Agile/ Lean Development and CMMI®

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Biographies

- Jeff Dutton
  - Technical Director for Jacobs Sverdrup's Information Technology Support Services
  - Experience in software project management, systems and software process improvement, systems and software engineering, weapons systems modeling and simulation, operations research, test and evaluation, and systems and software acquisition
  - Member of the CMMI® Product Team
  - Authored a section of CMMI Distilled: A Practical Introduction to Integrated Process Improvement
  - SEI Visiting Scientist
  - Candidate SCAMPI℠ Lead Appraiser
- Rich McCabe
  - Principal member of the technical staff at the Systems and Software Consortium (formerly the Software Productivity Consortium)
  - Co-authored the Consortium' s Object-Oriented Approach to Software-Intensive Systems (OOASIS) methodology
  - Currently working on the Consortium's Disciplined Agility (integrates agile development with the CMMI)
  - Headed the Consortium' s pioneering work in the product-line approach for systematic reuse
  - Nearly 15 years of software and system development experience with Bell Laboratories and other firms

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This workshop reflects the opinions of the authors, and does not necessarily reflect a position of the Systems and Software Consortium, Jacobs Sverdrup, or the Software Engineering Institute.

Workshop Agenda

- Define the problem and set the context
- Review concepts of agile development
- Review concepts of lean software development
- Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts
- Develop summary conclusions

Valuation Approach

- Gate 1: Does CMMI® model suite ALLOW agile/ lean dev?
  - Structural flexibility
  - Process areas
  - Goals
  - Practice flexibility
- Gate 2: Does the model suite SUPPORT agile/ lean dev?
  - Structural sufficiency
  - Process area sufficiency
  - Goal sufficiency
  - Practice sufficiency
- Gate 3: Does the model suite ENHANCE agile/ lean dev?
- Gate 4: Does agile/lean ENHANCE the model suite?

Problem and Context

- **Define the problem and set the context**
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The Problem

Effective approaches to developing complex software-intensive systems

- Software Intensive System—relies on software to provide core or priority mission capability
- Typical attributes of SIS development projects
  - Large team (tens to hundreds of developers)
  - Long schedule (months to years)
  - High cost and commitment ($M)
  - Composed of multiple systems or subsystems, all or most of which contain software
  - Often incorporate many off-the-shelf components

Challenges of SIS Development

- Software requirements
  - Vague and subtle, representing subjective tradeoffs; difficult to discover and pin down “in full”
  - Volatile, responding to budget and mission changes
  - Interdependent with solution concept and design tradeoffs
- Software design
  - Complex with many degrees of freedom
  - Architecture sensitive to detailed design tradeoffs
- Integration and communication
  - Coordination across groups often slow, dysfunctional
  - Test and integration often unpredictable, interminable

Agile Development

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Workshop Discussion

What are the important attributes of an agile development effort?

What Is Agile Development?

- Evolving systems in short iterations
  - Each release is a working system
  - Design for change
  - Focus on value
  - Actively guide to convergence
- Communicating efficiently
- Leveraging human strengths
  - Engage, align, and empower the team
  - Get power from each member

Comparing various interpretations of agile development, these themes seem to be common and essential (and non-specific to software

Agile Manifesto*

We believe in practices that emphasize

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

While there is value in the items on the right,
the items on the left are more valuable

* Paraphrased from “Manifesto for Agile Software Development” at www.agilealliance.org

Agile Principles*

- First and foremost: Satisfy the customer —
  Deliver working, valuable software early and frequently
- Measure progress primarily by working software
- Have business people and developers work together daily
- Welcome changing requirements
- Create a self-organizing team of motivated individuals
- Communicate using face-to-face conversation
- Avoid nonessential work
- Maintain a sustainable pace of development
- Attend continuously to good design
- Retrospect and adjust regularly

* Paraphrased from “Principles Behind the Agile Manifesto” at
www.agilealliance.org/principles.html

Agile "Brand Name" Methodologies

- eXtreme Programming (XP) *[Beck]*
  - Widest known, developer-focused for small teams
- Crystal methodolgies *[Coburn]*
  - Set of methodologies conditional on circumstances—Only 2 defined: Crystal Clear, Crystal Orange
- Feature-Driven Development (FDD) *[Palmer]*
  - Agile approach closest to conventional development
- Scrum *[Schwaber]*
  - Focused on management practices
- Lean Software Development *[Poppendieck]*
  - Inspired by Toyota Production System, particularly its product development practices

Crystal Methodologies*

- Crystal is a family of agile methodologies characterized by
  - Priorities
  - Principles
  - Properties
    - ***Frequent delivery***
    - ***Reflective improvement***
    - ***Close communication***
    - Personal safety
    - Focus
    - Easy access to expert users
    - Automated testing, CM, and frequent integration
  - Strategies and techniques in practice
- Crystal methodologies vary by project size and criticality
  - Crystal Clear is the most tolerant process for a small team

* Paraphrased from Crystal Clear by Alistair Cockburn

XP Core "Xtudes" (Core Techniques)*

- Fine scale feedback
  - Test-driven development via programmer tests and customer tests
  - Planning game
  - Whole team
  - Pair programming
- Programmer welfare
  - Sustainable pace
- Shared understanding
  - Simple design
  - System metaphor
  - Collective code ownership
  - Coding standard or coding conventions
- Continuous process rather than batch
  - Continuous integration
  - Design improvement / refactoring
  - Small releases

* http://www.c2.com/cgi/wiki?ExtremeProgrammingCorePractices

FDD* Processes

- Select domain experts, chief programmers and the chief architect
- Develop an overall model
  - What classes are in the domain, how are they connected to one another and under what constraints
- Build a features list
  - For each subject area, a list of the business activities
- Plan by feature
  - Development plan with completion dates and assignments
- Design by feature
  - Inspected design package
- Build by feature

* http://www.featuredrivendevelopment.com/

Scrum

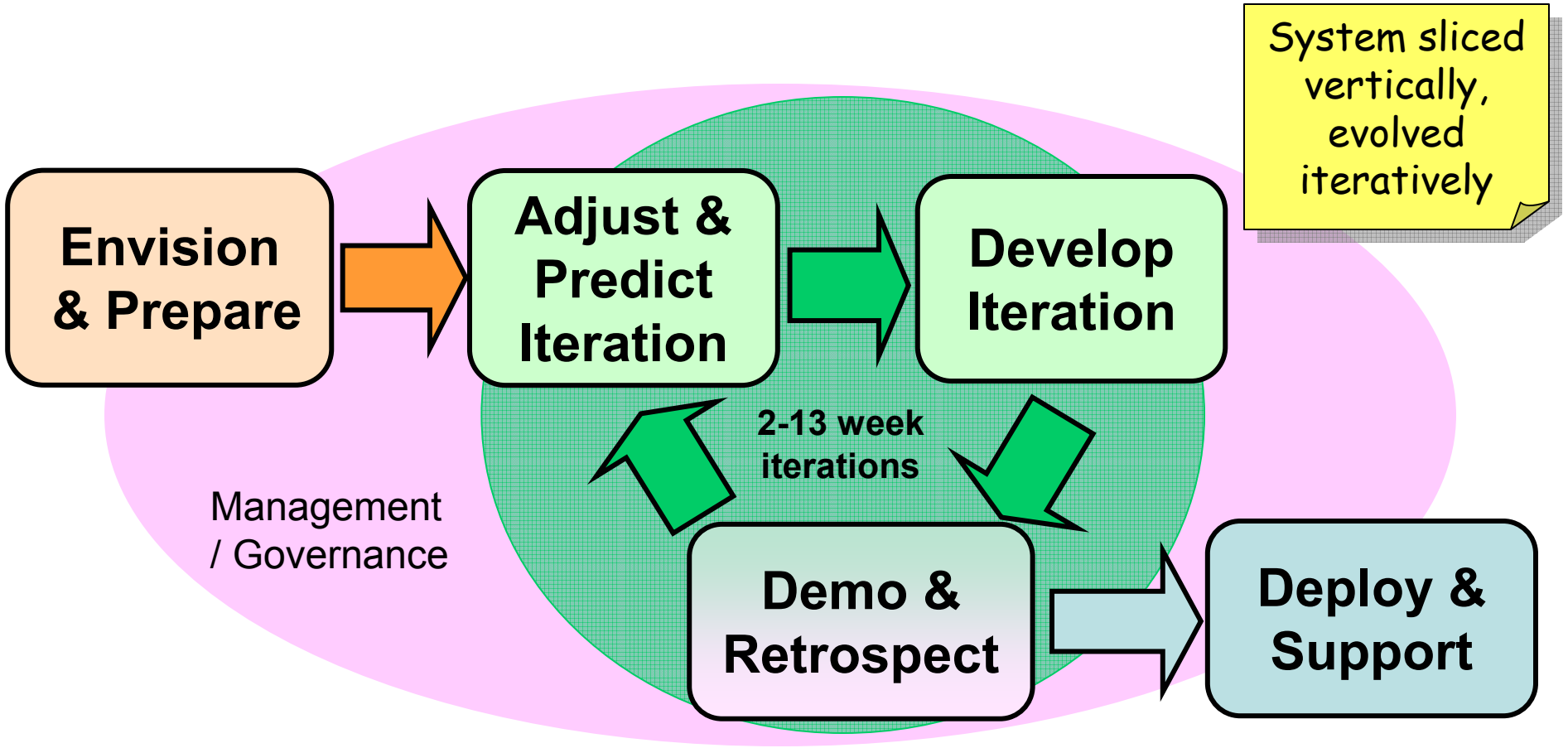
- Agile process to manage and control development work
  - Work from a backlog of prioritized features
  - Deliver in 30-day sprints
  - Coordinate via 15-minute daily status meeting
- Wrapper for existing engineering practices
- Oriented to rapidly-changing requirements
- Controls the chaos of conflicting interests and needs
- Maximizes productivity, communications, and cooperation — detects and removes obstacles to project success
- Scalable from single projects to entire organizations
- Want everyone to feel good about their job and their contributions

