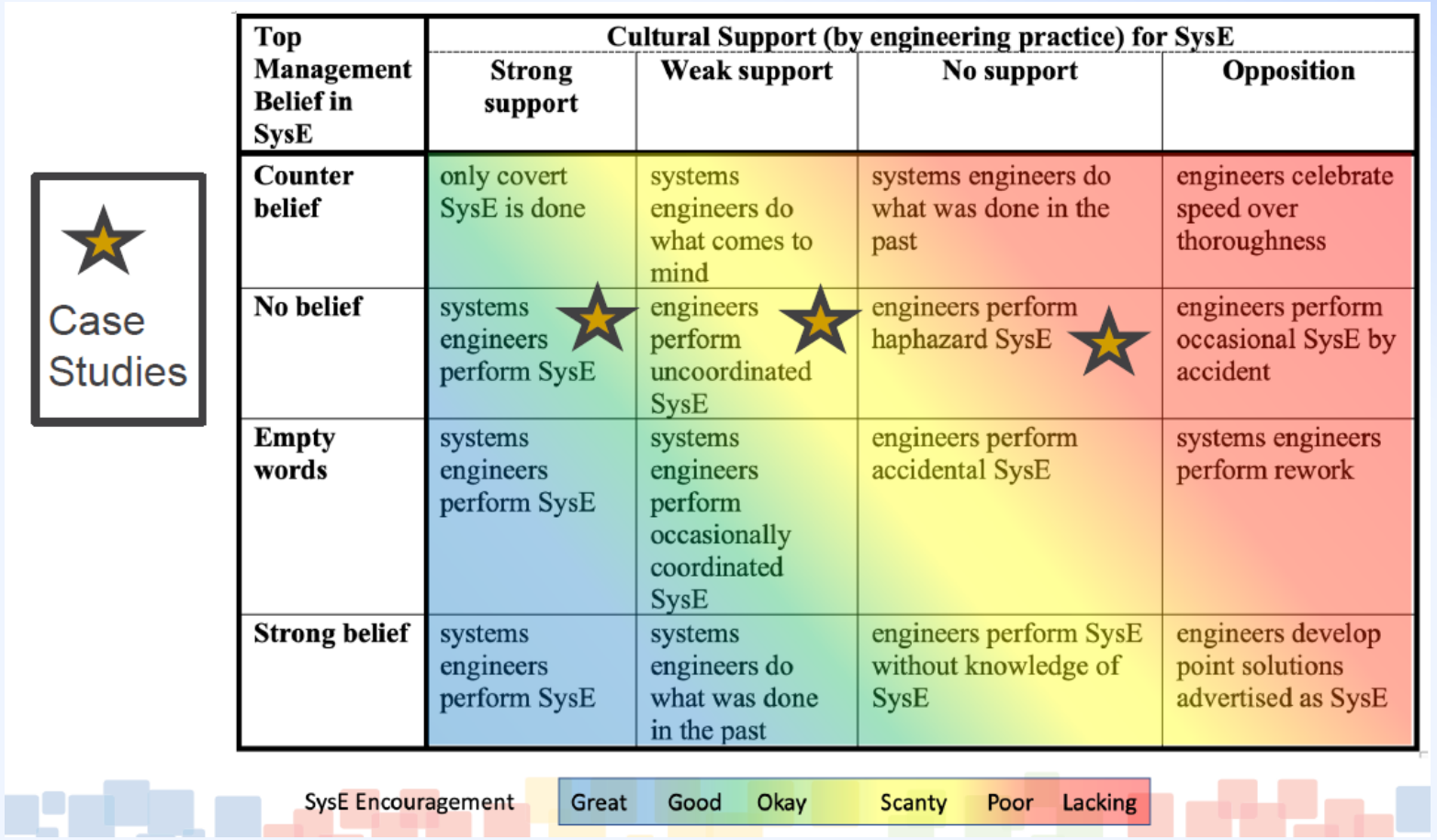
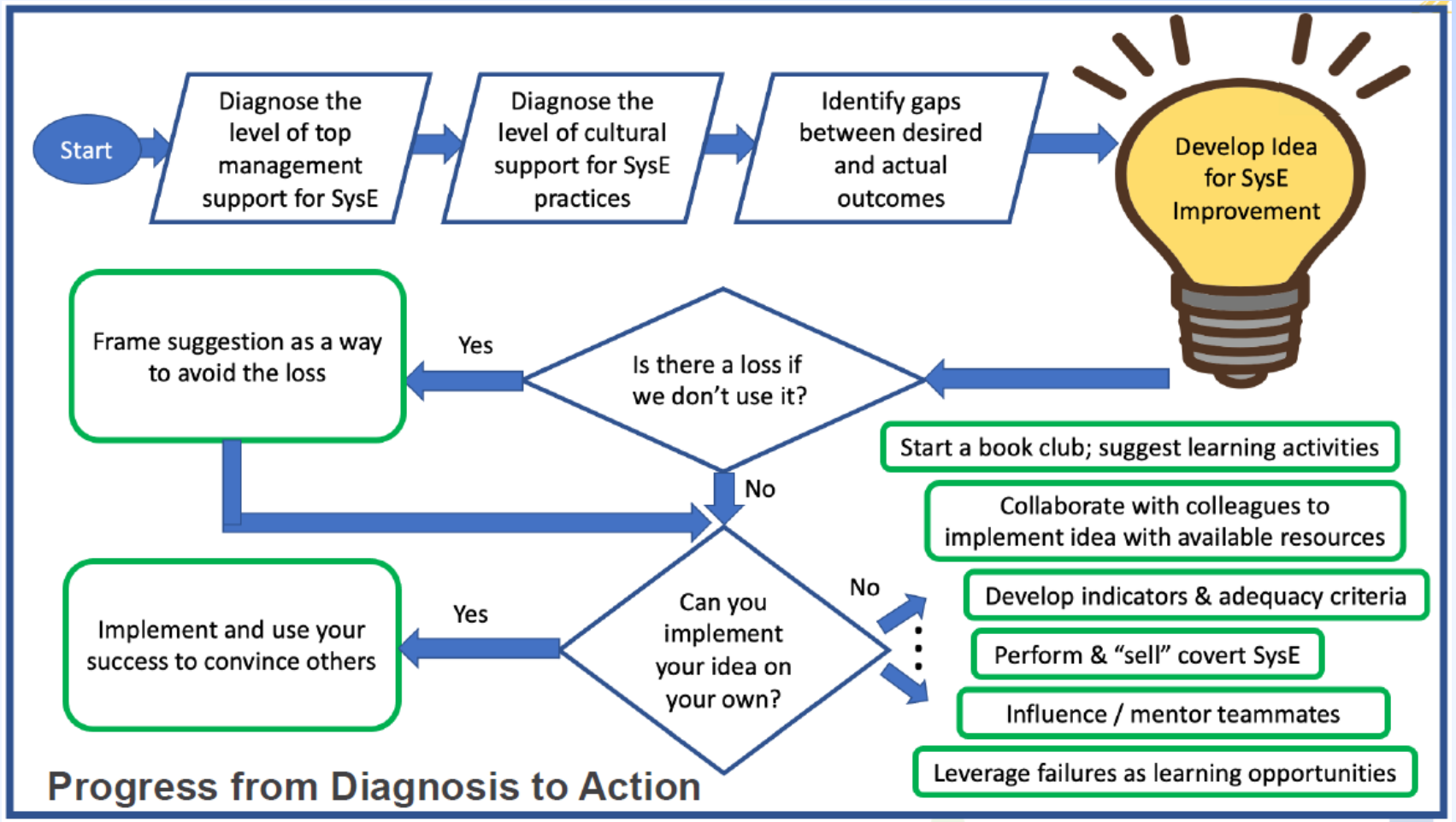
Effects: Organizational Environment on SE Case Studies

