What Do You Know About Process Improvement and Physics-Based Modeling?

CMMI® Technology Conference and User Group

Physics-based Modeling in Design & Development for U.S. Defense Conference

November 16, 2011

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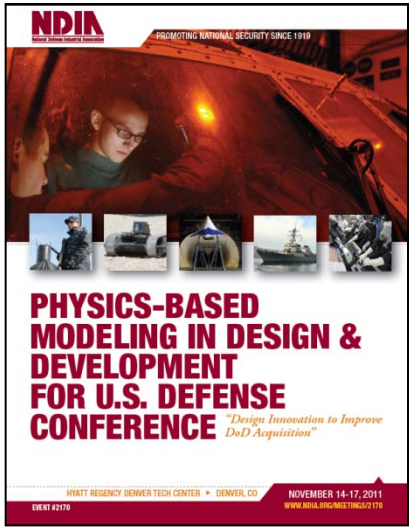
Welcome!

Objective:

- Help build awareness and interest in process improvement and physics-based modeling
- Facilitate integration between communities

Approach:

- Brief overview of fundamental concepts
- Interactive responses to targeted questions for community feedback

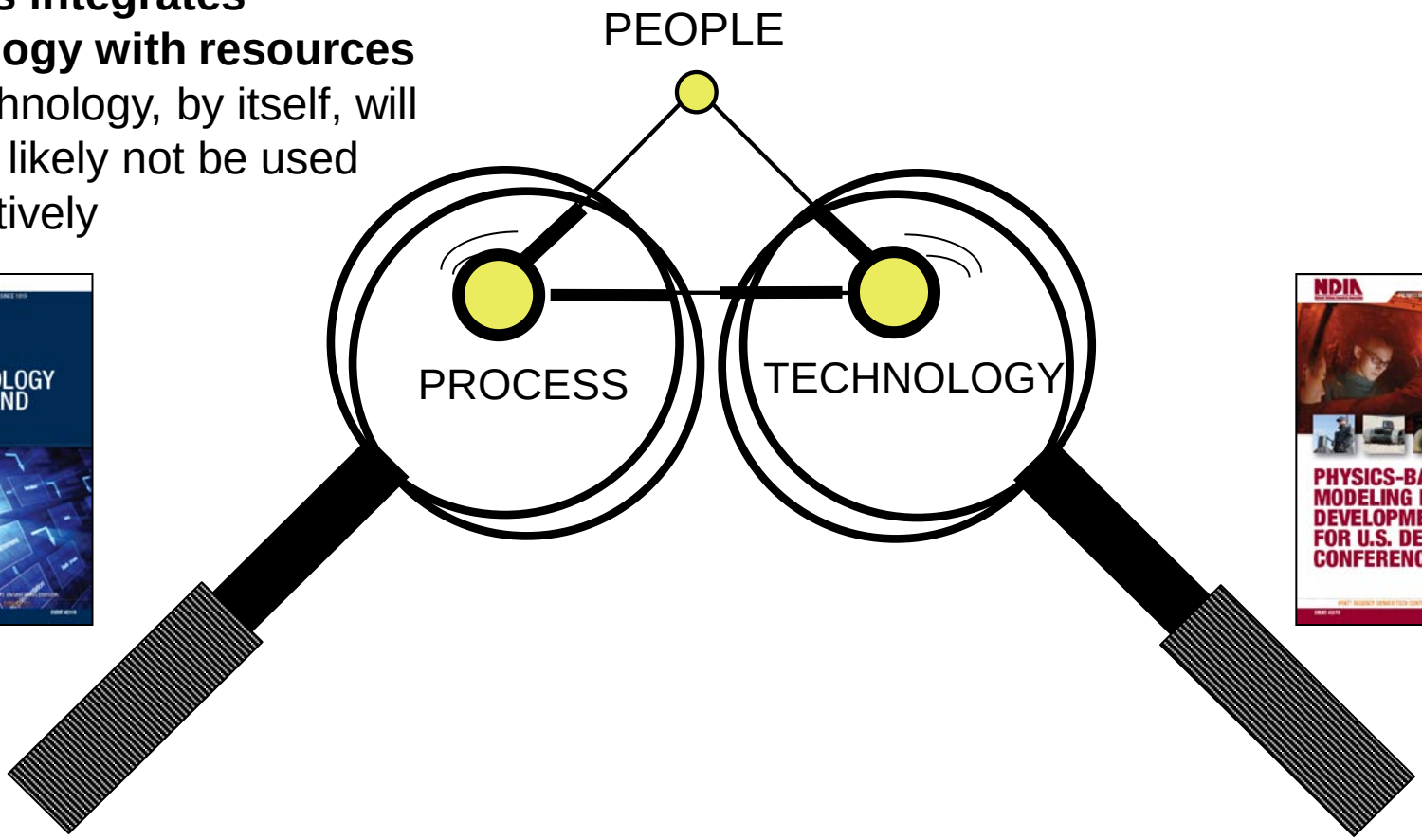


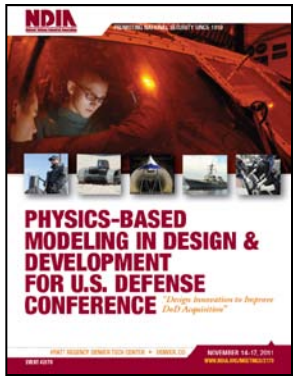
Note: Please return the interactive voting devices. They are on loan courtesy of Harris Corporation.

What's the Relationship between CMMI and Physics-Based Modeling?

