adaptive engineering

a gamechanger in systems development

Vinny DiGirolamo

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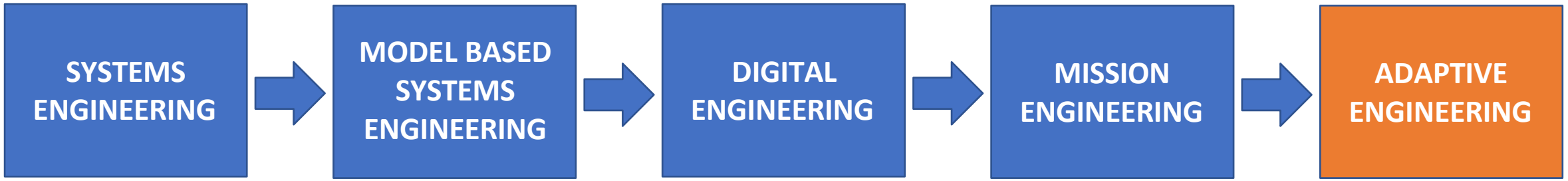
objectives

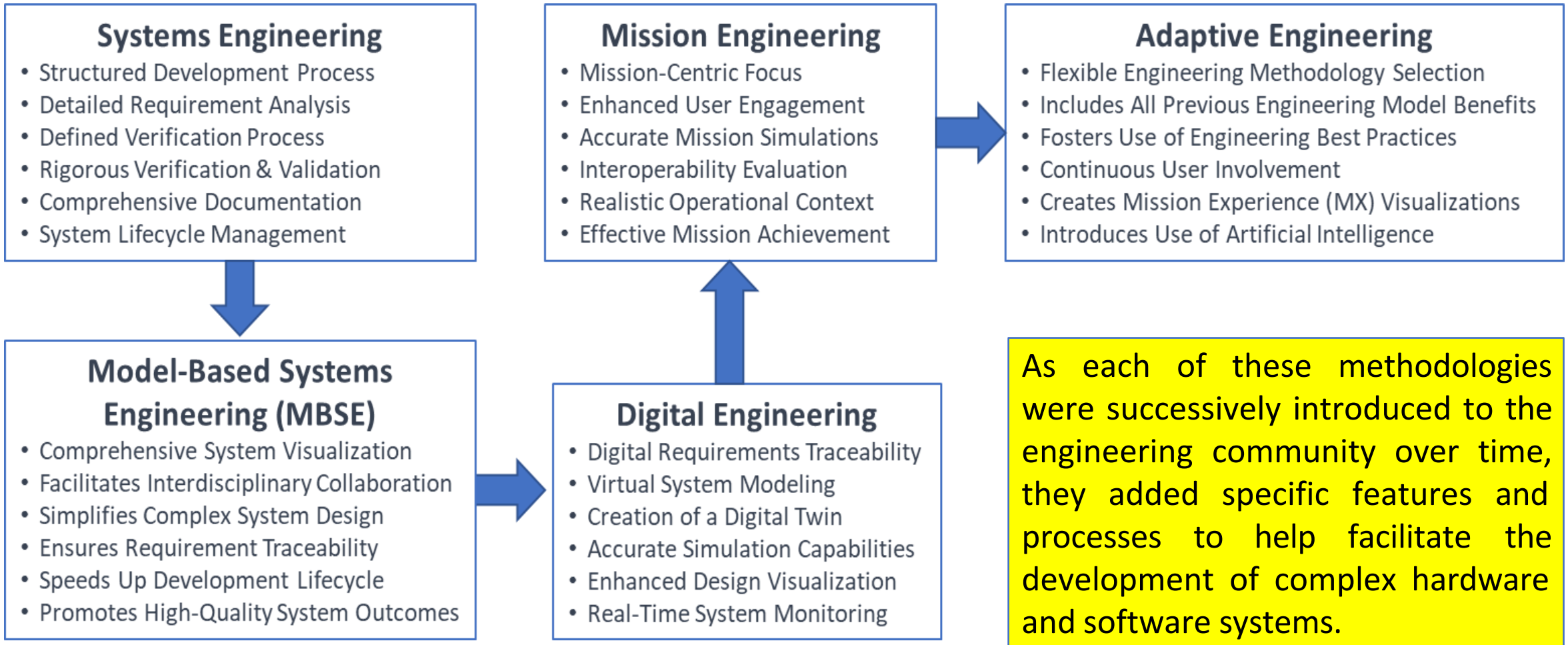
- Introduce a new concept in systems development, called Adaptive Engineering (AE), that encompasses all best practices of its predecessors, plus more.
- Introduce the foundational Systems Engineering building blocks AE embraces, its hierarchy of experience, and some new competencies needed to adapt.
- Describe what AE adds to the systems development equation
  - New Architecture Framework for Data in Motion
  - Mission Experience (MX)
  - Artificial Intelligence (AI)
- Suggest ideas on a Way Forward

