Part 3

Appendices, Glossary, and Index

The information contained in this part is not an American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, the information in this part may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to an ANS standard.

APPENDIX X1
SIXTH EDITION CHANGES

The purpose of this appendix is to provide an overview of the changes made to *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*—Fifth Edition to create the *PMBOK® Guide*—Sixth Edition.

X1.1 SCOPE OF UPDATE

The approved scope for the *PMBOK® Guide*—Sixth Edition includes:

- Review the following and determine whether the material will be included or excluded in the new editions, and track the disposition:
  - All material relevant to Sections 1 through 13, Annex A1, and the Glossary that was deferred during the development of *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*—Fifth Edition
  - All comments and feedback relevant to Sections 1 through 13, Annex A1, and the Glossary of *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*—Fifth Edition that have been received by PMI since the initial development and publication.
- Review, interpret, and ensure appropriate alignment with ISO 21500 in the development of the standard.
- Ensure harmonization with any other relevant PMI foundational standards.
- Consider the project manager role delineation study results and other PMI research studies for incorporation as appropriate.
- Review, conduct, and analyze research for significant additions, deletions, and changes to the Sixth Edition and possibly for strategic input to future editions.

With that directive in mind, the update team focused on bringing greater consistency and clarity by refining and standardizing the processes, inputs, tools and techniques, and outputs.

X1.2 RULES FOR HARMONIZATION BETWEEN GLOSSARY TERMS AND THE *PMI LEXICON OF PROJECT MANAGEMENT TERMS*

To ensure that terms used in the *PMBOK® Guide* align with the *PMI Lexicon of Project Management Terms*[1] and harmonize with other relevant PMI standards, the Sixth Edition followed these business rules:

- For terms found in both the *PMBOK® Guide* and the *PMI Lexicon, the definition* from the *PMI Lexicon* is used.
- Where terms used in the *PMBOK® Guide* are not found in the *PMI Lexicon* but are found in other relevant PMI standards, the definitions of the terms should be identical. If the definitions do not align with the respective standards, the term is elevated to the PMI Lexicon team for assistance in creating an acceptable common definition.

X1.3 RULES FOR HANDLING INPUTS AND OUTPUTS

The following business rules were used to provide consistency in the order and information within the inputs and outputs for each project management process:

- *Fundamental Rules:*
  - Inputs are any documents that are key to the process.
  - Outputs should become an input to another project management process unless the output is a terminal output or embedded within another input such as project documents.
  - Inputs should come from an output from another project management process unless the input comes from outside the project.
- *Project Documents Rules:*
  - When specific project documents are identified the first time, they are listed as a specific output. Subsequently, they are listed as "project documents updates" in the output list, and described in the section narrative.
  - When any project document is an input, the term "project documents" is listed and the specific project documents are described in the section narrative.
- *Project Management Plan Rules:*
  - For those planning processes that create a subsidiary plan, the project charter is the first input and the project management plan is the second input.
  - The process that creates a component of the project management plan lists the component specifically. Subsequently, components are listed as "project management plan updates" in the output list, and described in the section narrative.
  - When the project management plan serves as a process input, specific components of the project management plan that may be considered are described in the section narrative.

[1] Project Management Institute. 2016. *The PMI Lexicon of Project Management Terms.* Available from http://www.pmi.org/Lexiconterms

- *Sequencing Rules:*
  - If the project charter is an input, it is the first input.
  - When the project management plan is an input or output, the subsidiary management plans are listed in the order of the sections in the *PMBOK® Guide* where they are produced as an output, followed by baselines and then any other plans.
  - Project documents are listed in alphabetical order.
  - Enterprise environmental factors and organizational process assets are listed last in that order.
  - When updates are an output they are listed in the following sequence:
    - Project management plan updates,
    - Project documents updates, and
    - Organizational process assets updates.

X1.4 RULES FOR HANDLING TOOLS AND TECHNIQUES

The Sixth Edition endeavored to reduce the number of tools and techniques by focusing on those that are currently used on most projects most of the time. Based on academic and market research a number of tools and techniques were eliminated. In order to reduce repetition a tool or technique is described the first time it is listed and subsequent processes using that tool or technique refer back to the earlier description.

The Sixth Edition grouped some of the commonly used tools and techniques by their intent. Not all tools and techniques fall within a group, but for those tools or techniques that are part of a group, the group is listed and then examples of tools and techniques in that group are described in the narrative. The tools and techniques groups are:

- Data gathering,
- Data analysis,
- Data representation,
- Decision-making,
- Communication skills, and
- Interpersonal and team skills.

Appendix X6 identifies all the tools and techniques in the *PMBOK® Guide* by group, where appropriate, and lists the processes where they are used.

X1.5 PROJECT MANAGEMENT PLAN

Not every component of the project management plan is created in a separate process. Such components are considered to be created in the Develop Project Management Plan process. They include the change management plan, configuration management plan, performance measurement baseline, project life cycle, development approach, and management reviews.

X1.6 SECTION 1—INTRODUCTION

The Introduction section was significantly rewritten. Introductory information about projects, programs, and portfolios that aligns with other PMI foundational standards remains. However, there is new information on project and development life cycles, project phases, and phase gates. This information provides a high-level overview on selecting development approaches from predictive, iterative, incremental and adaptive, based on the nature of the project. New information on business documents includes the business case and the benefits management plan.

X1.7 SECTION 2—THE ENVIRONMENT IN WHICH PROJECTS OPERATE

The content of Section 2 was significantly rewritten. Information on organizational process assets and enterprise environmental factors remains. However, there is new content on governance, management elements, and organizational structure types.

X1.8 SECTION 3—THE ROLE OF THE PROJECT MANAGER

This is a new section that outlines the project manager's role on the team. It includes information on the project manager's sphere of influence and competencies. PMI's Talent Triangle® is discussed with its emphasis on strategic and business management skills, technical project management skills, and leadership skills. Leadership styles and personality are also discussed as part of this section. The final part of this section focuses on the project manager as an integrator.

X1.9 AGILE

Since the Fifth Edition of the *PMBOK® Guide* there has been more adoption of agile and adaptive methodologies in the management of projects. The Sixth Edition has included a subsection called Considerations for Adaptive Environments at the beginning of Sections 4 through 13. Some agile-specific tools and techniques have been introduced into the *PMBOK® Guide*, such as sprint and iteration planning. Appendix X3 describes the use of agile, adaptive, iterative, and hybrid approaches from the perspective of the Project Management Process Groups.

X1.10 KNOWLEDGE AREA FRONT MATERIAL

Each of the Knowledge Area sections includes standardized material prior to introducing the first process. The material is presented in the following subsections:

- **Key Concepts.** Collects key concepts associated with the specific knowledge area. This information was presented in earlier editions; in this edition it is consolidated and presented for consistency between knowledge areas. These key concepts are compiled in Appendix X4.
- **Trends and Emerging Practices**. The profession of project management continues to evolve. However, the purpose of the *PMBOK® Guide* is not to lead the industry; it is to describe what is considered good practice on most projects most of the time. This subsection identifies some of the trends or emerging practices that are occurring, but that may not be practiced on most projects.
- **Tailoring Considerations**. The Sixth Edition emphasizes the importance of tailoring all aspects of the project to meet the needs of the organization, environment, stakeholders and other variables. This subsection identifies areas the project manager can consider when tailoring their project. These tailoring considerations are compiled in Appendix X5.
- **Considerations for Agile/Adaptive Environments**. This subsection identifies some of the areas where adaptive approaches may differ from predictive approaches in the particular Knowledge Area.

X1.11 KNOWLEDGE AREA AND PROCESS CHANGES

Two Knowledge Areas names were changed to more closely reflect the work that is done.

- Project Time Management was changed to Project Schedule Management to reflect that the project schedule is defined and managed during the project, whereas time is not managed.
- Both team resources and physical resources are addressed in the Sixth Edition. Thus, the Knowledge Area Project Human Resource Management was changed to Project Resource Management.

One process was removed and three new processes were added, to reflect changes in the way projects are managed in practice. One process was moved between Knowledge Areas. These changes are summarized below, and discussed in the relevant Knowledge Area section:

- Manage Project Knowledge (Section 4.4)—Added.
- Estimate Activity Resources (Section 6.4)—Moved to Project Resource Management.
- Control Resources (Section 9.6)—Added.
- Implement Risk Responses (Section 11.6)—Added.
- Close Procurements (Section 12.4)—Eliminated.

Several process names were changed to improve consistency across the processes and to improve clarity. Research indicates that project managers tend to monitor, facilitate, and manage rather than control, particularly in processes that involve interactions with people. Therefore, process names for Control Communications, Control Risks, and Control Stakeholder Engagement were changed to Monitor Communications, Monitor Risks, and Monitor Stakeholder Engagement. The list below summarizes all the process name changes:

- Perform Quality Assurance (Section 8.2)—Changed to Manage Quality.
- Plan Human Resource Management (Section 9.1)—Changed to Plan Resource Management.
- Acquire Project Team (Section 9.2)—Changed to Acquire Resources.
- Develop Project Team (Section 9.3)—Changed to Develop Team.
- Manage Project Team (Section 9.4)—Changed to Manage Team.
- Control Communications (Section 10.3)—Changed to Monitor Communications
- Control Risks (Section 11.6)—Changed to Monitor Risks.
- Plan Stakeholder Management (Section 13.2)—Changed to Plan Stakeholder Engagement.
- Control Stakeholder Engagement (Section 13.4)—Changed to Monitor Stakeholder Engagement.

X1.12 SECTION 4—PROJECT INTEGRATION MANAGEMENT CHANGES

A new process, Manage Project Knowledge, was added. This is a result of many deferred comments from the Fifth Edition indicating the need to address knowledge management in projects. A key output of this process is the lessons learned register. This register is used throughout many of the processes in the Sixth Edition. This emphasizes the need to learn continually throughout the project rather than waiting until the end to reflect.

Business documents are inputs to the Develop Project Charter and Close Project or Phase processes. The introduction of business documents underscores the importance of staying attuned to the business case and benefits management throughout the project. Administrative closure activities for procurements have been absorbed into the Close Project or Phase process.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-1 summarizes the Section 4 processes:

Table X1-1. Section 4 Changes

Fifth Edition Processes	Sixth Edition Processes
4.1 Develop Project Charter	4.1 Develop Project Charter
4.2 Develop Project Management Plan	4.2 Develop Project Management Plan
4.3 Direct and Manage Project Work	4.3 Direct and Manage Project Work
4.4 Monitor and Control Project Work	4.4 Manage Project Knowledge
4.5 Perform Integrated Change Control	4.5 Monitor and Control Project Work
4.6 Close Project or Phase	4.6 Perform Integrated Change Control
	4.7 Close Project or Phase

X1.13 SECTION 5—PROJECT SCOPE MANAGEMENT CHANGES

The Sixth Edition team collaborated with The Standard for Business Analysis to ensure that both foundational standards were aligned, though not duplicative. No changes to process names were necessary.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented.

X1.14 SECTION 6—PROJECT SCHEDULE MANAGEMENT CHANGES

Section 6 was renamed from Project Time Management to Project Schedule Management. Research indicated support for the name change as project managers do not manage time, they define and manage the project schedule. Due to the shift in focus and renaming of Project Human Resource Management to Project Resource Management, the process Estimate Activity Resources was moved from this Knowledge Area to Project Resource Management. Some agile concepts were incorporated into the Develop Schedule process. Figures and associated text were updated to clarify scheduling concepts addressed in the section.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-2 summarizes the Section 6 processes:

Table X1-2. Section 6 Changes

Fifth Edition Processes	Sixth Edition Processes
6.1 Plan Schedule Management	6.1 Plan Schedule Management
6.2 Define Activities	6.2 Define Activities
6.3 Sequence Activities	6.3 Sequence Activities
6.4 Estimate Activity Resources	6.4 Estimate Activity Durations
6.5 Estimate Activity Durations	6.5 Develop Schedule
6.6 Develop Schedule	6.6 Control Schedule
6.7 Control Schedule	

X1.15 SECTION 7—PROJECT COST MANAGEMENT CHANGES

Changes consistent with information described in Sections X1.1 through X1.11 were implemented.

X1.16 SECTION 8—PROJECT QUALITY MANAGEMENT CHANGES

Academic and market research was conducted regarding the Perform Quality Assurance process. Research indicated that many of the quality tools and techniques that were identified previously are not widely used in today's projects. The profession focuses more on managing quality through the quality management plan. Thus, the Perform Quality Assurance process shifted focus and the name was changed to Manage Quality.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-3 summarizes the Section 8 processes:

Table X1-3. Section 8 Changes

Fifth Edition Processes	Sixth Edition Processes
8.1 Plan Quality Management	8.1 Plan Quality Management
8.2 Perform Quality Assurance	8.2 Manage Quality
8.3 Control Quality	8.3 Control Quality

X1.17 SECTION 9—PROJECT RESOURCE MANAGEMENT CHANGES

The Sixth Edition expanded the scope of this section from its previous focus on human resources to include all resources. To distinguish between human resources and other resources, the term team resources is used to refer to human resources and the term physical resources is used to refer to other resources. The Estimate Activity Resources process was transferred into this Knowledge Area from Project Schedule Management, and a new process Control Resources was added. The word "project" was eliminated from Develop Team and Manage Team as it is inferred that the only team the project manager is concerned about developing and managing is the project team.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-4 summarizes the Section 9 processes:

Table X1-4. Section 9 Changes

Fifth Edition Processes	Sixth Edition Processes
9.1 Plan Human Resource Management	9.1 Plan Resource Management
9.2 Acquire Project Team	9.2 Estimate Activity Resources
9.3 Develop Project Team	9.3 Acquire Resources
9.4 Manage Project Team	9.4 Develop Team
	9.5 Manage Team
	9.6 Control Resources

X1.18 SECTION 10—PROJECT COMMUNICATIONS MANAGEMENT CHANGES

A subtle but important distinction was made in this section about project communication. The term "communication" indicates the act of communicating, such as facilitating a meeting, giving information and active listening. The term "communications" indicates the artifacts of communication, such as memos, presentations, and emails. Because it is not possible to control how and when people communicate, the name of the Control Communications process has been changed to Monitor Communications.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-5 summarizes the Section 10 processes:

Table X1-5. Section 10 Changes

Fifth Edition Processes	Sixth Edition Processes
10.1 Plan Communications Management	10.1 Plan Communications Management
10.2 Manage Communications	10.2 Manage Communications
10.3 Control Communications	10.3 Monitor Communications

X1.19 SECTION 11—PROJECT RISK MANAGEMENT CHANGES

An increased emphasis on overall project risk was integrated throughout the risk management processes. A new process, Implement Risk Responses, was added. This process is part of the Executing Process Group. The new process emphasizes the importance of not just planning risk responses, but implementing them as well. A new risk response "escalate" was introduced to indicate that if risks are identified that are outside the scope of the project objectives, they should be passed to the relevant person or part of the organization. Because risks are uncertain future events or conditions, they cannot be controlled; however, they can be monitored. Thus, the process Control Risks was renamed to Monitor Risks.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-6 summarizes the Section 11 processes:

Table X1-6. Section 11 Changes

Fifth Edition Processes	Sixth Edition Processes
11.1 Plan Risk Management	11.1 Plan Risk Management
11.2 Identify Risks	11.2 Identify Risks
11.3 Perform Qualitative Risk Analysis	11.3 Perform Qualitative Risk Analysis
11.4 Perform Quantitative Risk Analysis	11.4 Perform Quantitative Risk Analysis
11.5 Plan Risk Responses	11.5 Plan Risk Responses
11.6 Control Risks	11.6 Implement Risk Responses
	11.7 Monitor Risks

X1.20 SECTION 12—PROJECT PROCUREMENT MANAGEMENT CHANGES

Much of the information in this Knowledge Area was updated to reflect a more global perspective. Many projects are conducted with stakeholders in various countries, or by organizations with offices in multiple countries.

Market research shows that very few project managers actually close out procurements. Someone in contracts, procurement or legal departments usually has that authority. Therefore, information from Close Procurements about evaluating all completed deliverables and comparing them to the contract was absorbed into Control Procurements. Information about administrative, communications, and records was moved to Close Project or Phase.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-7 summarizes the Section 12 processes:

Table X1-7. Section 12 Changes

Fifth Edition Processes	Sixth Edition Processes
12.1 Plan Procurement Management	12.1 Plan Procurement Management
12.2 Conduct Procurements	12.2 Conduct Procurements
12.3 Administer Procurements	12.3 Control Procurements
12.4 Close Procurements	

X1.21 SECTION 13—PROJECT STAKEHOLDER MANAGEMENT CHANGES

In keeping with current research and practice, a shift was made to focus on stakeholder engagement rather than stakeholder management. Because project managers rarely, if ever, have the ability to control stakeholders, Control Stakeholder Engagement was renamed to Monitor Stakeholder Engagement.

Changes consistent with information described in Sections X1.1 through X1.11 were implemented. Table X1-8 summarizes the Section 13 processes:

Table X1-8. Section 13 Changes

Fifth Edition Processes	Sixth Edition Processes
13.1 Identify Stakeholders	13.1 Identify Stakeholders
13.2 Plan Stakeholder Management	13.2 Plan Stakeholder Engagement
13.3 Manage Stakeholder Engagement	13.3 Manage Stakeholder Engagement
13.4 Control Stakeholder Engagement	13.4 Monitor Stakeholder Engagement

X1.22 GLOSSARY

The glossary of the *PMBOK® Guide*—Sixth Edition was updated to clarify meaning and improve the quality and accuracy of any translations. Terms that are not used in the Sixth Edition, or are not used differently from everyday usage, were eliminated.

APPENDIX X2
CONTRIBUTORS AND REVIEWERS OF THE *PMBOK® GUIDE*—SIXTH EDITION

PMI volunteers first attempted to codify the Project Management Body of Knowledge in the *Special Report on Ethics, Standards, and Accreditation,* published in 1983. Since that time, other volunteers have come forward to update and improve that original document and contribute to this globally recognized standard for project management, PMI's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*. This appendix lists, those individuals who have contributed to the development and production of the *PMBOK® Guide* – Sixth Edition. No list can adequately portray all the contributions of those who have volunteered to develop the *PMBOK® Guide* – Sixth Edition.

The Project Management Institute is grateful to all of these individuals for their support and acknowledges their contributions to the project management profession.

X2.1 *PMBOK® GUIDE*—SIXTH EDITION CORE COMMITTEE

The following individuals served as members, were contributors of text or concepts, and served as leaders within the Project Core Committee:

Cyndi Snyder Dionisio, MBA, PMP, Chair
David A. Hillson, PhD, PMI Fellow, HonFAPM, Vice Chair (Volunteer Engagement Lead & Section 11 Lead)
Lynda Bourne, DPM, FACS (Sections 10 & 13 Lead)
Larkland A. Brown, PMP, PMI-ACP (Section 6 Lead)
Pan C.P. Kao, PhD, PMP, (Sections 7 & 12 Lead)
Mercedes Martinez Sanz, PMP (Section 4 Lead)
Alejandro Romero-Torres, PhD, PMP, (Document Quality & Management Lead & Section 5 Lead)
Guy Schleffer, PfMP, PMP, (Sections 8 & 9 Lead)
Michael J. Stratton, PhD, PMP (Section 1, 2, & 3 Lead)†
Kristin L. Vitello, Standards Project Specialist
Gwen Whitman, EMBA, PfMP (Project Communications Lead)

†Deceased. The core committee and PMI acknowledge Michael J. Stratton for his work on the *PMBOK Guide* - Sixth Edition. Mike was dedicated to the profession and this work is a testament of his contributions to the field of project management.

X2.2 SIGNIFICANT CONTRIBUTORS

In addition to the members of the Project Core Committee, the following individuals provided significant input or concepts:

Ernest Baker, PMP, PRINCE2® Practitioner
Cheryl Burcham, PMP
Guido Caciagli, B., PMP
Jimmy I. Char, PMP, SDI
Cătălin-Teodor Dogaru, PhD, MBA
Andrés Falcón, PMP
Anna Maria Felici, PMP
Eren Gokce, MBA, PMP
Pamela S. Goodhue, MBA, PMP
Franco R. Graziano, MPA, PMP
Joy Gumz, CPA, PMP
Salah M. Haswah, PMP, PgMP
Puja Kasariya, PMP
Srikanth Krishnamoorthy, PMP, PGDSA
Tom Magee, MBA, PMP
David A. Maynard, MBA, PMP
Bob Mahler, PMP, PMI-RMP
Frank R. Parth, MBA, PMP
Dattatraya Y. Pathak, PMP, PfMP
Judy Payne, PhD, MBA
Nagy Attalla Saad, PMP, ITIL
Davidov Shai
Kavita Sharma, PMP, RMP
Jurgen T. Sturany, PMP
Dirk Withake, PgMP, PMP

X2.3 *PMBOK® GUIDE*—SIXTH EDITION CONTENT COMMITTEE

The following individuals were contributors of text or concepts and provided recommendations on drafts of the *PMBOK® Guide*—Sixth Edition:

Vahid Azadmanesh, MBA, PMP
Brad Bigelow, PMP, MSP
Wayne R. Brantley, MSEd, PMP
Marcelo A. Briola PhD, PMP
Michael C. Broadway, PMP
Mariana Nella Caffarena Bolivar
Steven Flannes
Sandra Fonseca, PhD, CISA, CRISC
Theofanis C. Giotis, PMP, PMI-ACP
Piyush Govil, BE, PMP
Rex M. Holmlin, PE, PMP
Éamonn V. Kelly, DBA, PMP
Srikanth Krishnamoorthy
Fabiano de Alcântara de Lima, PhD, PMP
Shashank Neppalli
Andrea Pantano
Kristine Persun, PMP
Piyush Prakash PMP, Prince 2
Raju N. Rao, PMP, SCPM
Krupakar Reddy, PMP, PRINCE2 Practitioner
Emadeldin Seddik, PhD, PMP
Tejas V. Sura, PMP, PfMP
Nicholas Tovar
Fede Varchavsky, MBA, PMP
Angelo Valle, PhD, CRK
Ronald H. Verheijden, PMP

X2.4 REVIEWERS

X2.4.1 SME REVIEW

In addition to the members of the Committee, the following individuals provided their review and recommendations on drafts of the standard:

David P. Bieg, PMI-PBA
James F. Carilli, PMP, PgMP
Shika Carter, PMP, PgMP
Dan Deakin, PMP, CISSP
Theofanis C. Giotis, PMP, PMI-ACP
Dave Gunner, MSc, PMP
George Jucan, PMP
Ginger Levin, PhD, PMP, PgMP
Vanina Mangano, PMP, PMI-RMP
Juan Carlos Moreno, MBA, PMP
Marvin R. Nelson, MBA, SCPM
Klaus Nielsen, MBA, PMP
Chris Richards, PMP
Ivan Rincon, MBA, PMP
Shaligram Pokharel, REng (Nepal), PhD
Paul E. Shaltry, MA, PMP
Carolina Gabriela Spindola, PMP, SSBB
Langeswaran Supramaniam, C Build E FCABE, PMP
Michael A Yinger

X2.4.2 FINAL EXPOSURE DRAFT REVIEW (STANDARD PORTION)

In addition to the members of the Committee, the following individuals provided recommendations for improving the Exposure Draft of the *PMBOK® Guide*—Sixth Edition (standard portion):

Ahmed A. Raouf Hamdy, PhD, PMP
Farhad Abdollahyan, PMP, OPM3 CP
Adil Abdulghani
Tetsuhide Abe, PMP
Klaus Abert
Ayodeji R. Abitogun, MBA, PMP
Taiwo Abraham
Mohammad I. Abu Irshaid, PMP, PfMP
Manuel Acosta A.
Phill C. Akinwale, MSc, PMP
Mazen Al Bazreh
Jose Rafael Alcala Gomez, PMP
Ameer Ali
Hammam Zayed Alkouz, PMP, PMI-RMP
Bill Allbee, PMP
Charmaine Y. Allen, PMP, PBA
Kristin L. Allen, PE, PMP
Abdulaziz Almalki
Ayman Alminawi, MBA, PMP
Ahmad Moh. Al-Musallami, MSc, PMP
Imad Alsadeq, P3M3, MB
Mohammed Ahmad S. Al-Shamsi, PhD, PEng
Essam Alsultan, MBA, PMP
Haluk Altunel, PhD, PMP
Priscilla S. R. Alves, PMP
Angelo Amaral
Barnabas Seth Amarteifio, PMP, ITIL (Expert)
Wilson Anandaraj, MBA, PMP
Guillermo Anton
John Aogon, PMP
Hamid Aougab, PMP, PMI-ACP
Charalampos Apostolopoulos, PhD, PMP
Rodolfo Arguello
Abd Razak B Ariffin, PMP
Deepak Arora, MBA, PMP
C. H. ArunPrabu, PMP
Zaher Asfari, MBA, PMI-ACP
Ayman Atallah, BE, PMP
Reza Atashfaraz, MSc, PMP
Sharaf A. Attas, PMP, PMI-RMP
Abdurazaq Attuwaijri
Ashraf M Awwad, MSc, PMP
Vikram Kumar B. T.
Nabeel Eltyeb Babiker, PMP, P3O
Mohamed A Badie, PMP, Prince2 Practitioner
Smitha Balakrishnan
Saket Bansal, PMP, PMI-ACP
Manuel F. Baquero V., MSc, PMP
Haytham Baraka, PMP, CCP
Robert Barclay
Karuna Basu
Joy Beatty, PMI-PBA, CBAP
Frances Bellows, PMP, ACP
Peter G. Bembir, MPhil, PMP
Anis Ben Hassen, Msc Project/Programme/Portfolio Management, PMP
Racquel Benedict
German Bernate, MPM
Bryan D. Berthot, MBA, PMP
Karl F. Best, PMP, CStd
Shantanu Bhamare, PMP, LIMC
Jasbir Singh Bhogal, PMP, ITIL-V3
Michael M. Bissonette, MBA, PfMP
Molly Blake-Michaels, MS, PMP
Nigel Blampied, PE, PMP
Wolfgang Blickle, PMP, PMI-ACP
Jaqueline Boeck
Dennis L. Bolles, PMP
Kiron D. Bondale, PMP, PMI-RMP
Raúl Borges, PMP
Farid F. Bouges, PhD, PMP, PfMP
Joao Boyadjian
Damiano Bragantini, PMP
Ralf Braune
Kevin Brennan
Naga Pradeep Buddhavarapu, PMP
David E. Buehler, PMP
Susan M. Burk
Andrea Caccamese, PMP, Prince2 Practitioner
Roberto A. Cadena Legaspi, PMP, MCI
Shawna D. Camp, MBA, PMP
Iker Castillo, PMP
Igor Castro
Helena Cedersjö, MSc, PMP
Balasubramanian Chandrasekaran, BE, PMP
Joo-Kwan Chang
Panos Chatzipanos, PhD, Dr Eur Ing
Pengzhi Chen, PMP, MSC
Wilson Lee Chung, PMP
Xavier Clerfeuille, MSc, SSL Black Belt
Martin A. Collado, PMP, ITIL
Sergio Luis Conte, PhD, PMP
Lawrence (Larry) Cooper, PMP, PMI-ACP
Hélio R. Costa, DSc
Scott Cunningham

Adriano Jose da Silva Neves
Hernán D'Adamo, MPM, PMP
Michelle Daigle, PMP
Larry C Dalton, PfMP, PgMP
Farshid Damirchilo, MSc
Tran Dang
Teodor Darabaneanu, PMP, MEng
Russell W. Darnall, DM, PMP
Edson G. Freitas, PMP
Jean-Michel de Jaeger, EMBA, PMP
Maria Angela de Souza Fernandes
Allan E. Dean PMP, PgMP
G. Murat Dengiz, PMP
Valerie P. Denney, DBA, PMP
Jacqueline E. Dennis, PMP, PgMP
Konika Dey, MCA, PMP
Cyndi Snyder Dionisio, MBA, PMP
Ajay Kumar Dixit, MBA, B Tech
Roland Doerr, MSc, PMP
Rex Wotan Dominguez Chang
Jorge Duenas-Lozano
Stephen M. Duffield, MPM, CPPD
Josée Dufour, PMP
Darya Duma, PEng, PMP
Keiran J. Dunne, PhD
Awab Elameer, PMP, PMI-SP
Khaled EL-Nakib, MSc, PMP
Yasir Elsadig, PMP, PfMP
Majdi N. Elyyan, PMP, PMI-RMP
Pedro Engrácia
Mark W. Erwin, PMP, PMI-ACP
Behnam Faizabadi, PhD, PMP
Marco Falcao, PMP, PMI-RMP
Puian Masudi Far, PhDc, PMP
Jamil Faraj
Saurater Faraday, PMI-RMP
Fereydoun Fardad, PMP, PRINCE2
Sergio Ferreto Gutiérrez, MPM, MBA
David Foley, MBA
Les Foley, MPM, PMP
Gloria Folle Estrada, PMP
Frank P. Forte, PMP
Laura Franch, PMP
Nestor C. Gabarda Jr., ECE, PMP
Jaime Garcia Castro, PMP
Sam Ghavanloo, PMP
Ing Gustavo Giannattasio MBA, PMP
Sheila Gibbs
Carl M. Gilbert, PMP PfMP
Theofanis Giotis, PhDc, PMP
José Abranches Gonçalves, MSc, PMP
Juan Carlos González, PMP, PMI-ACP
Jean Gouix, PMP, PgMP
Therese Graff
Scott M. Graffius, PMP, CSM
Brian Grafsgaard, PMP, PgMP
Sara Grilli Colombo
Anita Griner
Maxim Grishin, PhD, PMP
Robert C Grove, MBA, PMP
David Guan, PMP
Juan E. Guarache, V, BEng, PMP
Pier Luigi Guida
Vijay Guliani, PMP, PMI-PBA
Tomasz Gutmanski
Omar Haddad, CAPM, PMP
Mustafa Hafizoglu, PMP
Yoshifumi Hamamichi
Simon Harris, PMP, CGEIT
Patti M. Harter, PMP
Sean Shraden Hasley, MSIT-PM
Ahmed Hassan
Akram Hassan, PhD, PMP
Susumu Hayakawa, PMP
Bruce A. Hayes, PMP
Guangcheng He, PMP
David G. Hendrickson, PMP
Barbara Henrich
Baruch Herrera
Sergio Herrera-Apestigue, PMP, P3O
Robert Hierholtz, PhD, MBA, PMP
Robert N. Higgins V, PMP, ITIL Expert
David A. Hillson, PhD, PMI Fellow, HonFAPM
Shirley Hinton, PMP
Kenji Hiraishi, MsE, PMP
Lenora Holmsten, PMP, MPM
Jenny Anne Horst-Martz, JD, PMP
Alfred J. Howard, PMP, ITIL Expert
Cynthia L. Hoxey, PMP
Gheorghe Hriscu, PMP, CGEIT
Ananth HV PMP, CSM
Guillermo A. Ibañez, PMP, ITIL
Victor Manuel Ibanez Salazar, PMP, MA
Waleed Idris
Shuichi Ikeda, PMP
Andrea Innocenti PMP, CGEIT
Can Izgi, PMP
Pablo Jaramillo
Tariq Javed, MS, PMP
Cari Jewell, PMP, MISST
Gabriela Jimenez P.
Icvillajoe Joe
Tony Johnson, PMP, PfMP
Michele J. Jones, PMP
Yves Jordan, PMP
Alisher Kabildjanov, PMP
SS Kanagaraj, PMP, ITIL
Naoki Kasahara, PMP
Arcady Katnikov
Suhail Khaled
Basher Khalil
Aaron Ho Khong, PMP, ITIL Expert

M. Raashid Kiani, PMP, CSM
Taeyoung Kim, PMP
Ariel S. Kirshbom, PMP, ACP
Konstantinos Kirytopoulos, PhD, PMP
Ian Koenig PMP
Athens Kolias, MPM, PMP
Henry Kondo, PMP, PfMP
Maciej Koszykowski, PMP, PMI-RMP
Rouzbeh Kotobzadeh, PMP, PMI-ACP
Srikanth Krishnamoorthy, PMP, PGDSA
Amit Kumar
Devesh Kumar
Pramit Kumar, PMP
Rakesh Kumar, MBA, PMP
Santosh Kumar
S. Y. Satish Kumar
Abhilash Kuzhikat, PMP, CISA
Thierry Labriet
G.Lakshmi Sekhar, PMP, PMI-SP
Boon Soon Lam
Vincent Hiu Sing Lam, PMP
Ruchie Lamba
Deborah Langlois MBA, PMP
Alvaro Latorre,MsC, PMP
Olivier Lazar
Chang-Hee Lee, PMP, CISA
Cheryl G. Lee, PMP, PMI-PBA
Oliver F. Lehmann, MSc, PMP
Michael J Leisegang, PMP
Craig Letavec, PgMP, PfMP
Jean-Pierre Lhomme, PMP
Junquan Liu
Shihan Liu
Tong Liu (James Liu), PhD, PMP
Anand Loganathan, MS
Anand Lokhande, PMP
Nancy Lopez
Samuel López González de Murillo, MPM, PMP
Carlos López Javier, MBA, PMP
Zheng Lou, MBA, PMP
Sérgio Lourenço, PMP, PMI-RMP
Catia Lourenço
Hugo Kleber Magalhães Lourenço, PMP, ACP
Amy S. Lugibihl, PMP
Sergio O. Lugo, MBA, PMP
Vijaya Prasanth M. L., PMP, MCTS
José Carlos Machicao, MSc, PMP
Frederick G. Mackaden, CRISC, PMP
Jas Madhur
Krishan Gopal Maheshwari, PMP, ITILv3 Expert
Konstantinos Maliakas, MSc (PM), PMP
Rich Maltzman, PMP
Vaios Maniotis
Antonio Marino, PMP, PMI-ACP
Gaitan Marius Titi, Eng, PMP
Photoula Markou-Voskou
Lou Marks, PMP
Cristian Martín Corrales, MPM, PMP
Mike McElroy, MHA, PMP
Jon McGlothian, MBA, PMP
William T. McNamara, PMP
Rob D. Meadows, MBA, PMP
Alain Patrick Medenou, PMP, PRINCE2 Practitioner
Lourdes Medina, PMP, PfMP
Peter Berndt de Souza Mello, PMI-SP, PMP
Yan Bello Mendez
Ernst Menet, PMP
Sunil Meshram, PMP
Mohammed M'Hamdi, PMP
Lubomira Mihailova, MBA, PMP
Gloria J. Miller, PMP
Romeo Mitchell, MSc, BSc
Mannan Mohammed, Peng, PMP
Venkatram Vasi Mohanvasi
Ricardo Monteiro
Paula Morais
Maciej Mordaka, PMP
Rachel A. Morris, PMP
Doris Moss
Henrique Moura, PMP, PMI-RMP
Timur Mukharyamov, PhD, PMP
Antonio Muntaner, PMP
Muktesh Murthy, MBA (IS), PMP
Lemya Musa M. Idris, PMP, PMI-PBA
Khalid M. Musleh, PMP, PMI-RMP
Syed Ahsan Mustaqeem, PE, PMP
Todd Nielsen Myers, MBA, PMP
Narayanaswamy Nagarajan, PMP
Kiran Nalam
Faig Nasibov, PMP
Asad Naveed, PMP, RMP
Serge Patrick N'Guessan, MSIS, PMP
Praveen K. Nidumolu, PMP, PMI-ACP
Eric Nielsen, PMP
Jeffrey S. Nielsen, PMP, PgMP
Víctor Nieva Martín-Portugués, PMP
Michael C. Nollet, PMP, PMI-ACP
Takamasa Nomura
Ernesto Antonio Noya Carbajal
Mufaro M. Nyachoto, PMI-PBA, CAPM
Conor O'Brien, MBA (Tech Open), PMP
Peter O'Driscoll
Michael O. Ogberuhor, PMP, EVP
Bayonle Oladoja, PMP, PRINCE2

Antonio Oliva González, PMP, EMPM
Habeeb Omar, PgMP, PfMP
Stefan Ondek, PMP
Marian Oprea, PMP, ITIL
Henrique Ortega-Tenorio, PMP
Venkateswar Oruganti, FIETE, PMP
Musab Abdalmageed Osman Abubakar
Jaime Andres Alvarez Ospina, PMP, PMI-RMP
Tabitha A. Palmer, PMP
Neeraj Pandit, PMP
Luke Panezich, PMP, PMI-ACP
Hariyo Pangarso
Laura Paton, PMP, PMI-PBA
Seenivasan Pavanasam, PMP, PgMP
Anil Peer, PEng, PMP
Mauricio Perez Calvo, PMP, PMI-RMP
Dana Persada Mulyoto, MBA, PMP
LEE Nan Phin, PMP, CSM
Luca Pietrandrea
Crispin ("Kik") Piney, BSc, PgMP
Jose Angelo Pinto, PMP, OPM3 CP
Narendra Pondugula, PMP, PMI-ACP
Hin-Fei Poon
Svetlana Prahova, PMP
B. K. Subramanya Prasad, PMP, CSM
T.V. Prasanna Raaj, PMP
Suhail Qadir, PMP, BTech
Collin Quiring, PMP, OPM3
Nader K. Rad, PMP
Noalur Rahim, PMP
Prashanth Bagepalli Rajarao, BE, PMP
S. Ramani, PgMP, PfMP
Gurdev S. Randhawa, PMP
Alakananda Rao
Vicky Restrepo, PMP
Raman Rezaei
Tashfeen Riaz, PMP, MPM
Juan Carlos Rincón Acuña, PhD, PMP
Juan Sebastian Rivera Ortiz
Dan Roman, PMP, PMI-ACP
Rafael Fernando Ronces Rosas, PMP, ITIL
David W. Ross, PMP, PgMP
Kaydashov Ruslan, PMP
Philip Leslie Russell, PMP
Mohamed Salah Eldien Saad, PMP
Eyad Saadeh, PfMP, PgMP
Imad Sabonji, PMP
Kumar Sadasivan, PMP
Mihail Sadeanu, PhD, PMP
Gopal Sahai, PMP, PMI-PBA
Joudi Ahmad Said, PMP, MSc
Ibrahim Saig, PhD, PMP, MRCPI
Brian Salk, PhD, PMP
Omar A. Samaniego, PMP, PMI-RMP
Abubaker Sami, PfMP, PgMP
Carlos Sánchez Golding, PMP
Yiannis Sandis, MSc, PMP
Iván S. Tejera Santana, PMP, PMI-ACP
Murali Santhanam, PMP, BCom
Subhendu Sarangi
Saikat Sarkar, PMP
Shreesh Sarvagya
Supriya Saxena
Nicole Schelter, PMP
Kathy Schwalbe, PhD, PMP
Dion Serben
Marcus Gregorio Serrano, MBA, PMP
Isaac Sethian, MBA, PMP
Bruce G. Shapiro, PMP
Ian Sharpe, 4-DM CPPD
Cindy C Shelton, PMP, PMI-ACP
Nitin Shende, PMP, PRINCE2
Gregory P. Shetler, PhD, PgMP
Patricia C. C. Sibinelli, MEng, PMP
Alexsandro Silva
Christopher M. Simonek, PMP
Rohit Singh
Sathya Sivagurunathan
Venkatramanan S., PMP
Michelle A. Sobers, MS
Pamela L. Soderholm, PMP
Khaled Soliman
Mauro Sotille, PMP, PMI-RMP
Sriram Srinivasan, PMP, CGEIT
Pranay Srivastava, PMP, CSM
Alexander Stamenov
Jamie Stasch
John Stenbeck, PMP, PMI-ACP
Michael J. Stratton, PhD, PMP
S. Sudha, PMP
John L. Sullivan, MEd, PMP
Karen Z. Sullivan, PMP, PSM
Surichaqui Yasuji Suzuki, PMP
Mark A. Swiderski, PMP, MBA
Titus K. Syengo, PMP
Paul S. Szwed, DSc, PMP
Hadi Tahmasbi Ashtiani
Shoji Tajima, PMP, ITC
Peter Tashkoff, PMP
Ahmet Taspinar
Gokrem Tekir
Sunil Telkar PMP, PGDBL
Sal J. Thompson, MBA, PMP
Mark S. Tolbert, PMP, PMI-ACP
Mukund Toro, PMP
Stephen Tower, PMP, MBCI
John Tracy, PMP, MBA
Biagio Tramontana, Eng, PMP
Micol Trezza, MBA, PMP
Konstantin Trunin, PMP
Ahmet Tümay, PhD, PMP

M. Jeffery Tyler, PMP
Hafiz Umar, MBA, PMP
Krishnakant T. Upadhyaya, PMP
Atta Ur Rahman, MBA, PMP
Ebenezer Uy
Madhavan V.
Ali Vahedi Diz, PgMP, PfMP
Tom Van Medegael, PMP
Stephen VanArsdale
Enid T. Vargas Maldonado, PMP, PMI-PBA
Paola D. Vargas
Allam V. V. S. Venu, PMP, PgMP
Roberto Villa, PMP
Tiziano Villa, PMP, PMI-ACP
Benjamin Villar Lurquin, Bs
Dave Violette, MPM, PMP
Vijay Srinivas Vittalam PMP, RMP
Julian Vivas
Sameh Wahba, PMP, CPMC
Prakash Waknis, PMP
Xiaojin Wang, PhD, PMP
Tsunefumi Watanabe, PMP
Barbara A. Waters, MBA, PMP
Shayla P. Watson, MA
Patrick Weaver, PMP, PMI-SP
Kevin R. Wegryn, PMP, Security+
Lars Wendestam, MSc, PMP
Jan Werewka, PMP
Carol E. P. Whitaker, MBA, PMP
Sean Whitaker, MBA, PMP
Angela Wick, PMP, PBA
Michal P. Wieteska
J. Craig Williams
Malgorzata Wolny
Sek-Kay Steve Wong, MBA, PMP
Louise M. Worsley
Yan Wu, APME, PMP
Clement C. L. Yeung, PMP
Cynthia J. Young, PhD, PMP, LSSMBB
Gordon Young
Alan E. Yue, PMP, PMI-ACP
Hany I. Zahran
Saeed Zamani
Alessandri Zapata Rosas, PMP
Azam M. Zaqzouq, MCT, PMP
Salim Zid, MSc, PMP
Eire Emilio Zimmermann
Marcin Zmigrodzki, PhD, PgMP

X2.4.3 FINAL EXPOSURE DRAFT REVIEW (GUIDE PORTION)

In addition to the members of the Committee, the following individuals provided recommendations for improving the Exposure Draft of the *PMBOK® Guide*—Sixth Edition (guide portion):

Farhad Abdollahyan, PMP, OPM3CP
Tetsuhide Abe, PMP
Ali Abedi, PhD, PMP
Amir Mansour Abdollahi, MSc, PE
Eric Aboagye
Umesh AC
Jer Adamsson
Carles Adell, MPM, PMP
Mounir A. Ajam, RMP, GPM-bTM
Uğur Aksoylu, PMP
Tarik Al Hraki, PMP, PMI-RMP
Melad Al Aqra, PMP, MIET
Amer Albuttma, BSc, PMP
Jose Rafael Alcala Gomez, PMP
Filippo Alessandro, PMP
Hammam Zayed Alkouz, PMP, PMI-RMP
Eric Allen
Wasel A. Al-Muhammad, MBA, PMP
Turki Mohammed Alqawsi, MITM
Imad Alsadeq, MB, P3M3
Haluk Altunel, PhD, PMP
Barnabas Seth Amarteifio, PMP, ITIL (Expert)
Serge Amon, MBA, PMP
Abd Razak B Ariffin, PMP
Sridhar Arjula
Kalpesh Ashar, PMP, PMI-ACP
Vijaya C. Avula, PMP, ACP
Andy Bacon, PMP, CSP
Andrey Badin
Sherif I. Bakr, PMP, MBA
Karuna Basu
Chandra Beaveridge, BEng, PMP
Jane Alam Belgaum, PMP
Stefan Bertschi, PhD
Harwinder Singh Bhatia, PMP, PMI-ACP
Jasbir Singh Bhogal, PMP, ITIL-V3
Jayaram Bhogi PMP, CSM
Michael M. Bissonette, MBA, MS
Greta Blash, PMP, PMI-ACP
Steve Blash, PMP, PMI-ACP
Dennis L. Bolles, PMP
Rodolphe Boudet, PMP
Farid F. Bouges, PhD, PfMP, PMP
Damiano Bragantini, PMP
Ralf Braune, PhD, PMP
Maria del Carmen Brown, PMP
James N. Bullock, PMP, ASQ CMQ/OE
Andy Burns PMP, PMI-ACP
Nicola Bussoni, PMP
Roberto A. Cadena Legaspi, PMP, MCI
Carla M. Campion, BEng (Hons), PMP
Shika Carter, PMP, PgMP
Luis Casacó, MA, PMP
Guillermo A. Cepeda L., PMP, PMI-RMP
Kristine Chapman
Panos Chatzipanos, PhD, Dr Eur Eng.
Satish Chhiba
Aditya Chinni
Virgiliu Cimpoeru, PhDc, PMP
Jorge Omar Clemente, PMP, CPA
Martin A. Collado, PMP, ITIL
Sergio Luis Conte, PhD, PMP
Franco Cosenza, PGDipBA, PMP
Veronica Cruz
Ron Cwik MBA, PMP
Yudha P. Damiat, PMP, PMI-SP
Farshid Damirchilo, MSc
William H. Dannenmaier, PMP, MBA
Sankalpa Dash
Gina Davidovic PMP, PgMP
Beatriz Benezra Dehtear, MBA
G. Murat Dengiz, PMP
Stephen A. Devaux, PMP, MSPM
Shanmugasundaram Dhandapani
Sachin S. Dhaygude, PMP, PMI-ACP
Ivana Dilparic
Marcelo Sans Dodson, DBA,PMP
Nedal A. Dudin, PMP, PBA
Jorge A. Dueñas, PMP, AVS
Eunice Duran Tapia, PMP, PfMP
Wael K. Elmetwaly, PMP, PMI-ACP
Talha M. El-Gazzar, PMP
Carol Elliott, MBA, PMP
Larry Elwood, PMP, CISSP
Angela England
Marco Falcao, PMP, PMI-RMP
Puian Masudi Far, PhDc, PMP
Jared Farnum
Jose L. Fernandez-Sanchez, PhD
Eduardo S. Fiol, PMP
Regis Fitzgibbon
Garry Flemings
Carlos Augusto Freitas, CAPM, PMP
Scott J. Friedman, PMP, ACG
MAG Sanaa Fuchs
Nestor C. Gabarda Jr., ECE, PMP
Robert M. Galbraith, PMP
Carl M. Gilbert, PMP, PfMP
Theofanis Giotis, PhDc, PMP
Dhananjay Gokhale

José Abranches Gonçalves, MSc, PMP
Herbert G. Gonder, PMP
Edward Gorni, PMP, MSc
Julie Grabb PMP, B Math
Stuart Gray
Christiane Gresse von Wangenheim, Dr. rer. nat., PMP
Grzegorz Grzesiak
Ahmed Guessous, PMP
Neeraj Gupta, PMP, CSM
Sunita Gupta
Raj Guttha PhD, PMP
Mustafa Hafizoglu, PMP
Kazuro Haga, PMP, PMI-RMP
Yoshifumi Hamamichi
Simon Harris, PMP, CGEIT
Gabrielle B. Haskins, PMP
Hossam Hassan
Madhavi Hawa, MBA
Randell R. Hayes II, PMP, MBA
Guangcheng He, PMP
Kym Henderson, RFD, MSc (Comp)
Sergio Herrera-Apestigue, PMP, P3O
Robert Hierholtz, PhD, MBA, PMP
Bob Hillier, PMP
Aaron Ho Khong, PMP, ITIL Expert
Scott C. Holbrook, PMP, CISSP
Regina Holzinger, PhD, PMP
Christina M. House, MBA, PMP
Gheorghe Hriscu, PMP, CGEIT
Terri Anne Iacobucci, SPHR, PMP
Guillermo A. Ibañez, PMP, ITIL
Can Izgi, PMP
Anand Jayaraman PMP, MCA
Anil K. Jayavarapu, PMP
Cari Jewell, PMP, MISST
Martina Jirickova
Alan John
Tony Johnson, PMP, PfMP
Michele J. Jones, PMP
Rajesh G. Kadwe, PMP
Orhan Kalayci, PMP, CBAP
Samer Faker Kamal, PMP, LEED AP BD+C
Surendran Kamalanathan
Vaijayantee Kamat, PMP
Nils Kandelin
Carl Karshagen, PMP
Anton Kartamyshev
Scott Kashkin, MS, PMP
Katsuichi Kawamitsu, PMP, ITC
Rachel V. Keen, PMP
Suhail Khaled
Jamal Khalid
Eng. Ahmed Samir Khalil, PMP, OPM3-CP
Basher Khalil
Ranga Raju Kidambi
Mostafa K. Kilani, BEng, PMP
Diwakar Killamsetty
Taeyoung Kim, PMP
Konstantinos Kirytopoulos, PhD, PMP
Kashinath Kodliwadmanth
Maarten Koens, PMP
Dwaraka Ramana Kompally, MBA, PMP
Henry Kondo, PMP, PfMP
Maciej Koszykowski, PMP, PMI-RMP
Ahmed A F Krimly
Srikanth Krishnamoorthy, PMP, PGDSA
Bret Kuhne
Avinash Kumar, PMP
Pramit Kumar, PMP
Thomas M. Kurihara
Andrew Lakritz
Boon Soon Lam
Luc R. Lang PMP
Jon Lazarus
Chang-Hee Lee PMP, CISA
Ivan Lee PMP, PMI-ACP
Oliver F. Lehmann, MSc, PMP
Katherine A. Leigh
Donald LePage
Peter Liakos, PMP, Cert APM
Tong Liu, PhD, PMP
Chandra Sekhar Lolla Venkata Satya
Stefania Lombardi, PhDc, PMP
Daniel D. Lopez, CSP, PMP
Zheng Lou, MBA, PMP
Sérgio Lourenço, PMP, PMI-RMP
Hugo Kleber Magalhães Lourenço, PMP, ACP
Xiang Luo, PMP, PMI-PBA
José Carlos Machicao, PMP, MSc
Sowjanya Machiraju, MS, PMP
Robert Mahler
Mostafa M. Abbas, PMP, OCE
Konstantinos Maliakas, MSc (PM), PMP
Rich Maltzman, PMP
Ammar Mango
Antonio Marino, PMP, PMI-ACP
Gaitan Marius Titi, Eng, PMP
Lou Marks, PMP
Rodrigo Marques da Rocha
Ronnie Maschk, PMP
Maria T Mata-Sivera, PMP
Kurisinkal Mathew
Stephen J. Matney, CEM, PMP
David A. Maynard, MBA, PMP
Pierre Mbeniyaba Mboundou
Thomas McCabe
Jon McGlothian, MBA, PMP
Alan McLoughlin, PMP, PMI-ACP