Process integrates technology with resources

- Technology, by itself, will most likely not be used effectively



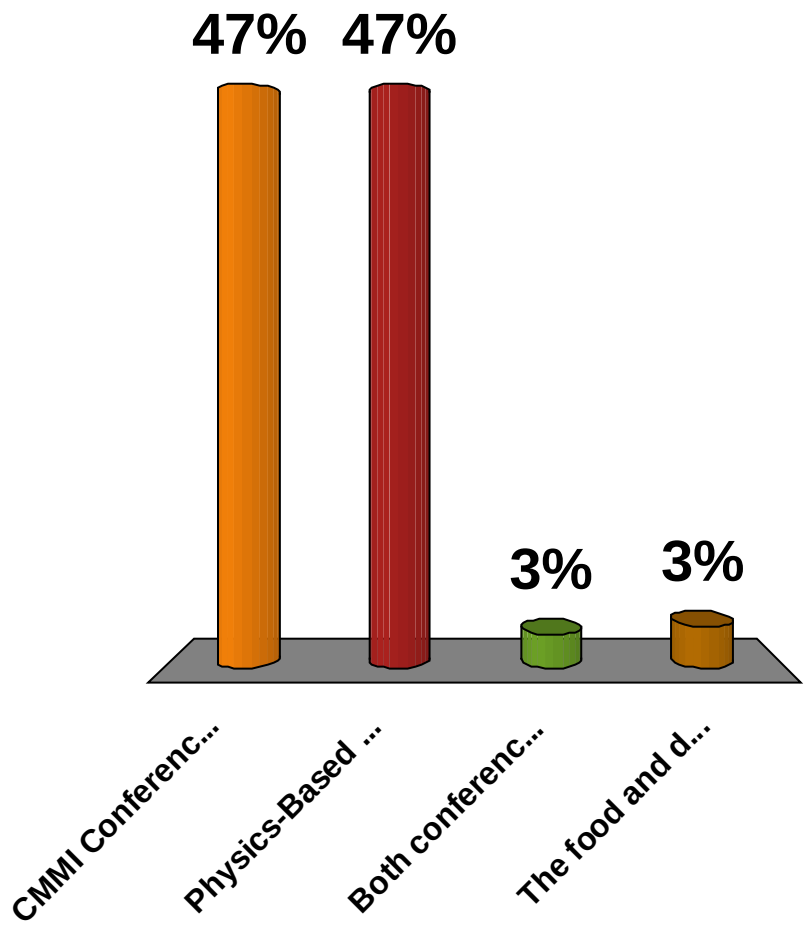


CMMI Technology Conference and User Group

Physics-Based Modeling in Design & Development for U.S. Defense Conference

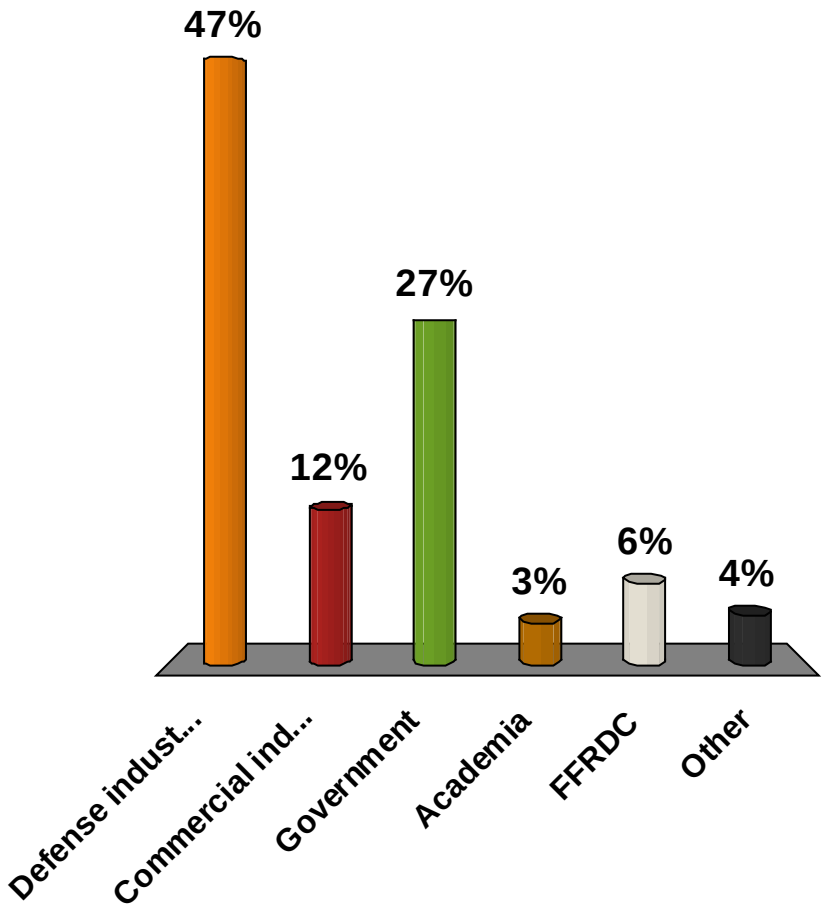
I am here primarily for…

1. CMMI Conference
2. Physics-Based Modeling Conference
3. Both conferences
4. The food and drinks



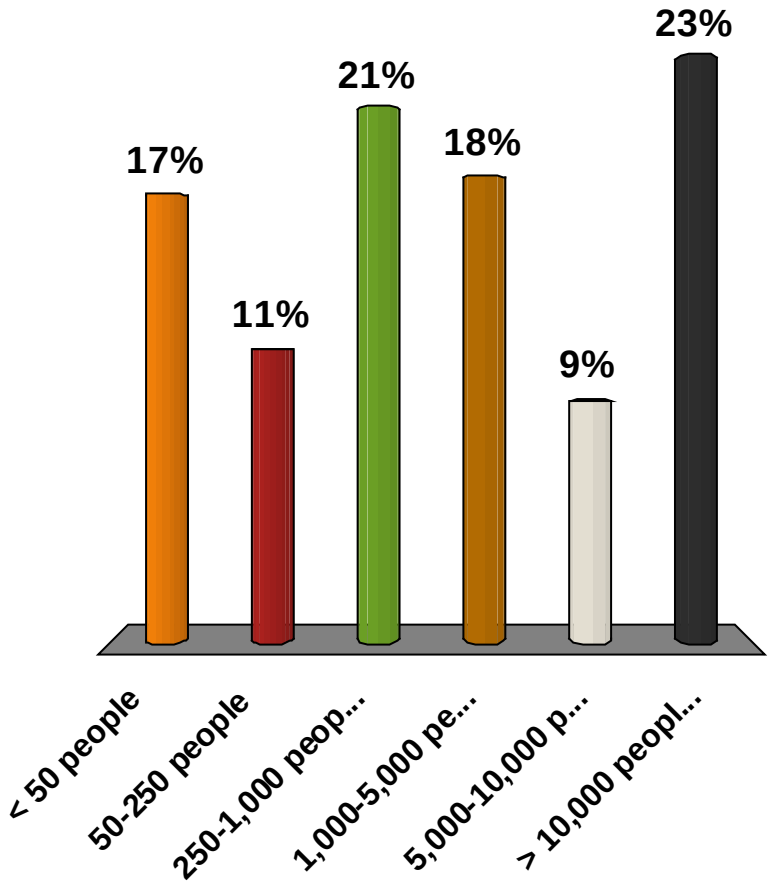
What domain are you representing?

1. Defense industry
2. Commercial industry
3. Government
4. Academia
5. FFRDC
6. Other



How large is your organizational unit?

1. < 50 people
2. 50-250 people
3. 250-1,000 people
4. 1,000-5,000 people
5. 5,000-10,000 people
6. > 10,000 people



What Is CMMI?

CMMI is a model representing a collection of best practices proven effective in industry

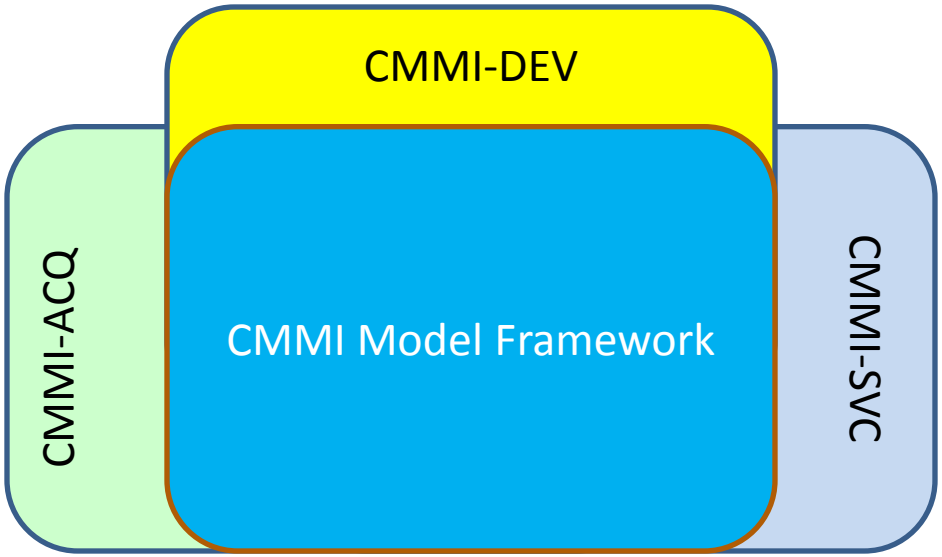
- A framework for developing, improving, and sustaining business performance
- Provides a process focus on work activities
- Developed by industry (commercial and defense), government, academia

