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Advanced Engineering Environments for Small Manufacturing Enterprises

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Sponsored by the U.S. Department of Defense

Introduction

The future of manufacturing includes supply chain integration.

Advanced Engineering Environments (AEEs) will play a pivotal role in this integration.

Integration of Small Manufacturing Enterprises (SMEs) into the supply chain is a significant challenge.

- SMEs face unique challenges in adopting AEEs

Agenda

Context of Research

Small Manufacturing Enterprises (SMEs)

Advanced Engineering Environments (AEEs)

AEE Adoption Benefits

AEE Adoption Challenges

Summary

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Summary

Context of Research

Sponsor

Technology Insertion, Demonstration, and Evaluation (**TIDE**) Program

Objective

"… demonstrate the cost savings and efficiency benefits of applying commercially available software and information technology to the manufacturing lines of small defense firms."

DEPARTMENT OF DEFENSE APPROPRIATIONS ACT, 2000

Participants

- Software Engineering Institute, Carnegie Mellon University
- NIST – Manufacturing Engineering Laboratory
- Oversight by DoD ManTech

TIDE - risk reduction, proof of feasibility for SMEs

TIDE Overview/Strategy

TECHNOLOGY DEVELOPMENT

(OCTAVE^{SM}-S, Advanced Engineering Environments (AEE), CMMI® for SMEs)

- Technology Adaptations

DEMONSTRATION PROJECTS

Early Demo Projects (Core Insertions) → **Advanced Demo Projects**

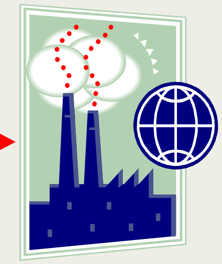
- Lessons Learned
- Publications
- Barrier Identification
- Vendor Impact

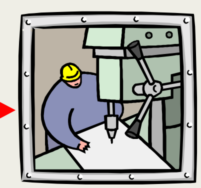
Body of Knowledge - Support for SMEs

WORKFORCE DEVELOPMENT

- IT Prof. Development series
- Selected SEI Courses
- Tech Adoption Workshops
- New courses and training

DISTRIBUTION



Small Manufacturing Enterprises

Who are they?

- <750 employees
- Not software centric
- Most <250 employees
- Short term focus

Why focus on SMEs?

- **Critical to the US economy**
  - Manufacturing comprises 14% of the US GDP
    - That's **$1.4 TRILLION** *BEA, US Dept. of Commerce*
  - 98% of US manufacturing firms are SMEs employing 41% of the manufacturing workforce *U.S. Small Business Administration*
- **Critical to US Defense**
  - Primes concentrating on core VALUE ADDED activities
    - PM, System Engineering, System Integration
  - >80% of production of some weapons system is outsourced

OPPORTUNITY ~~CHALLENGE~~ FOR SMALL MANUFACTURERS !!!

SME Community Stress Factors

Increasing global competition

Aging workforce and ownership

Expanding technology options

Changing Needs of the DoD

- Dual use components and systems
- Increasing supply chain integration
- Rate transparent production
- Surge production capacity
- Rapid product realization

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Potential to drive many SMEs out of business

What Does this Mean for SMEs?

SMEs are more tightly integrated with the Primes

- Not just component build-to-print
- Participate in Product Development, Inventory Management, Quality Improvement, and Life Cycle Cost Reduction

New demands upon the SME

- Expanded design and engineering capabilities
- Improved technical and project data communication
- Enhanced process management and control

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AEEs can help

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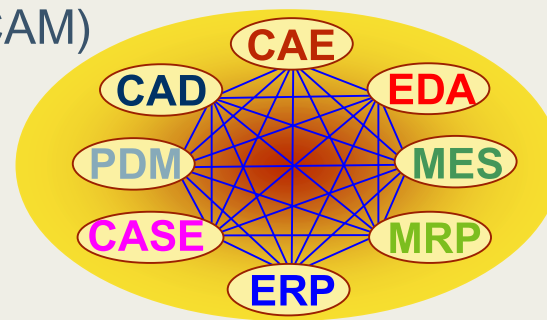
Advanced Engineering Environments

AEEs are …

"… computational and communications systems that can create virtual and/or distributed environments functioning to link researchers, technologists, designers, manufacturers, suppliers, and customers." [**NRC 99**]

AEEs consist of

- Design tools
  - computer-aided design (CAD)
  - computer-aided engineering (CAE)
- Production tools
  - computer-aided manufacturing (CAM)
- Project management tools
- Data repositories
  - product data management (PDM)
- Networks
- and more



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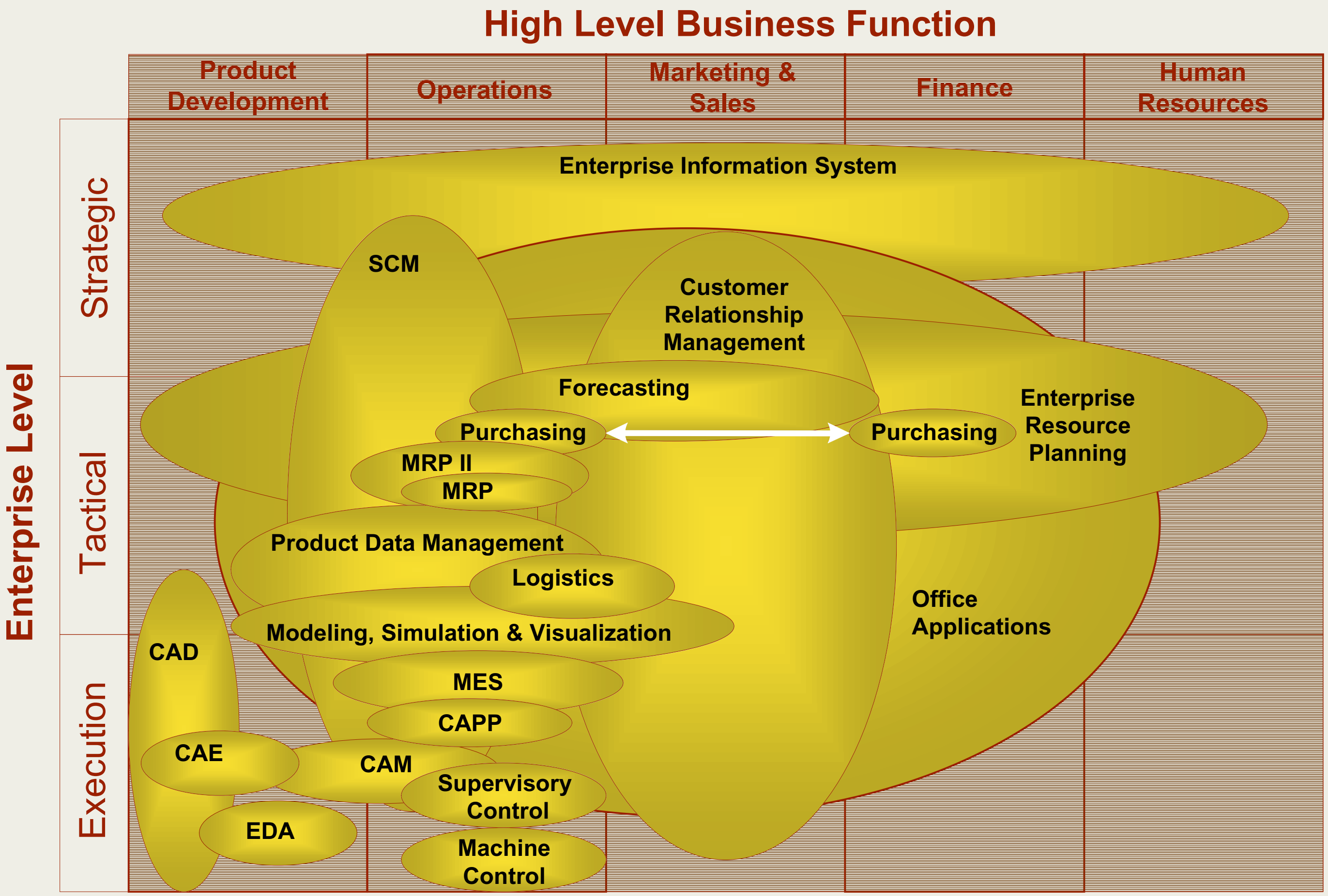
A Wide Domain for AEEs …