adaptive Engineering Defined



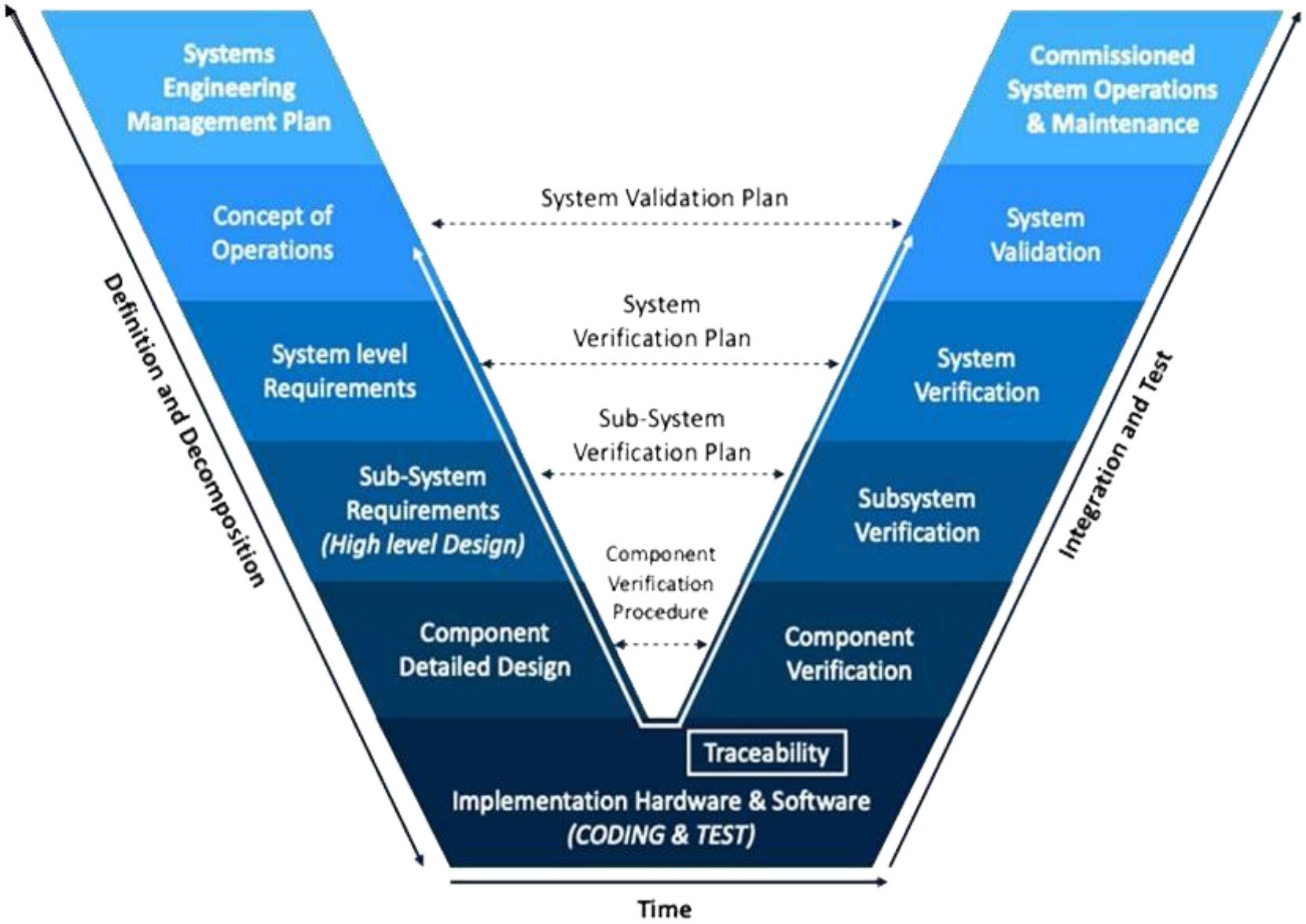
Adaptive Engineering (AE), enhanced by generative AI and data-in-motion concepts, is an all-encompassing systems development process that amalgamates and builds upon established methodologies and processes. It addresses distinct project phases, dynamically adapts to evolving requirements, leans heavily on User feedback, and optimizes every phase of a project's lifecycle.

adaptive Engineering evolution

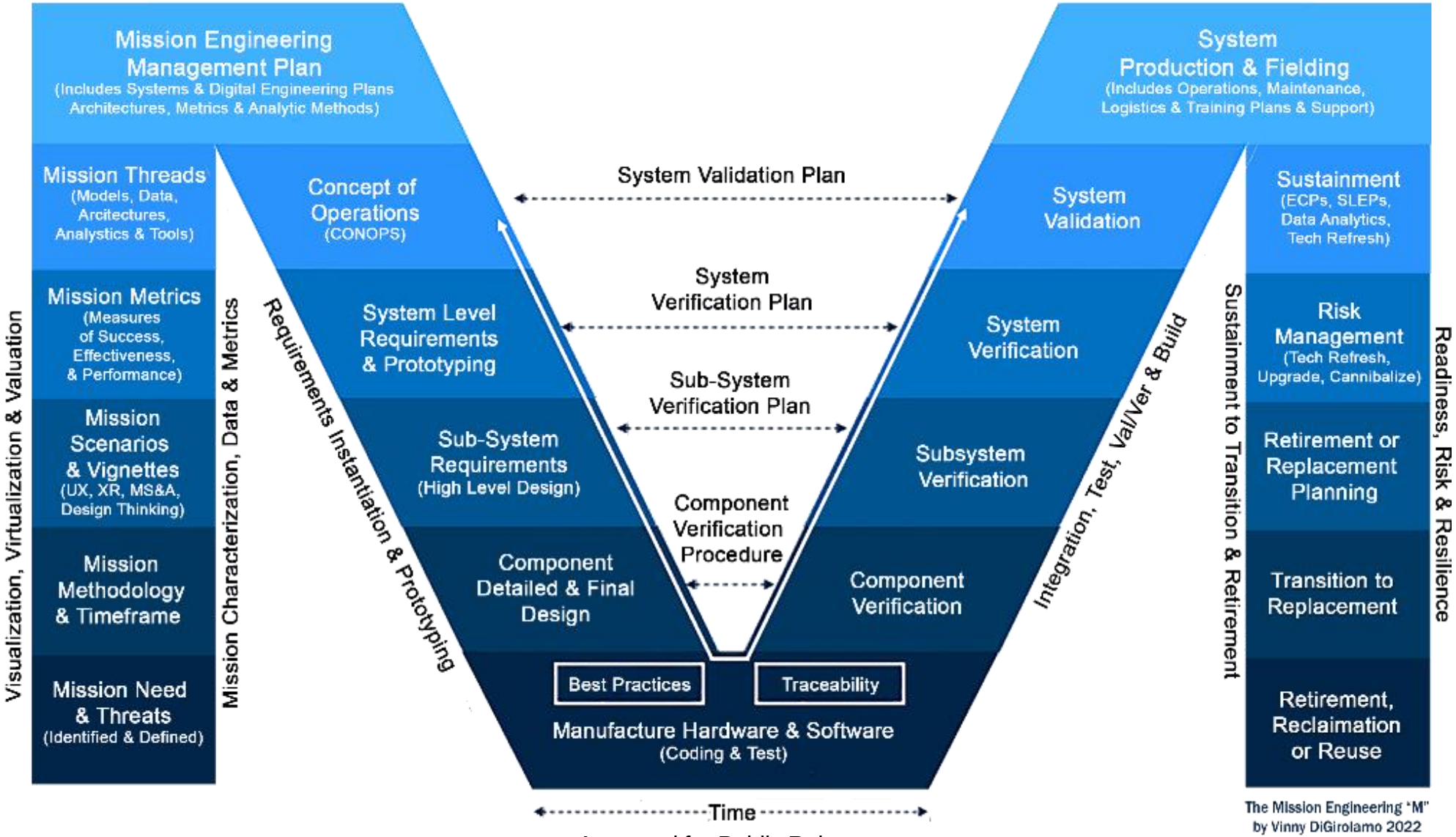


As each of these methodologies were successively introduced to the engineering community over time, they added specific features and processes to help facilitate the development of complex hardware and software systems.