* Paraphrased from http://www.controlchaos.com/about/

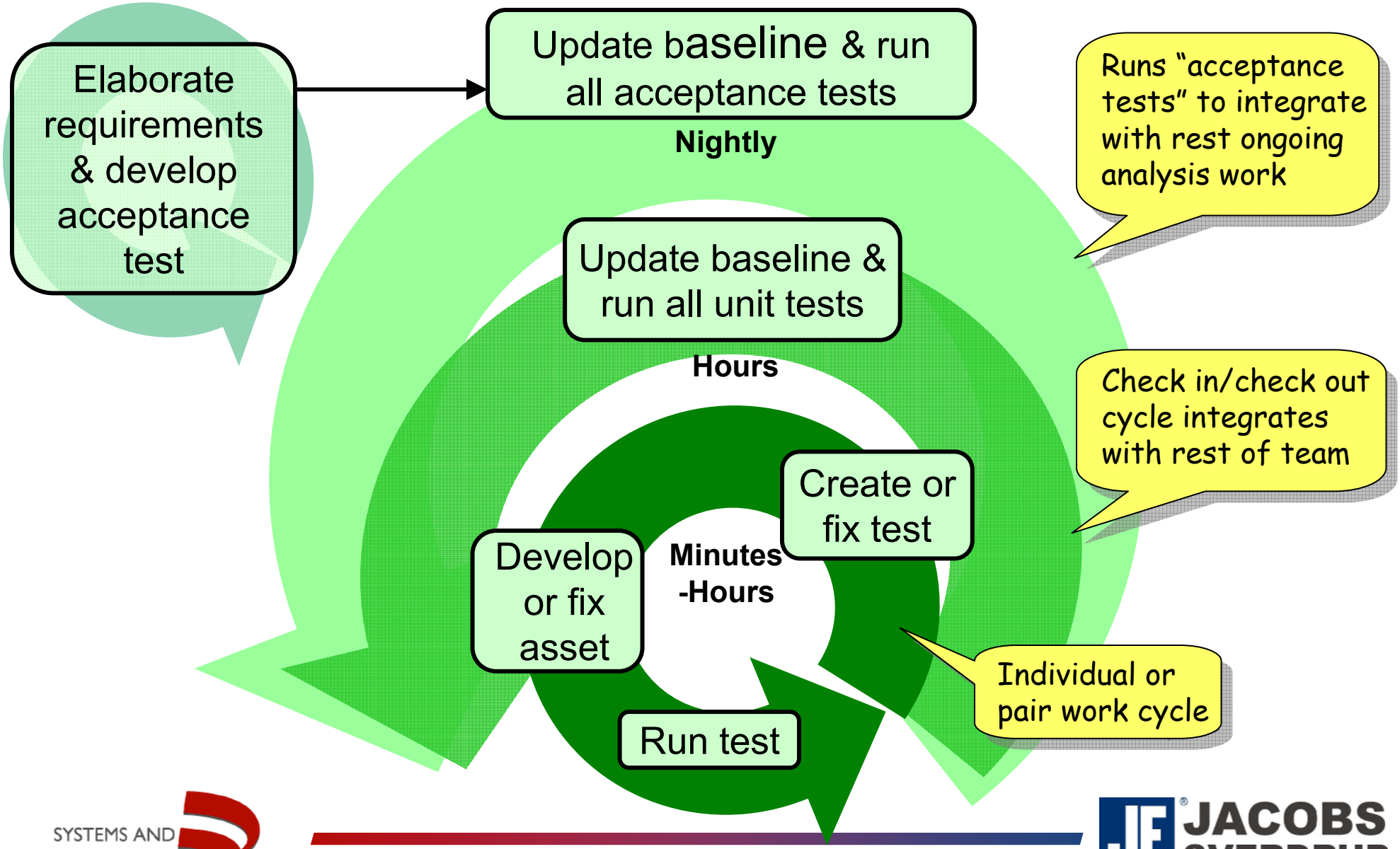
Typical Agile Development

- Applications evolve in multiple short iterations
  - Iterations are constant length, in range of 2-13 weeks
  - Release a working application at end of each iteration
  - Add as many of customer's highest priority features to each new release as can fit in an iteration
  - Requirements and design elaborated each release to support features in that release
  - Extensively test features in each iteration
- Customer (or customer surrogate) reviews each release—can redirect priorities for next iteration
- Track project progress by features completed
- Never slip a release date, instead slip features

