

JCSEM Producibility M&S Sub-Committee Mid-Year Progress

Dr. Al Sanders, Chairman
June 11, 2009

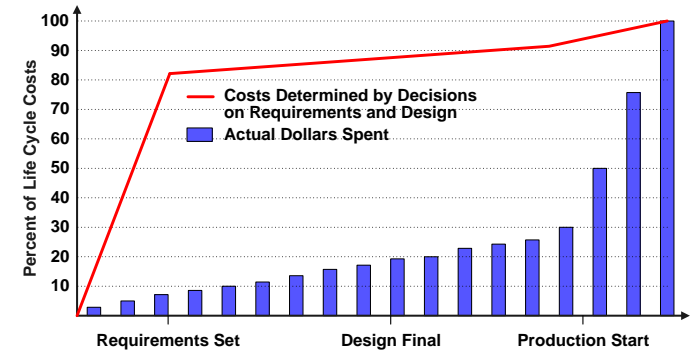
JCSEM M&S Sub-Committee Core Team (Active Participants)

- Al Sanders - Chair (Honeywell)
 - John Allen (Honeywell)
 - Kevin Fischer (Rockwell Collins)
 - Greg Pollari (Rockwell Collins)
 - Charlie Stirk (Cost Vision)
 - Gary Belie (LMCO)
 - Simon Frechette (NIST)
 - Tim Comerford (Missouri University)
 - Scott Frost (Anser)
- * 17 members on initial roster

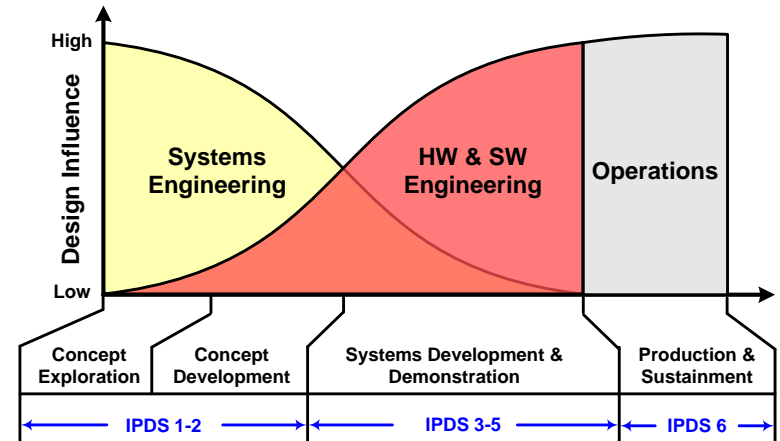
JCSEM M&S Sub-Committee

Example Producibility Issues

- Avionics RF transponder
 - Circuit architecture drives trial & error tuning of each individual card
- Display graphics card
 - Functionality upgrade for a dense design drove yield into single digits
- Engine controller chassis
 - Size & functionality drove compact design which cannot be assembled
- Composite engine bypass duct
 - Weight drove selection of composite material for use in a metallic design
- Advanced heat exchanger
 - Weight drove non-optimal joint design susceptible to braze erosion



GAO-03-57: "Setting Requirements Differently Could Reduce Weapon Systems' Total Ownership Costs", February 2003