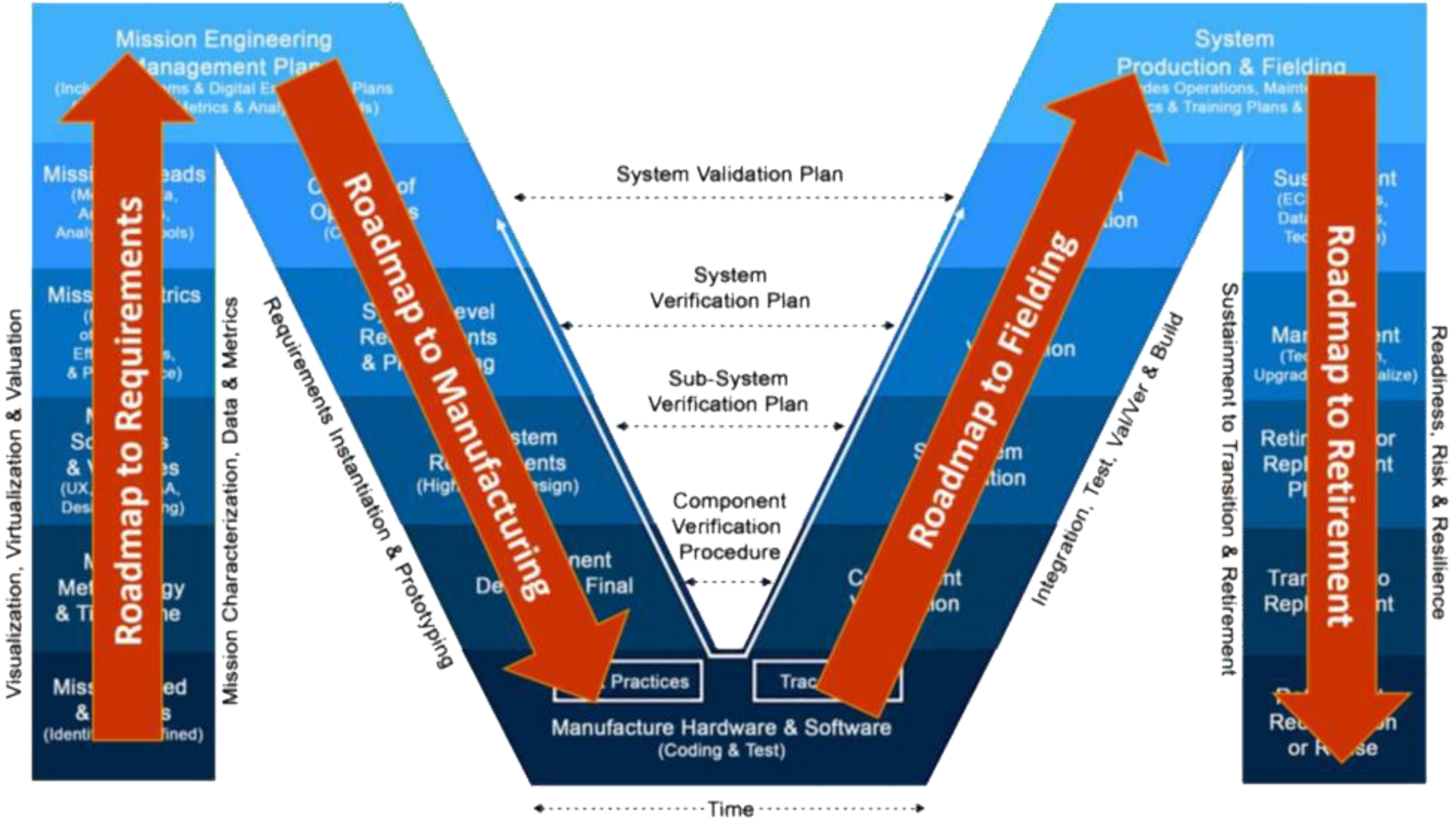
Systems engineering "v"



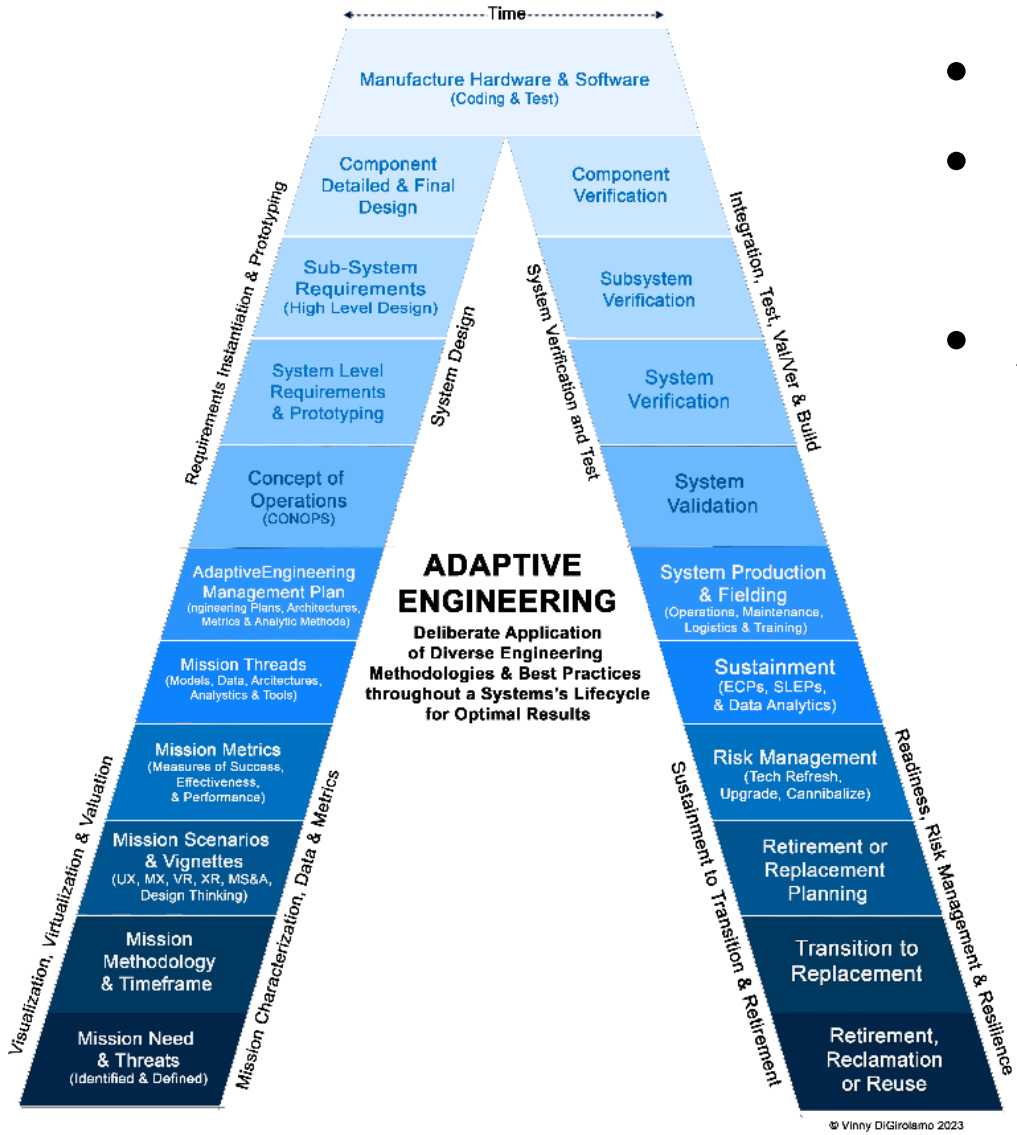
Mission Engineering "M"



