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Incorporating Systems Engineering

Using CMMI to Bring Disciplines Together

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Barriers to Integration

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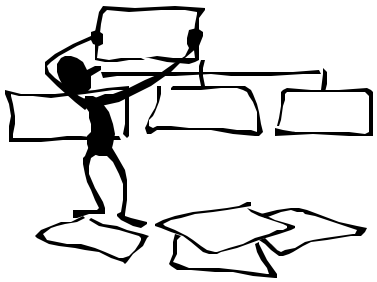
- **Historically different backgrounds and focus**
  - **-- Hardware, software, systems**
  - **-- Legacy hardware development organizations evolving to software and systems**

- **Stovepiping -- separate functional groups / disciplines**
  - **-- Competitive in some organizations (hardware, software, 'ilities', test)**
  - **-- Organization culture has influence**
  - **-- 'Matrix' organization**



CMMI-Based Process Improvement

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Software has been focus of improvement for years

- **Legacy of using SW-CMM to stimulate:**
  - **-- More effective management methods**
  - **-- Proactive use of defined processes**
  - **-- Collection, analysis, and use of metrics in management and technical coordination**
  - **-- Leading to Fact-based management**

Systems engineering focus in recent years

- **Recognized engineering discipline**
  - **-- Engineering technology focus**
  - **-- Project coordination and discipline interfaces**
  - **-- May direct use of engineering processes, methods, and tools**

- **Legacy of hardware engineering methods and standards**

Best Practice at Raytheon Integrating Disciplines for CMMI-Based Improvement

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Topics in presentation

- **Process focus – multiple disciplines perspective**
- **Integrating appraisal team disciplines/expertise for effective appraisals**
- **Planned evolution of CMMI knowledge**
- **Planned role of the CMMI Expert Team**
- **Moving organizations/sites to CMMI**
  - **-- Drawing on CMMI expertise**
  - **-- Integrating disciplines together**
- **Common site's CMMI strategy**
- **Typical appraisal cycle**
- **Lessons learned**

Process Focus

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Hardware engineering
- *Long history of systematic design, prototype, and model development*
- *Defined documentation methods and control*
- *Mil standards*
- *Commonly understood management approach*

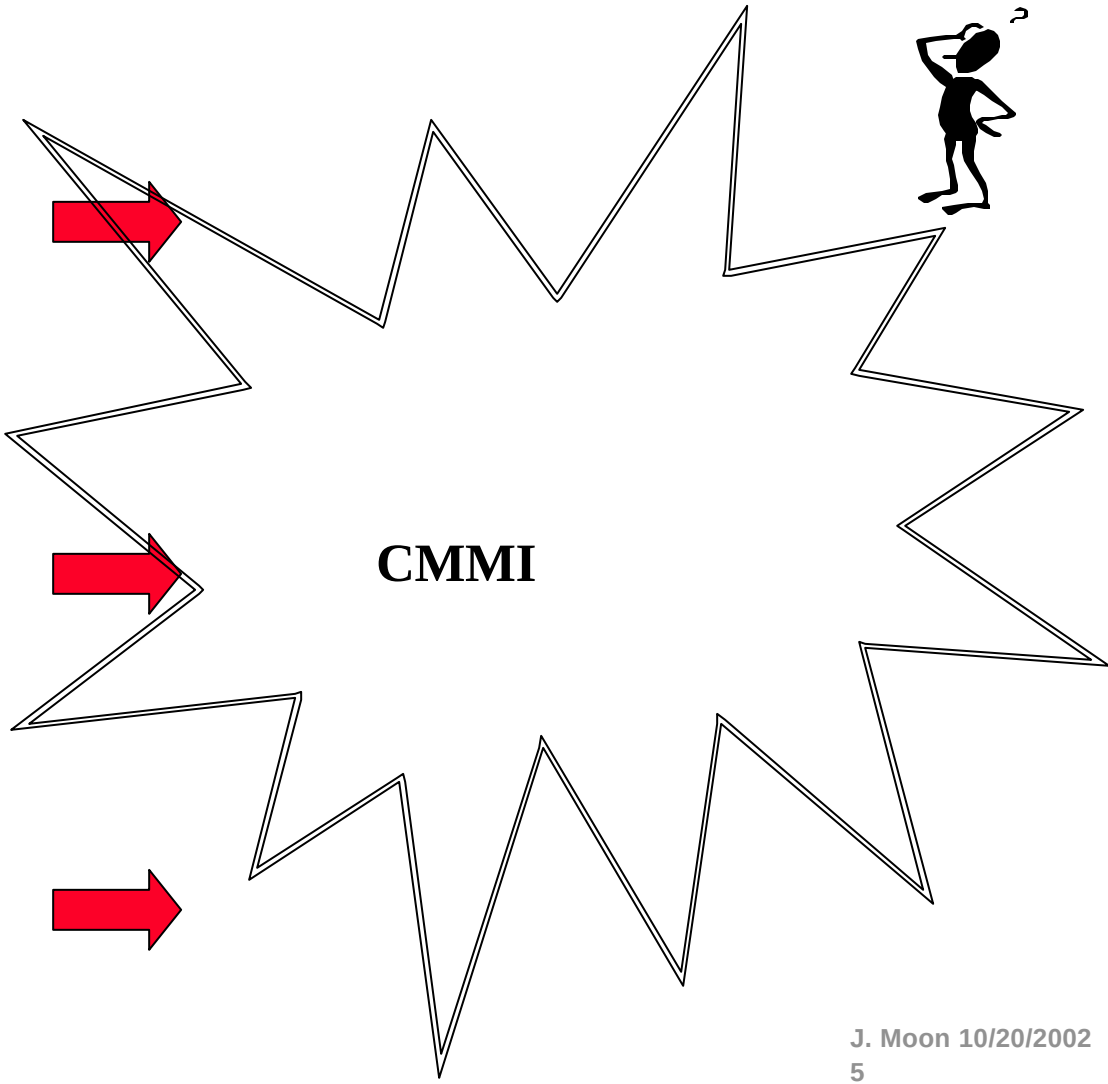
Software engineering
- *2-3 decades of defined design and development*
- *Defined documentation*
- *DoD standards and SW-CMM*
- *Recently disciplined management approach*