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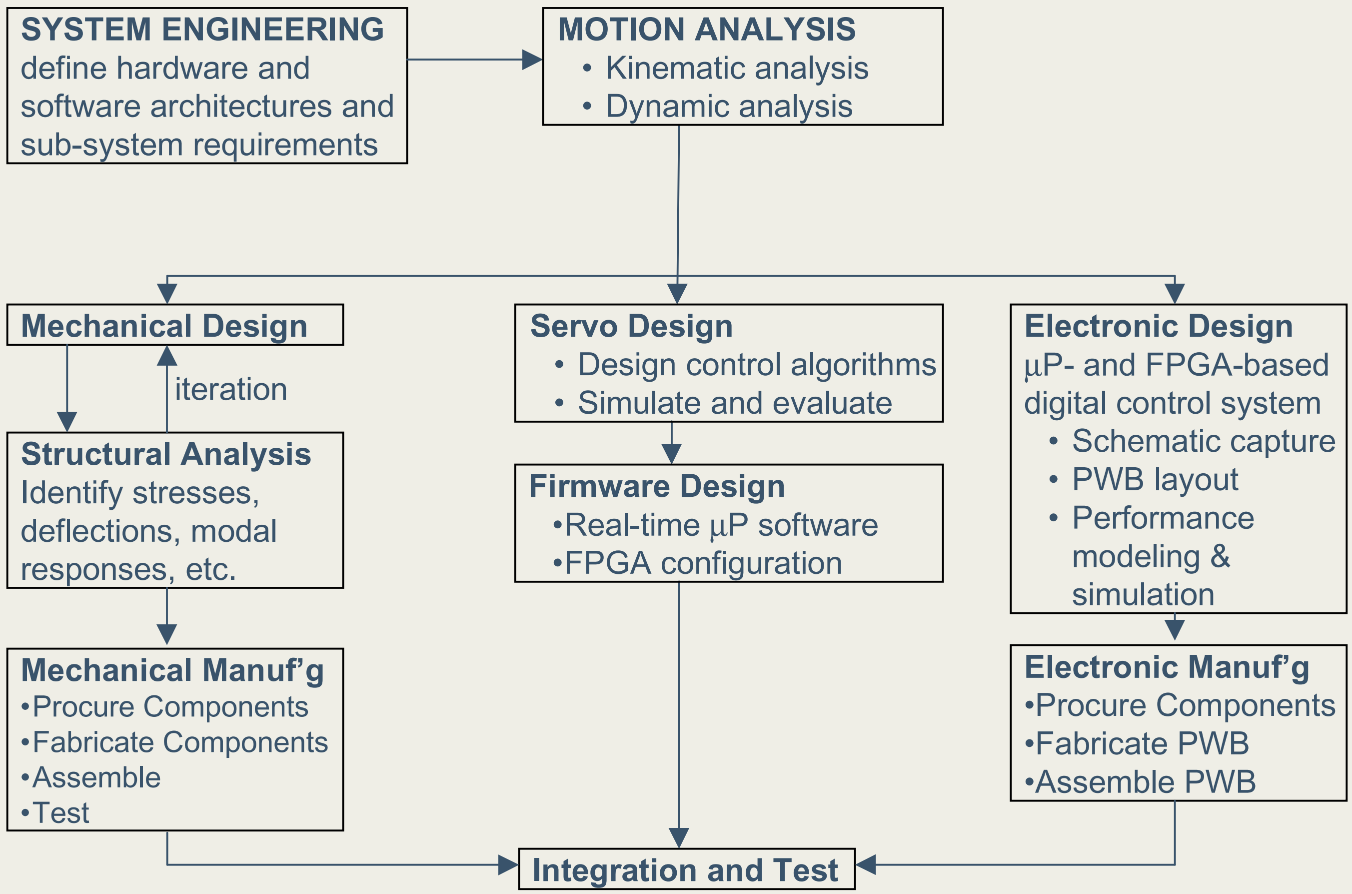
Notional Example – Robotic Arm