Ernst Menet, PMP
Mohammed M'Hamdi, PMP
Roberta Miglioranza, PMP, Prince2
Gloria J. Miller, PMP
Daniel Minahan, MSPM, PMP
Javier A Miranda, PMP, PMI-ACP
Saddam Mohammed Babikr Mohammed
Venkatramvasi Mohanvasi, PMP
Maciej Mordaka, PMP
Paola Morgese, PMP
Moises Moshinsky, MSc, PMP
Henrique Moura, PMP, PMI-RMP
Nathan Mourfield
Alison K. Munro, MSc, PMP
Khalid M. Musleh, PMP, PMI-RMP
Vasudev Narayanan
Faig Nasibov, PMP
Daud Nasir, PMP, LSSBB
Nasrullah
Nghi M. Nguyen, PhD, PMP
Eric Nielsen, PMP
Yamanta Raj Niroula, PMP
Emily Nyindodo
Peter O'Driscoll
Kiyohisa Okada
Bayonle Oladoja, PMP, PRINCE2
Sofia Olguin
Edward C. Olszanowski III, PMP, EMBA
Austen B. Omonyo, PhD, PMP
Stefan Ondek, PMP
Tom Oommen
H. Metin Ornek, PMP, MBA
Juan Carlos Pacheco
Durgadevi S. Padmanaban, MBA, PMP
Ravindranath Palahalli
Boopathy Pallavapuram, PMP
Rajeev R. Pandey
Luke Panezich, PMP, PMI-ACP
Sungjoon Park, PMP
Gino Parravidino Jacobo, PMP, ITIL
Richard L. Pascoe, PMP
George Pasieka, PMP
Sneha Patel, PMP
Satyabrata Pati, PMP
Seenivasan Pavanasam PMP, PgMP
R. Anthoney Pavelich, PMP
P. B. Ramesh, PMP, ACP
Brent C. Peters, BA
Yvan Petit, PhD, PMP
Crispin ("Kik") Piney, BSc, PgMP
Jose Angelo Pinto, PMP, OPM3 CP
Napoleón Posada, MBA, PMP
B K Subramanya Prasad, PMP, CSM
Carl W. Pro, PMP, PMI-RMP
Srikanth PV
Nader K. Rad, PMP
Karen Rainford, EdD, PMP
S. Ramani, PfMP, PgMP
Niranjana Koodavalli Ramaswamy, BE Mech, PGDM
Jesus Esteban Ramirez, BEng, eCS
Michele Ranaldo, PMP
Gurdev S. Randhawa, PMP
Sreekiran K. Ranganna, PMP, MBA
Alakananda Rao
Muhammad Sauood ur Rauf, PMP
P. Ravikumar, PMP, PMI-ACP
Michael Reed, PMP, PfMP
Messias Reis, PMP
Alexander V. Revin, PMP
Mohammadreza Rezaei
Gustavo Ribas
David B. Rich, PMP
Gregg D. Richie, PMP, MCTS
Edgar Robleto Cuadra
Bernard Roduit
David Roe, PMP
Rafael Fernando Ronces Rosas, PMP, ITIL
Prakash Roshan
William S. Ruggles, PMP, CSSMBB
Nagy Attalla Saad, PMP, ITIL
Natesa Sabapathy, PhD, PMP
Kumar Sadasivan, PMP
Dzhamshid Safin, PhD, PMP
Edgardo S. Safranchik, PMP
Ibrahim Mohammed Ali Saig
Naoto Sakaue
Xavier Salas Ceciliano, MSc, PMP
Anderson Sales
Floriano Salvaterra, PMP, IPMA-C
Omar A. Samaniego, PMP, PMI-RMP
Abubaker Sami, PfMP, PgMP
Angela Sammon
P. Sampathkumar, MBA, PMP
Iván S. Tejera Santana, PMP, PMI-ACP
Luciana de Jesus Santos, PMP
Aminu Sarafa, PMP, CCP
Darpan Saravia, PMP, CSM
Tamara Scatcherd
Stephen M. Schneider, PhD, PMP
Ludwig Schreier, Eur Ing, PMP
Birgitte Sharif, PMP
Sanjeev Sharma
Alexander Shavrin, PhD, PMP
Nitin Shende, PMP, PRINCE2
Luqman Shantal, PMP, TOGAF
N. K. Shrivastava, PMP, SPC4
Mohamad Sibai
Gustavo Silva
Sumit Kumar Sinha, PMP
Ronald Zack Sionakides, MBA, PMP
Klas Skogmar, EMBA, PMP
J. Greg Smith, EVP
Kenneth F. Smith, PhD, PMP
Pamela L. Soderholm, PMP

John Paul Soltesz
Sheilina Somani, RPP, PMP
Mauro Sotille, PMP, PMI-RMP
Setty Sreelatha, PMP, PMI-ACP
Shishir Srivastav, PMP, CSM
Pranay Srivastava, PMP, CSM
John Stenbeck, PMP, PMI-ACP
Jim Stewart
Yasuji Suzuki, PMP
Mark A. Swiderski, PMP, MBA
Ahmed Taha, PMP, PMI-RMP
Francis Taiwo, PMP, PMI-ACP
Yahya Tatar, PMP, MBA
Gerhard J. Tekes, PMP, PMI-RMP
Gokrem Tekir
João Paulo Tinoco
Claudia A. Tocantins, MSc, PMP
Mukund Toro, PMP
Juan Torres Vela
Stephen Tower, PMP, MBCI
Brenda Tracy
John Tracy, MBA, PMP
Konstantin Trunin, PMP
Tassos Tsochataridis, MSc, PMP
Krishnakant T. Upadhyaya, PMP
Ali Vahedi Diz, PgMP, PfMP
Jorge Valdés Garciatorres, PMP, SMC
Jose Felix Valdez-Torero, PMP
Tom Van Medegael, PMP
Raymond Z van Tonder, PMP, ND Elec Eng
Ravi Vanukuru, BE, PMP
Ricardo Viana Vargas, MSc, PMP
Neelanshu Varma, PMP
Debbie Varn, PMP, SHRM-SCP
Vijay Vemana, PgMP, PMP
Nagesh V., PMP
Aloysio Vianna Jr., DEng, PMP
Roberto Villa, PMP
Jorge Villanueva, MSc (PM), PMP
Dave Violette, MPM, PMP
Yiannis Vithynos PMP, PMI-ACP
Steve Waddell, MBA, PMP
Xiaojin Wang, PhD, PMP
J. LeRoy Ward, PMP, PgMP
Toshiyuki Henry Watanabe, PE, PMP
Ashleigh Waters, PMP
Ganesh Watve, MBA, PMP
Patrick Weaver, PMP, PMI-SP
Michal P. Wieteska
Roger Wild, PMP
Rebecca A. Winston, JD
Lisa Wolf
Carlos Magno Xavier, PhD, PMP
Wenyi Xiao, PMP
Haotian Xu, CAPM
Clement C. L. Yeung, PMP
Saeed Zamani
Azam M. Zaqzouq, MCT, PMP
Omran M. Zbeida, PMP, BSP
Marcin Zmigrodzki, PMP, PgMP
Rolf Dieter Zschau, PMP
Alan Zucker, PMP, CSM

X2.5 PMI STANDARDS PROGRAM MEMBER ADVISORY GROUP (MAG)

The following individuals served as members of the PMI Standards Program Member Advisory Group during development of the *PMBOK® Guide*—Sixth Edition:

Maria Cristina Barbero, PMP, PMI-ACP
Brian Grafsgaard, PMP, PgMP
Hagit Landman, PMP, PMI-SP
Yvan Petit, PhD, PMP
Chris Stevens, PhD
Dave Violette, MPM, PMP
John Zlockie, MBA, PMP, PMI Standards Manager

X2.6 CONSENSUS BODY REVIEW

The following individuals served as members of the PMI Standards Program Consensus Body:

Nigel Blampied, PE, PMP
Dennis L. Bolles, PMP
Chris Cartwright, MPM, PMP
Sergio Coronado, PhD
Andrea Demaria, PMP
John L. Dettbarn, Jr., DSc, PE
Charles T. Follin, PMP
Laurence Goldsmith, MBA, PMP
Dana J Goulston, PMP
Brian Grafsgaard, PMP, PgMP
David Gunner, PMP
Dorothy L. Kangas, PMP
Thomas Kurihara
Hagit Landman, PMP, PMI-SP
Timothy MacFadyen
Harold "Mike" Mosley, Jr., PE, PMP
Eric S Norman, PMP, PgMP
Nanette Patton, MSBA, PMP
Yvan Petit, PhD, PMP
Crispin ("Kik") Piney, BSc, PgMP
Michael Reed, PMP, PfMP
David W. Ross, PMP, PgMP
Paul E. Shaltry, PMP
Chris Stevens, PhD
Adam D. Sykes, MS, PMP
Matthew D. Tomlinson, PMP, PgMP
Dave Violette, MPM, PMP

X2.7 PRODUCTION STAFF

Special mention is due to the following employees of PMI:

Donn Greenberg, Manager, Publications
Roberta Storer, Product Editor
Barbara Walsh, Publications Production Supervisor

APPENDIX X3
AGILE, ITERATIVE, ADAPTIVE, AND HYBRID PROJECT ENVIRONMENTS

This appendix explores the nuances of how the Project Management Process Groups described in *The Standard for Project Management* are performed with respect to the project environment and life cycle.

Section 1.4.2.1 of the *PMBOK® Guide* states that the "project life cycle needs to be flexible enough to deal with the variety of factors included in the project." It is the nature of projects to evolve as more detailed and specific information becomes available. This ability to evolve and adapt is more relevant in environments with a high degree of change and uncertainty or with a wide variation of stakeholder interpretation and expectations.

X3.1 THE CONTINUUM OF PROJECT LIFE CYCLES

To understand the application of the process in adaptive projects, the continuum of project life cycles should be defined. The *PMBOK® Guide* Glossary describes the project life cycle as "the series of phases that a project passes through from its start to its completion." Within a project life cycle, there are generally one or more phases that are associated with the development of the product, service, or result. These are called a development life cycle. Development life cycles can be predictive (plan-driven), adaptive (agile), iterative, incremental, or a hybrid.

Figure X3-1 shows the various ways in which requirements and plans are handled, how risk and cost are managed, schedule considerations, and how the involvement of key stakeholders is handled depending on the type of life cycle being employed.

Predictive	Iterative	Incremental	Agile
Requirements are defined up-front before development begins	Requirements can be elaborated at periodic intervals during delivery		Requirements are elaborated frequently during delivery
Deliver plans for the eventual deliverable. Then deliver only a single final product at end of project timeline	Delivery can be divided into subsets of the overall product		Delivery occurs frequently with customer-valued subsets of the overall product
Change is constrained as much as possible	Change is incorporated at periodic intervals		Change is incorporated in real-time during delivery
Key stakeholders are involved at specific milestones	Key stakeholders are regularly involved		Key stakeholders are continuously involved
Risk and cost are controlled by detailed planning of mostly knowable considerations	Risk and cost are controlled by progressively elaborating the plans with new information		Risk and cost are controlled as requirements and constraints emerge

Figure X3-1. The Continuum of Project Life Cycles

Predictive project life cycles are characterized by an emphasis on specification of requirements and detailed planning during the beginning phases of a project. Detailed plans based on known requirements and constraints may reduce risk and cost. Milestones for key stakeholder involvement are also planned. As execution of the detailed plan progresses, the monitoring and controlling processes focus on constraining changes that might impact the scope, schedule, or budget.

Highly adaptive or agile life cycles for projects are characterized by progressive elaboration of requirements based on short iterative planning and executing cycles. Risk and cost are reduced by progressive evolution of initial plans. Key stakeholders are continuously involved and provide frequent feedback which enables responding to changes more quickly and also leads to better quality.

The following considerations apply to the center of the life cycle continuum: (a) risk and cost are reduced by iterative evolution of initial plans; and (b) key stakeholders have more opportunities to be involved in incremental, iterative, and agile cycles than stakeholders at the project milestones of highly predictive life cycles.

Project life cycles in the center of the life cycle continuum tend to align more closely with the predictive side or the agile side of the continuum depending on the way requirements are specified, how risk and cost are handled, and the nature of key stakeholder involvement. Projects in this part of the continuum may utilize hybrid project methods.

It should be emphasized that development life cycles are complex and multidimensional. Often, the different phases in a given project employ different life cycles, just as distinct projects within a given program may each be executed differently.

X3.2 PROJECT PHASES

Section 1.2.4.2 of the *PMBOK® Guide* defines phases as "a collection of logically related project activities that culminates in the completion of one or more deliverables." Processes in each of the Process Groups are repeated as necessary in each phase until the completion criteria for that phase have been satisfied.

Projects on the more adaptive side of the continuum make use of two recurring patterns of project phase relationships as described in Sections X3.2.1 and X3.2.2.

X3.2.1 SEQUENTIAL ITERATION-BASED PHASES

Adaptive projects are often decomposed into a sequence of phases called Iterations. Each iteration utilizes the relevant project management processes. These iterations create a cadence of predictable, timeboxed pre-agreed, consistent duration that aids with scheduling.

Performing the process groups repeatedly incurs overhead. The overhead is considered necessary to effectively manage projects with high degrees of complexity, uncertainty, and change. The effort level for iteration-based phases is illustrated in Figure X3-2.

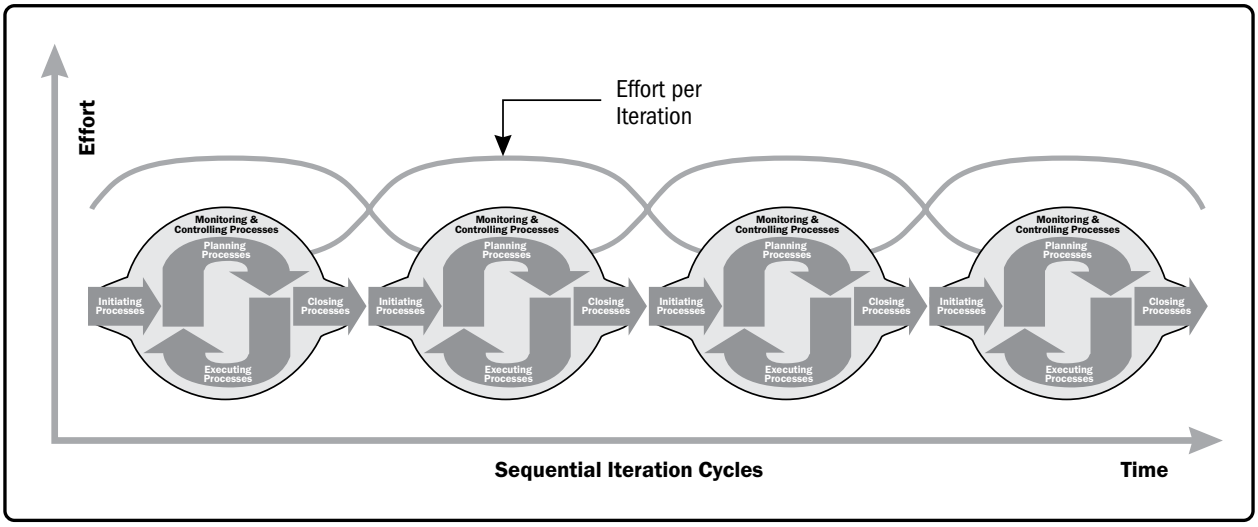

Figure X3-2. Level of Effort for Process Groups across Iteration Cycles

X3.2.2 CONTINUOUS OVERLAPPING PHASES

Projects that are highly adaptive will often perform all of the project management process groups continuously throughout the project life cycle. Inspired by techniques from lean thinking, the approach is often referred to as "continuous and adaptive planning," which acknowledges that once work starts, the plan will change, and the plan needs to reflect this new knowledge. The intent is to aggressively refine and improve all elements of the project management plan, beyond the prescheduled checkpoints associated with Iterations. The interaction of the Process Groups in this approach is illustrated in Figure X3-3.

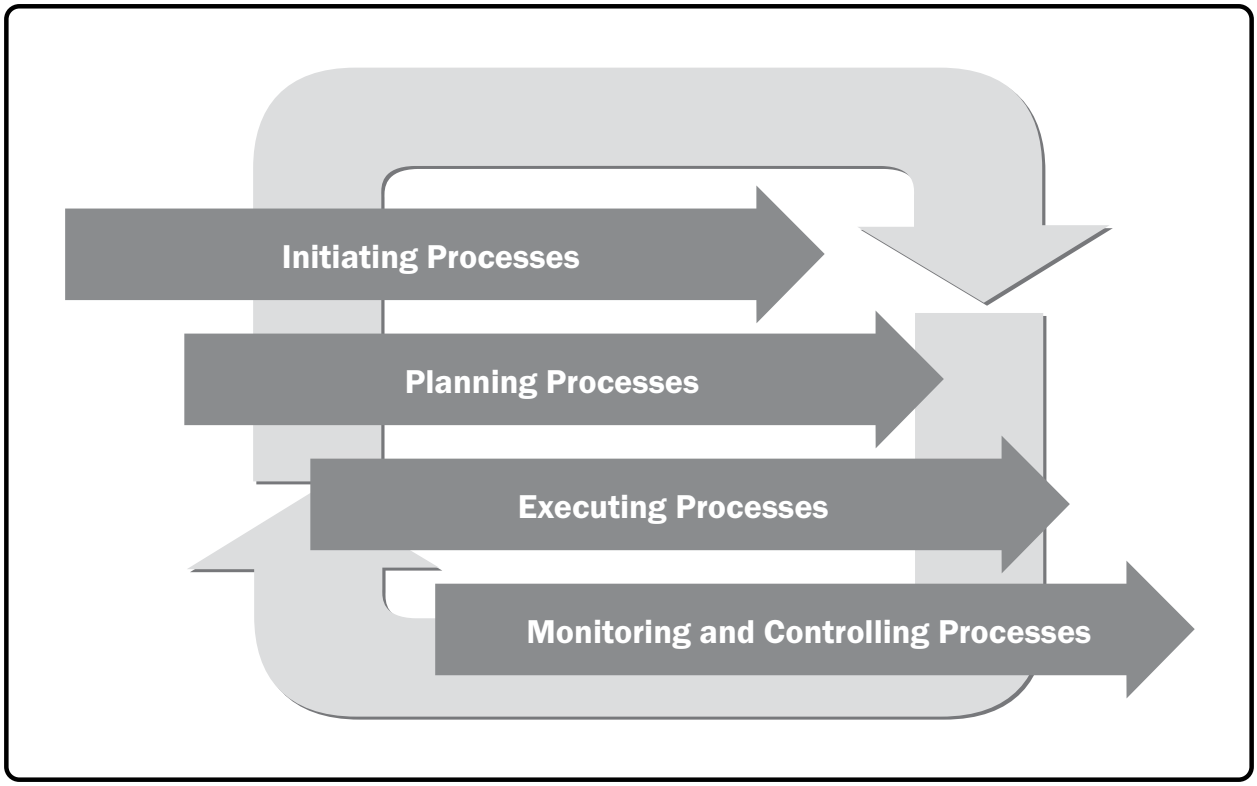

Figure X3-3. Relationship of Process Groups in Continuous Phases

These highly adaptive approaches continuously pull tasks from a prioritized list of work. This aims to minimize the overhead of managing Process Groups repeatedly, by removing the start and end of iteration activities. Continuous pull systems can be viewed as microiterations with an emphasis on maximizing the time available on execution rather than management. They do however need their own planning, tracking, and adjustment mechanisms to keep them on track and adapt to changes.

X3.3 PROCESS GROUPS IN ADAPTIVE ENVIRONMENTS

As shown in the previous section, each of the Project Management Process Groups occurs in projects across the project life cycle continuum. There are some variations in how the Process Groups interact within adaptive and highly adaptive life cycles.

X3.3.1 INITIATING PROCESS GROUP

Initiating processes are those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase. Adaptive projects revisit and revalidate the project charter on a frequent basis. As the project progresses, competing priorities and changing dynamics may cause the project constraints and success criteria to become obsolete. For this reason, the Initiating processes are performed regularly on adaptive projects in order to ensure the project is moving within constraints and toward goals that reflect the latest information.

Adaptive projects rely heavily on a knowledgeable customer or designated customer representative who can state needs and desires, and provide feedback on the emerging deliverable on a continuous, ongoing basis. Identifying this stakeholder or other stakeholders at the start of the project permits frequent interactions when performing Execution and Monitoring and Controlling processes. The associated feedback ensures that the correct project outputs are delivered. As indicated previously, an Initiating process is typically conducted on each iterative cycle of an adaptive life cycle project.

X3.3.2 PLANNING PROCESS GROUP

Planning processes are those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.

Highly predictive project life cycles are generally characterized by few changes to project scope and high stakeholder alignment. These projects benefit from detailed up-front planning. Adaptive life cycles, on the other hand, develop a set of high-level plans for the initial requirements and progressively elaborate requirements to an appropriate level of detail for the planning cycle. Therefore, predictive and adaptive life cycles differ as to how much planning is done and when it is done.

Additionally, projects navigating high degrees of complexity and uncertainty should involve as many team members and stakeholders as possible in the planning processes. The intent is to overcome uncertainty by incorporating a wide band of input into planning.

X3.3.3 EXECUTING PROCESS GROUP

Executing processes are those processes performed to complete the work defined in the project management plan to satisfy the project requirements.

Work in agile, iterative, and adaptive project life cycles is directed and managed through iterations. Each iteration is a short, fixed time period to undertake work followed by a demonstration of functionality or design. Based on the demonstration, relevant stakeholders and the team conduct a retrospective review. The demonstration and review helps check progress against the plan and determines if any changes to the project scope, schedule, or execution processes are necessary. These sessions also help manage stakeholder engagement by showing increments of work done and discussing future work. The retrospective allows issues with the execution approach to be identified and discussed in a timely fashion along with ideas for improvements. Retrospectives are a primary tool to manage project knowledge and develop the team through discussions of what is working well and team-based problem solving.

While work is undertaken via short iterations, it is also tracked and managed against longer-term project delivery timeframes. Trends of development speed, spend, defect rates, and team capacity that are tracked at an iteration level are summed and extrapolated at a project level to track completion performance. Highly adaptive approaches aim to utilize specialized team knowledge for task completion. Rather than a project manager selecting and sequencing work, higher-level objectives are explained and the team members are empowered to self-organize specific tasks as a group to best meet those objectives. This leads to the creation of practical plans with high levels of buy-in from the team members.

Junior teams working on highly adaptive projects typically need coaching and work assignments before reaching this empowered team state. However, with progressive trials within the confines of a short iteration, teams are reviewed as part of the retrospective to determine if they acquired the required skills to perform without coaching.

X3.3.4 MONITORING AND CONTROLLING PROCESS GROUP

Monitoring and Controlling processes are those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.

Iterative, agile, and adaptive approaches track, review, and regulate progress and performance by maintaining a backlog. The backlog is prioritized by a business representative with help from the project team who estimates and provides information about technical dependencies. Work is pulled from the top of the backlog for the next iteration based on business priority and team capacity. Requests for change and defect reports are evaluated by the business representative in consultation with the team for technical input and are prioritized accordingly in the backlog of work.

This single-list-of-work-and-changes approach originated in project environ-ments with very high rates of change that tended to overwhelm any attempts to separate change requests from originally planned work. Combining these work streams into a single backlog that can be easily resequenced provides a single place for stakeholders to manage and control project work, perform change control, and validate scope.

As prioritized tasks and changes are pulled from the backlog and completed via iterations, trends, and metrics on work performed, change effort and defect rates are calculated. By sampling progress frequently via short iterations, measures of team capacity and progress against the original scope are made by measuring the number of change impacts and defect remediation efforts. This allows estimates of cost, schedule, and scope to be made based on real progress rates and change impacts.

These metrics and projections are shared with project stakeholders via trend graphs (information radiators) to communicate progress, share issues, drive continuous improvement activities, and manage stakeholder expectations.

X3.3.5 CLOSING PROCESS GROUP

The Closing processes are the processes performed to formally complete or close a project, phase, or contract. Work on iterative, adaptive, and agile projects is prioritized to undertake the highest business value items first. So, if the Closing Process Group prematurely closes a project or phase, there is a high chance that some useful business value will already have been generated. This allows premature closure to be less of a failure due to sunk costs and more of an early benefits realization, quick win, or proof of concept for the business.

APPENDIX X4
SUMMARY OF KEY CONCEPTS FOR KNOWLEDGE AREAS

The purpose of this appendix is to provide a summary of the sections on Key Concepts for each of the Knowledge Areas in Sections 4-13. It can be used as an aid for project practitioners, a checklist of learning objectives for providers of project management training, or as a study aid by those preparing for certification.

X4.1 KEY CONCEPTS FOR PROJECT INTEGRATION MANAGEMENT

Key concepts for Project Integration Management include:

- Project Integration Management is the specific responsibility of the project manager and it cannot be delegated or transferred. The project manager is the one that combines the results from all the other Knowledge Areas to provide an overall view of the project. The project manager is ultimately responsible for the project as a whole.
- Projects and project management are integrative by nature, with most tasks involving more than one Knowledge Area.
- The relationships of processes within the Project Management Process Groups and between the Project Management Process
- Project Integration Management is about:
  - Ensuring that the due dates of project deliverables, the project life cycle, and the benefits realization plan are aligned;
  - Providing a project management plan to achieve the project objectives;
  - Ensuring the creation and the use of appropriate knowledge to and from the project;
  - Managing project performance and changes to the project activities;
  - Making integrated decisions regarding key changes impacting the project;
  - Measuring and monitoring progress and taking appropriate action;
  - Collecting, analyzing and communicating project information to relevant stakeholders;
  - Completing all the work of the project and formally closing each phase, contract, and the project as a whole; and
  - Managing phase transitions when necessary.

X4.2 KEY CONCEPTS FOR PROJECT SCOPE MANAGEMENT

Key concepts for Project Scope Management include:

- Scope can refer to product scope (the features and functions that characterize a product, service, or result), or to project scope (the work performed to deliver a product, service, or result with the specified features and functions).
- Project life cycles range along a continuum from predictive to adaptive or agile. In a life cycle that uses a predictive approach, the project deliverables are defined at the beginning of the project and any changes to the scope are progressively managed. In an adaptive or agile approach, the deliverables are developed over multiple iterations where a detailed scope is defined and approved for each iteration when it begins.
- Completion of the project scope is measured against the project management plan. Completion of the product scope is measured against the product requirements.

X4.3 KEY CONCEPTS FOR PROJECT SCHEDULE MANAGEMENT

Key concepts for Project Schedule Management include:

- Project scheduling provides a detailed plan that represents how and when the project will deliver the products, services, and results defined in the project scope.
- The project schedule is used as a tool for communication, managing stakeholder expectations, and a basis for performance reporting.
- When possible, the detailed project schedule should remain flexible throughout the project to adjust for knowledge gained, increased understanding of the risk, and value-added activities.

X4.4 KEY CONCEPTS FOR PROJECT COST MANAGEMENT

Key concepts for Project Cost Management include:

- Project Cost Management is primarily concerned with the cost of the resources needed to complete project activities, but it should also consider the effect of project decisions on the subsequent recurring cost of using, maintaining, and supporting project deliverables.
- Different stakeholders will measure project costs in different ways and at different times. Stakeholder requirements for managing costs should be considered explicitly.
- Predicting and analyzing the prospective financial performance of the project's product may be performed outside the project, or it may be part of Project Cost Management.

X4.5 KEY CONCEPTS FOR PROJECT QUALITY MANAGEMENT

Key concepts for Project Quality Management include:

- Project Quality Management addresses the management of the project and the deliverables of the project. It applies to all projects, regardless of the nature of their deliverables. Quality measures and techniques are specific to the type of deliverables being produced by the project.
- Quality and grade are different concepts. Quality is "the degree to which a set of inherent characteristics fulfills requirements" (ISO 9000).[1] Grade is a category assigned to deliverables having the same functional use but different technical characteristics. The project manager and team are responsible for managing trade-offs associated with delivering the required levels of both quality and grade.
- Prevention is preferred over inspection. It is better to design quality into deliverables, rather than to find quality issues during inspection. The cost of preventing mistakes is generally much less than the cost of correcting mistakes when they are found by inspection or during usage.
- Project managers may need to be familiar with sampling. Attribute sampling (the result either conforms or does not conform) and variable sampling (the result is rated on a continuous scale that measures the degree of conformity).
- Many projects establish tolerances and control limits for project and product measurements. Tolerances (the specified range of acceptable results) and control limits (the boundaries of common variation in a statistically stable process or process performance).
- The cost of quality (COQ) includes all costs incurred over the life of the product by investment in preventing nonconformance to requirements, appraising the product or service for conformance to requirements, and failing to meet requirements (rework). Cost of quality is often the concern of program management, portfolio management, the PMO, or operations.
- The most effective quality management is achieved when quality is incorporated into the planning and designing of the project and product, and when organizational culture is aware and committed to quality.

[1] International Standards Organization. 2015. Quality Management Systems—Fundamentals and Vocabulary. Geneva: Author.

X4.6 KEY CONCEPTS FOR PROJECT RESOURCE MANAGEMENT

Key concepts for Project Resource Management include:

- Project resources include both physical resources (equipment, materials, facilities, and infrastructure) and team resources (individuals with assigned project roles and responsibilities).
- Different skills and competences are needed to manage team resources versus physical resources.
- The project manager should be both the leader and the manager of the project team, and should invest suitable effort in acquiring, managing, motivating, and empowering team members.
- The project manager should be aware of team influences such as the team environment, geographical location of team members, communication among stakeholders, organizational change management, internal and external politics, cultural issues, and organizational uniqueness.
- The project manager is responsible for proactively developing team skills and competences while retaining and improving team satisfaction and motivation.
- Physical resource management is concentrated on allocating and utilizing the physical resources needed for successful completion of the project in an efficient and effective way. Failure to manage and control resources efficiently may reduce the chance of completing the project successfully.

X4.7 KEY CONCEPTS FOR PROJECT COMMUNICATIONS MANAGEMENT

Key concepts for Project Communications Management include:

- *Communication* is the process of exchanging information, intended or involuntary, between individuals and/or groups. *Communications* describes the means by which information can be sent or received, either through activities, such as meetings and presentations, or artifacts, such as emails, social media, project reports, or project documentation. Project Communications Management addresses both the process of communication, as well as management of communications activities and artifacts.
- Effective communication creates a bridge between diverse stakeholders whose differences will generally have an impact or influence upon the project execution or outcome, so it is vital that all communication is clear and concise.
- Communication activities include internal and external, formal and informal, written and oral.
- Communication can be directed upwards to senior management stakeholders, downwards to team members, or horizontally to peers. This will affect the format and content of the message.

- Communication takes place consciously or unconsciously through words, facial expressions, gestures and other actions. It includes developing strategies and plans for suitable communications artifacts, and the application of skills to enhance effectiveness.
- Effort is required to prevent misunderstandings and miscommunication, and the methods, messengers, and messages should be carefully selected.
- Effective communication depends on defining the purpose of communication, understanding the receiver of the communications, and monitoring effectiveness.

X4.8 KEY CONCEPTS FOR PROJECT RISK MANAGEMENT

Key concepts for Project Risk Management include:

- All projects are risky. Organizations choose to take project risk in order to create value, while balancing risk and reward.
- Project Risk Management aims to identify and manage risks that are not covered by other project management processes.
- Risk exists at two levels within every project: *Individual project risk* is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives. *Overall project risk* is the effect of uncertainty on the project as a whole, arising from all sources of uncertainty including individual risks, representing the exposure of stakeholders to the implications of variations in project outcome, both positive and negative. Project Risk Management processes address both levels of risk in projects.
- Individual project risks can have a positive or negative effect on project objectives if they occur. Overall project risk can also be positive or negative.
- Risks will continue to emerge during the lifetime of the project, so Project Risk Management processes should be conducted iteratively.
- In order to manage risk effectively on a particular project, the project team needs to know what level of risk exposure is acceptable in pursuit of project objectives. This is defined by measurable risk thresholds that reflect the risk appetite of the organization and project stakeholders.

X4.9 KEY CONCEPTS FOR PROJECT PROCUREMENT MANAGEMENT

Key concepts for project procurement management include:

- The project manager should be familiar enough with the procurement process to make intelligent decisions regarding contracts and contractual relationships.
- Procurement involves agreements that describe the relationship between a buyer and a seller. Agreements can be simple or complex, and the procurement approach should reflect the degree of complexity. An agreement can be a contract, a service-level agreement, an understanding, a memorandum of agreement, or a purchase order.
- Agreements must comply with local, national, and international laws regarding contracts.
- The project manager should ensure that all procurements meet the specific needs of the project, while working with procurement specialists to ensure organizational policies are followed.
- The legally binding nature of an agreement means it will be subjected to a more extensive approval process, often involving the legal department, to ensure that it adequately describes the products, services, or results that the seller is agreeing to provide, while being in compliance with the laws and regulations regarding procurements.
- A complex project may involve multiple contracts simultaneously or in sequence. The buyer-seller relationship may exist at many levels on any one project, and between organizations internal to and external to the acquiring organization.

X4.10 KEY CONCEPTS FOR PROJECT STAKEHOLDER MANAGEMENT

Key concepts for project stakeholder management include:

- Every project has stakeholders who are impacted by or can impact the project in a positive or negative way. Some stakeholders will have a limited ability to influence the project's work or outcomes; others will have significant influence on the project and its expected outcomes.
- The ability of the project manager and team to correctly identify and engage all of the stakeholders in an appropriate way can mean the difference between project success and failure.
- To increase the chances of success, the process of stakeholder identification and engagement should commence as soon as possible after the project charter has been approved, the project manager has been assigned, and the team begins to form.
- The key to effective stakeholder engagement is a focus on continuous communication with all stakeholders. Stakeholder satisfaction should be identified and managed as a key project objective.
- The process of identifying and engaging stakeholders for the benefit of the project is iterative, and should be reviewed and updated routinely, particularly when the project moves into a new phase, or if there are significant changes in the organization or the wider stakeholder community.

APPENDIX X5
SUMMARY OF TAILORING CONSIDERATIONS FOR KNOWLEDGE AREAS

The purpose of this appendix is to provide a summary of the Tailoring Concepts sections for each of the Knowledge Areas in Sections 4 through 13. Because each project is unique, this information can be used to aid practitioners in determining how to tailor processes, inputs, tools and techniques, and outputs for a project. This information can also help determine the degree of rigor that should be applied to the various processes in a Knowledge Area.

X5.1 PROJECT INTEGRATION MANAGEMENT

Considerations for tailoring project integration management include but are not limited to:

- **Project life cycle.** What is an appropriate project life cycle? What phases should comprise the project life cycle?
- **Development life cycle**. What development life cycle and approach is appropriate for the product, service or result? Is a predictive or adaptive approach appropriate? If adaptive, should the product be developed incrementally or iteratively? Is a hybrid approach best?
- **Management approaches**. What management processes are most effective based on the organizational culture and the complexity of the project?
- **Knowledge management.** How will knowledge be managed in the project to foster a collaborative working environment?
- **Change**. How will change be managed in the project?
- **Governance**. What control boards, committees, and other stakeholders are part of the project? What are the project status reporting requirements?
- **Lessons learned**. What information should be collected throughout and at the end of the project? How will historical information and lessons learned be made available to future projects?
- **Benefits**. When and how should benefits be reported: at the end of the project or at the end of each iteration or phase?

X5.2 PROJECT SCOPE MANAGEMENT

Considerations for tailoring project scope management include but are not limited to:

- **Knowledge and requirements management**. Does the organization have formal or informal knowledge and requirements management systems? What guidelines should the project manager establish for requirements to be reused in the future?
- **Validation and control**. Does the organization have existing formal or informal validation and control-related policies, procedures, and guidelines?
- **Use of agile approach**. Does the organization use agile approaches in managing projects? Is the development approach iterative or incremental? Is a predictive approach used? Will a hybrid approach be productive?
- **Governance**. Does the organization have formal or informal audit and governance policies, procedures, and guidelines?

X5.3 PROJECT SCHEDULE MANAGEMENT

Considerations for tailoring project schedule management include but are not limited to:

- **Life cycle approach.** What is the most appropriate life cycle approach that allows for a detailed schedule?
- **Duration and resource.** What are the factors influencing durations, such as the correlation between resource availability and productivity?
- **Project dimensions.** How will the presence of project complexity, technological uncertainty, product novelty, pace or progress tracking, (such as earned value management, percentage complete, red-yellow-green (stop light) indicators) impact the desired level of control?
- **Technology support.** Is technology used to develop, record, transmit, receive, and store project schedule model information and is it readily accessible?

X5.4 PROJECT COST MANAGEMENT

Considerations for tailoring project cost management include but are not limited to:

- **Knowledge management**. Does the organization have a formal knowledge management and financial databases repository that a project manager is required to use and is readily accessible?
- **Estimating and budgeting**. Does the organization have existing formal or informal cost estimating and budgeting-related policies, procedures, and guidelines?
- **Earned value management**. Does the organization use earned value management in managing projects?
- **Use of agile approach**. Does the organization use agile methodologies in managing projects? How does this impact cost estimating?
- **Governance**. Does the organization have formal or informal audit and governance policies, procedures, and guidelines?

X5.5 PROJECT QUALITY MANAGEMENT

Considerations for tailoring project quality management include but are not limited to:

- **Policy compliance and auditing**. What quality policies and procedures exist in the organization? What quality tools, techniques, and templates are used in the organization?
- **Standards and regulatory compliance**. Are there any specific quality standards in the industry that need to be applied? Are there any specific governmental, legal, or regulatory constraints that need to be taken into consideration?
- **Continuous improvement**. How will quality improvement be managed in the project? Is it managed at the organizational level or at the level of each project?
- **Stakeholder engagement**. Is there a collaborative environment with stakeholders and suppliers?

X5.6 PROJECT RESOURCE MANAGEMENT

Considerations for tailoring project resource management include but are not limited to:

- **Diversity**. What is the diversity background of the team?
- **Physical location**. What is the physical location of team members and physical resources?
- **Industry-specific resources**. What special resources are needed in in the industry?
- **Acquisition of team members**. How will team members be acquired for the project? Are team resources full-time or part-time on the project?
- **Development and management of team**. How is team development managed for the project? Are there organizational tools to manage team development or will new ones need to be established? Will the team need special training to manage diversity?
- **Life cycle approaches**. What life cycle approach will be used on the project?

X5.7 PROJECT COMMUNICATIONS MANAGEMENT

Considerations for tailoring project communications management include but are not limited to:

- **Stakeholders**. Are the stakeholders internal or external to the organization, or both?
- **Physical location**. What is the physical location of team members? Is the team colocated? Is the team in the same geographical area? Is the team distributed across multiple time zones?
- **Communications technology**. What technology is available to develop, record, transmit, retrieve, track, and store communication artifacts? What technologies are most appropriate and cost effective for communicating to stakeholders?
- **Language**. Language is a main factor to consider in communication activities. Is one language used? Or are many languages used? Have allowances been made to adjust to the complexity of team members from diverse language groups?
- **Knowledge management**. Does the organization have a formal knowledge management repository? Is the repository used?

X5.8 PROJECT RISK MANAGEMENT

Considerations for tailoring project risk management include but are not limited to:

- **Project size**. Does the project's size in terms of budget, duration, scope, or team size require a more detailed approach to risk management? Or is it small enough to justify a simplified risk process?
- **Project complexity**. Is a robust risk approach demanded by high levels of innovation, new technology, commercial arrangements, interfaces, or external dependencies that increase project complexity? Or is the project simple enough that a reduced risk process will suffice?
- **Project importance**. How strategically important is the project? Is the level of risk increased for this project because it aims to produce breakthrough opportunities, addresses significant blocks to organizational performance, or involves major product innovation?
- **Development approach**. Is this a waterfall project where risk processes can be followed sequentially and iteratively, or does the project follow an agile approach where risk is addressed at the start of each iteration as well as during execution?

X5.9 PROJECT PROCUREMENT MANAGEMENT

Considerations for tailoring project procurement management include but are not limited to:

- **Complexity of procurement**. Is there one main procurement or are there multiple procurements at different times with different sellers that add to the complexity of the procurements?
- **Physical location**. Are the buyers and sellers in the same location or reasonably close or in different time zones, countries, or continents?
- **Governance and regulatory environment**. Are local laws and regulations regarding procurement activities integrated with the organization's procurement policies? How does this affect contract auditing requirements?
- **Availability of contractors**. Are there available contractors who are capable of performing the work?

X5.10 PROJECT STAKEHOLDER MANAGEMENT

Considerations for tailoring project stakeholder management include but are not limited to:

- **Stakeholder diversity**. How many stakeholders are there? How diverse is the culture within the stakeholder community?
- **Complexity of stakeholder relationships**. How complex are the relationships within the stakeholder community? The more networks a stakeholder or stakeholder group participates in, the more complex the networks of information and misinformation the stakeholder may receive.
- **Communication technology**. What communication technology is available? What support mechanisms are in place to ensure that best value is achieved from the technology?

APPENDIX X6
TOOLS AND TECHNIQUES

X6.1 INTRODUCTION

The *PMBOK® Guide* - Sixth Edition presents tools and techniques differently from previous editions. Where appropriate, this edition groups tools and techniques by their purpose. The group name describes the intent of what needs to be done and the tools and techniques in the group represent different methods to accomplish the intent. For example, data gathering is a group with the intent of gathering data and information. Brainstorming, interviews, and market research are among the techniques that can be used to gather data and information.

This approach reflects the emphasis in the Sixth Edition on the importance of tailoring the information presented in the *PMBOK® Guide* to the needs of the environment, situation, organization, or project.

There are 132 individual tools and techniques in the *PMBOK® Guide* – Sixth Edition. These are not the only tools and techniques that can be used to manage a project. They represent those tools and techniques that are considered to be good practice on most projects most of the time. Some are mentioned once and some appear many times in the *PMBOK® Guide*.

To assist practitioners in identifying where specific tools and techniques are used, this appendix identifies each tool and technique, the group to which it belongs (if appropriate), and the process(es) where it is listed in the *PMBOK® Guide*. The process in which a tool or technique is described in the guide is in boldface type. In other processes where the tool or technique is listed, it will reference the process in which it is described. Processes may provide additional verbiage on how a tool or technique is used in a particular process.

X6.2 TOOLS AND TECHNIQUES GROUPS

The following tools and techniques groups are used throughout the *PMBOK® Guide*:

- **Data gathering techniques.** Used to collect data and information from a variety of sources. There are nine data gathering tools and techniques.
- **Data analysis techniques.** Used to organize, assess, and evaluate data and information. There are 27 data analysis tools and techniques.
- **Data representation techniques.** Used to show graphic representations or other methods used to convey data and information. There are 15 data representation tools and techniques.
- **Decision-making techniques.** Used to select a course of action from different alternatives. There are two decision-making tools and techniques.
- **Communication skills.** Used to transfer information between stakeholders. There are two communication skills tools and techniques.
- **Interpersonal and team skills.** Used to effectively lead and interact with team members and other stakeholders. There are 17 interpersonal and team skills tools and techniques.

There are 60 ungrouped tools and techniques.

Table X6-1. Categorization and Index of Tools and Techniques

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Data Gathering Tools and Techniques										
Benchmarking		5.2			**8.1**					13.2
Brainstorming	**4.1**, 4.2	5.2			8.1			11.2		13.1
Check sheets					**8.3**					
Checklists	4.2				8.2, 8.3			**11.2**		
Focus groups	4.1, 4.2	**5.2**								
Interviews	4.1, 4.2	**5.2**			8.1			11.2, 11.3, 11.4, 11.5		
Market research									**12.1**	
Questionnaires and surveys		**5.2**								13.1
Statistical sampling					**8.3**					

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Data Analysis Tools and Techniques										
Alternatives analysis	4.5, 4.6	5.1, 5.4	6.1, 6.4	7.1, 7.2	8.2	**9.2**, 9.6		11.5		13.4
Assessment of other risk parameters								**11.3**		
Assumption and constraint analysis								**11.2**		
Cost of quality				7.2	**8.1**					
Cost-benefit analysis	4.5, 4.6				**8.1**	9.6		11.5		
Decision tree analysis								**11.4**		
Document analysis	4.7	**5.2**			8.2			11.2		13.1
Earned value analysis	4.5		6.6	**7.4**					12.3	
Influence diagrams								**11.4**		
Iteration burndown chart			**6.6**							
Make-or-buy analysis									**12.1**	
Performance reviews			**6.6**		8.3	9.6			12.3	
Process analysis					**8.2**					
Proposal evaluation									**12.2**	

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Data Analysis Tools and Techniques *(cont.)*										
Regression analysis		**4.7**								
Reserve analysis			6.4	**7.2**, 7.3, 7.4				11.6		
Risk data quality assessment								**11.3**		
Risk probability and impact assessment								**11.3**		
Root cause analysis	4.5				**8.2**, 8.3			11.2		13.2, 13.4
Sensitivity analysis								**11.4**		
Simulation			6.5					**11.4**		
Stakeholder analysis								11.1		**13.1**, 13.4
SWOT analysis								**11.2**		13.2
Technical performance analysis								**11.7**		
Trend analysis	**4.5**, 4.7	5.6	6.6	7.4		9.6			12.3	
Variance analysis	**4.5**, 4.7	5.6	6.6	7.4						
What-if scenario analysis			**6.5**, 6.6							

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Data Representation Tools and Techniques										
Affinity diagrams		**5.2**			8.2					
Cause-and-effect diagrams					**8.2**, 8.3					
Control charts					**8.3**					
Flowcharts					**8.1**, 8.2					
Hierarchical charts						**9.1**				
Histograms					**8.2**, 8.3					
Logical data model					**8.1**					
Matrix diagrams					**8.1**, 8.2					
Matrix-based charts						**9.1**				
Mind mapping		**5.2**			8.1					13.2
Probability and impact matrix								**11.3**		
Scatter diagrams					**8.2**, 8.3					
Stakeholder engagement assessment matrix							10.1, 10.3			**13.2**, 13.4
Stakeholder mapping/ representation										**13.1**
Text-oriented formats						**9.1**				
Decision-Making Tools and Techniques										
Multicriteria decision analysis	4.6	5.2, 5.3			**8.1**, 8.2	9.3		11.5		13.4
Voting	4.5, 4.6	**5.2**, 5.5	6.4	7.2						13.4
Communication Skills Tools and Techniques										
Feedback							**10.2**			13.4
Presentations							**10.2**			13.4

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Interpersonal and Team Skills Tools and Techniques										
Active listening	4.4						**10.2**			13.4
Communication styles assessment							**10.1**			
Conflict management	4.1, 4.2					9.4, **9.5**	10.2			13.3
Cultural awareness							**10.1**, 10.2			13.3, 13.4
Decision making						**9.5**				
Emotional intelligence						**9.5**				
Facilitation	**4.1**, 4.2, 4.4	5.2, 5.3						11.2, 11.3, 11.4, 11.5		
Influencing						9.4, **9.5**, 9.6		11.6		
Leadership	4.4					**9.5**				13.4
Meeting management	4.1, 4.2						**10.2**			
Motivation						**9.4**				
Negotiation						9.3, 9.4, 9.6			**12.2**	13.3
Networking	4.4						**10.2**			13.4
Nominal group technique		**5.2**								
Observation/ conversation		**5.2**					10.3			13.3
Political awareness	4.4						**10.1**, 10.2			13.3, 13.4
Team building						**9.4**				

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Ungrouped Tools and Techniques										
Advertising									**12.2**	
Agile release planning			**6.5**							
Analogous estimating			**6.4**	7.2		9.2				
Audits					**8.2**			11.7	12.3	
Bidder conferences									**12.2**	
Bottom-up estimating			**6.4**	7.2		9.2				
Change control tools	**4.6**									
Claims administration									**12.3**	
Colocation						**9.4**				
Communication methods							**10.1**, 10.2			
Communication models							**10.1**			
Communication requirements analysis							**10.1**			
Communication technology						9.4	**10.1**, 10.2			
Context diagram		**5.2**								
Contingent response strategies								**11.5**		
Cost aggregation				**7.3**						
Critical path method			**6.5**, 6.6							

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Ungrouped Tools and Techniques *(cont.)*										
Decomposition		**5.4**	6.3							
Dependency determination and integration			**6.3**							
Design for X					**8.2**					
Expert judgment	**4.1**, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7	5.1, 5.2, 5.3, 5.4	6.1, 6.2, 6.4	7.1, 7.2, 7.3, 7.4	8.1	9.1, 9.2	10.1, 10.3	11.1, 11.2, 11.3, 11.4, 11.5, 11.6	12.1, 12.2, 12.3	13.1, 13.2, 13.3
Financing				**7.3**						
Funding limit reconciliation				**7.3**						
Ground rules										**13.3**
Historical information review				**7.3**						
Individual and team assessments						**9.4**				
Information management	**4.4**									
Inspections		5.5			**8.3**				12.3	13.3
Knowledge management	**4.4**									
Leads and lags			**6.3**, 6.5, 6.6							
Meetings	4.1, 4.2, 4.3, 4.5, 4.6, 4.7	5.1	6.1, 6.2, 6.4	7.1	8.1, 8.3	9.1, 9.2, 9.4	**10.1**, 10,2, 10.3	11.1, 11.2, 11.3, 11.6	12.1	13.1, 13.2, 13.3, 13.4

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Ungrouped Tools and Techniques *(cont.)*										
Organizational theory						**9.1**				
Parametric estimating			**6.4**	7.2		9.2				
Pre-assignment						**9.3**				
Precedence diagramming method			**6.3**							
Problem solving					**8.2**	9.6				
Product analysis		**5.3**								
Project management information system	**4.3**		6.3, 6.5, 6.6	7.2, 7.4		9.2, 9.5, 9.6	10.2, 10.3	11.6		
Project reporting					**8.2**					
Prompt lists								**11.2**		
Prototypes		**5.2**								
Quality improvement methods					**8.2**					
Recognition and rewards						**9.4**				
Representations of uncertainty								**11.4**		
Resource optimization			**6.5**, 6.6							
Risk categorization								**11.3**		
Rolling wave planning			**6.2**							

Table X6-1. Categorization and Index of Tools and Techniques *(cont.)*

Tool and Technique	Knowledge Area[A]									
	Integration	Scope	Schedule	Cost	Quality	Resources	Communication	Risk	Procurement	Stakeholder
Ungrouped Tools and Techniques *(cont.)*										
Schedule compression			**6.5**, 6.6							
Schedule network analysis			**6.5**							
Source selection analysis									**12.1**	
Strategies for opportunities								**11.5**		
Strategies for overall project risk								**11.5**		
Strategies for threats								**11.5**		
Test and inspection planning					**8.1**					
Testing/product evaluations					**8.3**					
Three-point estimating			**6.4**	7.2						
To-complete performance index				**7.4**						
Training						**9.4**				
Virtual teams						**9.3**, 9.4				

[A] The boldface entries indicate the section numbers of the processes where a tool or technique is described.