Systems engineering
- *Recently acknowledged discipline*
- *DoD standards and INCOSE, EIA 731*
- *Recently defined management approach*

Hardware legacy design & development

Software design & development

Systems design & development



Integrating Team Discipline / Expertise for CMMI-Based Appraisals

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Early CMMI appraisals

- **For Raytheon pilots:**
  - **-- Select team members with complementary backgrounds (Typical 10-11 person team: 5 each SE and SW in addition to team leader)**
  - **-- Systems engineering background from multiple organizations across company, including 4 EIA 731 team leaders**
  - **-- Software engineering background from multiple organizations across company, including 5 IPI Lead Assessors**
  - **-- Site representatives, one each for SE and SW**

- **Each subsequent pilot appraisal:**
  - **-- Add 2-3 new team members, typically from both disciplines, ensuring gradual growth of expertise with CMMI**
  - **-- Include team members with complementary backgrounds and experience**

- **Completion of 4 pilots -> 18 experienced team members, most with team experience in multiple appraisals**

Planned Evolution of CMMI Knowledge

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Team expertise

- **Selected team members' experience 3-4 CMMI appraisals by 12/2001**
  - **-- Geographically diverse sites assessed**
  - **-- Experts' background half SE and SW; some multiple disciplines; most both technical and management; from multiple site locations:**
    - *** East coast, central US, west coast**
  - **-- Provide guidance to own site in its CMMI-based improvement efforts**

- **Each subsequent CMMI appraisal:**
  - **-- Continue to add 2-3 new team members, typically from both disciplines, ensuring continuing growth of expertise with CMMI**
  - **-- Include team members with complementary backgrounds and diverse experience**

- **Establishment of CMMI Expert Team (CET)**
  - **-- Guidance and mentoring CMMI deployment at multiple locations**
  - **-- Extensive SE background and knowledge**

Planned Role of CMMI Expert Team (CET)

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Team expertise and leadership

- **CET members becoming Lead Appraisers, may be model instructors**
  - **-- Experts' background both SE and SW; some multiple disciplines; most both technical and management**
  - **-- Experts from multiple, diverse organization/site locations:**
    - *** East coast, central US, west coast**
  - **-- Provide guidance to multiple organizations/sites in their CMMI-based improvement plans and deployment**