4 Mission Engineering Roadmaps

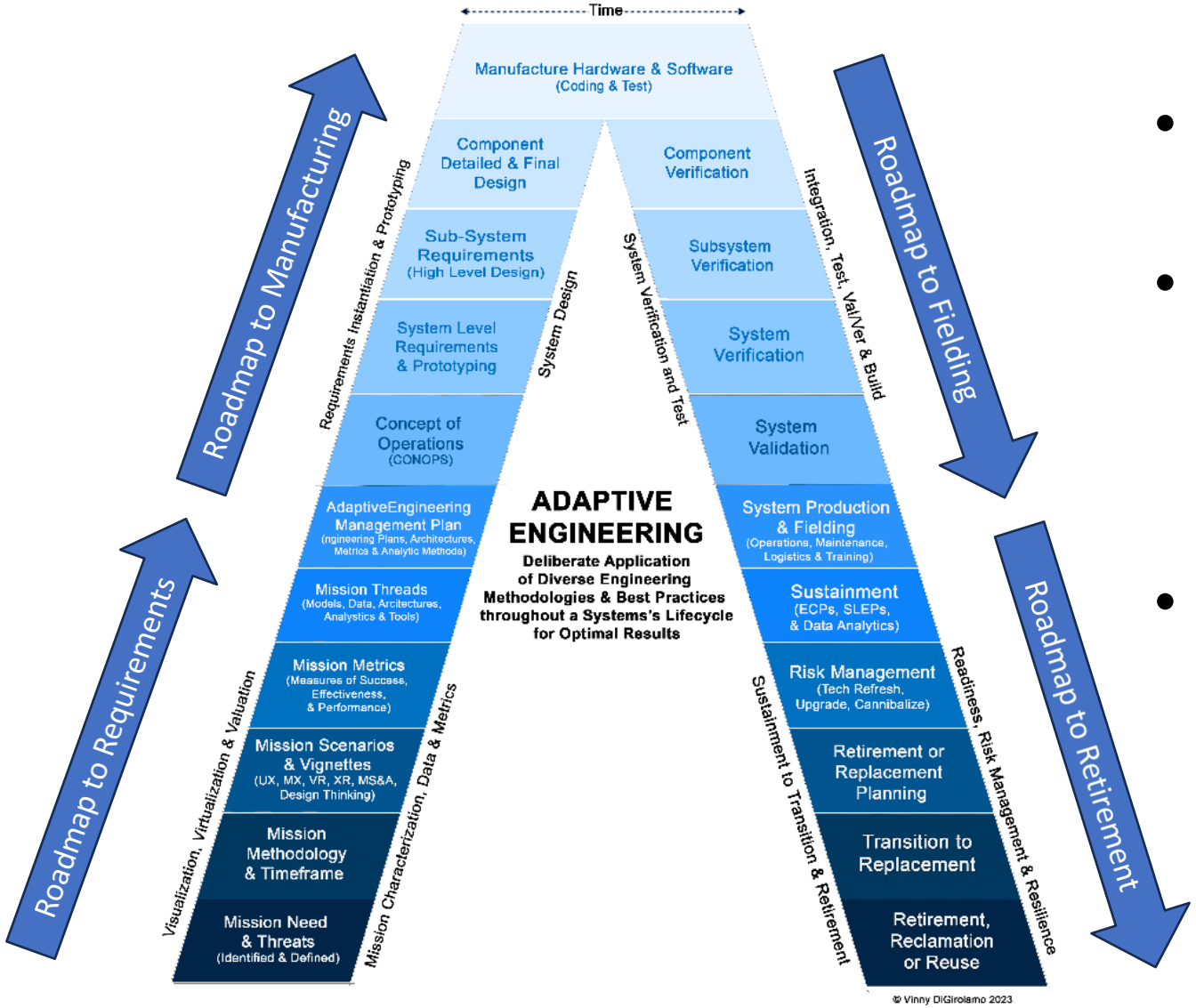


adaptive engineering “a”



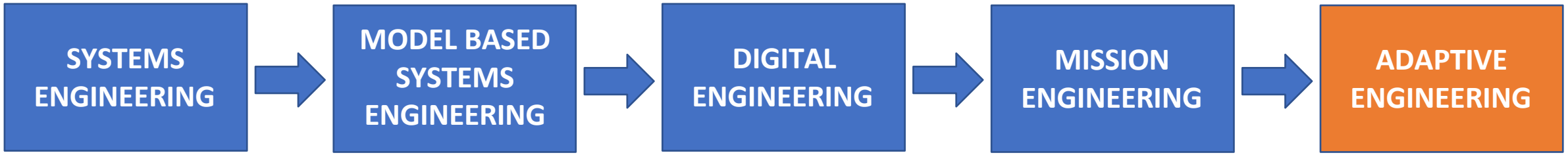
- Preserves Systems Engineering “V”
- Incorporates all Mission Engineering Concepts
- AE Introduces Several New Concepts:
  - Data in Motion, Mission Experience (MX), and Artificial Intelligence (AI) concepts
  - Allows flexibility to choose or adapt the systems development approach throughout the system’s lifecycle

adaptive engineering “a”