- Provided 3 different case studies based on past experience
  - Seat-of-the pants org (defense)
  - Doing SE without knowing (aerospace)
  - Fail faster (aerospace)



Progress from Diagnosis to Action

- This is like trying to asking the customer for their needs. Instead of a customer, it is the project team or your own company
- Figure out what the pain points are for the project team members then identify SE methods to help provide value to the team



What You Can Do

- **On your own (use your success to convince others)**
  - Develop indicators and adequacy criteria
  - Perform covert SE
  - Use models and tools in your own work
  - Use SE methods in your own work but do not call it that
  - Stay current on new technologies, SE approaches and trends
- **With Colleagues**
  - Start a book club
  - Suggest learning activities
  - “Sell” indicators and adequacy criteria
  - “Sell” covert SE
  - Influence/mentor teammates
  - Leverage failures as learning opportunities

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Illustrating Business Relevance of Systems Engineering via Storytelling Paper/Presentation

- Authors: Jeannine Siviy (PointClickCare), Lauren Stolzar, Dorothy McKinney (Lockheed Martin [retired]), Sarah Sheard (Carnegie Mellon University [retired])
- Topic: Using storytelling to showcase situational implementation of the right elements of systems engineering to show project success and customer value
- Key Takeaways
  - Used Pixar Story Arc:
    - Once upon a time, there was (a business situation), One day, something happened…, Because of that…, Until finally…., And ever since…
  - Provided 6 stories/vignettes for an audience of digital transformation executives
  - Quickest wins injected systems thinking, broad application of SE principles and intersection of PM/SE
  - *"The Unicorn Project"* by Gene Kim: did not use SE terms, but lessons learned were SE lessons
  - Everything is a System

Illustrating Business Relevance of Systems Engineering via Storytelling Paper/Presentation

- Example

An eCommerce Story

(for orgs who say "Systems what????")

The Story: Innovative idea for a restaurant reservation system tests organizational silos and allows Systems Thinking to shine.

Innovative Idea

Organizational Silo Prevents Collaboration

Systems Thinking Brings Together Best Ideas

Feature Launch!

Systems Thinking Fully Incorporated

The Big Idea: Looking across an organization for the best features to support a new and innovative idea allows faster time to market with fewer bugs.

