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Rotorcraft Acquisition: Development of Modeling and Simulation Procedures

AMRDEC

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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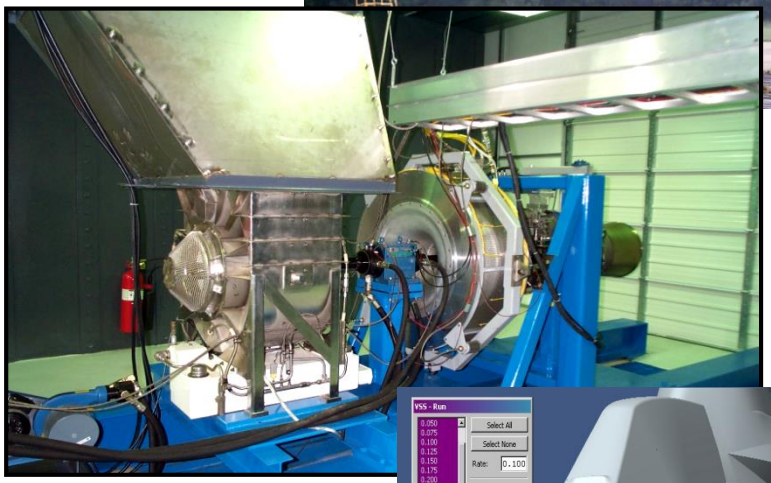
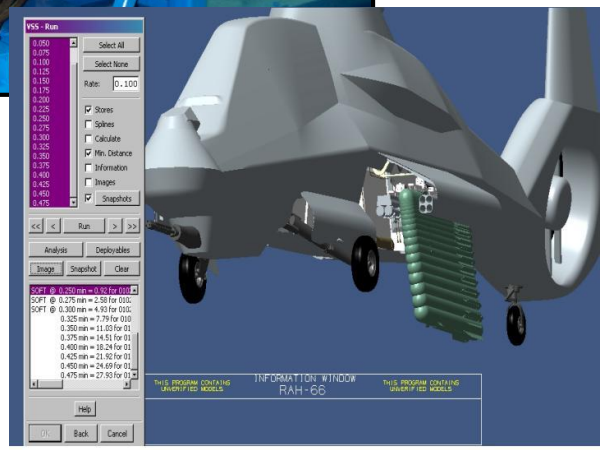
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Lifecycle Acquisition Support

- Contractor development test
- Formal inspection, design review, and safety assessment
- Component qualification test of performance under specified conditions and duration
- Formal contractor demonstrations
- Government testing
- *Engineering analysis, modeling and simulation (M&S)*