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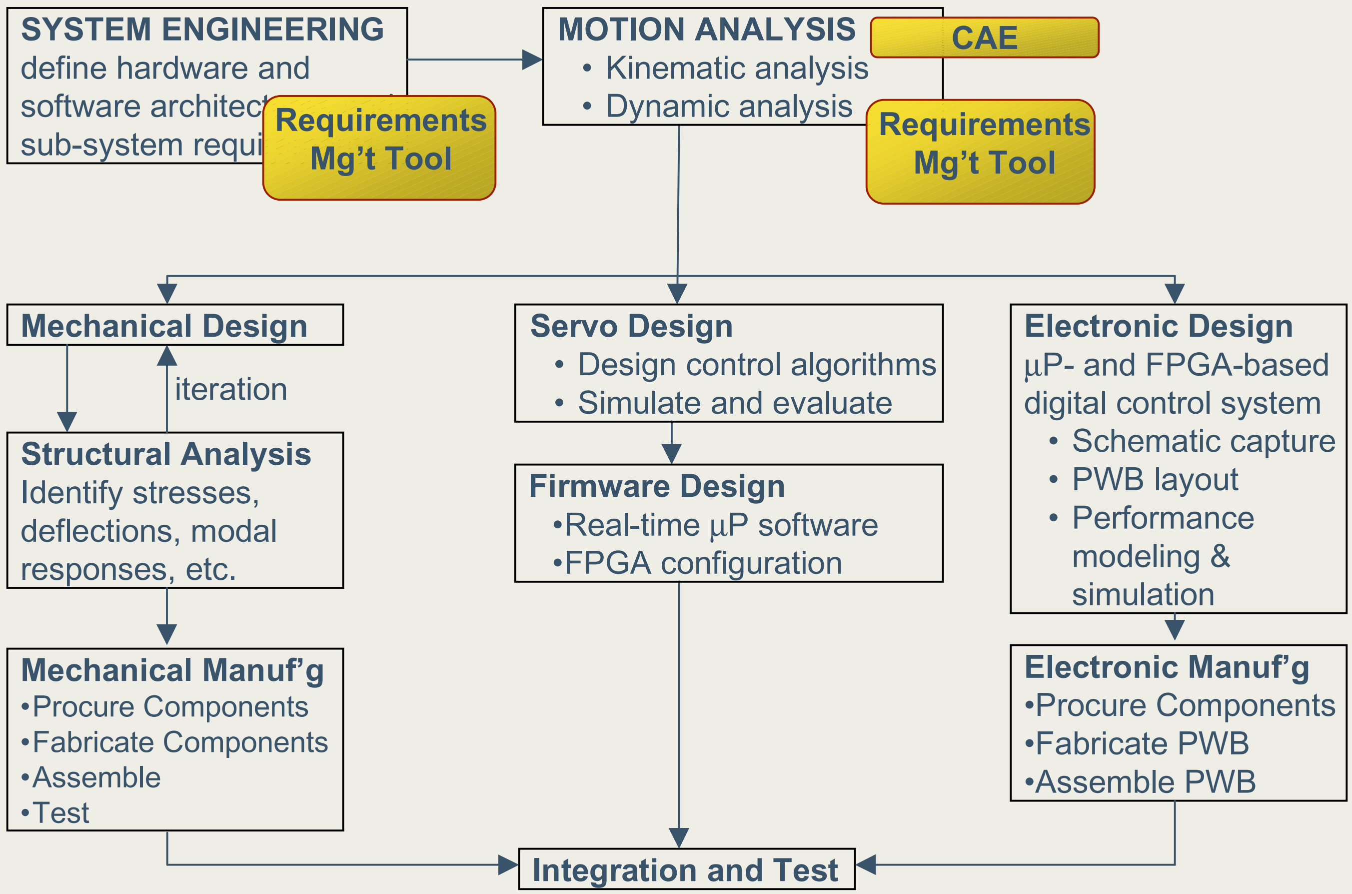

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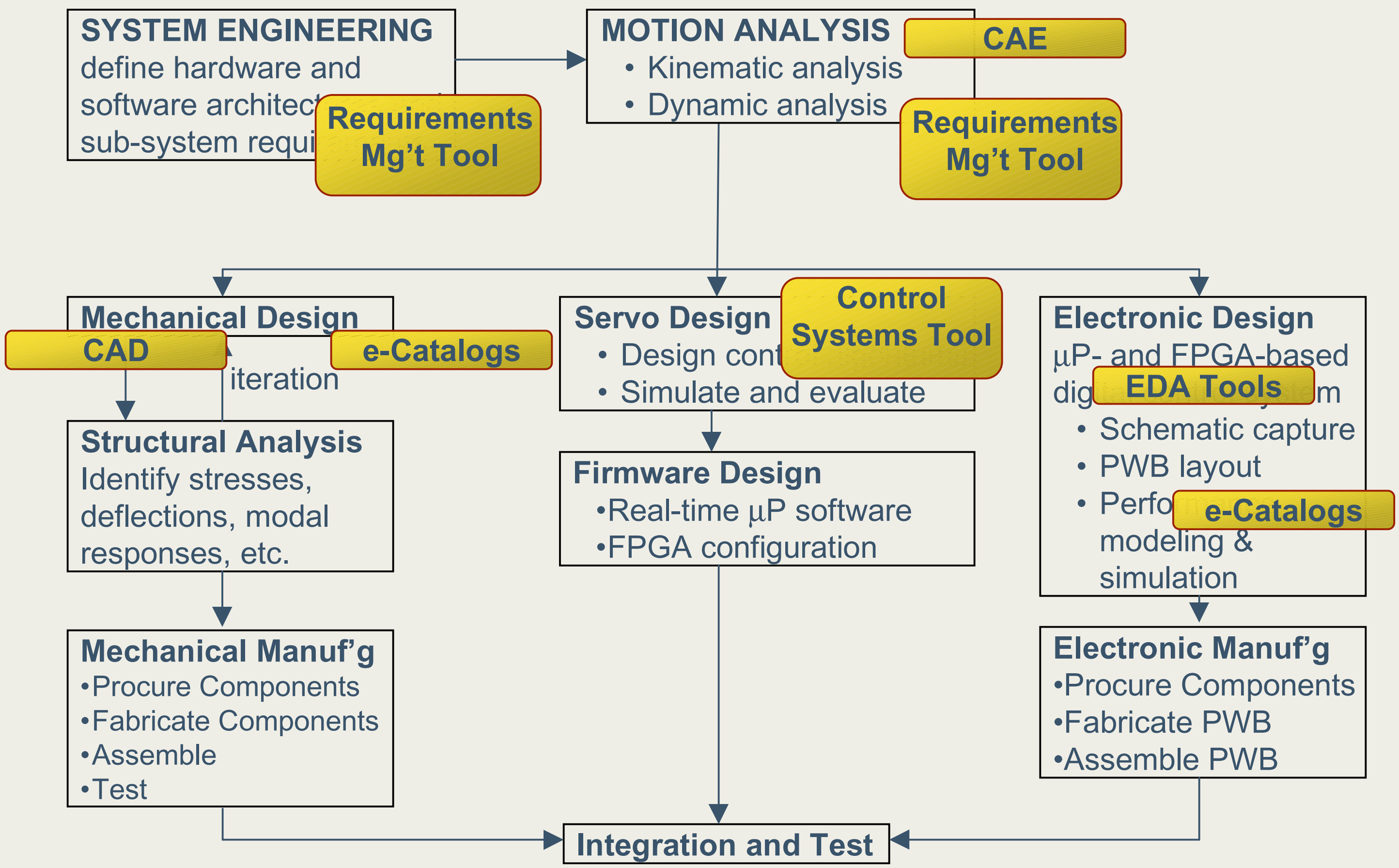