CMMI targets three primary environments:

- Development -
  Engineering a product or service
- Services –
  Providing services
- Acquisition –
  Acquiring products and services

The CMMI product suite consists of:

- Models and primers
- Appraisal methods
- Training courses



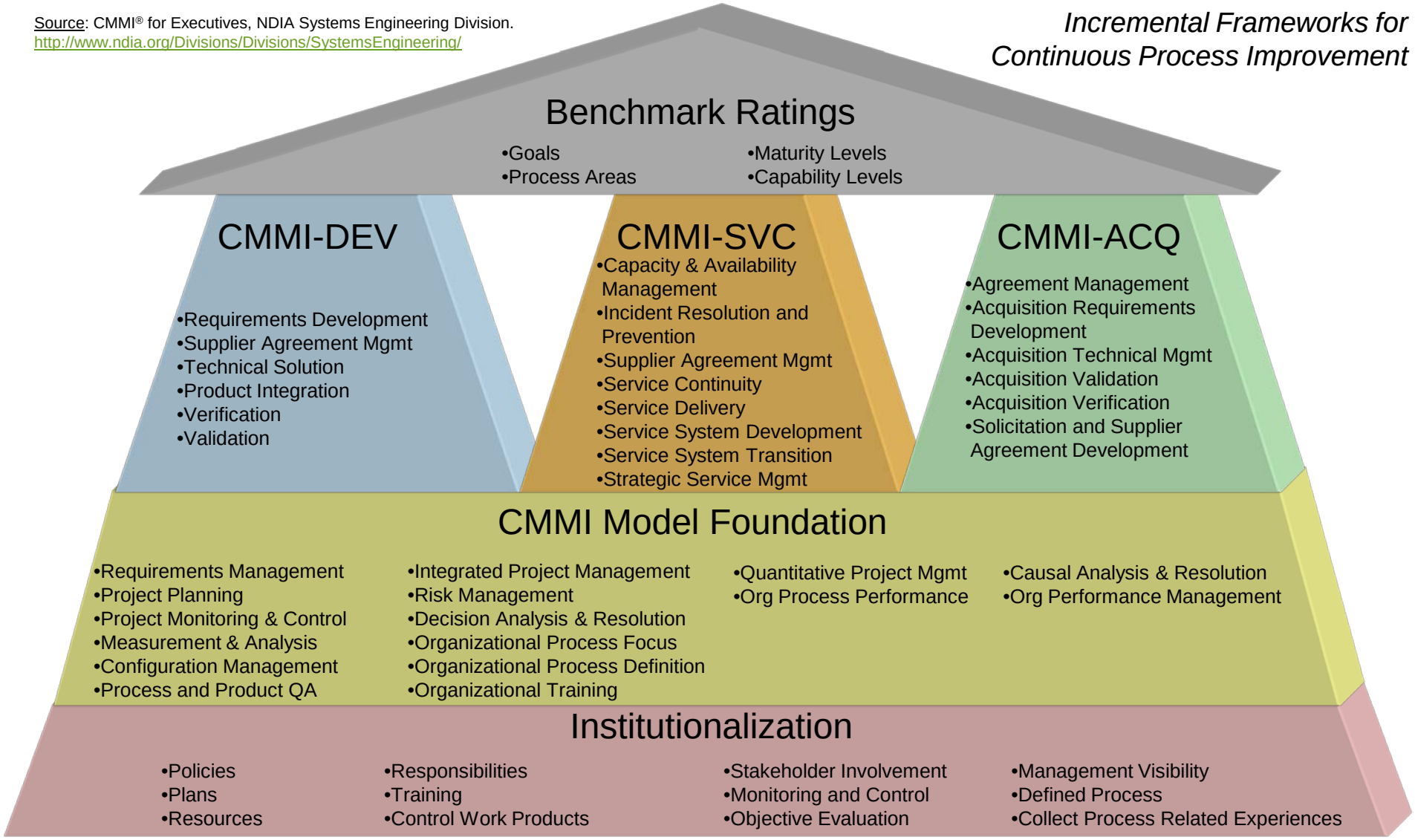
Capability Maturity Model Integration (CMMI®)

Source: CMMI® for Executives, NDIA Systems Engineering Division.
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/

CMMI Model Structure

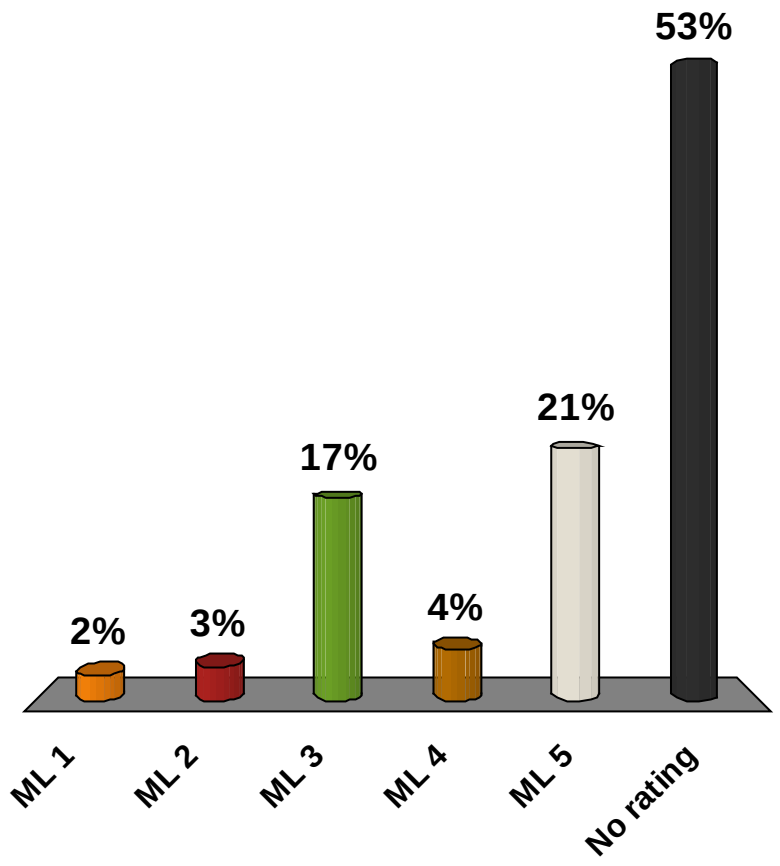
Source: CMMI® for Executives, NDIA Systems Engineering Division.
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/