GLOSSARY

1. INCLUSIONS AND EXCLUSIONS

This glossary includes terms that are:

- Unique or nearly unique to project management (e.g., project scope statement, work package, work breakdown structure, critical path method).
- Not unique to project management, but used differently or with a narrower meaning in project management than in general everyday usage (e.g., early start date).

This glossary generally does not include:

- Application area-specific terms.
- Terms used in project management that do not differ in any material way from everyday use (e.g., calendar day, delay).
- Compound terms whose meaning is clear from the meanings of the component parts.
- Variants when the meaning of the variant is clear from the base term.
- Terms that are used only once and are not critical to understanding the point of the sentence. This can include a list of examples that would not have each term defined in the Glossary.

2. COMMON ACRONYMS

AC	actual cost
BAC	budget at completion
CCB	change control board
COQ	cost of quality
CPAF	cost plus award fee
CPFF	cost plus fixed fee
CPI	cost performance index
CPIF	cost plus incentive fee
CPM	critical path method
CV	cost variance
EAC	estimate at completion
EF	early finish date
ES	early start date
ETC	estimate to complete
EV	earned value
EVM	earned value management
FF	finish-to-finish
FFP	firm fixed price
FPEPA	fixed price with economic price adjustment
FPIF	fixed price incentive fee
FS	finish to start
IFB	invitation for bid

LF	late finish date
LOE	level of effort
LS	late start date
OBS	organizational breakdown structure
PDM	precedence diagramming method
PMBOK	Project Management Body of Knowledge
PV	planned value
QFD	quality function deployment
RACI	responsible, accountable, consult, and inform
RAM	responsibility assignment matrix
RBS	risk breakdown structure
RFI	request for information
RFP	request for proposal
RFQ	request for quotation
SF	start-to-finish
SOW	statement of work
SPI	schedule performance index
SS	start-to-start
SV	schedule variance
SWOT	strengths, weaknesses, opportunities, and threats
T&M	time and material contract
WBS	work breakdown structure
VAC	variance at completion

3. DEFINITIONS

Many of the words defined here have broader, and in some cases different, dictionary definitions. In some cases, a single glossary term consists of multiple words (e.g., root cause analysis).

Acceptance Criteria. A set of conditions that is required to be met before deliverables are accepted.

Accepted Deliverables. Products, results, or capabilities produced by a project and validated by the project customer or sponsors as meeting their specified acceptance criteria.

Accuracy. Within the quality management system, accuracy is an assessment of correctness.

Acquire Resources. The process of obtaining team members, facilities, equipment, materials, supplies, and other resources necessary to complete project work.

Acquisition. Obtaining human and material resources necessary to perform project activities. Acquisition implies a cost of resources, and is not necessarily financial.

Activity. A distinct, scheduled portion of work performed during the course of a project.

Activity Attributes. Multiple attributes associated with each schedule activity that can be included within the activity list. Activity attributes include activity codes, predecessor activities, successor activities, logical relationships, leads and lags, resource requirements, imposed dates, constraints, and assumptions.

Activity Duration. The time in calendar units between the start and finish of a schedule activity. See also duration.

Activity Duration Estimates. The quantitative assessments of the likely number of time periods that are required to complete an activity.

Activity List. A documented tabulation of schedule activities that shows the activity description, activity identifier, and a sufficiently detailed scope of work description so project team members understand what work is to be performed.

Activity-on-Node (AON). See precedence diagramming method (PDM).

Actual Cost (AC). The realized cost incurred for the work performed on an activity during a specific time period.

Actual Duration. The time in calendar units between the actual start date of the schedule activity and either the data date of the project schedule if the schedule activity is in progress or the actual finish date if the schedule activity is complete.

Adaptive Life Cycle. A project life cycle that is iterative or incremental.

Affinity Diagrams. A technique that allows large numbers of ideas to be classified into groups for review and analysis.

Agreements. Any document or communication that defines the initial intentions of a project. This can take the form of a contract, memorandum of understanding (MOU), letters of agreement, verbal agreements, email, etc.

Alternative Analysis. A technique used to evaluate identified options in order to select the options or approaches to use to execute and perform the work of the project.

Analogous Estimating. A technique for estimating the duration or cost of an activity or a project using historical data from a similar activity or project.

Analytical Techniques. Various techniques used to evaluate, analyze, or forecast potential outcomes based on possible variations of project or environmental variables and their relationships with other variables.

Assumption. A factor in the planning process that is considered to be true, real, or certain, without proof or demonstration.

Assumption Log. A project document used to record all assumptions and constraints throughout the project life cycle.

Attribute Sampling. Method of measuring quality that consists of noting the presence (or absence) of some characteristic (attribute) in each of the units under consideration.

Authority. The right to apply project resources, expend funds, make decisions, or give approvals.

Backward Pass. A critical path method technique for calculating the late start and late finish dates by working backward through the schedule model from the project end date.

Bar Chart. A graphic display of schedule-related information. In the typical bar chart, schedule activities or work breakdown structure components are listed down the left side of the chart, dates are shown across the top, and activity durations are shown as date-placed horizontal bars. See also Gantt chart.

Baseline. The approved version of a work product that can be changed only through formal change control procedures and is used as a basis for comparison to actual results.

Basis of Estimates. Supporting documentation outlining the details used in establishing project estimates such as assumptions, constraints, level of detail, ranges, and confidence levels.

Benchmarking. Benchmarking is the comparison of actual or planned products, processes, and practices to those of comparable organizations to identify best practices, generate ideas for improvement, and provide a basis for measuring performance.

Benefits Management Plan. The documented explanation defining the processes for creating, maximizing, and sustaining the benefits provided by a project or program.

Bid Documents. All documents used to solicit information, quotations, or proposals from prospective sellers.

Bidder Conference. The meetings with prospective sellers prior to the preparation of a bid or proposal to ensure all prospective vendors have a clear and common understanding of the procurement. Also known as contractor conferences, vendor conferences, or pre-bid conferences.

Bottom-Up Estimating. A method of estimating project duration or cost by aggregating the estimates of the lower-level components of the work breakdown structure (WBS).

Budget. The approved estimate for the project or any work breakdown structure component or any schedule activity.

Budget at Completion (BAC). The sum of all budgets established for the work to be performed.

Buffer. *See reserve.*

Business Case. A documented economic feasibility study used to establish validity of the benefits of a selected component lacking sufficient definition and that is used as a basis for the authorization of further project management activities.

Business Value. The net quantifiable benefit derived from a business endeavor. The benefit may be tangible, intangible, or both.

Cause and Effect Diagram. A decomposition technique that helps trace an undesirable effect back to its root cause.

Change. A modification to any formally controlled deliverable, project management plan component, or project document.

Change Control. A process whereby modifications to documents, deliverables, or baselines associated with the project are identified, documented, approved, or rejected.

Change Control Board (CCB). A formally chartered group responsible for reviewing, evaluating, approving, delaying, or rejecting changes to the project, and for recording and communicating such decisions.

Change Control System. A set of procedures that describes how modifications to the project deliverables and documentation are managed and controlled.

Change Control Tools. Manual or automated tools to assist with change and/or configuration management. At a minimum, the tools should support the activities of the CCB.

Change Log. A comprehensive list of changes submitted during the project and their current status.

Change Management Plan. A component of the project management plan that establishes the change control board, documents the extent of its authority, and describes how the change control system will be implemented.

Change Request. A formal proposal to modify a document, deliverable, or baseline.

Charter. *See project charter.*

Checklist Analysis. A technique for systematically reviewing materials using a list for accuracy and completeness.

Checksheets. A tally sheet that can be used as a checklist when gathering data.

Claim. A request, demand, or assertion of rights by a seller against a buyer, or vice versa, for consideration, compensation, or payment under the terms of a legally binding contract, such as for a disputed change.

Claims Administration. The process of processing, adjudicating, and communicating contract claims.

Close Project or Phase. The process of finalizing all activities for the project, phase, or contract.

Closing Process Group. The process(es) performed to formally complete or close a project, phase, or contract.

Code of Accounts. A numbering system used to uniquely identify each component of the work breakdown structure (WBS).

Collect Requirements. The process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives.

Colocation. An organizational placement strategy where the project team members are physically located close to one another in order to improve communication, working relationships, and productivity.

Communication Methods. A systematic procedure, technique, or process used to transfer information among project stakeholders.

Communication Models. A description, analogy, or schematic used to represent how the communication process will be performed for the project.

Communication Requirements Analysis. An analytical technique to determine the information needs of the project stakeholders through interviews, workshops, study of lessons learned from previous projects, etc.

Communications Management Plan. A component of the project, program, or portfolio management plan that describes how, when, and by whom information about the project will be administered and disseminated.

Communication Styles Assessment. A technique to identify the preferred communication method, format, and content for stakeholders for planned communication activities.

Communication Technology. Specific tools, systems, computer programs, etc., used to transfer information among project stakeholders.

Conduct Procurements. The process of obtaining seller responses, selecting a seller, and awarding a contract.

Configuration Management Plan. A component of the project management plan that describes how to identify and account for project artifacts under configuration control, and how to record and report changes to them.

Configuration Management System. A collection of procedures used to track project artifacts and monitor and control changes to these artifacts.

Conformance. Within the quality management system, conformance is a general concept of delivering results that fall within the limits that define acceptable variation for a quality requirement.

Constraint. A limiting factor that affects the execution of a project, program, portfolio, or process.

Context Diagrams. A visual depiction of the product scope showing a business system (process, equipment, computer system, etc.), and how people and other systems (actors) interact with it.

Contingency. An event or occurrence that could affect the execution of the project that may be accounted for with a reserve.

Contingency Reserve. Time or money allocated in the schedule or cost baseline for known risks with active response strategies.

Contingent Response Strategies. Responses provided which may be used in the event that a specific trigger occurs.

Contract. A contract is a mutually binding agreement that obligates the seller to provide the specified product or service or result and obligates the buyer to pay for it.

Contract Change Control System. The system used to collect, track, adjudicate, and communicate changes to a contract.

Control. Comparing actual performance with planned performance, analyzing variances, assessing trends to effect process improvements, evaluating possible alternatives, and recommending appropriate corrective action as needed.

Control Account. A management control point where scope, budget, actual cost, and schedule are integrated and compared to earned value for performance measurement.

Control Chart. A graphic display of process data over time and against established control limits, which has a centerline that assists in detecting a trend of plotted values toward either control limit.

Control Costs. The process of monitoring the status of the project to update the project costs and manage changes to the cost baseline.

Control Limits. The area composed of three standard deviations on either side of the centerline or mean of a normal distribution of data plotted on a control chart, which reflects the expected variation in the data. See also specification limits.

Control Procurements. The process of managing procurement relationships, monitoring contract performance, making changes and corrections as appropriate, and closing out contracts.

Control Quality. The process of monitoring and recording results of executing the quality management activities to assess performance and ensure the project outputs are complete, correct, and meet customer expectations.

Control Resources. The process of ensuring that the physical resources assigned and allocated to the project are available as planned, as well as monitoring the planned versus actual utilization of resources and performing corrective action as necessary.

Control Schedule. The process of monitoring the status of the project to update the project schedule and manage changes to the schedule baseline.

Control Scope. The process of monitoring the status of the project and product scope and managing changes to the scope baaseline.

Corrective Action. An intentional activity that realigns the performance of the project work with the project management plan.

Cost Aggregation. Summing the lower-level cost estimates associated with the various work packages for a given level within the project's WBS or for a given cost control account.

Cost Baseline. The approved version of the time-phased project budget, excluding any management reserves, which can be changed only through formal change control procedures and is used as a basis for comparison to actual results.

Cost-Benefit Analysis. A financial analysis tool used to determine the benefits provided by a project against its costs.

Cost Management Plan. A component of a project or program management plan that describes how costs will be planned, structured, and controlled.

Cost of Quality (CoQ). All costs incurred over the life of the product by investment in preventing nonconformance to requirements, appraisal of the product or service for conformance to requirements, and failure to meet requirements.

Cost Performance Index (CPI). A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost.

Cost Plus Award Fee Contract (CPAF). A category of contract that involves payments to the seller for all legitimate actual costs incurred for completed work, plus an award fee representing seller profit.

Cost Plus Fixed Fee Contract (CPFF). A type of cost-reimbursable contract where the buyer reimburses the seller for the seller's allowable costs (allowable costs are defined by the contract) plus a fixed amount of profit (fee).

Cost Plus Incentive Fee Contract (CPIF). A type of cost-reimbursable contract where the buyer reimburses the seller for the seller's allowable costs (allowable costs are defined by the contract), and the seller earns its profit if it meets defined performance criteria.

Cost-Reimbursable Contract. A type of contract involving payment to the seller for the seller's actual costs, plus a fee typically representing the seller's profit.

Cost Variance (CV). The amount of budget deficit or surplus at a given point in time, expressed as the difference between the earned value and the actual cost.

Crashing. A technique used to shorten the schedule duration for the least incremental cost by adding resources.

Create WBS. The process of subdividing project deliverables and project work into smaller, more manageable components.

Criteria. Standards, rules, or tests on which a judgment or decision can be based or by which a product, service, result, or process can be evaluated.

Critical Path. The sequence of activities that represents the longest path through a project, which determines the shortest possible duration.

Critical Path Activity. Any activity on the critical path in a project schedule.

Critical Path Method (CPM). A method used to estimate the minimum project duration and determine the amount of schedule flexibility on the logical network paths within the schedule model.

Data. Discrete, unorganized, unprocessed measurements or raw observations.

Data Analysis Techniques. Techniques used to organize, assess, and evaluate data and information.

Data Date. A point in time when the status of the project is recorded.

Data Gathering Techniques. Techniques used to collect data and information from a variety of sources.

Data Representation Techniques. Graphic representations or other methods used to convey data and information.

Decision-Making Techniques. Techniques used to select a course of action from different alternatives.

Decision Tree Analysis. A diagramming and calculation technique for evaluating the implications of a chain of multiple options in the presence of uncertainty.

Decomposition. A technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts.

Defect. An imperfection or deficiency in a project component where that component does not meet its requirements or specifications and needs to be either repaired or replaced.

Defect Repair. An intentional activity to modify a nonconforming product or product component.

Define Activities. The process of identifying and documenting the specific actions to be performed to produce the project deliverables.

Define Scope. The process of developing a detailed description of the project and product.

Deliverable. Any unique and verifiable product, result, or capability to perform a service that is required to be produced to complete a process, phase, or project.

Dependency. *See logical relationship.*

Determine Budget. The process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.

Development Approach. The method used to create and evolve the product, service, or result during the project life cycle, such as predictive, iterative, incremental, agile, or a hybrid method.

Develop Project Charter. The process of developing a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities.

Develop Project Management Plan. The process of defining, preparing, and coordinating all plan components and consolidating them into an integrated project management plan.

Develop Schedule. The process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model for project execution and monitoring and controlling.

Develop Team. The process of improving competences, team member interaction, and overall team environment to enhance project performance.

Diagramming Techniques. Approaches to presenting information with logical linkages that aid in understanding.

Direct and Manage Project Work. The process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project's objectives.

Discrete Effort. An activity that can be planned and measured and that yields a specific output. [Note: Discrete effort is one of three earned value management (EVM) types of activities used to measure work performance.]

Discretionary Dependency. A relationship that is established based on knowledge of best practices within a particular application area or an aspect of the project where a specific sequence is desired.

Documentation Reviews. The process of gathering a corpus of information and reviewing it to determine accuracy and completeness.

Duration. The total number of work periods required to complete an activity or work breakdown structure component, expressed in hours, days, or weeks. Contrast with effort.

Early Finish Date (EF). In the critical path method, the earliest possible point in time when the uncompleted portions of a schedule activity can finish based on the schedule network logic, the data date, and any schedule constraints.

Early Start Date (ES). In the critical path method, the earliest possible point in time when the uncompleted portions of a schedule activity can start based on the schedule network logic, the data date, and any schedule constraints.

Earned Value (EV). The measure of work performed expressed in terms of the budget authorized for that work.

Earned Value Management. A methodology that combines scope, schedule, and resource measurements to assess project performance and progress.

Effort. The number of labor units required to complete a schedule activity or work breakdown structure component, often expressed in hours, days, or weeks. *Contrast with duration.*

Emotional Intelligence. The ability to identify, assess, and manage the personal emotions of oneself and other people, as well as the collective emotions of groups of people.

Enterprise Environmental Factors. Conditions, not under the immediate control of the team, that influence, constrain, or direct the project, program, or portfolio.

Estimate. A quantitative assessment of the likely amount or outcome of a variable, such as project costs, resources, effort, or durations.

Estimate Activity Durations. The process of estimating the number of work periods needed to complete individual activities with the estimated resources.

Estimate Activity Resources. The process of estimating team resources and the type and quantities of material, equipment, and supplies necessary to perform project work.

Estimate at Completion (EAC). The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete.

Estimate Costs. The process of developing an approximation of the monetary resources needed to complete project work.

Estimate to Complete (ETC). The expected cost to finish all the remaining project work.

Execute. Directing, managing, performing, and accomplishing the project work; providing the deliverables; and providing work performance information.

Executing Process Group. Those processes performed to complete the work defined in the project management plan to satisfy the project requirements.

Expert Judgment. Judgment provided based upon expertise in an application area, knowledge area, discipline, industry, etc., as appropriate for the activity being performed. Such expertise may be provided by any group or person with specialized education, knowledge, skill, experience, or training.

Explicit Knowledge. Knowledge that can be codified using symbols such as words, numbers, and pictures.

External Dependency. A relationship between project activities and non-project activities.

Fallback Plan. Fallback plans include an alternative set of actions and tasks available in the event that the primary plan needs to be abandoned because of issues, risks, or other causes.

Fast Tracking. A schedule compression technique in which activities or phases normally done in sequence are performed in parallel for at least a portion of their duration.

Fee. Represents profit as a component of compensation to a seller.

Finish Date. A point in time associated with a schedule activity's completion. Usually qualified by one of the following: actual, planned, estimated, scheduled, early, late, baseline, target, or current.

Finish-to-Finish (FF). A logical relationship in which a successor activity cannot finish until a predecessor activity has finished.

Finish-to-Start (FS). A logical relationship in which a successor activity cannot start until a predecessor activity has finished.

Firm Fixed Price Contract (FFP). A type of fixed price contract where the buyer pays the seller a set amount (as defined by the contract), regardless of the seller's costs.

Fishbone diagram. *See Cause and Effect Diagram.*

Fixed-Price Contract. An agreement that sets the fee that will be paid for a defined scope of work regardless of the cost or effort to deliver it.

Fixed Price Incentive Fee Contract (FPIF). A type of contract where the buyer pays the seller a set amount (as defined by the contract), and the seller can earn an additional amount if the seller meets defined performance criteria.

Fixed Price with Economic Price Adjustment Contract (FPEPA). A fixed-price contract, but with a special provision allowing for predefined final adjustments to the contract price due to changed conditions, such as inflation changes, or cost increases (or decreases) for specific commodities.

Float. Also called slack. *See total float and free float.*

Flowchart. The depiction in a diagram format of the inputs, process actions, and outputs of one or more processes within a system.

Focus Groups. An elicitation technique that brings together prequalified stakeholders and subject matter experts to learn about their expectations and attitudes about a proposed product, service, or result.

Forecast. An estimate or prediction of conditions and events in the project's future based on information and knowledge available at the time of the forecast.

Forward Pass. A critical path method technique for calculating the early start and early finish dates by working forward through the schedule model from the project start date or a given point in time.

Free Float. The amount of time that a schedule activity can be delayed without delaying the early start date of any successor or violating a schedule constraint.

Functional Organization. An organizational structure in which staff is grouped by areas of specialization and the project manager has limited authority to assign work and apply resources.

Funding Limit Reconciliation. The process of comparing the planned expenditure of project funds against any limits on the commitment of funds for the project to identify any variances between the funding limits and the planned expenditures.

Gantt Chart. A bar chart of schedule information where activities are listed on the vertical axis, dates are shown on the horizontal axis, and activity durations are shown as horizontal bars placed according to start and finish dates.

Grade. A category or rank used to distinguish items that have the same functional use but do not share the same requirements for quality.

Ground Rules. Expectations regarding acceptable behavior by project team members.

Histogram. A bar chart that shows the graphical representation of numerical data.

Historical Information. Documents and data on prior projects including project files, records, correspondence, closed contracts, and closed projects.

Identify Risks. The process of identifying individual risks as well as sources of overall risk and documenting their characteristics.

Identify Stakeholders. The process of identifying project stakeholders regularly and analyzing and documenting relevant information regarding their interests, involvement, interdependencies, influence, and potential impact on project success.

Implement Risk Responses. The process of implementing agreed-upon risk response plans.

Imposed Date. A fixed date imposed on a schedule activity or schedule milestone, usually in the form of a "start no earlier than" and "finish no later than" date.

Incentive Fee. A set of financial incentives related to cost, schedule, or technical performance of the seller.

Incremental Life Cycle. An adaptive project life cycle in which the deliverable is produced through a series of iterations that successively add functionality within a predetermined time frame. The deliverable contains the necessary and sufficient capability to be considered complete only after the final iteration.

Independent Estimates. A process of using a third party to obtain and analyze information to support prediction of cost, schedule, or other items.

Influence Diagram. A graphical representation of situations showing causal influences, time ordering of events, and other relationships among variables and outcomes.

Information. Organized or structured data, processed for a specific purpose to make it meaningful, valuable, and useful in specific contexts.

Information Management Systems. Facilities, processes, and procedures used to collect, store, and distribute information between producers and consumers of information in physical or electronic format.

Initiating Process Group. Those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.

Input. Any item, whether internal or external to the project, which is required by a process before that process proceeds. May be an output from a predecessor process.

Inspection. Examination of a work product to determine whether it conforms to documented standards.

Interpersonal and Team Skills. Skills used to effectively lead and interact with team members and other stakeholders.

Interpersonal Skills. Skills used to establish and maintain relationships with other people.

Interviews. A formal or informal approach to elicit information from stakeholders by talking to them directly.

I**nvitation for Bid (IFB).** Generally, this term is equivalent to request for proposal. However, in some application areas, it may have a narrower or more specific meaning.

Issue. A current condition or situation that may have an impact on the project objectives.

Issue Log. A project document where information about issues is recorded and monitored.

Iterative Life Cycle. A project life cycle where the project scope is generally determined early in the project life cycle, but time and cost estimates are routinely modified as the project team's understanding of the product increases. Iterations develop the product through a series of repeated cycles, while increments successively add to the functionality of the product.

Knowledge. A mixture of experience, values and beliefs, contextual information, intuition, and insight that people use to make sense of new experiences and information.

Lag. The amount of time whereby a successor activity will be delayed with respect to a predecessor activity.

Late Finish Date (LF). In the critical path method, the latest possible point in time when the uncompleted portions of a schedule activity can finish based on the schedule network logic, the project completion date, and any schedule constraints.

Late Start Date (LS). In the critical path method, the latest possible point in time when the uncompleted portions of a schedule activity can start based on the schedule network logic, the project completion date, and any schedule constraints.

Lead. The amount of time whereby a successor activity can be advanced with respect to a predecessor activity.

Lessons Learned. The knowledge gained during a project which shows how project events were addressed or should be addressed in the future for the purpose of improving future performance.

Lessons Learned Register. A project document used to record knowledge gained during a project so that it can be used in the current project and entered into the lessons learned repository.

Lessons Learned Repository. A store of historical information about lessons learned in projects.

Level of Effort (LOE). An activity that does not produce definitive end products and is measured by the passage of time.

Life Cycle. *See project life cycle.*

Log. A document used to record and describe or denote selected items identified during execution of a process or activity. Usually used with a modifier, such as issue, change, issue, or assumption.

Logical Relationship. A dependency between two activities, or between an activity and a milestone.

Make-or-Buy Analysis. The process of gathering and organizing data about product requirements and analyzing them against available alternatives including the purchase or internal manufacture of the product.

Make-or-Buy Decisions. Decisions made regarding the external purchase or internal manufacture of a product.

Manage Communications. Manage Communications is the process of ensuring timely and appropriate collection, creation, distribution, storage, retrieval, management, monitoring, and the ultimate disposition of project information.

Management Reserve. An amount of the project budget or project schedule held outside of the performance measurement baseline (PMB) for management control purposes, that is reserved for unforeseen work that is within scope of the project.

Management Skills. The ability to plan, organize, direct, and control individuals or groups of people to achieve specific goals.

Manage Project Knowledge. The process of using existing knowledge and creating new knowledge to achieve the project's objectives and contribute to organizational learning.

Manage Quality. The process of translating the quality management plan into executable quality activities that incorporate the organization's quality policies into the project.

Manage Stakeholder Engagement. The process of communicating and working with stakeholders to meet their needs and expectations, address issues, and foster appropriate stakeholder involvement.

Manage Team. The process of tracking team member performance, providing feedback, resolving issues, and managing team changes to optimize project performance.

Mandatory Dependency. A relationship that is contractually required or inherent in the nature of the work.

Master Schedule. A summary-level project schedule that identifies the major deliverables and work breakdown structure components and key schedule milestones. *See also milestone schedule.*

Matrix Diagrams. A quality management and control tool used to perform data analysis within the organizational structure created in the matrix. The matrix diagram seeks to show the strength of relationships between factors, causes, and objectives that exist between the rows and columns that form the matrix.

Matrix Organization. Any organizational structure in which the project manager shares responsibility with the functional managers for assigning priorities and for directing the work of persons assigned to the project.

Methodology. A system of practices, techniques, procedures, and rules used by those who work in a discipline.

Milestone. A significant point or event in a project, program, or portfolio.

Milestone Schedule. A type of schedule that presents milestones with planned dates. See also master schedule.

Mind-Mapping. A technique used to consolidate ideas created through individual brainstorming sessions into a single map to reflect commonality and differences in understanding and to generate new ideas.

Monitor. Collect project performance data, produce performance measures, and report and disseminate performance information.

Monitor and Control Project Work. The process of tracking, reviewing, and reporting overall progress to meet the performance objectives defined in the project management plan.

Monitor Communications. The process of ensuring that the information needs of the project and its stakeholders are met.

Monitoring and Controlling Process Group. Those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.

Monitor Risks. The process of monitoring the implementation of agreed-upon risk response plans, tracking identified risks, identifying and analyzing new risks, and evaluating risk process effectiveness throughout the project.

Monitor Stakeholder Engagement. The process of monitoring project stakeholder relationships, and tailoring strategies for engaging stakeholders through the modification of engagement strategies and plans.

Monte Carlo Simulation. An analysis technique where a computer model is iterated many times, with the input values chosen at random for each iteration driven by the input data, including probability distributions and probabilistic branches. Outputs are generated to represent the range of possible outcomes for the project.

Multicriteria Decision Analysis. This technique utilizes a decision matrix to provide a systematic analytical approach for establishing criteria, such as risk levels, uncertainty, and valuation, to evaluate and rank many ideas.

Network. *See project schedule network diagram.*

Network Logic. All activity dependencies in a project schedule network diagram.

Network Path. A sequence of activities connected by logical relationships in a project schedule network diagram.

Networking. Establishing connections and relationships with other people from the same or other organizations.

Node. A point at which dependency lines connect on a schedule network diagram.

Nominal Group Technique. A technique that enhances brainstorming with a voting process used to rank the most useful ideas for further brainstorming or for prioritization.

Objective. Something toward which work is to be directed, a strategic position to be attained, a purpose to be achieved, a result to be obtained, a product to be produced, or a service to be performed.

Opportunity. A risk that would have a positive effect on one or more project objectives.

Organizational Breakdown Structure (OBS). A hierarchical representation of the project organization, which illustrates the relationship between project activities and the organizational units that will perform those activities.

Organizational Learning. A discipline concerned with the way individuals, groups, and organizations develop knowledge.

Organizational Process Assets. Plans, processes, policies, procedures, and knowledge bases that are specific to and used by the performing organization.

Output. A product, result, or service generated by a process. May be an input to a successor process.

Overall Project Risk. The effect of uncertainty on the project as a whole, arising from all sources of uncertainty including individual risks, representing the exposure of stakeholders to the implications of variations in project outcome, both positive and negative.

Parametric Estimating. An estimating technique in which an algorithm is used to calculate cost or duration based on historical data and project parameters.

Path Convergence. A relationship in which a schedule activity has more than one predecessor.

Path Divergence. A relationship in which a schedule activity has more than one successor.

Percent Complete. An estimate expressed as a percent of the amount of work that has been completed on an activity or a work breakdown structure component.

Performance Measurement Baseline (PMB). Integrated scope, schedule, and cost baselines used for comparison to manage, measure, and control project execution.

Performance Reviews. A technique that is used to measure, compare, and analyze actual performance of work in progress on the project against the baseline.

Perform Integrated Change Control. The process of reviewing all change requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating the decisions.

Perform Qualitative Risk Analysis. The process of prioritizing individual project risks for further analysis or action by assessing their probability of occurrence and impact as well as other characteristics.

Perform Quantitative Risk Analysis. The process of numerically analyzing the combined effect of identified individual project risks and other sources of uncertainty on overall project objectives.

Phase. *See project phase.*

Phase Gate. A review at the end of a phase in which a decision is made to continue to the next phase, to continue with modification, or to end a project or program.

Plan Communications Management. The process of developing an appropriate approach and plan for project communication activities based on the information needs of each stakeholder or group, available organizational assets, and the needs of the project.

Plan Cost Management. The process of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled.

Planned Value (PV). The authorized budget assigned to scheduled work.

Planning Package. A work breakdown structure component below the control account with known work content but without detailed schedule activities. See also control account.

Planning Process Group. Those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.

Plan Procurement Management. The process of documenting project procurement decisions, specifying the approach, and identifying potential sellers.

Plan Quality Management. The process of identifying quality requirements and/or standards for the project and its deliverables, and documenting how the project will demonstrate compliance with quality requirements and/or standards.

Plan Resource Management. The process of defining how to estimate, acquire, manage, and utilize physical and team resources.

Plan Risk Management. The process of defining how to conduct risk management activities for a project.

Plan Risk Responses. The process of developing options, selecting strategies, and agreeing on actions to address overall project risk exposure, as well as to treat individual project risks.

Plan Schedule Management. The process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.

Plan Scope Management. The process of creating a scope management plan that documents how the project and product scope will be defined, validated, and controlled.

Plan Stakeholder Engagement. The process of developing approaches to involve project stakeholders, based on their needs, expectations, interests, and potential impact on the project.

Plurality. Decisions made by the largest block in a group, even if a majority is not achieved.

Policy. A structured pattern of actions adopted by an organization such that the organization's policy can be explained as a set of basic principles that govern the organization's conduct.

Portfolio. Projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives.

Portfolio Management. The centralized management of one or more portfolios to achieve strategic objectives.

Practice. A specific type of professional or management activity that contributes to the execution of a process and that may employ one or more techniques and tools.

Precedence Diagramming Method (PDM). A technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed.

Precedence Relationship. A logical dependency used in the precedence diagramming method.

Predecessor Activity. An activity that logically comes before a dependent activity in a schedule.

Predictive Life Cycle. A form of project life cycle in which the project scope, time, and cost are determined in the early phases of the life cycle.

Preventive Action. An intentional activity that ensures the future performance of the project work is aligned with the project management plan.

Probability and Impact Matrix. A grid for mapping the probability of occurrence of each risk and its impact on project objectives if that risk occurs.

Procedure. An established method of accomplishing a consistent performance or result, a procedure typically can be described as the sequence of steps that will be used to execute a process.

Process. A systematic series of activities directed towards causing an end result such that one or more inputs will be acted upon to create one or more outputs.

Procurement Audits. The review of contracts and contracting processes for completeness, accuracy, and effectiveness.

Procurement Documents. The documents utilized in bid and proposal activities, which include the buyer's Invitation for bid, invitation for negotiations, request for information, request for quotation, request for proposal, and seller's responses.

Procurement Documentation. All documents used in signing, executing, and closing an agreement. Procurement documentation may include documents predating the project.

Procurement Management Plan. A component of the project or program management plan that describes how a project team will acquire goods and services from outside of the performing organization.

Procurement Statement of Work. Describes the procurement item in sufficient detail to allow prospective sellers to determine if they are capable of providing the products, services, or results.

Procurement Strategy. The approach by the buyer to determine the project delivery method and the type of legally binding agreement(s) that should be used to deliver the desired results.

Product. An artifact that is produced, is quantifiable, and can be either an end item in itself or a component item. Additional words for products are material and goods. See also deliverable.

Product Analysis. For projects that have a product as a deliverable, it is a tool to define scope that generally means asking questions about a product and forming answers to describe the use, characteristics, and other relevant aspects of what is going to be manufactured.

Product Life Cycle. The series of phases that represent the evolution of a product, from concept through delivery, growth, maturity, and to retirement.

Product Scope. The features and functions that characterize a product, service, or result.

Product Scope Description. The documented narrative description of the product scope.

Program. Related projects, subsidiary programs, and program activities that are managed in a coordinated manner to obtain benefits not available from managing them individually.

Program Management. The application of knowledge, skills, and principles to a program to achieve the program objectives and obtain benefits and control not available by managing program components individually.

Progressive Elaboration. The iterative process of increasing the level of detail in a project management plan as greater amounts of information and more accurate estimates become available.

Project. A temporary endeavor undertaken to create a unique product, service, or result.

Project Calendar. A calendar that identifies working days and shifts that are available for scheduled activities.

Project Charter. A document issued by the project initiator or sponsor that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities.

Project Communications Management. Project Communications Management includes the processes required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and ultimate disposition of project information.

Project Cost Management. Project Cost Management includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so the project can be completed within the approved budget.

Project Funding Requirements. Forecast project costs to be paid that are derived from the cost baseline for total or periodic requirements, including projected expenditures plus anticipated liabilities.

Project Governance. The framework, functions, and processes that guide project management activities in order to create a unique product, service, or result to meet organizational, strategic, and operational goals.

Project Initiation. Launching a process that can result in the authorization of a new project.

Project Integration Management. Project Integration Management includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups.

Project Life Cycle. The series of phases that a project passes through from its start to its completion.

Project Management. The application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

Project Management Body of Knowledge. A term that describes the knowledge within the profession of project management. The project management body of knowledge includes proven traditional practices that are widely applied as well as innovative practices that are emerging in the profession.

Project Management Information System. An information system consisting of the tools and techniques used to gather, integrate, and disseminate the outputs of project management processes.

Project Management Knowledge Area. An identified area of project management defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools, and techniques.

Project Management Office (PMO). A management structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques.

Project Management Plan. The document that describes how the project will be executed, monitored and controlled, and closed.

Project Management Process Group. A logical grouping of project management inputs, tools and techniques, and outputs. The Project Management Process Groups include initiating processes, planning processes, executing processes, monitoring and controlling processes, and closing processes. Project Management Process Groups are not project phases.

Project Management System. The aggregation of the processes, tools, techniques, methodologies, resources, and procedures to manage a project.

Project Management Team. The members of the project team who are directly involved in project management activities. *See also Project Team.*

Project Manager (PM). The person assigned by the performing organization to lead the team that is responsible for achieving the project objectives.

Project Organization Chart. A document that graphically depicts the project team members and their interrelationships for a specific project.

Project Phase. A collection of logically related project activities that culminates in the completion of one or more deliverables.

Project Procurement Management. Project Procurement Management includes the processes necessary to purchase or acquire products, services, or results needed from outside the project team.

Project Quality Management. Project Quality Management includes the processes for incorporating the organization's quality policy regarding planning, managing, and controlling project and product quality requirements, in order to meet stakeholders' expectations.

Project Resource Management. Project Resource Management includes the processes to identify, acquire, and manage the resources needed for the successful completion of the project.

Project Risk Management. Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project.

Project Schedule. An output of a schedule model that presents linked activities with planned dates, durations, milestones, and resources.

Project Schedule Management. Project Schedule Management includes the processes required to manage the timely completion of the project.

Project Schedule Network Diagram. A graphical representation of the logical relationships among the project schedule activities.

Project Scope. The work performed to deliver a product, service, or result with the specified features and functions.

Project Scope Management. Project Scope Management includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully.

Project Scope Statement. The description of the project scope, major deliverables, assumptions, and constraints.

Project Stakeholder Management. Project Stakeholder Management includes the processes required to identify the people, groups, or organizations that could impact or be impacted by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution.

Project Team. A set of individuals who support the project manager in performing the work of the project to achieve its objectives. See also Project Management Team.

Project Team Directory. A documented list of project team members, their project roles, and communication information.

Proposal Evaluation Techniques. The process of reviewing proposals provided by suppliers to support contract award decisions.

Prototypes. A method of obtaining early feedback on requirements by providing a working model of the expected product before actually building it.

Quality. The degree to which a set of inherent characteristics fulfills requirements.

Quality Audits. A quality audit is a structured, independent process to determine if project activities comply with organizational and project policies, processes, and procedures.

Quality Checklists. A structured tool used to verify that a set of required steps has been performed.

Quality Control Measurements. The documented results of control quality activities.

Quality Management Plan. A component of the project or program management plan that describes how applicable policies, procedures, and guidelines will be implemented to achieve the quality objectives.

Quality Management System. The organizational framework whose structure provides the policies, processes, procedures, and resources required to implement the quality management plan. The typical project quality management plan should be compatible to the organization's quality management system.

Quality Metrics. A description of a project or product attribute and how to measure it.

Quality Policy. A policy specific to the Project Quality Management Knowledge Area, it establishes the basic principles that should govern the organization's actions as it implements its system for quality management.

Quality Report. A project document that includes quality management issues, recommendations for corrective actions, and a summary of findings from quality control activities and may include recommendations for process, project, and product improvements.

Quality Requirement. A condition or capability that will be used to assess conformance by validating the acceptability of an attribute for the quality of a result.

Questionnaires. Written sets of questions designed to quickly accumulate information from a large number of respondents.

RACI Chart. A common type of responsibility assignment matrix that uses responsible, accountable, consult, and inform statuses to define the involvement of stakeholders in project activities.

Regression Analysis. An analytical technique where a series of input variables are examined in relation to their corresponding output results in order to develop a mathematical or statistical relationship.

Regulations. Requirements imposed by a governmental body. These requirements can establish product, process, or service characteristics, including applicable administrative provisions that have government-mandated compliance.

Request for Information (RFI). A type of procurement document whereby the buyer requests a potential seller to provide various pieces of information related to a product or service or seller capability.

Request for Proposal (RFP). A type of procurement document used to request proposals from prospective sellers of products or services. In some application areas, it may have a narrower or more specific meaning.

Request for Quotation (RFQ). A type of procurement document used to request price quotations from prospective sellers of common or standard products or services. Sometimes used in place of request for proposal and, in some application areas, it may have a narrower or more specific meaning.

Requirement. A condition or capability that is necessary to be present in a product, service, or result to satisfy a business need.

Requirements Documentation. A description of how individual requirements meet the business need for the project.

Requirements Management Plan. A component of the project or program management plan that describes how requirements will be analyzed, documented, and managed.

Requirements Traceability Matrix. A grid that links product requirements from their origin to the deliverables that satisfy them.

Reserve. A provision in the project management plan to mitigate cost and/or schedule risk. Often used with a modifier (e.g., management reserve, contingency reserve) to provide further detail on what types of risk are meant to be mitigated.

Reserve Analysis. An analytical technique to determine the essential features and relationships of components in the project management plan to establish a reserve for the schedule duration, budget, estimated cost, or funds for a project.

Residual Risk. The risk that remains after risk responses have been implemented.

Resource. A team member or any physical item needed to complete the project.

Resource Breakdown Structure. A hierarchical representation of resources by category and type.

Resource Calendar. A calendar that identifies the working days and shifts upon which each specific resource is available.

Resource Histogram. A bar chart showing the amount of time that a resource is scheduled to work over a series of time periods.

Resource Leveling. A resource optimization technique in which adjustments are made to the project schedule to optimize the allocation of resources and which may affect critical path. *See also resource optimization technique and resource smoothing.*

Resource Management Plan. A component of the project management plan that describes how project resources are acquired, allocated, monitored, and controlled.

Resource Manager. An individual with management authority over one or more resources.

Resource Optimization Technique. A technique in which activity start and finish dates are adjusted to balance demand for resources with the available supply. *See also resource leveling and resource smoothing.*

Resource Requirements. The types and quantities of resources required for each activity in a work package.

Resource Smoothing. A resource optimization technique in which free and total float are used without affecting the critical path. See also resource leveling and resource optimization technique.

Responsibility. An assignment that can be delegated within a project management plan such that the assigned resource incurs a duty to perform the requirements of the assignment.

Responsibility Assignment Matrix (RAM). A grid that shows the project resources assigned to each work package.

Result. An output from performing project management processes and activities. Results include outcomes (e.g., integrated systems, revised process, restructured organization, tests, trained personnel, etc.) and documents (e.g., policies, plans, studies, procedures, specifications, reports, etc.). See also deliverable.

Rework. Action taken to bring a defective or nonconforming component into compliance with requirements or specifications.

Risk. An uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives.

Risk Acceptance. A risk response strategy whereby the project team decides to acknowledge the risk and not take any action unless the risk occurs.

Risk Appetite. The degree of uncertainty an organization or individual is willing to accept in anticipation of a reward.

Risk Audit. A type of audit used to consider the effectiveness of the risk management process.

Risk Avoidance. A risk response strategy whereby the project team acts to eliminate the threat or protect the project from its impact.

Risk Breakdown Structure (RBS). A hierarchical representation of potential sources of risks.

Risk Categorization. Organization by sources of risk (e.g., using the RBS), the area of the project affected (e.g., using the WBS), or other useful category (e.g., project phase) to determine the areas of the project most exposed to the effects of uncertainty.

Risk Category. A group of potential causes of risk.

Risk Data Quality Assessment. Technique to evaluate the degree to which the data about risks is useful for risk management.

Risk Enhancement. A risk response strategy whereby the project team acts to increase the probability of occurrence or impact of an opportunity.

Risk Escalation. A risk response strategy whereby the team acknowledges that a risk is outside of its sphere of influence and shifts the ownership of the risk to a higher level of the organization where it is more effectively managed.

Risk Exploiting. A risk response strategy whereby the project team acts to ensure that an opportunity occurs.

Risk Exposure. An aggregate measure of the potential impact of all risks at any given point in time in a project, program, or portfolio.

Risk Management Plan. A component of the project, program, or portfolio management plan that describes how risk management activities will be structured and performed.

Risk Mitigation. A risk response strategy whereby the project team acts to decrease the probability of occurrence or impact of a threat.

Risk Owner. The person responsible for monitoring the risks and for selecting and implementing an appropriate risk response strategy.

Risk Register. A repository in which outputs of risk management processes are recorded.

Risk Report. A project document developed progressively throughout the Project Risk Management processes, which summarizes information on individual project risks and the level of overall project risk.

Risk Review. A meeting to examine and document the effectiveness of risk responses in dealing with overall project risk and with identified individual project risks.

Risk Sharing. A risk response strategy whereby the project team allocates ownership of an opportunity to a third party who is best able to capture the benefit of that opportunity.

Risk Threshold. The level of risk exposure above which risks are addressed and below which risks may be accepted.

Risk Transference. A risk response strategy whereby the project team shifts the impact of a threat to a third party, together with ownership of the response.

Role. A defined function to be performed by a project team member, such as testing, filing, inspecting, or coding.

Rolling Wave Planning. An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.

Root Cause Analysis. An analytical technique used to determine the basic underlying reason that causes a variance or a defect or a risk. A root cause may underlie more than one variance or defect or risk.

Schedule. *See project schedule and schedule model.*

Schedule Baseline. The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results.

Schedule Compression. A technique used to shorten the schedule duration without reducing the project scope.

Schedule Data. The collection of information for describing and controlling the schedule.

Schedule Forecasts. Estimates or predictions of conditions and events in the project's future based on information and knowledge available at the time the schedule is calculated.

Schedule Management Plan. A component of the project or program management plan that establishes the criteria and the activities for developing, monitoring, and controlling the schedule.

Schedule Model. A representation of the plan for executing the project's activities including durations, dependencies, and other planning information, used to produce a project schedule along with other scheduling artifacts.

Schedule Network Analysis. A technique to identify early and late start dates, as well as early and late finish dates, for the uncompleted portions of project activities.

Schedule Performance Index (SPI). A measure of schedule efficiency expressed as the ratio of earned value to planned value.

Schedule Variance (SV). A measure of schedule performance expressed as the difference between the earned value and the planned value.

Scheduling Tool. A tool that provides schedule component names, definitions, structural relationships, and formats that support the application of a scheduling method.

Scope. The sum of the products, services, and results to be provided as a project. See also project scope and product scope.

Scope Baseline. The approved version of a scope statement, work breakdown structure (WBS), and its associated WBS dictionary, that can be changed using formal change control procedures and is used as a basis for comparison to actual results.

Scope Creep. The uncontrolled expansion to product or project scope without adjustments to time, cost, and resources.

Scope Management Plan. A component of the project or program management plan that describes how the scope will be defined, developed, monitored, controlled, and validated.

Secondary Risk. A risk that arises as a direct result of implementing a risk response.

Self-Organizing Teams. A team formation where the team functions with an absence of centralized control.

Seller. A provider or supplier of products, services, or results to an organization.

Seller Proposals. Formal responses from sellers to a request for proposal or other procurement document specifying the price, commercial terms of sale, and technical specifications or capabilities the seller will do for the requesting organization that, if accepted, would bind the seller to perform the resulting agreement.

Sensitivity Analysis. An analysis technique to determine which individual project risks or other sources of uncertainty have the most potential impact on project outcomes, by correlating variations in project outcomes with variations in elements of a quantitative risk analysis model.

Sequence Activities. The process of identifying and documenting relationships among the project activities.

Service Level Agreement (SLA). A contract between a service provider (either internal or external) and the end user that defines the level of service expected from the service provider.

Simulation. An analytical technique that models the combined effect of uncertainties to evaluate their potential impact on objectives.

Source Selection Criteria. A set of attributes desired by the buyer which a seller is required to meet or exceed to be selected for a contract.

Specification. A precise statement of the needs to be satisfied and the essential characteristics that are required.

Specification Limits. The area, on either side of the centerline, or mean, of data plotted on a control chart that meets the customer's requirements for a product or service. This area may be greater than or less than the area defined by the control limits. See also control limits.

Sponsor. A person or group who provides resources and support for the project, program, or portfolio and is accountable for enabling success.

Sponsoring Organization. The entity responsible for providing the project's sponsor and a conduit for project funding or other project resources.

Stakeholder. An individual, group, or organization that may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio.

Stakeholder Analysis. A technique of systematically gathering and analyzing quantitative and qualitative information to determine whose interests should be taken into account throughout the project.

Stakeholder Engagement Assessment Matrix. A matrix that compares current and desired stakeholder engagement levels.

Stakeholder Engagement Plan. A component of the project management plan that identifies the strategies and actions required to promote productive involvement of stakeholders in project or program decision making and execution.

Stakeholder Register. A project document including the identification, assessment, and classification of project stakeholders.

Standard. A document established by an authority, custom, or general consent as a model or example.

Start Date. A point in time associated with a schedule activity's start, usually qualified by one of the following: actual, planned, estimated, scheduled, early, late, target, baseline, or current.

Start-to-Finish (SF). A logical relationship in which a successor activity cannot finish until a predecessor activity has started.

Start-to-Start (SS). A logical relationship in which a successor activity cannot start until a predecessor activity has started.

Statement of Work (SOW). A narrative description of products, services, or results to be delivered by the project.

Statistical Sampling. Choosing part of a population of interest for inspection.

Successor Activity. A dependent activity that logically comes after another activity in a schedule.

Summary Activity. A group of related schedule activities aggregated and displayed as a single activity.

SWOT Analysis. Analysis of strengths, weaknesses, opportunities, and threats of an organization, project, or option.

Tacit Knowledge. Personal knowledge that can be difficult to articulate and share such as beliefs, experience, and insights.

Tailoring. Determining the appropriate combination of processes, inputs, tools, techniques, outputs, and life cycle phases to manage a project.

Team Charter. A document that records the team values, agreements, and operating guidelines, as well as establishing clear expectations regarding acceptable behavior by project team members.