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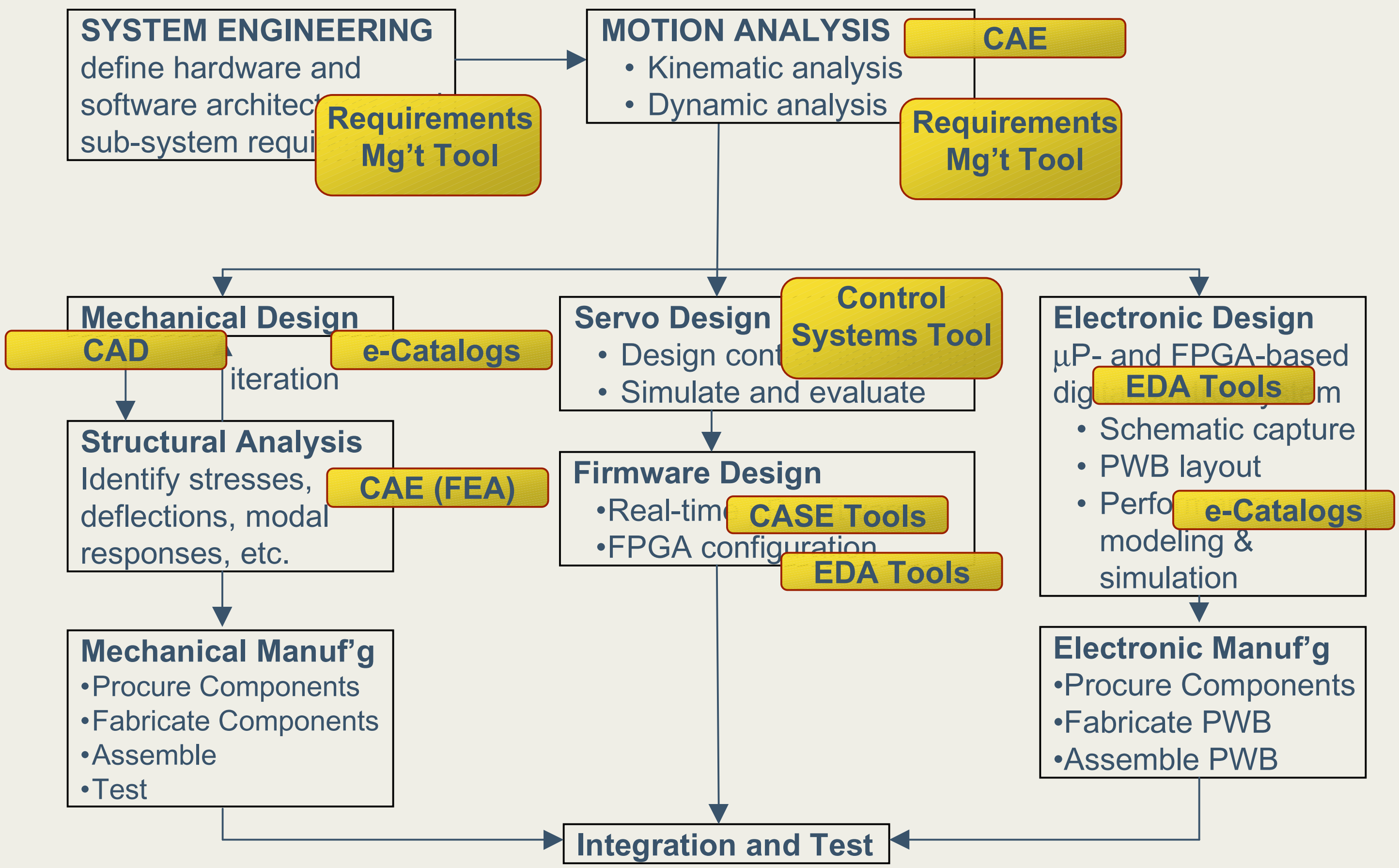

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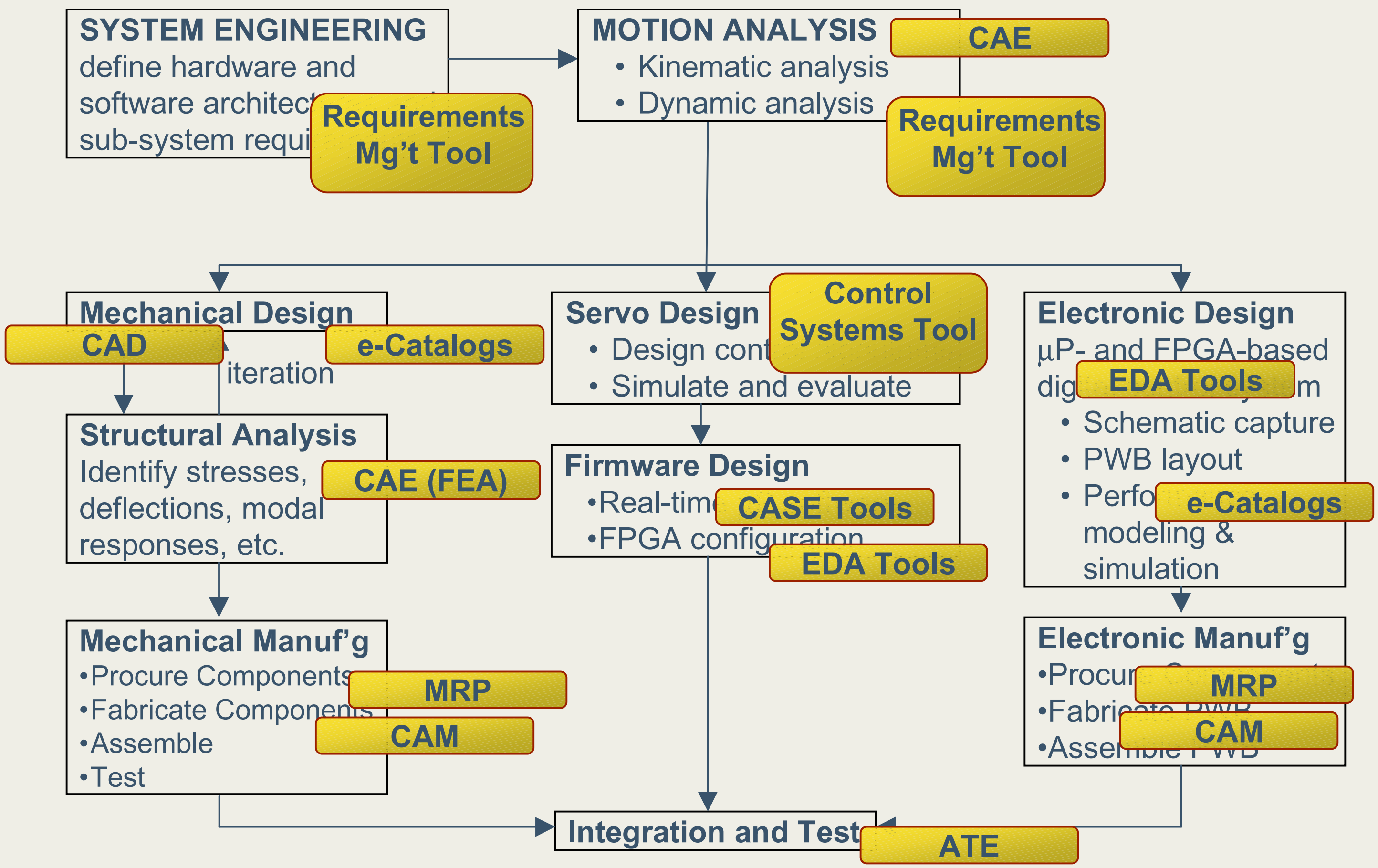