Incremental Frameworks for Continuous Process Improvement



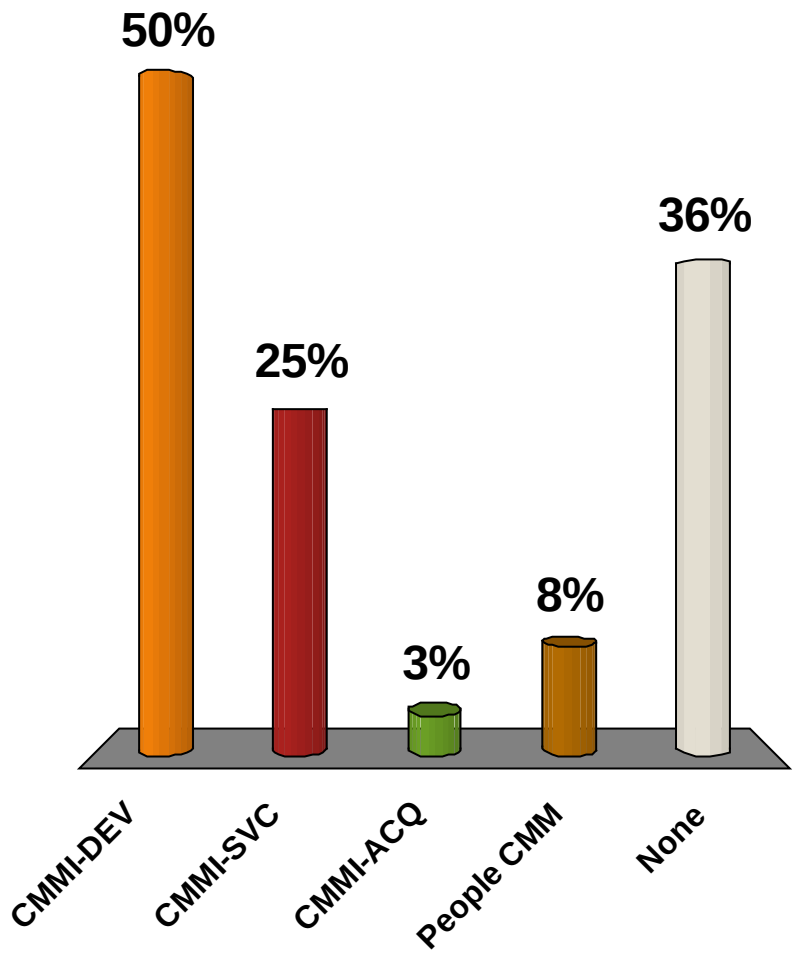
Does your organization have a CMMI maturity level rating?

1. ML 1
2. ML 2
3. ML 3
4. ML 4
5. ML 5
6. No rating



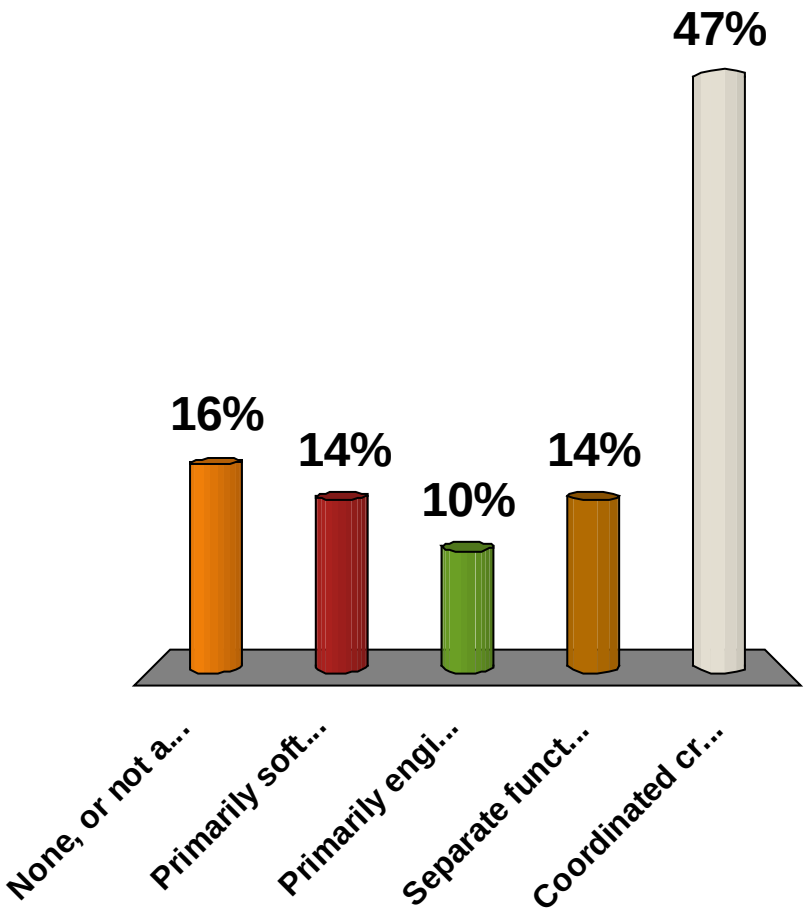
Which model constellations has your organization used, or will use in the next year? (select all that apply)

1. CMMI-DEV
2. CMMI-SVC
3. CMMI-ACQ
4. People CMM
5. None



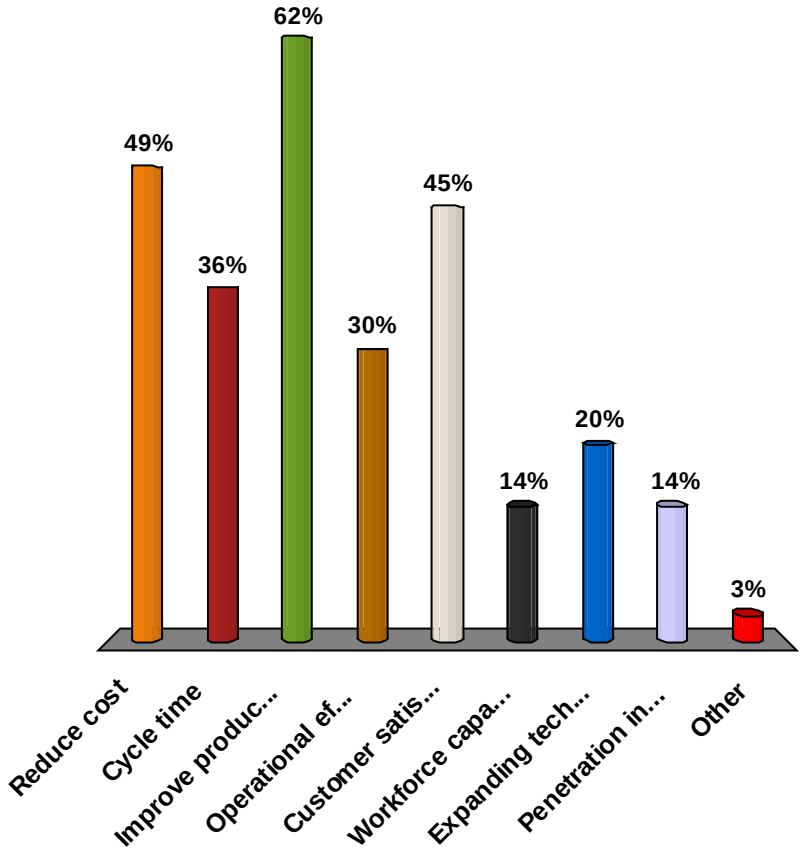
How does your organization implement process improvement?

1. None, or not applicable
2. Primarily software
3. Primarily engineering
4. Separate functional process groups
5. Coordinated cross-functionally (Engineering, PM, Mfg, Quality, etc.)