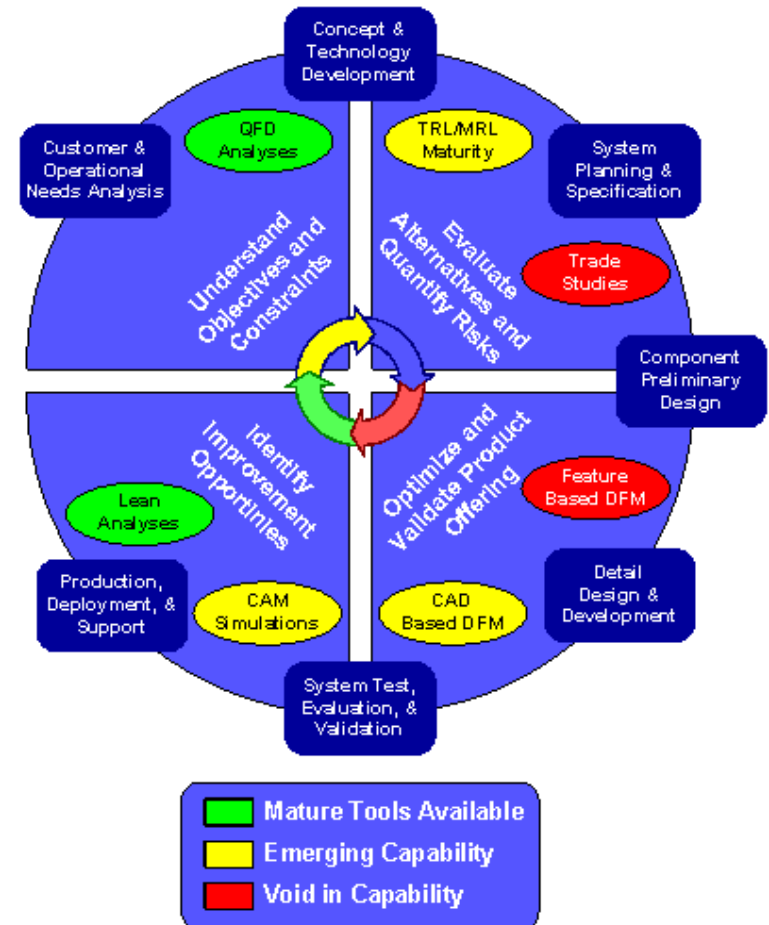


* Examples from "Modeling & Simulation Approaches for Conceptual Design Producibility Trades", A. Sanders, Presented at 2008 DMC

Most Producibility Issues Driven by Early Decisions

JCSEM M&S Sub-Committee Motivation for Up-Front M&S

- Most producibility issues driven by architecture shortfalls not identified until late in design
- Current producibility analyses are rule-based CAD plug-ins that drive late risk identification
- Low-fidelity M&S capabilities needed to guide up-front SE trades to identify risk early on
- Quantitative analysis capability needed to enable balanced performance/producibility trades



Void in Producibility M&S Capability Exists Today

JCSEM M&S Sub-Committee Charter and Scope Statement

“Identify industry M&S analysis needs to facilitate the integration of producibility concerns into the earliest phases of the system engineering process”

In-Scope:

- Validated models to help answer early MRL 1-6 questions
- Product/process centric producibility analyses for trade studies
- Factory and supply chain analyses to guide industrial base design
- Cost modeling analyses and approaches that enable CAIV trades
- Methodologies to enable SE performance/producibility trade studies

Out-of-Scope:

- Virtual collaboration tools and existing SW enhancements
- Data standards and interoperability requirements
- Digital/IT type solutions to facilitate information sharing

JCSEM M&S Sub-Committee Objectives & 2009 Deliverables

Objectives and Focus Areas:

1. Identification of *product/process centric analysis needs*
2. Development of *methodology for SE trade study integration*
3. Identification of *industrial base war gaming analysis needs*

2009 Deliverables:

1. *Development of a matrix describing product/process centric producibility analysis needs that maps to both the MRL criteria and the DoD 5001 systems engineering process*
2. *White paper describing product/process centric producibility analysis needs and a proposed framework and guidance document for system engineering trade study integration*
3. *White paper describing top supply chain risk drivers and enterprise “system-of-systems” analysis needs for defense industrial base war gaming applications*

JCSEM M&S Sub-Committee Progress & Next Steps

What's been done to date:

1. *Draft industrial base war gaming white paper completed*
2. *Product/process centric analysis needs matrix complete*

Next steps:

1. *Develop methodology for M&S-based performance/producibility trade study integration into the SE process (currently performance based)*
2. *Develop white paper describing product/process centric producibility analysis needs and guidance document for SE trade study integration*
3. *Finalize white paper for industrial base war gaming based on ManTech feedback to help define future investment focus areas*

JCSEM M&S Sub-Committee Analysis Need Focus Areas

Matrix Focus Areas:

- Cost analyses
- Mechanical yield prediction
- Electronics yield prediction
- DFX analyses
- Process modeling
- Production line modeling
- Physics based mechanical analyses, e.g., casting
- Physics based electronics analyses, e.g., solder flow
- Ergonomics modeling
- “Green” manufacturing