M&S VV&A Standard

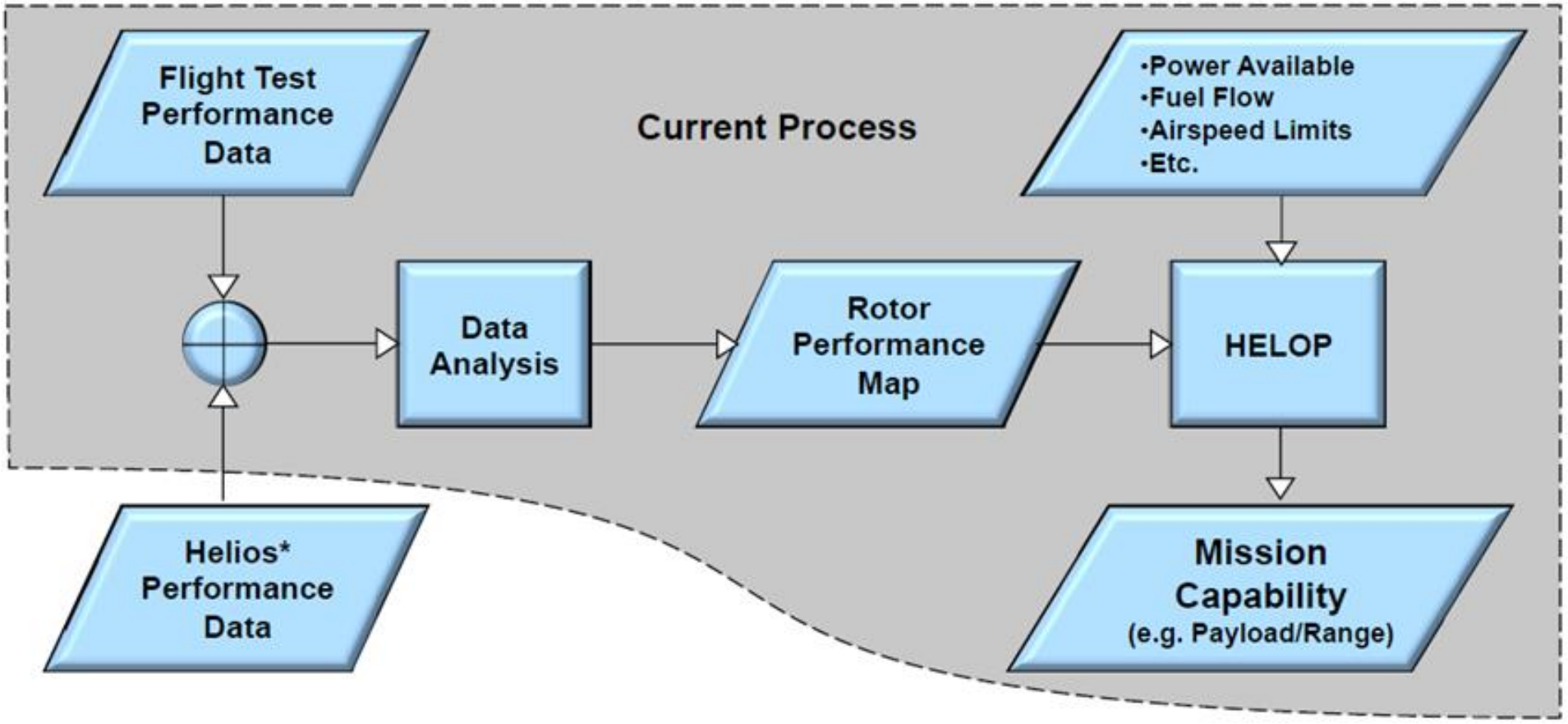
DoDI 5000.61 defines the minimum set of items to document as part of Verification, Validation & Accreditation (VV&A).

AR 5-11 requires VV&A of models.

DA PAM 5-11 gives procedures to assist the M&S developer, proponent, and application sponsor in conforming to the VV&A policies.

- VV&A establishes the credibility of M&S to effectively support Army decisions.
- All models, simulations, and associated data developed, made available, managed, or used by the Army to support Army or DOD processes, products, and decisions will undergo verification and validation throughout their lifecycles and be accredited for the intended use.
- Cargo PM identified a requirement for M&S IAW AR 5-11.
- Process development started with the CH-47 Block 2 efforts and continues to evolve.

Leveraging M&S for Acquisition
Flight Performance



* CREATE-AV Software Product: High-fidelity, full vehicle, multi-physics analysis tool for rotary-wing aircraft

CH-47 w/ACRB Blades Mission Analysis Prediction

Objective

Predict mission performance for the CH-47 helicopter w/ACRB blades using Helios Engineering Model based rotor map.

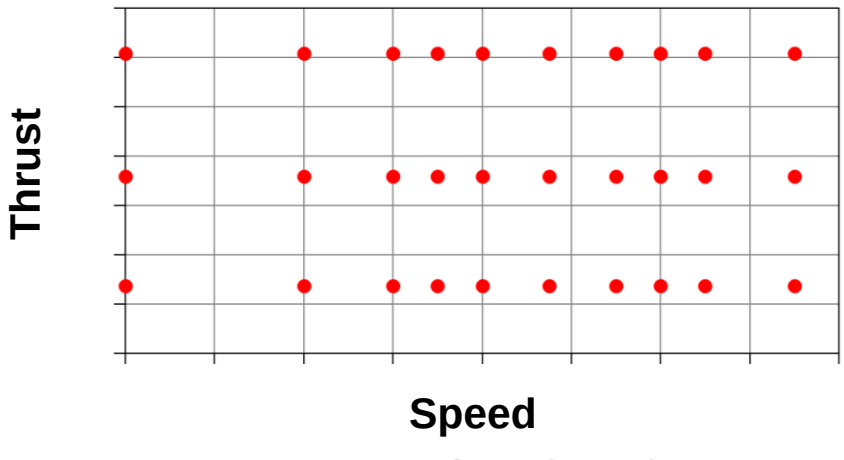
Software Basis

Helios v4.0

Evaluation Data

Will compare with flight test data when available.