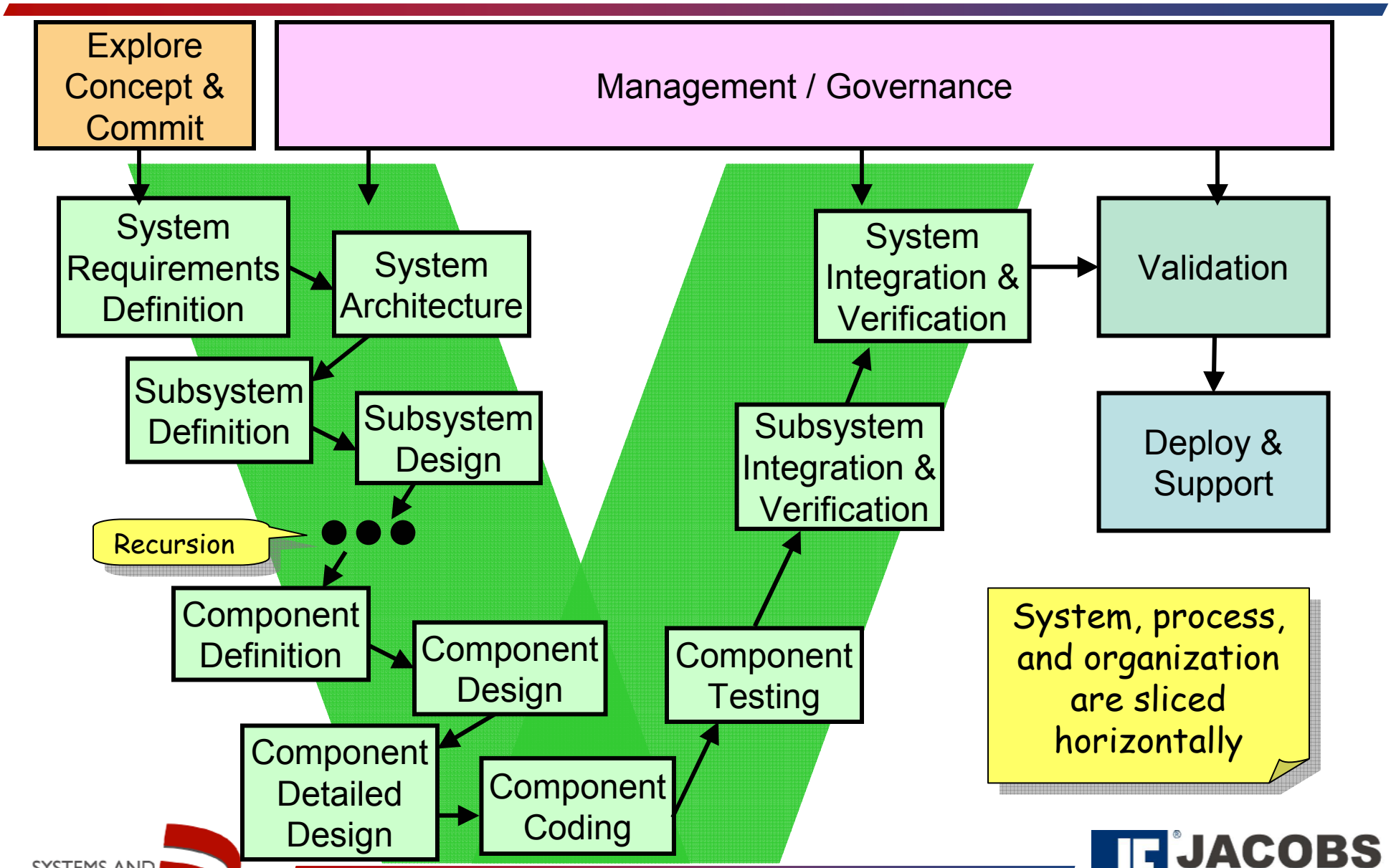
A Typical Agile Process Depiction



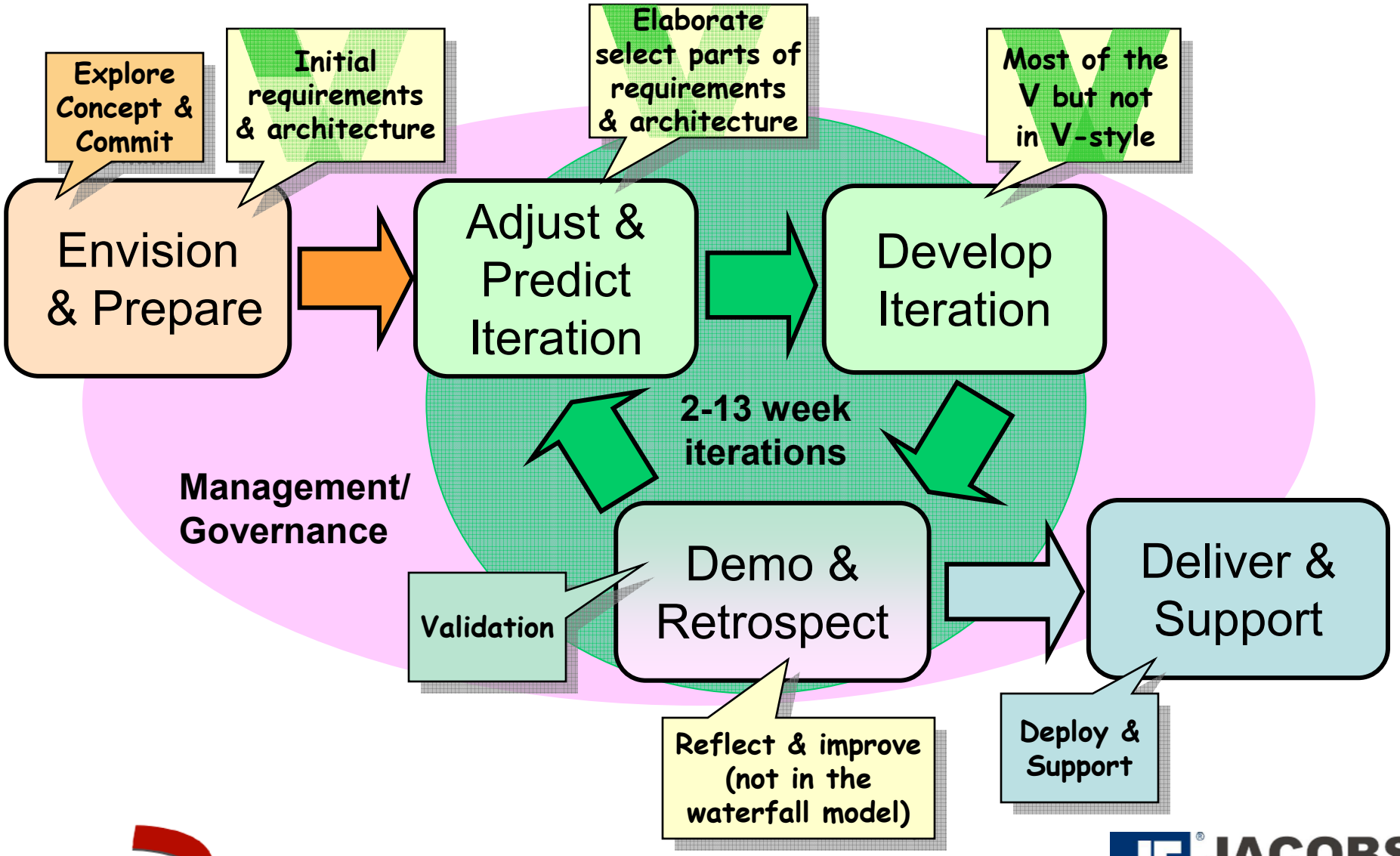
Typical Loops Within *Develop Iteration*



A Conventional Waterfall Process



Rough Mapping: Waterfall to Agile

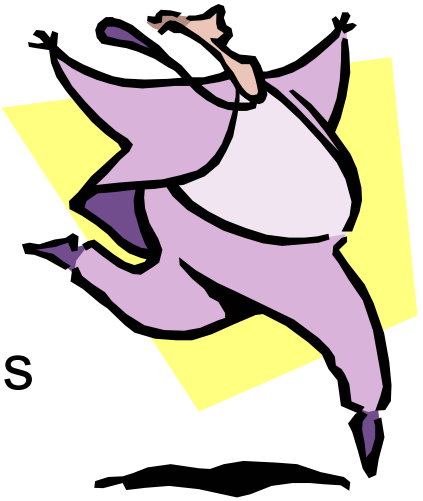


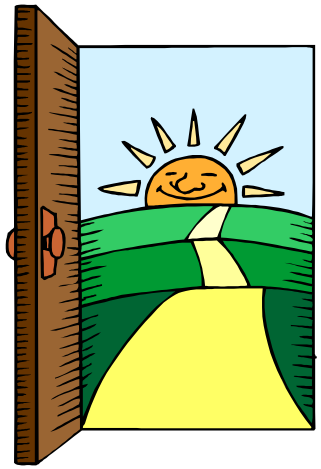
Typical and Possible Agile Practices

- Automated testing
- Barely sufficient documentation
- Bottleneck management
- Coding standards
- Collective code ownership
- Colocation
- Continuous team integration and CM
- CRC cards
- Customer focus group review
- Customer onsite
- Daily standup
- Design metaphor
- Exploratory spikes
- Feature-based planning
- Group design
- Information radiators
- Inspections
- “Intentional” design
- Issue tracking
- Monitor and adjust
- Pair programming
- Project velocity
- Refactoring
- Retrospectives
- Risk management
- Self-tasking
- Simple, robust design
- Small releases
- Sustainable pace
- Test-driven development
- Test first
- Unit testing
- Unity statement
- Use cases
- User stories

Potential Agile Benefits

- More predictable deliveries
- Early return on investment;
  working software delivered and in use sooner
- Quick response to changes in customer needs
- Risk mitigation provided by shorter delivery cycles
  - Multiple opportunities to recover from missteps
  - Validation of requirements
  - Confirmation of technical approach
  - Realistic assessment of progress
- High productivity and quality
- Satisfied customers, successful projects





Lean Software Development

- Define the problem and set the context
- Review concepts of agile development
- **Review concepts of lean software development**
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Workshop Discussion

What are the important attributes of a lean development effort?

How does lean differ from agile development?

Lean SW Development

- Quality Redefined
- User/Customer Involvement
- The Idea of Iterations
- Iteration Management and Convergence
- Options Thinking
- Decide as Late as Possible
- Deliver as Fast as Possible
- Tacit Knowledge (vs. Process) and Rapid Learning
- Concurrency and Communication (IPT)
- Agile Engineering Support
- Lean/Agile Project Management
- Waste in Lean/Agile Development

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Quality Redefined

- Variation is not (necessarily) bad
  - (Too) detailed processes can be restrictive
  - Software development is a creative process
- "Do it right the first time" is a BAD idea
  - Fast development drives out the "right" requirements
  - Fast development produces mistakes – which are the (very) basis for learning, product (quality) and value

User/Customer Involvement

- (Near) continuous feedback and tight coupling to the users/customer is a hard requirement of lean/agile development
- User/customer “awakening” occurs over several iterations of the software
- Lack of user/customer coupling drastically reduces effectiveness of lean/agile approach

The Idea of Iterations

- Basic idea: fast iterations drive out requirements clarity and lead to “better” code faster, and with fewer resources
- Iterations = lean “workflow”
- Iterations are not prototypes
- Fast iterations enable “decide as late as possible”
- Fast iterations enable “options thinking”
- “Fast” means days or weeks, perhaps a month or two

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Iteration Management and Convergence

- "Pure" agility carries a significant risk of "out of bounds" solutions
- Convergence relies on:
  - Reliance on software architecture as a "vision point"
  - High level design as an adjunct to SW architecture
  - Skilled practitioners
  - Project/technical leadership skills

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Options Thinking

- Idea based on root of decision making difficulties:
  - "Up front" full requirements baseline
  - Full detailed design early in life cycle
  - "Frozen" architecture
- Options include:
  - Requirements or features
  - Detailed design
  - Designing in a tolerance for change
  - Designing in acceptance for evolution
  - Many others

Decide as Late as Possible

- Delaying decisions to the “last responsible moment” = high business value
- Depth-first approaches force premature low-level decisions
- Requirements development
  - Early decisions based on “criticality”
    - Hard-to-do’s
    - Technical challenges
    - High priority user needs
  - Spiral (sprint) requirements decisions evolve as the learning curve accelerates
- Early architecture decisions are necessary
  - Technical constraints
  - Critical user needs
  - System design constraints