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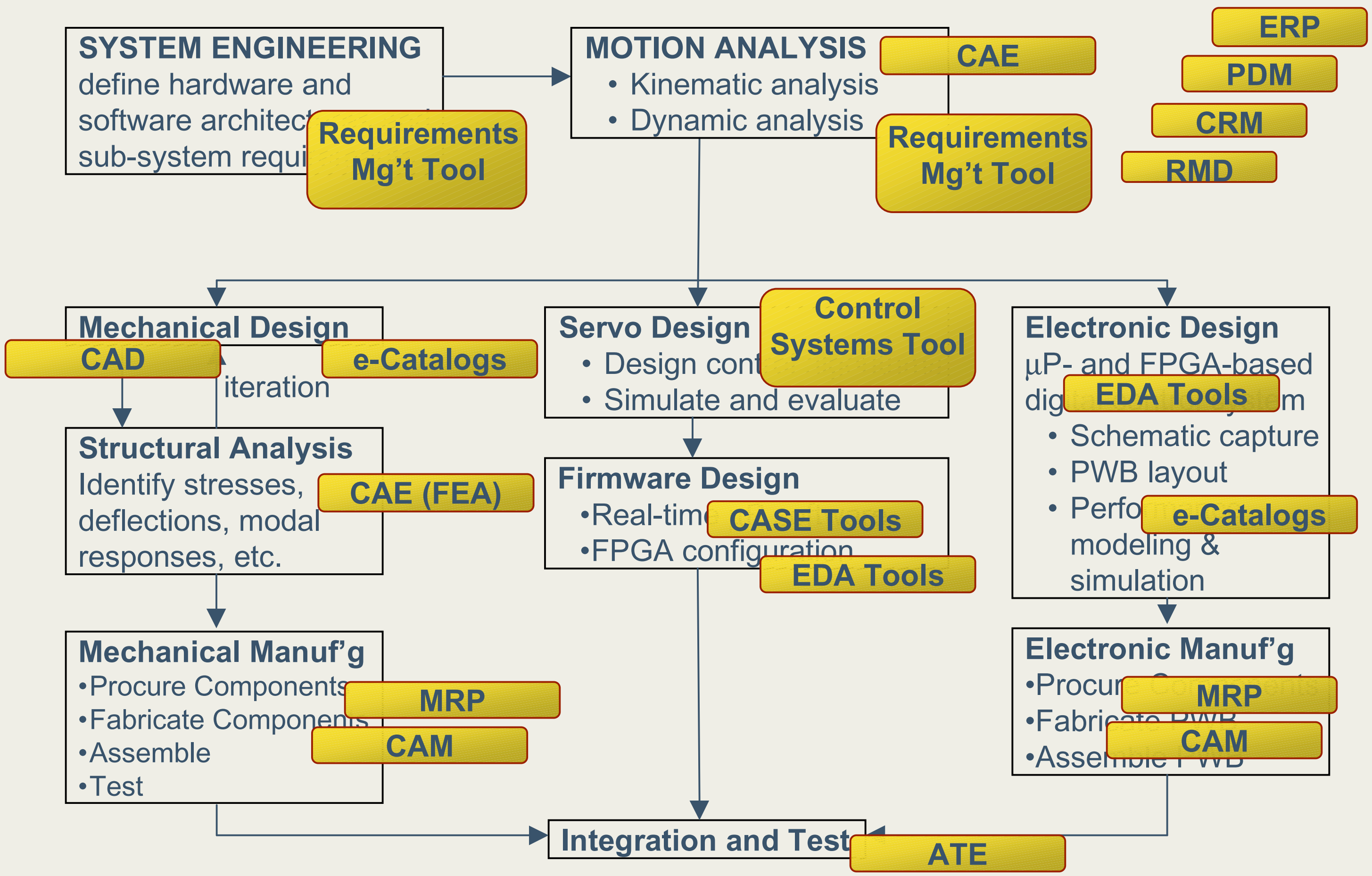