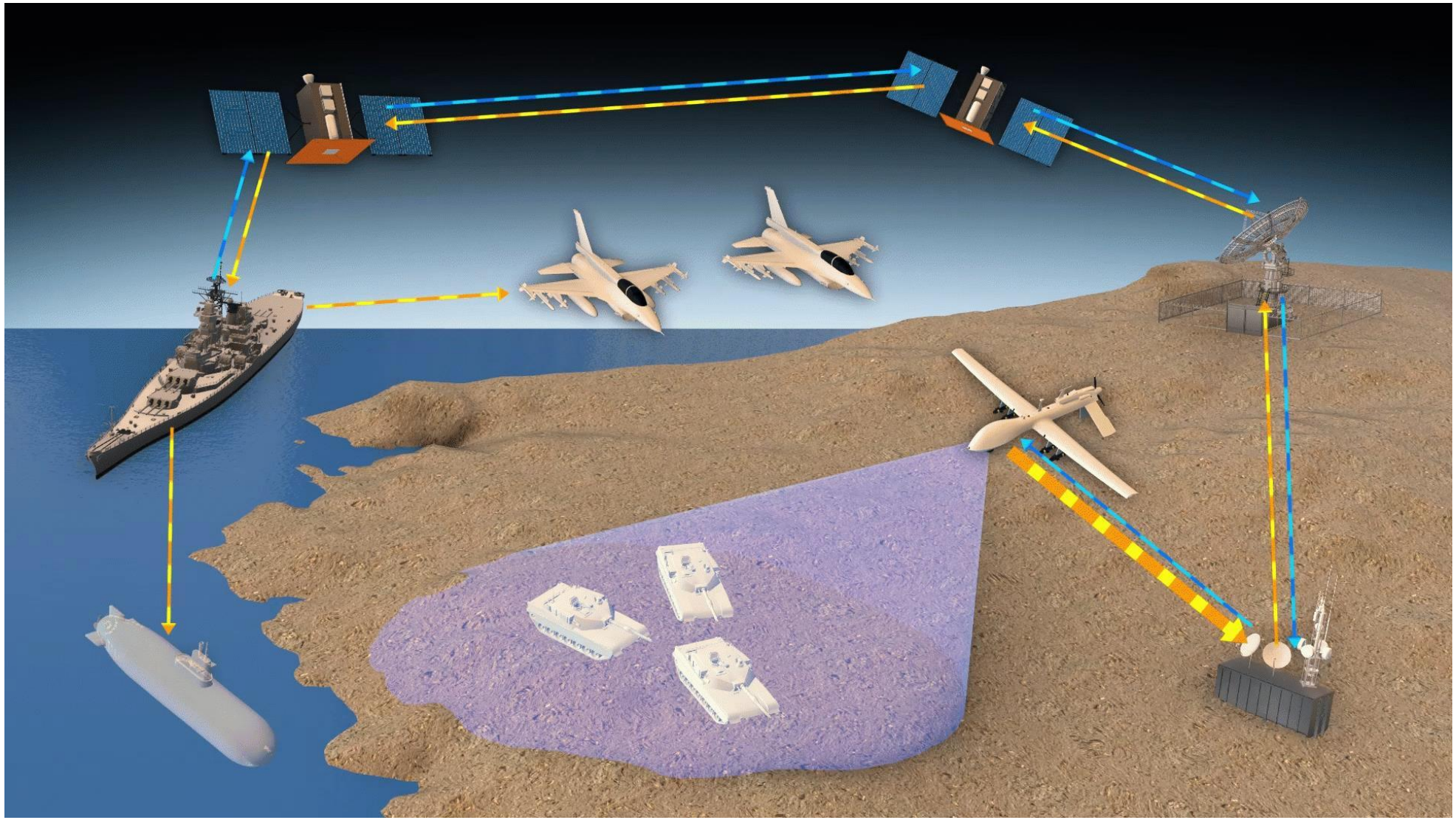
- Preserves Roadmaps from start to finish
- Incorporates all previous Systems Engineering capabilities, processes, methodologies and tools
- Allows for continued evolution of applications, tools, technologies, and systems development processes.

What adaptive engineering adds to the equation

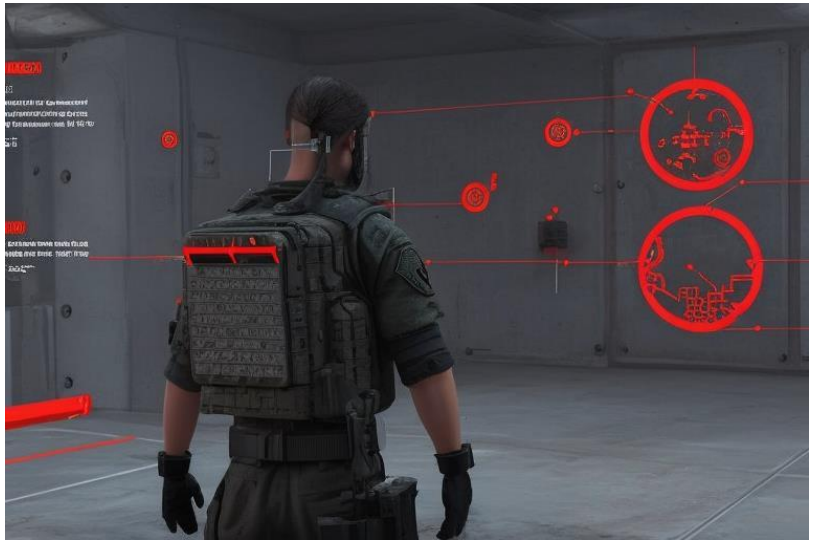


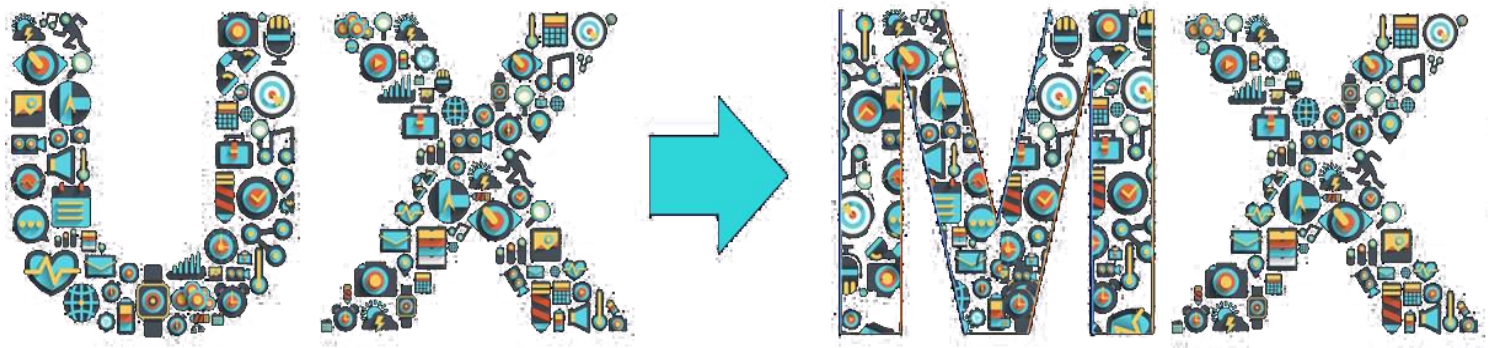
- Builds on All Previous Systems Development Concepts & Principles
  - Processes, Tools, and Practices
  - Adaptable enough to change development direction
- Adds Data in Motion Concepts
  - Example: DODAF OV-1 Data in Motion
- Introduces Mission Experience (MX)
  - Fully Immersive User Experiences (UX) throughout a mission scenario's time-line
- Embraces Artificial Intelligence (AI) Applications throughout Lifecycle
  - Start to Finish: Capability Inception to Retirement or Replacement

oV-1 Data in Motion



Mission Experience Introduced





Mission Experience (MX) is a dynamic, virtual immersion of a User's Experience (UX) throughout a Mission Thread or Scenario's timeline using an array of Extended Reality (XR) tools, and Modeling, Simulation, and Analysis Methods.

Mx: Scenario-Driven ops and Environment

Dismounted Warrior | Mounted Humvee Ops | Command Post Theater Picture | Airborne Overwatch

Same Mission Scenario and System. UX design considerations will vary according to different needs, perspectives, responsibilities, environments, equipment, networks, etc.

MX Timeline: Experience the Mission virtually first

- Warfighter starts with clear objectives, segmenting operations into distinct phases, tactics and milestones.
- Decision points guide actions, with synchronization harmonizing unit efforts and contingencies addressing uncertainties.
- Temporal references (H-Hour, +1, +2…) anchor the timeline while communications and situational awareness is maintained at all levels.

