



# Hybrid Management of Engineering Projects

An Online Continuing Education Course for Engineers

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# Hybrid Management of Engineering Projects

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# 1. Introduction

Technological innovation, shifting customer expectations, and the accelerating pace of global competition mean that change is now the default rather than the exception. The Project Management Institute (PMI) reported that in the time period between 2019 and 2025, technological progress and market shifts have caused business change to accelerate by 183%.

The pace of business change has trickled down to engineering projects, including the following pressures:

- Complete design deliverables faster
- Incorporate changes based on regular stakeholder feedback
- Design with shorter lead time equipment
- Design for an accelerated construction schedule
- Order long lead items during design
- Start construction before design is complete
- Change the scope of work based on market changes
- Performance guarantees
- Designing for flexibility and expansion capability
- Changing delivery approach, such as design-bid-build to design-build

The conventional plan-execute-deliver model for engineering projects is stability-oriented. It focuses on up-front planning, sequential execution, and scope control. Conventional approaches are effective for projects that have an established set of requirements and a stable regulatory environment. For example, a project to design the replacement of an old bridge in-kind. But conventional approaches are not always well-adapted to highly dynamic environments, where requirements are constantly changing, new technology is being considered, or client feedback has to be integrated swiftly.

An alternate approach is called Agile. Agile focuses on teamwork, iterative development, learning, and responsiveness. In 2001, the Agile Manifesto was developed by 17 software practitioners, and its values put people and relationships above processes and tools, working software above detailed documentation, customer collaboration above contract negotiation, and responding to change above adhering to a plan. These values are very different from conventional waterfall approaches in engineering projects. Although Agile originated in the software industry, its concepts have found their way into various design and engineering projects, with companies promoting the approaches as more adaptable and client-focused.

In most industries, particularly those that are highly regulated or with large capital improvement projects, conventional project management approaches remain common. Changing conventional processes to full-on Agile approaches is risky. However, the value Agile brings is acknowledged. So, rather than completely changing to Agile, many business models allow a “hybrid approach,” which is a combination of the conventional project stages and the flexibility of Agile methodologies.

An “integrated approach” to project management is a hybrid project management approach that integrates the standalone predictive methods (like Waterfall) and iterative processes (like Agile) so that the advantages of both approaches can be realized with less risk.

Agile and hybrid adoption is increasing. Survey data from the Smartsheet 2025 Project and Portfolio Management Report indicate that the percentage of people using predictive-only methodologies declined by approximately 24% between 2020 and 2023. The popularity of using hybrid increased by over 57% over this period.

This course reviews the incorporation of Agile and conventional approaches, with a focus on applications for engineering projects. The course approaches first, and then explains how they can be integrated. Throughout, there are real-world examples and scenario problems, as well as questions with recommended answers to help guide the reader. The goal is to help PMs and other leaders select and tailor approaches that fit the needs of the project and organization.

## 2. Waterfall Approach

The Waterfall model is the earliest formalized life-cycle approach. It completes each phase before the next begins. Progress flows largely in one direction, like a waterfall cascading through successive pools.

Below is a depiction of a project following a waterfall approach with discrete phases/stages, with gates between each stage.



A common stage gate methodology is Front-End Planning (FEP), also called Front-End Loading (FEL). FEP focuses on the early development of strategic information to confirm the business case for the project.

The sequential structure of waterfall methods enables thorough documentation, clear milestones, and strong control over scope, schedule, and budget. When requirements are well understood and unlikely to change, the waterfall approach can provide predictability and compliance. It is common in consulting, engineering, construction, manufacturing, and highly regulated industries.

However, waterfall projects often struggle when requirements evolve. Because the model emphasizes extensive up-front planning, and the scope of work is tightly tied to schedule and budget, any changes later in the process can result in change orders and delays. The deliverables might not be visible to the stakeholders until near the end of the project, as there will be little time to implement adjustments based on the feedback. Clients and owners are pressured to accept what has been done, even if better ideas come along.

Consider a team that has been charged with the task of producing a safety-critical embedded system in an aircraft. Regulatory certification involves lots of documentation and a proper audit trail. Adopting a

waterfall approach, the team may proceed step by step with defining requirements, design, implementation, integration, verification, and validation, with sign-off after each phase/stage. Formal change control is initiated whenever requirements change.

### 3. Agile Approach

Agile is not a single methodology but an iteration mindset. In 2001, the Agile Alliance published the Manifesto for Agile Software Development, which articulates four values:

- **Individuals and interactions over processes and tools** – competent people working together effectively are more important than rigid procedures.
- **Working solutions over comprehensive documentation** – the main point of development is to deliver value, not to produce documents for their own sake.
- **Customer collaboration over contract negotiation** – close collaboration with customers helps uncover real needs and enables course corrections.
- **Responding to change over following a plan** – plans have value, but they must not be so rigid that they prevent adapting to new information.

