Enhancing Aerospace Systems Performance with Agile Framework

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Abstract

This poster presents a case study on implementing Agile methodology in aerospace engineering, with a focus on an engine design project. The aim was to transition to a new SysML program called Cameo, to enhance team productivity, quality, and collaboration. The study includes a comprehensive literature review, assessing various sources to underscore Agile's effectiveness and challenges in the aerospace industry. The methodology section describes the team's approach, detailing the execution of Agile across 25-30 sprints, each spanning two weeks, along with its results and interpretations. This involves integrating user testing and stakeholder feedback. It concludes with an in-depth analysis of each sprint, key takeaways, and recommendations, emphasizing Agile methodology's role in improving team dynamics and product quality in aerospace systems development.

Key Terms —Agile, sprints, stakeholders and SysML.

Background

The main findings in aerospace engineering highlight the significant benefits of Agile methodologies in various sectors, ranging from manufacturing to software development. The work of Erbschloe's [1] underscores the important shift from lean to Agile practices, leveraging advanced technologies for increased flexibility and rapid adaptation. Another critical study in this field [2] explores the integration of Agile methodologies with Concurrent Engineering principles specifically in the realm of spacecraft design. This integration has shown to yield remarkable improvements in terms of communication and overall efficiency in the design and development process. In study [3] illustrates the effectiveness of the Agile methodology in Multi-Disciplinary Optimization for aeronautical systems, notably shortening lead times in UAV development. Study [4] remarks a revolution in aircraft design decision-making, integrating tools such as decision trees and optimization algorithms for quicker and more effective results. Additionally, the research presented in study [5] serves as an exemplary case for the shift towards Agile methodologies in aerospace software development. It particularly emphasizes the versatility and effectiveness of frameworks like Scrum and Kanban in handling complex and multifaceted software projects in the aerospace sector. Altogether, these studies highlight the transformative role of Agile methodologies in aerospace engineering, boosting efficiency, communication, and adaptability in a rapidly evolving technological environment.

Problem Statement

Company X is focused on securing new military contracts, a goal dependent on effectively adapting to a modeling program called Cameo, an essential step to meet the evolving needs of the defense sector. To achieve this, a diverse team of engineers, each with unique specialties, is being formed. This team will collaborate on the project, utilizing the Agile framework as the foundation while incorporating the SysML program. This combination is poised to revolutionize traditional models by integrating live feedback, dynamic modeling, and the development of new engines. The primary goal of adopting the Agile methodology is to improve team productivity, quality, and collaboration. This approach is designed to enable ongoing testing, accommodate changes, and facilitate direct feedback from stakeholders. The primary objective of the project is to implement the Agile methodology through approximately 25 to 30 sprints, each spanning a period of two weeks. This initiative is anticipated to yield valuable insights and create a model for rapid implementation in future projects.

Methodology

The methodology focuses on transitioning to the SysML program Cameo using Agile project management, facilitated through JIRA. The next table and Gantt chart presents key aspects, is as follows:

Table 1: Project Methodology	Description
Objective	Transition to Cameo for systems modeling, using Agile methodology for flexibility and efficiency.
Team Composition	A lead engineer, four additional engineers with diverse skills, overseen by a Scrum Master.
Workflow Structure	The process involves 25 to 30 sprints, each lasting two weeks.
Task Management	Tasks, labeled as 'stories', are rated on a difficulty scale (1-12 points). The total difficulty for each sprint ranges between 17 to 25 points.
Backlog Management	The lead engineer creates 20-30 initial stories in JIRA, with modifications and additions by the team. Priority is given to stakeholders' urgent needs.
Review and Feedback	After each sprint, a review meeting with stakeholders for feedback, followed by a planning meeting for the next sprint led by the Scrum Master.
Results Interpretation	Outcomes of each sprint are analyzed to assess Agile efficacy, with a focus on story completion, team availability, and task complexity.

The Gannt chart is employed to provide an overview of each sprint, detailing the timeline, and tracking the completion of the experimental of this project. This table also outlines the creation of the chapters of the article and presentation schedule for the completion of the design project.