	SE Design & Analysis	Prelim Design	Detail Design	Proto Manuf
PRODUCT/PROCESS CENTRIC PRODUCTIVITY ANALYSIS NEEDS				
SEIIC	requirements analysis	functional analysis & allocation	system performance design (thermal) & SDC	product/process preliminary design
CAD/CAM framework	3-D, 4-D	mathematical, system functional models	solid models	product component detail design
cost modeling	<ul style="list-style-type: none"> * cost driver identification * cost estimates based on analogs to complexity relationships, analogs, and assumptions * prediction of size and weight estimates * constant impact on productivity and cost * prediction of cost of manufacturing technology maturity * prediction analysis to define cost sensitivity for cost estimating relationships 	<ul style="list-style-type: none"> * cost per function modeling and analysis * identification of alternative structure and surface complexity drivers * analysis of functional interactions impact on cost and risk * prediction of manufacturing learning curve * prediction of unit cost * prediction of material base material location, capacity, process maturity, etc.) 	<ul style="list-style-type: none"> * prediction of cost per geometric feature and per characteristic tolerance range * prediction of alternative material * prediction of throughgoing costs * prediction of plug down component assembly * analysis of labor and overhead rate impact * prediction of change impact analysis * manufacturing cost, cycle time, and capacity constraints * automated MRCM cost analysis * statistical analysis of component base characteristics * identification of critical components along the value chain * identification of design simplification and yield improvement opportunities * prediction of component variation impact on production * prediction of total coverage overlap impact due to DFM variation impact on yield * prediction of yield fallout due to supplier * prediction of assembly attributes on yield * prediction of component type and processing * prediction of component yield classification * prediction of yield fallout due to assembly 	<ul style="list-style-type: none"> * prediction of cost impact due to dimensional tolerancing * prediction of cost optimization value * design change impact analysis * cost to performance vs productivity optimization analysis
electronics yield modeling	<ul style="list-style-type: none"> * yield driver identification * identification of yield impact due to alternate process technologies * identification of acceptance criteria and ranges 	<ul style="list-style-type: none"> * prediction of yield after design based on design risk, material, process, analogs * functional decomposition impact on variability * prediction of assembly attributes on yield * prediction of assembly attributes on yield * prediction of yield impact due to alternate process technologies * identification of acceptance criteria and ranges 	<ul style="list-style-type: none"> * analysis of yield target feasibility risk per configuration item * integration, assembly, and test yield modeling * prediction of yield impact on assembly cost, cycle time, and capacity constraints * identification of assembly simplification and yield improvement opportunities * prediction of assembly attributes on yield fallout (interfaces, connectors, cables, tolerances, attachment complexity, configuration item quantify, etc.) 	<ul style="list-style-type: none"> * prediction of optimum test coverage levels to meet specs * prediction of yield impact due to DFM * prediction of yield fallout due to assembly * prediction of component feature tolerance impact * analysis that automatically set tolerances * identification of secondary process interaction effects * analysis of detail design impact on manufacturability * analysis of cost-net shape waste material * prediction of component type and processing * prediction of optimum composite ply lay-up * prediction of process capability * analysis of process variation
mechanical yield modeling	same as above	same as above	same as above	<ul style="list-style-type: none"> * analysis to identify key process parameters (Wear yield and COPD) * prediction of final process capability * prediction of initial process capability * prediction of final wear limits * prediction of machine repeatability and hysteresis * prediction of processing parameters on product characteristics
physics based electronics analysis	none	none	none	<ul style="list-style-type: none"> * analysis to identify key process parameters (Wear yield and COPD) * prediction of final process capability * prediction of initial process capability * prediction of final wear limits * prediction of machine repeatability and hysteresis * prediction of processing parameters on product characteristics
operator assembly/ test modeling (human ergonomics)	<ul style="list-style-type: none"> * identification of potential impacts to personal productivity (injury, fatigue, environment, etc.) 	<ul style="list-style-type: none"> * analysis of workpiece size and availability * ergonomics of potential assembly sequence due to accessibility * prediction of process parameter impact on green metrics * prediction of cycle recycle and disposal issues * analysis of approach/work option impact on force and wear * analysis of green manufacturing process, material, and test alternatives 	<ul style="list-style-type: none"> * prediction of CO2 footprint and waste trace off * analysis of process flow, cleaning, and energy usage impact on manufacturing component * analysis of scheduling impact on manufacturing energy usage * analysis of process waste reduction opportunity and trade-offs 	<ul style="list-style-type: none"> * prediction of thermal coefficient expansion mismatch impact on profile characteristics * prediction of thermal coefficient expansion mismatch impact on profile characteristics * prediction of thermal coefficient expansion mismatch impact on profile characteristics * prediction of thermal coefficient expansion mismatch impact on profile characteristics
physics based mechanical analysis	none	none	none	<ul style="list-style-type: none"> * analysis to identify key process parameters (Wear yield and COPD) * prediction of final process capability * prediction of initial process capability * prediction of final wear limits * prediction of machine repeatability and hysteresis * prediction of processing parameters on product characteristics

Electronics Yield Prediction

- * analysis of yield target feasibility risk per configuration item
- * integration, assembly, and test yield modeling
- * prediction of yield impact on assembly cost, cycle time, and capacity constraints
- * identification of assembly simplification and yield improvement opportunities
- * prediction of assembly attributes on yield fallout (interfaces, connectors, cables, tolerances, attachment complexity, configuration item quantify, etc.)