Back to Basics: Fundamentals for Systems Engineering Success - Tutorial

- Presenter: David Long
- Topic: This half-day tutorial provides a primer to the foundational concepts of systems engineering within a framework for overall project success. Focused on the classic systems engineering domains of requirements, behavior, architecture, and V&V.
- Key Takeaways:
  - Recommended book: *"Team of Teams"* by Gen. Stanley McChrystal
  - 4 primary SE activities: Requirements, Behavior, Architecture, Verification and Validation
  - David Long uses "glass box" instead of "white box" to further make the point that you can see inside the box
  - Decomposing behavior in sufficient detail
    - When a function can be uniquely allocated to a single component, stop decomposing
    - Objective is congruence between behavioral and physical architecture

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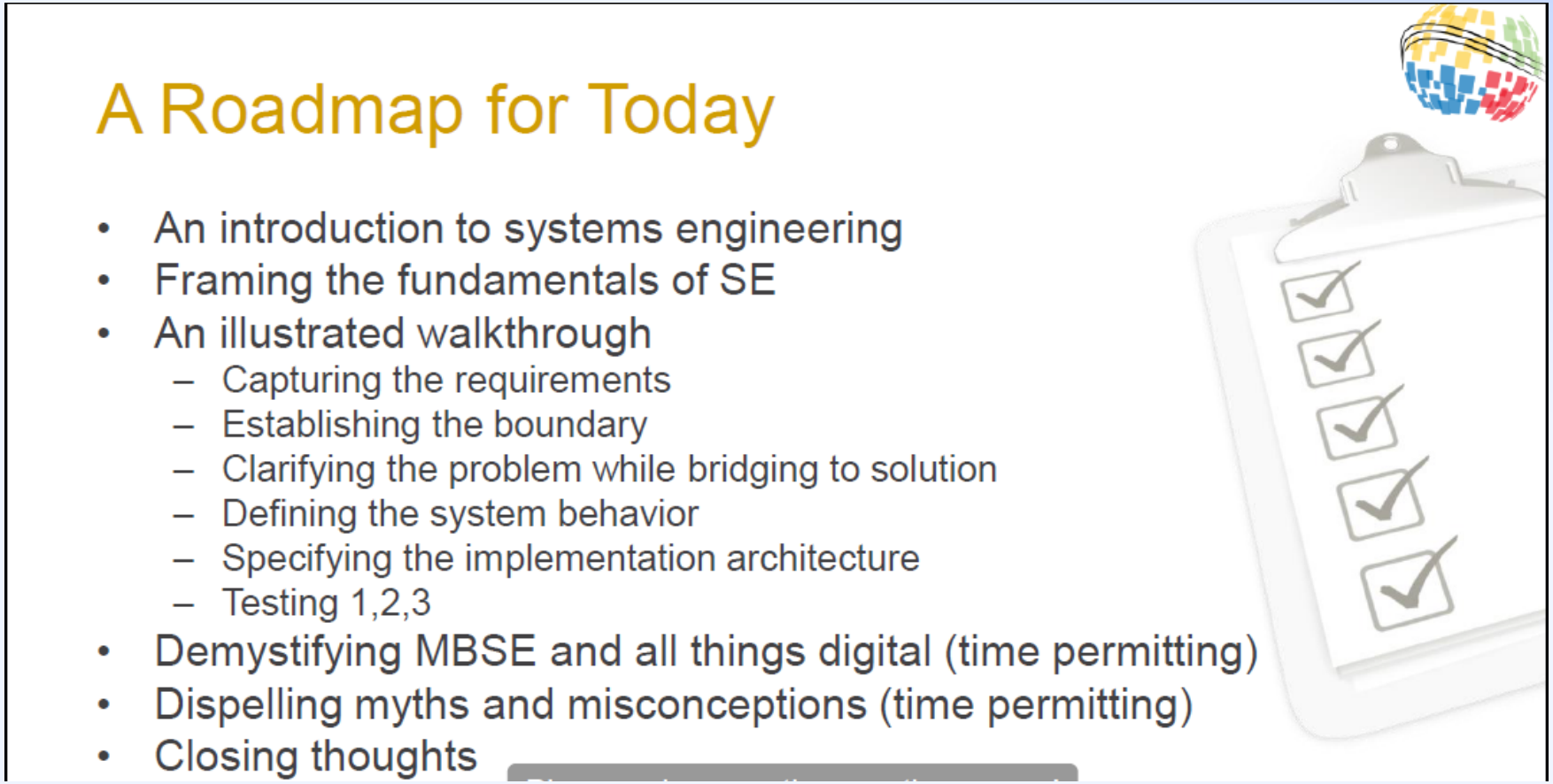
Back to Basics: Fundamentals for Systems Engineering Success - Tutorial