TEKTONUX

MX Use during Mission Characterization

From UX Concepts to Full Immersion MX

Mission Concept	Architecture Graphical Representation	UX Journey Map	Multiple User Experience (UX) Designs	Integrated MX Design Framework
Boundaries & Metrics	MOEs, MOPs & KPPs	MS&A Findings	Visualization Virtualization	Mission Gamification
Desired Capability	Requirements Determination	CONOPS Mission Threads	Scenarios Vignettes	Optimized MX Design
Talent Required	Users Visionaries Engineers Modelers Gamers	Users Modelers, UX Designers Graphic Artists, Gamers, Testers		Users Champions & Decision Makers

Draw the Picture First

Get Agreement ➔ Simulate & Animate ➔ Add Words ➔ Test on Users ➔ Repeat

artificial Intelligence – The Game Changer

1. AI Application Use is not the future, it is TODAY! NOW!

2. AI applications and capabilities are being created at an exponential rate.

3. "AI capabilities are currently as bad as they are going to get."

How many here today have some level of experience using AI Applications in the development of any of your proposals, products, processes or documentation? If not, why not? Go home. Start today!

- **Example 1:**
  - Given 9 spreadsheets of 9,000-line items of supply and maintenance information and DoD customer asked for specific information in 3 days
  - Asked AI for an MS Excel formula to analyze the data and get the info needed. This would have taken 3-days of 24/7 hours to derive desired information
  - Took us 20 minutes with an AI provided formula (no one knew how to create) and delivered the requested report with charts in a matter of a few hours (not two weeks of manual labor)
- **Example 2:**
  - Create competency exam for Systems Engineering competencies, but first determine valid competencies (the knowledge engineers need to be proficient in the field of Systems Engineering)
  - AI generated 40+ competencies in 3 minutes, vetted in 30 minutes, 12 multiple choice questions with plausible answers for all competencies created and reviewed in 2 hours (not two months)

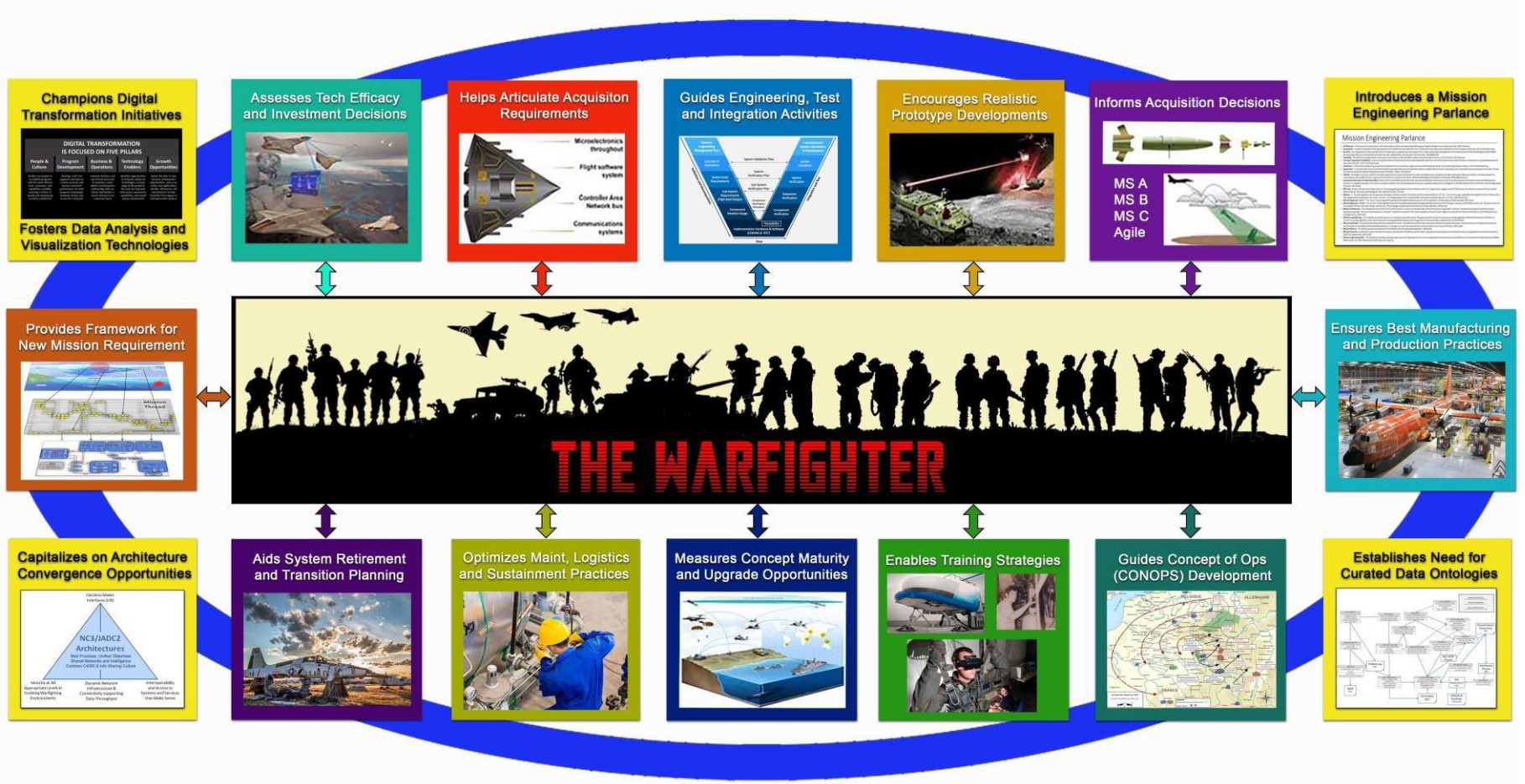
Human in the Loop is Required. Results Must Make Sense –AI results need to be plausible and recognizable when provided to the user. Creation of your organization's 'AI Use Policies' is prudent.

Typical Requirements Scenario

- A contract is let to develop a system. The system is bid at $80M and a team is stood up.
- Then the customer decides they need to build the trainers as well, so they are asked for another bid.
- The bid comes in for another $80M – go figure. Same team but now duplicate CDRLs, PM, staff, overhead, etc.
- If the requirements were established more rigorously early in the process for the entire lifecycle, and more time is spent up front characterizing the mission, significant savings can be realized, or unnecessary costs avoided.
- Project should have cost, $100M, not $160M.