- **Develop and maintain CMMI calendar**
  - **-- Planned appraisals – includes team leader, team members, and schedule**
  - **-- Balance availability of team members to ensure sufficient experience, growth, discipline and site representation**
  - **-- Plan and schedule workshops to support future appraisal plans**
  - **-- Communicate upcoming CMMI-related events**

- **Collect, analyze, and communicate lessons learned**

Planned Role of CMMI Expert Team (CET)

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Team roles and functions

- **Develop and provide workshops and training**
  - **-- CMMI assessment workshop – includes team training and approach to Raytheon appraisals**
  - **-- CMMI deployment and site coordination workshop – provides transition approach, overview of lessons learned, approach to planning and preparing for appraisals**

- **May be assigned particular organizations to provide mentoring**
  - **-- Typically, work collaboratively conducting site visits and providing recommendations**
  - **-- May help develop organization/site CMMI deployment plans**

Moving Organization/Site to CMMI – Draw on CMMI Knowledge & Expertise

Work with CMMI mentors, integrating disciplines together

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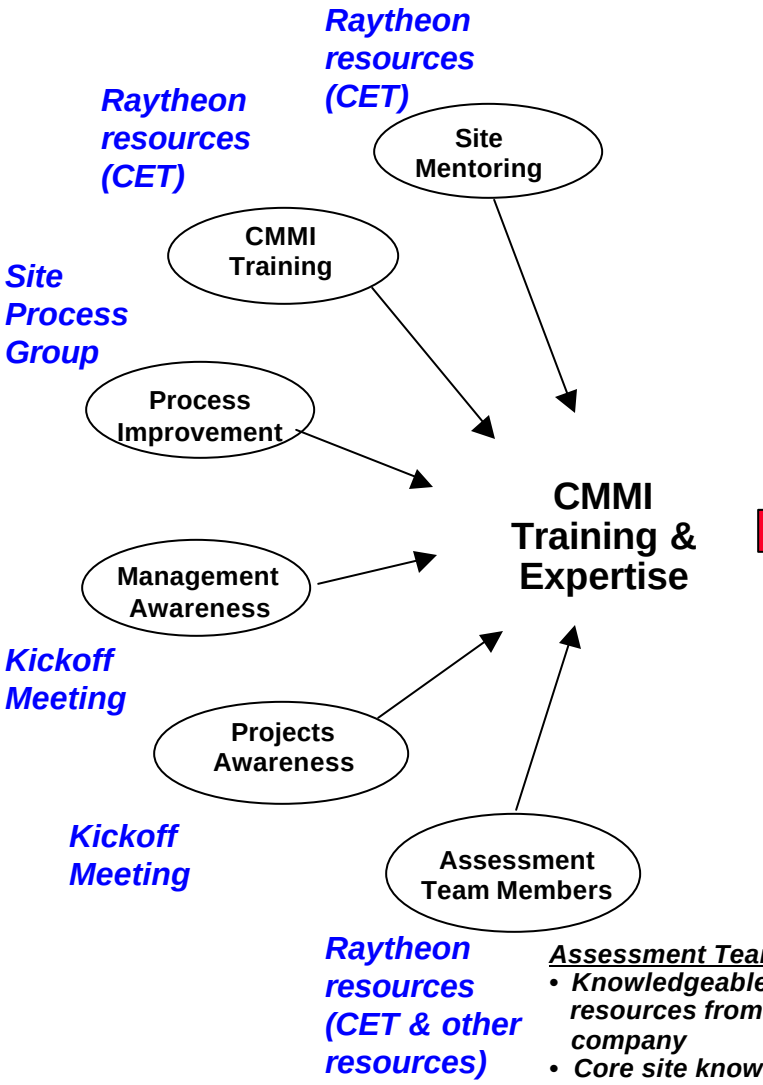

Site Knowledge
- *CMMI model & site processes*
- *CMMI relationship to site goals*
- *Current strengths and weaknesses*

Sr Management Sponsorship
- *Commitment to integrated SE-SW-PM processes*
- *Regular reviews per CMMI guidelines*

Process Improvement Leadership
- *Focus on CMMI in processes*
- *Strong SE & SW background*
- *Include specialty engr & HW*
- *Project deployment supported by process group*

Project Management
- *Benefits from integrated processes*
- *Higher probability of new contracts*
- *Collaborative project team environment*