Deliver as Fast as Possible

- Fast delivery forces fast coding
- Fast delivery enables delayed decisions
- Fast delivery requires near-continuous integration
- Fast delivery requires near-continuous testing (drives out defects early)
- Fast delivery enables faster delivery of high value, high quality products at less cost
- Fast delivery leads to “steady state” workflow (and to efficiency and productivity increases)

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Tacit Knowledge and Rapid Learning

- Tacit Knowledge = project/domain/skills knowledge in the heads of team members
- Balance of tacit knowledge with training and defined process is key
- Lean/agile development mandates a rapid learning environment
  - Skills
  - Domains
  - Technologies
  - Improvement to high-level (lean) processes

Concurrency & Communication

- Lean/agile development = crucible for concurrency and communication
- Concurrency = all team members and stakeholders have near-real-time “push” access to all project information
- Continuous push communication is critical
  - Technologies
  - Communication skill set

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Agile Engineering Support

- Engineering support = CM, QA, Metrics
- Agile Configuration Management
  - Agile check-in/check-out
  - Agile status accounting and configuration audits
  - Agile CM system
  - Agile change management
- Agile Quality Assurance
  - Add value by reducing risk or defects in hours or a day
  - Tight coupling to project activities
- Agile Metrics
  - Kanban or “pull” visualization for all team members
  - Project progress and design convergence

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- Waste in Lean/Agile Development

Lean/Agile Project Management

- (NOT) "Plan based" approaches (like "traditional" CMMI) skills:
  - Early detailed planning
  - Early requirements "understanding" and stability
  - Focused on project monitoring against the plan
- Lean/Agile Project Management skills:
  - Seeing waste
  - Value stream mapping
  - Feedback
  - Iteration leadership/management
  - Options thinking
  - Last responsible moment decision making
  - Pull/Kanban systems and measurements
  - Cost of delay awareness
  - Self determination/team empowerment
  - Motivation and leadership
  - Technical expertise
  - Refactoring (design against more stable architecture)

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- Lean/Agile Project Management
- **Waste in Lean/Agile Development**

Waste in Lean/Agile Development

- Partially done work
- Extra processes
- Extra features
- Task switching
- Waiting
- Motion
- Defects
- Traditional oversight/control activities

CMMI Interpretation

- Define the problem and set the context
- Review concepts of agile development
- Review concepts of lean software development
- **Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts**
- Develop summary conclusions

Workshop Discussion

Can the CMMI® model suite be applied to agile/lean development organizations?

What problems or issues (or roadblocks) might arise?

Previous Mapping Efforts

- Agile+ (AgileTek)
  - Extended XP to meet CMMI Level 3
- Microsoft Solutions Framework
  - Methodology, management training, and tool
  - Version 4 was agile “with some overhead” to achieve CMMI Level 3 consistency
- ASCEND (BAE Systems)
  - Variant of agile development for small project team
  - Uses Fagan inspections, Earned Value tracking
  - Claims CMMI Level 5 compatibility

Model Components

- What model components are **required**?
  - Specific goals
    (the actual goal – not the title or explanatory information)
  - Generic goals
- What model components are **expected**?
  - Specific practices
  - Generic practices
- What model components are **informative**?
  - Subpractices
  - Typical work products
  - Discipline amplifications
  - GP elaborations
  - Goal and practice titles
  - Goal and practice notes
  - References

Specific and Generic Goals

- **Required*:**
  Specific goals and generic goals are required model components. These components must be achieved by an organization's planned and implemented processes. Required components are essential to rating the achievement of a process area. Goal achievement (or satisfaction) is used in appraisals as the basis upon which process area satisfaction and organizational maturity are determined. *Only the statement of the specific or generic goal is a required model component*. The title of a specific or generic goal and any notes associated with the goal are considered informative model components.

*CMMI SE/SW V1.1

Specific and Generic Practices

- **Expected*:**
  Specific practices and generic practices are expected model components. Expected components describe what an organization will typically implement to achieve a required component. Expected components guide those implementing improvements or performing appraisals. *Either the practices as described, or acceptable alternatives to them, are expected to be present in the planned and implemented processes of the organization before goals can be considered satisfied. Only the statement of the practice is an expected model component.* The title of a practice and any notes associated with the practice are considered informative model components.

*CMMI SE/SW V1.1

Informative Elements

- **Informative*:**
  Subpractices, typical work products, discipline amplifications, generic practice elaborations, goal and practice titles, goal and practice notes, and references are informative model components that help model users understand the goals and practices and how they can be achieved. *Informative components provide details that help model users get started in thinking about how to approach goals and practices.*

*CMMI SE/SW V1.1

Agile/Lean Interpretation of the CMMI

Challenge Everything

CMMI Process Areas

Project Planning
Project Monitoring and Control
Supplier Agreement Management
Integrated Project Management
Risk Management
Quantitative Project Management
Requirements Management
Requirements Development
Technical Solution
Product Integration
Verification
Validation
Measurement and Analysis
Process and Product Quality Assurance
Configuration Management
Decision Analysis and Resolution
Causal Analysis and Resolution
Organizational Process Focus
Organizational Process Definition
Organizational Training
Organizational Process Performance
Organizational Innovation and Deployment

	Process Mgt.	Project Mgt.	Engr.	Engr. Support.
ML 5	OID			CAR
ML 4	OPP	QPM		
ML 3	OPF OPD OT	IPM RSKM	RD TS PI Ver Val	DAR
ML 2		PP PMC SAM	REQM	M&A PPQA CM

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Process Area Valuation Approach

- **Goal Level Insufficiency** — **Unacceptable**
  - Goals do not allow or support conduct of accepted lean/agile practices
- **Goal Level Sufficiency**: — **Acceptable**
  - Goals allow or support conduct of accepted lean/agile practices
  - One or more specific practices must be replaced with one or more alternative practices to support conduct of lean/agile practices
- **Practice Level Sufficiency**: — **Supportive**
  - Goals allow or support conduct of accepted lean/agile practices
  - Practices, as stated, fully support conduct of accepted lean/agile practices
  - Informative elements are largely unhelpful
- **Informative Element Level Sufficiency**: — **Enabling**
  - Goals allow or support conduct of accepted lean/agile practices
  - Practices, as stated, fully support conduct of accepted lean/agile practices
  - Informative elements are largely helpful