Team Management Plan. A component of the resource management plan that describes when and how team members will be acquired and how long they will be needed.

Technique. A defined systematic procedure employed by a human resource to perform an activity to produce a product or result or deliver a service, and that may employ one or more tools.

Templates. A partially complete document in a predefined format that provides a defined structure for collecting, organizing, and presenting information and data.

Test and Evaluation Documents. Project documents that describe the activities used to determine if the product meets the quality objectives stated in the quality management plan.

Threat. A risk that would have a negative effect on one or more project objectives.

Three-Point Estimating. A technique used to estimate cost or duration by applying an average or weighted average of optimistic, pessimistic, and most likely estimates when there is uncertainty with the individual activity estimates.

Threshold. A predetermined value of a measurable project variable that represents a limit that requires action to be taken if it is reached.

Time and Material Contract (T&M). A type of contract that is a hybrid contractual arrangement containing aspects of both cost-reimbursable and fixed-price contracts.

To-Complete Performance Index (TCPI). A measure of the cost performance that is required to be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget.

Tolerance. The quantified description of acceptable variation for a quality requirement.

Tool. Something tangible, such as a template or software program, used in performing an activity to produce a product or result.

Tornado Diagram. A special type of bar chart used in sensitivity analysis for comparing the relative importance of the variables.

Total Float. The amount of time that a schedule activity can be delayed or extended from its early start date without delaying the project finish date or violating a schedule constraint.

Trend Analysis. An analytical technique that uses mathematical models to forecast future outcomes based on historical results.

Trigger Condition. An event or situation that indicates that a risk is about to occur.

Unanimity. Agreement by everyone in the group on a single course of action.

Update. A modification to any deliverable, project management plan component, or project document that is not under formal change control.

Validate Scope. The process of formalizing acceptance of the completed project deliverables.

Validation. The assurance that a product, service, or result meets the needs of the customer and other identified stakeholders. Contrast with *verification*.

Variance. A quantifiable deviation, departure, or divergence away from a known baseline or expected value.

Variance Analysis. A technique for determining the cause and degree of difference between the baseline and actual performance.

Variance At Completion (VAC). A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.

Variation. An actual condition that is different from the expected condition that is contained in the baseline plan.

Verification. The evaluation of whether or not a product, service, or result complies with a regulation, requirement, specification, or imposed condition. Contrast with *validation*.

Verified Deliverables. Completed project deliverables that have been checked and confirmed for correctness through the Control Quality process.

Virtual Teams. Groups of people with a shared goal who fulfill their roles with little or no time spent meeting face to face.

Voice of the Customer. A planning technique used to provide products, services, and results that truly reflect customer requirements by translating those customer requirements into the appropriate technical requirements for each phase of project product development.

WBS Dictionary. A document that provides detailed deliverable, activity, and scheduling information about each component in the work breakdown structure.

What-If Scenario Analysis. The process of evaluating scenarios in order to predict their effect on project objectives.

Work Breakdown Structure (WBS). A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables.

Work Breakdown Structure Component. An entry in the work breakdown structure that can be at any level.

Work Package. The work defined at the lowest level of the work breakdown structure for which cost and duration are estimated and managed.

Work Performance Data. The raw observations and measurements identified during activities being performed to carry out the project work.

Work Performance Information. The performance data collected from controlling processes, analyzed in comparison with project management plan components, project documents, and other work performance information.

Work Performance Reports. The physical or electronic representation of work performance information compiled in project documents, intended to generate decisions, actions, or awareness.

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AGILE

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AGILE PRACTICE GUIDE

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PREFACE

The Project Management Institute and Agile Alliance® chartered this practice guide to create a greater understanding of agile approaches in their communities. The vision for this practice guide is to equip project teams with tools, situational guidelines, and an understanding of the available agile techniques and approaches to enable better results.

Project teams are using agile approaches in a variety of industries beyond software development. Both organizations realize that expansion has created a need for a common language, open mindedness, and the willingness to be flexible in how products and deliverables are brought to market. In addition, both organizations realize there are multiple ways to achieve successful delivery. There are a broad range of tools, techniques, and frameworks; teams have choices for approaches and practices that fit their project and the organizational culture in order to achieve the desired outcome.

The *Agile Practice Guide* core committee members are from varying backgrounds and use various approaches. Some of the committee members are consultants and some work inside organizations. All have worked in agile ways for many years.

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1

INTRODUCTION

Welcome to the *Agile Practice Guide*! This guide was developed as a collaborative effort by the Project Management Institute (PMI) and Agile Alliance®. The members of the core writing team who developed this practice guide included volunteers from both organizations, drawing on subject matter expertise from a broad range of current practitioners and leaders from a diverse range of backgrounds, beliefs, and cultures.

This practice guide provides practical guidance geared toward project leaders and team members adapting to an agile approach in planning and executing projects. While our core writing team recognizes there is staunch support to use predictive approaches and conversely, passion around shifting to an agile mindset, values, and principles, this practice guide covers a practical approach to project agility. This practice guide represents a bridge to understanding the pathway from a predictive approach to an agile approach. In fact, there are similar activities between the two, such as planning, that are handled differently but occur in both environments.

Our core writing team used an agile mindset to collaborate and manage the development of this first edition of the practice guide. As technology and culture changes, future updates and refinements to the practice guide will reflect current approaches.

Our core team adopted a more informal, relaxed writing style for this practice guide than is typical for PMI standards. The guide incorporates new elements, such as tips, sidebars, and case studies to better illustrate key points and concepts. Our team intends for these changes to make this practice guide more readable and user-friendly.

This practice guide goes beyond addressing the use of agile in the computer software development industry, because agile has expanded into non-software development environments. Manufacturing, education, healthcare and other industries are becoming agile to varying degrees and this use beyond software is within the scope of this practice guide.

AGILE-BASED LEARNING

Education is a prime and fertile ground to expand agile practices beyond software development. Teachers in middle schools, high schools, and universities around the world are beginning to use agile to create a culture of learning. Agile techniques are used to provide focus on prioritizing competing priorities. Face-to-face interaction, meaningful learning, self-organizing teams, and incremental and/or iterative learning that exploit the imagination are all agile principles that can change the mindset in the classroom and advance educational goals (Briggs, 2014).*

*Briggs, Sara. "Agile Based Learning: What Is It and How Can It Change Education?" *Opencolleges.edu.au* February 22, 2014, retrieved from http://www.opencolleges.edu.au/informed/features/agile-based-learning-what-is-it-and-how-can-it-change-education/

So why an *Agile Practice Guide* and why now? Project teams have used agile techniques and approaches in various forms for at least several decades. The Agile Manifesto [1][1] expressed definitive values and principles of agile as the use of agile gained substantial momentum (see Section 2.1). Today, project leaders and teams find themselves in an environment disrupted by exponential advances in technology and demands from customers for more immediate delivery of value. Agile techniques and approaches effectively manage disruptive technologies. In addition, the first principle of agile places customer satisfaction as the highest priority and is key in delivering products and services that delight customers (see Section 2.1). Rapid and transparent customer feedback loops are readily available with the widespread use of social media. Therefore, in order to stay competitive and relevant, organizations can no longer be internally focused but rather need to focus outwardly to the customer experience.

[1] The numbers in brackets refer to the list of references at the end of this practice guide.

Disruptive technologies are rapidly changing the playing field by decreasing the barriers to entry. More mature organizations are increasingly prone to being highly complex and potentially slow to innovate, and lag behind in delivering new solutions to their customers. These organizations find themselves competing with smaller organizations and startups that are able to rapidly produce products that fit customer needs. This speed of change will continue to drive large organizations to adopt an agile mindset in order to stay competitive and keep their existing market share.

The *Agile Practice Guide* is project-focused and addresses project life cycle selection, implementing agile, and organizational considerations for agile projects. Organizational change management (OCM) is essential for implementing or transforming practices but, since OCM is a discipline within itself, it is outside the scope of this practice guide. Those seeking guidance in OCM may refer to *Managing Change in Organizations—A Practice Guide* [2].

Additional items that are in scope and out of scope for this practice guide are listed in Table 1-1.

DISRUPTIVE TECHNOLOGY

Disruptive technology is especially enabled by the transition to cloud computing. Companies across the globe are leveraging the model for quick and cheap access to computing resources and to gain entry into traditional markets. Cloud computing requires a reduced upfront payment, but is paid over time via a subscription service, based upon a pay-as-you-go or pay-what-you-use model. Updated applications, infrastructure, and platforms are released into the cloud in an iterative and incremental fashion, keeping pace with improvements to technology and evolving customer demand.

Table 1-1. In-Scope and Out-of-Scope Items

In Scope	Out of Scope
Implementing agile approaches at a project or team level	Implementing agile throughout the organization or creating agile programs
Coverage of most popular agile approaches, as listed in industry surveys	Coverage of niche approaches, company-specific methods, or incomplete life cycle techniques
Suitability factors to consider when choosing an agile approach and/or practice	Recommending or endorsing a particular approach/ practice
Mapping agile to *PMBOK® Guide* processes and Knowledge Areas	Change or modification of *PMBOK® Guide* processes and/or Knowledge Areas
Discussion on the use of agile beyond software development	Removal of software industry influence on agile approaches. (Note that software is included in this practice guide even though the use of agile is growing in many other industries beyond software.)
Guidance, techniques, and approaches to consider when implementing agile in projects or organizations	Prescriptive step-by-step instructions on how to implement agile in projects or organizations
Definitions of generally accepted terms	New terms and/or definitions

This practice guide is for project teams who find themselves in the messy middle-ground between predictive and agile approaches, who are trying to address rapid innovation and complexity, and who are dedicated to the team's improvement. This practice guide provides useful guidance for successful projects that deliver business value to meet customer expectations and needs.

This practice guide is organized as follows:

Section 2 An Introduction to Agile—This section includes the Agile Manifesto mindset, values, and principles. It also covers the concepts of definable and high-uncertainty work, and the correlation between lean, the Kanban Method, and agile approaches.

Section 3 Life Cycle Selection—This section introduces the various life cycles discussed in this practice guide. This section also addresses suitability filters, tailoring guidelines, and common combinations of approaches.

Section 4 Implementing Agile: Creating an Agile Environment—This section discusses critical factors to consider when creating an agile environment such as servant leadership and team composition.

Section 5 Implementing Agile: Delivering in an Agile Environment—This section includes information on how to organize teams and common practices teams can use for delivering value on a regular basis. It provides examples of empirical measurements for teams and for reporting status.

Section 6 Organizational Considerations for Project Agility—This section explores organizational factors that impact the use of agile approaches, such as culture, readiness, business practices, and the role of a PMO.

Section 7 A Call to Action—The call to action requests input for continuous improvement of this practice guide.

The annexes, appendixes, references, bibliography, and glossary provide additional useful information and definitions:

- **Annexes.** Contain mandatory information that is too lengthy for inclusion in the main body of the practice guide.
- **Appendixes.** Contain nonmandatory information that supplements the main body of this practice guide.
- **References.** Identify where to locate standards and other publications that are cited in this practice guide.
- **Bibliography.** Lists additional publications by section that provide detailed information on topics covered in this practice guide.
- **Glossary.** Presents a list of terms and their definitions that are used in this practice guide.

2

AN INTRODUCTION TO AGILE

2.1 DEFINABLE WORK VS. HIGH-UNCERTAINTY WORK

Project work ranges from definable work to high-uncertainty work. Definable work projects are characterized by clear procedures that have proved successful on similar projects in the past. The production of a car, electrical appliance, or home after the design is complete are examples of definable work. The production domain and processes involved are usually well understood and there are typically low levels of execution uncertainty and risk.

New design, problem solving, and not-done-before work is exploratory. It requires subject matter experts to collaborate and solve problems to create a solution. Examples of people encountering high-uncertainty work include software systems engineers, product designers, doctors, teachers, lawyers, and many problem-solving engineers. As more definable work is automated, project teams are undertaking more high-uncertainty work projects that require the techniques described in this practice guide.

High-uncertainty projects have high rates of change, complexity, and risk. These characteristics can present problems for traditional predictive approaches that aim to determine the bulk of the requirements upfront and control changes through a change request process. Instead, agile approaches were created to explore feasibility in short cycles and quickly adapt based on evaluation and feedback.

2.2 THE AGILE MANIFESTO AND MINDSET

Thought leaders in the software industry formalized the agile movement in 2001 with the publication of the Manifesto for Agile Software Development (see Figure 2-1).

> We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:
>
> **Individuals and interactions** over processes and tools
> **Working software** over comprehensive documentation
> **Customer collaboration** over contract negotiation
> **Responding to change** over following a plan
>
> That is, while there is value in the items on the right, we value the items on the left more.

© 2001, the Agile Manifesto authors

Figure 2-1. The Four Values of the Agile Manifesto

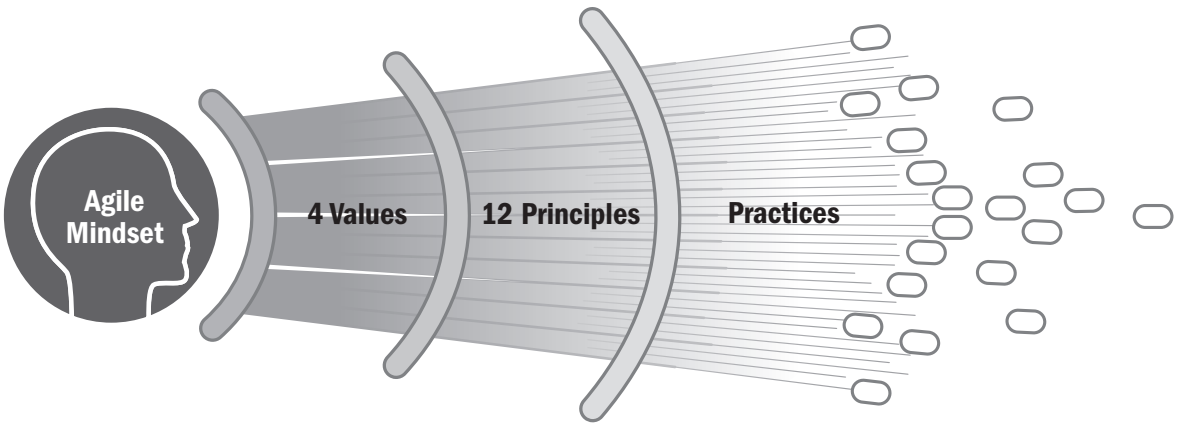
Twelve clarifying principles flowed from these values as shown in Figure 2-2.

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity—the art of maximizing the amount of work not done—is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Figure 2-2. The Twelve Principles Behind the Agile Manifesto

Although originating in the software industry, these principles have since spread to many other industries.

This embodiment of mindset, values, and principles defines what constitutes an agile approach. The various agile approaches in use today share common roots with the agile mindset, value, and principles. This relationship is shown in Figure 2-3.



Agile is a mindset defined by values, guided by principles, and manifested through many different practices. Agile practitioners select practices based on their needs.

Figure 2-3. The Relationship Between the Agile Manifesto Values, Principles, and Common Practices

As shown in Figure 2-3, the model, inspired by Ahmed Sidky, articulates agile as a mindset defined by the Agile Manifesto values, guided by the Agile Manifesto principles, and enabled by various practices. It is worth noting that while the term "agile" became popularized after the Manifesto, the approaches and techniques being used by project teams today existed before the Agile Manifesto by many years and, in some cases, decades.

Agile approaches and *agile methods* are umbrella terms that cover a variety of frameworks and methods. Figure 2-4 places agile in context and visualizes it as a blanket term, referring to any kind of approach, technique, framework, method, or practice that fulfills the values and principles of the Agile Manifesto. Figure 2-4 also shows agile and the Kanban Method as subsets of lean. This is because they are named instances of lean thinking that share lean concepts such as: "focus on value," "small batch sizes," and "elimination of waste."

Is agile an approach, a method, a practice, a technique, or a framework? Any or all of these terms could apply depending on the situation. This practice guide, uses the term "approach" unless one of the other terms is obviously more correct.

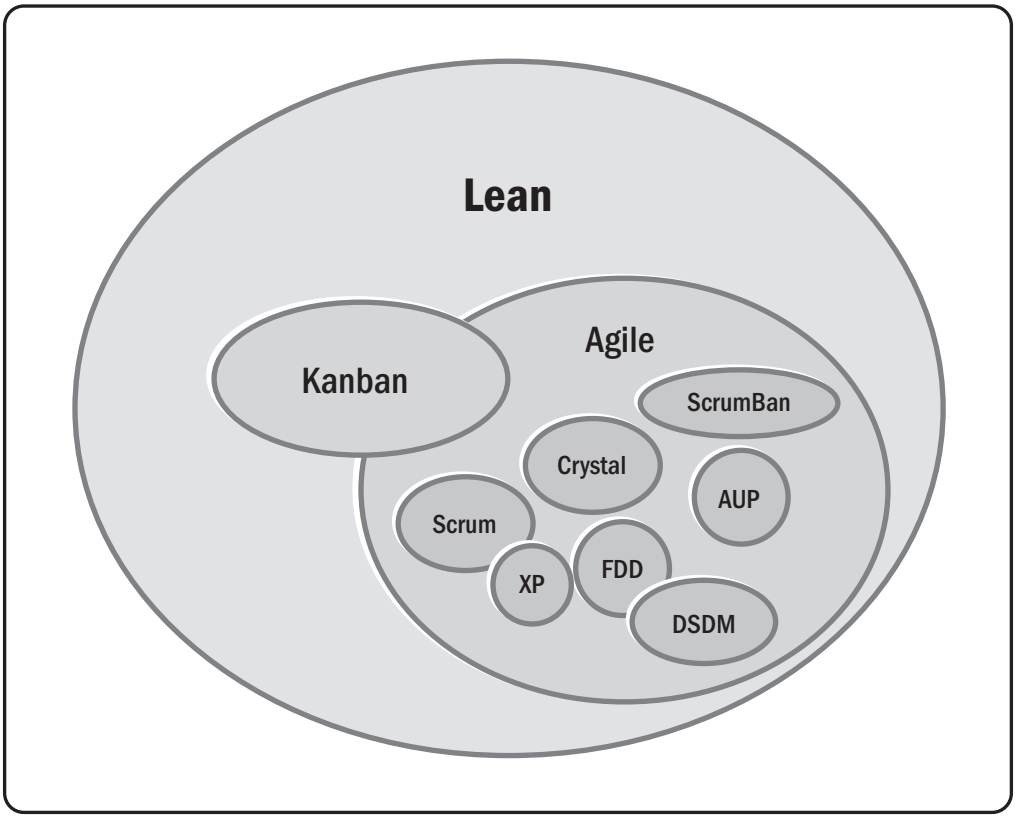


Figure 2-4. Agile is a Blanket Term for Many Approaches

In general, there are two strategies to fulfill agile values and principles. The first is to adopt a formal agile approach, intentionally designed and proven to achieve desired results. Then take time to learn and understand the agile approaches before changing or tailoring them. Premature and haphazard tailoring can minimize the effects of the approach and thus limit benefits. *(See Appendix X2 for Tailoring Considerations).*

The second strategy is to implement changes to project practices in a manner that fits the project context to achieve progress on a core value or principle. Use timeboxes to create features, or specific techniques to iteratively refine features. Consider dividing up one large project into several releases, if that works for the specific project context. Implement changes that will help the project succeed—the changes do not need to be part of the organization's formal practices. The end goal is not to be agile for its own sake, but rather to deliver a continuous flow of value to customers and achieve better business outcomes.

2.3 LEAN AND THE KANBAN METHOD

One way to think about the relationship between lean, agile, and the Kanban Method is to consider agile and the Kanban Method as descendants of lean thinking. In other words, lean thinking is a superset, sharing attributes with agile and Kanban.

This shared heritage is very similar and focuses on delivering value, respect for people, minimizing waste, being transparent, adapting to change, and continuously improving. Project teams sometimes find it useful to blend various methods—whatever works for the organization or team is what should be done regardless of its origin. The objective is the best outcome regardless of the approach used.

The Kanban Method is inspired by the original lean-manufacturing system and used specifically for knowledge work. It emerged in the mid-2000s as an alternative to the agile methods that were prevalent at the time.

The Kanban Method is less prescriptive than some agile approaches and less disruptive, as it is the original "start-where-you-are" approach. Project teams can begin applying the Kanban Method with relative ease and progress toward other agile approaches if that is what they deem necessary or appropriate. For more details on the Kanban Method, see Annex A3 on Overview of Agile and Lean Frameworks.

CASE

There is and probably always will be a lot of discussion around the Kanban Method and whether it belongs to the lean or agile movement. It was conceived in and around lean manufacturing, but is widely used in agile settings.

2.4 UNCERTAINTY, RISK, AND LIFE CYCLE SELECTION

Some projects have considerable uncertainty around project requirements and how to fulfill those requirements using current knowledge and technology. These uncertainties can contribute to high rates of change and project complexity. These characteristics are illustrated in Figure 2-5.

As project uncertainty increases, so too does the risk of rework and the need to use a different approach. To mitigate the impact of these risks, teams select life cycles that allow them to tackle projects with high amounts of uncertainty via small increments of work.

Teams can verify their work when they use small increments and can change what they do next. When teams deliver small increments, they are better able to understand the true customer requirements faster and more accurately than with a static written specification.

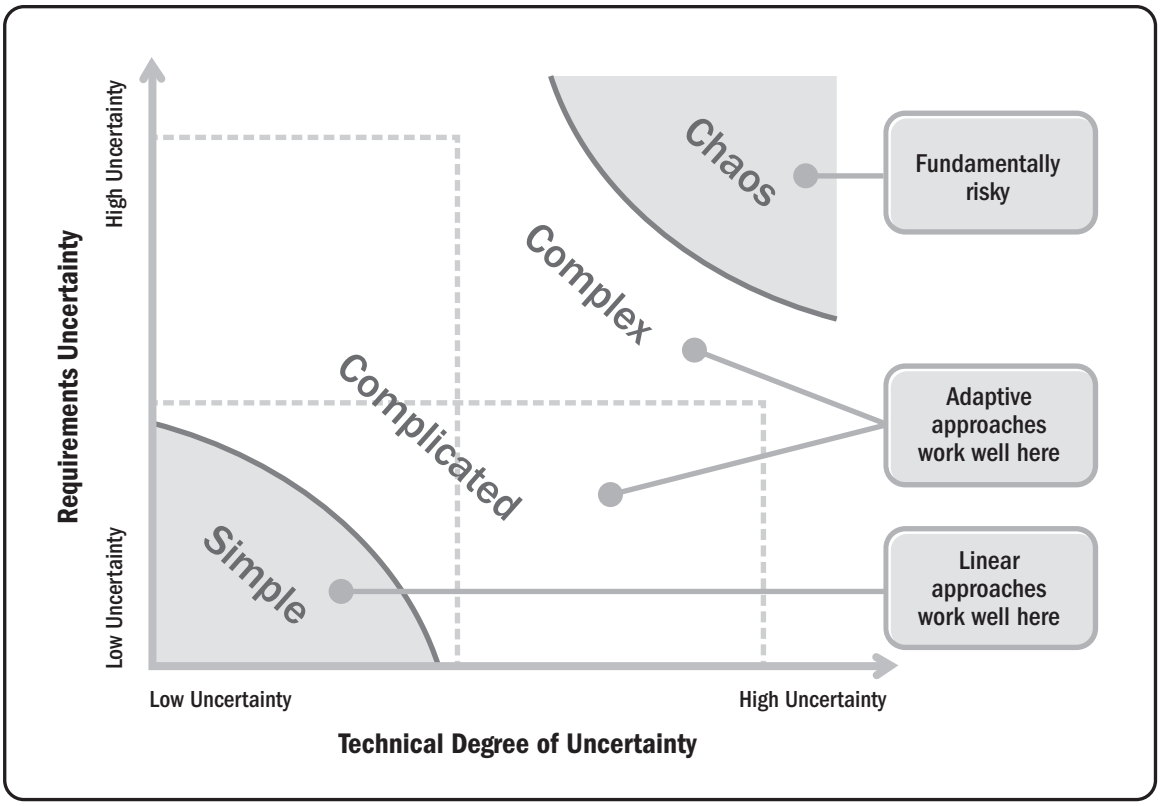


Figure 2-5. Uncertainty and Complexity Model Inspired by the Stacey Complexity Model

Teams can plan and manage projects with clear and stable requirements and clear technical challenges with little difficulty. However, as the uncertainty in the project increases, the likelihood of changes, wasted work, and rework also increases, which is costly and time consuming.

Some teams have evolved project life cycles to use iterative and incremental approaches. Many teams discover that when they explore the requirements iteratively and deliver more often incrementally, the teams adapt to changes more easily. These iterative and incremental approaches reduce waste and rework because the teams gain feedback. These approaches use:

- Very short feedback loops,
- Frequent adaptation of process,
- Reprioritization,
- Regularly updated plans, and
- Frequent delivery.

TIP

What do simple, complicated, and complex projects mean? Consider large projects, such as the Boston Big Dig construction project. On the surface, the project seemed fairly straightforward: move the elevated highway underground. There was high agreement on the requirements (see the Y axis in Figure 2-5). There was low uncertainty on how the project would proceed until the project started. And, as is the case for many large projects, the project encountered surprises along the way.

When a team works on a project where there is little opportunity for interim deliverables or little opportunity for prototyping, the team most likely will use a predictive life cycle to manage it. The team can adapt to what it discovers, but will not be able to use agile approaches to manage the iterative discovery of requirements or incremental deliverables for feedback.

The Big Dig project was not simple by any means. However, many projects that start out in the lower left part of the Stacey Complexity Model have no real means of moving to other approaches. Assess the project, both in the requirements and the means of delivery, to determine the best approach for the life cycle of the project.

These iterative, incremental, and agile approaches work well for projects that involve new or novel tools, techniques, materials, or application domains. (Refer to Section 3 on Life Cycle Selection). They also work well for projects that:

- Require research and development;
- Have high rates of change;
- Have unclear or unknown requirements, uncertainty, or risk; or
- Have a final goal that is hard to describe.

By building a small increment and then testing and reviewing it, the team can explore uncertainty at a low cost in a short time, reduce risk, and maximize business value delivery. This uncertainty may be centered on suitability and requirements (is the right product being built?); technical feasibility and performance (can this product be built this way?); or process and people (is this an effective way for the team to work?). All three of these characteristics—product specification, production capability, and process suitability—typically have elements of high uncertainty.

However, iterative and incremental approaches have their limits of applicability. When both technology uncertainty and requirements uncertainty are very high (the top right of Figure 2-5), the project moves beyond complex to chaotic. In order for the project to become reliably possible, it needs one of the variables (uncertainty or disagreement) to be contained.

3

LIFE CYCLE SELECTION

Projects come in many shapes and there are a variety of ways to undertake them. Project teams need awareness of the characteristics and options available to select the approach most likely to be successful for the situation.

This practice guide refers to four types of life cycles, defined as follows:

- **Predictive life cycle.** A more traditional approach, with the bulk of planning occurring upfront, then executing in a single pass; a sequential process.
- **Iterative life cycle.** An approach that allows feedback for unfinished work to improve and modify that work.
- **Incremental life cycle.** An approach that provides finished deliverables that the customer may be able to use immediately.
- **Agile life cycle.** An approach that is both iterative and incremental to refine work items and deliver frequently.

WHAT TO CALL NON-AGILE APPROACHES?

There is no single term that is universally used to describe non-agile approaches. Initially, the practice guide used the term *plan-driven* to describe the emphasis on an upfront plan and then execution of that plan. Some people prefer the terms *waterfall* or *serial* to describe this life cycle. In the end, we settled on the term *predictive* since it is used in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* [3] and the *Software Extension to the PMBOK® Guide Fifth Edition* [4].

Many organizations do not experience either of these extremes and instead occupy some middle ground. That is natural, but we still need a way to talk about both ends of the spectrum. If *agile* is at one end, we call the other end *predictive*.

3.1 CHARACTERISTICS OF PROJECT LIFE CYCLES

Table 3-1 summarizes the characteristics of the four life cycle categories covered in this practice guide.

Table 3-1. Characteristics of Four Categories of Life Cycles

Characteristics				
Approach	**Requirements**	**Activities**	**Delivery**	**Goal**
Predictive	Fixed	Performed once for the entire project	Single delivery	Manage cost
Iterative	Dynamic	Repeated until correct	Single delivery	Correctness of solution
Incremental	Dynamic	Performed once for a given increment	Frequent smaller deliveries	Speed
Agile	Dynamic	Repeated until correct	Frequent small deliveries	Customer value via frequent deliveries and feedback

It is important to note that all projects have these characteristics—no project is completely devoid of considerations around requirements, delivery, change, and goals. A project's inherent characteristics determine which life cycle is the best fit for that project.

Another way to understand how project life cycles vary is by using a continuum ranging from predictive cycles on one end, to agile cycles on the other end, with more iterative or incremental cycles in the middle.

Figure X3-1 of Appendix X3 of the *PMBOK® Guide* – Sixth Edition displays the continuum as a flat line. This view emphasizes the shifting of project characteristics from one end to the other. Another way to visualize the continuum is with a two-dimensional square, as shown in Figure 3-1.

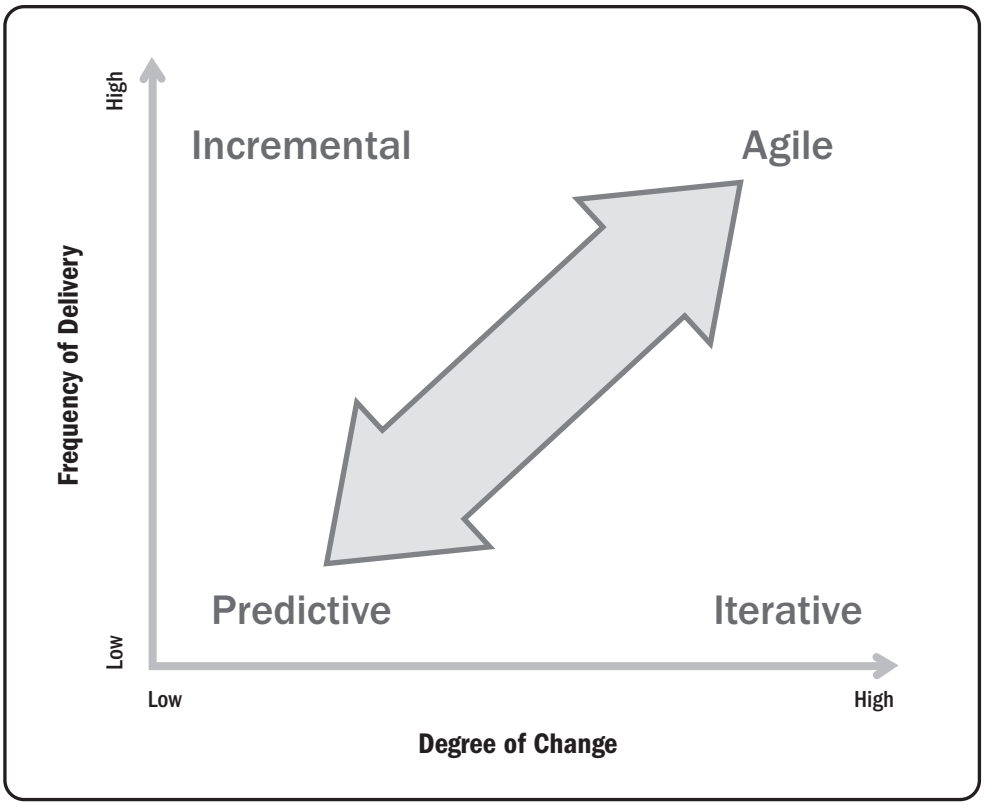


Figure 3-1. The Continuum of Life Cycles

No life cycle can be perfect for all projects. Instead, each project finds a spot on the continuum that provides an optimum balance of characteristics for its context. Specifically,

- **Predictive life cycles.** Take advantage of things that are known and proven. This reduced uncertainty and complexity allows teams to segment work into a sequence of predictable groupings.
- **Iterative life cycles.** Allow feedback on partially completed or unfinished work to improve and modify that work.
- **Incremental life cycles.** Provide finished deliverables that the customer may be able to use immediately.
- **Agile life cycles.** Leverage both the aspects of iterative and incremental characteristics. When teams use agile approaches, they iterate over the product to create finished deliverables. The team gains early feedback and provides customer visibility, confidence, and control of the product. Because the team can release earlier, the project may provide an earlier return on investment because the team delivers the highest value work first.

PLANNING IS ALWAYS THERE

A key thing to remember about life cycles is that each of them share the element of planning. What differentiates a life cycle is not whether planning is done, but rather how much planning is done and when.

At the predictive end of the continuum, the plan drives the work. As much planning as is possible is performed upfront. Requirements are identified in as much detail as possible. The team estimates when they can deliver which deliverables and performs comprehensive procurement activities.

In iterative approaches, prototypes and proofs are also planned, but the outputs are intended to modify the plans created in the beginning. Earlier reviews of unfinished work help inform future project work.

Meanwhile, incremental initiatives plan to deliver successive subsets of the overall project. Teams may plan several successive deliveries in advance or only one at a time. The deliveries inform the future project work.

Agile projects also plan. The key difference is that the team plans and replans as more information becomes available from review of frequent deliveries. Regardless of the project life cycle, the project requires planning.

3.1.1 CHARACTERISTICS OF PREDICTIVE LIFE CYCLES

Predictive life cycles expect to take advantage of high certainty around firm requirements, a stable team, and low risk. As a result, project activities often execute in a serial manner, as shown in Figure 3-2.

In order to achieve this approach, the team requires detailed plans to know what to deliver and how. These projects succeed when other potential changes are restricted (e.g., requirements changes; project team members change what the team delivers). Team leaders aim to minimize change for the predictive project.

When the team creates detailed requirements and plans at the beginning of the project, they can articulate the constraints. The team can then use those constraints to manage risk and cost. As the team progresses through the detailed plan, they monitor and control changes that might affect the scope, schedule, or budget.

By emphasizing a departmentally efficient, serialized sequence of work, predictive projects do not typically deliver business value until the end of the project. If the predictive project encounters changes or disagreements with the requirements, or if the technological solution is no longer straightforward, the predictive project will incur unanticipated costs.

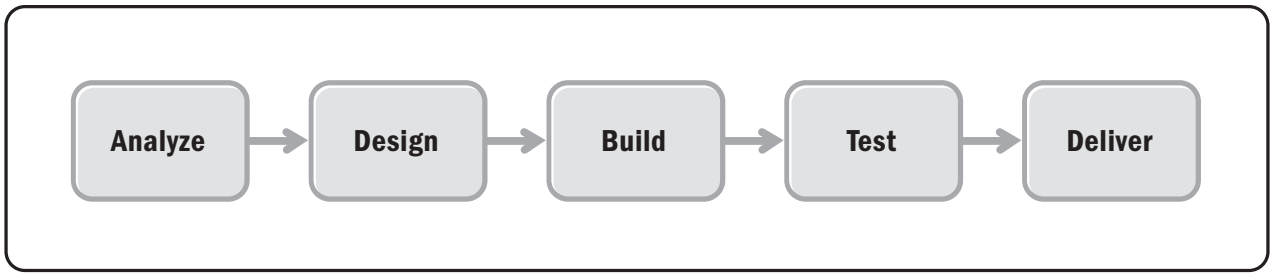


Figure 3-2. Predictive Life Cycle

3.1.2 CHARACTERISTICS OF ITERATIVE LIFE CYCLES

Iterative life cycles improve the product or result through successive prototypes or proofs of concept. Each new prototype yields new stakeholder feedback and team insights. Then, the team incorporates the new information by repeating one or more project activities in the next cycle. Teams may use timeboxing on a given iteration for a few weeks, gather insights, and then rework the activity based on those insights. In that way, iterations help identify and reduce uncertainty in the project.

Projects benefit from iterative life cycles when complexity is high, when the project incurs frequent changes, or when the scope is subject to differing stakeholders' views of the desired final product. Iterative life cycles may take longer because they are optimized for learning rather than speed of delivery.

Figure 3-3 illustrates some elements of an iterative project life cycle for a single product delivery.

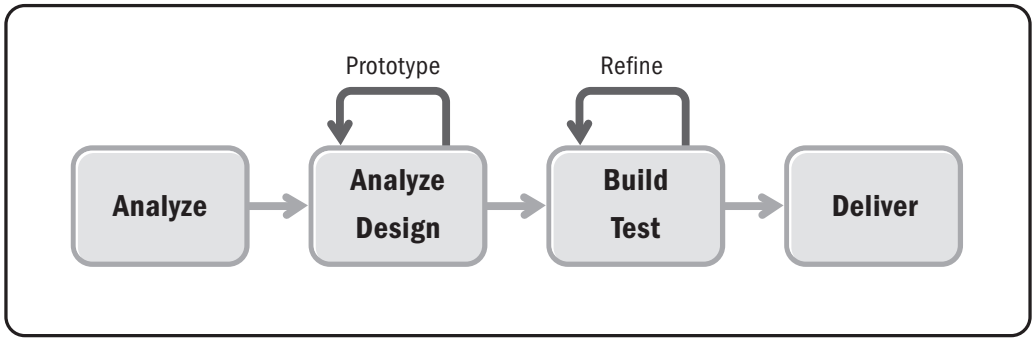


Figure 3-3. Iterative Life Cycle

Have you ever been involved on a project where the requirements seemed to change daily and thought, "We will know the requirements when we deliver a prototype that the business approves." If so, this was a project where agile approaches could have helped. A prototype encourages feedback and a better understanding of the requirements that can be incorporated into each deliverable.

3.1.3 CHARACTERISTICS OF INCREMENTAL LIFE CYCLES

Some projects optimize for speed of delivery. Many businesses and initiatives cannot afford to wait for everything to be completed; in these cases, customers are willing to receive a subset of the overall solution. This frequent delivery of smaller deliverables is called an incremental life cycle (see Figure 3-4).

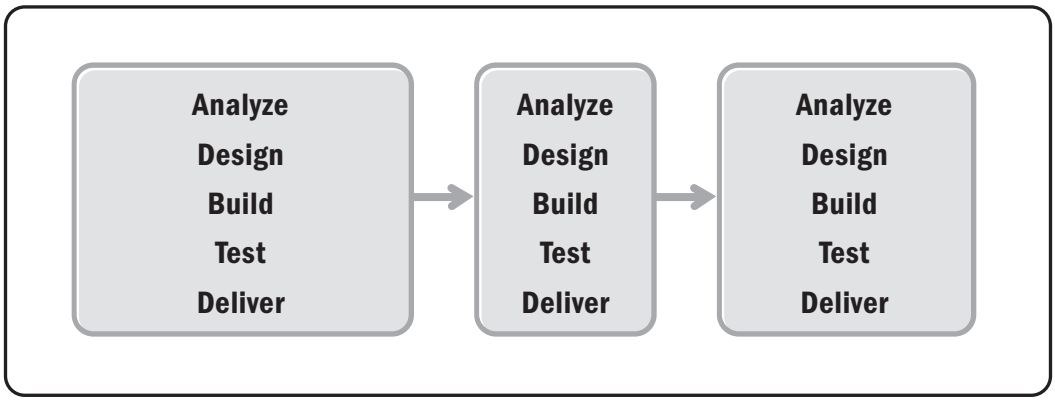


Figure 3-4. A Life Cycle of Varying-Sized Increments

TIP

Are you unsure of how a new business service might work in practice? Create a proof of concept with evaluation criteria to explore desired outcomes. Use iterative approaches when you suspect the requirements will change based on customer feedback.

Incremental life cycles optimize work for delivering value to sponsors or customers more often than a single, final product. Teams plan initial deliverables before beginning their work, and they begin working on that first delivery as soon as possible. Some agile projects deliver value within days of project initiation. Others could take longer, ranging from 1 week to several weeks.

As the project continues, the team may deviate from the original vision. The team can manage the deviations, because the team delivers value sooner. The degree of change and variation is less important than ensuring customers get value sooner than at the end of the project.

Providing a customer a single feature or a finished piece of work is an example of the incremental approach.

For example, builders may want to show a finished room or floor of a building before they continue with the remainder of the building. In that case, they may complete a floor with fixtures, paint, and everything else intended for the finished floor before proceeding to the next floor. The customer is able to see and approve of the style, color, and other details, allowing adjustments to be made before further investments of time and money are made. This reduces potential rework and/or customer dissatisfaction.

Completeness and delivery are subjective. The team may need feedback on a prototype and may then choose to deliver a minimum viable product (MVP) to a subset of customers. The customers' feedback helps the team to learn what they need to provide for subsequent delivery of the final finished feature.

Agile teams, as a key differentiator, deliver business value often. As the product adds a broader set of features and a broader range of consumers, we say it is delivered incrementally.

3.1.4 CHARACTERISTICS OF AGILE LIFE CYCLES

In an agile environment, the team expects requirements to change. The iterative and incremental approaches provide feedback to better plan the next part of the project. However, in agile projects, incremental delivery uncovers hidden or misunderstood requirements. Figure 3-5 illustrates two possible ways to achieve incremental delivery so the project aligns with customer needs and can be adapted as necessary.

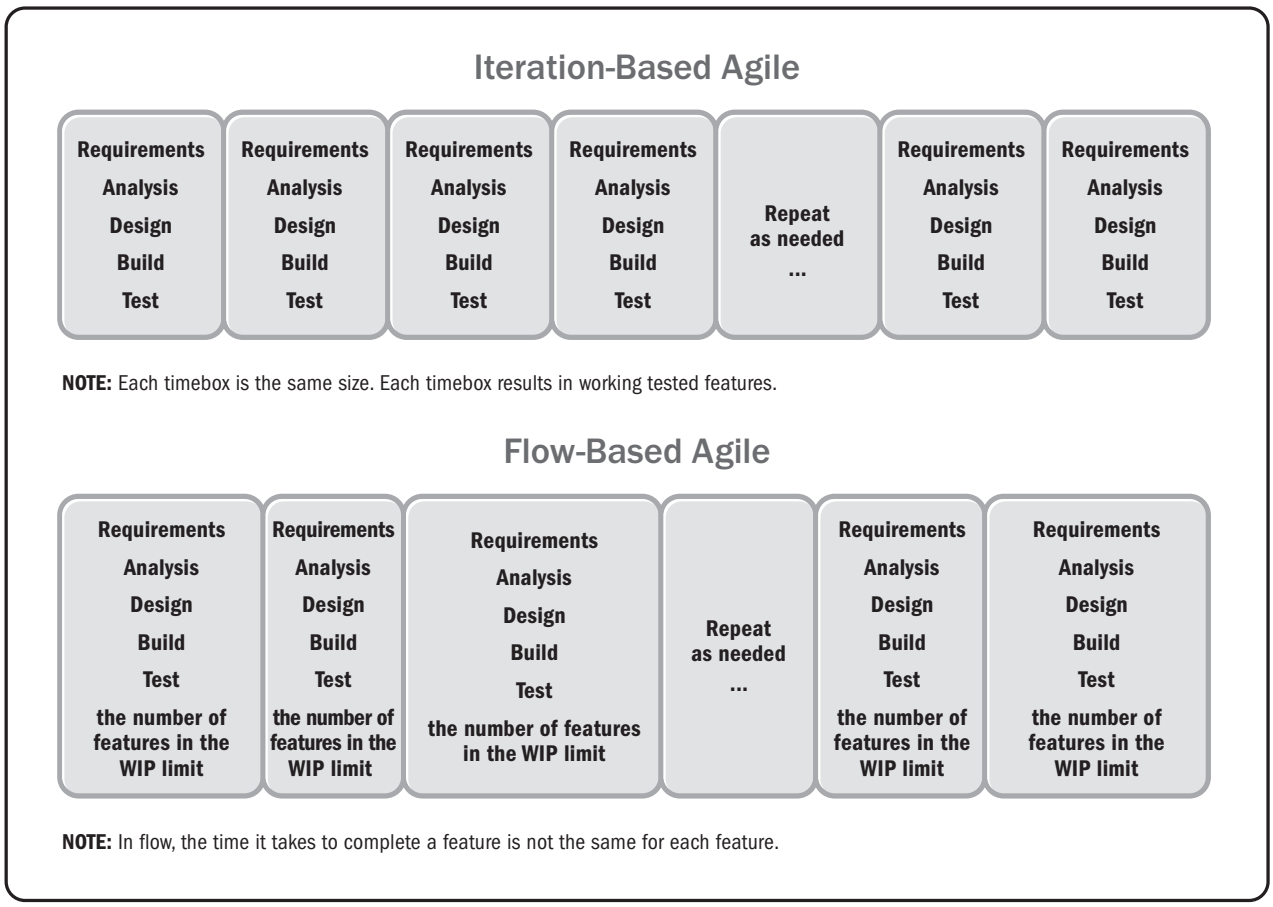


Figure 3-5. Iteration-Based and Flow-Based Agile Life Cycles

In iteration-based agile, the team works in iterations (timeboxes of equal duration) to deliver completed features. The team works on the most important feature, collaborating as a team to finish it. Then the team works on the next most important feature and finishes it. The team may decide to work on a few features at a time, but the team does not address all of the work for the iteration at once (i.e., does not address all of the requirements, followed by all of the analyses, etc.).

In flow-based agile, the team pulls features from the backlog based on its capacity to start work rather than on an iteration-based schedule. The team defines its workflow with columns on a task board and manages the work in progress for each column. Each feature may take a different amount of time to finish. Teams keep work-in-progress sizes small to better identify issues early and reduce rework should changes be required. Without iterations to define planning and review points, the team and business stakeholders determine the most appropriate schedule for planning, product reviews, and retrospectives.

Agile life cycles are those that fulfill the principles of the Agile Manifesto. In particular, customer satisfaction increases with early and continuous delivery of valuable products. Moreover, an incremental deliverable that is functional and provides value is the primary measure of progress. Agile life cycles combine both iterative and incremental approaches in order to adapt to high degrees of change and deliver project value more often.

3.1.5 AGILE SUITABILITY FILTERS

Various assessment models exist to help determine the likely fit or gaps for using agile approaches. These models assess project and organizational factors associated with adoption and suitability and then provide scores indicating alignment or potential risk areas. Appendix X3 provides a synthesis of popular assessment models for use as an agile suitability filter.

EXAMPLE OF A HYBRID LIFE CYCLE PROJECT

A pharmaceutical company that had a time-consuming U.S. Food and Drug Administration (FDA) approval process tagged onto the end of its development process and its entire life cycle looked like Figure 3-6. While project teams undertook drug trials in an agile fashion, they had to present the drugs to an external group to perform the FDA approval process. A consultant helped to integrate the FDA approval process portion into the agile development process to create a more streamlined hybrid approach.

The short version of the story is that because FDA approval is required to be completed at the end of the development process or repeated after any change (this includes even after the most minor change), the process had to remain at the end as a separate phase. Integration using the iterative process was unsuccessful. However, the consultant created some useful quick-start guides and testing protocols that shortened the final FDA approval process.

3.1.6 CHARACTERISTICS OF HYBRID LIFE CYCLES

It is not necessary to use a single approach for an entire project. Projects often combine elements of different life cycles in order to achieve certain goals. A combination of predictive, iterative, incremental, and/or agile approaches is a hybrid approach.

Figure 3-6 depicts the basic, pure approaches to project types that combine to form a hybrid model. The early processes utilize an agile development life cycle, which is then followed by a predictive rollout phase. This approach can be used when there is uncertainty, complexity, and risk in the development portion of the project that would benefit from an agile approach, followed by a defined, repeatable rollout phase that is appropriate to undertake in a predictive way, perhaps by a different team. An example of this approach is the development of a new high-tech product followed by rollout and training to thousands of users.

Figure 3-6. Agile Development Followed by a Predictive Rollout

3.1.7 COMBINED AGILE AND PREDICTIVE APPROACHES

Another approach is to use a combination of agile and predictive approaches throughout the life cycle.

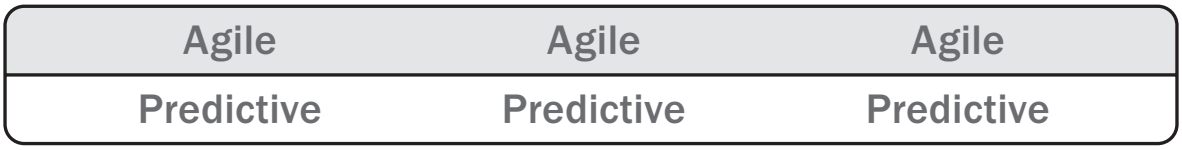


Figure 3-7. A Combined Agile and Predictive Approach Used Simultaneously

In Figure 3-7, a combination of both predictive and agile approaches are used in the same project. Perhaps the team is incrementally transitioning to agile and using some approaches like short iterations, daily standups, and retrospectives, but other aspects of the project such as upfront estimation, work assignment, and progress tracking are still following predictive approaches.

Using both predictive and agile approaches is a common scenario. It would be misleading to call the approach agile since it clearly does not fully embody the agile mindset, values, and principles. However, it would also be inaccurate to call it predictive since it is a hybrid approach.

3.1.8 PREDOMINANTLY PREDICTIVE APPROACH WITH SOME AGILE COMPONENTS

Figure 3-8 shows a small agile element within a chiefly predictive project. In this case, a portion of the project with uncertainty, complexity, or opportunity for scope creep is being tackled in an agile way, but the remainder of the project is being managed using predictive approaches. An example of this approach would be an engineering firm that is building a facility with a new component.

Figure 3-8. A Largely Predictive Approach with Agile Components

While the majority of the project may be routine and predictable, like many other facility projects the organization has undertaken before, this project incorporates a new roofing material. The contractor may plan for some small-scale installation trials on the ground first to determine the best installation method and to uncover issues early while there is plenty of time to solve them and incrementally improve processes through experimentation and adaptation.

3.1.9 A LARGELY AGILE APPROACH WITH A PREDICTIVE COMPONENT

Figure 3-9 depicts a largely agile approach with a predictive component. This approach might be used when a particular element is non-negotiable or not executable using an agile approach. Examples include integrating an external component developed by a different vendor that cannot or will not partner in a collaborative or incremental way. A single integration is required after the component is delivered.