- 4 hour tutorial
- Agenda



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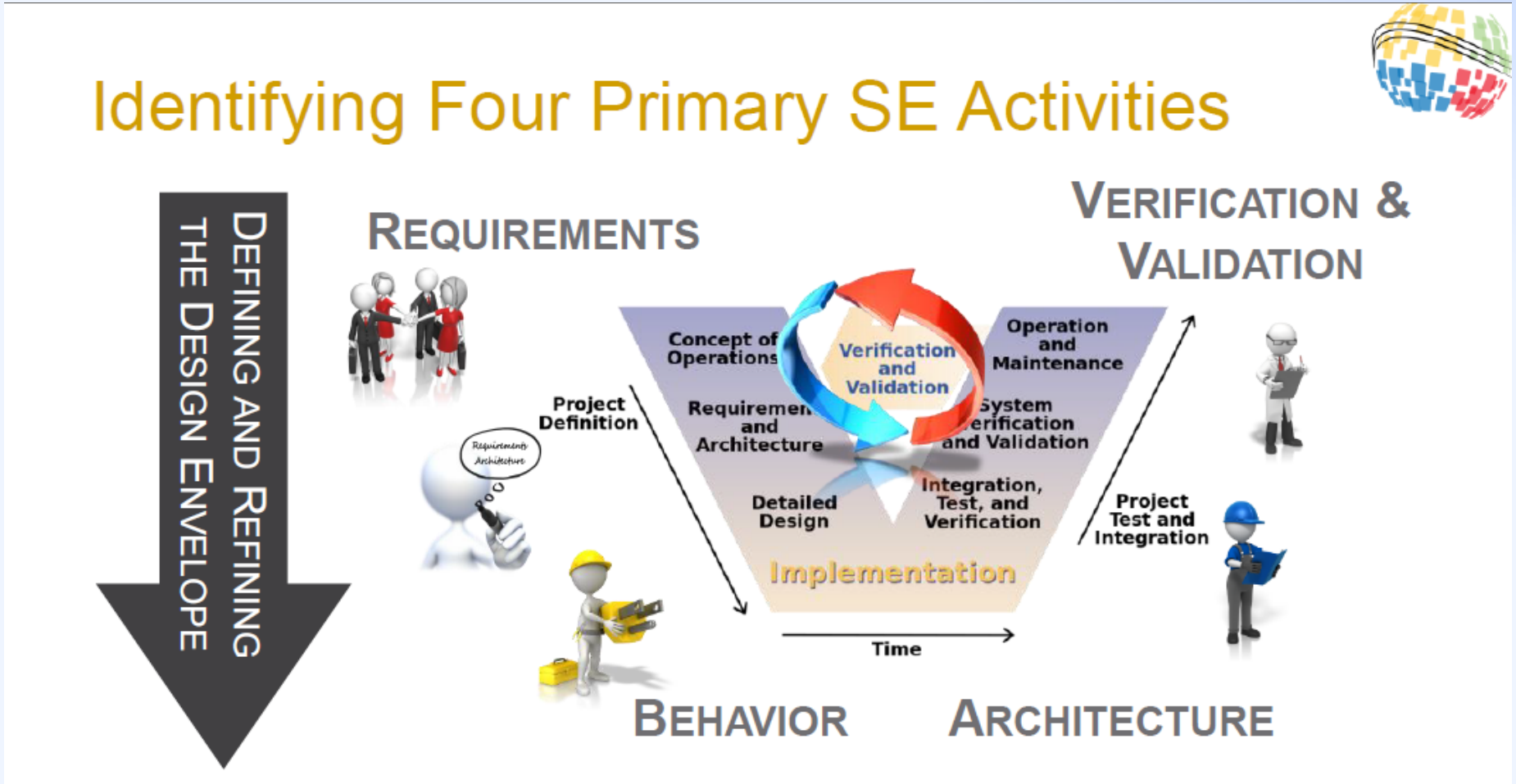