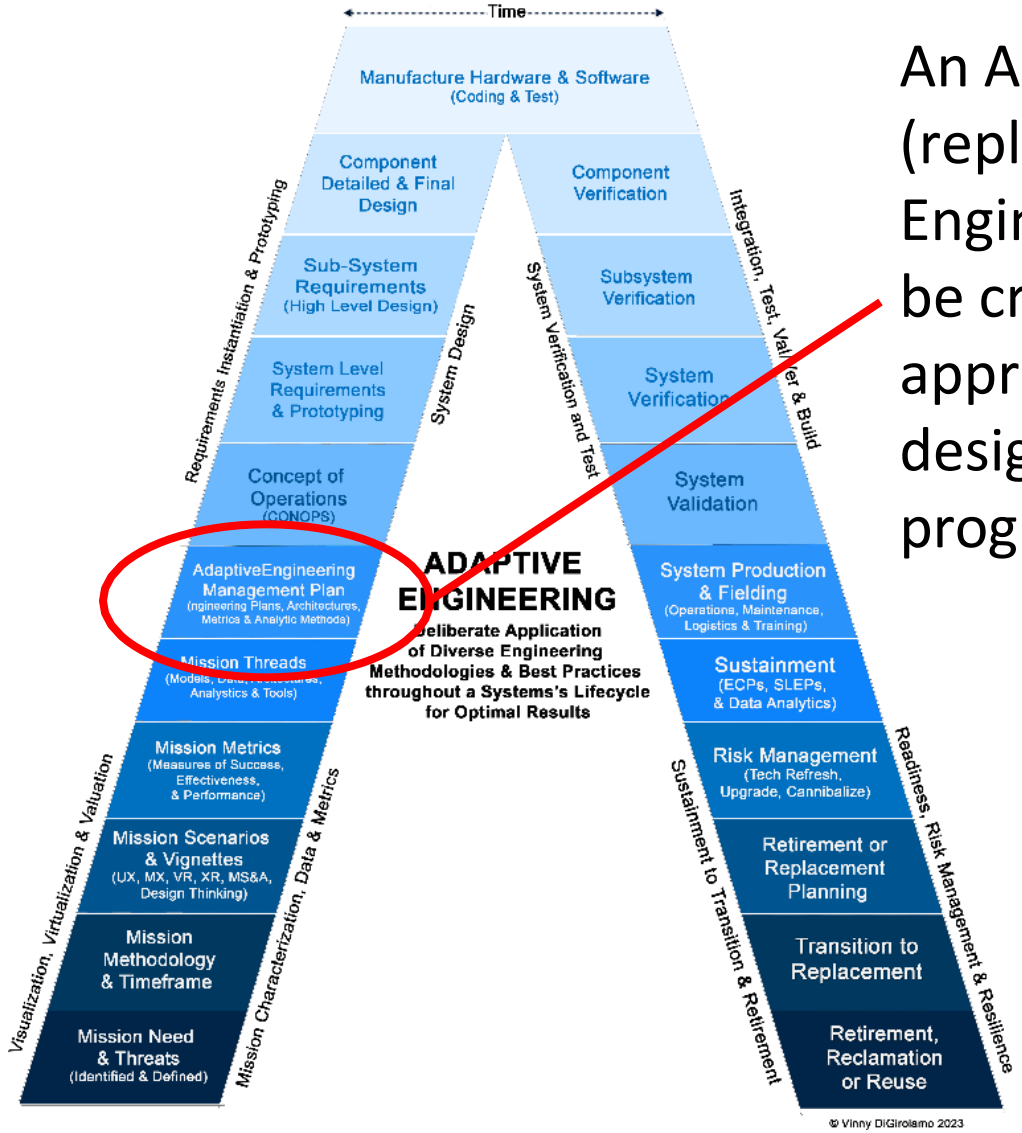
Spend more dwell time on requirements and mission characterization activities using all the tools available to visualize and virtualize the desired capabilities, but also consider requirements up front for every stage of the entire system's lifecycle!

ai's life-cycle influence



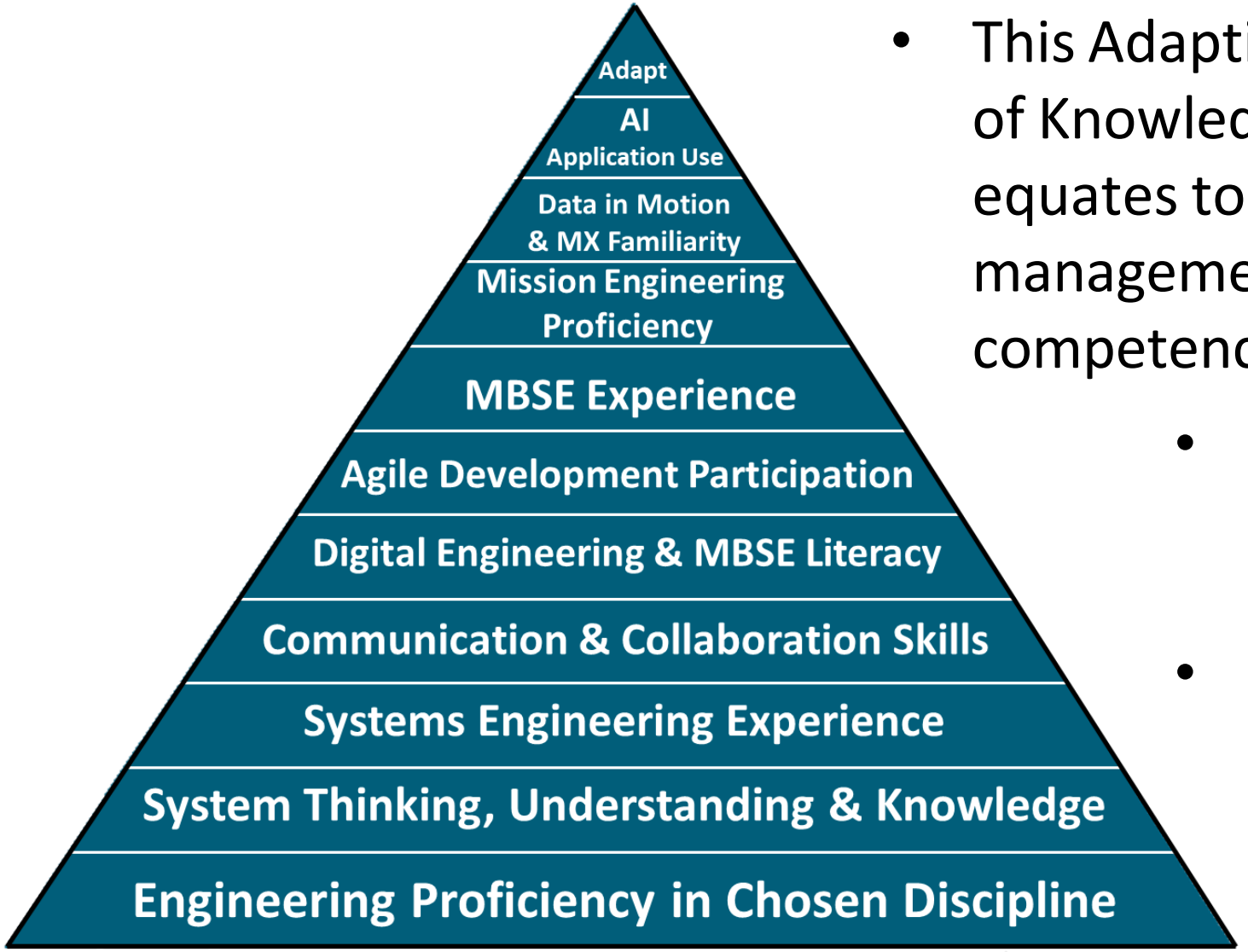
AI Applications can be used (and in some cases are being used) to influence all stages of the lifecycle. Example 1 influenced a Sustainment query and Example 2 influenced the workforce working on the system throughout the lifecycle. AI Apps being created for all phases of the system life cycle and 9+ Million companies are adopting some form of generative AI practices.

adaptive engineering Management Plan



An Adaptive Engineering Management Plan (replaces and adds to the required Systems Engineering Management Plan (SEMP)) would be created to include a section on industry's approach using AI applications during the design, development, and life cycle of the program.