Table 2: Gannt Chart

Task Name	Duration (days)	Start Date	End Date	Dependencies
Sprint 1	13	1/28/2022	2/10/2022	Availability of Staff
Sprint 2	13	2/8/2022	2/21/2022	Availability of Staff
Sprint 3	13	2/22/2022	3/7/2022	Availability of Staff
Sprint 4	13	3/16/2022	3/29/2022	Availability of Staff
Sprint 5	13	3/29/2022	4/11/2022	Availability of Staff
Sprint 6	13	4/12/2022	4/25/2022	Availability of Staff
Sprint 7	13	4/26/2022	5/9/2022	Availability of Staff
Sprint 8	13	5/10/2022	5/23/2022	Availability of Staff
Sprint 9	13	5/24/2022	6/6/2022	Availability of Staff
Sprint 10	13	6/7/2022	6/20/2022	Availability of Staff
Sprint 11	13	6/23/2022	7/6/2022	Availability of Staff
Sprint 12	13	7/7/2022	7/20/2022	Availability of Staff
Sprint 13	13	7/19/2022	8/1/2022	Availability of Staff
Sprint 14	13	8/2/2022	8/15/2022	Availability of Staff
Sprint 15	13	8/16/2022	8/29/2022	Availability of Staff
Sprint 16	13	8/30/2022	9/12/2022	Availability of Staff
Sprint 17	13	9/13/2022	9/26/2022	Availability of Staff
Sprint 18	13	9/27/2022	10/10/2022	Availability of Staff
Sprint 19	13	10/11/2022	10/24/2022	Availability of Staff
Sprint 20	13	10/25/2022	11/7/2022	Availability of Staff
Sprint 21	13	11/8/2022	11/21/2022	Availability of Staff
Sprint 22	13	11/30/2022	12/13/2022	Availability of Staff
Sprint 23	13	1/4/2023	1/17/2023	Availability of Staff
Sprint 24	13	1/18/2023	1/31/2023	Availability of Staff
Sprint 25	13	2/1/2023	2/14/2023	Availability of Staff
Sprint 26	13	2/15/2023	2/28/2023	Availability of Staff
Sprint 27	13	3/1/2023	3/14/2023	Availability of Staff
Sprint 28	13	3/15/2023	3/28/2023	Availability of Staff
Sprint 29	13	3/30/2023	4/12/2023	Availability of Staff
Sprint 30	13	4/12/2023	4/25/2023	Availability of Staff
Research Proposal	18	11/13/2023	12/1/2023	N/A
Results, Discussion and Conclusion	30	12/1/2023	12/31/2023	N/A
Design Project Article	39	12/31/2023	2/8/2024	N/A
Project Poster	7	2/8/2024	2/15/2024	N/A

Results and Discussion

This presents an analysis of the revised Gantt chart, which was updated following the completion of all sprints. It offers valuable insights, with a focus on examining variations on sprint completion and discuss its discrepancies. Special attention is given to instances where average values in certain sprints significantly diverged from expected figures. Understanding these differences is key to understanding the project's timelines, resource utilization, and sprint-specific performance metrics. This version of the Gannt chart includes an average calculated based on the difficulty of the stories committed to and completed. The committed stories emphasize the cumulative difficulty of each individual story, rather than focusing on the quantity of stories. Additionally, it incorporates the previous average to determine the new average. In the average column, different colors represent varying levels of achievement relative to commitments. Red indicates underperformance, yellow signifies that the average performance was close to the committed objectives, and green denotes that the performance met or exceeded the commitments.

Table 3: Updated Gantt Chart

Task Name	Duration (days)	Start Date	End Date	Dependencies	Committed	Completed	Average
Sprint 1	11	1/28/2022	2/8/2022	Staff Availability	25	25	25
Sprint 2	14	2/9/2022	2/23/2022	Staff Availability	23	46	31
Sprint 3	21	2/24/2022	3/17/2022	Staff Availability	23	29	28
Sprint 4	12	3/18/2022	3/30/2022	Staff Availability	32	28	29
Sprint 5	13	3/31/2022	4/13/2022	Staff Availability	28	24	27
Sprint 6	13	4/14/2022	4/27/2022	Staff Availability	14	21	21
Sprint 7	13	4/28/2022	5/11/2022	Staff Availability	24	24	23
Sprint 8	13	5/12/2022	5/25/2022	Staff Availability	27	35	28
Sprint 9	13	5/26/2022	6/8/2022	Staff Availability	32	29	30
Sprint 10	13	6/9/2022	6/22/2022	Staff Availability	30	25	28
Sprint 11	12	6/23/2022	7/5/2022	Staff Availability	17	11	19
Sprint 12	11	7/6/2022	7/17/2022	Staff Availability	25	24	23
Sprint 13	13	7/18/2022	7/31/2022	Staff Availability	25	20	23
Sprint 14	13	8/1/2022	8/14/2022	Staff Availability	28	12	21
Sprint 15	13	8/15/2022	8/28/2022	Staff Availability	27	24	24
Sprint 16	14	8/29/2022	9/12/2022	Staff Availability	23	25	24
Sprint 17	13	9/13/2022	9/26/2022	Staff Availability	20	18	21
Sprint 18	13	9/27/2022	10/10/2022	Staff Availability	27	29	26
Sprint 19	13	10/11/2022	10/24/2022	Staff Availability	27	28	27
Sprint 20	13	10/25/2022	11/7/2022	Staff Availability	24	22	24
Sprint 21	20	11/8/2022	11/28/2022	Staff Availability	29	30	28
Sprint 22	12	11/29/2022	12/11/2022	Staff Availability	32	28	29
Sprint 23	13	12/12/2022	12/25/2022	Staff Availability	31	31	30
Sprint 24	13	12/26/2022	1/8/2023	Staff Availability	27	29	29
Sprint 25	13	1/9/2023	1/22/2023	Staff Availability	28	38	32
Sprint 26	13	1/23/2023	2/5/2023	Staff Availability	30	21	28
Sprint 27	13	2/6/2023	2/19/2023	Staff Availability	26	17	24
Sprint 28	13	2/20/2023	3/5/2023	Staff Availability	22	20	22
Sprint 29	13	3/6/2023	3/19/2023	Staff Availability	19	15	19
Sprint 30	13	3/20/2023	4/2/2023	Staff Availability	11	11	14
Research Proposal	9	11/13/2023	11/22/2023	N/A	N/A	N/A	N/A
Results, Discussion & Conclusion	21	11/23/2023	12/14/2023	N/A	N/A	N/A	N/A
Design Project Article	18	12/15/2023	1/2/2024	N/A	N/A	N/A	N/A
Project Poster	43	1/3/2024	2/15/2024	N/A	N/A	N/A	N/A

