

Platform / Armament Systems Integration

Application of Best Practices

THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN

NDIA Armament Systems Forum

3 June 2019

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Northrop Grumman
Mesa, AZ

- **32 years Aerospace & Defense Mechanical Design and Gun System Integration**
 - **AH-64D Apache – 30mm M230 Chain Gun, Turret, Ammo Handling System / Sideloader**
 - **RAH-66 Comanche – Armament Systems Integration Lead**
 - **20mm XM301 Turreted Gun System**
 - **Hydra 70 Rockets**
 - **Hellfire Missiles**
 - **7.62mm M134 Machine Gun (aka “Minigun”)**
 - **4 Design Improvement Patents**
 - **Gun System Integration on Rotorcraft and Land Vehicles**
- **30mm M230LF Remote Weapon Systems Integration**
 - **CASA 212 Aircraft**
 - **Toyota LC79 Pickup**
- **BS Mechanical Engineering, University of Arizona - 1986**
- **MBA, University of Phoenix – 2000**
- **McDonnell Douglas / Boeing / Sikorsky / ATK / Profense / Northrop Grumman**

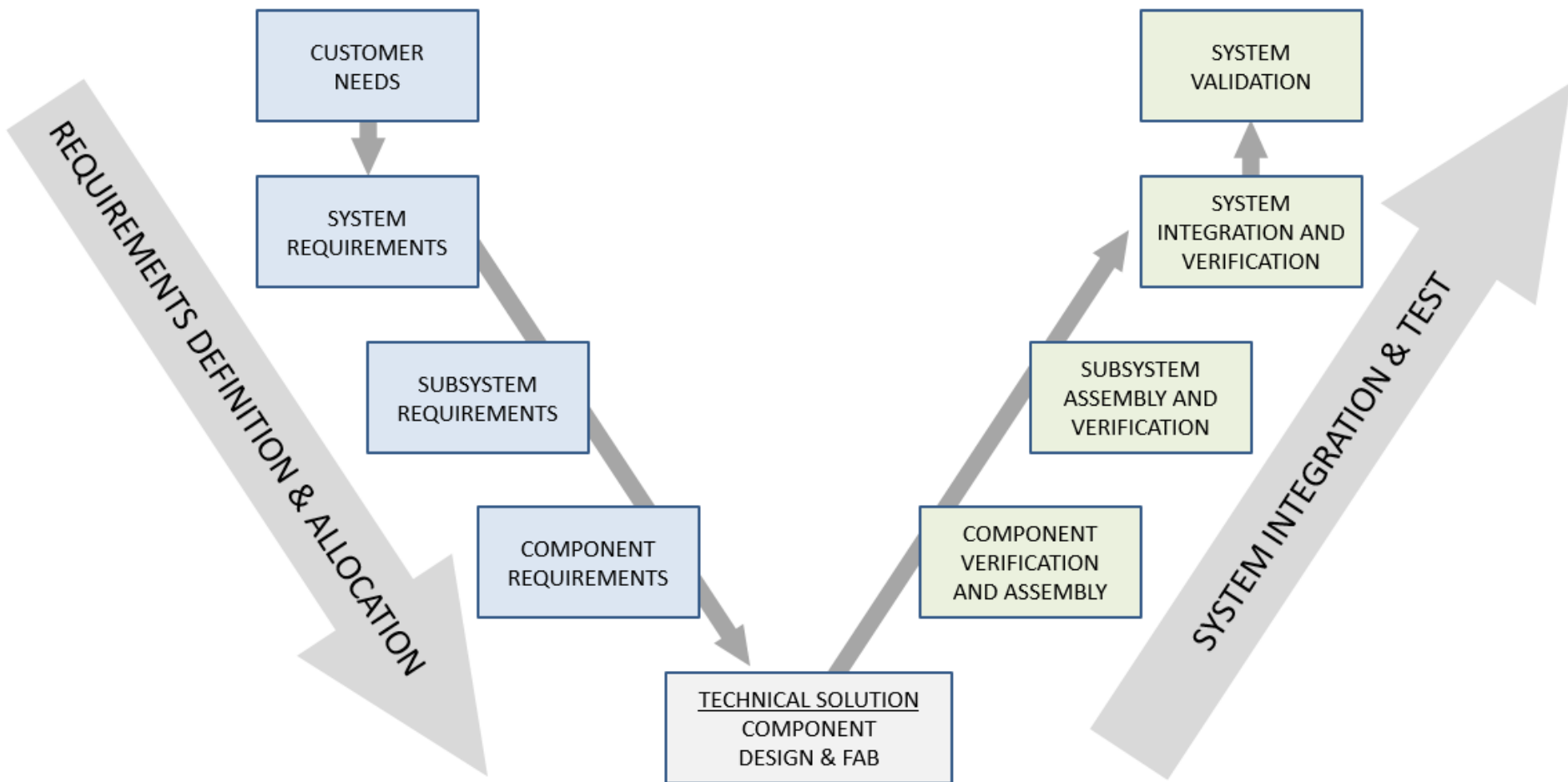
Complexity is a Variable



COMPLEXITY DRIVES THE NEED FOR BEST PRACTICES – AND NEW TOOLS

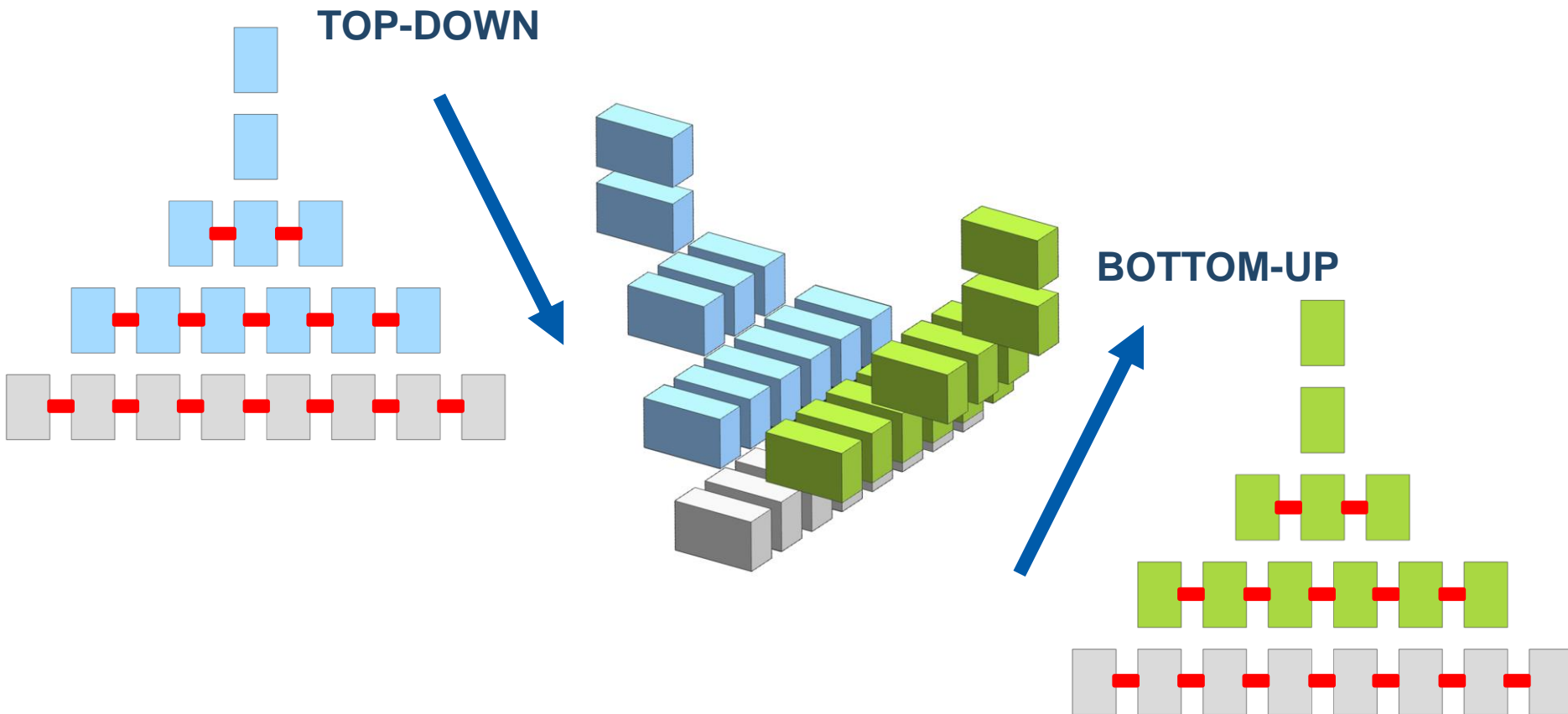
Systems Engineering V-Model

2-Dimensional



CONSIDER THE INTERFACES BETWEEN SYSTEM ELEMENTS

3-Dimensional



UNCOVER THE INTERFACES – AND MANAGE THEM

Plan the Integration Project

SEMP

TEMP

Document Tree

IMP / IMS

Secure the Resources

Personnel

Modeling & Simulation SW

Labs/Test Equipment: SIL / HILS

Range Time

Ammunition

Mine the Requirements

Contract Requirements

Derived Requirements

Key Performance Parameters

Technical Performance Measures

Interface Definition

Manage Change

Press for Commitment

Combat Scope Creep

Early & Loud on Change Impact

START EARLY AND STAY ON TOP OF THESE 4 AREAS

TYPICAL KPPs / TPMs

- Felt Recoil
- Weight
- Lethality
 - Ph / Pk
 - Accuracy
 - Dispersion
 - ROF
 - Stowed Kills
- Ammo Reload Timeline