Assessment Coordination
- *Planning & assessment coordination with multidisciplinary teams; develops site expertise*
- *Benefits from lessons learned*
- *Assessment preparation supported by team leader and process group*

Assessment Team Members
- *Knowledgeable CMMI resources from across company*
- *Core site knowledge & CMMI deployment implementation*

Moving Organization/Site to CMMI -- Integrating Multiple Disciplines Together

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The most effective organizations

- **Provide and effectively use integrated CMMI steering team**
  - **-- Active sponsorship at organization/site executive level**
  - **-- Most senior level key individuals: program management, business area management, engineering and QA and supply chain management**
  - **-- Direct involvement of key managers responsible for product lines and projects**

- **Integrate their process group**
  - **-- Typically, work collaboratively defining process improvement plans and guiding/supporting action teams and projects**
  - **-- Provide synergy between other process imperatives**
    - *** Six Sigma, ISO 9000, other company or organizational improvement activities**
  - **-- Ensure active involvement of program management and supporting discipline representatives**

Common Site's CMMI Strategy

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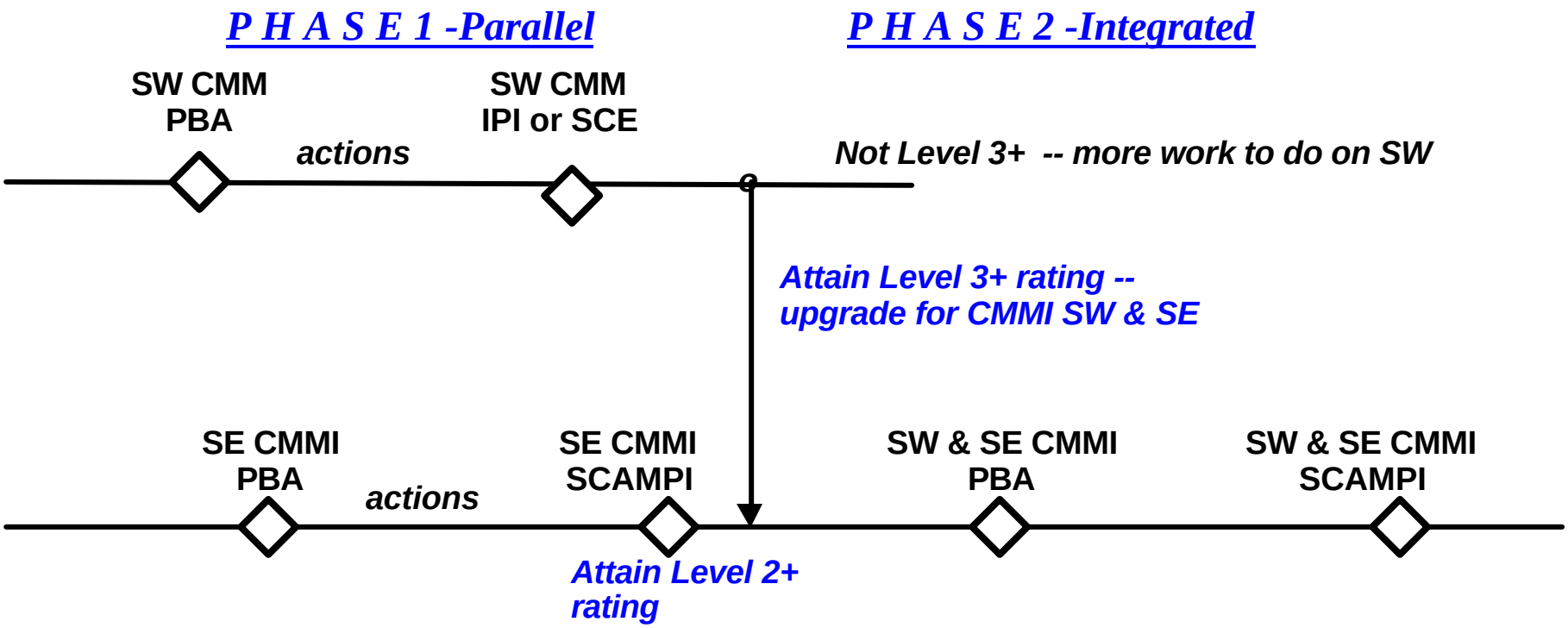
Strategy: Ensure success in software engineering at CMM Level 3+ and SE CMMI Level 2, before added effort dedicated to integrating SE and SW for CMMI deployment moving to Level 3