The project spring performance overview shows the trend in sprint performance over time, using a line graph. Each point represents a sprint's performance, with the performance categories ranging from "Significant Underperformance" to "Exceptional/Significantly Exceeded."

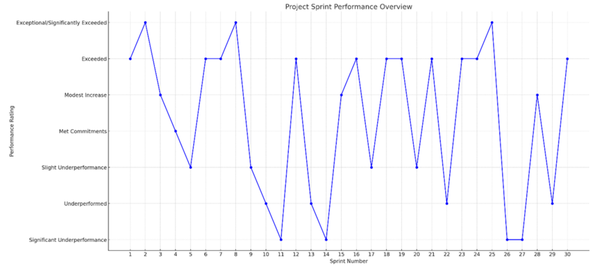


Table 4: Initial analysis Summary

Aspect	Description
SysML Program Learning Curve	Team members faced challenges despite domain expertise.
Planning & Execution Strategy Adjustments	Significant departure from previous practices, managed effectively.
Story Complexity & Task Division	Complex stories led to delays due to the inability to simplify.
Backlog Management & Sprint Planning	Initially underestimated, impacting sprint lengths and preparations.

Extended sprints, such as Sprint 3 and Sprint 21, showed improved performance and task completion effectiveness. While the extended duration offered advantages in task execution, it also impacted the timeline of subsequent sprints and stakeholder receptiveness due to delayed retrospectives.

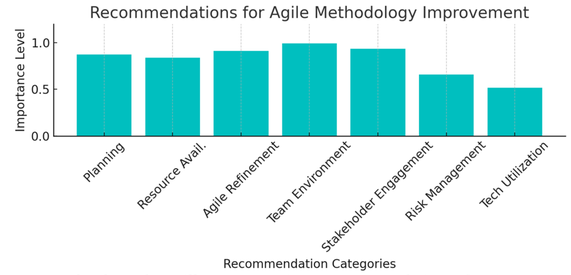
Table 5: Reasons for Variance

Factor	Impact on Sprint Outcomes
Team Size & Adaptability	Varied impact on completion rates and achievement levels.
Task Complexity	Increasing complexity led to underperformance in some sprints.
Backlog Planning	Inadequate planning led to performance issues.
External Factors	Holidays, vacations, stakeholder demands affected performance.

Table 6: Key Learnings from Team Feedback

Learning Aspect	Benefit
Breaking Down Complex Tasks	Increased task manageability and completion rate.
Direct Stakeholder Communication	More effective project aspect handling.
Internal Team Communication	Fostered collaborative and efficient environment.
Accounting for Availability	Ensured consistent and uninterrupted workflow.

Feedback from stakeholders, provided every two or three sprints, served as a vital quality metric. This feedback process was instrumental in setting realistic expectations and maintaining high standards, despite some challenges in aligning stakeholder suggestions with available tools and capabilities.



The bar chart illustrates various recommendations for improving Agile practices, along with their relative importance levels. Recommendations include enhancing planning processes, ensuring consistent resource availability, refining Agile practices, fostering a collaborative team environment, enhancing stakeholder engagement, managing risks, and effectively utilizing technology and tools.

Conclusions

The aerospace systems development project represented a significant achievement in integrating Agile methodologies with SysML, showcasing both impressive accomplishments and insightful challenges. The key success of the project was the effective blending of Agile principles with SysML, which notably improved team productivity, work quality, and collaboration. This integration was crucial for meeting the dynamic demands of aerospace system development. However, the project was not without its challenges, including time management issues as sprint durations lengthened, and a learning curve for team members unfamiliar with SysML. Despite initial efficiency, the project experienced a dip in task completion rates during the middle phase, attributed to underprepared backlogs and increasing story complexity. Nevertheless, performance rebounded in later sprints. The project also benefited greatly from active stakeholder engagement, which was vital in aligning the project with customer needs and enhancing overall satisfaction. The experience gleaned from this project lays a solid foundation for future research in the domain, particularly in refining Agile methodologies for complex and dynamic project environments.

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