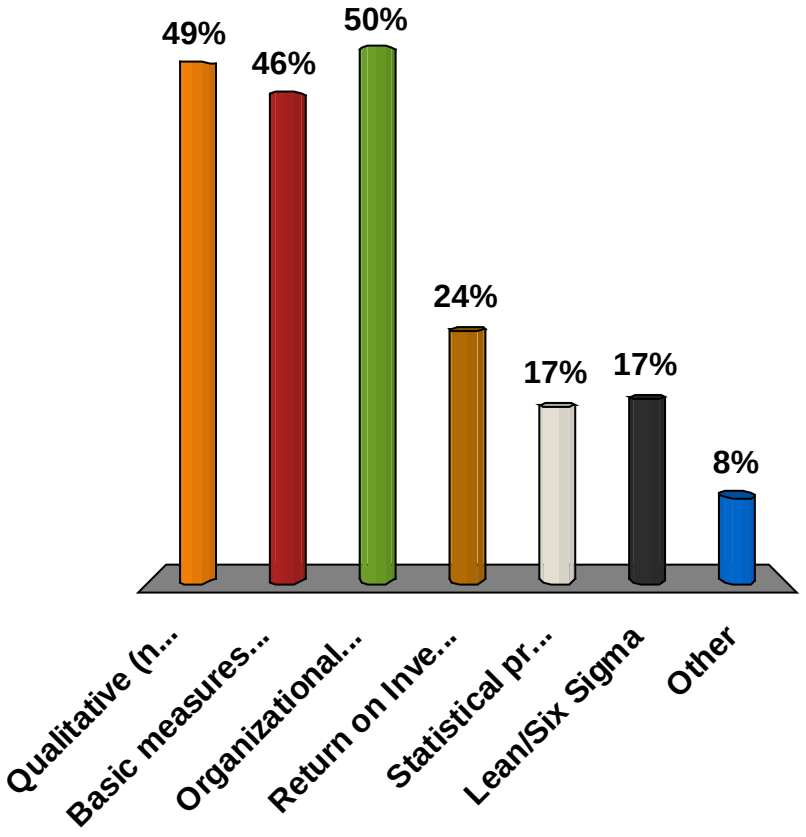
What top organizational improvement goals drive your measurable improvement initiatives? (select up to 3)

1. Reduce cost
2. Cycle time
3. Improve product quality (reduce rework)
4. Operational effectiveness
5. Customer satisfaction
6. Workforce capability/skills
7. Expanding technologies (e.g., Agile)
8. Penetration into new markets
9. Other



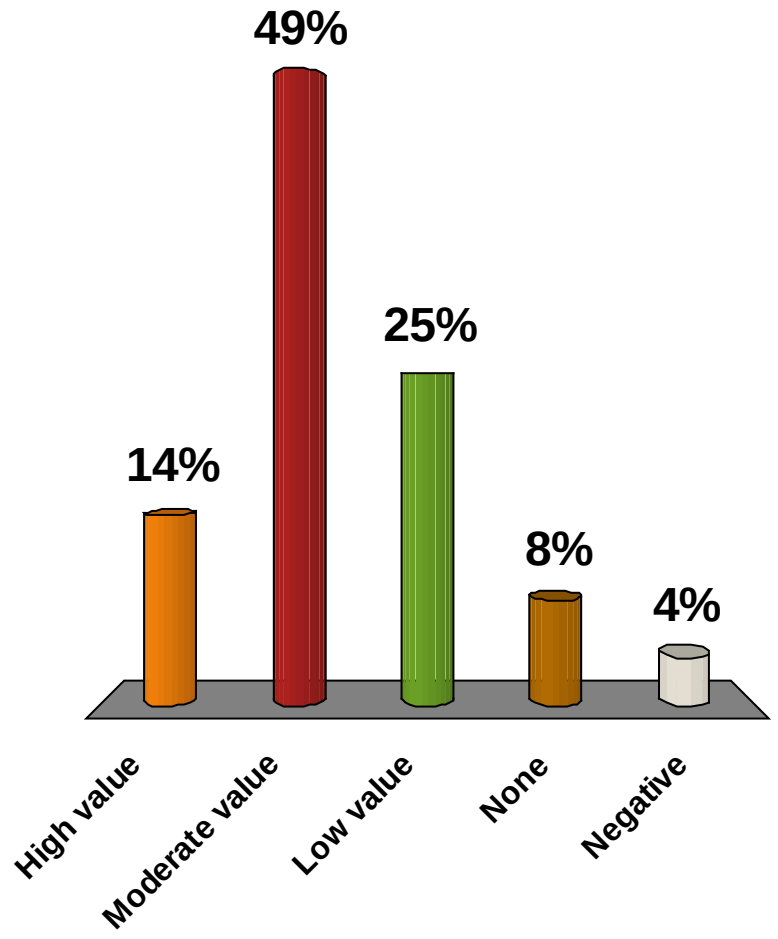
How do you measure the effectiveness of your improvement initiatives? (select up to 3 choices)

1. Qualitative (not measured)
2. Basic measures for individual initiatives
3. Organizational improvement trends (e.g., across projects)
4. Return on Investment (ROI)
5. Statistical process control (SPC)
6. Lean/Six Sigma
7. Other



What real impact has process improvement had on your business performance?

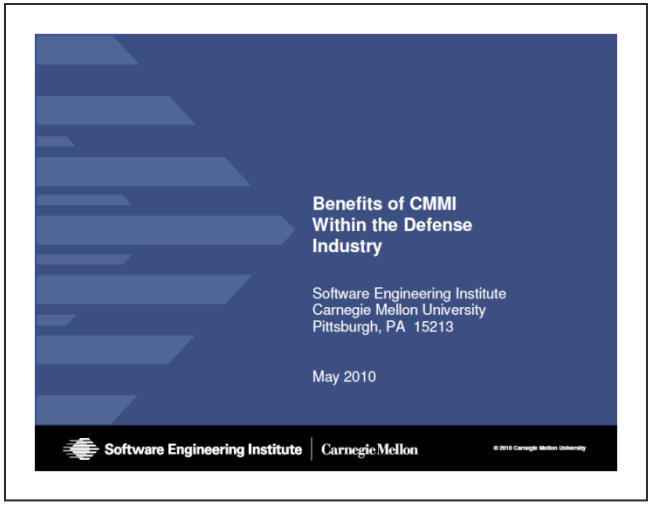
1. High value
2. Moderate value
3. Low value
4. None
5. Negative

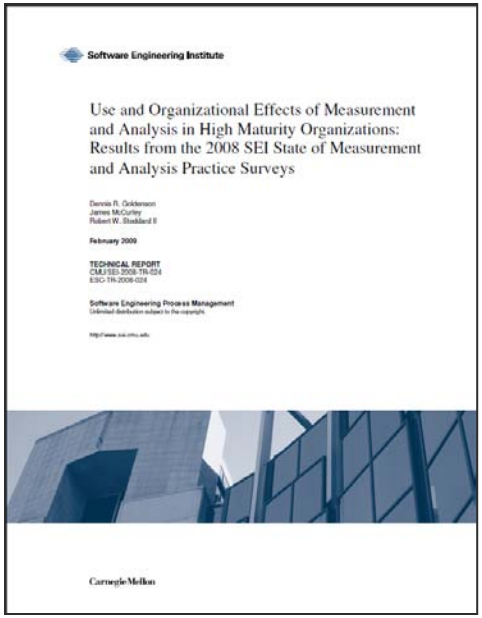


Measures of CMMI Adoption and Performance Benefits

- Studies
- Reports
- Workshops
- Analyses

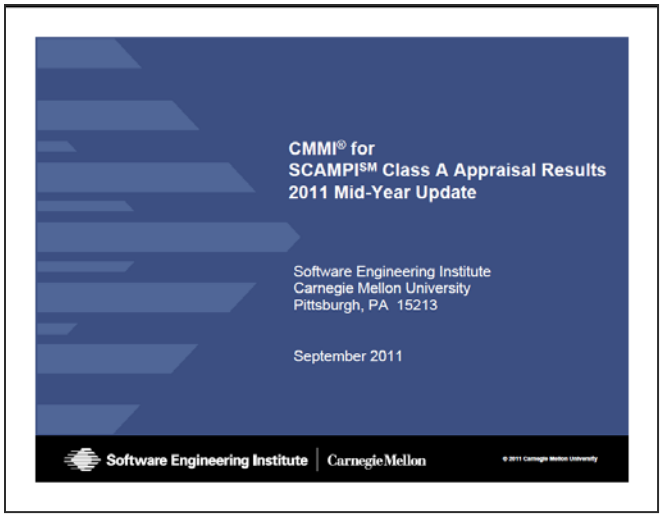
http://www.sei.cmu.edu/library/assets/presentations/CMMI%20Benefits.pdf