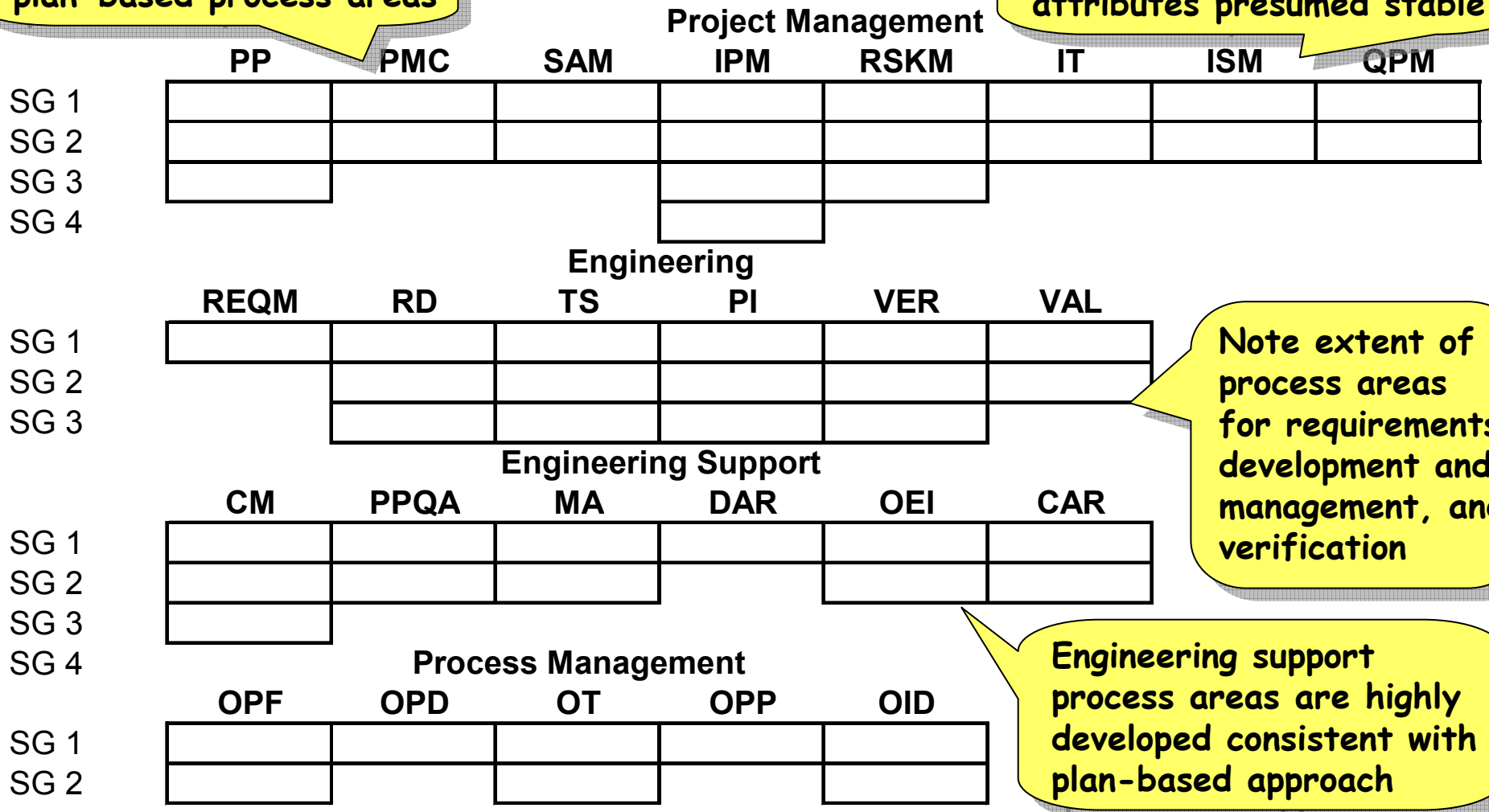
Practice Valuation Approach

- **Alternative practice required** — **Alternative**
  - Practice does not allow or support conduct of accepted lean/agile practices – Alternative practice is required
- **Supportive**: — **Supportive**
  - Practice, as stated, fully supports conduct of accepted lean/agile practices
  - Informative elements are largely unhelpful
- **Enabling**: — **Enabling**
  - Practice, as stated, fully supports conduct of accepted lean/agile practices
  - Informative elements are largely helpful

Overview of CMMI to Agile/Lean Match

Note heavy focus on plan-based process areas

Detailed project plans and oversight against project attributes presumed stable



Note extent of process areas for requirements development and management, and verification

Engineering support process areas are highly developed consistent with plan-based approach

Apparent Areas of Friction

- Empowerment and trust versus micromanagement
  - Process and Product Quality Assurance
- Organization standards versus project standards
  - Quantitative Project Management
  - All the "Organizational" process areas
- Elaboration and review of intermediate work products
  - Requirements Management
  - Requirements Development
  - Technical Solution
  - Verification

Empowerment and Trust

- Agile/Lean enhances productivity by empowerment (team and each member has both responsibility *and* authority)
  - Bottom-line results of each iteration provide external accountability across iterations
  - Peer pressure provides internal accountability
  - Improvements in process are a team responsibility
- External audits undercut this agile/lean philosophy
  - QA is independent—self-discipline is demotivated
  - Auditing is non-value-added, justified only by lack of trust
  - Compliance becomes the focus, not effective practices justified by results
- Agile Coach is a hybrid role—challenges team behaviors but does not dictate resolutions—can QA become a coach?

Organization Versus Project Standards

- Agile/Lean teams determine their own process and practices by consensus
- Does CMMI tailoring guidance allow project team data *or* consensus to overrule
  - Organizational standards?
  - Accumulated organizational performance data?
- Otherwise, process performers are no longer the process owners
  - See previous discussion of empowerment and trust

Intermediate Work Products

- Agile/Lean suspects any non-deliverable is waste
  - Code is a necessary “detailed spec” for executable delivery
  - Tests drive code development, define and verify requirements
  - But conventional requirements and design docs only support understanding, hence “barely sufficient” documentation
- Does CMMI demand “complete” system representations in intermediate work products?
  - How much is enough to “define” and “elaborate”…
    - Requirements before …
    - Design and interfaces before …
    - Implementation and testing
  - What is sufficient review?
  - Is bi-directional traceability necessary? To what level?

Project Management

Project Planning

✓SG 1 Estimates of project planning parameters are established and maintained.
✓SG 2 A project plan is established and maintained as the basis for managing the project.
✓SG 3 Commitments to the project plan are established and maintained.

- Good match to agile and lean!
- However, must interpret in light of
  - Large-grained initial release plan (features roughly allocated to iterations)
  - More detailed planning to begin each iteration
  - Work Breakdown Structure likely different (distinctions between testing and development less important)

Project Planning

Acceptable

SG 1	**Establish Estimates**		Acceptable
●	SP 1.1	Estimate the Scope of the Project — Options thinking and workflow synchronization	Supportive
●	SP 1.2	Establish Estimates of Work Product and Task Attributes — Iteration planning, Closure criteria & mechanisms	ve
●	SP 1.3	Define Project Life Cycle — Interpretation of phases, iterations or hybrids, Value stream mapping	Alternative
	SP 1.4	Determine Estimates of Effort and Cost	Supportive
SG 2	**Develop a Project Plan**		Supportive
●	SP 2.1	Establish the Budget and Schedule — Workflow, options analysis, Stopping points, exit criteria	Enabling
	SP 2.2	Identify Project Risks	Enabling
	SP 2.3	Plan for Data Management	Enabling
	SP 2.4	Plan for Project Resources	Enabling
	SP 2.5	Plan for Needed Knowledge and Skills	Enabling
●	SP 2.6	Plan Stakeholder Involvement — Close coupling or stakeholders to project activities	Enabling
	SP 2.7	Establish the Project Plan	Supportive
SG 3	**Obtain Commitment to the Plan**		Acceptable
	SP 3.1	Review Plans that Affect the Project	Alternative
	SP 3.2	Reconcile Work and Resource Levels	Alternative
	SP 3.3	Obtain Plan Commitment	Enabling

Project Monitoring and Control

✓ SG 1 Actual performance and progress of the project are monitored against the project
✓ SG 2 Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.

- Good match to agile and lean!
  - Progress tracked by tested, completed features
  - Plans and priorities reset with each iteration based on current information, customer's ongoing guidance
- However, agile/lean is biased to different "corrective actions"
  - Drop features rather than slip an iteration release date
  - Original plan treated as an outdated prediction

Project Monitoring and Control

Supportive

SG 1 Monitor Project Against Plan — Supportive

- SP 1.1 Monitor Project Planning Parameters — Waste, progress, convergence — Enabling
- SP 1.2 Monitor Commitments — Enabling
- SP 1.3 Monitor Project Risks — Enabling
- SP 1.4 Monitor Data Management — Enabling
- SP 1.5 Monitor Stakeholder Involvement — Enabling
- SP 1.6 Conduct Progress Reviews — Continuous review, continuous waste elimination, pull Kanban metrics — Alternative
- SP 1.7 Conduct Milestone Reviews — Enabling

SG 2 Manage Corrective Action to Closure — Enabling

- SP 2.1 Analyze Issues — Enabling
- SP 2.2 Take Corrective Action — Agile record keeping, continuous corrective action — Enabling
- SP 2.3 Manage Corrective Action — Enabling

Supplier Agreement Management

Enabling

- SG 1 Establish Supplier Agreements — Enabling — Tight coupling of suppliers; Fast response times
  - SP 1.1 Determine Acquisition Type — Enabling
  - SP 1.2 Select Suppliers — Enabling
  - SP 1.3 Establish Supplier Agreements — Enabling
- SG 2 Satisfy Supplier Agreements — Enabling — Fast, agile practices
  - SP 2.1 Review COTS Products — Enabling
  - SP 2.2 Execute the Supplier Agreement — Enabling
  - SP 2.3 Accept the Acquired Product — Enabling
  - SP 2.4 Transition Products — Enabling

Integrated Project Management

Supportive

SG 1 Use the Project's Defined Process — Supportive

- SP 1.1 Establish the Project's Defined Process — Enabling
  Agile tailoring criteria, Learn internally and through organization. Tailor very fast
- SP 1.2 Use Organizational Process Assets for Planning Project Activities — Supportive
- SP 1.3 Integrate Plans — Supportive
- SP 1.4 Manage the Project Using the Integrated Plans — Supportive
- SP 1.5 Contribute to the Organizational Process Assets — Enabling
  Extremely rapid contribution to organization's process assets

SG 2 Coordinate and Collaborate with Relevant Stakeholders — Enabling

- SP 2.1 Manage Stakeholder Involvement — Enabling
  Key to agile/lean efforts
  Close, continuously coupled coordination and collaboration
- SP 2.2 Manage Dependencies — Enabling
- SP 2.3 Resolve Coordination Issues — Enabling

SG 3 Use the Project's Shared Vision for IPPD — Enabling

- SP 3.1 Define Project's Shared-Vision Context — Enabling
- SP 3.2 Establish the Project's Shared Vision — Enabling
  Consider shared vision point architectures

SG 4 Organize Integrated Teams for IPPD — Enabling
Consider agile team structure
Critical for self-motivating teams

- SP 4.1 Determine Integrated Team Structure for the Project — Enabling
- SP 4.2 Develop a Preliminary Distribution of Requirements to Integrated Teams — Enabling
- SP 4.3 Establish Integrated Teams — Enabling