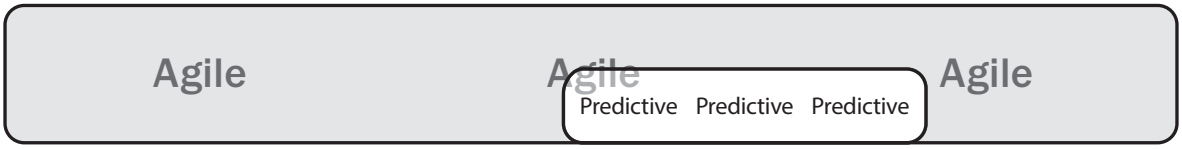


Figure 3-9. A Largely Agile Approach with a Predictive Component

A government department had a credit insurance application development project. The multi-year project was to replace its aging underwriting system with a new, more responsive user interface and system integrations. The bulk of the project was undertaken using an agile approach with continual business input.

The premium rate calculations were handed down from the Organisation for Economic Co-operation and Development (OECD) as a 200-page specification. The steps were very clearly explained with little opportunity for confusion (or interim result confirmation by the business) and were coded up by a separate team working its way through the calculation steps. The two teams collaborated on the input variables required for the calculation and how to consume and display the output values, but beyond that, the calculation team worked in a largely predictive manner.

When the calculation team's portion was complete, the outputs from the premium rate calculations were displayed on the screens and in the reports. Then the business users provided feedback on the appearance and use of the information. The two teams ran concurrently, but had little need for interaction. Having them physically close to each other made it easier to check in on development progress, but largely they were separate subprojects.

3.1.10 HYBRID LIFE CYCLES AS FIT-FOR-PURPOSE

Project teams may design a hybrid life cycle based on project risks. For example, a campus construction project may have multiple buildings to improve and build. An incremental approach would focus resources on completing some buildings earlier than others, accelerating the return on investment. Each individual delivery may be sufficiently well known to benefit from a predictive life cycle for that building alone.

The goal of project management is to produce business value in the best possible way given the current environment. It does not matter if that way is agile or predictive. The question to ask is: "How can we be most successful?"

Is feedback needed as the team produces value? If so, increments will help. Is it necessary to manage risk as ideas are explored? If so, iterations or agile will help.

When the organization cannot deliver intermediate value, agile approaches may not be useful. That is okay—agile for the sake of agile is not the goal. The point is to select a life cycle or a combination of life cycles that work for the project, the risks, and the culture.

Agile is about customer-based delivery on a frequent basis. That delivery creates feedback for the team. The team uses that feedback to plan and replan the next chunk of work.

3.1.11 HYBRID LIFE CYCLES AS TRANSITION STRATEGY

Many teams are not able to make the switch to agile ways of working overnight. Agile techniques look and feel very different to those who are accustomed to and have been successful in a predictive environment. The larger the organization and the more moving parts, the longer it will take to transition. For that reason, it makes sense to plan a gradual transition.

A gradual transition involves adding more iterative techniques to improve learning and alignment among teams and stakeholders. Later, consider adding more incremental techniques to accelerate value and return on investment to sponsors. This combination of various approaches is considered a hybrid approach.

Try these new techniques on a less risky project with a medium- to low-degree of uncertainty. Then, when the organization is successful with a hybrid approach, try more complex projects that require more of those techniques to be added. This is a way to tailor the progressive hybrid transition to the organization's situation and specific risks and the team's readiness to adapt and embrace the changes.

3.2 MIXING AGILE APPROACHES

Agile teams rarely limit their practices to one agile approach. Each project context has its own peculiarities, such as the varied mix of team member skills and backgrounds; the various components of the product under development; and the age, scale, criticality, complexity, and regulatory constraints of the environment in which the work takes place.

Agile frameworks are not customized for the team. The team may need to tailor practices to deliver value on a regular basis. Often, teams practice their own special blend of agile, even if they use a particular framework as a starting point.

BLENDING APPROACHES

As an example of tailoring agile frameworks, one of the most common blends in widespread use involves a coordinated use of the Scrum framework, the Kanban Method, and elements of the eXtreme Programming (XP) method. Scrum provides guidance on the use of a product backlog, a product owner, scrum master, and a cross-functional development team, including sprint planning, daily scrum, sprint review, and sprint retrospective sessions. A kanban board helps the team to further improve its effectiveness by visualizing the flow of work, making impediments easily visible, and allowing flow to be managed by adjusting work in process limits. In addition, XP-inspired engineering practices such as use of story cards, continuous integration, refactoring, automated testing, and test-driven development further increase the effectiveness of the agile team. In summary, the blend of practices from these various sources produces a synergistic result of higher performance than each individual component in isolation.

3.3 PROJECT FACTORS THAT INFLUENCE TAILORING

Sometimes project attributes require tailoring an approach for a better fit. Table 3-2 identifies some project factors and tailoring options to consider.

Table 3-2. Tailoring Options to Improve Fit

Project Factor	Tailoring Options
Demand pattern: steady or sporadic	Many teams find that using a cadence (in the form of a regular timebox) helps them demo, retrospect, and take in new work. In addition, some teams need more flexibility in their acceptance of more work. Teams can use flow-based agile with a cadence to get the best of both worlds.
Rate of process improvement required by the level of team experience	Retrospect more often and select improvements.
The flow of work is often interrupted by various delays or impediments	Consider making work visible using kanban boards and experimenting with limits for the various areas of the work process in order to improve flow.
The quality of the product increments is poor	Consider using the various test-driven development practices. This mistake-proofing discipline makes it difficult for defects to remain undetected.
More than one team is needed to build a product	To scale from one to several agile teams, with minimal disruption, first learn about agile program management or formal scaling frameworks. Then, craft an approach that fits the project context.
The project team members are inexperienced in the use of agile approaches	Consider starting by training team members in the fundamentals of the agile mindset and principles. If the team decides to use a specific approach such as Scrum or Kanban, provide a workshop on that approach so the team members can learn how to use it.

For additional guidance on factors that influence tailoring see Appendix X2 on Attributes that Influence Tailoring.

4

IMPLEMENTING AGILE: CREATING AN AGILE ENVIRONMENT

4.1 START WITH AN AGILE MINDSET

Managing a project using an agile approach requires that the project team adopt an agile mindset. The answers to the following questions will help to develop an implementation strategy:

- How can the project team act in an agile manner?
- What can the team deliver quickly and obtain early feedback to benefit the next delivery cycle?
- How can the team act in a transparent manner?
- What work can be avoided in order to focus on high-priority items?
- How can a servant-leadership approach benefit the achievement of the team's goals?

4.2 SERVANT LEADERSHIP EMPOWERS THE TEAM

Agile approaches emphasize servant leadership as a way to empower teams. Servant leadership is the practice of leading through service to the team, by focusing on understanding and addressing the needs and development of team members in order to enable the highest possible team performance.

The role of a servant leader is to facilitate the team's discovery and definition of agile. Servant leaders practice and radiate agile. Servant leaders approach project work in this order:

- **Purpose.** Work with the team to define the "why" or purpose so they can engage and coalesce around the goal for the project. The entire team optimizes at the project level, not the person level.
- **People.** Once the purpose is established, encourage the team to create an environment where everyone can succeed. Ask each team member to contribute across the project work.
- **Process.** Do not plan on following the "perfect" agile process, but instead look for the results. When a cross-functional team delivers finished value often and reflects on the product and process, the teams are agile. It does not matter what the team calls its process.

The following characteristics of servant leadership enable project leaders to become more agile and facilitate the team's success:

- Promoting self-awareness;
- Listening;
- Serving those on the team;
- Helping people grow;
- Coaching vs. controlling;
- Promoting safety, respect, and trust; and
- Promoting the energy and intelligence of others.

Servant leadership is not unique to agile. But once having practiced it, servant leaders can usually see how well servant leadership integrates into the agile mindset and value.

When leaders develop their servant leadership or facilitative skills, they are more likely to become agile. As a result, servant leaders can help their teams collaborate to deliver value faster.

Successful agile teams embrace the growth mindset, where people believe they can learn new skills. When the team and the servant leaders believe they can all learn, everyone becomes more capable.

4.2.1 SERVANT LEADER RESPONSIBILITIES

Servant leaders manage relationships to build communication and coordination within the team and across the organization. These relationships help the leaders navigate the organization to support the team. This kind of support helps to remove impediments and facilitates the team to streamline its processes. Because servant leaders understand agile and practice a specific approach to agile, they can assist in fulfilling the team's needs.

4.2.1.1 SERVANT LEADERS FACILITATE

When project managers act as servant leaders, the emphasis shifts from "managing coordination" to "facilitating collaboration." Facilitators help everyone do their best thinking and work. Facilitators encourage the team's participation, understanding, and shared responsibility for the team's output. Facilitators help the team create acceptable solutions.

Servant leaders promote collaboration and conversation within the team and between teams. For example, a servant leader helps to expose and communicate bottlenecks inside and between teams. Then the teams resolve those bottlenecks.

Additionally, a facilitator encourages collaboration through interactive meetings, informal dialog, and knowledge sharing. Servant leaders do this by becoming impartial bridge-builders and coaches, rather than by making decisions for which others should be responsible.

4.2.1.2 SERVANT LEADERS REMOVE ORGANIZATIONAL IMPEDIMENTS

The first value of the Agile Manifesto is individuals and interactions over processes and tools. What better responsibility for a servant leader to take on than to take a hard look at processes that are impeding a team's or organization's agility and work to streamline them? For example, if a department requires extensive documentation, the role of the servant leader could be to work with that department to review required documentation, assist with creating a shared understanding of how agile deliverables meet those requirements, and evaluate the amount of documentation required so teams are spending more time delivering a valuable product instead of producing exhaustive documentation.

Servant leaders should also look at other processes that are lengthy, causing bottlenecks and impeding a team's or organization's agility. Examples of processes or departments that may need to be addressed include finance, change control boards, or audits. Servant leaders can partner and work with others to challenge them to review their processes to support agile teams and leaders. For example, what good is it for the team to deliver working product every 2 weeks only to have the product fall into a queue or process that could take 6 or more weeks to release due to lengthy release processes? Far too many organizations have these "bottleneck" processes that prevent teams from quickly delivering valuable products or services. The servant leader has the ability to change or remove these organizational impediments to support delivery teams.

INTERPERSONAL SKILLS VERSUS TECHNICAL SKILLS

In addition to servant leadership, team members emphasize their interpersonal and emotional intelligence skills—not just technical skills. Everyone on the team works to exhibit more initiative, integrity, emotional intelligence, honesty, collaboration, humility, and willingness to communicate in various ways so that the entire team can work together well.

The team needs these skills so they can respond well to changes in project direction and technical product changes. When everyone can adapt to the work and to each other, the entire team is more likely to succeed.

4.2.1.3 SERVANT LEADERS PAVE THE WAY FOR OTHERS' CONTRIBUTION

In agile, the team manages its work process and its work product. That self-management and self-organization applies to everyone serving and supporting the organization and project. Servant leaders work to fulfill the needs of the teams, projects, and organization. Servant leaders may work with facilities for a team space, work with management to enable the team to focus on one project at a time, or work with the product owner to develop stories with the team. Some servant leaders work with auditors to refine the processes needed in regulatory environments, and some servant leaders work with the finance department to transition the organization to incremental budgeting.

The servant leader focuses on paving the way for the team to do its best work. The servant leader influences projects and encourages the organization to think differently.

4.2.1.4 CONSIDER THESE SERVANT LEADER RESPONSIBILITIES

Servant leaders can have many possible titles, but what is most important is what they do. Here are some examples of the responsibilities a servant leader may have:

- Educate stakeholders around why and how to be agile. Explain the benefits of business value based on prioritization, greater accountability and productivity of empowered teams, and improved quality from more frequent reviews, etc.
- Support the team through mentoring, encouragement, and support. Advocate for team members training and career development. The oxymoronic quote "We lead teams by standing behind them" speaks to the role of the leader in developing their team members. Through support, encouragement, and professional development, team members gain confidence, take on larger roles, and contribute at higher levels within their organizations. A key role of the servant leader is to nurture and grow team members through and beyond their current roles, even if that means losing them from the team.
- Help the team with technical project management activities like quantitative risk analysis. Sometimes team members may not have knowledge or experience in roles or functions. Servant leaders who may have more exposure or training in techniques can support the team by providing training or undertaking these activities.
- Celebrate team successes and support and bridge building activities with external groups. Create upward spirals of appreciation and good will for increased collaboration.

4.2.2 ROLE OF THE PROJECT MANAGER IN AN AGILE ENVIRONMENT

The role of the project manager in an agile project is somewhat of an unknown, because many agile frameworks and approaches do not address the role of the project manager. Some agile practitioners think the role of a project manager is not needed, due to self-organizing teams taking on the former responsibilities of the project manager. However, pragmatic agile practitioners and organizations realize that project managers can add significant value in many situations. The key difference is that their roles and responsibilities look somewhat different.

TIP

The value of project managers is not in their position, but in their ability to make everyone else better.

4.2.3 PROJECT MANAGERS USE SERVANT LEADERSHIP

The *PMBOK® Guide* – Sixth Edition, defines the project manager as "the person assigned by the performing organization to lead the team that is responsible for achieving the project objectives."

Many project managers are accustomed to being at the center of coordination for the project, tracking and representing the team's status to the rest of the organization. This approach was fine when projects were decomposed into siloed functions.

However, in high-change projects, there is more complexity than one person can manage. Instead, cross-functional teams coordinate their own work and collaborate with the business representative (the product owner).

When working on an agile project, project managers shift from being the center to serving the team and the management. In an agile environment, project managers are servant leaders, changing their emphasis to coaching people who want help, fostering greater collaboration on the team, and aligning stakeholder needs. As a servant leader, project managers encourage the distribution of responsibility to the team: to those people who have the knowledge to get work done.

4.3 TEAM COMPOSITION

A core tenet in both the values and the principles of the Agile Manifesto is the importance of individuals and interactions. Agile optimizes the flow of value, emphasizing rapid feature delivery to the customer, rather than on how people are "utilized."

TIP

Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done.

When teams think about how to optimize the flow of value, the following benefits become apparent:

- People are more likely to collaborate.
- Teams finish valuable work faster.
- Teams waste much less time because they do not multitask and have to re-establish context.

4.3.1 AGILE TEAMS

Agile teams focus on rapid product development so they can obtain feedback. In practice, the most effective agile teams tend to range in size from three to nine members. Ideally, agile teams are colocated in a team space. Team members are 100% dedicated to the teams. Agile encourages self-managing teams, where team members decide who will perform the work within the next period's defined scope. Agile teams thrive with servant leadership. The leaders support the teams' approach to their work.

Cross-functional agile teams produce functional product increments frequently. That is because the teams collectively own the work and together have all of the necessary skills to deliver completed work.

Regardless of the overall agile approach, the more a team limits its work in progress, the more likely its members can collaborate to expedite work across the board. Team members in successful agile teams work to collaborate in various ways (such as pairing, swarming, and mobbing) so they do not fall into the trap of mini-waterfalls instead of collaborative work. Mini-waterfalls occur when the team addresses *all* of the requirements in a given period, then attempts to do *all* of the design, then moves on to do *all* of the building. Using this scenario, at some point in the building or the testing following the building, the team may realize it had assumptions that are no longer valid. In this case, the team wasted time in addressing *all* of the requirements. Instead, when team members collaborate to produce a small number of features across the board, they learn as they proceed and deliver smaller finished features.

Agile projects benefit from project team structures that improve collaboration within and among the teams. Table 4-1 shows how collaborative team members boost productivity and facilitate innovative problem solving.

Table 4-1. Attributes of Successful Agile Teams

Attribute	Goal
Dedicated people	• Increased focus and productivity • Small team, fewer than ten people
Cross-functional team members	• Develop and deliver often • Deliver finished value as an independent team • Integrate all the work activities to deliver finished work • Provide feedback from inside the team and from others, such as the product owner
Colocation or ability to manage any location challenges	• Better communication • Improved team dynamics • Knowledge sharing • Reduced cost of learning • Able to commit to working with each other
Mixed team of generalists and specialists	• Specialists provide dedicated expertise and generalists provide flexibility of who does what • Team brings their specialist capabilities and often become generalizing specialists, with a focus specialty plus breadth of experience across multiple skills
Stable work environment	• Depend on each other to deliver • Agreed-upon approach to the work • Simplified team cost calculations (run rate) • Preservation and expansion of intellectual capital

4.3.2 AGILE ROLES

In agile, three common roles are used:

- Cross-functional team members,
- Product owner, and
- Team facilitator.

Table 4-2 describes these team roles.

Table 4-2. Agile Team Roles

Role	Description
Cross-functional team member	Cross-functional teams consist of team members with all the skills necessary to produce a working product. In software development, cross-functional teams are typically comprised of designers, developers, testers, and any other required roles. The cross-functional development teams consist of professionals who deliver potentially releasable product on a regular cadence. Cross-functional teams are critical because they can deliver finished work in the shortest possible time, with higher quality, without external dependencies.
Product owner	The product owner is responsible for guiding the direction of the product. Product owners rank the work based on its business value. Product owners work with their teams daily by providing product feedback and setting direction on the next piece of functionality to be developed/delivered. That means the work is small, often small enough to be described on one index card. The product owner works with stakeholders, customers, and the teams to define the product direction. Typically, product owners have a business background and bring deep subject matter expertise to the decisions. Sometimes, the product owner requests help from people with deep domain expertise, such as architects, or deep customer expertise, such as product managers. Product owners need training on how to organize and manage the flow of work through the team. In agile, the product owners create the backlog for and with the team. The backlog helps the teams see how to deliver the highest value without creating waste. A critical success factor for agile teams is strong product ownership. Without attention to the highest value for the customer, the agile team may create features that are not appreciated, or otherwise insufficiently valuable, therefore wasting effort.
Team facilitator	The third role typically seen on agile teams is of a team facilitator, a servant leader. This role may be called a project manager, scrum master, project team lead, team coach, or team facilitator. All agile teams need servant leadership on the team. People need time to build their servant leadership skills of facilitation, coaching, and impediment removal. Initially, many organizations invite external agile coaches to help them when their internal coaching capability is not yet fully developed. External coaches have the advantage of experience, but the disadvantage of weak relationships in the client organization. Internal coaches, on the other hand, have strong relationships in their organization, but may lack the breadth of experience that would make them highly effective.

"I-SHAPED PEOPLE AND T-SHAPED PEOPLE"

Some people have deep specializations in one domain, but rarely contribute outside of that domain. These people are known in agile communities as "I-shaped people" since, like the letter "I," they have depth, but not much breadth. By contrast "T-shaped people" supplement their expertise in one area with supporting, but less-developed skills in associated areas and good collaboration skills. As an example, a person who can test some areas of the product and develop different areas of the product is considered to be a T-shaped person.

A T-shaped person has a defined, recognized specialization and primary role, but has the skills, versatility, and aptitude for collaboration to help other people when and where necessary. This collaboration reduces hand-offs and the constraints of only one person being able to do the job.

4.3.3 GENERALIZING SPECIALISTS

Agile teams are cross-functional, but the people often do not start off that way. However, many successful agile teams are made up of generalizing specialists, or "T-shaped" people.

This means team members have both a focus specialty plus a breadth of experience across multiple skills, rather than a single specialization. Agile team members work to develop such characteristics due to intense collaboration and self-organization to swarm and get work done quickly, which requires them to routinely help each other.

A single person's throughput is not relevant. Focusing on a single person's throughput may even be harmful if it creates a bottleneck for the rest of the team. The goal is for the *team* to optimize the delivery of finished work to get feedback.

If the customer desires great results, such as rapid feature delivery with excellent quality, the team cannot be structured just with specialist roles in an attempt to maximize resource efficiency. The team's objective is flow efficiency, optimizing the throughput of the entire team. Small batch sizes promote working together as a team. The product owner's job is to make sure the team works on the highest-value work.

4.3.4 TEAM STRUCTURES

Teams have adopted agile principles and practices across many industries. They organize people into cross-functional teams to iteratively develop working products.

CASE

The core team assembled to write this practice guide had varied backgrounds—some represented PMI and some represented Agile Alliance. They were self-organizing and worked in increments to complete the work. PMI assembled a group of subject matter experts to inspect the work, and this allowed the team to incorporate feedback and improve the product as it was developed. However the core team was not representative of a typical agile team because its members' time was not 100% dedicated to this endeavor.

Some organizations have been able to create colocated, cross-functional teams; others have a different situation. Instead of having all team members colocated, some organizations have distributed or dispersed teams. Distributed teams have cross-functional teams in different locations. Dispersed teams may have each team member working in a completely different location, either in an office or from home. While these arrangements are not ideal due to increased communication costs, they may still be workable.

In one large, U.S.-based financial institution there was a program with a set of teams where the team members were based on the East Coast of the United States and several locations throughout India. When the team first started, it was one large dispersed team (UX, analysts, developers, and testers) doing a "follow the sun"[2] development practice where some working time overlapped across the team members to do warm hand-offs with the work. Team members conducted daily standups together and used webcams to include all team members. Key roles (analysts, product owners, UX designers, and development leads) in the U.S. would come in early to answer any questions from their India-based team members and help to resolve impediments.

As the product started getting larger, and more funding came through, they decided to break into five smaller teams. To do this, they decided to build colocated, distributed teams in various locations. They made the decision to build cross-functional, colocated teams in each of these locations consisting of developers and testers.

They also had a core set of analysts, based in the two U.S. locations, who worked with their U.S.-based product manager and product owners and then worked with each of the teams, respectively. Although they had some structure in place where they conducted product reviews as an entire program, most of the other activities were conducted at a team level, based on what worked best for each team, to allow them to self-organize.

4.3.5 DEDICATED TEAM MEMBERS

What happens when the team members' time is not 100% dedicated to the team? While this condition is not ideal, unfortunately, it sometimes cannot be avoided.

The key problem with having someone invest only a capacity of 25% or 50% on the team is that they will multitask and task switch. Multitasking reduces the throughput of the team's work and impacts the team's ability to predict delivery consistently.

TIP

Multitasking slows the progress of the entire team, because team members waste time context switching and/or waiting for each other to finish other work. When people are 100% dedicated to the team, the team has the fastest possible throughput.

[2] A follow-the-sun development process is one where work is handed off at the end of every day from one site to the next, many time zones away in order to speed up product development.

People experience productivity losses somewhere between 20% and 40% when task switching. The loss increases exponentially with the number of tasks.

When a person multitasks between two projects, that person is not 50% on each project. Instead, due to the cost of task switching, the person is somewhere between 20% and 40% on each project.

People are more likely to make mistakes when they multitask. Task-switching consumes working memory and people are less likely to remember their context when they multitask.

When everyone on the team is 100% allocated to one project, they can continuously collaborate as a team, making everyone's work more effective.

CASE

Since core team members developing this practice guide cannot dedicate 100% of their capacity to the team's efforts, their throughput is substantially lower than what it might be if they could afford to collocate and invest their attention full-time to the project. However, while it is economically viable to collaborate, even if dispersed and operating at a fraction of their full capacity, it is not feasible to colocate and focus at full capacity. Therefore, the team identified their dispersion as a potential risk. The team tracks and monitors the progress of their work through the use of collaborative tools and adjusts assignments based on individual capacity accordingly.

See Table A1-2 on Project Management Process Group and Knowledge Area Mapping for more tips on teams in agile environments, specifically the processes in the Project Resource Management Knowledge Area.

TIP

Not all teams have all the roles that they need. For example, some teams need support from database administrators or research analysts. When a team has temporarily assigned specialists, it is important to ensure that everyone has the same set of expectations. Is this specialist 100% allocated to the team and for how long? Set expectations with everyone (the specialist and the team) to clarify the level of commitment so the team can deliver. Part-time assignments create risks for the project.

4.3.6 TEAM WORKSPACES

Teams need a space in which they can work together, to understand their state as a team, and to collaborate. Some agile teams all work in one room together. Some teams have a team workspace for their standups and charts, and work on their own in cubicles or offices.

While companies are moving toward open, collaborative work environments, organizations also need to create quiet spaces for workers who need uninterrupted time to think and work. Therefore, companies are designing their offices to balance common and social areas (sometimes called "caves and common") with quiet areas or private spaces where individuals can work without being interrupted.

When teams have geographically distributed members, the team decides how much of their workplace is virtual and how much is physical. Technology such as document sharing, video conferencing, and other virtual collaboration tools help people collaborate remotely.

Geographically distributed teams need virtual workspaces. In addition, consider getting the team together in person at regular intervals so the team can build trust and learn how to work together.

Some techniques to consider for managing communication in dispersed teams are *fishbowl windows* and *remote pairing*:

- Create a fishbowl window by setting up long-lived video conferencing links between the various locations in which the team is dispersed. People start the link at the beginning of a workday, and close it at the end. In this way, people can see and engage spontaneously with each other, reducing the collaboration lag otherwise inherent in the geographical separation.
- Set up remote pairing by using virtual conferencing tools to share screens, including voice and video links. As long as the time zone differences are accounted for, this may prove almost as effective as face-to-face pairing.

TIP

Form teams by bringing people with different skills from different functions together. Educate managers and leaders about the agile mindset and engage them early in the agile transformation.

4.3.7 OVERCOMING ORGANIZATIONAL SILOS

The best place to start when forming agile teams is by building a foundational trust and a safe work environment to ensure that all team members have an equal voice and can be heard and considered. This, along with building the agile mindset is the underlying success factor—all other challenges and risks can be mitigated.

Often, siloed organizations create impediments for forming cross-functional agile teams. The team members needed to build the cross-functional teams typically report to different managers and have different metrics by which managers measure their performance. Managers need to focus on flow efficiency (and team-based metrics) rather than resource efficiency.

To overcome organizational silos, work with the various managers of these team members and have them dedicate the necessary individuals to the cross-functional team. This not only creates team synergy but also allows the organization to see how leveraging its people will optimize the project or product being built.

For more information about teams see Appendix X2 on Attributes that Influence Tailoring.

TIP

As an agile project leader, first focus on how you can create a team that is cross-functional and 100% dedicated to one team. Even if it means just getting key team members, such as the developers and testers, to work and communicate together on a daily basis, that is a step in the right direction toward agility.

5

IMPLEMENTING AGILE: DELIVERING IN AN AGILE ENVIRONMENT

5.1 CHARTER THE PROJECT AND THE TEAM

Every project needs a project charter so the project team knows why this project matters, where the team is headed and what the project objective is. However, the project charter itself may not be enough for the team. Agile teams require team norms and an understanding of how to work together. In that case, the team might need a team charter.

The chartering process helps the team learn how to work together and coalesce around the project.

At a minimum, for an agile project, the team needs the project vision or purpose and a clear set of working agreements. An agile project charter answers these questions:

- Why are we doing this project? This is the project vision.
- Who benefits and how? This may be part of the project vision and/or project purpose.
- What does done mean for the project? These are the project's release criteria.
- How are we going to work together? This explains the intended flow of work.

A servant leader may facilitate the chartering process. A team can coalesce by working together, and the project charter is a great way to start working. In addition, team members may want to collaborate to understand how they will work together.

Teams do not need a formal process for chartering as long as the teams understand how to work together. Some teams benefit from a team chartering process. Here are some chartering ideas for team members to use as a basis for their social contract:

- Team values, such as sustainable pace and core hours;
- Working agreements, such as what "ready" means so the team can take in work; what "done" means so the team can judge completeness consistently; respecting the timebox; or the use of work-in-process limits;
- Ground rules, such as one person talking in a meeting; and
- Group norms, such as how the team treats meeting times.

The servant leader together with the team may decide to address other behaviors.

Remember that the team's social contract—its team charter—is how the team members interact with each other. The goal of the team charter is to create an agile environment in which team members can work to the best of their ability as a team.

5.2 COMMON AGILE PRACTICES

Sections 5.2.1 through 5.2.8 describe a few of the most common agile project practices.

5.2.1 RETROSPECTIVES

The single most important practice is the retrospective because it allows the team to learn about, improve, and adapt its process.

Retrospectives help the team learn from its previous work on the product and its process. One of the principles behind the Agile Manifesto is: "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly."

Many teams use iterations—especially 2-week iterations—because the iteration prompts a demonstration and a retrospective at the end. However, the team does not need iterations in order to retrospect. Team members may decide to retrospect at these key times:

- When the team completes a release or ships something. It does not have to be a monumental increment. It can be any release, no matter how small.
- When more than a few weeks have passed since the previous retrospective.
- When the team appears to be stuck and completed work is not flowing through the team.
- When the team reaches any other milestone.

Teams benefit from allocating enough time to learn, either from an interim retrospective or an end-of-the-project retrospective. Teams need to learn about their work product and work process. For example, some teams have trouble finishing work. When teams plan enough time, they can structure their retrospective to gather data, process that data, and decide what to try later as an experiment.

First and foremost, a retrospective is not about blame; the retrospective is a time for the team to learn from previous work and make small improvements.

The retrospective is about looking at the qualitative (people's feelings) and quantitative (measurements) data, then using that data to find root causes, designing countermeasures, and developing action plans. The project team may end up with many action items to remove impediments.

Consider limiting the number of action items to the team's capacity to address improvement in the upcoming iteration or work period. Trying to improve too many things at once and not finishing any of them is much worse than planning to complete fewer items and successfully completing all of them. Then, when time allows, the team can work on the next improvement opportunity on the list. When the team selects the improvements, decide how to measure the outcomes. Then, in the next time period, measure the outcomes to validate success or failure of each improvement.

A facilitator from the team leads them through an activity to rank the importance of each improvement item. Once the improvement items are ranked by the team, the team chooses the appropriate number to work on for the next iteration (or adds work to the flow if flow-based).

5.2.2 BACKLOG PREPARATION

The backlog is the ordered list of all the work, presented in story form, for a team. There is no need to create all of the stories for the entire project before the work starts—only enough to understand the first release in broad brushstrokes and then sufficient items for the next iteration.

Product owners (or a product owner value team that includes the product manager and all relevant product owners for that area of the product,) might produce a product roadmap to show the anticipated sequence of deliverables over time. The product owner replans the roadmap based on what the team produces. (See Appendix X3 on Agile Suitability Filter Tools for examples of roadmaps.)

5.2.3 BACKLOG REFINEMENT

In iteration-based agile, the product owner often works with the team to prepare some stories for the upcoming iteration during one or more sessions in the middle of the iteration. The purpose of these meetings is to refine enough stories so the team understands what the stories are and how large the stories are in relation to each other.

There is no consensus on how long the refinement should be. There is a continuum of:

- Just-in-time refinement for flow-based agile. The team takes the next card off the to-do column and discusses it.
- Many iteration-based agile teams use a timeboxed 1-hour discussion midway through a 2-week iteration. (The team selects an iteration duration that provides them frequent-enough feedback.)
- Multiple refinement discussions for iteration-based agile teams. Teams can use this when they are new to the product, the product area, or the problem domain.

TIP

Consider using impact mapping to see how the product fits together. Under normal circumstances, the product owner leads this work. A servant leader can facilitate any necessary meetings as a way of serving the project.

Refinement meetings allow the product owner to present story ideas to the team and for the team to learn about the potential challenges or problems in the stories. If the product owner is unsure of the dependencies, the product owner can request the team to spike the feature in order to understand the risks.

There are many ways for the product owner to conduct backlog preparation and refinement meetings, including for example:

- Encourage the team to work as triads of developer, tester, business analyst/product owner to discuss and write the story.
- Present the overall story concept to the team. The team discusses and refines it into as many stories as required.
- Work with the team to find various ways to explore and write the stories together, making sure all of the stories are small enough so the team can produce a steady flow of completed work. Consider becoming able to complete a story at least once a day.

Teams often have a goal of spending not more than 1 hour per week refining stories for the next batch of work. Teams want to maximize the time spent doing work as opposed to planning work. If the team needs to spend more than 1 hour per week refining stories, the product owner could be overpreparing, or the team may be lacking some critical skills needed to evaluate and refine the work.

5.2.4 DAILY STANDUPS

Teams use standups to microcommit to each other, uncover problems, and ensure the work flows smoothly through the team.

Timebox the standup to no longer than 15 minutes. The team "walks" the Kanban or task board in some way, and anyone from the team can facilitate the standup.

In iteration-based agile, everyone answers the following questions in a round-robin fashion:

- What did I complete since the last standup?
- What am I planning to complete between now and the next standup?
- What are my impediments (or risks or problems)?

Questions like these generate answers that allow the team to self-organize and hold each other accountable for completing the work they committed to the day before and throughout the iteration.

Flow-based agile has a different approach to standups, focusing on the team's throughput. The team assesses the board from right to left. The questions are:

- What do we need to do to advance this piece of work?
- Is anyone working on anything that is not on the board?
- What do we need to finish as a team?
- Are there any bottlenecks or blockers to the flow of work?

One of the antipatterns typically seen in standups is they become status meetings. Teams who have traditionally worked in a predictive environment may tend to fall into this antipattern since they are used to providing a status.

Another antipattern typically seen in standups is that the team begins to solve problems as they become apparent. Standups are for realizing there are problems—not for solving them. Add the issues to a parking lot, and then create another meeting, which might be right after the standup, and solve problems there.

Teams run their own standups. When run well, standups can be very useful, provided the nature of the team's work requires intense collaboration. Make a conscious decision about when the team needs, or can effectively use, standups.

TIP

Encourage any team member to facilitate the standup instead of a project manager or leader to ensure it does not turn into a status meeting, but instead is used as a time for the team to self-organize and make commitments to each other.

5.2.5 DEMONSTRATIONS/REVIEWS

As the team completes the features usually in the form of user stories, the team periodically demonstrates the working product. The product owner sees the demonstration and accepts or declines stories.

In iteration-based agile, the team demonstrates all completed work items at the end of the iteration. In flow-based agile, the team demonstrates completed work when it is time to do so, usually when enough features have accumulated into a set that is coherent. Teams, including the product owner, need feedback to decide how early to ask for product feedback.

As a general guideline, demonstrate whatever the team has as a working product at least once every 2 weeks. That frequency is enough for most teams, so team members can get feedback that prevents them from heading in a wrong direction. That is also frequent enough so that the teams can keep the product development clean enough to build a complete product as often as they want or need to.

A fundamental part of what makes a project agile is the frequent delivery of a working product. A team that does not demonstrate or release cannot learn fast enough and is likely not adopting agile techniques. The team may require additional coaching to enable frequent delivery.

5.2.6 PLANNING FOR ITERATION-BASED AGILE

Each team's capacity is different. Each product owner's typical story size is different. Teams consider their story size so they do not try to commit to more stories than there is team capacity to complete within one iteration.

When people are unavailable (e.g., holidays, vacations, or anything that prevents people from participating in the next set of work), the product owner understands that the team has reduced capacity. The team will not be able to finish the same amount of work as it finished in the previous time period. When teams have a reduced capacity, they will only plan for work that meets that capacity.

Teams estimate what they can complete, which is a measure of capacity (see Section 4.10 for examples). Teams cannot predict with 100% certainty what they can deliver, as they cannot know the unexpected. When product owners make the stories smaller and teams see progress in the form of a finished product, teams learn what they are able to do for the future.

Agile teams do not plan just once in one single chunk. Instead, agile teams plan a little, deliver, learn, and then replan a little more in an ongoing cycle.

TIP

Draw the team's attention to the antipattern and help the team to discover how to improve its standups.

5.2.7 EXECUTION PRACTICES THAT HELP TEAMS DELIVER VALUE

If the team does not pay attention to quality, it will soon become impossible to release anything rapidly.

The following technical practices, many of which come from eXtreme Programming, may help the team to deliver at their maximum speed:

- **Continuous integration.** Perform frequent incorporation of work into the whole, no matter the product, and then retest to determine that the entire product still works as intended.
- **Test at all levels.** Employ system-level testing for end-to-end information and unit testing for the building blocks. In between, understand if there is a need for integration testing and where. Teams find smoke testing helpful as a first look at whether the work product is any good. Teams have found that deciding when to run regression tests and which ones helps them maintain product quality with good build performance. Agile teams have a strong preference for automated tests so they can build and maintain a momentum of delivery.
- **Acceptance Test-Driven Development (ATDD).** In ATDD, the entire team gets together and discusses the acceptance criteria for a work product. Then the team creates the tests, which allows the team to write just enough code and automated tests to meet the criteria. For non-software projects, consider how to test the work as the team completes chunks of value.
- **Test-Driven Development (TDD) and Behavior-Driven Development (BDD).** Writing automated tests before writing/creating the product actually helps people design and mistake-proof the product. For non-software projects, consider how to "test-drive" the team's designs. Hardware and mechanical projects often use simulations for interim tests of their designs.
- **Spikes (timeboxed research or experiments).** Spikes are useful for learning and may be used in circumstances such as: estimation, acceptance criteria definition, and understanding the flow of a user's action through the product. Spikes are helpful when the team needs to learn some critical technical or functional element.

5.2.8 HOW ITERATIONS AND INCREMENTS HELP DELIVER WORKING PRODUCT

Iterations help a team create a cadence for delivery and many kinds of feedback. Teams produce increments of value for delivery and feedback. The first part of this delivery is a demonstration. Teams receive feedback about how the product looks and operates through a demo. Team members retrospect to see how they can inspect and adapt their process to succeed.

Demonstrations or reviews are a necessary part of the agile project flow. Schedule the demonstration as appropriate for the team's delivery cadence.

5.3 TROUBLESHOOTING AGILE PROJECT CHALLENGES

Agile approaches were born out of the need to solve issues associated with high rates of change, uncertainty, and complexity on projects. Due to these origins, they contain a variety of tools and techniques for dealing with issues that present problems in predictive approaches. Refer to Table 5-1.

TIP

Teams should demo often for feedback and to show progress. Encourage the PMO and other interested parties to watch demonstrations so the people deciding on the project portfolio can see the actual progress.

Table 5-1. Agile Pain Points and Troubleshooting Possibilities

Pain Point	Troubleshooting Possibilities
Unclear purpose or mission for the team	Agile chartering for purpose—vision, mission, and mission tests
Unclear working agreements for the team	Agile chartering for alignment—values, principles, and working agreements
Unclear team context	Agile chartering for context—boundaries, committed assets, and prospective analysis
Unclear requirements	Help sponsors and stakeholders craft a product vision. Consider building a product roadmap using specification by example, user story mapping, and impact mapping. Bring the team and product owner together to clarify the expectations and value of a requirement. Progressively decompose roadmap into backlog of smaller, concrete requirements.
Poor user experience	User experience design practices included in the development team involve users early and often.
Inaccurate estimation	Reduce story size by splitting stories. Use relative estimation with the entire team to estimate. Consider agile modeling or spiking to understand what the story is.
Unclear work assignments or work progress	Help the team learn that they self-manage their work. Consider kanban boards to see the flow of work. Consider a daily standup to walk the board and see what work is where.
Team struggles with obstacles	A servant leader can help clear these obstacles. If the team doesn't know the options they have, consider a coach. Sometimes, the team needs to escalate stories the team or servant leader has not been able to remove.
Work delays/overruns due to insufficiently refined product backlog items	Product owner and team workshop stories together. Create a definition of ready for the stories. Consider splitting stories to use smaller stories.
Defects	Consider the technical practices that work for the environment. Some possibilities are: pair work, collective product ownership, pervasive testing (test-driven and automated testing approaches) and a robust definition of done.
Work is not complete	Team defines definition of done for stories including acceptance criteria. Also add release criteria for projects.
Technical debt (degraded code quality)	Refactoring, agile modeling, pervasive testing, automated code quality analysis, definition of done

Table 5-1. Agile Pain Points and Troubleshooting Possibilities *(cont.)*

Pain Point	Troubleshooting Possibilities
Too much product complexity	For software and non-software encourage the team always to be thinking "What is the simplest thing that would work?" and apply the agile principle of "Simplicity--the art of maximizing the amount of work not done". These help reduce complexity.
Slow or no improvement in the teamwork process	Capture no more than three items to improve at each retrospective. Ask the servant leader to help the team learn how to integrate those items.
Too much upfront work leading to rework	Instead of much upfront work, consider team spikes to learn. In addition, measure the WIP during the beginning of the project and see what the team's options are to deliver value instead of designs. Shorten iterations and create a robust definition of done.
False starts, wasted efforts	Ask the product owner to become an integral part of the team.
Inefficiently ordered product backlog items	Rank with value including cost of delay divided by duration (CD3) and other value models
Rush/wait uneven flow of work	Plan to the team's capacity and not more. Ask people to stop multitasking and be dedicated to one team. Ask the team to work as pairs, a swarm, or mob to even out the capabilities across the entire team.
Impossible stakeholder demands	Servant leadership to work with this stakeholder (and possibly product owner).
Unexpected or unforeseen delays	Ask the team to check in more often, use kanban boards to see the flow of work and work in progress limits to understand the impact of the demands on the team or product. Also track impediments and impediment removal on an impediment board.
Siloed teams, instead of cross-functional teams	Ask the people who are part of projects to self-organize as cross-functional teams. Use servant leadership skills to help the managers understand why agile needs cross-functional teams.

5.4 MEASUREMENTS IN AGILE PROJECTS

Transitioning to agile means using different measurements. Using agile means looking at new metrics that matter to the team and to management. These metrics matter because they focus on customer value.

One problem with status reporting is the team's ability to predict completion or to use traffic light status to describe the project. For instance, project leaders describe the project as "90% done." At that point the team tries to integrate the pieces into a product. The team discovers missing requirements or surprises, or finds that the product doesn't integrate the way they thought it would.

The project is only partway done, and the traffic light status reporting does not reflect the real state. Too often, the project team realizes it will need just as much time to complete the remainder of the project. For too many projects, the team realizes they are—at most—10% done because of issues the team discovered.

The problem with predictive measurements is that they often do not reflect reality. It often happens that a project status light is green up until 1 month before the release date; this is sometimes referred to as a watermelon project (green on the outside, red on the inside). Oftentimes project status lights turn red with seemingly no warnings, because there is no empirical data about the project until 1 month before the release date.

Metrics for agile projects contain meaningful information that provide a historical track record, because agile projects deliver value (finished work) on a regular basis. Project teams can use such data for improved forecasts and decision making.

Surrogate measurements such as percent done are less useful than empirical measurements such as finished features. See Section 4.10 for more information on value management. Agile helps teams see problems and issues so the team can diagnose and address them.

In addition to quantitative measures, the team can consider collecting qualitative measures. Some of these qualitative measures focus on practices the team has chosen and assess how well the team uses those practices, for example, the business satisfaction with delivered features, the morale of the team; and anything else the team wants to track as a qualitative measure.

5.4.1 AGILE TEAMS MEASURE RESULTS

Agile favors empirical and value-based measurements instead of predictive measurements. Agile measures what the team delivers, not what the team predicts it will deliver.

A team that is accustomed to having project baselines and estimates of earned value and ROI might be puzzled about working on a project and not managing to a baseline. Agile is based on working products of demonstrable value to customers.

Baselines are often an artifact of attempted prediction. In agile, the team limits its estimation to the next few weeks at most. In agile, if there is low variability in the team's work and if the team members are not multitasking, the team's capacity can become stable. This allows better prediction for the next couple of weeks.

After the team completes work in iteration or flow, the team can replan. Agile does not create the ability to do more work. However, there is evidence that the smaller the chunk of work, the more likely people are to deliver it.

Software product development, like other knowledge work, is about learning—learning while delivering value. Hardware development and mechanical development are similar in the design parts of the project. Learning takes place by experimenting, delivering small increments of value, and getting feedback on what has been accomplished thus far. Many other product development projects incorporate learning also.

Sponsors usually want to know when the project will be done. Once the team establishes a reliable velocity (average stories or story points per iteration) or the average cycle time, the team can predict how much longer the project will take.

As an example, if the team averages 50 story points per iteration, and the team estimates there are about another 500 points remaining, the team estimates it has about 10 iterations remaining. As the product owner refines the stories remaining and as the team refines its estimates, the project estimate could go up or down, but the team can provide an estimate.

If the team averages a cycle time of three days per story and there are 30 remaining stories, the team would have 90 business days remaining, approximately 4 to 5 months.

Reflect the estimate variability with hurricane-style charts, or some other variability measure that the sponsors will understand.

Because learning is such a large part of the project, the team needs to balance uncertainty and provide value to the customers. The team plans the next small part of the project. The team reports empirical data and replans further small increments to manage the project uncertainty.

Some iteration-based projects use burndown charts to see where the project is going over time. Figure 5-1 shows an example of a burndown chart where the team planned to deliver 37 story points. Story points rate the relative work, risk, and complexity of a requirement or story. Many agile teams use story points to estimate effort. The dotted burndown line is the plan. In Figure 5-1, the team can see by Day 3 that they are at risk for that delivery.

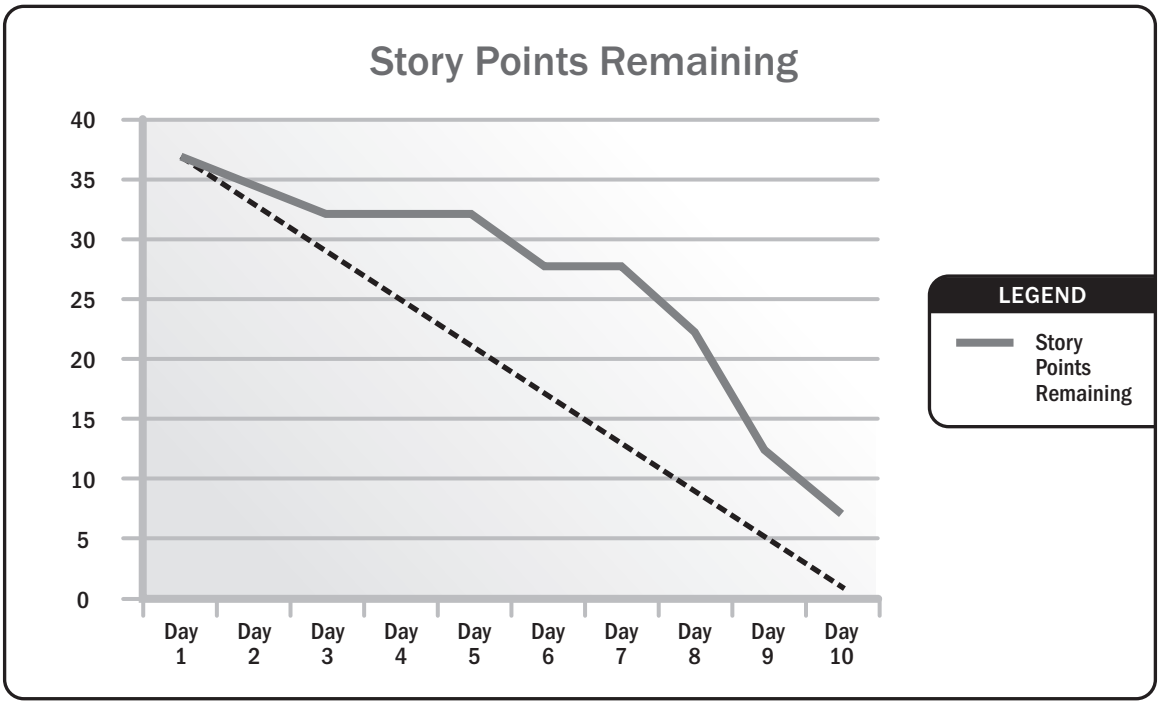


Figure 5-1. Burndown Chart for Remaining Story Points

Some project teams prefer burnup charts. The same data used in Figure 5-1 is shown in Figure 5-2 in a burnup chart.

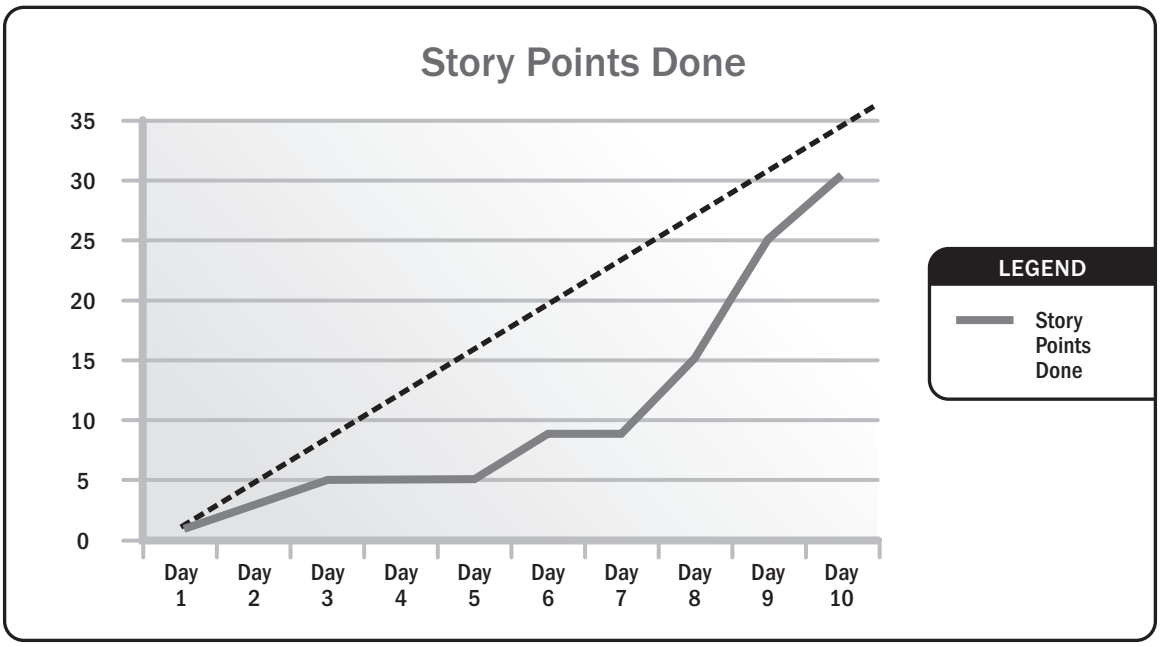


Figure 5-2. Burnup Chart for Showing Story Points Completed

Burnup charts show the work completed. The two charts in Figures 5-1 and 5-2 are based on the same data, but displayed in two different ways. Teams may prefer how to see their data.