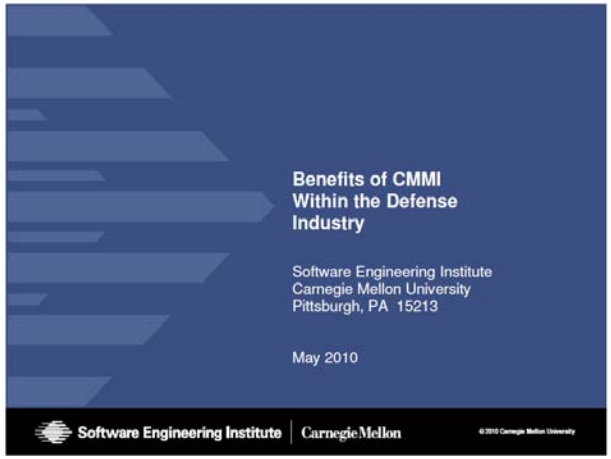


http://www.sei.cmu.edu/library/abstracts/reports/08tr024.cfm

http://www.sei.cmu.edu/cmmi/casestudies/profiles/pdfs/upload/2011SepCMMI.pdf



Industry Benefits from CMMI



Example measures reported by NDIA member companies:	
Defect repair effort	•Defect repair hours: -58% (ML3 to ML5) •Defect cost savings: -105 hrs per defect •I&T hrs/defect: -24% •Hours/KLOC: -22% *(ML3 to ML5)*
Defect density	•62% fewer high-severity defects *(ML5)* •Defect phase containment: +240% *(ML5)* •>85% defects removed prior to sys test •Acceptance test: < 0.15 defects/KLOC
Development cost	•SW development cost: -28% *(ML3 to ML5)* •Potential project savings: $1.9M–$2.3M
Productivity	•Productivity gain: +42% *(ML5, 9 yrs)*
Cost/schedule	•Over 6X less likely cost/schedule impact

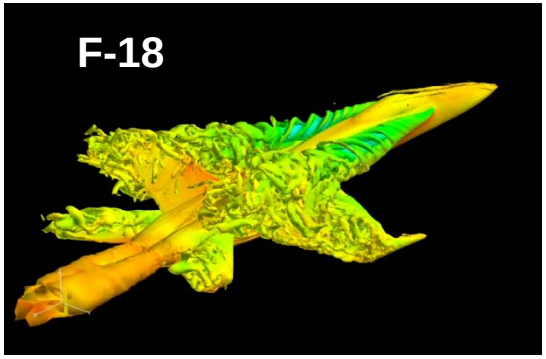
The new data presented in this report demonstrates that effective implementation of good practices aided by use of CMMI can improve cost, schedule, and quality performance.

Benefits of CMMI in the Defense Industry, Software Engineering Institute, May 2010.
http://www.sei.cmu.edu/library/abstracts/presentations/CMMI-Benefits-to-Defense-Industry.cfm

Source: CMMI® for Executives, NDIA Systems Engineering Division.
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/

What is Physics-Based Modeling?

- Physics-Based Modeling is the use of computer software applications to design and analyze the performance of systems by solving the physics equations that govern the behavior of the system
- Reduces the need for physical testing
- Examples:
  - Air Vehicles—predict air vehicle performance by solving the equations that describe the airflow over the wings and other components (i.e. lift and drag) together with the deformation of the air vehicle structure due to the airflow loads.
  - Tires—predict tire performance by solving the equations that describe tire flexing, deformation, and treadwear e.g. behavior of rubber, steel belts, water flow in treads, etc.



Vortex induced Tail Buffet

~ 60 Million Cycles During an 80,000 Mile Tire Lifetime

CREATE Program

The **Computational Research & Engineering Acquisition Tools and Environments** (CREATE) project was initiated by the Department of Defense in 2008 as a long term effort to enable major improvements in the acquisition process with the following goals:

- Prevent defects and design flaws early in the acquisition process
- Reduce rework thereby enabling faster system deployment
- Reduce experimental testing time and effort through analysis of virtual prototypes

It would accomplish this by injecting multi-physics based predictions early within the design and analysis process, by developing and deploying production quality design and analysis software that is adaptable and maintainable, and developing and deploying multi-physics based Computational Engineering tools that exploit next generation high-speed computer resources. These tools have the real potential to dramatically reduce the overall time and effort required to design and develop DoD systems and products in fixed and rotary wing aircraft, ships, propulsion systems, antennae, and related systems, while greatly improving accuracy as well.

CREATE Products

Air Vehicles

DaVinci - Rapid conceptual design development and initial system integration

Kestrel - High-fidelity, full vehicle, multi-physics analysis tool for fixed-wing aircraft- Release 1.0 Provides Rigid body CFD fixed wing AV with preliminary aeroelastics

Helios - High-fidelity, full vehicle, multi-physics analysis tool for rotary-wing aircraft – Release 1.0 Provides highly accurate calculation of rotorcraft vortex shedding

Firebolt - Module for propulsion systems in fixed and rotary-wing air vehicles

Ships

RDI - Rapid Design and Synthesis Capability—Partnership with ONR and NAVSEA

NESM - Ship Shock & Damage-prediction of shock and damage effects – Release 0.1 provides initial ship shock vulnerability analysis for underwater explosions

NAVYFOAM - Ship Hydrodynamics-predict hydrodynamic performance

IHDE - Environment to facilitate access to Naval design tools – Release 1.0 provides initial user interface for ship hydrodynamics

RF Antenna

SENTRI - Electromagnetics antenna design integrated with platforms – Release 1.0 and 1.5 provides Initial RF antenna design and analysis with V&V