Risk Management

Enabling

SG 1 Prepare for Risk Management — Enabling

- SP 1.1 Determine Risk Sources and Categories — Enabling
- SP 1.2 Define Risk Parameters — Enabling
- SP 1.3 Establish a Risk Management Strategy — Enabling

Good fit
Ramp up to agile/lean record keeping
Migrate to continuous mitigation and action

SG 2 Identify and Analyze Risks — Enabling

- SP 2.1 Identify Risks — Enabling
- SP 2.2 Evaluate, Categorize, and Prioritize Risks — Enabling

SG 3 Mitigate Risks — Enabling

- SP 3.1 Develop Risk Mitigation Plans — Enabling
- SP 3.2 Implement Risk Mitigation Plans — Enabling

Integrated Teaming

Enabling

SG 1	Establish Team Composition	Enabling
SP 1.1	Identify Team Tasks	Enabling
SP 1.2	Identify Needed Knowledge and Skills	Enabling
SP 1.3	Assign Appropriate Team Members	Enabling
SG 2	Govern Team Operation	Enabling
SP 2.1	Establish a Shared Vision	Enabling
SP 2.2	Establish a Team Charter	Enabling
SP 2.3	Define Roles and Responsibilities	Enabling
SP 2.4	Establish Operating Procedures	Enabling
SP 2.5	Collaborate among Interfacing Teams	Enabling

Best CMMI support for management of tacit knowledge
Overall extremely good fit for agile/lean efforts

Integrated Supplier Management

Enabling

SG 1 Analyze and Select Sources of Products — Enabling

- SP 1.1 Analyze Potential Sources of Products — Enabling
- SP 1.2 Evaluate and Determine Sources of Products — Enabling

SG 2 Coordinate Work with Suppliers — Enabling

- SP 2.1 Monitor Selected Supplier Processes — Enabling
- SP 2.2 Evaluate Selected Supplier Work Products — Enabling
- SP 2.3 Revise the Supplier Agreement or Relationship — Enabling

Quantitative Project Management

✓ SG 1 Quantitatively manage using quality and process-performance objectives.
- ? SP 1.2 Select the subprocesses that compose the project's defined process based on historical stability and capability data.

? SG 2 The performance of selected subprocesses within the project's defined process is statistically managed.
- ? SP 2.2 Establish and maintain an understanding of the variation of the selected subprocesses …
- ? SP 2.3 Monitor the performance of the selected subprocesses to determine their capability to satisfy their … objectives, and identify corrective action as necessary.

- Agile focus: reliably valuable results despite uncertainty and volatility—not predictability through invariance
- What subprocess in agile development should be "statistically managed"? Iterations? (E.g., feature points/iteration, or convergence)
- What "historical data"? From the project? From other projects?

Quantitative Project Management

Acceptable

SG 1 Quantitatively Manage the Project — Acceptable

- SP 1.1 Establish the Project's Objectives — Limited number of subprocesses E.G., workflow control — Supportive
- SP 1.2 Compose the Defined Process — Iteration length Architecture convergence — Alternative
- SP 1.3 Select the Subprocesses that Will Be Statistically Managed — Supportive
- SP 1.4 Manage Project Performance — Enabling

SG 2 Statistically Manage Subprocess Performance — Acceptable

- SP 2.1 Select Measures and Analytic Techniques — Enabling
- SP 2.2 Apply Statistical Methods to Understand Variation — Enabling
- SP 2.3 Monitor Performance of the Selected Subprocesses — Enabling
- SP 2.4 Record Statistical Management Data — Agile/lean record keeping — Alternative

Summary Valuation for Project Management

	PP	PMC	SAM	IPM	RSKM	IT	ISM	QPM
	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 1	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 2	Supportive	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Supportive
SG 3	Acceptable			Enabling	Enabling	Enabling	Enabling	
SG 4				Enabling				

Process Area Valuation Approach

- **Goal Level Insufficiency** — Unacceptable
  - Goals do not allow or support conduct of accepted lean/agile practices
- **Goal Level Sufficiency**: — Acceptable
  - Goals allow or support conduct of accepted lean/agile practices
  - One or more specific practices must be replaced with one or more alternative practices to support conduct of lean/agile practices
- **Practice Level Sufficiency**: — Supportive
  - Goals allow or support conduct of accepted lean/agile practices
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  - Informative elements are largely unhelpful
- **Informative Element Level Sufficiency**: — Enabling
  - Goals allow or support conduct of accepted lean/agile practices
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Engineering

Requirements Management

✓ SG 1 Requirements are managed and inconsistencies with project plans and work products are identified.

? SP 1.4 Maintain bidirectional traceability among the requirements and the project plans and work products.

- Agile addresses consistency with lower-overhead practices
  - Acceptance tests tied to features
  - Group Design, Code/Design Standards
  - Clean Design and Refactoring
  - Collective Code Ownership
  - Continuous Integration and high level of communication among team members
- But is bi-directional traceability necessary for large projects?
  - And if so, to what level of granularity? To local team level?

Requirements Management

Acceptable

SG 1 Manage Requirements — Acceptable

- SP 1.1 Obtain an Understanding of Requirements — "Fuzzy set" at SW/system level; Clarity at iteration level
- SP 1.2 Obtain Commitment to Requirements — At each iteration — Enabling
- SP 1.3 Manage Requirements Changes — Tie group design, collective code ownership, and acceptance tests to features (very high level) — Enabling
- SP 1.4 Maintain Bidirectional Traceability of Requirements — Manage "fuzzy set" as design is refactored toward acceptable solution — native
- SP 1.5 Identify Inconsistencies between Project Work and Requirements — Enabling

Requirements Development

Supportive

SG 1 Develop Customer Requirements — Enabling

- SP 1.1 Elicit Needs — Enabling
- SP 1.2 Develop the Customer Requirements — Enabling

SG 2 Develop Product Requirements — Enabling

- SP 2.1 Establish Product and Product-Component Requirements
  - "Fuzzy set" at "SW system" level
  - Prioritize at iteration level (by technical challenge, importance, functional precedence
  - Validate only those accepted into interations
- SP 2.2 Allocate Product-Component Requirements — Enabling
- SP 2.3 Identify Interface Requirements — Enabling

SG 3 Analyze and Validate Requirements — Supportive

- SP 3.1 Establish Operational Concepts and Scenarios — Enabling
- SP 3.2 Establish a Definition of Required Functionality
  - Much less functional analysis needed
  - What is done is at a much higher level of abstraction
- SP 3.3 Analyze Requirements — Enabling
- SP 3.4 Analyze Requirements to Achieve Balance — Enabling
- SP 3.5 Validate Requirements with Comprehensive Methods — Enabling

Technical Solution

Supportive

Informative elements imply
Full-design-before-coding

SG 1	Select Product-Component Solutions	Supportive	
	SP 1.1	Develop Detailed Alternative Solutions and Selection Criteria	Supportive
	SP 1.2	Evolve Operational Concepts and Scenarios	Supportive
	SP 1.3	Select Product-Component Solutions	Supportive
SG 2	Develop the Design	Supportive	
	SP 2.1	Design the Product or Product Component	Supportive
	SP 2.2	Establish a Technical Data Package	Supportive
	SP 2.3	Design Interfaces Using Criteria	Supportive
	SP 2.4	Perform Make, Buy, or Reuse Analyses	Supportive
SG 3	Implement the Product Design	Supportive	
	SP 3.1	Implement the Design	Supportive
	SP 3.2	Develop Product Support Documentation	Supportive

Product Integration

Supportive

Informative elements are based on a systems approach that appears somewhat biased against agile/lean

SG 1	Prepare for Product Integration	Supportive
SP 1.1	Determine Integration Sequence	Supportive
SP 1.2	Establish the Product Integration Environment	Supportive
SP 1.3	Establish Product Integration Procedures and Criteria	Supportive
SG 2	Ensure Interface Compatibility	Supportive
SP 2.1	Review Interface Descriptions for Completeness	Supportive
SP 2.2	Manage Interfaces	Supportive
SG 3	Assemble Product Components and Deliver the Product	Supportive
SP 3.1	Confirm Readiness of Product Components for Integration	Supportive
SP 3.2	Assemble Product Components	Supportive
SP 3.3	Evaluate Assembled Product Components	Supportive
SP 3.4	Package and Deliver the Product or Product Component	Supportive

Verification

SG1: Preparation for verification is conducted.
SG2: Peer reviews are performed on selected work products.
SG3: Selected work products are verified against their specified requirements.

- What work products? How are they verified?
- Suppose
  - We only verify software (and hardware, and their integration) with tests … good enough?
  - The entire team participates in
    - Defining features (requirements), and then …
    - Creating the initial design in “whiteboard UML” …

  Does that verify design against its requirements?