When a team sees what it has not yet completed as it works through an iteration, the team may become dispirited and possibly rush to complete the work without meeting the acceptance criteria. However, the team could have any number of good reasons for not completing work as it expected. Burndowns show the effect of team members multitasking, stories that are too large, or team members out of the office.

Especially with teams new to agile, the burnup will show changes in scope during the iteration. Burnups allow teams to see what they have accomplished, which helps the team proceed to the next piece of work.

Whether teams use burndown or burnup charts, they see what they have completed as the iteration progresses. At the end of the iteration, they might base their next measure of capacity (how many stories or story points) on what they completed in this iteration. That allows the product owner along with the team to replan what the team is more likely to succeed in delivering in the next iteration.

Velocity, the sum of the story point sizes for the features actually completed in this iteration, allows the team to plan its next capacity more accurately by looking at its historical performance.

Flow-based agile teams use different measurements: lead time (the total time it takes to deliver an item, measured from the time it is added to the board to the moment it is completed), cycle time (the time required to process an item), and response time (the time that an item waits until work starts). Teams measure cycle time to see bottlenecks and delays, not necessarily inside the team.

TIP

Teams might discover it can take four to eight iterations to achieve a stable velocity. The teams need the feedback from each iteration to learn about how they work and how to improve.

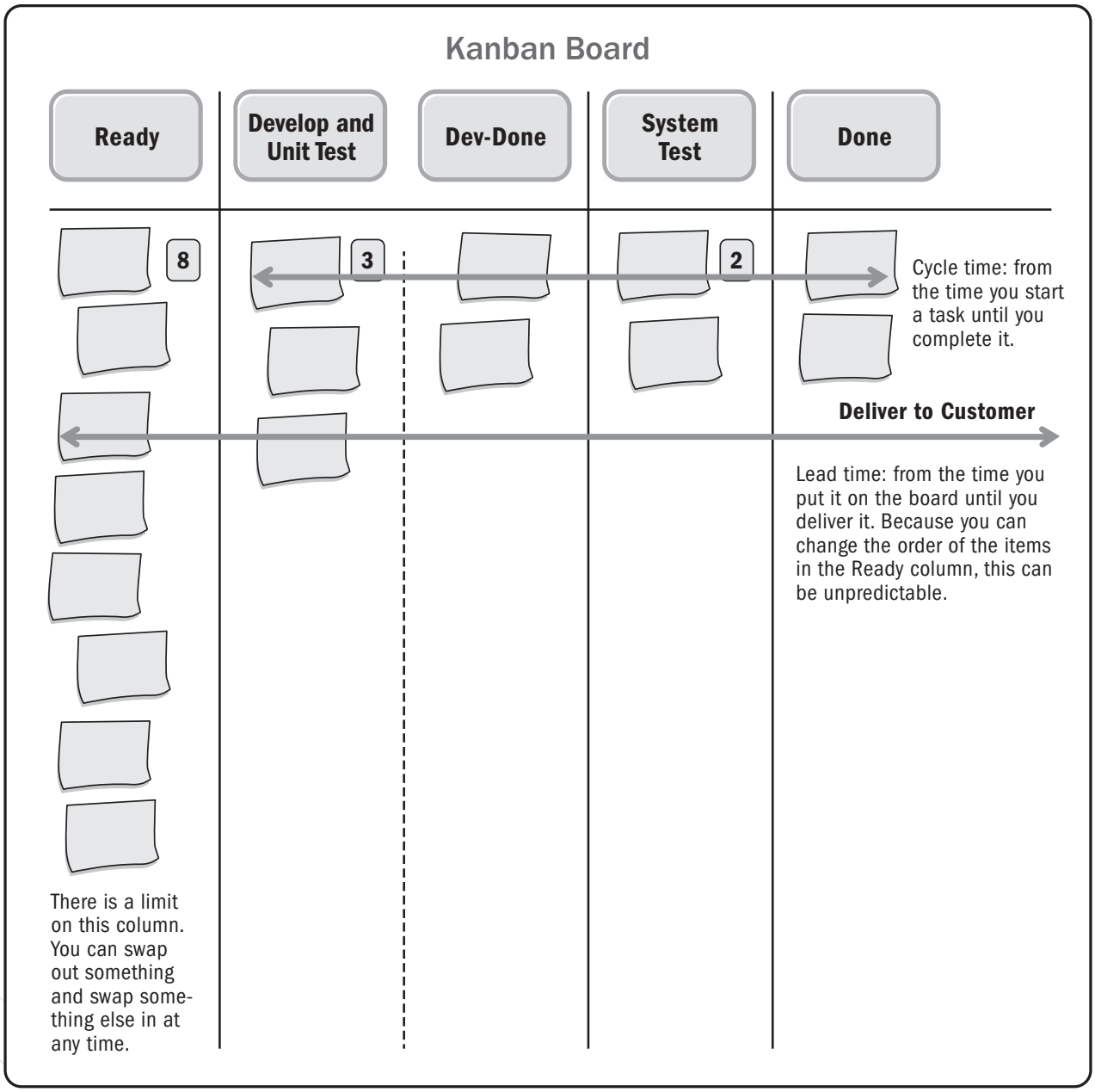


Figure 5-3. Example of a Kanban Board

Lead time is useful to understand cycle time from the first look at a particular feature to the length of time it took to release it to the customer. The work in progress (WIP) limits at the top of each column, shown in boxes here, allows the team to see how to pull work across the board. When the team has met its WIP limits, the team cannot pull work from the left into the next column. Instead, the team works from the right-most full column and asks, "What do we do as a team to move this work into the next column?"

Each feature is unique, so its cycle time is unique. However, a product owner might notice that smaller features have smaller cycle times. The product owner wants to see throughput, so the product owner creates smaller features or works with the team to do so.

Burnups, burndowns (capacity measures) and lead time, and cycle time (predictability measures) are useful for in-the-moment measurements. They help a team understand how much more work they have and whether the team might finish on time.

Measuring story points is not the same as measuring completed stories or features. Some teams attempt to measure story points without completing the actual feature or story. When teams measure only story points, they measure capacity, not finished work, which violates the principle of "the primary measure of progress is working software" (or, other product if not software).

Each team has its own capacity. When a team uses story points, be aware that the number of story points a team can complete in a given time is unique to that team.

TIP

When teams depend on external people or groups, measure cycle time to see how long it takes for the team to complete the work. Measure lead time to see the external dependencies after the team completes its work. Teams can also measure the reaction time, the time from ready to the first column, to see how long it takes them—on average—to respond to new requests.

When teams provide their own units of measure, teams are better able to assess and estimate and deliver their work. The downside of relative estimation is that there is no way to compare teams or add velocity across teams.

The team can measure completed work in a feature burnup/burndown chart and in a product backlog burnup chart. These charts provide trends of completion over time, as shown in Figure 5-4.

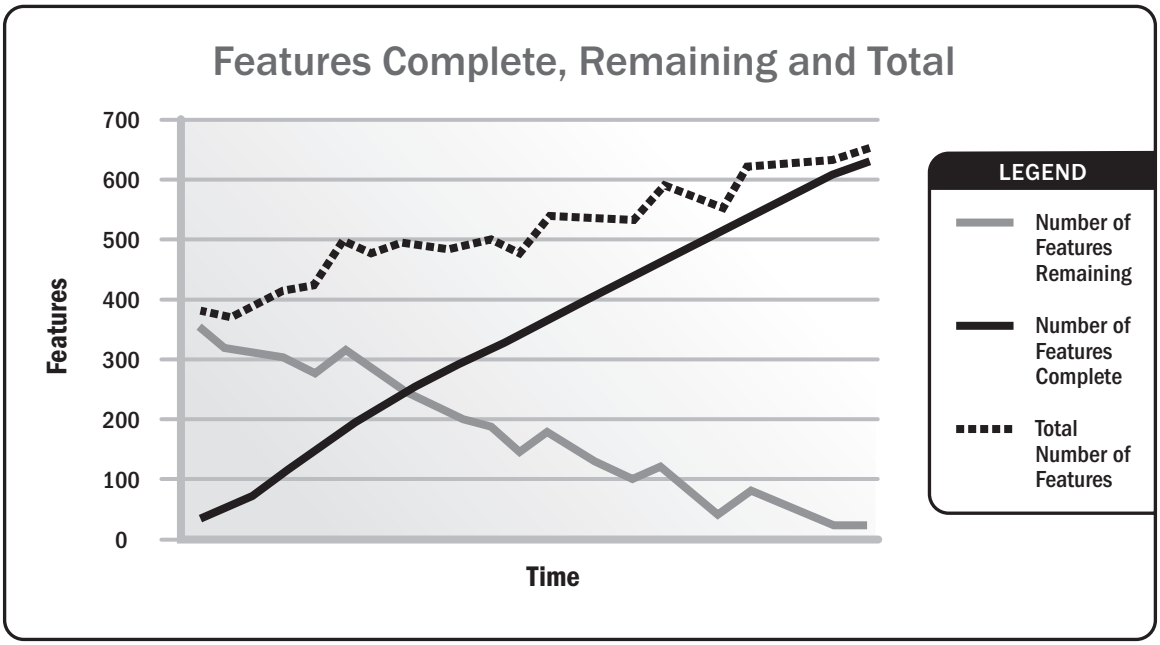


Figure 5-4. Feature Chart

Feature burnup/burndown charts may show that requirements grew during the project. The features complete line shows that the team completes features at a regular pace. The total features line shows how the project's total features changed over time. The features remaining burndown line shows that the rate of feature completion varies. Every time features are added to the project, the burndown line changes.

Earned value in agile is based on finished features, as shown in Figure 5-5. The product backlog burnup chart shows completed work compared to total expected work at interval milestones or iterations.

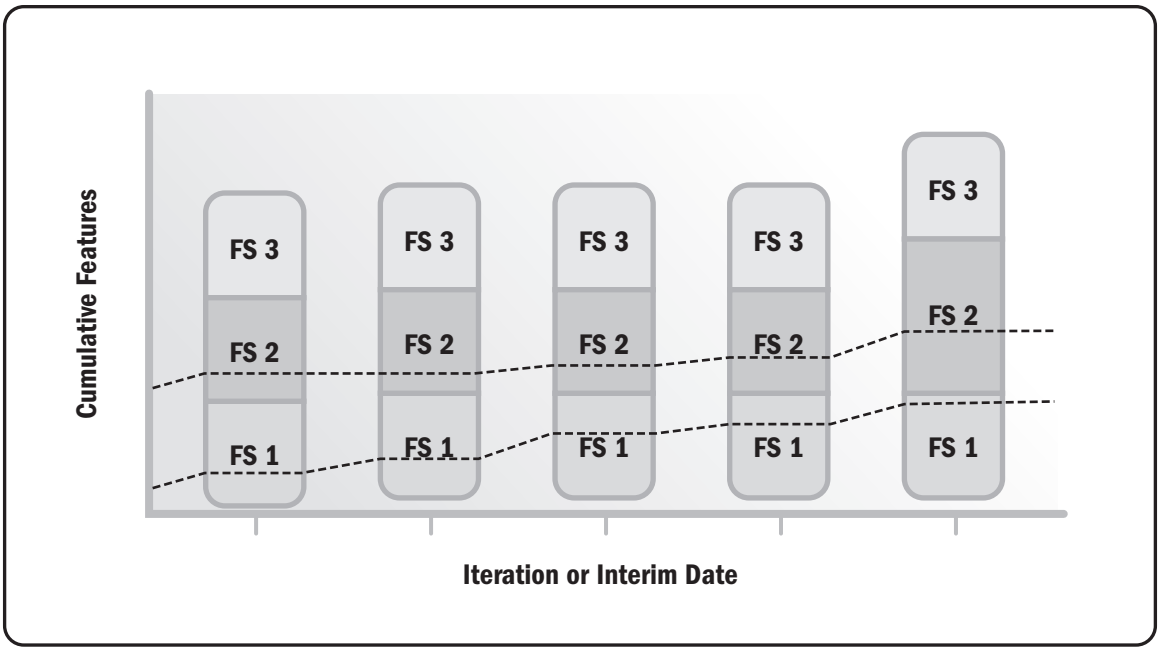


Figure 5-5. Product Backlog Burnup Chart

A team can only finish one story at a time. To complete a large feature that contains several stories, the team will have remaining stories to complete and may not complete that entire feature until several more time periods have passed. The team can show its completed value with a product backlog burnup chart as shown in Figure 5-5.

If a team needs to measure earned value, it can consider using this burnup chart in Figure 5-6 as an example: Note that the left Y axis represents story points as scope, and the right Y axis represents the project spend.

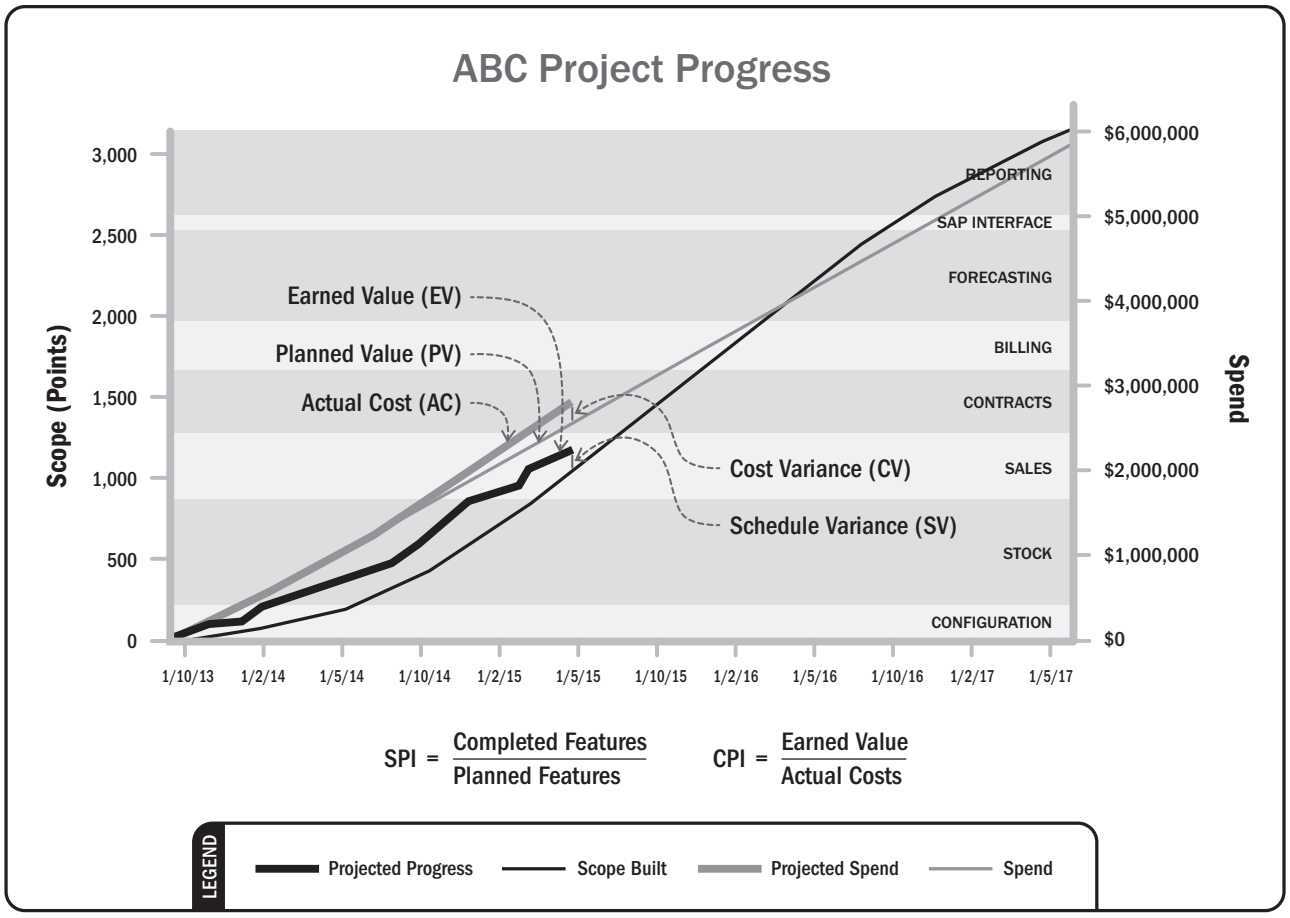


Figure 5-6. Earned Value in an Agile Context

Traditional EVM metrics like schedule performance index (SPI) and cost performance index (CPI) can be easily translated into agile terms. For example, if the team planned to complete 30 story points in an iteration, but only completed 25 then the SPI is 25/30 or 0.83 (the team is working at only 83% of the rate planned). Likewise, CPI is the earned value (completed features value) to date divided by the actual costs to date or, as shown in Figure 5-6, \$2.2M / \$2.8M = 0.79. This means a result of only 79 cents on the dollar compared to plan (but of course this assumes that the prediction is still correct.)

A cumulative flow diagram, illustrated in Figure 5-7, shows the work in progress across a board. If a team has many stories waiting for test, the testing band will swell. Work accumulation can be seen at a glance.

Teams have trouble with accumulating work: the team has work in progress instead of work completed. When teams have a lot of work in progress, they delay their overall feature delivery. The longer it takes for a team to deliver, the more pressure a team will have for yet more features in the same period of time.

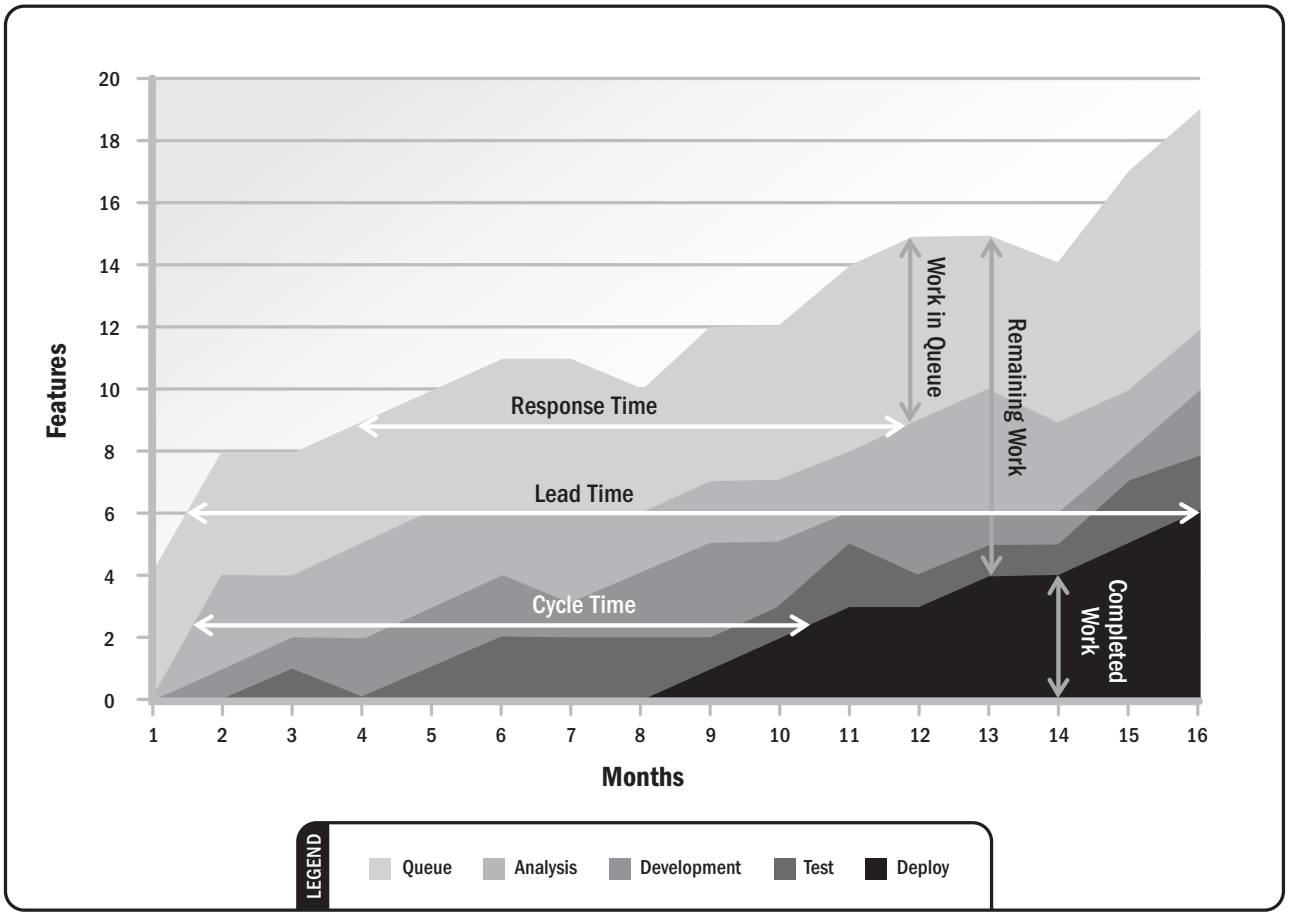


Figure 5-7. Cumulative Flow Diagram of Completed Features

Adapt this cumulative flow to the project task board.

6

ORGANIZATIONAL CONSIDERATIONS FOR PROJECT AGILITY

Every project exists in an organizational context. Cultures, structures, and policies can influence both the direction and the outcome of any project. These dynamics can challenge project leaders.

While project leaders may not have the ability to change organizational dynamics as they see fit, they are expected to navigate those dynamics skillfully.

This section explores the way the organization and in some circumstances, the project context, influences projects. Leaders can explore options for change, to increase project success.

> Project agility is more effective and sustained as the organization adjusts to support it.

6.1 ORGANIZATIONAL CHANGE MANAGEMENT

Organizational change management covers the skills and techniques for influencing changes that support agility.

The PMI publication, *Managing Change in Organizations: A Practice Guide* [2], describes a comprehensive and holistic approach for successfully introducing meaningful change. The recommendations offered there include:

- Models for describing change dynamics,
- Framework for achieving change, and
- Application of change management practices at the project, program, and portfolio levels.

Sections 6.1.1 and 6.1.2 explore the considerations of change management specific to an agile context.

Figure 6-1 shows the relationship between these two topics.

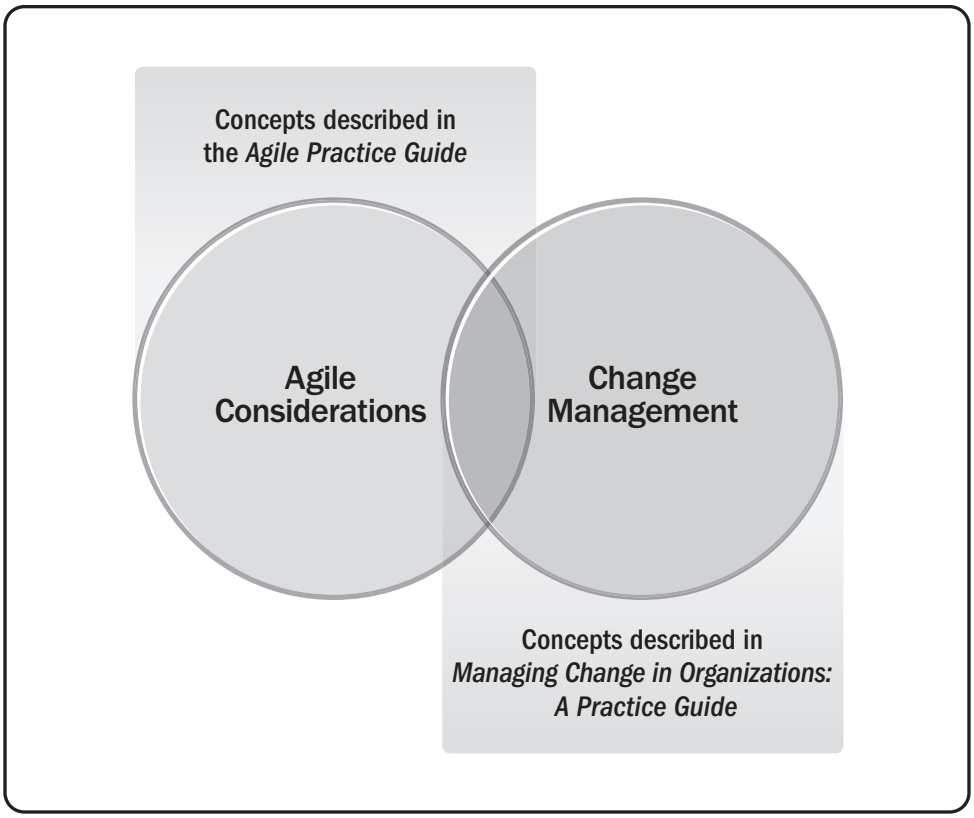


Figure 6-1. The Relationship Between Change Management and Agile Approaches

6.1.1 DRIVERS FOR CHANGE MANAGEMENT

All projects are about change. However, there are two key factors that further motivate the use of change management practices in an agile context:

- **Changes associated with accelerated delivery.** Agile approaches emphasize delivering project outputs early and often. However, the receiving organization may not be fully prepared to incorporate those outputs at an increased pace. Accelerating delivery will test the organization's ability to accommodate that delivery. Successfully discovering and delivering a project's features is not enough. If the organization resists the project's output, then the targeted return on investment is delayed. Customer acceptance of and alignment with project outputs becomes even more prevalent in an agile environment.
- **Changes associated with agile approaches.** Organizations just beginning to use agile approaches also experience high degrees of change. Higher degrees of collaboration may require more frequent handoffs between teams, departments, or vendors. Decomposing work into iterative prototypes involves rework that could be viewed negatively. Leaders should consider change management techniques to address the hurdles of transitioning to the use of agile approaches.

6.1.2 READINESS FOR CHANGE

Organizations beginning to use agile approaches should understand the relative compatibility of those methods with their current approaches. Some organizations will have characteristics that more easily support agile principles of cross-department collaboration, continuous learning, and evolving internal processes. Examples of these change-friendly characteristics include:

- Executive management's willingness to change;
- Organization's willingness to shift the way it views, reviews, and assesses employees;
- Centralization or decentralization of project, program, and portfolio management functions;
- Focus on short-term budgeting and metrics versus long-term goals; and
- Talent management maturity and capabilities.

Conversely, there are other institutional characteristics that may be roadblocks to achieving the changes associated with organizational agility. Examples of these include:

- Work is decomposed into departmental silos, creating dependencies that prevent accelerated delivery instead of building cross-functional teams with guidance from centers of competencies.
- Procurement strategies are based on short-term pricing strategies, rather than long-term competencies.
- Leaders are rewarded for local efficiencies rather than end-to-end flow of project delivery or optimizing the whole (in regard to the organization).
- Employees are specialized contributors with limited tools or incentives to diversify their skills instead of building T-shaped specialists.
- Decentralized portfolios pull employees simultaneously onto too many projects at once instead of keeping them focused on one project at a time.

The degree to which an organization is willing to review and modify these practices will determine how quickly and effectively agile approaches can be adopted. However, in response to these organizational impediments to agility, project leaders can try various approaches to accelerate a cultural compatibility for:

- Visible and active executive sponsorship,
- Change management practices, including communication and coaching,
- Progressively pacing the adoption of agile practices on a project-by-project basis
- Incremental introduction of agile practices to the team; and
- Leading by example by using agile techniques and practices where possible.

6.2 ORGANIZATIONAL CULTURE

An organization's culture is its DNA—its core identity. Culture will always influence the use of agile approaches. Organizational culture runs along a continuum, from highly predictive plans to lean startup where everything is an experiment. Although agile approaches fit well with the lean startup culture, a highly predictive organization can encourage empirical measurements, small experiments, and learning so they can move toward agility.

6.2.1 CREATING AN ENVIRONMENT OF SAFETY

Organizational culture is difficult to change, but the most important cultural norm in an organization willing to try any new method or technique is enabling a safe work environment.

Only in a safe, honest, and transparent environment can team members and leaders truly reflect on their successes to ensure their projects continue to advance, or apply lessons learned on failed projects so they do not fall back into the same patterns.

6.2.2 ASSESSING CULTURE

Every project finds itself in tension with competing aspirations. How can the team go fast without compromising quality? How can the team preserve flexibility while also hitting a firm date? Most importantly, how does the team satisfy and meet the requirements of the customer?

Project leaders may feel their job is to meet every expectation of every stakeholder; but, when compelled to make a choice, there is often a priority depending on the culture and requirements of the organization's business environment. For example, a mobile telecom project has a greater bias for speed, where a government program may have a greater bias for generalization and stability.

"Culture eats strategy for breakfast" —Peter Drucker

This statement stresses the importance of people's commitment and passion for a cause. No matter what strategy or plan you implement with your team, its success is going to be governed by the people implementing the plan. If the people who are driving the strategy aren't passionate about the change, or worse, are apathetic about their job and their organization, then you stand little chance of implementing the change.

To navigate these dynamics, project leaders should take the time to assess where emphasis is most often applied in the organization. Figure 6-2 illustrates what an assessment might look like. In this example, a project leader initiates a conversation about organizational priorities with stakeholders, team members, and senior management. Those priorities are then recorded as positions on a sliding scale between two extremes. The results are then used to find agile techniques that best fit with those priorities.

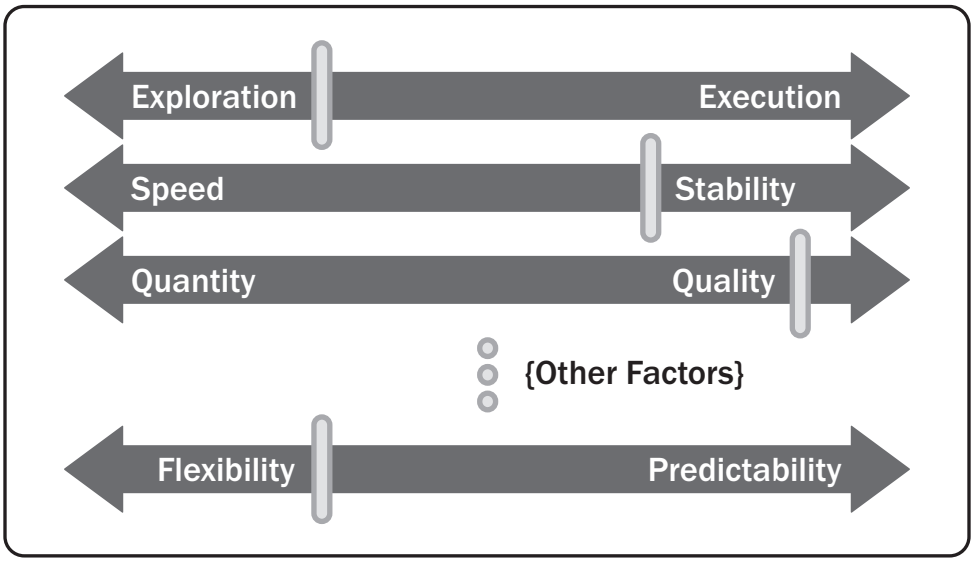


Figure 6-2. Example of Assessing Organizational Culture

Several models exist for assessing such dynamics; however, the model or method used is not that important. It is more critical that project leaders invest the effort to understand the forces that shape their context. Understanding the organization and the industry requirements that an organization needs to satisfy allows for choosing the right conversations, the right tradeoffs, and, especially, the right techniques.

6.3 PROCUREMENT AND CONTRACTS

As mentioned earlier in this practice guide, the Agile Manifesto values "customer collaboration over contract negotiation." Many project failures stem from breakdowns in the customer–supplier relationship. Projects incur more risk when those involved in the contract take the perspective of winners vs. losers. A collaborative approach is one that pursues a shared-risk-reward relationship, where all sides win. Some contracting techniques that can formalize this dynamic include the following:

- **Multi-tiered structure.** Rather than formalizing an entire contracting relationship in a single document, project parties can achieve more flexibility by describing different aspects in different documents. Mostly fixed items (e.g., warranties, arbitration) can be locked in a master agreement. Meanwhile, all parties list other items subject to change (e.g., services rates, product descriptions) in a schedule of services. The contract can reference them in the master services agreement. Finally, more dynamic items such as scope, schedule, and budget can be formalized in a lightweight statement of work. Isolating the more changing elements of a contract into a single document simplifies modifications and thus flexibility.
- **Emphasize value delivered.** Many vendor relationships are governed by fixed milestones or "phase gates" focused on intermediate artifacts, rather than a full deliverable of incremental business value. Often, these controls limit the use of feedback to improve the product. Instead, milestones and payment terms can be structured based on value-driven deliverables in order to enhance the project's agility.
- **Fixed-price increments.** Rather than lock an entire project scope and budget into a single agreement, a project can decompose the scope into fixed-price microdeliverables, such as user stories. For the customer, this gives more control over how the money is spent. For the supplier, it limits the financial risk of over-commitment to a single feature or deliverable.

TIP

Culture versus Structure

Some people insist new organizational structures be installed before any cultural shift can begin. Others maintain the opposite—those new organizational structures are only superficial adjustments until the collective culture moves in a meaningful direction. In reality, one cannot progress without the other. Project leaders wanting to achieve agility should consider the current and future states of both of these aspects in their organization.

- **Not-to-exceed time and materials.** Customers incur unwanted risk from a traditional time and materials approach. One alternative is to limit the overall budget to a fixed amount. This allows the customer to incorporate new ideas and innovations into the project not originally planned. When customers want to incorporate new ideas, they will have to manage to a given capacity, replacing original work with new work. Work should be closely monitored as hours allocated reach their limit. Also, additional contingency hours could be planned into the maximum budget if considered helpful.
- **Graduated time and materials.** Another alternative is a shared financial risk approach. In agile, the quality criteria are part of what done means. Therefore, the supplier can be rewarded with a higher hourly rate when delivery is earlier than the contracted deadline. Conversely, the supplier would suffer a rate reduction for late delivery.
- **Early cancellation option.** When an agile supplier delivers sufficient value with only half of the scope completed, the customer should not be bound to pay the remaining half if the customer no longer needs it. Instead, a contract can offer the customer to buy the remainder of the project for a cancellation fee. The customer limits budget exposure and the supplier earns positive revenue for services no longer required.
- **Dynamic scope option.** For those contracts with a fixed budget, a supplier may offer the customer the option to vary the project scope at specified points in the project. The customer can adjust features to fit the capacity. Then the customer can leverage innovation opportunities, while limiting the supplier's risk of over commitment.
- **Team augmentation.** Arguably the most collaborative contracting approach is to embed the supplier's services directly into the customer organization. Funding teams instead of a specific scope preserves the customer's strategic discretion on what work should actually be done.

- **Favor full-service suppliers.** In order to diversify risk, customers may seek a multisupplier strategy. However, the temptation will be to contract the work such that each supplier does only one thing, which creates a web of dependencies before any usable service or product emerges. Instead, place an emphasis on engagements that deliver full value (as in the idea of completed independent feature sets).

It is possible to create agile contracts. Agile is built on a synergy of collaboration and trust. The supplier can help by delivering value early and often. The customer can help by providing timely feedback.

6.4 BUSINESS PRACTICES

The willingness and ability to create new competences within an organization when the need arises is a mark of organizational agility. These do not have to be earth-shattering changes and could be less disruptive in an organization that is focused on agility and the results it provides. Transparency and open collaboration are absolutely key.

As cross-functional teams deliver value, the teams and individuals might encounter problems with various support functions in the organization.

As team delivers value on a regular basis, finance departments may have the opportunity to capitalize the product differently. If the team has contracts with other organizations, procurement departments may need to change those contracts to help the other organizations deliver value frequently and synchronize with the team.

Once teams start to work in a cohesive and cooperative manner, they will challenge internal management policies. Human resources may notice individual incentives make less sense, and managers may struggle with the performance appraisals of self-organizing employees. In each case, these are opportunities to review the degree to which existing practices support agile ways of working.

As organizations progress to greater agility, there will be obvious needs for additional business units to change the way they interact and perform their responsibilities. The changes that have benefited other areas of the organization should now be embraced so the effectiveness of the entire organization can be realized.

6.5 MULTITEAM COORDINATION AND DEPENDENCIES (SCALING)

Many projects incur dependencies, even when they are not managed within a given program. For this reason, it is necessary to have an understanding of how agile works within an existing program and portfolio management context.

6.5.1 FRAMEWORKS

The guidance of the most widespread agile methods such as Scrum and eXtreme Programming focus on the activities of a single, small, usually colocated, cross-functional team. While this is very useful for efforts that require a single team, it may provide insufficient guidance for initiatives that require the collaboration of multiple agile teams in a program or portfolio.

A range of frameworks (such as the Scaled Agile Framework, Large Scale Scrum, and Disciplined Agile) and approaches (e.g., Scrum of Scrums) have emerged to cater to just such circumstances. More details on these can be found in Annex A3.

6.5.2 CONSIDERATIONS

There is more than one way to scale work. The team might need to scale the work of several agile projects into a single agile program. Alternatively, the organization can design a structure that supports agile approaches across the entire portfolio.

For example, it is helpful to start small and learn as rapidly as possible what works well in the organizational context. Teams can achieve successful outcomes even when everything is not completely transformed into an agile approach.

Regardless of the approach, a critical success factor is the healthy agile team. If using an agile approach for a single team is not successful, do not try to scale up to using it more broadly; instead, address the organizational impediments that prevent teams from working in an agile way.

The goal of large-scale agile projects is to coordinate the efforts of different teams to bring value to customers. There is more than one way to do that. Teams may use a formal framework or apply agile thinking to adjust existing program management practices.

6.6 AGILE AND THE PROJECT MANAGEMENT OFFICE (PMO)

The PMO exists to shepherd business value throughout the organization. It might do this by helping projects achieve their goals. Sometimes, the PMO educates teams (or arranges for training) and supports projects. Sometimes, the PMO advises management about the relative business value for a given project or set of projects.

Because agile creates cultural change, over time, the organization might need to change, including the PMO. For example, managers make decisions about which projects to fund and when, and teams decide what they need for training or advice.

6.6.1 AN AGILE PMO IS VALUE-DRIVEN

Any project should deliver the right value, to the right audience, at the right time. The PMO's objective is to facilitate and enable this goal. An agile-based PMO approach is based on a customer-collaboration mindset and is present in all PMO programs. In many cases, this means the PMO operates as if it were a consulting business, tailoring its efforts to meet specific needs requested by a given project. Some projects may need tools and templates, while others may benefit from executive coaching. The PMO should strive to deliver what is needed and keep the pulse on its customers to ensure that it knows and is able to adapt to their needs. This intrapreneur approach focuses on the PMO activities that are perceived as the most valuable to the projects it supports.

6.6.2 AN AGILE PMO IS INVITATION-ORIENTED

In order to accelerate progress on a value-based charter, a PMO may be tempted to mandate certain solutions or approaches, for example, to make everyone do it the same way to get some quick wins. However, a more deliberate perspective incorporates the desire for employee engagement. This is achieved by inviting only those interested to engage with PMO services. Higher engagement with PMO practices makes it easier for those practices to be "sticky." If the PMO is delivering value to its clients, it is more likely that clients will request its services and adopt its practices.

6.6.3 AN AGILE PMO IS MULTIDISCIPLINARY

In order to support project-specific needs, the PMO needs to be conversant in several competencies beyond project management itself, because different projects require distinct capabilities. For instance, one project may need organizational design to address staffing challenges while another may require organizational change management techniques for stakeholder engagement or unique business models to support customer goals.

Some organizations have been transforming their PMOs into agile centers of excellence that provide such services as:

- **Developing and implementing standards.** Provide templates for user stories, test cases, cumulative flow diagrams, etc. Provide agile tools and educate supporting groups on iterative development concepts.
- **Developing personnel through training and mentoring.** Coordinate agile training courses, coaches, and mentors to help people transition to an agile mindset and upgrade their skills. Encourage and support people to attend local agile events.
- **Multiproject management.** Coordinate between agile teams by communicating between projects. Consider sharing items such as progress, issues, and retrospective findings and improvement experiments. Help manage major customer releases at the program level and investment themes at the portfolio level using an appropriate framework.
- **Facilitating organizational learning.** Gather project velocity profiles and capture, store, and index retrospective findings.
- **Managing stakeholders.** Provide product owner training, guidance on acceptance testing, and how to evaluate and give feedback on systems. Champion the importance of subject matter experts (SMEs) to projects.
- **Recruiting, selecting, and evaluating team leaders.** Develop guidelines for interviewing agile practitioners.
- **Executing specialized tasks for projects.** Train and provide retrospective facilitators, create agreements with agile project troubleshooters, and provide mentors and coaches.

6.7 ORGANIZATIONAL STRUCTURE

The structure of an organization strongly influences its ability to pivot to new information or shifting market needs. Here is a listing of key characteristics:

- **Geography.** Geographically distributed and dispersed project organizations may find several challenges impeding their work on any project. Project leaders and regional managers may have alternative or even competing goals. Additionally, cultural differences, language barriers, and lower visibility can slow down productivity. Fortunately, the use of agile approaches can encourage more collaboration and confidence than would otherwise exist. Project leaders in these contexts should encourage dialog at the team and executive level to tailor techniques for the context and to manage expectations about the effort required to do so.
- **Functionalized structures.** Some organizations are structured on a spectrum ranging from highly projectized to matrixed to highly functionalized. Projects with highly functionalized structures may find general resistance to collaboration across its organization.
- **Size of project deliverable.** Reducing the size of a project deliverable will motivate more frequent handoffs across departments, and thus more frequent interactions and a faster flow of value across the organization.
- **Allocation of people to projects.** Another approach is to ask for a single person from each department to be temporarily, yet fully allocated, to the highest priority project.
- **Procurement-heavy organizations.** Some organizations choose to implement projects primarily through vendors. Although project goals may be clear, vendors have a responsibility to look after their own financial viability. Moreover, once vendors complete their obligations and leave the engagement, the associated project knowledge goes with them. This limits the internal competencies needed for sustained flexibility and speed. Agile techniques such as retrospectives and follow up on possible improvement areas when the vendor is still engaged can help mitigate loss of product knowledge.

6.8 EVOLVING THE ORGANIZATION

When addressing an individual challenge area or implementing a new hybrid or agile approach, it is recommended to undertake the work incrementally. A common practice is to treat the change process as an agile project with its own backlog of changes that could be introduced and prioritized by the team, based on perceived value or other considerations. Each of the changes can be treated as an experiment, which is tested for a short period of time to determine suitability as-is or the need for further refinement/consideration.

Use kanban boards to track progress, showing the new approaches already in use as “done,” those being tried as “in progress,” and those still waiting to be introduced as “to do.” See Figure 6-3 for the initial board with a ranked backlog. Figure 6-4 shows an example of what a board might have as work progresses.

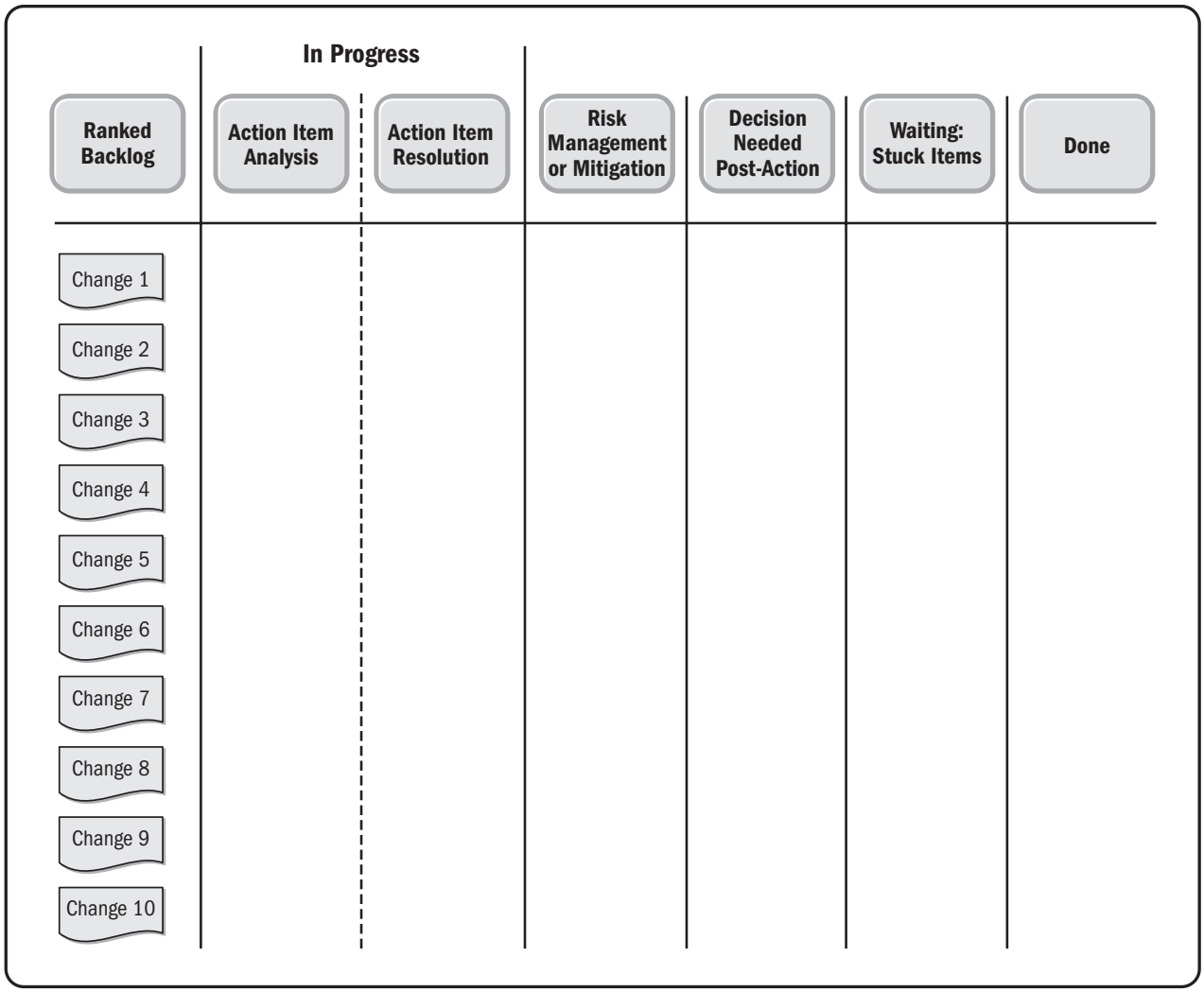


Figure 6-3. Initial Ranked Backlog for Changes

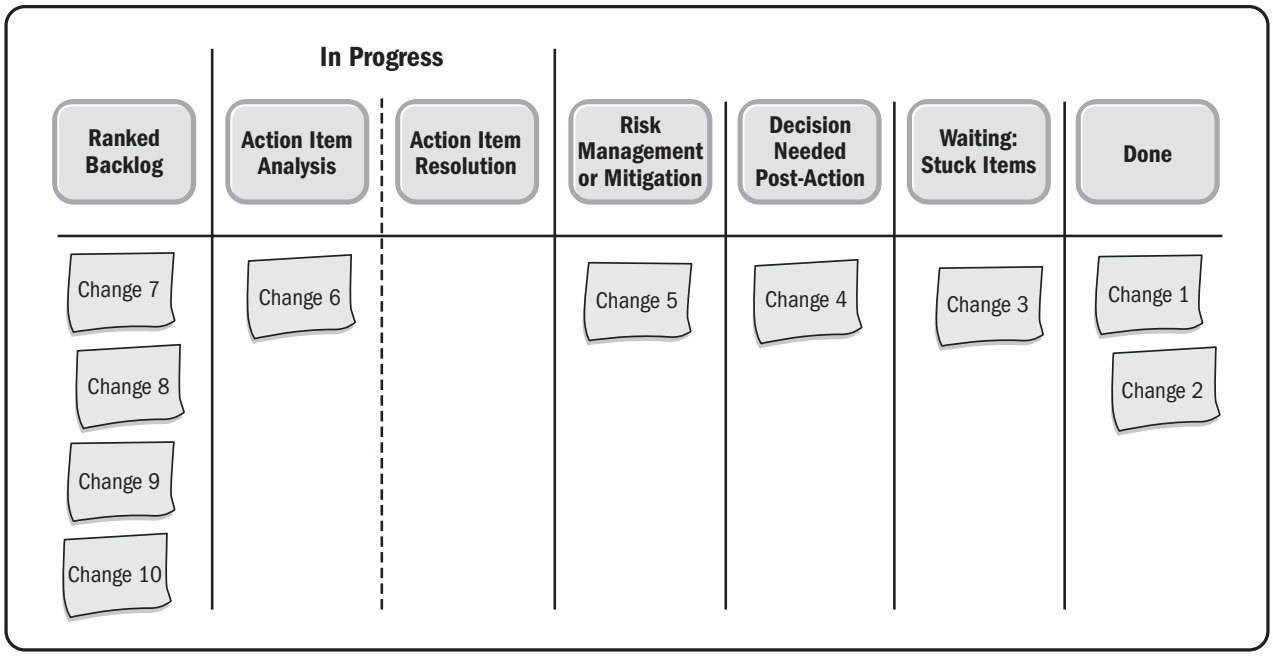


Figure 6-4. Using Backlogs and Kanban Boards to Organize and Track Change Work

Using these tools to organize and manage the change implementation provides visibility into progress and also models the approaches being implemented. Rolling out changes in a transparent and appealing way improves the likelihood of their success.

7

A CALL TO ACTION

The adoption of agile and its approaches for managing projects has increased dramatically since the Agile Manifesto was first published in 2001. Adoption and the desire to operate with an agile mindset is no longer limited to a certain sized organization or those specializing only in information technology. The mindset applies universally and the approaches are successful in many settings.