Run Matrix



Schedule

Task ID	Task Name	Q1 14 J F M	Q2 14 A M J	Q3 14 J A S	Q4 14 O N D	Q1 15 J F M	Q2 15 A M J
4	CH-47F w/ ACRB Mission Analysis						
4.1	Thrust Sweep - Hover						
4.2	~~Thrust Sweep - 200 ft/min VROC~~						
4.3	Speed Sweep - High Gross Weight						
4.4	Speed Sweep - Mid Gross Weight						
4.5	Speed Sweep - Low Gross Weight						
4.6	Perform Mission Analysis						
4.7	Report						

Summary of Predictions

- Initial 2012 ACRB predictions based on SME experience (not a repeatable process)
- Final 2015 ACRB predictions based on modeling and simulation (repeatable process)
- M&S supported critical programmatic decision to proceed with acquisition

Positively Impacting Defense Acquisition Programs: CH-47 Steady State Flight Envelope

Opportunity: The Cargo PMO is developing a new rotor blade to increase flight performance, and the increase may impact dynamic component fatigue loads.

Project Objectives: Utilize Helios to develop and validate a model to predict dynamic component loads for rotor steady state operating conditions. Extend the validated baseline model to predict steady state dynamic component loads for the proposed rotor blade.

Potential Impacts:

- Enhance structural airworthiness assessments
- Provide capability for Flight Test Matrix Optimization through virtual test capacity
- Perform risk-reduction assessments of rotor design parameters on critical fatigue loads

Validation Challenges:

- Adoption of M&S into existing organizational processes
- Available test data not specifically obtained for validation
- Validation of the model near edge of aircraft envelope requires focused SME involvement

Definitions of VV&A

Definitions of verification, validation, and accreditation are as follows:

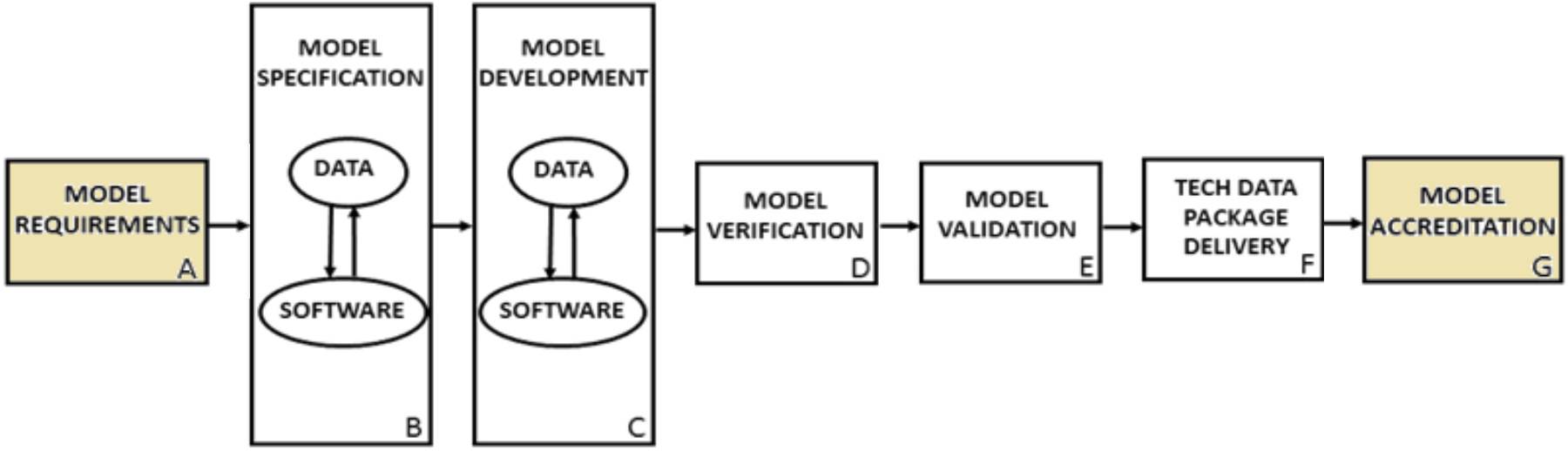
- Verification is the process of determining that an M&S accurately represents the developer's conceptual description and specifications. Verification evaluates the extent to which the M&S have been developed using sound and established software-engineering techniques.