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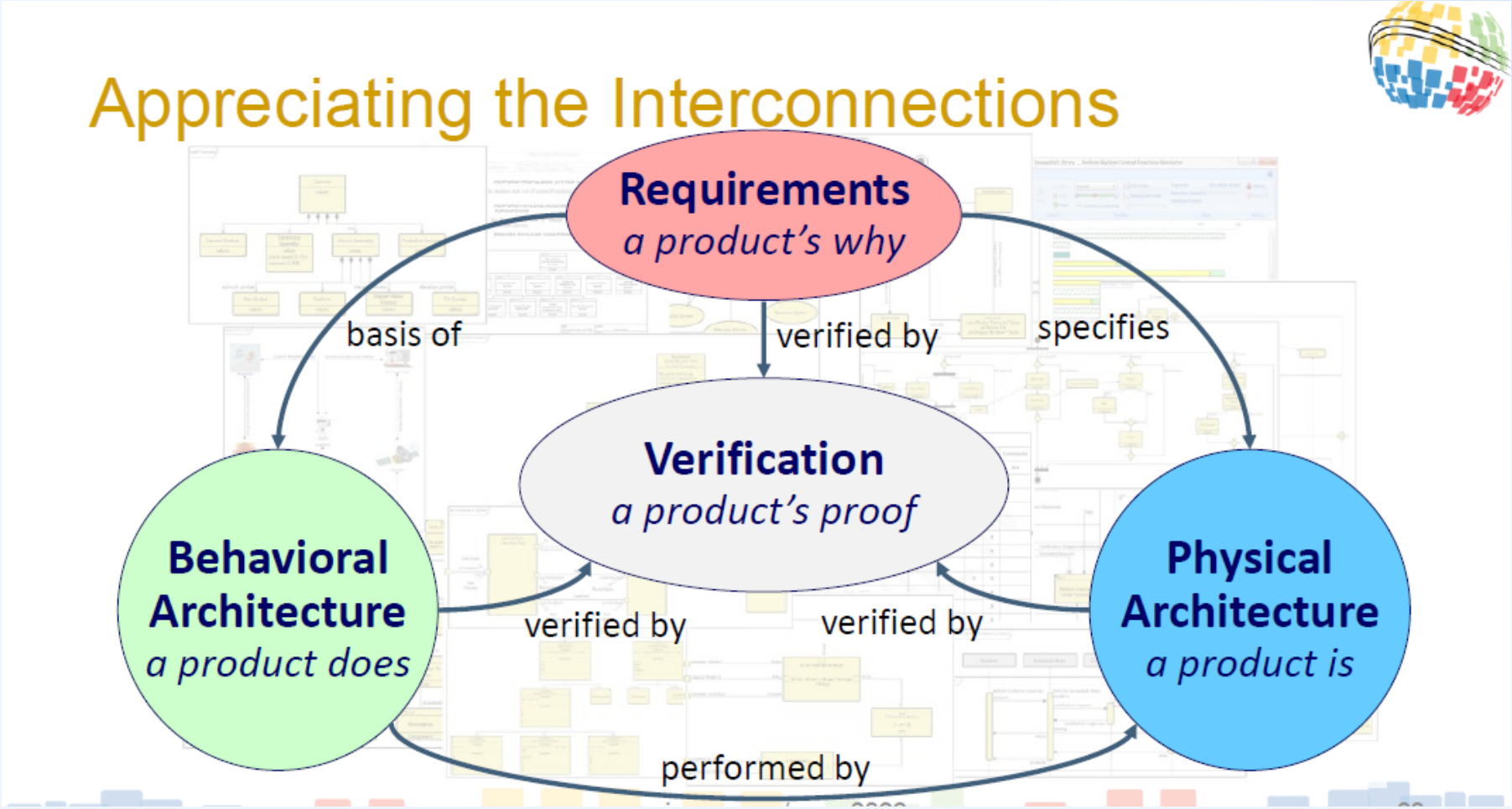

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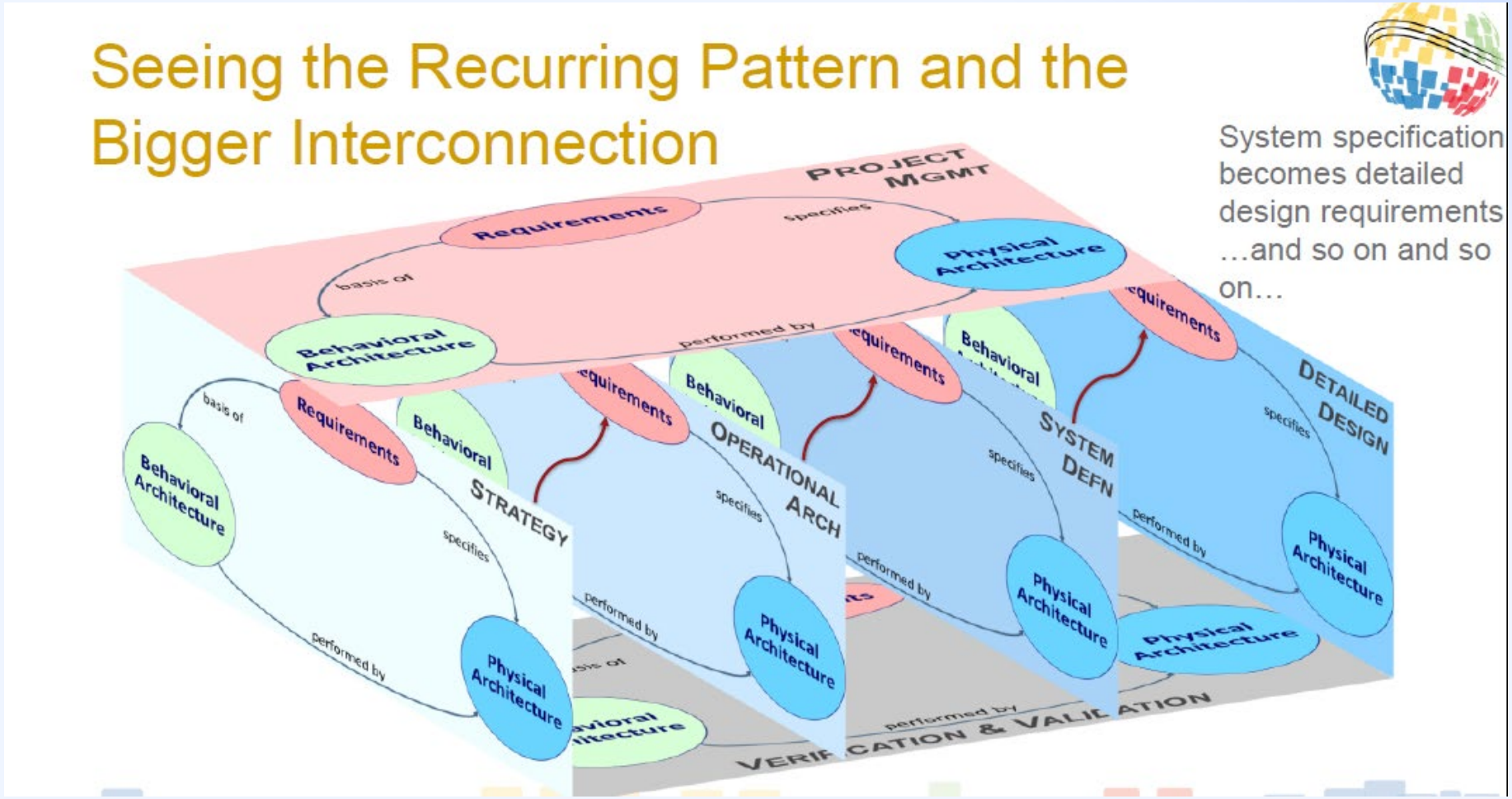