Today, the demand for "being agile" is higher than ever. The debate over the best path to agility continues to keep the conversation and innovation evolving. One truth remains constant—inspection, adaptation, and transparency are critical to successfully delivering value.

You may not see everything you expected to see in this practice guide. Our core team realizes you may disagree with some elements or approaches we did choose to present—and passionately so. We call on your passion to continue the conversation and improve the next iteration of this practice guide. This is your journey—learn, experiment, gain feedback, and experiment again. Then help us retrospect; give us feedback on the guidance and contribute to future editions of this practice guide. After all, inspection without adaptation is wasted effort.

Lastly, we want to encourage you to be engaged in the broader communities of project management and agile to further conversations on these topics. Look for representatives from both PMI and Agile Alliance® at conferences and meetings and engage them in discussion. Use social media and blog your thoughts and opinions.

You can provide feedback and engage in conversation regarding the contents of this practice guide at the blog called "Agile in Practice" at https://www.projectmanagement.com/blogs/347350/Agile-in-Practice.

ANNEX A1
PMBOK® GUIDE MAPPING

Table A1-1 illustrates the mapping of Project Management Process Groups to the Knowledge Areas defined in the *PMBOK® Guide* – Sixth Edition.

This annex describes how hybrid and agile approaches address the attributes described in the *PMBOK® Guide* Knowledge Areas (see Table A1-2). It covers what stays the same and what may be different along with some guidelines to consider for increasing the likelihood of success.

Table A1-1. Project Management Process Group and Knowledge Area Mapping

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work 4.4 Manage Project Knowledge	4.5 Monitor and Control Project Work 4.6 Perform Integrated Change Control	4.7 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Schedule Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Durations 6.5 Develop Schedule		6.6 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Manage Quality	8.3 Control Quality	
9. Project Resource Management		9.1 Plan Resource Management 9.2 Estimate Activity Resources	9.3 Acquire Resources 9.4 Develop Team 9.5 Manage Team	9.6 Control Resources	
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Monitor Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses	11.6 Implement Risk Responses	11.7 Monitor Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Engagement	13.3 Manage Stakeholder Engagement	13.4 Monitor Stakeholder Engagement	

Table A1-2. Application of Agile in *PMBOK® Guide* Knowledge Areas

PMBOK® Guide Knowledge Area	Application in an Agile Work Process
Section 4 **Project Integration Management**	Iterative and agile approaches promote the engagement of team members as local domain experts in integration management. The team members determine how plans and components should integrate. The expectations of the project manager as noted in the *Key Concepts for Integration Management* sections in the *PMBOK® Guide* do not change in an adaptive environment, but control of the detailed product planning and delivery is delegated to the team. The project manager's focus is on building a collaborative decision-making environment and ensuring the team has the ability to respond to changes. This collaborative approach can be further enhanced when team members possess a broad skill base rather than a narrow specialization.
Section 5 **Project Scope Management**	In projects with evolving requirements, high risk, or significant uncertainty, the scope is often not understood at the beginning of the project or it evolves during the project. Agile methods deliberately spend less time trying to define and agree on scope in the early stage of the project and spend more time establishing the process for its ongoing discovery and refinement. Many environments with emerging requirements find that there is often a gap between the real business requirements and the business requirements that were originally stated. Therefore, agile methods purposefully build and review prototypes and release versions in order to refine the requirements. As a result, scope is defined and redefined throughout the project. In agile approaches, the requirements constitute the backlog.

Table A1-2. Application of Agile in *PMBOK® Guide* Knowledge Areas *(cont.)*

PMBOK® Guide Knowledge Area	Application in an Agile Work Process
Section 6 **Project Schedule Management**	Adaptive approaches use short cycles to undertake work, review the results, and adapt as necessary. These cycles provide rapid feedback on the approaches and suitability of deliverables, and generally manifest as iterative scheduling and on-demand, pull-based scheduling, as discussed in the Key Trends and Emerging Practices section for Project Schedule Management in the *PMBOK® Guide*. In large organizations, there may be a mixture of small projects and large initiatives requiring long-term roadmaps to manage the development of these programs using scaling factors (e.g., team size, geographical distribution, regulatory compliance, organizational complexity, and technical complexity). To address the full delivery life cycle for larger, enterprise-wide systems, a range of techniques utilizing a predictive approach, adaptive approach, or a hybrid of both, may need to be adopted. The organization may need to combine practices from several core methods, or adopt a method that has already done so, and adopt a few principles and practices of more traditional techniques. The role of the project manager does not change based on managing projects using a predictive development life cycle or managing projects in adaptive environments. However, to be successful in using adaptive approaches, the project manager will need to be familiar with the tools and techniques to understand how to apply them effectively.
Section 7 **Project Cost Management**	Projects with high degrees of uncertainty or those where the scope is not yet fully defined may not benefit from detailed cost calculations due to frequent changes. Instead, lightweight estimation methods can be used to generate a fast, high-level forecast of project labor costs, which can then be easily adjusted as changes arise. Detailed estimates are reserved for short-term planning horizons in a just-in-time fashion. In cases where high-variability projects are also subject to strict budgets, the scope and schedule are more often adjusted to stay within cost constraints.

Table A1-2. Application of Agile in *PMBOK® Guide* Knowledge Areas *(cont.)*

PMBOK® Guide Knowledge Area	Application in an Agile Work Process
Section 8 **Project Quality Management**	In order to navigate changes, agile methods call for frequent quality and review steps built in throughout the project rather than toward the end of the project. Recurring retrospectives regularly check on the effectiveness of the quality processes. They look for the root cause of issues then suggest trials of new approaches to improve quality. Subsequent retrospectives evaluate any trial processes to determine if they are working and should be continued or new adjusting or should be dropped from use. In order to facilitate frequent, incremental delivery, agile methods focus on small batches of work, incorporating as many elements of project deliverables as possible. Small batch systems aim to uncover inconsistencies and quality issues earlier in the project life cycle when the overall costs of change are lower.
Section 9 **Project Resource Management**	Projects with high variability benefit from team structures that maximize focus and collaboration, such as self-organizing teams with generalizing specialists. Collaboration is intended to boost productivity and facilitate innovative problem solving. Collaborative teams may facilitate accelerated integration of distinct work activities, improve communication, increase knowledge sharing, and provide flexibility of work assignments in addition to other advantages. Although the benefits of collaboration also apply to other project environments, collaborative teams are often critical to the success of projects with a high degree of variability and rapid changes, because there is less time for centralized tasking and decision making. Planning for physical and human resources is much less predictable in projects with high variability. In these environments, agreements for fast supply and lean methods are critical to controlling costs and achieving the schedule.

Table A1-2. Application of Agile in *PMBOK® Guide* Knowledge Areas *(cont.)*

PMBOK® Guide Knowledge Area	Application in an Agile Work Process
Section 10 **Project Communications Management**	Project environments subject to various elements of ambiguity and change have an inherent need to communicate evolving and emerging details more frequently and quickly. This motivates streamlining team member access to information, frequent team checkpoints, and colocating team members as much as possible. In addition, posting project artifacts in a transparent fashion, and holding regular stakeholder reviews are intended to promote communication with management and stakeholders.
Section 11 **Project Risk Management**	High-variability environments, by definition, incur more uncertainty and risk. To address this, projects managed using adaptive approaches make use of frequent reviews of incremental work products and cross-functional project teams to accelerate knowledge sharing and ensure that risk is understood and managed. Risk is considered when selecting the content of each iteration, and risks will also be identified, analyzed, and managed during each iteration. Additionally, the requirements are kept as a living document that is updated regularly, and work may be reprioritized as the project progresses, based on an improved understanding of current risk exposure.

Table A1-2. Application of Agile in *PMBOK® Guide* Knowledge Areas *(cont.)*

PMBOK® Guide Knowledge Area	Application in an Agile Work Process
Section 12 **Project Procurement Management**	In agile environments, specific sellers may be used to extend the team. This collaborative working relationship can lead to a shared risk procurement model where both the buyer and the seller share in the risk and rewards associated with a project. Larger projects may use an adaptive approach for some deliverables and a more stable approach for other parts. In these cases, a governing agreement such as a master services agreement (MSA) may be used for the overall engagement, with the adaptive work being placed in an appendix or supplement. This allows changes to occur on the adaptive scope without impacting the overall contract.
Section 13 **Project Stakeholder Management**	Projects experiencing a high degree of change require active engagement and participation with project stakeholders. To facilitate timely, productive discussion and decision making, adaptive teams engage with stakeholders directly rather than going through layers of management. Often the client, user, and developer exchange information in a dynamic co-creative process that leads to more stakeholder involvement and higher satisfaction. Regular interactions with the stakeholder community throughout the project mitigate risk, build trust, and support adjustments earlier in the project cycle, thus reducing costs and increasing the likelihood of success for the project. In order to accelerate the sharing of information within and across the organization, agile methods promote aggressive transparency. The intent of inviting any stakeholders to project meetings and reviews or posting project artifacts in public spaces is to surface as quickly as possible any misalignment, dependency, or other issue related to the changing project.

ANNEX A2
AGILE MANIFESTO MAPPING

This annex describes how the elements of the Agile Manifesto are covered in the *Agile Practice Guide*.

Table A2-1. Agile Manifesto Values Covered in the *Agile Practice Guide*

Value	*Agile Practice Guide* Coverage by Section and Title
Individuals and interactions over processes and tools	4.2 Servant Leadership Empowers the Team 4.3 Team Composition 5.1 Charter the Project and the Team 5.2.4 Daily Standups 6.2 Organizational Culture
Working software over comprehensive documentation	5.2.2 Backlog Preparation 5.2.3 Backlog Refinement 5.2.5 Demonstrations/Reviews 5.2.7 Execution Practices that Help Teams Deliver Value
Customer collaboration over contract negotiation	4.3 Team Composition 5.4 Measurements in Agile Projects 6.2 Organizational Culture 6.3 Procurement and Contracts 6.7 Organizational Structure
Responding to change over following a plan	5.2.1 Retrospectives 5.2.3 Backlog Refinement 5.2.5 Demonstrations/Reviews

Table A2-2. *Agile Practice Guide* Mapping of Principles Behind the Agile Manifesto

Principle	Agile Practice Guide Coverage
Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.	3.1 Characteristics of Project Life Cycles 5.2.7 Execution Practices that Help Teams Deliver Value
Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.	5.2.3 Backlog Refinement
Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.	5.2 Common Agile Practices
Business people and developers must work together daily throughout the project.	4.2 Servant Leadership Empowers the Team 5.2.2 Backlog Preparation 5.2.3 Backlog Refinement
Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.	4.3 Team Composition 5.1 Charter the Project and the Team 5.2.1 Retrospectives
The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.	4.3.4 Team Structures 5.2.4 Daily Standups
Working software is the primary measure of progress.	5.2.7 Execution Practices that Help Teams Deliver Value 5.2.8 How Iterations and Increments Help Delivery Working Product
Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.	5.1 Charter the Project and the Team
Continuous attention to technical excellence and good design enhances agility.	5.2 Common Agile Practices
Simplicity—the art of maximizing the amount of work not done is essential.	5.2.2 Backlog Preparation 5.2.3 Backlog Refinement
The best architectures, requirements, and designs emerge from self-organizing teams.	4.3 Team Composition
At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.	5.2.1 Retrospectives

ANNEX A3
OVERVIEW OF AGILE AND LEAN FRAMEWORKS

This annex describes some of the commonly used agile approaches. These approaches can be used as is or combined to adapt to what works best for a given environment or situation. It is not necessary to use any of these; an agile approach can be developed from scratch as long as it adheres to the mindset, values, and principles of the Agile Manifesto. If the agile principles are followed to deliver value at a sustainable pace, and the developed approach promotes collaboration with the customer, a specific approach is not required. A link to more information regarding each approach can be found in the Bibliography section of this guide.

A3.1 SELECTION CRITERIA FOR THE *AGILE PRACTICE GUIDE*

There are too many agile approaches and techniques to be explicitly included in this practice guide. Figure A3-1 depicts a sample of agile approaches based on their depth of guidance and breadth of their life cycles. The specific approaches selected for discussion are popular examples that are:

- **Designed for holistic use.** Some agile approaches are centered on a single project activity, such as estimation or reflecting. The listed examples include only the more holistic agile frameworks. Some are more full-featured than others, but all of the selected approaches are those intended to guide a broad set of project activities.
- **Formalized for common use.** Some agile frameworks are proprietary in nature and designed for specific use by a single organization or within a single context. The frameworks described in Sections A3.2 through A3.14 focus on those intended for common use in a variety of contexts.
- **Popular in modern use.** Some agile frameworks are holistically designed and well formalized, but are simply not commonly being used in most projects or organizations. The agile frameworks described in this annex have been adopted by a significant number of industries, as measured by a collection of recent industry surveys.

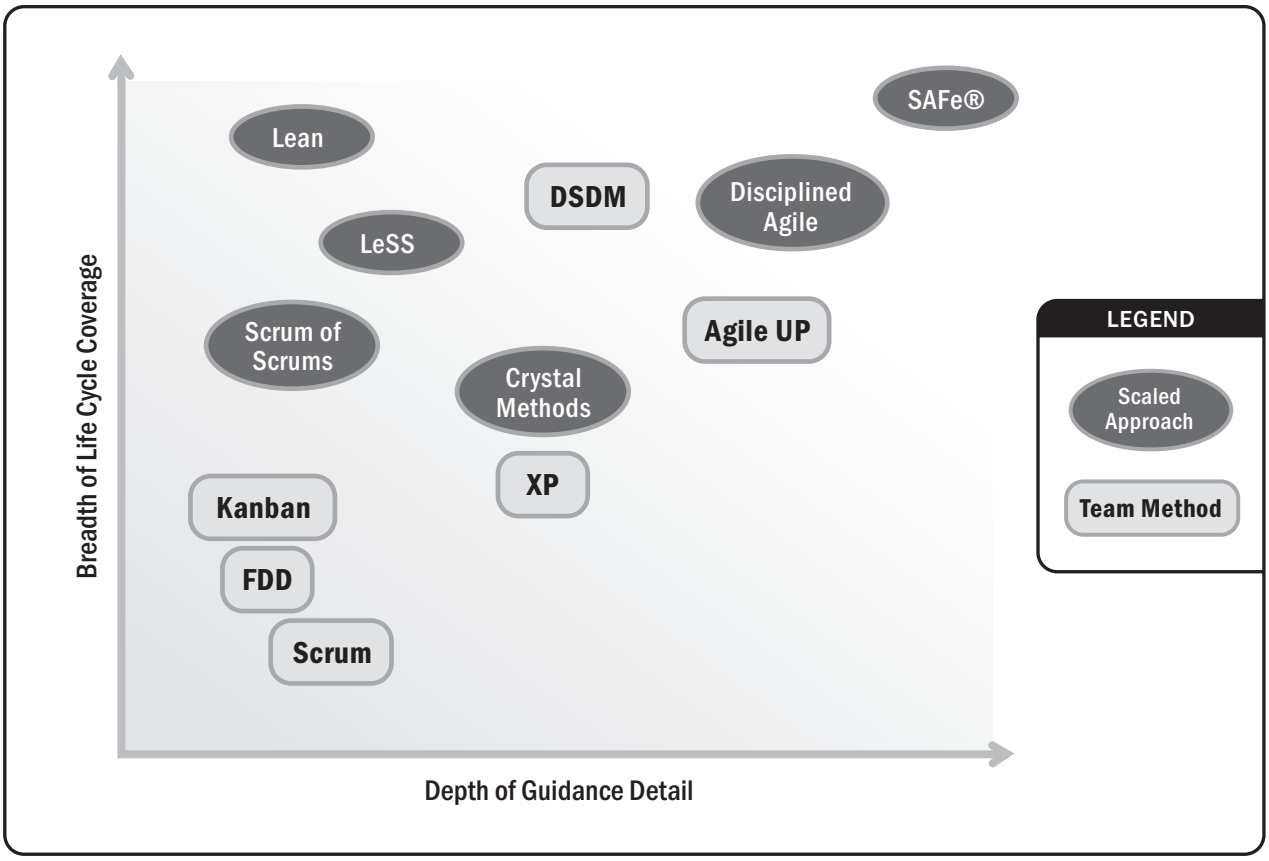


Figure A3-1. Agile Approaches Plotted by Breadth and Detail

A3.2 SCRUM

Scrum is a single-team process framework used to manage product development. The framework consists of Scrum roles, events, artifacts, and rules, and uses an iterative approach to deliver working product. Scrum is run on timeboxes of 1 month or less with consistent durations called sprints where a potentially releasable increment of product is produced. Table A3-1 lists Scrum events and artifacts utilized for project execution.

The Scrum team consists of a product owner, development team, and scrum master.

- The product owner is responsible for maximizing the value of the product.
- The development team is a cross-functional, self-organizing team consisting of team members who have everything they need within the team to deliver working product without depending on others outside of the team.
- The scrum master is responsible for ensuring the Scrum process is upheld and works to ensure the Scrum team adheres to the practices and rules as well as coaches the team on removing impediments.

Table A3-1. Scrum Events and Artifacts

Events	Artifacts
Sprint	Product backlog
Sprint planning	Sprint backlog
Daily scrum	Increments
Sprint review	
Sprint retrospective	

A3.3 EXTREME PROGRAMMING

eXtreme Programming (XP) is a software development method based on frequent cycles. The name is based on the philosophy of distilling a given best practice to its purest, simplest form, and applying that practice continuously throughout the project.

XP is most known for popularizing a holistic set of practices intended to improve the results of software projects. The method was first formalized as a set of twelve primary practices, but then gradually evolved to adopt several other corollary practices. These are listed in Table A3-2.

Table A3-2. The Practices of eXtreme Programming

XP Practice Area	Primary	Secondary
Organizational	• Sit together • Whole team • Informative workspace	• Real customer involvement • Team continuity • Sustainable pace
Technical	• Pair programming • Test-first programming • Incremental design	• Shared code/collective ownership • Documentation from code and tests • Refactoring
Planning	• User stories • Weekly cycle • Quarterly cycle • Slack	• Root cause analysis • Shrinking teams • Pay per use • Negotiated scope contract • Daily standups
Integration	• 10-minute build • Continuous integration • Test-first	• Single code base • Incremental deployment • Daily deployment

This evolution was the result of designing and adopting techniques through the filter of core values (communication, simplicity, feedback, courage, respect), and informed by key principles (humanity, economics, mutual benefit, self-similarity, improvement, diversity, reflection, flow, opportunity, redundancy, failure, quality, baby steps, accepted responsibility).

A3.4 KANBAN METHOD

Kanban in lean manufacturing is a system for scheduling inventory control and replenishment. This process of "just-in-time" inventory replenishment was originally seen in grocery stores when shelves were restocked based on the gaps in the shelves and not supplier inventory. Inspired by these just-in-time inventory systems, Taiichi Ohno developed Kanban and it was applied at the main Toyota manufacturing facility in 1953.

The word *kanban* is literally translated as "visual sign" or "card." Physical kanban boards with cards enable and promote the visualization and flow of the work through the system for everyone to see. This information radiator (large display) is made up of columns that represent the states the work needs to flow through in order to get to done. The simplest of boards could have three columns (i.e., to do, doing, and done), but it is adaptable to whatever states are deemed needed by the team utilizing it.

The Kanban Method is utilized and applicable in many settings and allows for a continuous flow of work and value to the customer. The Kanban Method is less prescriptive than some agile approaches and thus less disruptive to begin implementing as it is the original "start where you are" method. Organizations can begin applying Kanban Methods with relative ease and progress toward fully implementing the method if that is what they deem necessary or appropriate.

Unlike most agile approaches, the Kanban Method does not prescribe the use of timeboxed iterations. Iterations can be used within the Kanban Method, but the principle of pulling single items through the process continuously and limiting work in progress to optimize flow should always remain intact. The Kanban Method may be best used when a team or organization is in need of the following conditions:

- **Flexibility.** Teams are typically not bound by timeboxes and will work on the highest priority item in the backlog of work.
- **Focus on continuous delivery.** Teams are focused on flowing work through the system to completion and not beginning new work until work in progress is completed.
- **Increased productivity and quality.** Productivity and quality are increased by limiting work in progress.

- **Increased efficiency.** Checking each task for value adding or non-value-added activities and removing the non-value adding activities.
- **Team member focus.** Limited work in progress allows the team to focus on the current work.
- **Variability in the workload.** When there is unpredictability in the way that work arrives, and it becomes impossible for teams to make predictable commitments; even for short periods of time.
- **Reduction of waste.** Transparency makes waste visible so it can be removed.

The Kanban Method is derived from lean thinking principles. The defining principles and the core properties of the Kanban Method are listed in Table A3-3.

The Kanban Method is a holistic framework for incremental, evolutionary process and systems change for organizations. The method uses a "pull system" to move the work through the process. When the team completes an item, the team can pull an item into that step.

Table A3-3. Defining Principles and Properties of the Kanban Method

Defining Principles	Core Properties
Start with current state Agree to pursue incremental, evolutionary change Respect the current process, roles, responsibilities, and titles Encourage acts of leadership at all levels	Visualize the workflow Limit work in progress Manage flow Make process policies explicit Implement feedback loops Improve collaboratively

Kanban boards, such as the one shown in Figure A3-2, are a low-tech, high-touch technology that may seem overly simplistic at first, but those using them soon realize their power. Utilizing policies for entry and exit to columns, as well as constraints such as limiting work in process, kanban boards provide clear insight to workflow, bottlenecks, blockers, and overall status. Additionally the board acts as an information radiator to anyone who sees it, providing up-to-date information on the status of the work of the team.

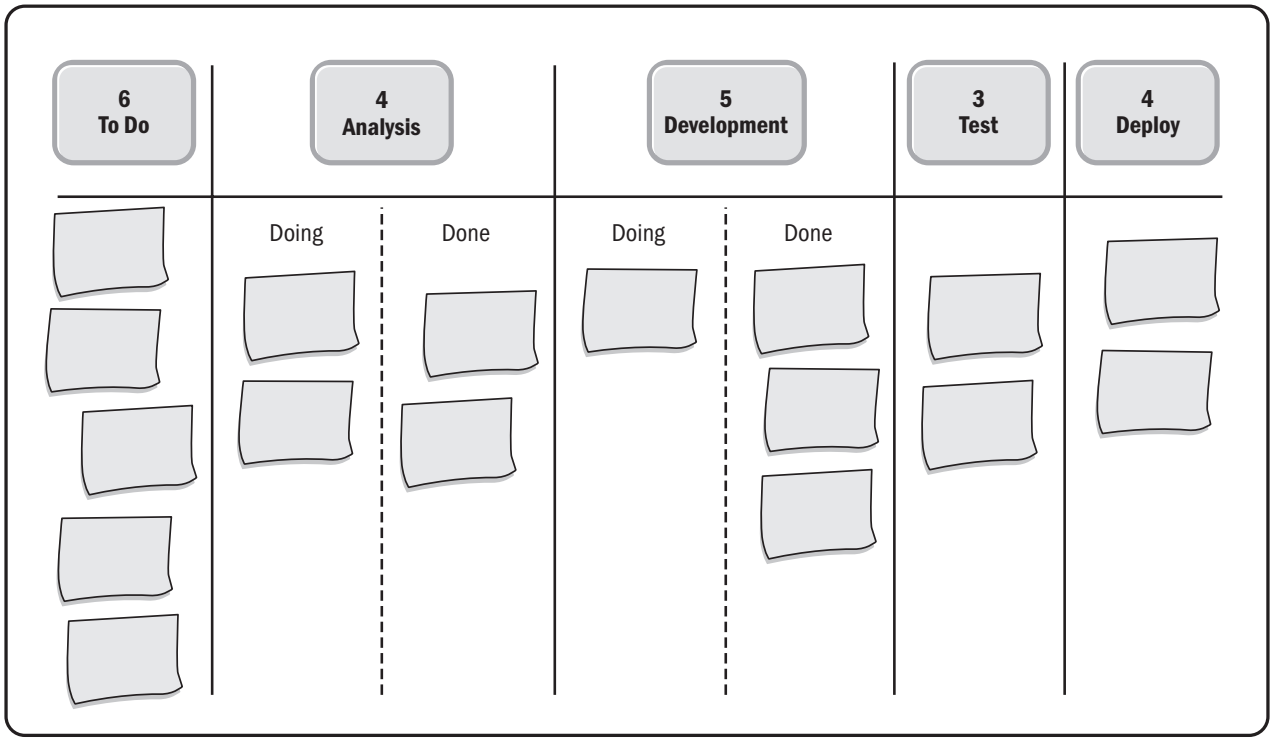


Figure A3-2. Kanban Board Demonstrating Work in Progress Limits, and a Pull System to Optimize the Flow of Work

In the Kanban Method, it is more important to complete work than it is to start new work. There is no value derived from work that is not completed so the team works together to implement and adhere to the work in progress (WIP) limits and get each piece of work through the system to "done."

A3.5 CRYSTAL METHODS

Crystal is a family of methodologies. Crystal methodologies are designed to scale, and provide a selection of methodology rigor based on project size (number of people involved in the project) and the criticality of the project.

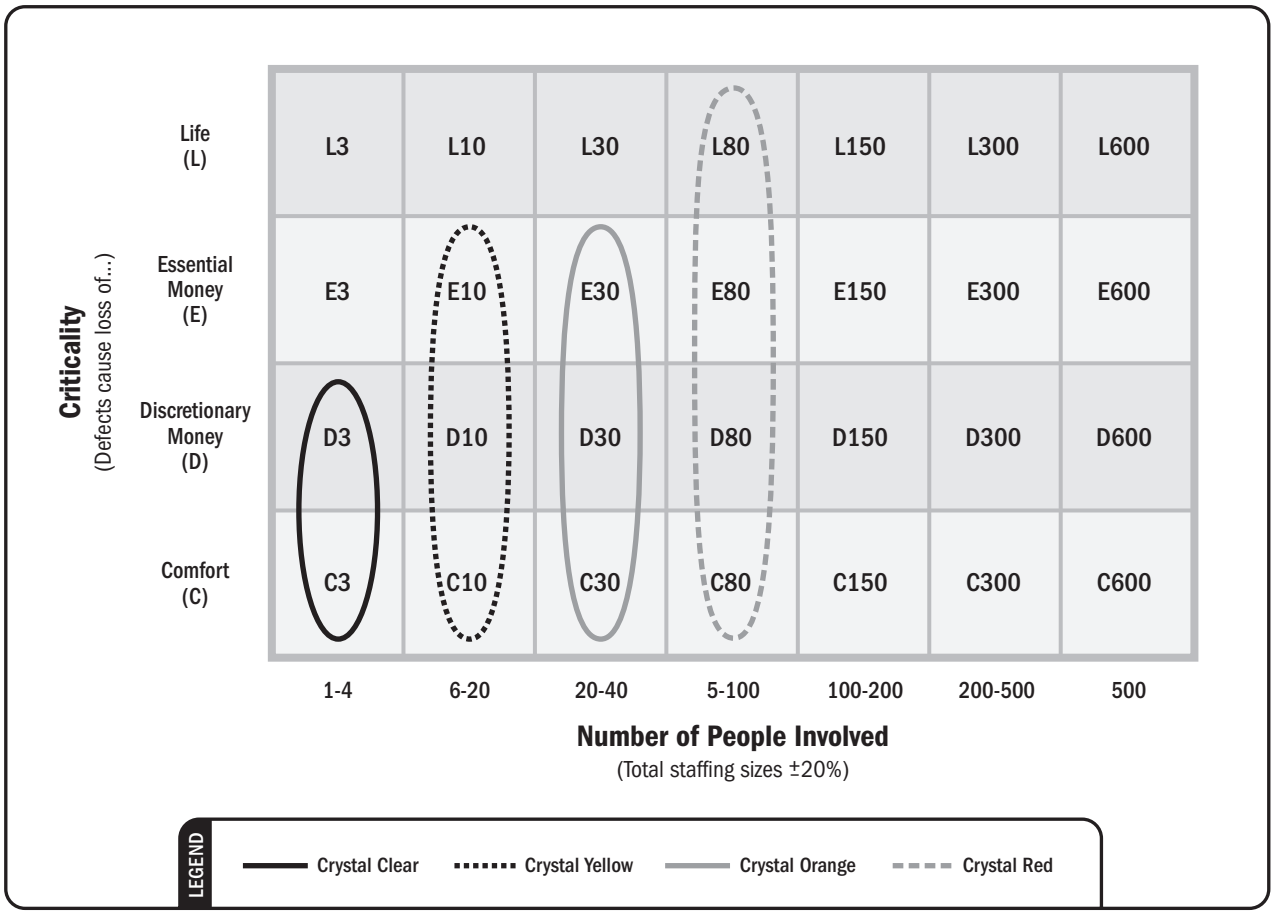


Figure A3-3. The Crystal Family of Methods

Crystal Methodology realizes that each project may require a slightly tailored set of policies, practices, and processes in order to meet the project's unique characteristics. The family of methodologies use different colors based on "weight" to determine which methodology to use. The use of the word crystal comes from the gemstone where the various "faces" represent underlying core principles and values. The faces are a representation of techniques, tools, standards, and roles listed in Table A3-4.

Table A3-4. The Core Values and Common Properties of Crystal

Core Values	Common Properties[A]
People	Frequent delivery
Interaction	Reflective improvement
Community	Close or osmotic communication
Skills	Personal safety
Talents	Focus
Communications	Easy access to expert users
	Technical environment with automated tests, configuration management, and frequent integration

[A] The more these properties are in a project, the more likely it is to succeed.

A3.6 SCRUMBAN

Scrumban is an agile approach originally designed as a way to transition from Scrum to Kanban. As additional agile frameworks and methodologies emerged, it became an evolving hybrid framework in and of itself where teams use Scrum as a framework and Kanban for process improvement.

In Scrumban, the work is organized into small "sprints" and leverages the use of kanban boards to visualize and monitor the work. The stories are placed on the kanban board and the team manages its work by using work-in-progress limits. Daily meetings are held to maintain the collaboration between the team and to remove impediments. A planning trigger is set in place for the team to know when to plan next, typically when the work-in-progress level is lower than a predetermined limit. There are no predefined roles in Scrumban—the team retains their current roles.

A3.7 FEATURE-DRIVEN DEVELOPMENT

Feature-Driven Development (FDD) was developed to meet the specific needs of a large software development project. Features relate to a small business value capability.

There are six primary roles on a Feature-Driven Development project where individuals can take on one or more of the following roles:

- Project manager,
- Chief architect,
- Development manager,
- Chief programmer,
- Class owner, and/or
- Domain expert.

A Feature-Driven Development project is organized around five processes or activities, which are performed iteratively:

- Develop an overall model,
- Build a features list,
- Plan by feature,
- Design by feature, and
- Build by features.

The life cycle flow and interaction of these five processes is illustrated in Figure A3-4.

Feature-Driven Development activities are supported by a core set of software engineering best practices:

- Domain object modeling,
- Developing by feature,
- Individual class ownership,
- Feature teams,
- Inspections,
- Configuration management,
- Regular builds, and
- Visibility of progress and results.

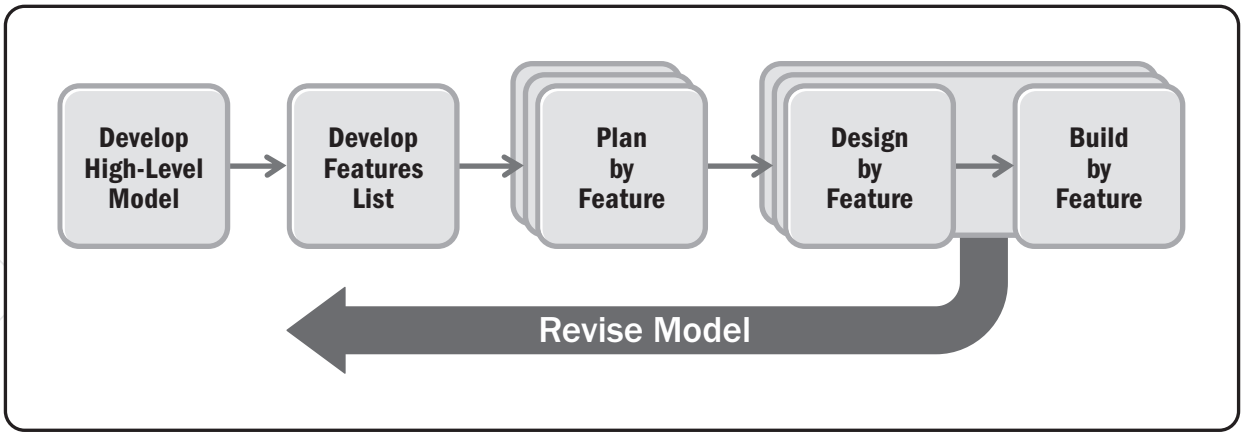


Figure A3-4. Feature-Driven Development Project Life Cycle

A3.8 DYNAMIC SYSTEMS DEVELOPMENT METHOD

Dynamic Systems Development Method (DSDM) is an agile project delivery framework initially designed to add more rigor to existing iterative methods popular in the 1990s. It was developed as a noncommercial collaboration among industry leaders.

DSDM is known best for its emphasis on constraint-driven delivery. The framework will set cost, quality, and time at the outset, and then use formalized prioritization of scope to meet those constraints as shown in Figure A3-5.

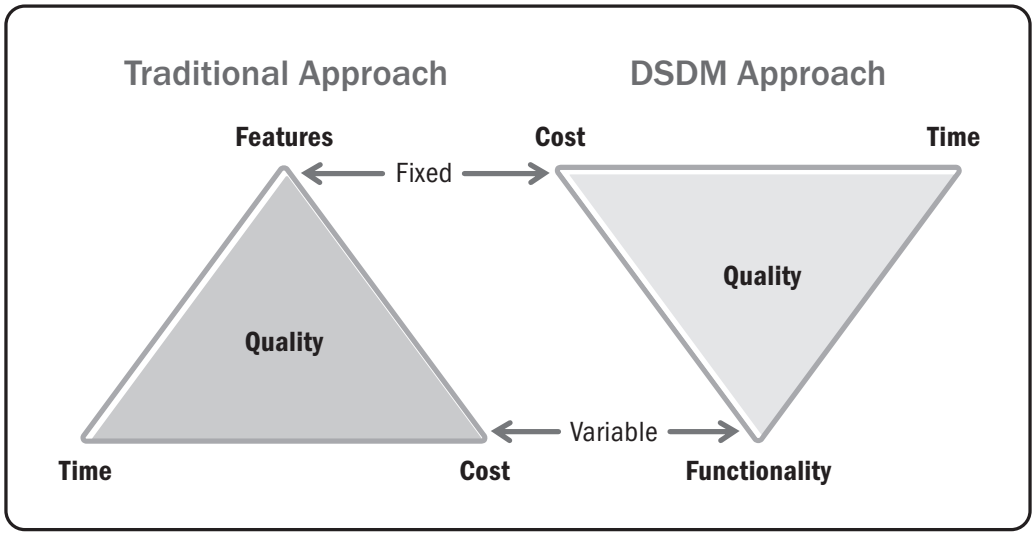


Figure A3-5. DSDM Approach to Constraint-Driven Agility

Eight principles guide the use of the DSDM framework:

- Focus on the business need.
- Deliver on time.
- Collaborate.
- Never compromise quality.
- Build incrementally from firm foundations.
- Develop iteratively.
- Communicate continuously and clearly.
- Demonstrate control (use appropriate techniques).

A3.9 AGILE UNIFIED PROCESS

The Agile Unified Process (AgileUP) is an offshoot of the Unified Process (UP) for software projects. It features more accelerated cycles and less heavyweight processes than its Unified Process predecessor. The intent is to perform more iterative cycles across seven key disciplines, and incorporate the associated feedback before formal delivery. The disciplines along with guiding principles are listed in Table A3-5.

Table A3-5. The Key Elements of the Agile Unified Process

Disciplines within a Release	Principles Guiding the Disciplines
Model	The team knows what it's doing
Implementation	Simplicity
Test	Agility
Deployment	Focus on high-value activities
Configuration management	Tool independence
Project management	Tailoring to fit
Environment	Situationally specific

A3.10 SCALING FRAMEWORKS

A3.10.1 SCRUM OF SCRUMS

Scrum of Scrums (SoS), also known as "meta Scrum," is a technique used when two or more Scrum teams consisting of three to nine members each need to coordinate their work instead of one large Scrum team. A representative from each team attends a meeting with the other team representative(s), potentially daily but typically two to three times a week. The daily meeting is conducted similar to the daily standup in Scrum where the representative reports completed work, next set of work, any current impediments, and potential upcoming impediments that might block the other team(s). The goal is to ensure the teams are coordinating work and removing impediments to optimize the efficiency of all the teams.

Large projects with several teams may result in conducting a Scrum of Scrum of Scrums, which follows the same pattern as SoS with a representative from each SoS reporting into a larger group of representatives as shown in Figure A3-6.

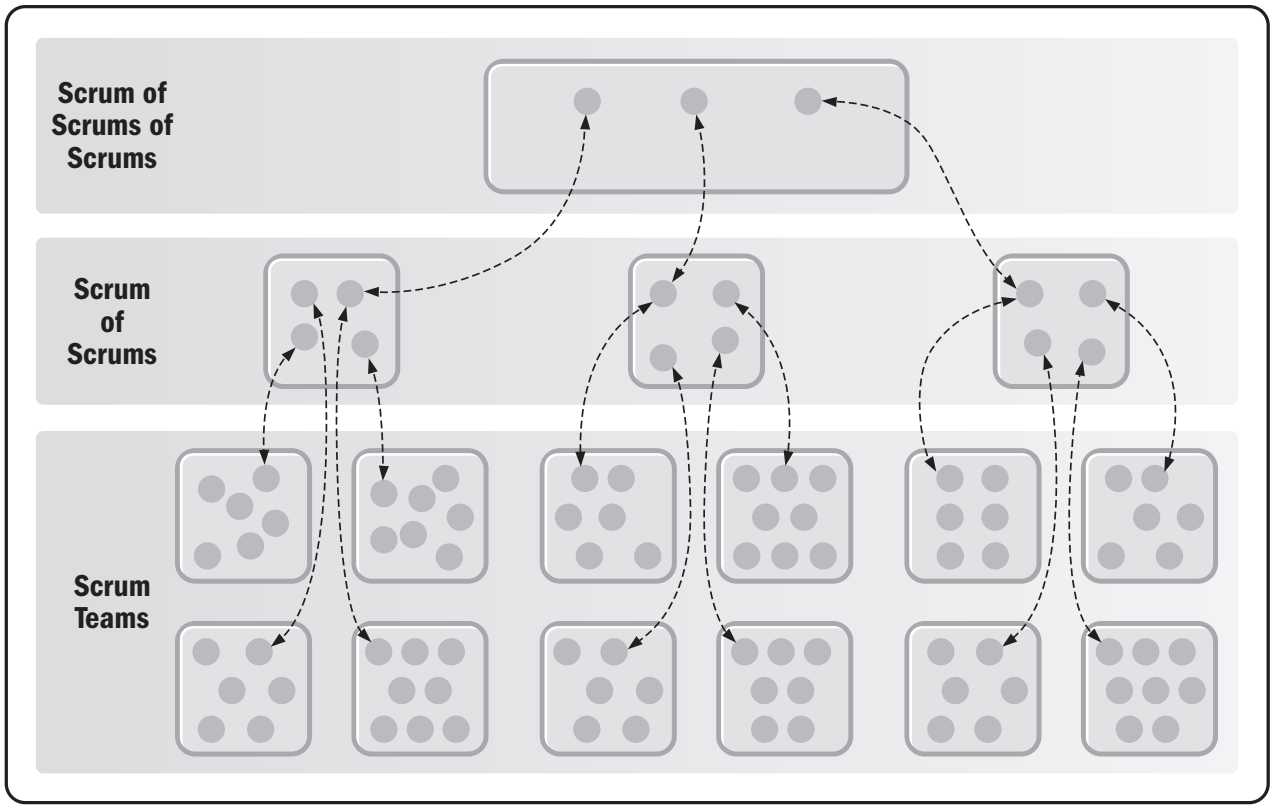


Figure A3-6. Representatives of Scrum Teams Participating in SoS teams

A3.11 SCALED AGILE FRAMEWORK

The Scaled Agile Framework (SAFe®) focuses on providing a knowledge base of patterns for scaling development work across all levels of the enterprise.

SAFe® is focused on the following principles:

- Take an economic view.
- Apply systems thinking.
- Assume variability; preserve options.
- Build incrementally with fast, integrated learning cycles.
- Base milestones on objective evaluation of working systems.

- Visualize and limit work in progress, reduce batch sizes, and manage queue lengths.
- Apply cadence; synchronize with cross-domain planning.
- Unlock the intrinsic motivation of knowledge workers.
- Decentralize decision making.

SAFe® focuses on detailing practices, roles, and activities at the portfolio, program, and team levels with an emphasis on organizing the enterprise around value streams that focus on providing continuous value to the customer.

A3.12 LARGE SCALE SCRUM (LeSS)

Large Scale Scrum (LeSS) is a framework for organizing several development teams toward a common goal extending the Scrum method shown in Figure A3-6. The core organizing principle is to retain as much as possible of the elements of the conventional single-team Scrum model. This helps minimize any extensions to the model that might create unnecessary confusion or complexity. Table A3-6 shows a comparison of LeSS and Scrum.

Table A3-6. Comparison of LeSS and Scrum

Similarities of LeSS and Scrum	LeSS Techniques Added to Scrum
One single product backlog One definition of done for all teams One potentially shippable product increment at the end of each sprint One product owner Complete, cross-functional teams One sprint	Sprint planning is more formally divided into two parts of what and how Organic cross-team coordination Overall cross-team refinement Overall retrospective focused on cross-team improvements

In order to extend Scrum without losing its essence, LeSS promotes the use of certain discerning principles, such as systems thinking, whole product focus, transparency, and others.

A3.13 ENTERPRISE SCRUM

Enterprise Scrum is a framework designed to apply the Scrum method on a more holistic organizational level rather than a single product development effort. Specifically, the framework advises organization leaders to:

- Extend the use of Scrum across all aspects of the organization;
- Generalize the Scrum techniques to apply easily at those various aspects; and
- Scale the Scrum method with supplemental techniques as necessary.

The intent is to use agile approaches beyond project execution by enabling disruptive innovation.

A3.14 DISCIPLINED AGILE (DA)

Disciplined Agile (DA) is a process decision framework that integrates several agile best practices into a comprehensive model. DA was designed to offer a balance between those popular methods deemed to be either too narrow in focus (e.g., Scrum) or too prescriptive in detail (e.g., AgileUP). To achieve that balance, it blends various agile techniques according to the following principles:

- **People-first.** Enumerating roles and organization elements at various levels.
- **Learning-oriented.** Encouraging collaborative improvement.
- **Full delivery life cycle.** Promoting several fit-for-purpose life cycles.
- **Goal-driven.** Tailoring processes to achieve specific outcomes.
- **Enterprise awareness.** Offering guidance on cross-departmental governance.
- **Scalable.** Covering multiple dimensions of program complexity.

APPENDIX X1
CONTRIBUTORS AND REVIEWERS

X1.1 *AGILE PRACTICE GUIDE* CORE COMMITTEE

The following individuals were members of the project Core Committee responsible for drafting the guide, including review and adjudication of reviewer recommendations.

X1.1.1 REPRESENTING THE PROJECT MANAGEMENT INSTITUTE:

Mike Griffiths, PMP, PMI-ACP, (Committee Chair)
Jesse Fewell, CST, PMI-ACP
Horia Sluşanschi, PhD, CSM
Stephen Matola, BA, PMP

X1.1.2 REPRESENTING AGILE ALLIANCE:

Johanna Rothman, MS (Committee Vice Chair)
Becky Hartman, PMI-ACP, CSP
Betsy Kauffman, ICP-ACC, PMI-ACP

X1.2 *AGILE PRACTICE GUIDE* SUBJECT MATTER EXPERT REVIEWERS

The following individuals were invited subject matter experts who reviewed the draft and provided recommendations through the SME Review.

Joe Astolfi, PMP, PSM
Maria Cristina Barbero, PMI-ACP, PMP
Michel Biedermann, PhD, PMI-ACP
Zach Bonaker
Robert Bulger, PfMP, CSM
Sue Burk
Shika Carter, PMP, PMI-ACP
Lauren Clark, PMP, CSM
Linda M Cook, CSM, CSPO
Pamela Corbin-Jones, PMI-ACP, CSM
Jeff Covert
Alberto Dominguez, MSc, PMP
Scott P. Duncan, CSM, ICP-ACC
Sally Elatta, PMI-ACP, EBAC
Frank R. Hendriks, PMP, PMI-ACP
Derek Huether
Ron Jeffries
Fred Koos
Philippe B. Kruchten, PhD, PEng
Steve Mayner, SPCT4, PMP
Michael S. McCalla, PMI-ACP, CSP
Don B. McClure, PMP, PMI-ACP
Anthony C. Mersino, PMI-ACP, CSP
Kenneth E. Nidiffer, PhD, PMP
Michael C. Nollet, PMP, PMI-ACP
Laura Paton, MBA, PMP
Yvan Petit, PhD, PMP
Dwayne Phillips, PhD, PMP
Piyush Prakash, PMP, Prince2
Dave Prior, PMP, CST
Daniel Rawsthorne, PhD, PMP
Annette D. Reilly, PMP, PhD
Stephan Reindl, PMI-ACP, PMP
Reed D. Shell, PMP, CSP
Cindy Shelton, PMP, PMI-ACP
Teresa Short
Lisa K. Sieverts, PMP, PMI-ACP
Christopher M. Simonek, PMP, CSM
Robert “Sellers” Smith, PMP, PMI-ACP
Ram Srinivasan, PMP, CST
Chris Stevens, PhD
Karen Strichartz, PMP, PMI-ACP
Rahul Sudame, PMI-ACP
Joanna L. Vahlsing, PMP
Erik L. van Daalen
Annette Vendelbo, PMP, PMI-ACP
Dave Violette, MPM, PMP
Anton Vishnyak, PMI-ACP, CSM
Chuck Walrad, MA, MS

X1.3 FORMAT FOCUS GROUP

The following individuals assisting in the development of new content style and formatting elements for the *Agile Practice Guide.*

Goran Banjanin, PgMP, PMP
Andrew Craig
Cătălin-Teodor Dogaru, PhD, PMP
Jorge Espinoza, PMP
Jennifer M. Forrest, CSM, PMP
Helen Fotos, PMP, PMI-ACP
Dave Hatter, PMP, PMI-ACP
Christopher Healy, PMP
Mike Hoffmann, MBA, PMP
Chadi Kahwaji, PMP
Rajaraman Kannan, PMP, MACS CP
Amit Khanna PMP, PMI–ACP
Ariel Kirshbom, PMI-ACP, CSP
Bernardo Marques, PMP
Noura Saad, PMI-ACP, CSPO
Kurt Schuler, PMP
Demetrius L. Williams, MBA, PMP
Liza Wood
Melody Yale, CSP, SPC4

X1.4 PMI STANDARDS MEMBER ADVISORY GROUP (MAG)

The following individuals are members of the PMI Standards Member Advisory Group, who provided direction to and final approval on behalf of PMI for the *Agile Practice Guide.*

Maria Cristina Barbero, PMI-ACP, PMP
Brian Grafsgaard, PMP, PgMP
Hagit Landman, PMP, PMI-SP
Yvan Petit PhD, PMP
Chris Stevens, PhD
Dave Violette, MPM, PMP
John Zlockie, MBA, PMP, PMI Standards Manager

X1.5 AGILE ALLIANCE® BOARD

The following individuals are members of Agile Alliance Board of Directors, who provided direction to and final approval on behalf of Agile Alliance for the *Agile Practice Guide.*

Juan Banda
Phil Brock (Managing Director)
Linda Cook
Stephanie Davis
Ellen Grove
Paul Hammond (Chair)
Victor Hugo Germano
Rebecca Parsons (Secretary)
Craig Smith
Declan Whelan

X1.6 PMI SUPPORT STAFF AND ACADEMIC RESEARCH SUPPORT

The following individuals worked to support the core committee in the development and approval of the draft, in support of the Format Focus Group, and in PMI marketing efforts.

Melissa M. Abel, Marketing Communications Specialist
Karl F. Best, PMP, CStd, Standards Specialist
Alicia C. Burke, MBA, CSM, Product Manager, Credentials
Edivandro C. Conforto, PhD, PMI Consultant on Agile Research
Dave Garrett, CSPO, Vice President, Transformation
Erica Grenfell, Administrative Assistant to VP, Organization Relations
M. Elaine Lazar, MA, MA, AStd, Project Specialist
Andrew Levin, PMP, Project Manager
Tim E. Ogline, User Experience Designer
Stephen A. Townsend, Director of Network Programs
Michael Zarro, PhD, UX Researcher

X1.7 PMI PRODUCTION STAFF

Donn Greenberg, Manager, Publications
Kim Shinners, Publications Production Associate
Roberta Storer, Product Editor
Barbara Walsh, Production Supervisor

APPENDIX X2
ATTRIBUTES THAT INFLUENCE TAILORING

X2.1 INTRODUCTION

This appendix provides high-level guidance on when and how to tailor agile approaches. It can be used to determine circumstances that might warrant changing or introducing new techniques, and then offers some recommendations to consider.

X2.2 FIRST SOME CAUTIONS

Tailoring is an advanced topic that should be undertaken by experienced practitioners who have been successful using agile approaches as originally described in multiple environments before they consider tailoring them. In other words, gain experience and be successful with one approach before attempting to tailor the approach.

A common response when struggling to adopt an agile practice is to consider whether to do it or not. A statement like "Retrospectives were unpopular so we decided to drop them" illustrates this issue and indicates a more fundamental problem on the team that is unlikely to be addressed by tailoring the method. The situation will be made worse by omitting the retrospective activity that aims to improve the process.