JCSEM M&S Sub-Committee Industrial Base War Gaming

Analysis Focus Areas:

- *Logistics factors*
- *Environmental factors*
- *Strategy factors*
- *Sustainability factors*
- *Product design factors*
- *Material factors*
- *Process factors*
- *Technology maturity factors*
- *Infrastructure factors*
- *Policy factors*
- *Work force factors*

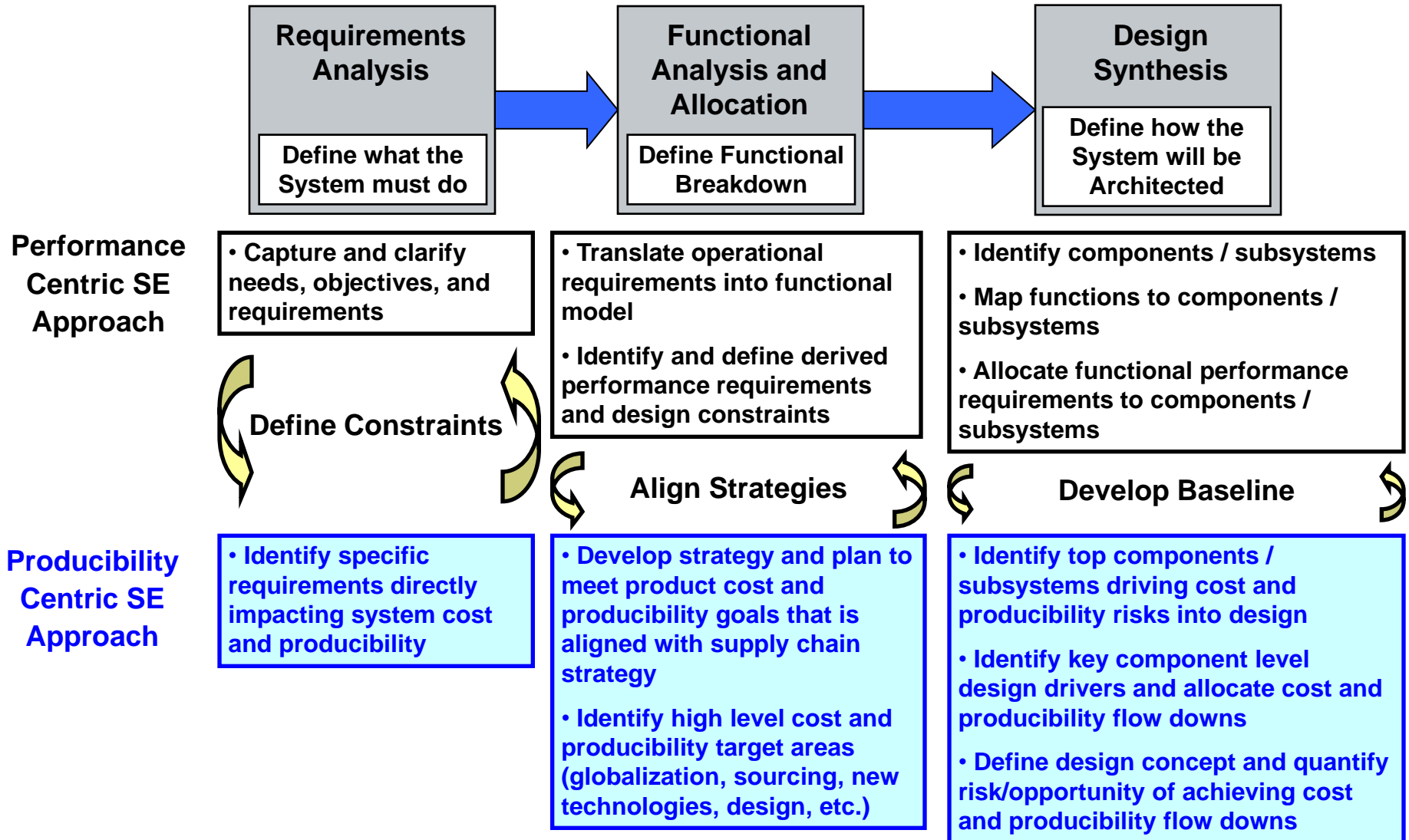
Black: currently modeled

Blue: currently not modeled

Proposed Approach:

- *Extend proven SE M&S approaches to facilitate supply chain analyses*
- *Develop standard supply chain architecture definitions and behavioral models*
- *Model transient and dynamic response of “system” due to disruptions and rate changes*
- *Three application areas:*
 - ***R&D and technology demonstration segment***
 - ***New product introduction segment***
 - ***Legacy product sustainment segment***

JCSEM M&S Sub-Committee Integration into SE Process



JCSEM M&S Sub-Committee Issues/Concerns

Deliverable Progress:

- *Product/process producibility analysis need matrix complete*
- *On-track to finalize industrial base war gaming white paper*
- *On-track to complete SE-based producibility analysis white paper*

Issues/Concerns/Challenges:

- *Challenge has been to maintain in-scope focus, i.e, identify next-generation analysis needs rather than use of existing software apps*
- *Aggressive year one deliverables require shifting focus away from analysis needs to developing a methodology to perform SE trades*

Areas for Help:

- *Need a few strong SE “engineers” on sub-committee to complete remaining deliverables, i.e., develop methodology and framework to integrate new producibility M&S analysis output into SE trade process*