Typical Appraisal Cycle

Approach that facilitates evolving improvements

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Project leader
- *Identifies gaps*
- *Takes actions to fill gaps*
- *Works closely with project personnel – both SE & SW*

Project Self-Appraisal

Verification & Mentoring

Process group
- *Reviews identified gaps and actual practices (Class C)*
- *Works closely with project leader and key personnel*

CMMI Focus Review

Early Appraisal (Class B)
- *May focus on individual project*
- *Provides in-depth feedback and recommendations to project and org,*

CMMI PBA

Intermediate Appraisal (Class B)
- *Focuses on 2-4 projects*
- *Provides in-depth feedback and recommendations to projects and org*

SCAMPI

SCAMPI (Class A)
- *Focuses on multiple projects*
- *Provides rating and in-depth feedback / recommendations to projects and org*

Effective Approaches on Programs

Bringing people together to work collaboratively

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Integrating project planning
- *Integrated program plans & schedules*
- *Multiple disciplines & supporting functions*

Integrating development of requirements, architecture, and design
- *Systems engineering leadership, with multiple engineering discipline collaboration*

Defining common metrics
- *Metrics defined to provide equivalent information*
- *Provide insights and support effective management of programs and org functions*

Integrating disciplines in process group
- *Collaboration between groups and functions, providing better synergy and more effective process improvement*

More effective management

Better control of programs

Some Lessons Learned

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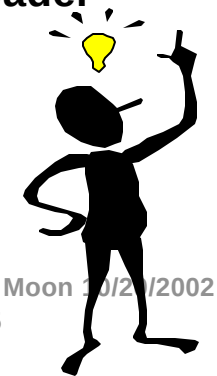
Benefits

- **Integrating disciplines in CET allows collaboration in planning and support for organizations/sites**
  - **-- Draws from past lessons learned and apply best practices**
  - **-- Assists organizations in understanding how to plan for their CMMI-based improvements**
  - **-- Provides extensive knowledge of CMMI in a collaborative team working together -> effective understanding across multiple sites**
  - **-- Builds understanding of what works well and what does not**

- **Integrating disciplines in appraisal teams leads to greater understanding**
  - **-- Provides cross-fertilization of past experience and discipline expertise**
  - **-- Application of CMMI in various organization/project/discipline implementations**
  - **-- Provides insights, allowing team members to return to own sites with broader knowledge**
  - **-- Can provide lessons learned to organization, based on real experience, which helps future understanding and improvements**

- **Integrating disciplines in process group leads to synergy and knowledge sharing -> more effective deployment**



Some Lessons Learned

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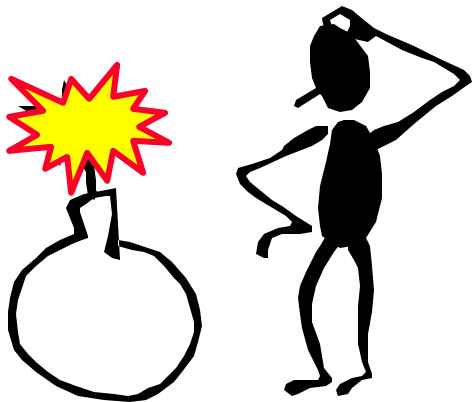
Inhibitors

- **Knowledge gained in past process improvement efforts may not be accepted by other disciplines**
  - -- Quite different appraisal methods can contribute to resistance
  - -- When past improvement efforts have been undertaken separately, resistance to working collaboratively has been observed
  - -- May take extended work together to overcome barriers

- **Organizations with limited collaborative or team environments may experience greater difficulty**
  - -- Past 'stovepiping' can lead to barriers or undermining
  - -- Competition between organizational entities (e.g., with separate discipline management) can inhibit cooperation
  - -- More difficult to deploy **CMMI**
    - * The "I" may be difficult to achieve



Significant Lessons

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*Always most important – must retain focus on **value** of the improvements, not just the evidence or achieving success in assessments*

*Aim for the **benefits** to the entire organization*

CMMI provides an environment that encourages collaboration that can be effectively applied in implementing the CMMI-based improvements themselves