The Shu-Ha-Ri model of skills acquisition describes progression from obeying the rules (Shu 守, means to obey and protect), through consciously moving away from the rules (Ha 破, means to change or digress), and finally through steady practice and improvement finding an individual path (Ri 離, means to separate or leave). We need to start and practice at the Shu level before we are ready to move to the Ha level to tailor the process or the Ri level to invent a new custom process.

Finally, tailoring should be undertaken in collaboration with the teammates or whoever the change is likely to impact. People need to be engaged in the thinking and decision-making process about changing processes in order for them to commit and buy-in to the changes in order to have a successful transition. Omitting people from tailoring a process is likely to result in resistance and resentment to the change, even if it makes good sense technically. Often, experienced coaches or leaders can help to engage people effectively.

X2.3 HOW TO USE THIS APPENDIX

To benefit from the guidance listed in this appendix, we recommend first successfully using the agile approaches as designed. Then review the tailoring guidelines in Table X2-1 that match the situation and read the associated recommendations. Next, discuss the change with the people it will impact and agree on a course of action.

As discussed in Section 5, a good way to evaluate a change is try it for an iteration or two first before adopting it permanently. Or, consider a flow-based approach to try to deliver several features. Then, reflect with a retrospective and reassess.

When people know they can experiment and provide feedback on the experiment, they are more likely to try something new. Having tried it for a timeboxed period, the team should review its effectiveness at a retrospective to determine whether it should be continued as-is, modified to improve it, or dropped from use.

Finally, successfully adopted, tailored approaches can be institutionalized into the standard processes used for projects that share these characteristics. It is also recommended that guidelines from Section 5 be followed that describe adopting (or tailoring) new approaches.

X2.4 TAILORING RECOMMENDATIONS

Listed below are some good practices to consider before tailoring an approach.

X2.4.1 BEWARE OF TAKING THINGS AWAY

Many of the agile practices act as self-supporting pairs. For instance, colocation and frequent business conversations allow for lightweight requirements since gaps in understanding can be filled quickly. Likewise, XP's ruthless testing allows for courageous refactoring as one practice supports the other. Removing something without understanding or addressing its counterbalanced practice will likely create more problems than it solves.

X2.4.2 USE THE TAILORING GUIDELINES TABLE

Using Table X2-1, find the circumstances that match a given situation and consider recommendations for tailoring. Discuss any changes with those who will be impacted by the change and plan a short trial first, along with an honest follow-up review before committing to the change.

Table X2-1. Tailoring Guidelines

Situation	Tailoring Recommendation
Very large project teams	Restructure large projects as multiple smaller projects. Try a technology trial project first and then an implementation project. Consider more frequent releases of fewer features each, which allows for the creation of smaller project teams. Consider reducing the team down to its critical core members. Often too many people hinder a process, not help it. Reducing a team size can reduce churn as well as costs. Break large teams into multiple smaller teams and use program management to synchronize and coordinate. Use agile and lean program management to organize the larger effort. Consider a scaled agile or lean framework such as DA, SAFe®, or LeSS. Each offers some useful ideas, and each carries implementation risks and process weight/cost.

Table X2-1. Tailoring Guidelines *(cont.)*

Situation	Tailoring Recommendation
Dispersed teams	Many projects have (some) dispersed team members. Tools like instant messaging, video conferencing, and electronic team boards help bridge many of the communication gaps. When teams are likely to remain stable, set up face-to-face meetings as soon as possible to make future remote conversations more effective. People who have met face-to-face are more likely to enter unfiltered debate because of higher trust. When conducting meetings with remote participants where there is a loss of facial and body-language cues, consider round-robin check-ins to ensure participation and check consensus for decisions. Also, consider the use of iteration-based agile approaches. When team members are many time zones apart, consider using whole-project interactions less frequently, while encouraging more personal meetings (two or three people at a time) more frequently.
Some safety critical products may require additional documentation and conformance checks beyond what agile processes suggest out-of-the-box	Agile approaches can still be used in these environments, but they need to have the appropriate additional layers of conformance review, documentation, and certification that is required by the domain. In that case, documentation could be part of what the team delivers along with finished features. Features may not be done until the documentation is completed. Consider using a hybrid approach (multiple agile approaches) to get the benefits of improved collaboration and communication brought by agile with the added rigor required by the product environment. Aircraft flight system developers and drug companies use agile approaches coupled with their own additional processes to leverage the benefits and retain appropriate controls.
Stable requirements and execution process	Is agile really needed? If uncertainty in requirements is low, low rates of change, or minimal execution risk, the full suite of agile approaches may not be needed. While any project benefits from increased collaboration and transparency; some of the iterative build and review cycles might be overkill. If build/feedback cycles do not routinely uncover or refine requirements, consider extending their durations to minimize the cost impact of review time. If the project has high rates of change during design and development, but rolling it out to customers is a defined and repeatable process, hybrid approaches that use the appropriate life cycle model for each project phase may make more sense.
Teams are in functional silos inside functional organizations	Agile is built on the idea of cross-functional teams. Consider asking people to create cross-functional teams themselves, without management involvement and see what happens. If the compensation system is organized to recognize and reward functional areas, consider changing that first. People might not act in the interest of the product or the team until it affects their compensation in some way.

Table X2-1. Tailoring Guidelines *(cont.)*

Situation	Tailoring Recommendation
Transparency can cause fear	Agile creates a culture of transparency: people show and share their work throughout development. This sharing of interim deliverables and being open and honest about successes, failures, and current state is transparency. Transparency requires courage. Lead by example and demonstrate transparency in decision-making processes by using a status board or whiteboard.
Many of the team members have little technical domain knowledge	Agile approaches encourage and make use of self-directing teams to make local decisions about work items, such as task sequencing and which approach to use when solving a problem. When the majority of team members are inexperienced, consensus-based approaches may lead to problems and rework. So, for these teams, additional help "assigning" and "directing" may be necessary until the team gains the necessary skills. In other words, do not just declare that agile will be used and let an inexperienced team try to figure everything out because they are empowered and self-directing. Consider building centers of competencies to help provide guidance and build domain knowledge.
Lack of executive buy-in	When executive buy-in is missing, teams will encounter a clash between the agile mindset and approaches and the more predictive mindset and approaches. Find common ground, areas for improvement based on the organization's needs, and then use experiments and retrospectives to progress. Consider education/training for executives. Consider explaining agile in terms of lean thinking: short cycles, small batch sizes, frequent reviews, and retrospectives with small improvements.
Agile terms and language do not fit the organizational culture	Modify the terms so people will understand and agree to the activities, if not the agile language. Be specific about what each term means. For example, if the organization finds the word "game" unprofessional, don't use terms such as "planning game." Instead, consider using the term "planning workshop."

APPENDIX X3
AGILE SUITABILITY FILTER TOOLS

X3.1 INTRODUCTION

Agile literature contains many agile suitability filter tools to help assess under what circumstances an agile approach is appropriate to use. In 1994, the Dynamic Systems Development Method (DSDM) developed an Agile Project Suitability Questionnaire and an Organizational Suitability Questionnaire to help gauge likely fit and potential problem areas.

The Crystal family of approaches also employed suitability criteria, ranking projects by team size and the criticality of the product or service being developed. Crystal recommends that smaller, less critical projects be undertaken with lighter controls and simpler approaches. Large, mission or life critical projects were recommended to use more rigor and validation.

Since the development of these approaches, there have been many more models created to help determine where and when to employ agile approaches. Boehm and Turner adopted some of the elements from DSDM and Crystal to develop a popular assessment model to help determine if projects should be undertaken with agile or more traditional approaches.

Based on these previous models and expanded to consider the middle ground of hybrid approaches, the following model is proposed. It represents a synthesis of several suitability filter attributes to help organizations assess and discuss whether projects should be undertaken using predictive, hybrid, or agile approaches.

X3.2 OVERVIEW OF THE MODEL

Organizational and project attributes are assessed under three main categories:

- **Culture.** Is there a supportive environment with buy-in for the approach and trust in the team?
- **Team.** Is the team of a suitable size to be successful in adopting agile, do its members have the necessary experience and access to business representatives to be successful?
- **Project.** Are there high rates of change? Is incremental delivery possible? How critical is the project?

Questions in each of these categories are answered and the results plotted on a radar chart. Clusters of values around the center of the chart indicate a good fit for agile approaches. Results around the outside indicate a predictive approach may be more suitable. Values in the middle portion (between agile and predictive) indicate a hybrid approach could work well. An example is shown in Figure X3-1.

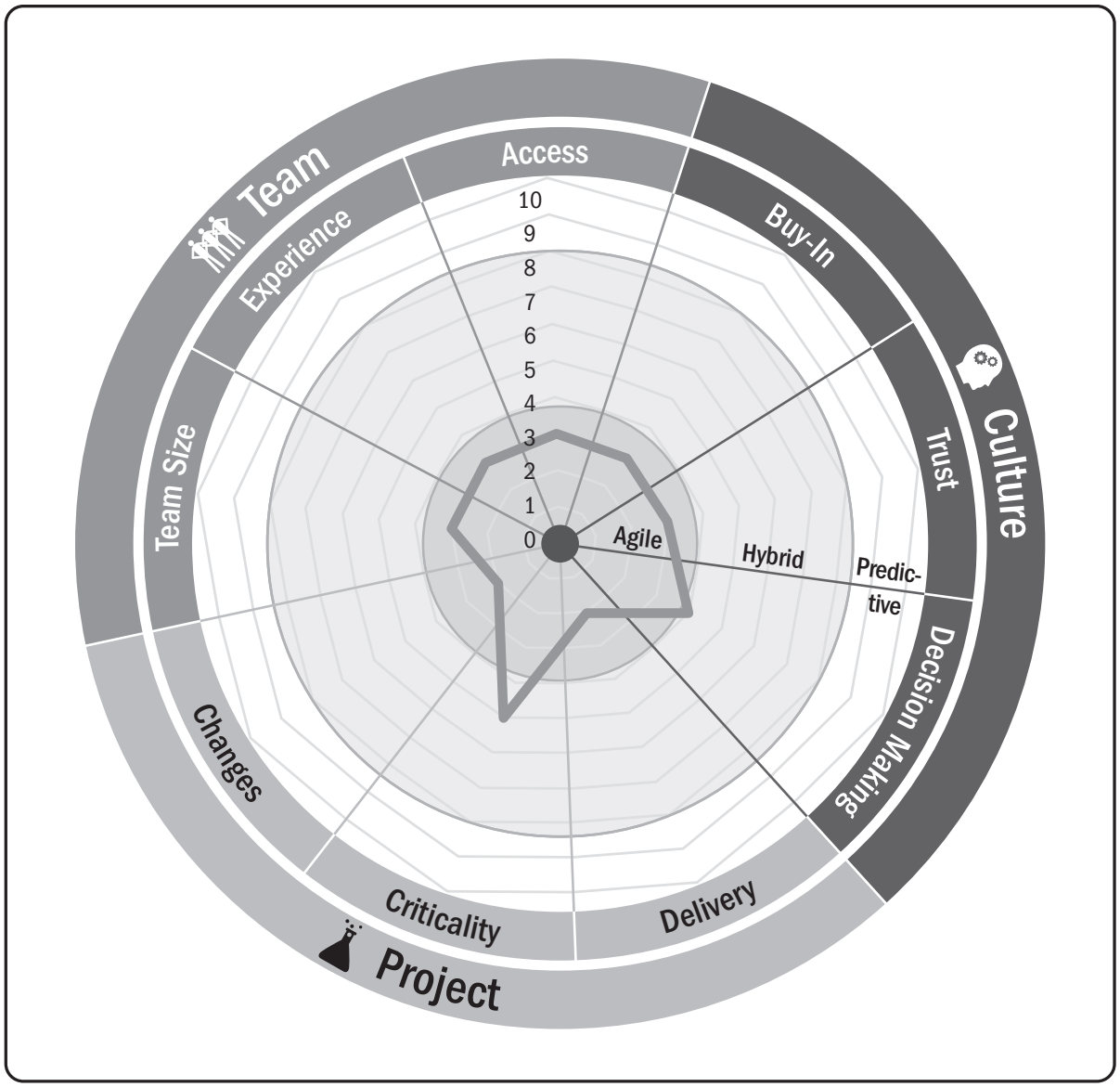


Figure X3-1. Model for Suitability of Agile Approach

X3.3 INSTRUCTIONS FOR USE

X3.3.1 COMPLETE THE QUESTIONNAIRE AS A GROUP

For small projects, this group may simply be the sponsor, technical lead, and a customer. For large projects, this may include representatives from the sponsoring group, project execution team, impacted business group(s), project governance group(s), and customer community. The idea is that just as no single stakeholder should estimate or plan a project because of representing only one viewpoint and having personal bias; so too should no single person assess the suitability of an approach since any one person will also have a limited view with a bias.

Instead, the value of the tool is the conversation it encourages with the invested parties of the project. Even if the results point to a hybrid approach, but the stakeholders want to proceed with a largely agile or predictive approach, follow the stakeholder consensus. This tool is a high-level diagnostic only, the final decision should rest and be supported by the people involved.

X3.3.2 SCORE THE QUESTIONS FROM 1 TO 10

As a group, discuss and agree (or compromise) on a score that most accurately reflects the subjective evaluation of the question. While definitive options are only provided for the start, middle, and end points of the answer spectrum representing scores of 1, 5, and 10, it is fine (and desirable) to use scores such as 2 for "almost a 1, but not quite," or 7 for "somewhere between a 5 and a 10." Again, the assessment is a discussion tool—views will be subjective and shades of gray are to be expected.

When the group cannot agree on a score, discuss the issues openly and honestly. Before suggesting compromises (i.e., using average scores or marking PMO scores with a blue "X" and the development team with a green "O"), consider how successful is the project likely to be when the participants cannot agree on completing a simple assessment? When discussing the issues, if the differences of opinion can be identified—then great, it is working; now come to an agreement. Likewise, if the assessment indicates a predictive approach but everyone wants to try an agile approach (or vice versa) that is fine too, just understand the issues and discuss how the impacts of the approach will be handled.

X3.3.3 INTERPRET THE RESULTS

Mark the answers from the questions on a blank suitability assessment chart and connect the points. Results clustered around the center in the agile zone indicate a good fit for a purely agile approach.

Results predominantly in the hybrid zone indicate some combination of agile and predictive approaches might work best. However, it is also possible that an agile approach with some additional risk reduction steps such as extra education and training or extra validation and documentation rigor in the case of high criticality projects may suffice. Alternatively, a predictive approach with some proof-of-concept work or extra processes could also work.

Results predominantly in the predictive zone indicate a good fit for a purely predictive approach. As mentioned in Section X3.3.2 (Score the Questions step), this diagnostic tool is aimed at starting meaningful conversations with the impacted parties about the most appropriate approach to use. If the approach suggested by the tool is not acceptable it is allowed to use a different approach. Use the results as inputs to the risk management process, since the tool indicates mismatches that will need to be managed.

X3.4 SUITABILITY FILTER QUESTIONS

X3.4.1 CATEGORY: CULTURE

X3.4.1.1 BUY-IN TO APPROACH

Is there senior sponsor understanding and support for using an agile approach for this project? See Figure X3-2.

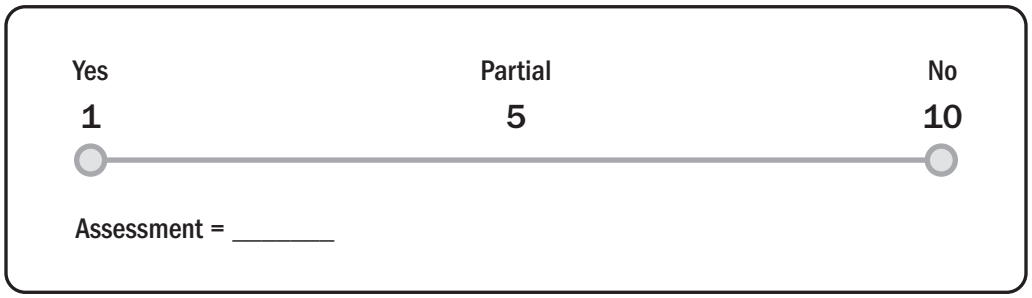


Figure X3-2. Buy-In to Approach Assessment

X3.4.1.2 TRUST IN TEAM

Considering the sponsors and the business representatives who will be working with the team. Do these stakeholders have confidence that the team can transform their vision and needs into a successful product or service—with ongoing support and feedback going both directions? See Figure X3-3.

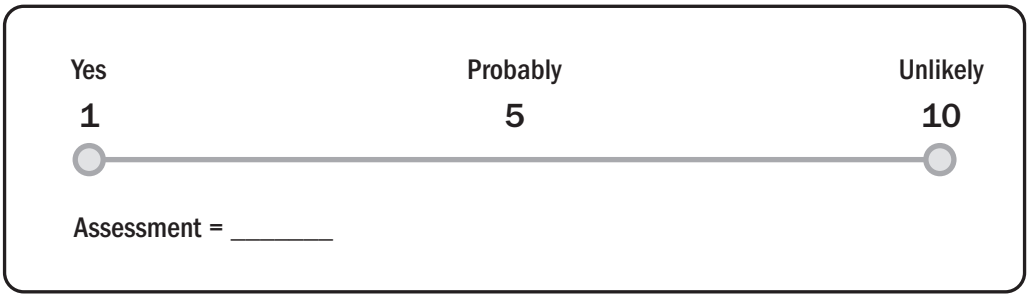


Figure X3-3. Trust in Team Assessment

X3.4.1.3 DECISION-MAKING POWERS OF TEAM

Will the team be given autonomy to make their own local decisions about how to undertake work? See Figure X3-4.

Figure X3-4. Assessment for Decision-Making Powers of Team

X3.4.2 CATEGORY: TEAM

X3.4.2.1 TEAM SIZE

What is the size of the core team? Use this scale: 1-9 = 1, 10-20 = 2, 21-30 = 3, 31-45 = 4, 46-60 = 5, 61-80 = 6, 81-110 = 7, 111-150 = 8, 151 – 200 = 9, 201+ = 10. See Figure X3-5.

Figure X3-5. Team Size Assessment

X3.4.2.2 EXPERIENCE LEVELS

Considering the experience and skill levels of the core team roles. While it is normal to have a mix of experienced and inexperienced people in roles, for agile projects to go smoothly; it is easier when each role has at least one experienced member. See Figure X3-6.

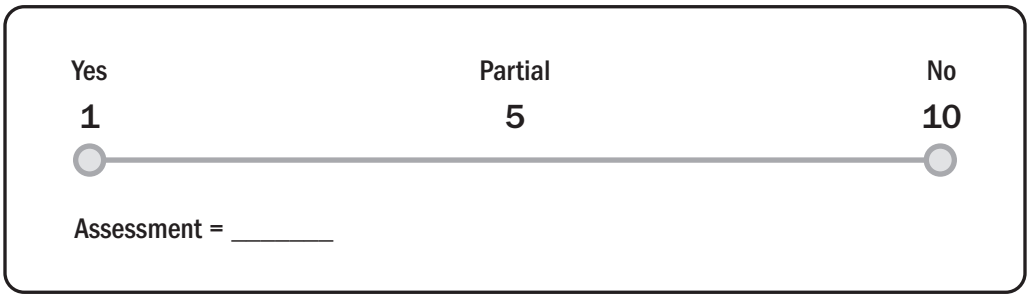


Figure X3-6. Experience Level Assessment

X3.4.2.3 ACCESS TO THE CUSTOMER/BUSINESS

Will the team have daily access to at least one business/customer representative to ask questions and get feedback? See Figure X3-7.

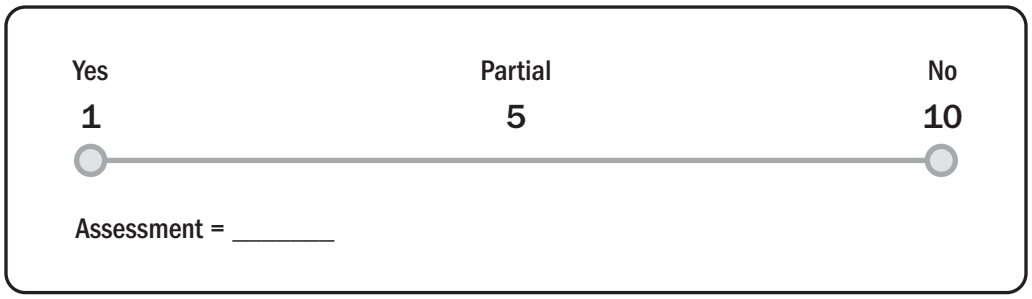


Figure X3-7. Assessment for Access to the Customer/Business

X3.4.3 CATEGORY: PROJECT

X3.4.3.1 LIKELIHOOD OF CHANGE

What percentage of requirements are likely to change or be discovered on a monthly basis? See Figure X3-8.

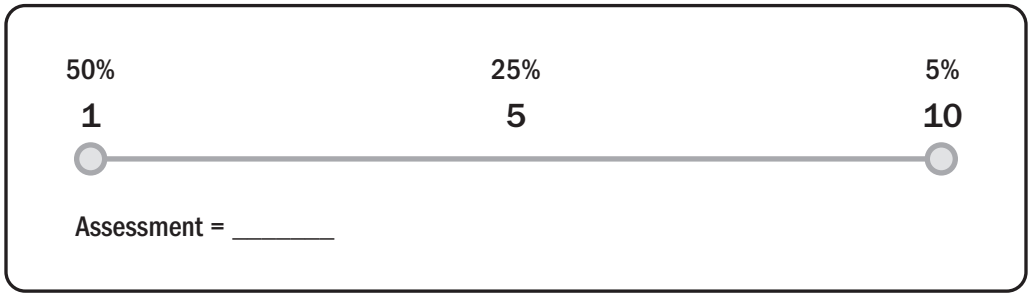


Figure X3-8. Likelihood of Change Assessment

X3.4.3.2 CRITICALITY OF PRODUCT OR SERVICE

To help determine likely levels of additional verification and documentation rigor that may be required, assess the criticality of the product or service being built. Using an assessment that considers loss due to possible impact of defects, determine what a failure could result in. See Figure X3-9.

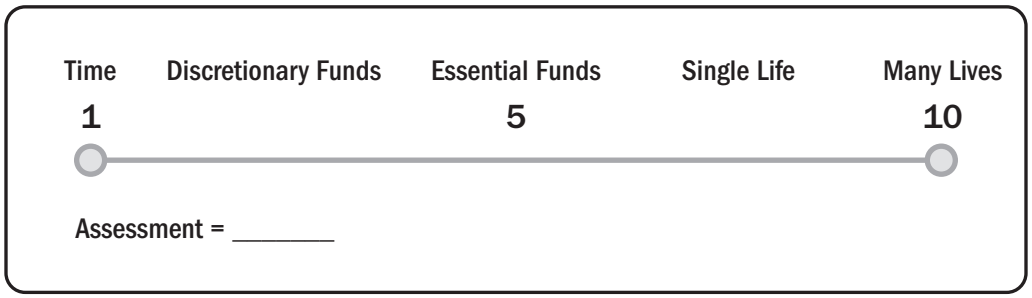


Figure X3-9. Assessment for Criticality of Product or Service

X3.4.3.3 INCREMENTAL DELIVERY

Can the product or service be built and evaluated in portions? Also, will business or customer representatives be available to provide timely feedback on increments delivered? See Figure X3-10.

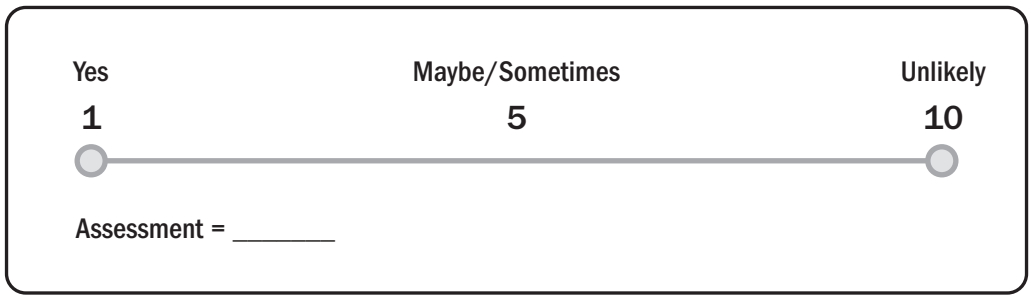


Figure X3-10. Incremental Delivery Assessment

X3.5 SUITABILITY ASSESSMENT CHART

Figure X3-11 is the radar chart used for the suitability assessment.

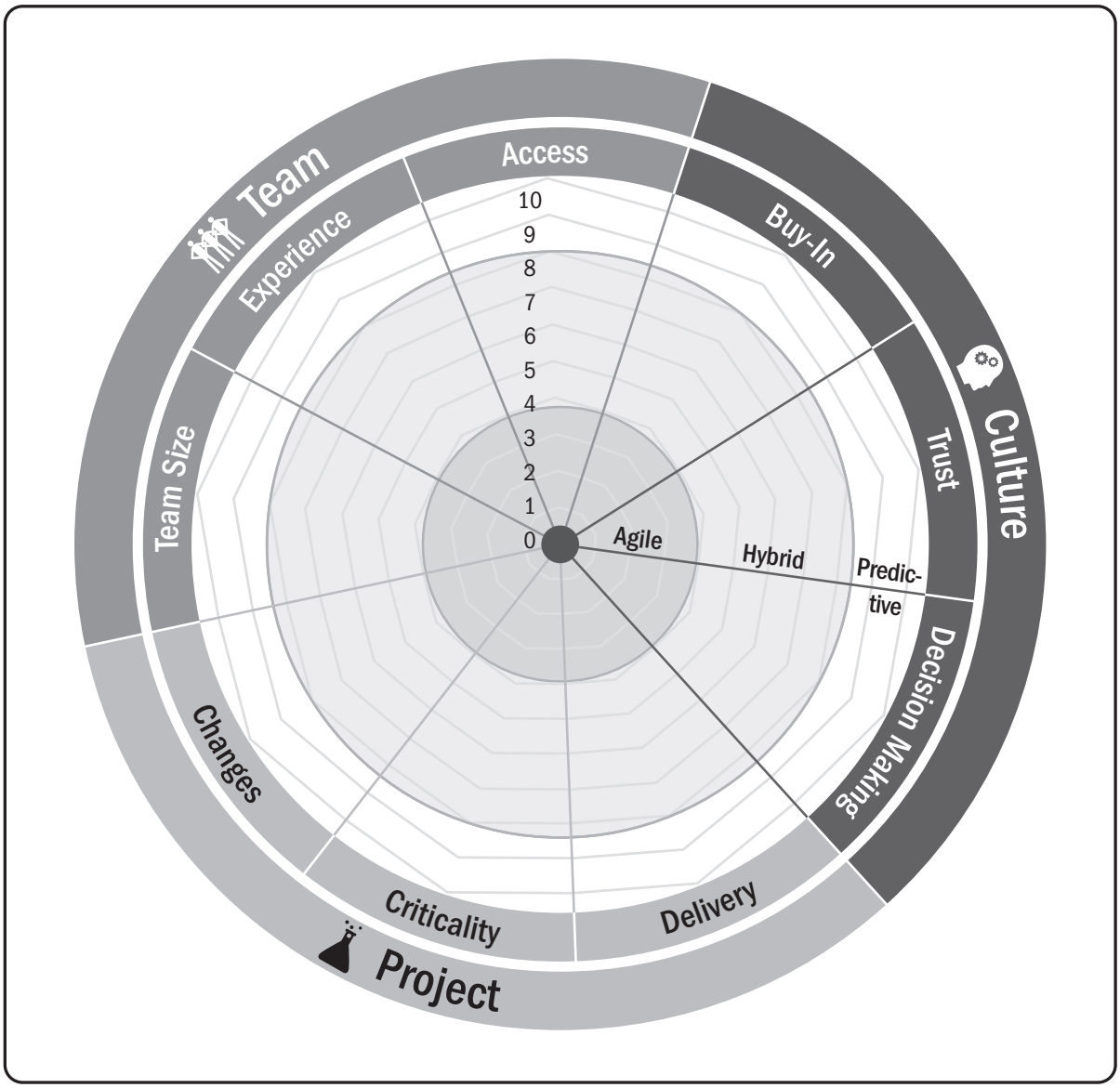


Figure X3-11. Suitability Assessment Radar Chart

X3.5.1 CASE STUDIES

To illustrate how the radar chart works, here are two examples of using the model to score very different types of projects. The first is an example of an online drug store project (see Figure X3-12) and the second (Figure X3-13) is an example of a military messaging system. These two case studies illustrate some of the variances seen on projects. Central clustering indicates a good fit for agile approaches, peripheral scores indicate predictive approaches might be more suitable. Some projects are centered around the middle but then spike out on one or two axes. These projects may be best solved with a hybrid approach.

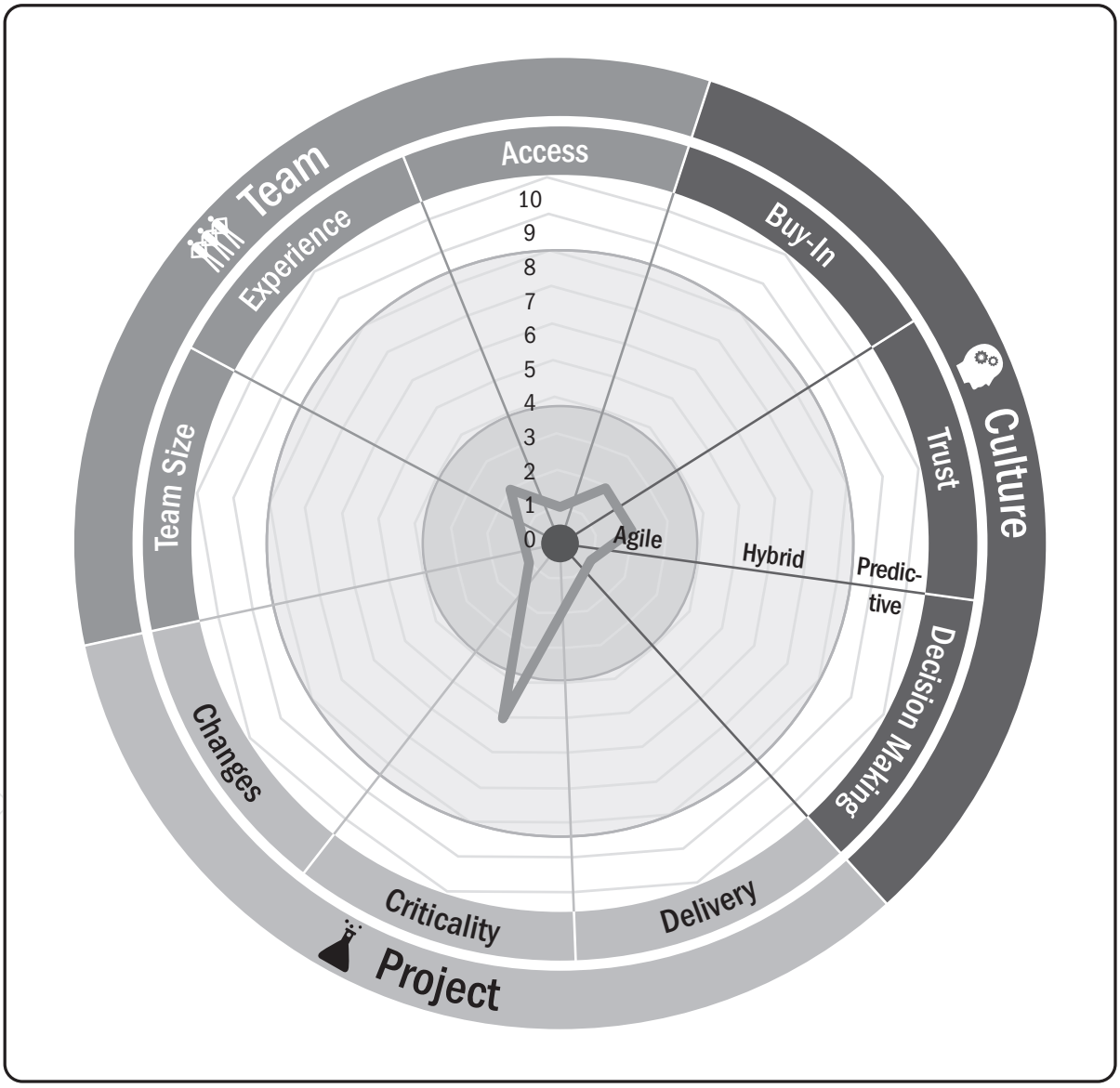


Figure X3-12. Drug Store Project

X3.5.1.1 DRUG STORE EXAMPLE

The project was to develop an online drug store to sell cheaper Canadian prescription drugs to (primarily) U.S. customers. The sale of these drugs is a contentious subject in Canada as well as the U.S. and as a result the industry is characterized by swift regulation changes and fierce competition. The project faced extremely volatile requirements with major changes week on week. It used very short (2-day) iterations and weekly releases to tackle the high rates of change.

As shown in Figure X3-12, high levels of buy-in and trust are evident for those who worked in an empowered way. The visual nature of the website made it easy to show new increments of functionality, but the system criticality was fairly high with essential funds for the pharmacy at stake. As mentioned, there were very high rates of change, but the small experienced team handled them well and had easy access to a knowledgeable business representative. The approach was very successful and extremely agile.

X3.5.1.2 MILITARY MESSAGING SYSTEM EXAMPLE

Contrast the first example with a large project to develop military messaging system that had already been running for 5 years when the assessment was made. See Figure X3-13.

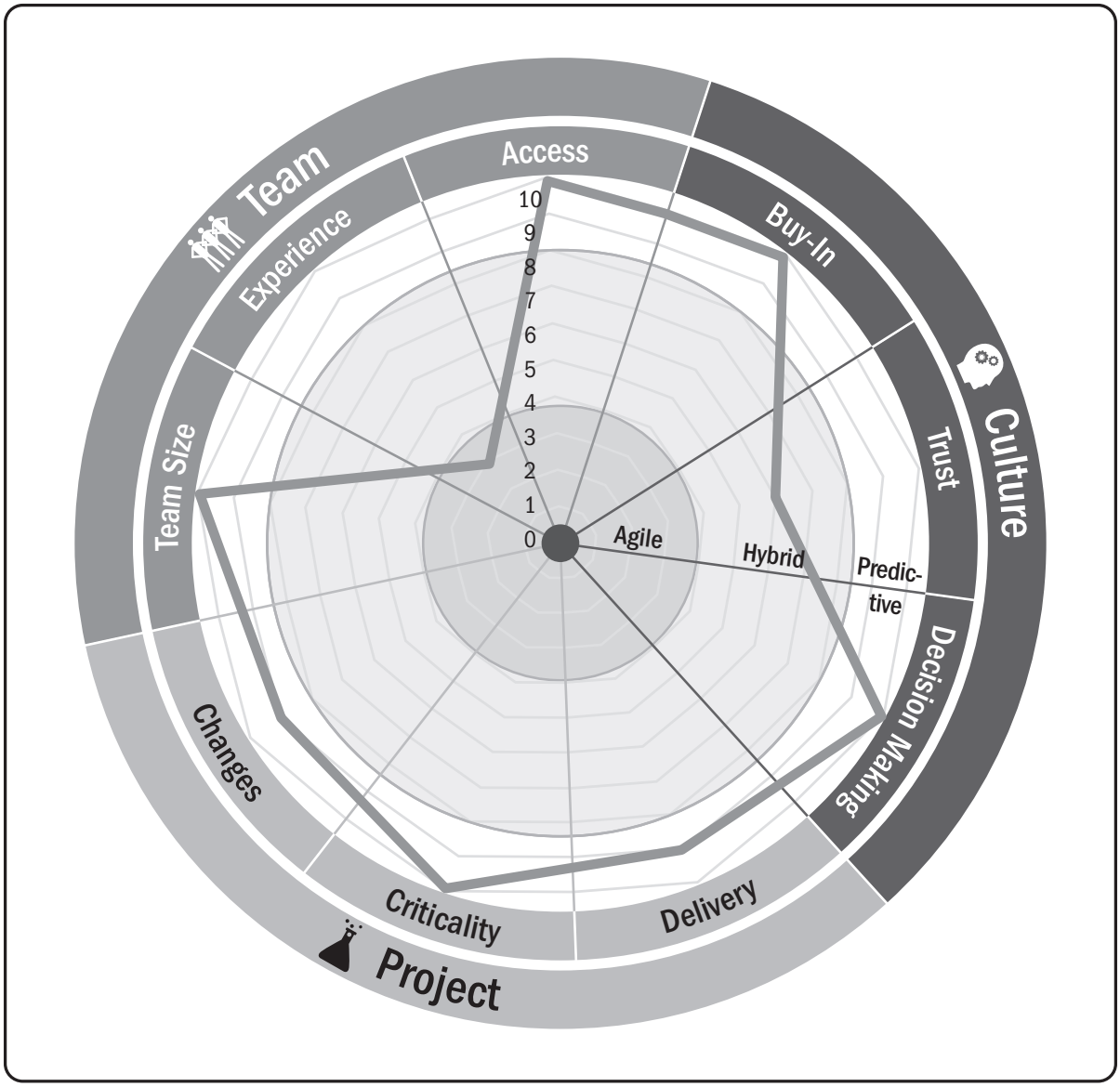


Figure X3-13. Military Messaging Example

Buy-in for an agile approach was lacking because an agile approach was not being considered. Trust in the vendors was mixed but generally respected. Decision making was not local, but instead made by architecture and requirements committees. While elements of the design could be tested incrementally in a laboratory, they could not be gathered together for an end to end demonstration of functionality. Many lives were potentially at risk, so criticality was very high. Requirements were locked down because changes impacted so many subcontractor organizations.

The project was large with more than 300 people from one vendor alone, but each role had many experienced practitioners. Finally, access to the business/customer was not possible, but contract analysts were available to ask specification questions to and they usually replied or asked clarifying questions within 10 days. Parts of the project could have been carved off and run as agile projects, but at the heart of the initiative was a single large project.

X3.6 SUMMARY

Agile suitability filters are useful tools for identifying potential fits and gaps for agile approaches. They should not be used as definitive inclusion or exclusion gates, but instead as topics for objective discussion with all interested parties.

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APPENDIX X2—ATTRIBUTES THAT INFLUENCE TAILORING

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GLOSSARY

1. ACRONYMS

ATDD	acceptance test-driven development
BDD	behavior-driven development
BRD	business requirement documents
DA	Disciplined Agile
DoD	definition of done
DoR	definition of ready
DSDM	Dynamic Systems Development Method
Evo	evolutionary value delivery
LeSS	Large-Scale Scrum
LSD	Lean Software Development
PDCA	Plan-Do-Check-Act
PMO	project management office
ROI	return on investment
RUP	rational unified process
SAFe®	Scaled Agile Framework®
SBE	specification by example
XP	eXtreme Programming

2. DEFINITIONS

A3. A way of thinking and a systematic problem-solving process that collects the pertinent information on a single A3-size sheet of paper.

Acceptance Test-Driven Development (ATDD). A method of collaboratively creating acceptance test criteria that are used to create acceptance tests before delivery begins.

Agile. A term used to describe a mindset of values and principles as set forth in the Agile Manifesto.

Agile Coach. An individual with knowledge and experience in agile who can train, mentor, and guide organizations and teams through their transformation.

Agile Life Cycle. An approach that is both iterative and incremental to refine work items and deliver frequently.

Agile Manifesto. The original and official definition of agile values and principles.

Agile Mindset. A way of thinking and behaving underpinned by the four values and twelve principles of the Agile Manifesto.

Agile Practitioner. A person embracing the agile mindset who collaborates with like-minded colleagues in cross-functional teams. Also referred to as agilist.

Agile Principles. The twelve principles of agile project delivery as embodied in the Agile Manifesto.

Agile Unified Process. A simplistic and understandable approach to developing business application software using agile techniques and concepts. It is a simplified version of the Rational Unified Process (RUP).

Agilist. See *Agile Practitioner.*

Anti-Pattern. A known, flawed pattern of work that is not advisable.

Automated Code Quality Analysis. The scripted testing of code base for bugs and vulnerabilities.

Backlog. See *Product Backlog.*

Backlog Refinement. The progressive elaboration of project requirements and/or the ongoing activity in which the team collaboratively reviews, updates, and writes requirements to satisfy the need of the customer request.

Behavior-Driven Development (BDD). A system design and validation practice that uses test-first principles and English-like scripts.

Blended Agile. Two or more agile frameworks, methods, elements, or practices used together such as Scrum practiced in combination with XP and Kanban Method.

Blocker. See *Impediment.*

Broken Comb. Refers to a person with various depths of specialization in multiple skills required by the team. Also known as Paint Drip. See also *T-shaped* and *I-shaped.*

Burndown Chart. A graphical representation of the work remaining versus the time left in a timebox.

Burnup Chart. A graphical representation of the work completed toward the release of a product.

Business Requirement Documents (BRD). Listing of all requirements for a specific project.

Cadence. A rhythm of execution. See also *Timebox.*

Collective Code Ownership. A project acceleration and collaboration technique whereby any team member is authorized to modify any project work product or deliverable, thus emphasizing team-wide ownership and accountability.

Continuous Delivery. The practice of delivering feature increments immediately to customers, often through the use of small batches of work and automation technology.

Continuous Integration. A practice in which each team member's work products are frequently integrated and validated with one another.

Cross-Functional Team. A team that includes practitioners with all the skills necessary to deliver valuable product increments.

Crystal Family of Methodologies. A collection of lightweight agile software development methods focused on adaptability to a particular circumstance.

Daily Scrum. A brief, daily collaboration meeting in which the team reviews progress from the previous day, declares intentions for the current day, and highlights any obstacles encountered or anticipated. Also known as daily standup.

Definition of Done (DoD). A team's checklist of all the criteria required to be met so that a deliverable can be considered ready for customer use.

Definition of Ready (DoR). A team's checklist for a user-centric requirement that has all the information the team needs to be able to begin working on it.

DevOps. A collection of practices for creating a smooth flow of delivery by improving collaboration between development and operations staff.

Disciplined Agile (DA). A process decision framework that enables simplified process decisions around incremental and iterative solution delivery.

Double Loop Learning. A process that challenges underlying values and assumptions in order to better elaborate root causes and devise improved countermeasures rather than focusing only on symptoms.

Dynamic Systems Development Method (DSDM). An agile project delivery framework.

Evolutionary Value Delivery (EVO). Openly credited as the first agile method that contains a specific component no other methods have: the focus on delivering multiple measurable value requirements to stakeholders.

eXtreme Programming. An agile software development method that leads to higher quality software, a greater responsiveness to changing customer requirements, and more frequent releases in shorter cycles.

Feature-Driven Development. A lightweight agile software development method driven from the perspective of features valued by clients.

Fit for Purpose. A product that is suitable for its intended purpose.

Fit for Use. A product that is usable in its current form to achieve its intended purpose.

Flow Master. The coach for a team and service request manager working in a continuous flow or Kanban context. Equivalent to *Scrum Master.*

Framework. A basic system or structure of ideas or facts that support an approach.

Functional Requirement. A specific behavior that a product or service should perform.

Functional Specification. A specific function that a system or application is required to perform. Typically represented in a functional specifications document.

Hoshin Kanri. A strategy or policy deployment method.

Hybrid Approach. A combination of two or more agile and non-agile elements, having a non-agile end result.

IDEAL. An organizational improvement model that is named for the five phases it describes: initiating, diagnosing, establishing, acting, and learning.

Impact Mapping. A strategic planning technique that acts as a roadmap to the organization while building new products.

Impediment. An obstacle that prevents the team from achieving its objectives. Also known as a blocker.

Increment. A functional, tested, and accepted deliverable that is a subset of the overall project outcome.

Incremental Life Cycle. An approach that provides finished deliverables that the customer may be able to use immediately.

Information Radiator. A visible, physical display that provides information to the rest of the organization enabling up-to-the-minute knowledge sharing without having to disturb the team.

I-shaped. Refers to a person with a single deep area of specialization and no interest or skill in the rest of the skills required by the team. See also *T-Shaped* and *Broken Comb.*

Iteration. A timeboxed cycle of development on a product or deliverable in which all of the work that is needed to deliver value is performed.

Iterative Life Cycle. An approach that allows feedback for unfinished work to improve and modify that work.

Kaizen Events. Events aimed at improvement of the system.

Kanban Board. A visualization tool that enables improvements to the flow of work by making bottlenecks and work quantities visible.

Kanban Method. An agile method inspired by the original Kanban inventory control system and used specifically for knowledge work.

Large Scale Scrum (LeSS). Large-Scale Scrum is a product development framework that extends Scrum with scaling guidelines while preserving the original purposes of Scrum.

Lean Software Development (LSD). Lean software development is an adaptation of lean manufacturing principles and practices to the software development domain and is based on a set of principles and practices for achieving quality, speed, and customer alignment.

Life Cycle. The process through which a product is imagined, created, and put into use.

Mobbing. A technique in which multiple team members focus simultaneously and coordinate their contributions on a particular work item.

Organizational Bias. The preferences of an organization on a set of scales characterized by the following core values: exploration versus execution, speed versus stability, quantity versus quality, and flexibility versus predictability.

Organizational Change Management. A comprehensive, cyclic, and structured approach for transitioning individuals, groups, and organizations from the current state to a future state with intended business benefits.

Paint-Drip. See *Broken Comb.*

Pairing. See *Pair Work.*

Pair Programming. Pair work that is focused on programming.

Pair Work. A technique of pairing two team members to work simultaneously on the same work item.

Personas. An archetype user representing a set of similar end users described with their goals, motivations, and representative personal characteristics.

Pivot. A planned course correction designed to test a new hypothesis about the product or strategy.

Plan-Do-Check-Act (PDCA). An iterative management method used in organizations to facilitate the control and continual improvement of processes and products.

Plan-Driven Approach. See *Predictive Approach.*

Predictive Approach. An approach to work management that utilizes a work plan and management of that work plan throughout the life cycle of a project.

Predictive Life Cycle. A more traditional approach, with the bulk of planning occurring up-front, then executing in a single pass; a sequential process.

Project Management Office (PMO). A management structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques.

Product Backlog. An ordered list of user-centric requirements that a team maintains for a product.

Product Owner. A person responsible for maximizing the value of the product and who is ultimately responsible and accountable for the end product that is built. See also *Service Request Manager.*

Progressive Elaboration. The iterative process of increasing the level of detail in a project management plan as greater amounts of information and more accurate estimates become available.

Refactoring. A product quality technique whereby the design of a product is improved by enhancing its maintainability and other desired attributes without altering its expected behavior.

Retrospective. A regularly occurring workshop in which participants explore their work and results in order to improve both process and product.

Rolling Wave Planning. An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.

Scaled Agile Framework (SAFe®). A knowledge base of integrated patterns for enterprise-scale lean–agile development.

Scrum. An agile framework for developing and sustaining complex products, with specific roles, events, and artifacts.

Scrumban. A management framework that emerges when teams employ Scrum as the chosen way of working and use the Kanban Method as a lens through which to view, understand, and continuously improve how they work.

Scrum Board. An information radiator that is utilized to manage the product and sprint backlogs and show the flow of work and its bottlenecks.

Scrum Master. The coach of the development team and process owner in the Scrum framework. Removes obstacles, facilitates productive events and defends the team from disruptions. See also *Flow Master.*

Scrum of Scrums. A technique to operate Scrum at scale for multiple teams working on the same product, coordinating discussions of progress on their interdependencies, and focusing on how to integrate the delivery of software, especially in areas of overlap.

Scrum Team. Describes the combination of development team, scrum master, and process owner used in Scrum.

Self-Organizing Team. A cross-functional team in which people fluidly assume leadership as needed to achieve the team's objectives.

Servant Leadership. The practice of leading through service to the team, by focusing on understanding and addressing the needs and development of team members in order to enable the highest possible team performance.

Service Request Manager. The person responsible for ordering service requests to maximize value in a continuous flow or Kanban environment. Equivalent to product owner.

Siloed Organization. An organization structured in such a way that it only manages to contribute a subset of the aspects required for delivering value to customers. For contrast, see *Value Stream.*

Single Loop Learning. The practice of attempting to solve problems by just using specific predefined methods, without challenging the methods in light of experience.

Smoke Testing. The practice of using a lightweight set of tests to ensure that the most important functions of the system under development work as intended.

Specification by Example (SBE). A collaborative approach to defining requirements and business-oriented functional tests for software products based on capturing and illustrating requirements using realistic examples instead of abstract statements.

Spike. A short time interval within a project, usually of fixed length, during which a team conducts research or prototypes an aspect of a solution to prove its viability.

Sprint. Describes a timeboxed iteration in Scrum.

Sprint Backlog. A list of work items identified by the Scrum team to be completed during the Scrum sprint.

Sprint Planning. A collaborative event in Scrum in which the Scrum team plans the work for the current sprint.

Story Point. A unit-less measure used in relative user story estimation techniques.

Swarming. A technique in which multiple team members focus collectively on resolving a specific impediment.

Technical Debt. The deferred cost of work not done at an earlier point in the product life cycle.

Test-Driven Development. A technique where tests are defined before work is begun, so that work in progress is validated continuously, enabling work with a zero defect mindset.

Timebox. A fixed period of time, for example, 1 week, 1 fortnight, 3 weeks, or 1 month. See also *Iteration.*

T-shaped. Refers to a person with one deep area of specialization and broad ability in the rest of the skills required by the team. See also *I-Shaped* and *Broken Comb.*

User Story. A brief description of deliverable value for a specific user. It is a promise for a conversation to clarify details.

User Story Mapping. A visual practice for organizing work into a useful model to help understand the sets of high-value features to be created over time, identify omissions in the backlog, and effectively plan releases that deliver value to users.

UX Design. The process of enhancing the user experience by focusing on improving the usability and accessibility to be found in the interaction between the user and the product.

Value Stream. An organizational construct that focuses on the flow of value to customers through the delivery of specific products or services.

Value Stream Mapping. A lean enterprise technique used to document, analyze, and improve the flow of information or materials required to produce a product or service for a customer.

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