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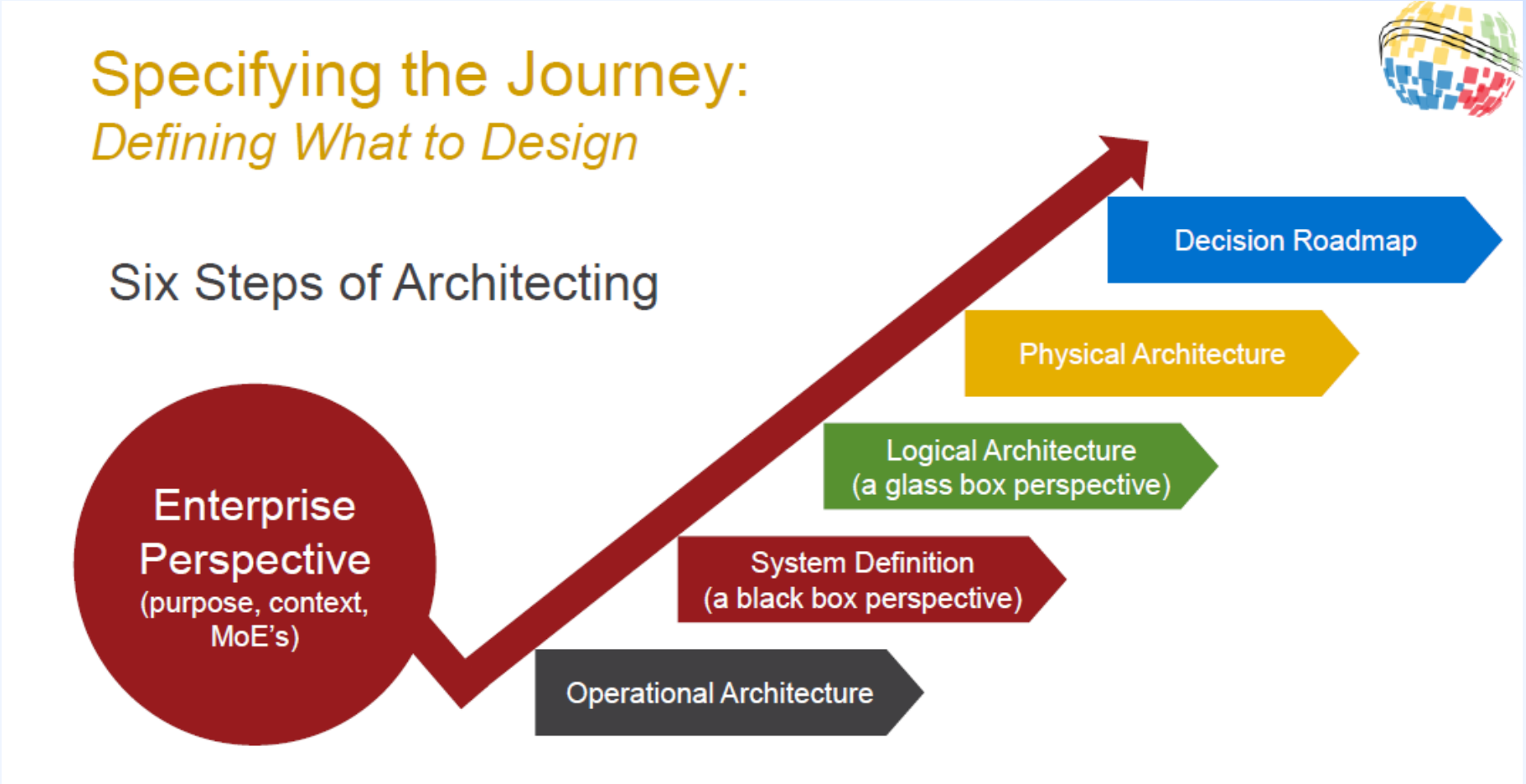