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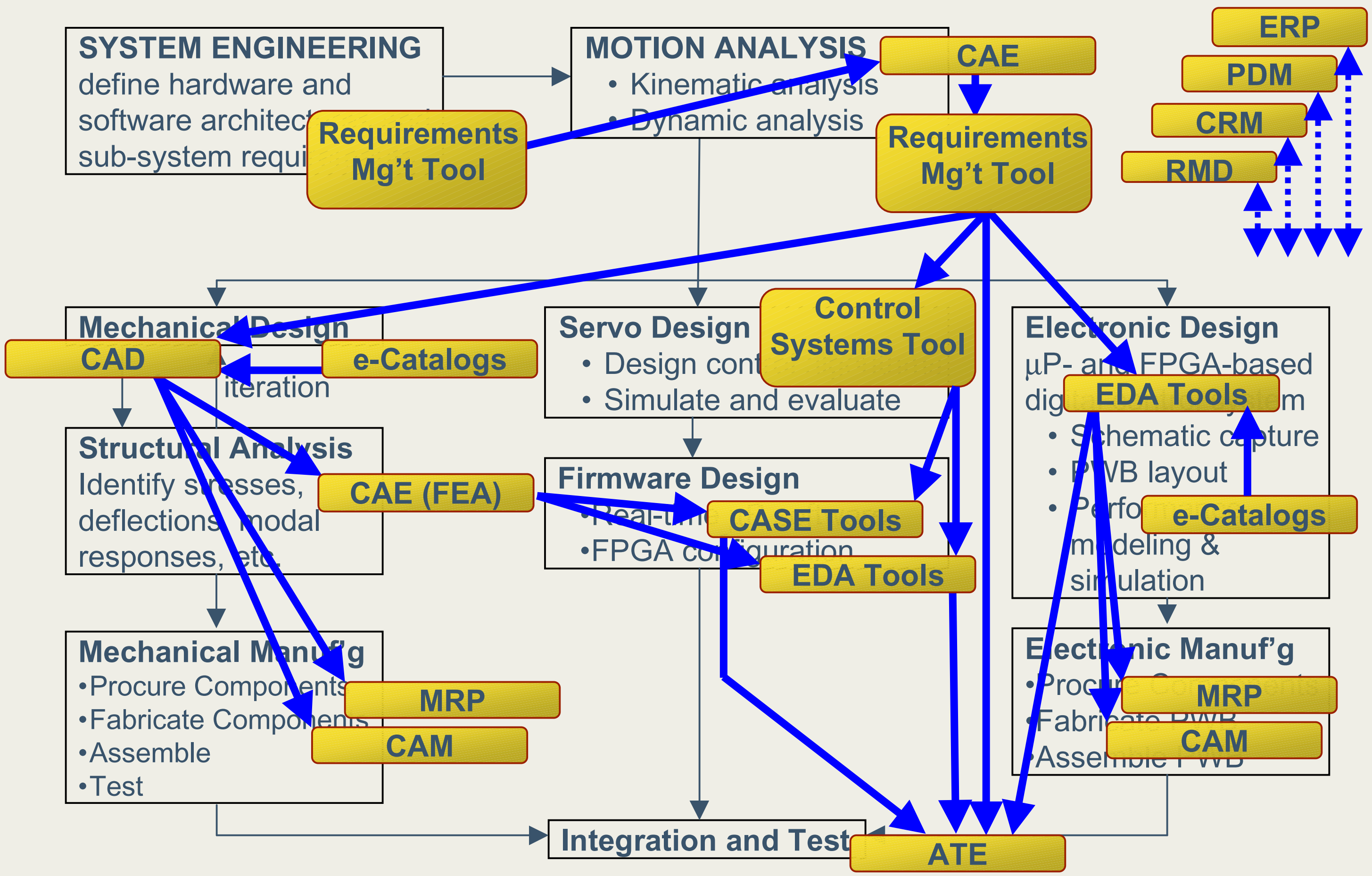
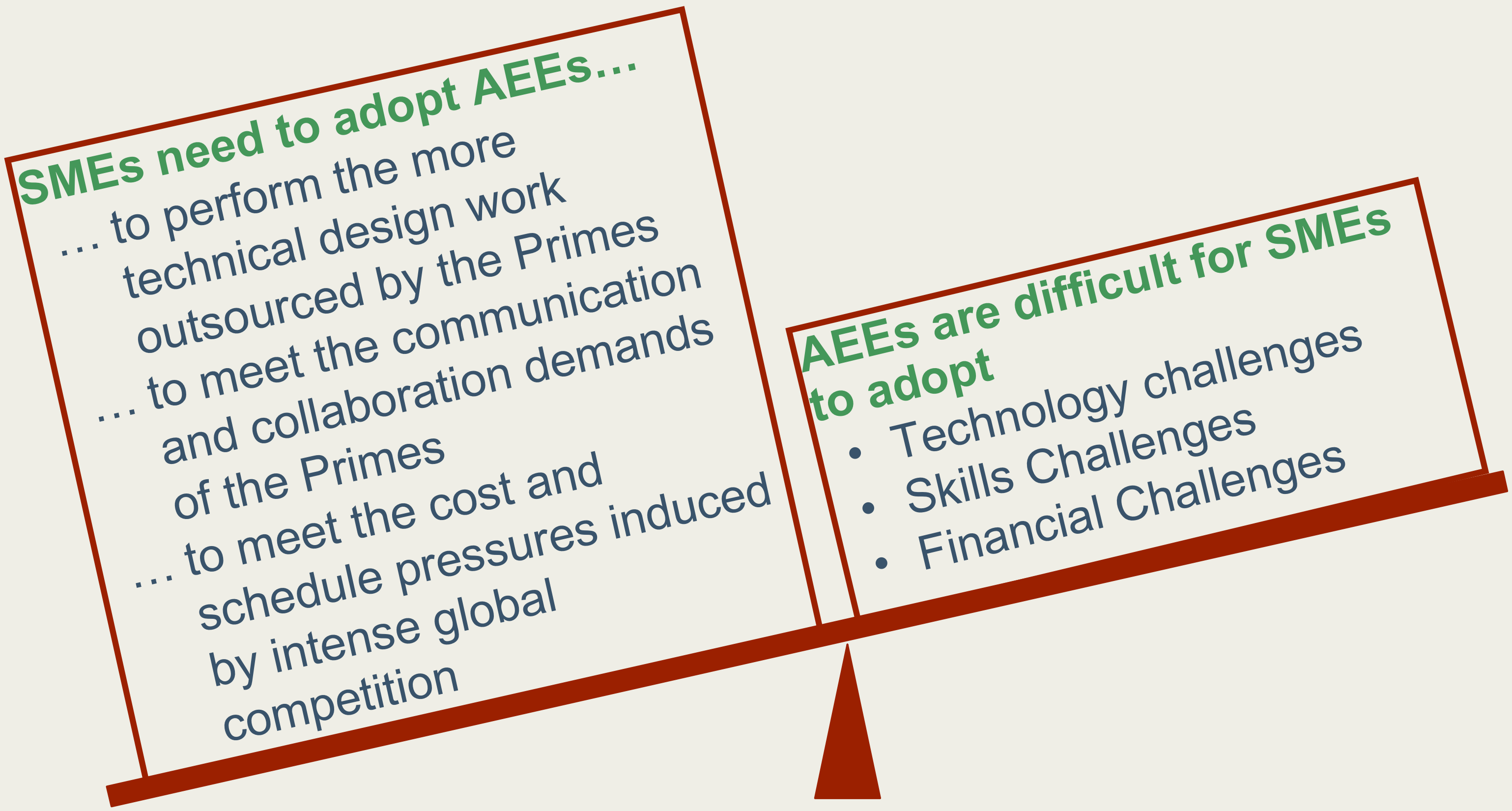