- Validation is the process of determining the extent to that an M&S is an accurate representation of the real world from the perspective of the intended use of the M&S. *Validation methods include expert consensus, comparison with historical results, comparison with test data, peer review, and independent review.*

- Accreditation is the official determination that a model, simulation, or federation of M&S is acceptable for use for a specific purpose.

Process Developed IAW AR 5-11

Generic Model Process



Accreditation Agent – The organization designated by the application sponsor to conduct an accreditation assessment for an M&S application including data.

Roles and responsibilities are defined during accreditation planning for a *specific project and intended use*.

FVL AoA M&S

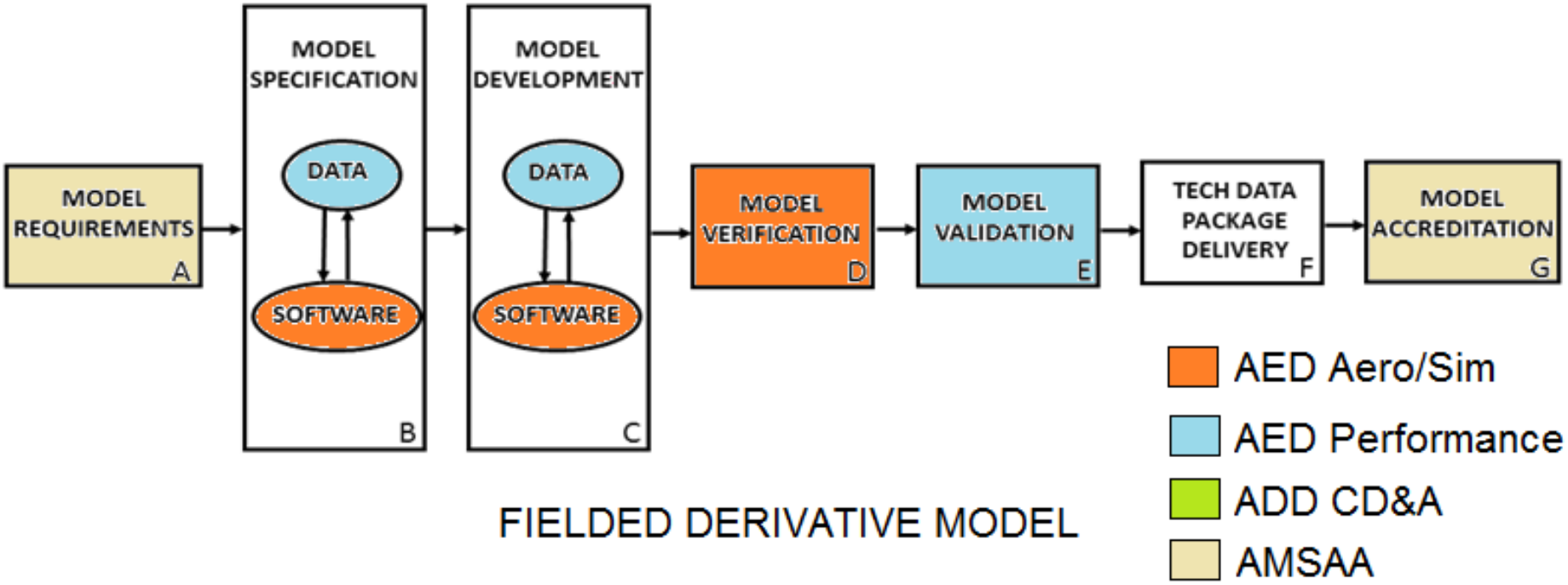
FVL Capability Set 3 AoA (Milestone A)

- AMSAA (Army Materiel Solution Analysis Activity) requires fielded aircraft data for baseline and alternative assessments.
- TRAC (TRADOC Analysis Center) requested to assess fielded and conceptual models in existing performance planning tools (CFPS/Falconview).
- IAW AR 5-11, *Management of Army Models and Simulations,* AMRDEC developed a VV&A process to wrap performance data in simplified engineering flight models to meet requirements.