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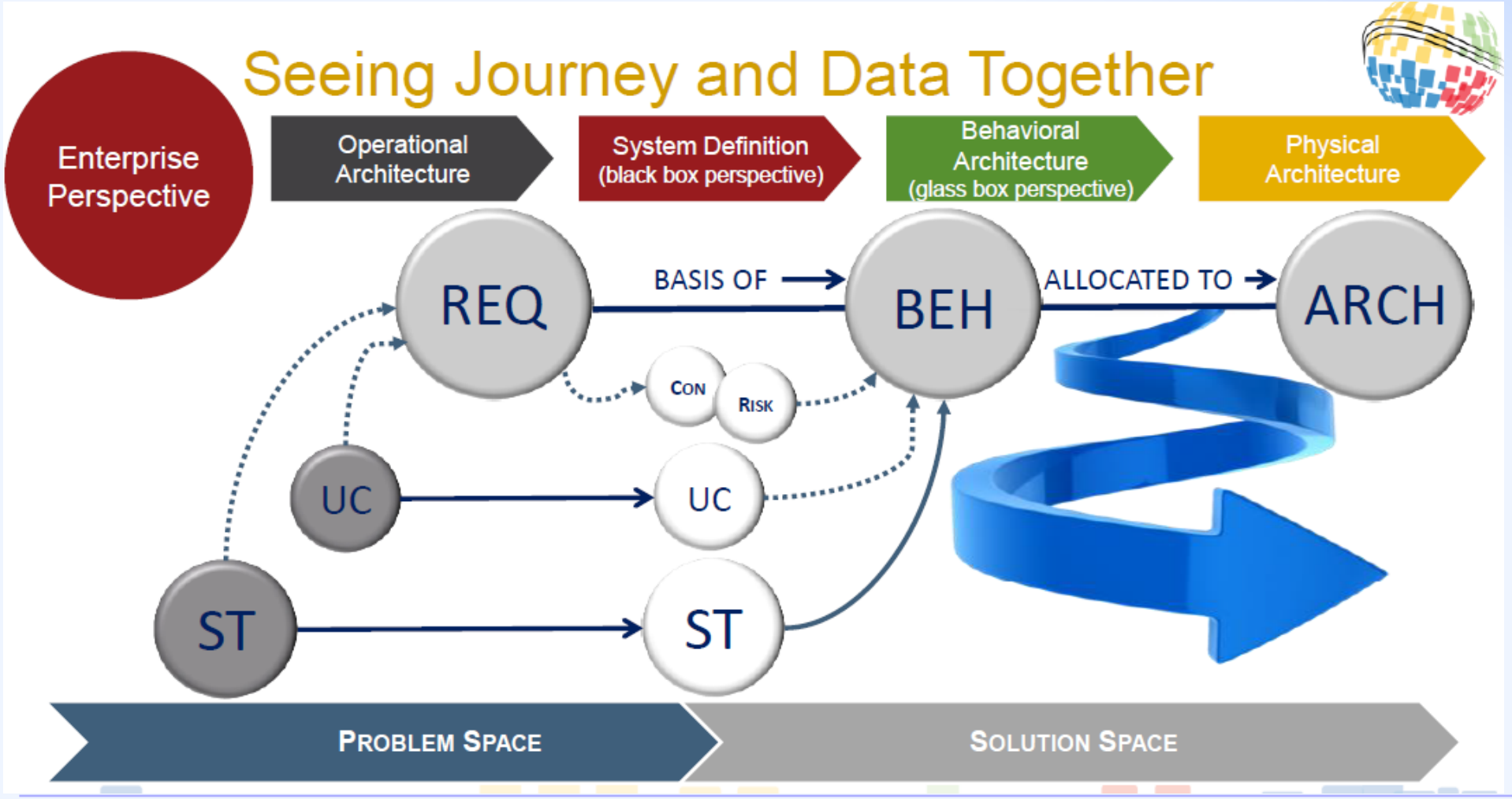