Meshing and Geometry

Capstone - Components for generating geometries and meshes

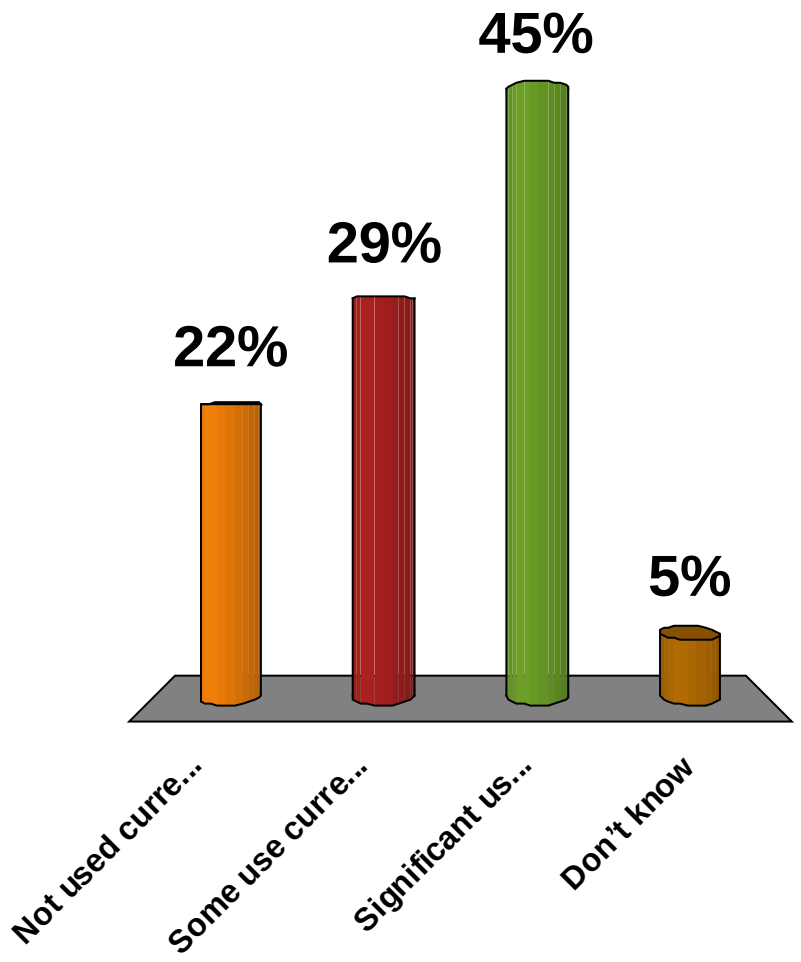
Other Computational Applications for Defense

National Defense Industrial Association

- Fluid Dynamics
- Structural Mechanics
- Computational Chemistry
- Weather and Climate Prediction
- Electromagnetics
- Electronics Design
- Signal Processing
- Materials Design
- Acoustics
- Space Weather Prediction
- Land Vehicle Design
- Munitions Design
- Armor Design

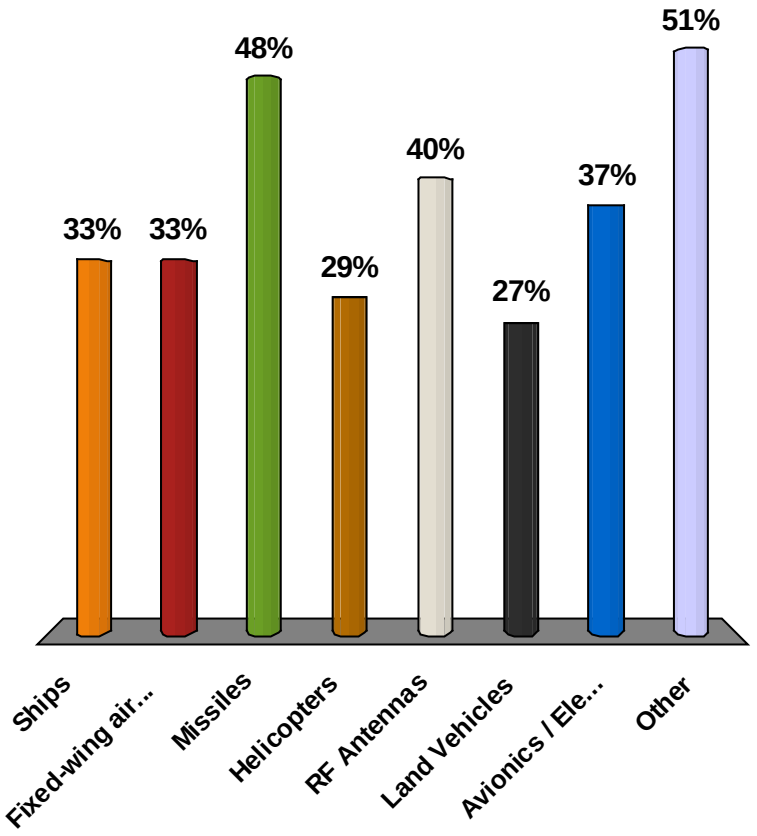
Does your organization now use any physics-based modeling as part of your design environment?

1. Not used currently
2. Some use currently
3. Significant use currently
4. Don’t know



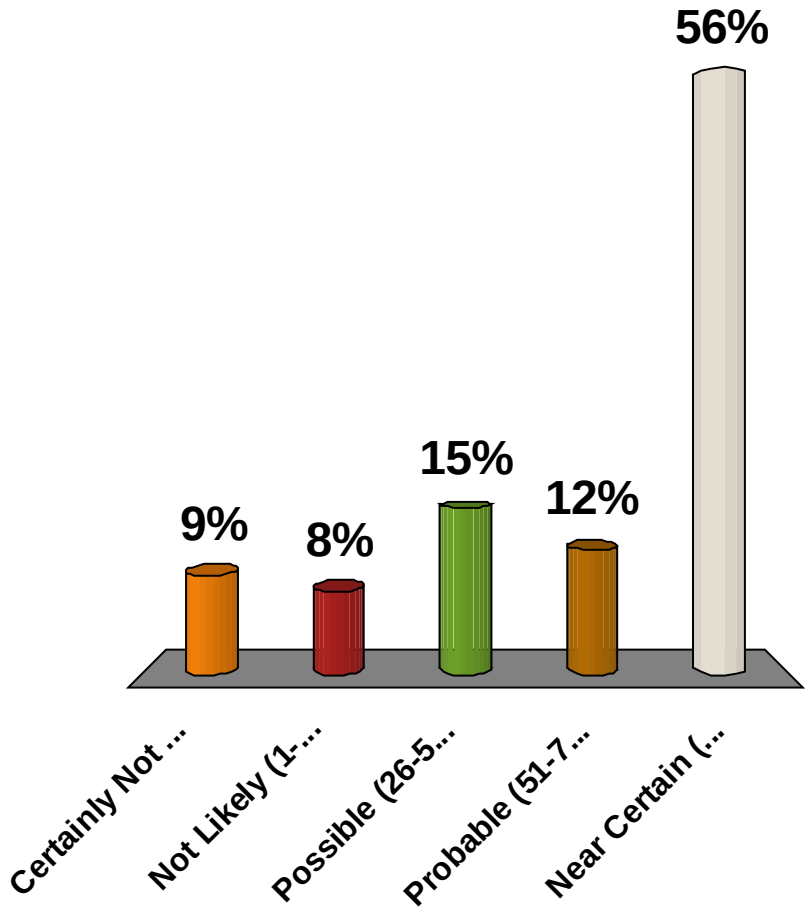
What is your design domain? (select all that apply)

1. Ships
2. Fixed-wing aircraft
3. Missiles
4. Helicopters
5. RF Antennas
6. Land Vehicles
7. Avionics / Electronics
8. Other