Verification

Acceptable

In general, informative elements Imply highle detailed data and plan-rich verification activities

SG 1 Prepare for Verification — Enabling

- SP 1.1 Select Work Products for Verification — Enabling
- SP 1.2 Establish the Verification Environment — Enabling
- SP 1.3 Establish Verification Procedures and Criteria — Enabling

SG 2 Perform Peer Reviews — Acceptable

- SP 2.1 Prepare for Peer Reviews — Supportive
- SP 2.2 Conduct Peer Reviews — Alternative
- SP 2.3 Analyze Peer Review Data — Alternative

SG 3 Verify Selected Work Products — Acceptable

- SP 3.1 Perform Verification — Supportive
- SP 3.2 Analyze Verification Results and Identify Corrective Action — Alternative

Validation

Acceptable

SG 1	Prepare for Validation	Enabling
SP 1.1	Select Products for Validation	Enabling
SP 1.2	Establish the Validation Environment	Enabling
SP 1.3	Establish Validation Procedures and Criteria	Enabling
SG 2	Validate Product or Product Components	Acceptable
SP 2.1	Perform Validation	Supportive
SP 2.2	Analyze Validation Results	Alternative

Summary Valuation for Engineering

	Acceptable	Supportive	Supportive	Supportive	Acceptable	Acceptable
	REQM	RD	TS	PI	VER	VAL
SG 1	Acceptable	Enabling	Supportive	Supportive	Enabling	Enabling
SG 2		Enabling	Supportive	Supportive	Acceptable	Acceptable
SG 3		Supportive	Supportive	Supportive	Acceptable	

Process Area Valuation Approach

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Engineering Support

Configuration Management

✓ SG 1 Baselines of identified work products are established.
✓ SG 2 Changes to the work products under CM are tracked and controlled.
✓ SG 3 Integrity of baselines is established and maintained.
? SP 3.2 Perform configuration audits to maintain integrity of the configuration baselines.

- Good match to goals, but what about CM audits practice?
- Agile/Lean preference
  - Automated controls (check-in, nightly build/test)
  - Peer pressure to enforce practices (audits are expensive)
  - Communication supported by “barely sufficient” and non-definitive documents (agile modeling)
- Good enough for software artifacts?
- But audits still necessary for large, distributed teams?
  - More communication by documentation

Configuration Management

By our definitions, these practices are enabling However, information elements to encourage agile, focused, lean CM are not present

SG 1	Establish Baselines	Enabling
SP 1.1	Identify Configuration Items	Enabling
SP 1.2	Establish a Configuration Management System	Enabling
SP 1.3	Create or Release Baselines	Enabling
SG 2	Track and Control Changes	Enabling
SP 2.1	Track Change Requests	Enabling
SP 2.2	Control Configuration Items	Enabling
SG 3	Establish Integrity	Enabling
SP 3.1	Establish Configuration Management Records	Enabling
SP 3.2	Perform Configuration Audits	Enabling

Process and Product Quality Assurance

By our definitions, these practices are enabling However, information elements to encourage agile, focused, lean evaluation practices are not present

Acceptable

SG 1 Objectively Evaluate Processes and Work Products — Enabling

- SP 1.1 Objectively Evaluate Processes — Enabling
- SP 1.2 Objectively Evaluate Work Products and Services — Enabling

Both the practices and the information elements imply systemic, plan-based, monolithic resolution of problems

- SG 2 Provide Objective Insight — Acceptable
  - SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues — Alternative
  - SP 2.2 Establish Records — Alternative

Measurement and Analysis

Supportive

SG 1 Align Measurement and Analysis Activities

Emphasis on voluminous metric data
Seems moot on all but large and complex programs

- SP 1.1 Establish Measurement Objectives — Enabling
- SP 1.2 Specify Measures — Enabling
- SP 1.3 Specify Data Collection and Storage Procedures — Supportive
- SP 1.4 Specify Analysis Procedures — Supportive

SG 2 Provide Measurement Results — Enabling

- SP 2.1 Collect Measurement Data — Enabling
- SP 2.2 Analyze Measurement Data — Enabling
- SP 2.3 Store Data and Results — Enabling
- SP 2.4 Communicate Results — Enabling

Decision Analysis and Resolution

Enabling

SG 1	Evaluate Alternatives	Enabling
SP 1.1	Establish Guidelines for Decision Analysis	Enabling
SP 1.2	Establish Evaluation Criteria	Enabling
SP 1.3	Identify Alternative Solutions	Enabling
SP 1.4	Select Evaluation Methods	Enabling
SP 1.5	Evaluate Alternatives	Enabling
SP 1.6	Select Solutions	Enabling

Organizational Environment for Integration

Enabling

SG 1	Evaluate Alternatives	Enabling
SP 1.1	Establish Guidelines for Decision Analysis	Enabling
SP 1.2	Establish Evaluation Criteria	Enabling
SP 1.3	Identify Alternative Solutions	Enabling
SP 1.4	Select Evaluation Methods	Enabling
SP 1.5	Evaluate Alternatives	Enabling
SP 1.6	Select Solutions	Enabling

Causal Analysis and Resolution

Enabling

SG 1	Determine Causes of Defects	Enabling
SP 1.1	Select Defect Data for Analysis	Enabling
SP 1.2	Analyze Causes	Enabling
SG 2	Address Causes of Defects	Enabling
SP 2.1	Implement the Action Proposals	Enabling
SP 2.2	Evaluate the Effect of Changes	Enabling
SP 2.3	Record Data	Enabling

Summary Valuation for Engineering Support

	Enabling	Acceptable	Supportive	Enabling	Enabling	Enabling
	CM	PPQA	MA	DAR	OEI	CAR
SG 1	Enabling	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Enabling	Acceptable	Enabling		Enabling	Enabling
SG 3	Enabling					

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Process Management

Organizational Process Focus

By our definitions, these practices are enabling However, information elements to encourage agile, focused, lean and rapid process improvement are not present

SG 1 Determine Process-Improvement Opportunities — Enabling

- SP 1.1 Establish Organizational Process Needs — Enabling
- SP 1.2 Appraise the Organization's Processes — Enabling
- SP 1.3 Identify the Organization's Process Improvements — Enabling

SG 2 Plan and Implement Process-Improvement Activities — Supportive

- SP 2.1 Establish Process Action Plans — Supportive
  Informative elements are contrary to rapid continuous improvement
- SP 2.2 Implement Process Action Plans — Enabling
- SP 2.3 Deploy Organizational Process Assets — Enabling
- SP 2.4 Incorporate Process-Related Experiences into the Organizational Process Assets — Enabling

Organizational Process Definition

Supportive

SG 1 Establish Organizational Process Assets — Supportive

- SP 1.1 Establish Standard Processes — Enabling
- SP 1.2 Establish Life-Cycle Model Descriptions — Life cycle informative elements are not all helpful in agile/lean efforts
- SP 1.3 Establish Tailoring Criteria and Guidelines — Informative elements are too focused on systemic tailoring
- SP 1.4 Establish the Organization's Measurement Repository — Enabling
- SP 1.5 Establish the Organization's Process Asset Library — Enabling

Organizational Training

Although these are all rated as enabling, informative elements that support the identification and application of tacit knowledge are missing

SG 1	Establish an Organizational Training Capability	Enabling
SP 1.1	Establish the Strategic Training Needs	Enabling
SP 1.2	Determine Which Training Needs Are the Responsibility of the Organization	Enabling
SP 1.3	Establish an Organizational Training Tactical Plan	Enabling
SP 1.4	Establish Training Capability	Enabling
SG 2	Provide Necessary Training	Enabling
SP 2.1	Deliver Training	Enabling
SP 2.2	Establish Training Records	Enabling
SP 2.3	Assess Training Effectiveness	Enabling

Organizational Process Performance

Enabling

SG 1	Establish Performance Baselines and Models	Enabling
SP 1.1	Select Processes	Enabling
SP 1.2	Establish Process Performance Measures	Enabling
SP 1.3	Establish Quality and Process-Performance Objectives	Enabling
SP 1.4	Establish Process Performance Baselines	Enabling
SP 1.5	Establish Process Performance Models	Enabling

Although these are all rated as enabling, elements such as improvement of skills-based teams with highly developed tacit knowledge are missing

Organizational Innovation and Deployment

Enabling

SG 1	Select Improvements	Enabling
SP 1.1	Collect and Analyze Improvement Proposals	Enabling
SP 1.2	Identify and Analyze Innovations	Enabling
SP 1.3	Pilot Improvements	Enabling
SP 1.4	Select Improvements for Deployment	Enabling
SG 2	Deploy Improvements	Enabling
SP 2.1	Plan the Deployment	Enabling
SP 2.2	Manage the Deployment	Enabling
SP 2.3	Measure Improvement Effects	Enabling

Summary Valuation for Process Management

	Supportive	Supportive	Enabling	Enabling	Enabling
	OPF	OPD	OT	OPP	OID
SG 1	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Supportive		Enabling	Enabling	Enabling