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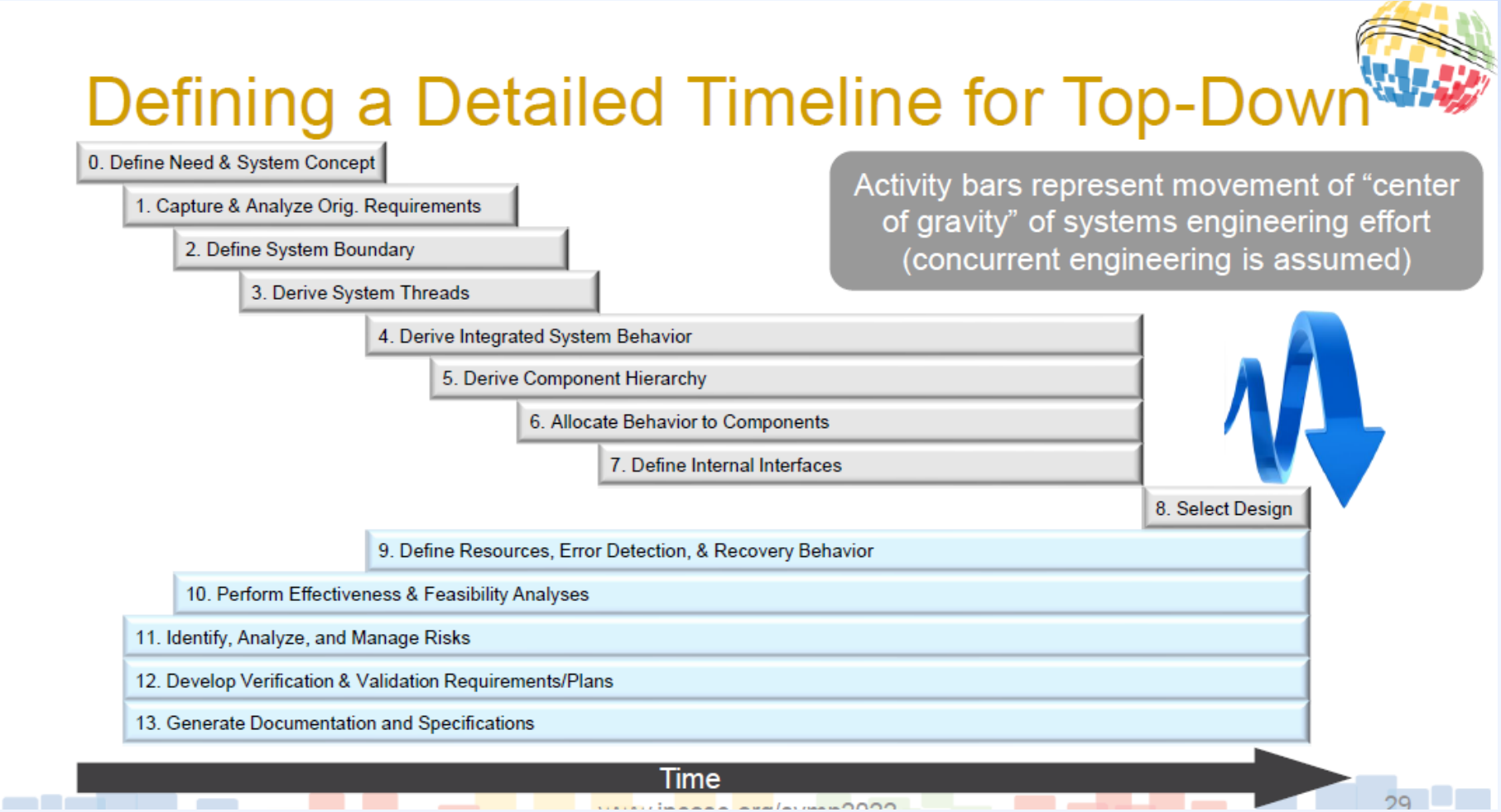
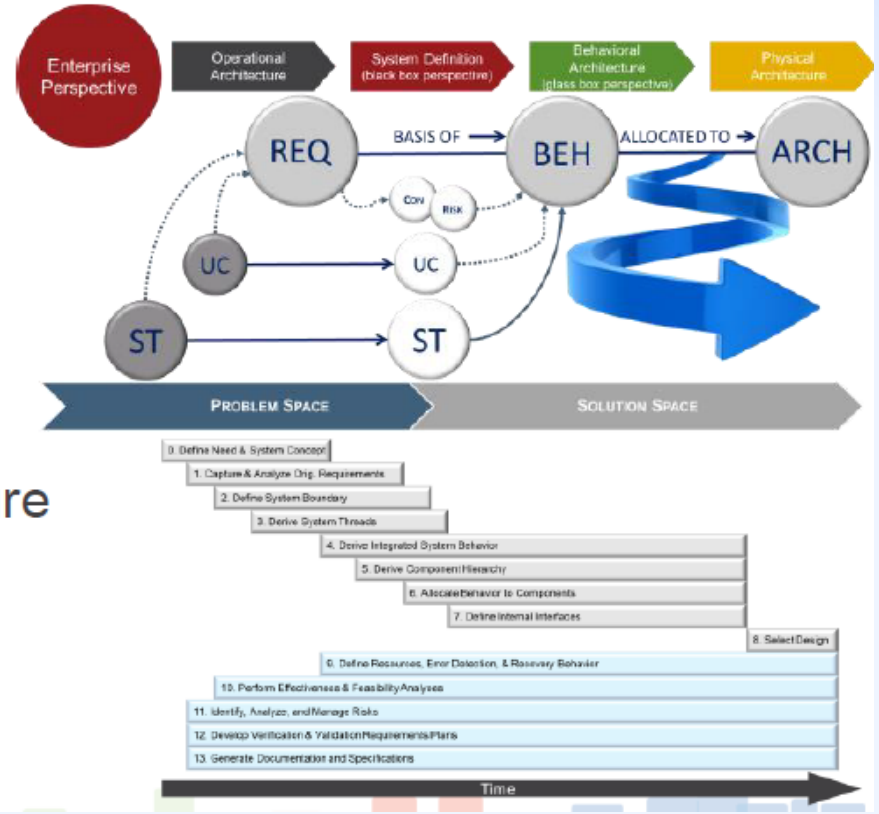


Back to Basics: Fundamentals for Systems Engineering Success - Tutorial

Framing Journey and Data Together:

Progressive Elaboration of SE

- Capture & analyze requirements
- Define the system boundary
- Analyze use cases and threads
- Identify states and transitions
- Define integrated behavior
- Specify implementation architecture
- Allocate behavior
- Analyze interfaces
- Define verification and validation



Back to Basics: Fundamentals for Systems Engineering Success - Tutorial

Weaving the Behavioral and Physical Architecture Mesh