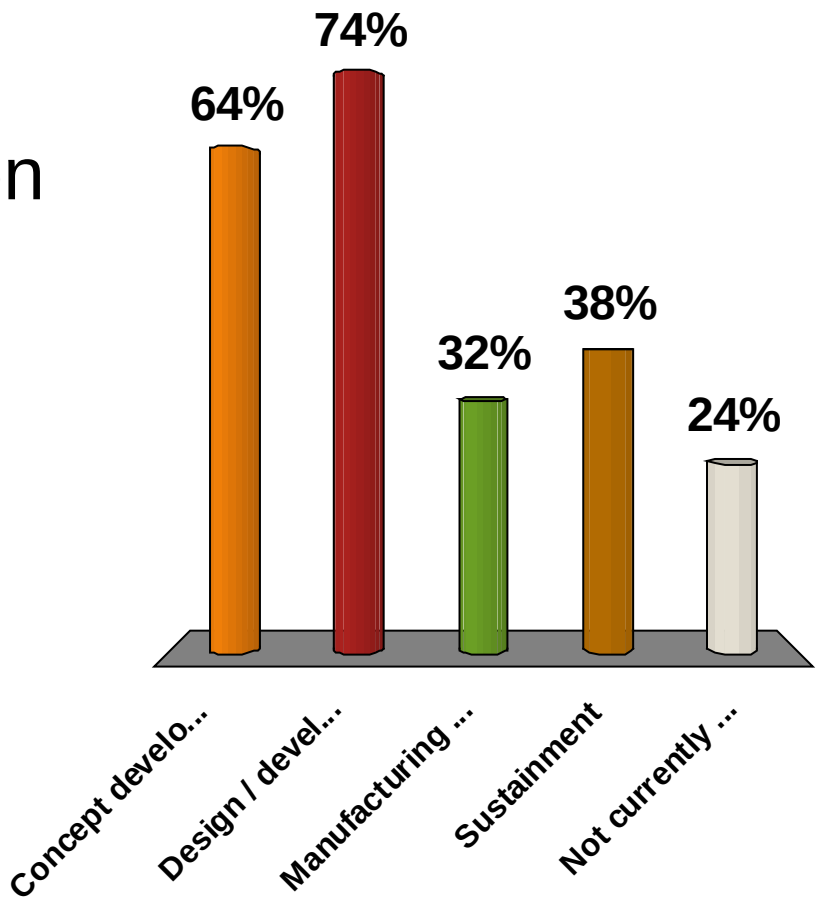
What is the likelihood your organization will adopt physics-based modeling in the next 5 years?

1. Certainly Not (0%)
2. Not Likely (1-25%)
3. Possible (26-50%)
4. Probable (51-75%)
5. Near Certain (76-100%)



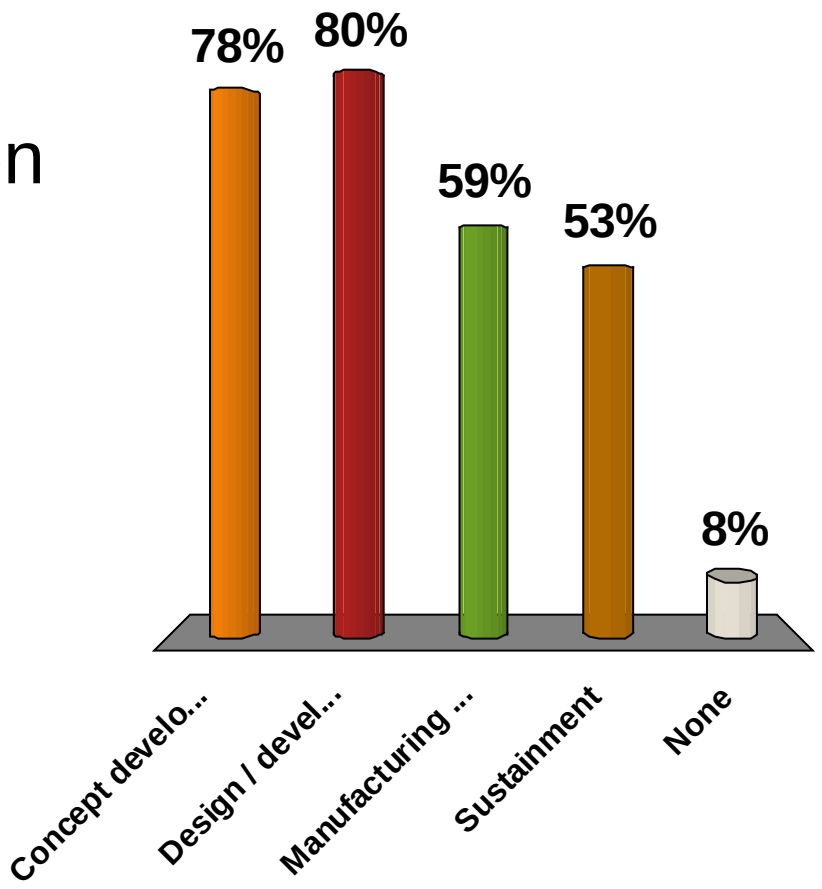
In what phases of the product development lifecycle are you currently using physics-based modeling? (select all that apply)

1. Concept development
2. Design / development
3. Manufacturing / Production
4. Sustainment
5. Not currently using



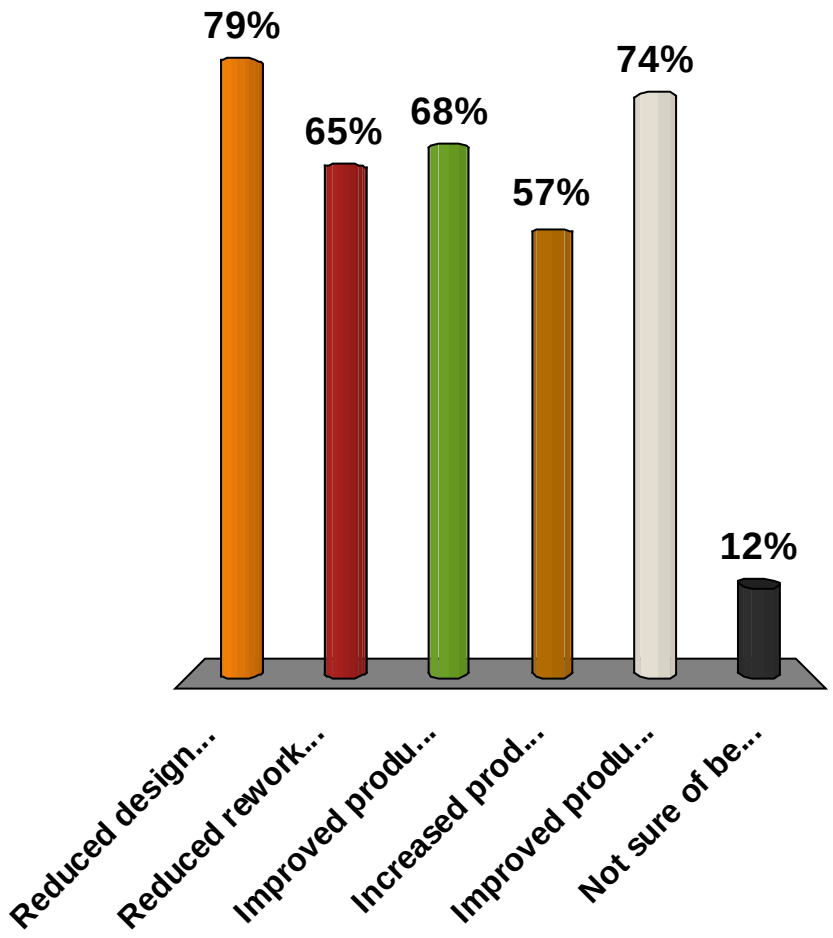
In what phases of the product development lifecycle would physics-based modeling be useful in the future? (select all that apply)

1. Concept development
2. Design / development
3. Manufacturing / Production
4. Sustainment
5. None



What do you believe are potential benefits of physics-based modeling in your organization? (Select all that apply)

1. Reduced design time and cost
2. Reduced rework during production
3. Improved product quality
4. Increased product innovation
5. Improved product performance
6. Not sure of benefits at this time



Thank you for your participation!

- To learn more about CMMI or Physics-Based Modeling contact the NDIA SE Division chair
  - Bob Rassa (rcrassa@raytheon.com)

Please return the interactive voting devices!