The Problem: AEEs @ SMEs



One Approach

SMEs need to adopt AEEs…

… to perform the more technical design work outsourced by the Primes

… to meet the communication and collaboration demands of the Primes

… to meet the cost and schedule pressures induced by intense global competition

AEEs Tailored for SMEs

Incre-mental AEE Adoption

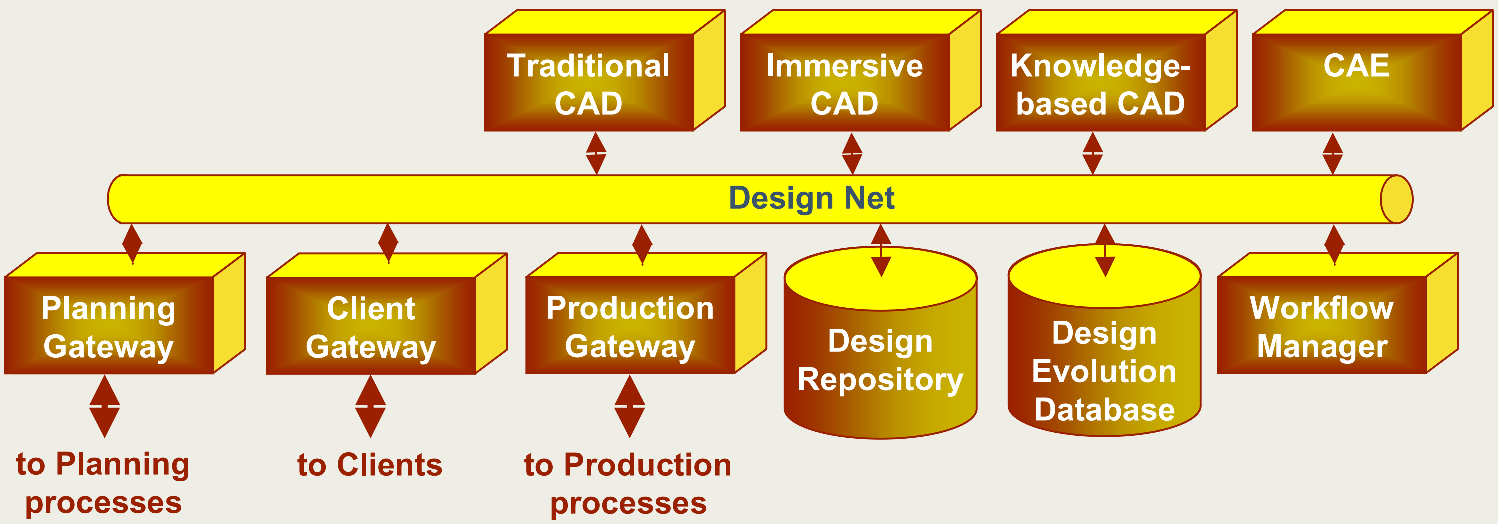
AEEs are difficult for SMEs to adopt

- Technology challenges
- Skills Challenges
- Financial Challenges

Comprehensive AEE

A suite of fully interoperable, integrated tools operating upon a common database of information accessible to all relevant design and analysis tools.

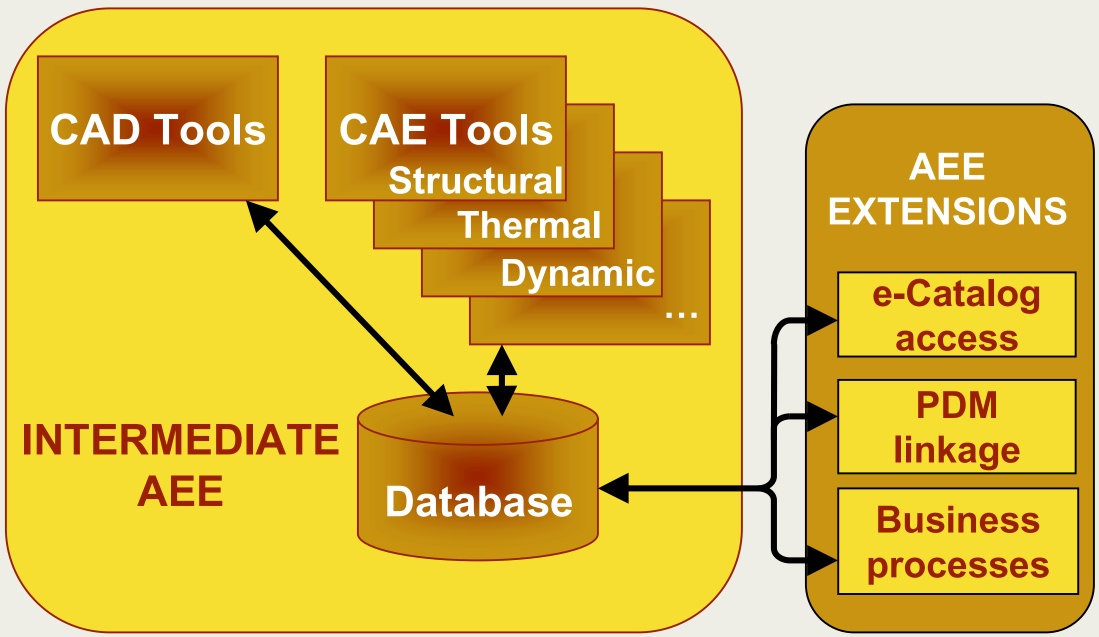
- Vision for the future
- Not fully realized today.
- Some tool integration from major vendors



Intermediate AEE

A suite of interfaced and interoperable tools (e.g. CAD, CAE, CAM, PDM) sharing compatible data.