OTHER CONSIDERATIONS

- Control System Architecture
- Physical Space Claim
- Gunfire Shock/Vibration Loads
- Muzzle Blast Overpressure
- Platform Mounting / Hard Points
- Airframe / Platform Stiffness
- Ammo Case / Links Eject Path
- Ammo Reload Under Armor
- Ready Rounds
- Power Source / Characteristics
- No-Fire Zones
- Slew Rates / Accelerations
- Control Signal Latency
- Thermal Management

COLLABORATE EARLY WITH END USER, CUSTOMER, AND SUBS

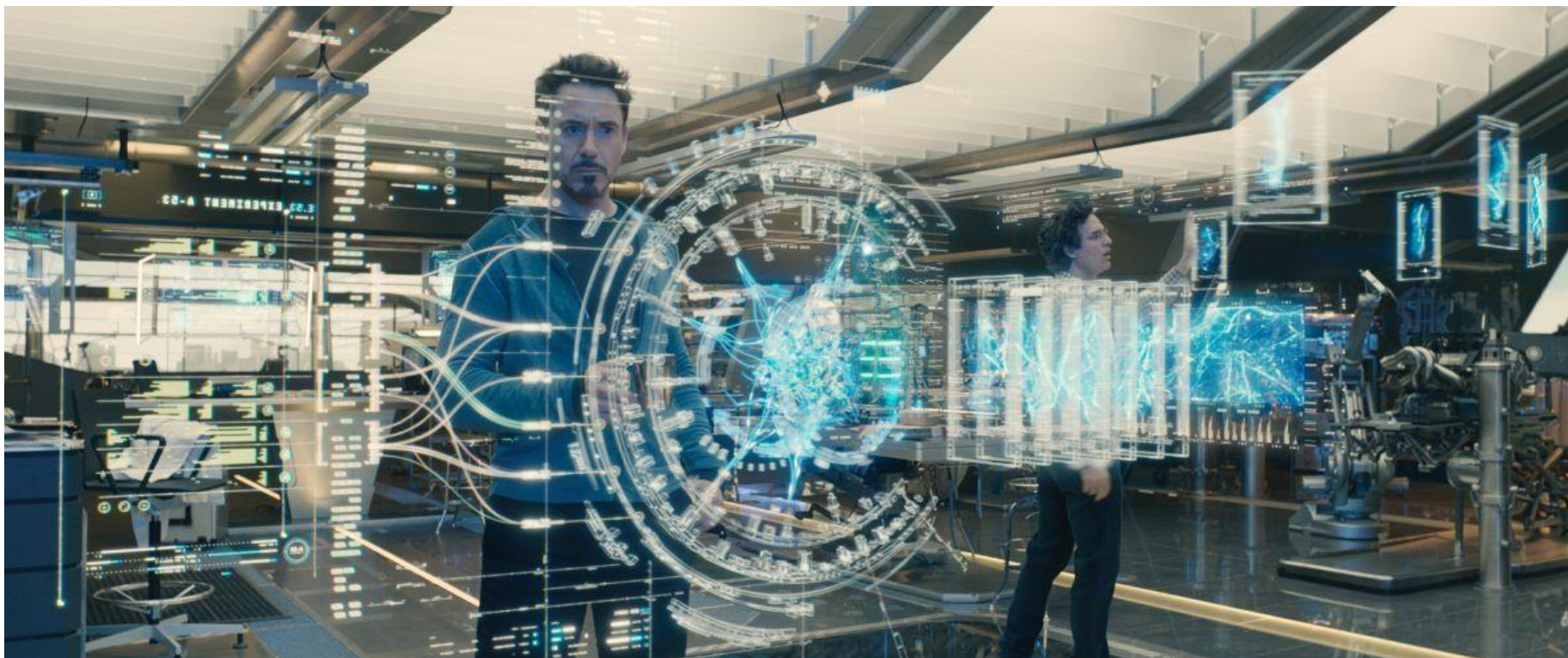
Legacy Tools & Templates

- Visit the Customer Workplace
 - End User
 - Maintainer
- Customer Questionnaire
- CONOPS Views
 - OV-1
- System Architecture Representations
 - Block Diagrams
 - Schematics
 - ICDs
 - CAD Views
- Systems Engineering Management Plan
- Test & Evaluation Master Plan
 - Hardware Utilization Matrix
- IMS Milestone Schedule
- Gate Reviews
 - SRR / SFR / PDR / CDR / BRR
- Document Tree
- Requirements Database
- Compliance Matrices
- Modeling & Simulation
- Hardware in the Loop Simulation
- Test Readiness Reviews
- Live Fire Testing

USE WHAT WORKS – ADOPT NEW TOOLS AS NEEDED

Evolving Tools

- High Fidelity Integrated Modeling and Simulation
- Team-Based Collaboration in Model-Based Design and Integration
- Artificial Intelligence / Machine Learning / Deep Learning / Hyperparameter Tuning



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