Process Area Valuation Approach

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Summary of Ratings

Project Management

	PP	PMC	SAM	IPM	RSKM	IT	ISM	QPM
	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 1	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 2	Supportive	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Supportive
SG 3	Acceptable			Enabling	Enabling	Enabling	Enabling	
SG 4				Enabling				

Engineering

	REQM	RD	TS	PI	VER	VAL
	Acceptable	Supportive	Supportive	Supportive	Acceptable	Acceptable
SG 1	Acceptable	Enabling	Supportive	Supportive	Enabling	Enabling
SG 2		Enabling	Supportive	Supportive	Acceptable	Acceptable
SG 3		Supportive	Supportive	Supportive	Acceptable	

Engineering Support

	CM	PPQA	MA	DAR	OEI	CAR
	Enabling	Acceptable	Supportive	Enabling	Enabling	Enabling
SG 1	Enabling	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Enabling	Acceptable	Enabling		Enabling	Enabling
SG 3	Enabling					

Process Management

	OPF	OPD	OT	OPP	OID
	Supportive	Supportive	Enabling	Enabling	Enabling
SG 1	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Supportive		Enabling	Enabling	Enabling

Generic Practices

- ***GP 1.1 Perform the base practices of the process area to develop work products and provide services to achieve the specific goals of the process area.***
- ***GP 2.1 Establish and maintain an organizational policy for planning and performing the process.***
- ***GP 2.2 Establish and maintain the plan for performing the process.***

  GP 2.2 A plan for performing the process will have to be intelligently applied to avoid undue burden on agile/lean processes
- ***GP 2.3 Provide adequate resources for performing the process, developing the work products, and providing the services of the process.***
- ***GP 2.4 Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.***
- ***GP 2.5 Train the people performing or supporting the process as needed.***

  GP 2.5 Training of agile/lean teams and team members should take advantage of continuous project/ organizational learning mechanisms – and support the building and extension of tacit knowledge and advanced skill sets.
- ***GP 2.6 Place designated work products of the process under appropriate levels of configuration management.***

  GP 2.6 Judicious choice of what work products to place under CM. In addition, CM practices must be agile.
- ***GP 2.7 Identify and involve the relevant stakeholders as planned.***
- ***GP 2.8 Monitor and control the process against the plan for performing the process and take appropriate corrective action.***

  GP 2.8 Careful selection and definition of processes should make this GP helpful.
- ***GP 2.9 Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.***

  GP 2.9 QA of processes is helpful- if the processes are agile/lean- and the practice of QA is agile as well.
- ***GP 2.10 Review the activities, status, and results of the process with higher level management and resolve issues.***

Generic Practices

- ***GP 3.1 Establish and maintain the description of a defined process.***
- ***GP 3.2 Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.***

  GP 3.2 Care must be taken in the application of this GP in agile/lean environments. Process must be carefully selected and made lean. Support of "future use" must be immediate, to the project itself as well as other projects.
- ***GP 4.1 Establish and maintain quantitative objectives for the process that address quality and process performance based on customer needs and business objectives.***
- ***GP 4.2 Stabilize the performance of one or more subprocesses to determine the ability of the process to achieve the established quantitative quality and process-performance objectives.***

  GP 4.2 As previously discussed, selection of processes to stabilize must be done with great care, as some agile/lean process are necessarily uncontrolled.
- ***GP 5.1 Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.***
- ***GP 5.2 Identify and correct the root causes of defects and other problems in the process.***

Conclusions

- Define the problem and set the context
- Review concepts of agile development
- Review concepts of lean software development
- Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts
- **Develop summary conclusions**

CMMI Interpretation—Bottom Line

- Primarily focused on processes and practices
- Largely ignores human aspects of (exc. IT, OEI)
  - Knowledge acquisition
  - Collaboration
- Thorough and systemic treatment of
  - Technologies
  - Informational elements and relationships
  - (Very) early "full" development of requirements
- Structure of required, expected, and information elements provides a great deal of flexibility

Does CMMI Model suite ALLOW agile/lean dev?
YES

Value Added From CMMI

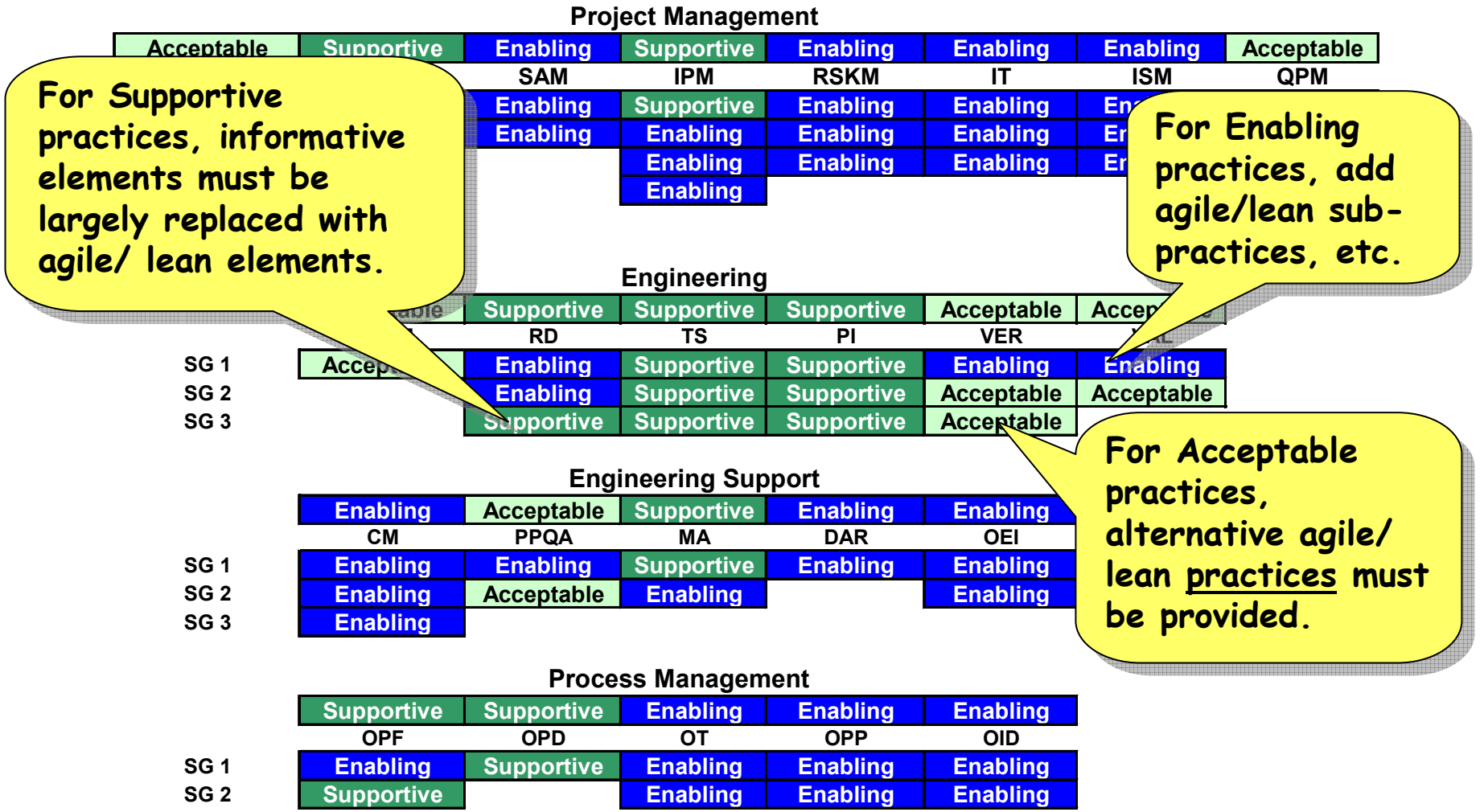
- Decision Analysis and Resolution is a counterpoint to agile bias toward “resolve by building”
- Organizational improvement beyond the project team (Organizational Environment for Integration, Training, Process Focus and Definition, Innovation and Deployment, and Process Performance)
- Hardware awareness—agile/lean ignore coordinating long-lead time efforts (Product Integration)
- Supplier interactions (ISM, SAM)
  - But note relevant agile/lean ideas
- Integrated Teaming and Organizational Environment for Integration are significant enablers for agile/lean efforts
- Robust set of practices ensures most are addressed in agile/lean efforts (where tendency may be to ignore or lessen effectiveness)

Thus, CMMI tends to reduce risk in agile/lean development

Value Added from Lean and Agile

- Iteration release rather than phased development
- Value of fast as possible production, work flow, and minimal Work In Progress
- Testing and continuous integration as essential drivers for implementation (and testing interleaved with other development activities)
- Waste reduction as a goal—testing and pair development as cost-effective options to inspection and review
- "Last responsible moment" decisions, options thinking, and incremental commitment [Gilb]
- Focus and synergy of technical leadership and technical management—practical concepts for engaging developers through empowerment
- Recognition and effective use of advanced skill sets

To Apply CMMI in Agile/Lean Environments



Workshop Discussion

Review CMMI® issues charts for closure.

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