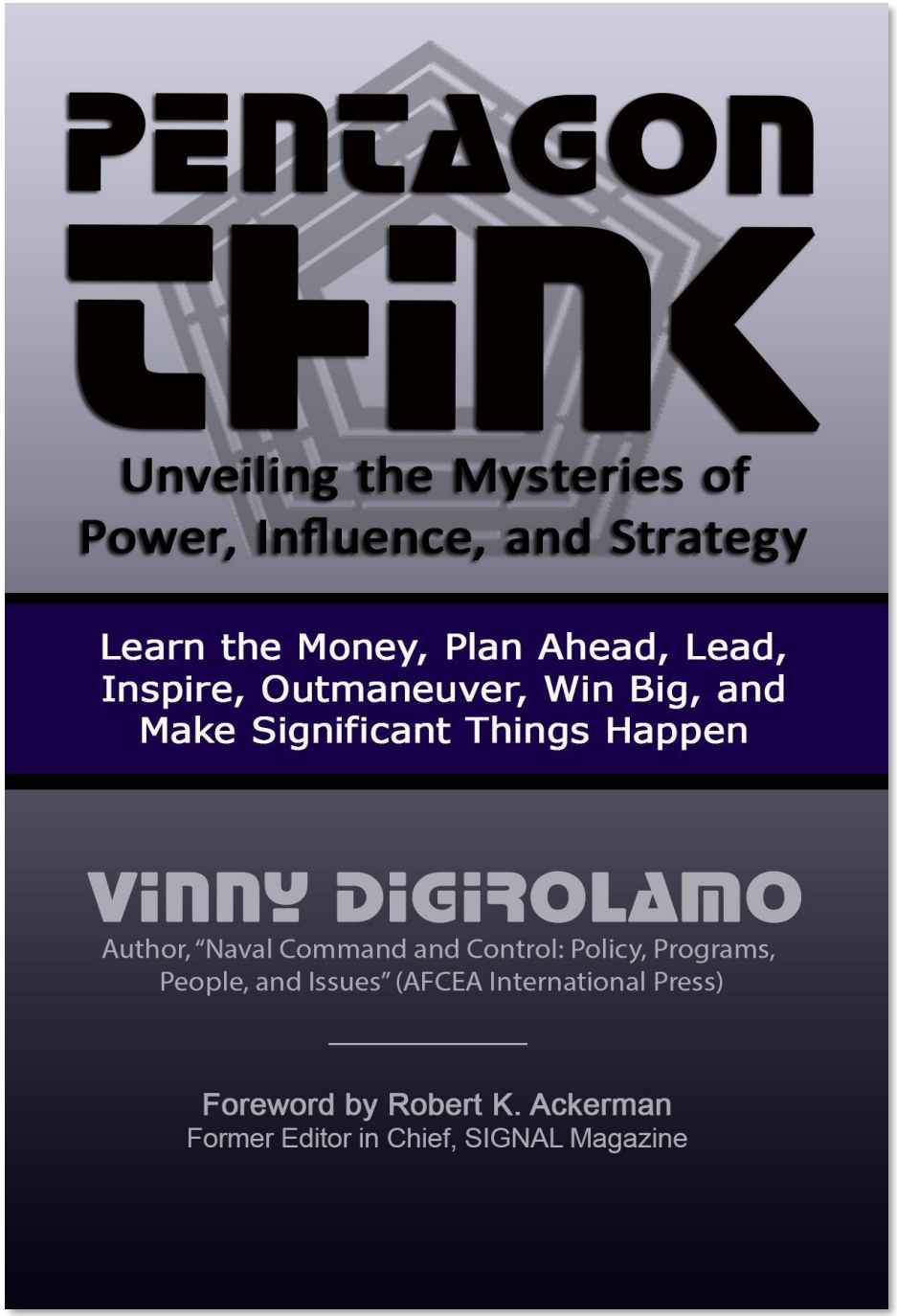
Experience hierarchy: Next generation adaptive engineers



- This Adaptive Engineering Hierarchy of Knowledge, Skills, and Experience equates to 50+ engineering, program management, and acquisition competency areas.
  - The order of experience in each competency may vary – same end result.
  - Nothing can replace good judgement based on experience and practice.

The Way forward: if I were king for the day

- **Encouraging News.** DoD recently commissioned **"Task Force Lima"** to help DOD formulate their adoption of generative AI in procuring and developing Warfighter capabilities.
- **Assess your organization's Systems Development processes** and "no-kidding" practices to see where you stand in the evolution to Adaptive Engineering concepts (see Adaptive Engineering hierarchy for competency areas). Understand your baseline and how your business model is best suited to participate in this technology evolution. Then build a plan to support AE concepts.
- **The further you get from DC, the less you know about Mission Engineering.** Start there, embrace the concepts in their guide, lean on the User early during concept development, and characterize the mission virtually first using today's AI and XR tools.
  - Mission Engineering proposes great concepts with incredible potential to make an impact on all DoD acquisitions, but in my opinion, needs better marketing, educational courses, and some real teeth with serious advocacy and incentives for wholesale adoption by government, military, and industry.
- **Leapfrog to an Adaptive Engineering mind-set** (at the very least) and embrace the concepts presented here. Why not? The future is now, and AI will not get any less or worse in capability going forward.
- **More work is needed** to refine Adaptive Engineering principles, define data in motion architectures, develop MX concepts, and identify AI applications that benefits or optimizes each stage of a system's lifecycle. Every part of the systems development and acquisition process must learn to adapt.



additional Info

- NEW Release: Pentagon THINK
  - Abridges 30 years of practical experience into ten chapters filled with hundreds of actions and recommendations to THINK about while working at, selling to, or facilitating Nuclear C3 and Joint C4ISR, IT and Cyber programs.
  - Available on Amazon.com
  - Includes a vignettes on both Mission and Adaptive Engineering
- Adaptive Engineering whitepaper requests or questions, vinny.digirolamo@citc2.com
- Items posted on my YouTube Channel
  www.youtube.com/channel/UCwd5giDGt3yZgR0gqPS5L8Q
  - OV-1 Data in Motion example
  - Adaptive Engineering Presentation
  - Several Mission Engineering videos