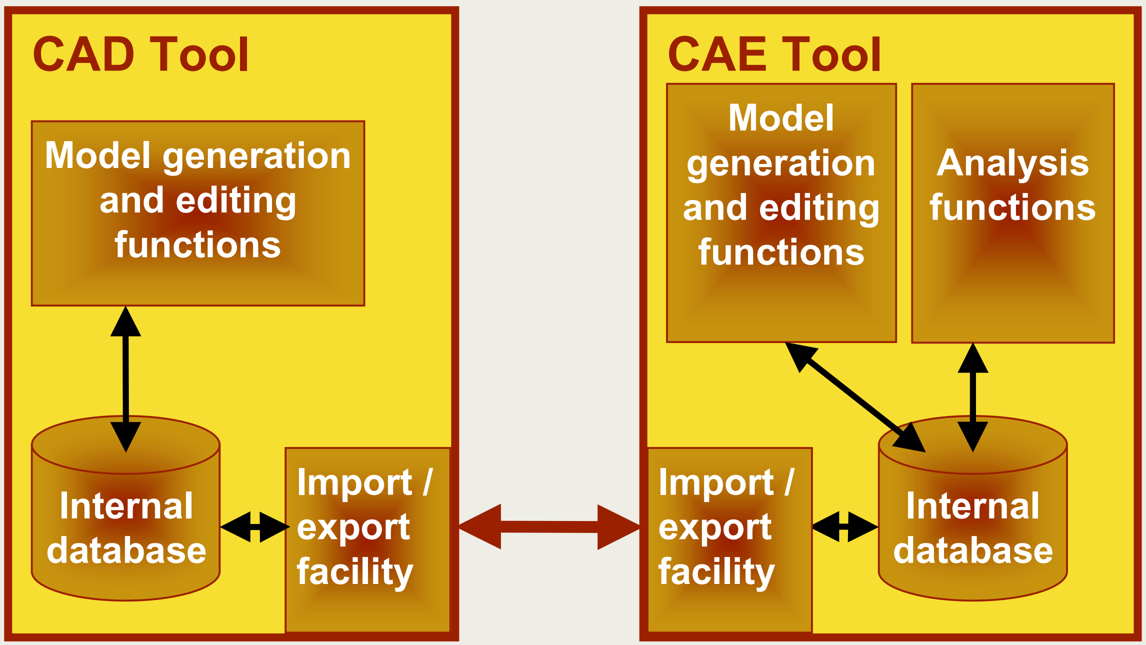
- Partially available today
- Standard interfaces (STEP)
- Some tool integration from major vendors



Basic AEE

A CAD system and compatible CAE systems

- Readily available today
- Within reach of SMEs



Operational Benefits of AEEs 1

Product Development and Production Time

- Provide accurate and rapid response to RFQs
- Minimize duplicated and repetitive work
- Reduce design iterations needed for successful design
- Maximize reuse of designs and design elements
- Improve interdisciplinary communication and collaboration

Cost in Product Development and Manufacturing

- Design Optimization
- Risk Reduction through Design Experiments
- Manufacturing Optimization through Simulation .

Operational Benefits of AEEs 2

Product Quality

- Enhanced Depth of Performance Analysis
- Optimization of Final Design
- Improved Collaboration in Early Design Stages
- Expanded Reuse of Proven Designs
- Enhanced Methods of Quality Evaluation

External Benefits of AEEs

Coping with Global Enterprises and Markets

- Improved flexibility
- Faster response to market demands

Improved Communication with Customers & Suppliers

- Access to supplier e-Catalogs
- Accurate data exchange with suppliers
- Accurate data exchange with customer
- Improved capability for collaboration with customer

Barriers for SMEs

Smaller manufacturers are not embracing many of the latest, best software tools. WHY?

- Lack of awareness
- Financial & Business Issues
- Technology Issues
- Organizational / Cultural roadblocks
- Vendor Issues

Lack of Awareness

SMEs lack awareness of available COTS technologies and the potential benefits they can provide

Challenges

- Lack of IT skills
- Unbiased consultants familiar with the domain and the technology are rare

Keys to Success

- Create a technology strategy
- Assign employees to study technologies
- Self-assessment tools [Ref 4, Ref 5]

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Financial / Business Issues

The risks & benefits must be evident for an SME to consider investing in software technology

Challenges

- Absence of Business Cases
- Identifying costs and benefits
- Competition with non-software investment options

Keys to Success

- Provide examples
- Identify costs and benefits for technologies [Ref 1, Ref 2]

Technology must be clearly tied to an SME's business objectives for measurable impact

Challenges

- Absence of technology adoption planning
- SME focus on short term benefits

Keys to Success

- Integrate technology into business planning
- Educate owners/CEOs on the role of technology

Technology Issues

Technology management is not an SME CORE COMPETENCY

Challenges
- Legacy systems & data
- Resources for IT support

Keys to Success
- Attention to interoperability
- A selection PROCESS [Ref 3]
- A support plan

Incompatible technology demands from multiple customers

Challenges
- Multiple system compatibility

Keys to Success
- Attention to interoperability
- Translation products and services

Organizational / Cultural Issues

Insufficient definition and understanding of the As-Is business processes is the standard among SMEs

Challenges

- Tribal knowledge
- Pride in flexible processes
- Culture of informal teamwork

Keys to Success

- Document the As-Is process
- Use appropriate level of detail

SMEs believe they are too busy and do not have time to do effective technology planning activities

Challenges

- Small size of organization
- Flat management structure
- Culture focus on short term benefits

Keys to Success

- Highlight cost of not planning
- Break up planning activities
- Constantly communicate benefits

Vendor Issues

Vendors do not target, and may specifically avoid, marketing to SMEs

Challenges
- focus on sales per sales call
- perception that SMEs require more support

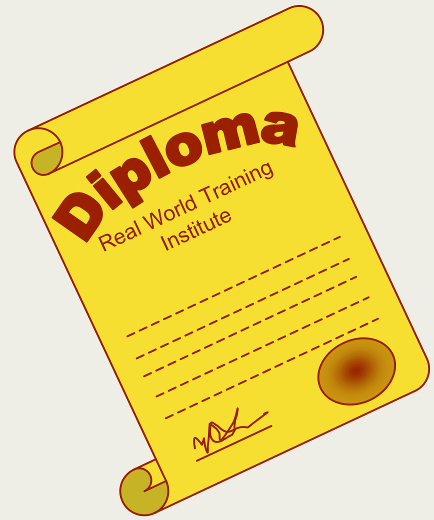
Keys to Success
- Awareness: SMEs are a growth market
- Consider an ASP model

There is a training gap between COTS training providers and SMEs

Challenges
- Vendors provide general product training
- training needed to apply the product to their SME's needs

Keys to Success
- Vendor consulting services
  - Bridge the training gap
  - Mentor to support risk management

Key Areas to Address - Education



… for SMEs

- AEE Concepts
- Benefits of AEEs
- Technology Adoption Processes
- Workforce Development

… for Tool Vendors

- Awareness / Appreciation of SME market niche

… for Tool Developers

- AEE Concepts
- Interoperability Standards
- SME needs and capabilities

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   Self Assessment Tool for Engineering Capabilities (SAT-ETC)

References are available via:

http://www.sei.cmu.edu/tide/publications/abstracts.html

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