Study Baseline	Baseline Upgrade	COTS / GOTS	New Start Compounds	New Start Tiltrotors
Current relevant combat fleets including SLEP as necessary. Include currently programmed upgrades and modifications, and those in Service-level long-range resource requirement forecasts	Study Baseline + Additional viable modifications to legacy systems need substantially increase speed, range, and/or worldwide operational capability	Commercial-off-the-shelf or Government-of-the-shelf options that offer significantly improved speed, range, and/or worldwide operational capability	New start options in a compound-helicopter configuration. Variants representing "high" or "low" cases should be assessed if expected to provide significant differences	New start options in a tiltrotor configuration. Variants representing "high" or "low" cases should be assessed if expected to provide significant differences

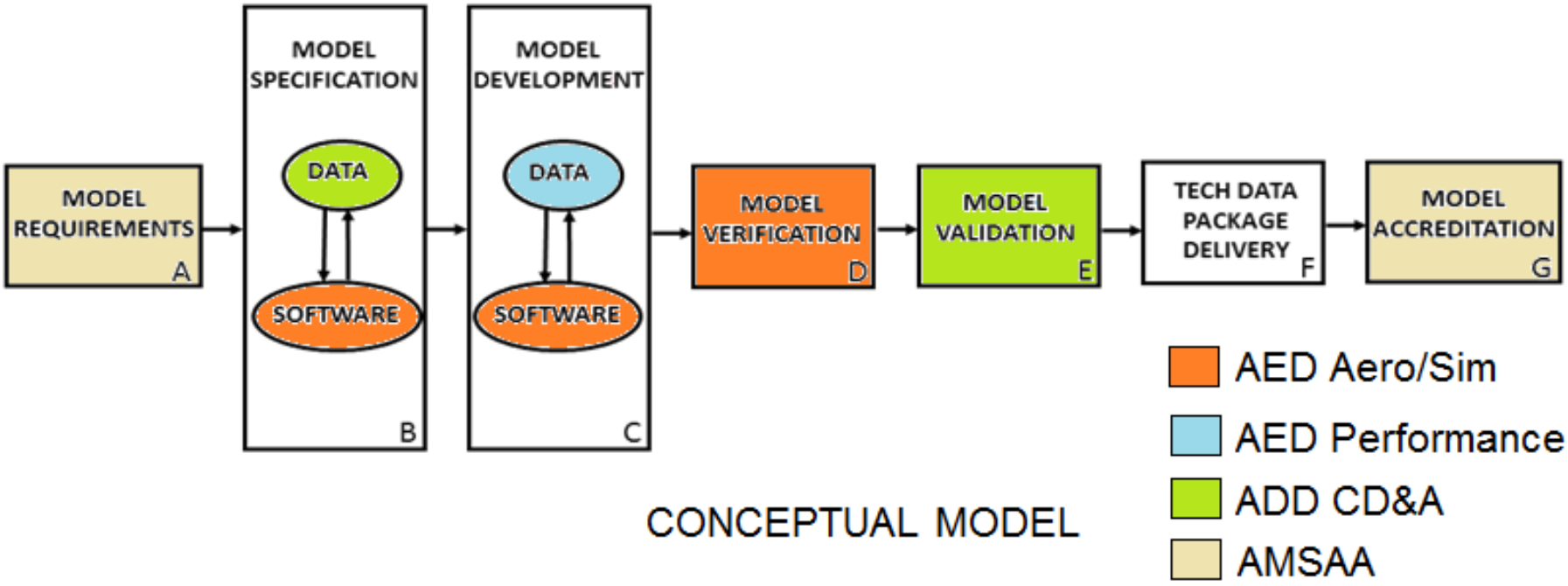
FVL AoA Fielded Alternatives

Tailored Process



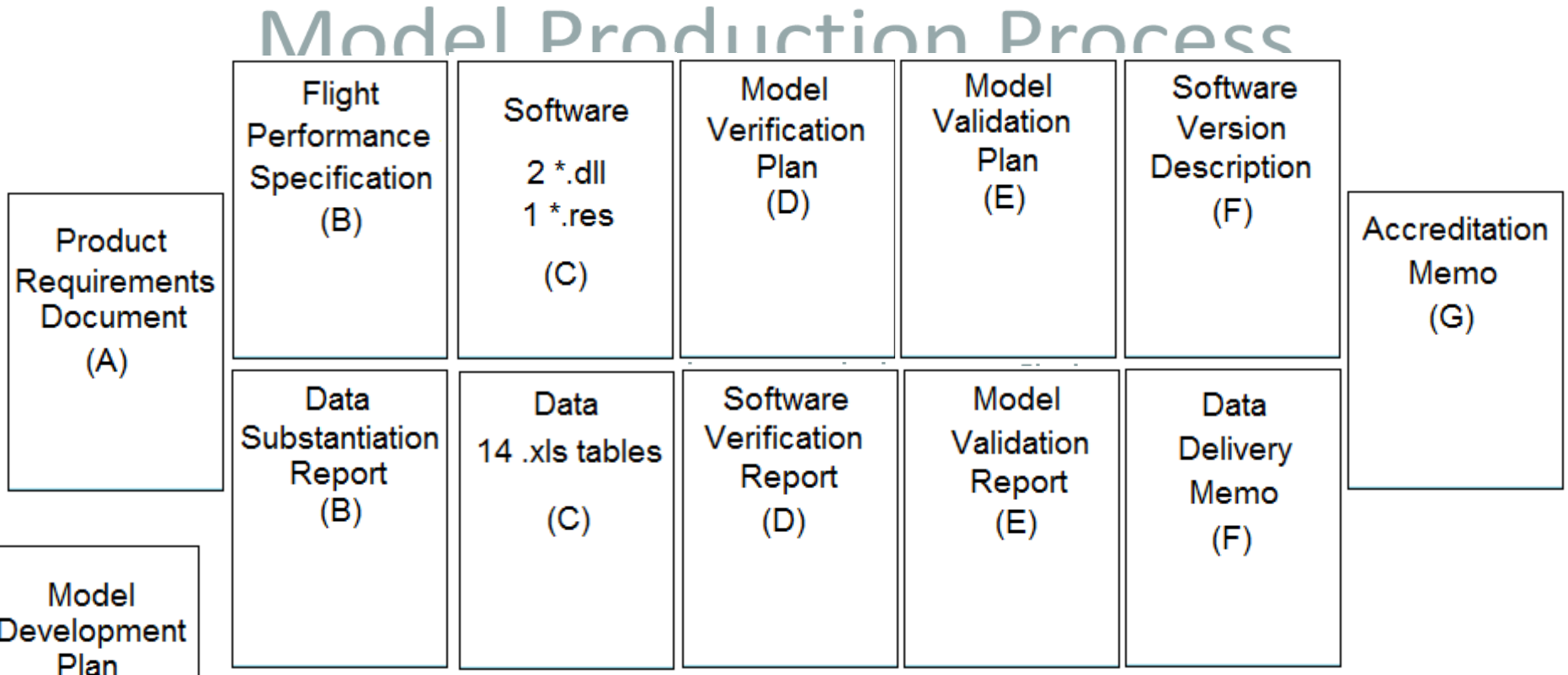
FVL AoA Conceptual Alternatives

Tailored Process



CONCEPTUAL MODEL

Process Documentation



Model Development plan was constructed specifically for the FVL AoA model effort to define process, roles and responsibilities.

Summary/Lessons Learned

- Credible lifecycle acquisition support that leverages modeling and simulation must provide a VV&A plan, including an accreditation agent, and subsequent documentation
- Lifecycle engineering support may require SME-based validation followed by test data-based validation
- Test plans must include requirements for M&S model development and validation
- Future Vertical Lift

JMR TD Configurations

Other Configurations

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