These values are supported by twelve principles (only the most relevant are highlighted in this course). The principles encourage early and continuous delivery of valuable outcomes, welcome changing requirements even late in development, and promote close cooperation between leadership, stakeholders, and implementers. Projects are built around motivated individuals who should be trusted, and face-to-face communication is considered the most effective way to convey information.

Agile methods break work into small increments (often called iterations or sprints) that typically last one to four weeks, although the timeframe is not critical. A cross-functional team plans the work at the start of each iteration, executes the tasks, and then reviews the results with stakeholders. Feedback is incorporated into the next iteration.

Figures 1 and 2 depict generic Agile cycles, showing planning, design, building, testing, and reviewing in a loop. Compared with conventional methods, Agile emphasizes frequent inspection and adaptation, delivering incremental value and encouraging learning through experimentation.

Consider a start-up company that is creating a mobile application to pilot a new business concept, which needs expedited iterations. They may also launch a minimum viable product in weeks, get user feedback, and make pivots based on feedback. Draft screens are provided to the client each week, and working review meetings are scheduled to allow modifications to be made live, reviewed, and client-approved during the meeting. The start-up is able to change priorities and features using Agile methods.

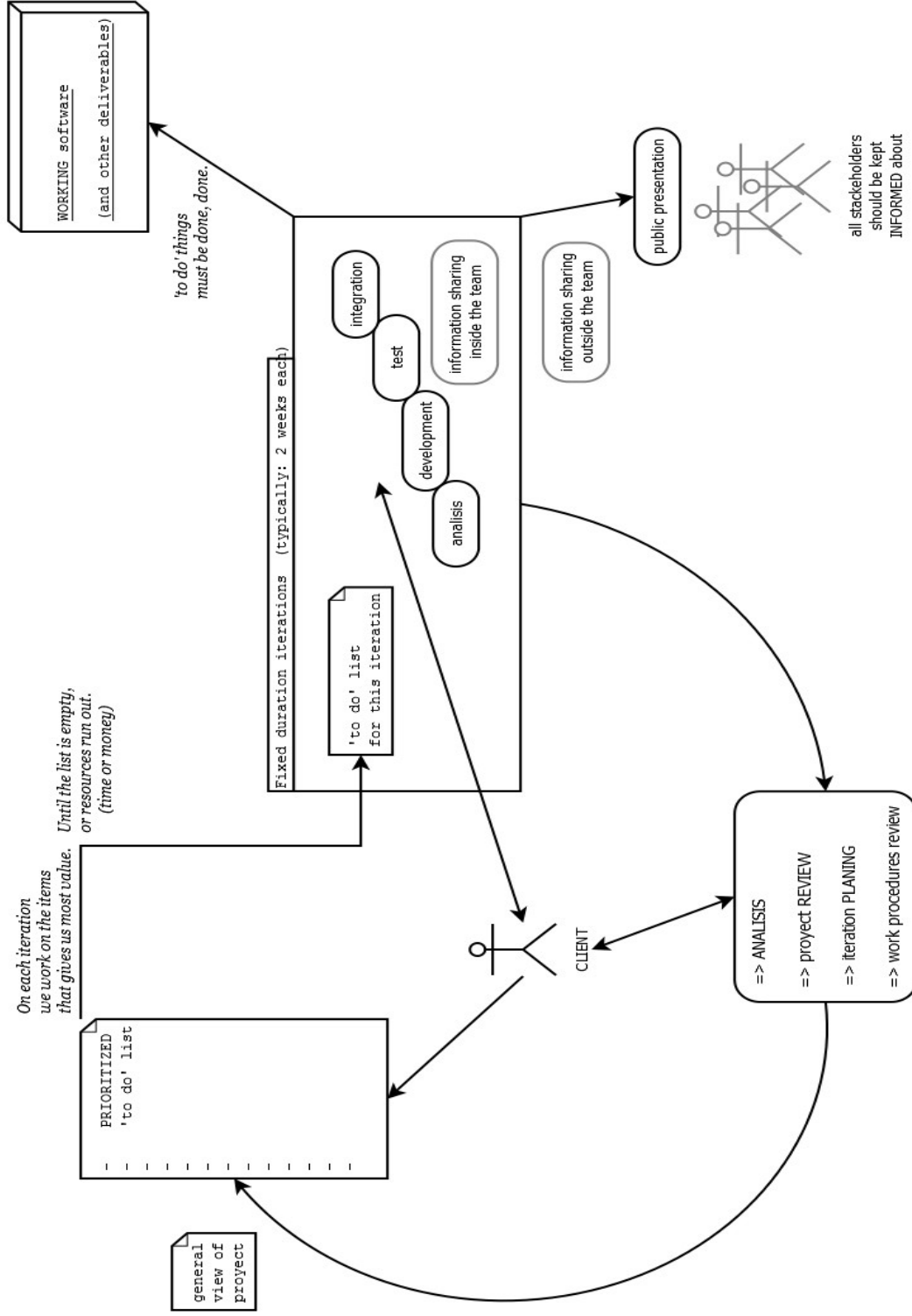


Figure 1: Agile cycle showing iterative planning, design, build, test, and review loops.  
 Source: "Agile methodology for software development" by Benzirpi (2012), via Wikimedia Commons (CC BY-SA 3.0)

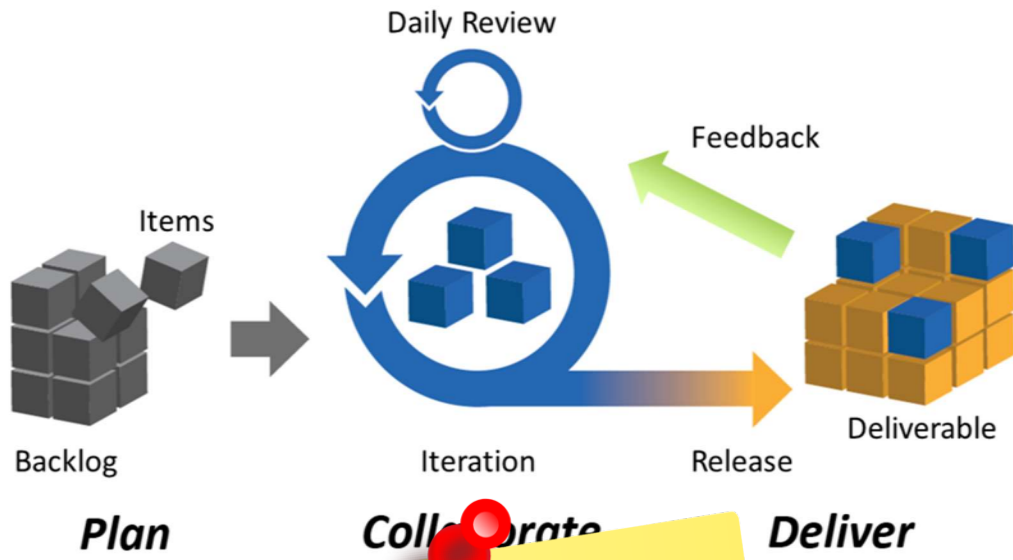


Figure 2: A depiction of the agile process flow. Source: commons.wikimedia.org/wiki/File:Agile\_workflow.png, Planbox, CC-BY-SA-3.0

Popular Agile frameworks

- Kanban - uses visual boards to manage workflow
- Scrum - organized into sprints, with a product owner, Scrum

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

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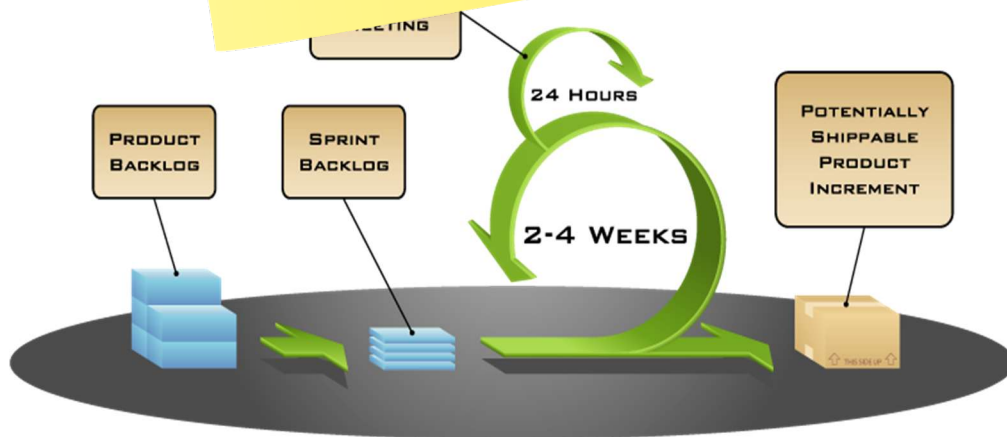


Figure 3: Scrum workflow diagram with the recurring "sprints" in green. Source: "Scrum diagram (labelled)" by Mountain Goat Software (2005), via Wikimedia Commons (CC BY 2.5)