

Owning the Sky with Agile

Building a Jet Fighter Faster, Cheaper, Better with Scrum

Jörgen Furuhjelm
Project Manager
R&D
Saab Aeronautics
jorgen.furuhjelm@saabgroup.com

Johan Segertoft
Project Manager
Avionics Software
Saab Aeronautics
johan.segertoft@saabgroup.com

Joe Justice and J.J. Sutherland
Scrum Inc.
Justice@scruminc.com
jj@scruminc.com

Abstract

Advanced military systems are some of the most expensive and most complex research, design, and manufacturing challenges in the world. The sheer cost of military procurement worldwide is measured in the trillions of dollars, and for decades costs risen seemingly indefinitely. As a result, many companies are seeking new ways of working that will control costs while delivering the highest quality. Saab Defense has adopted an Agile process to address the issue in both hardware and software teams to produce a new multi-role strike fighter, the JAS 39E Saab Gripen.

1. Introduction

The cost of Defense procurement is on a seemingly ever escalating cycle in the West. In the United States programs are now measured in the hundreds of billions of dollars. Cost increases from initial estimates can rise more than 60% [1].

One defense manufacturer decided that it was not only what they were building that was driving up costs, it was the way they were building it, their process itself.

Saab Aeronautics is a few years into the development program for the new Gripen E multi-role fighter. Saab has adopted an Agile approach to organizing itself and its efforts, delivering results more quickly, with higher quality, and at drastically lower cost.

2. Precedent

Agility has decades deep roots in complex military systems, and impressively Saab may be first to market with a complete fighter jet built using the modern practices of Scrum.

While predecessors to Test Driven Development and related Agile practices such as dedicated, co-located, cross functional teams

with flexible priorities have been used in fighter jet design as early as 1960 [2], modern Agile practices such as Scrum roles and release burn down charts in complex systems may be pioneered by Saab Aeronautics.

3. Agile at Saab

Saab introduced Agile [3] practices approximately ten years ago during updates of the previous Gripen versions. First, small independent teams of software developers adopted Scrum [4], serving as incubators for Agile. Rigorous Scrum was the initial backbone of the Saab Agile framework, and as it spread, it evolved through continuous improvement. The cornerstones of Scrum are still present, but other aspects have evolved to allow teams to interpret and tailor the framework to their particular process.

In the new Gripen fighter program, the Gripen E, Agile practices are implemented at every level and in every discipline: software, hardware and fuselage design. The Saab Agile framework contains practices from Lean, Scrum, Kanban, XP and others. Practices are not prescriptive. Individual teams and groups have the autonomy to develop the best implementation for their particular local context. Different teams have varied levels of Agile maturity. For that reason autonomy at the team level is critical, giving teams the freedom to incrementally improve their practice constantly.

Saab has learned that commitment and clarity drive performance and efficiency. Commitment is needed at the individual and team level, i.e. commitment to the project, to the process, and to each other. Please see the cited

studies that have shown that the key drivers of human motivation are autonomy, mastery, and purpose [5]. At Saab, decisions are driven down to the team level wherever possible. Teams are empowered both in process and technical terms. They self-organize where applicable, and customize the framework locally. Technical ownership is delegated to the teams. There is minimized organizational hierarchy, and efforts are made to be completely transparent. Each one of these organizational decisions is an effort to increase a sense of commitment at every level throughout the program.

Clarity is the critical translation of vision into action. While, clarity is important throughout the Saab Agile framework, there is a particular design focus. Each team should always understand what is desired of them. Not *required*, as that would stifle the very creative problem solving Saab is looking for, but *desired*. The team has clarity on the true goal, but has the freedom to create their own innovative solutions to get there.

In an Agile consumer product organization this clarity comes from the customer feedback generated by regular, incremental releases. The Gripen E program does not have that luxury. But that feedback is so important, that Saab uses the Product Owner as a proxy for the customer. The Product Owner is responsible for establishing the value of features and works with all stakeholders on different management levels re-prioritizing them on a regular cadence.

In the design and construction of a fighter plane, the Product Owner must not only consider features, but also risk mitigation, process and technical improvements, and other tasks that all need to be prioritized in the same backlog. With a project as large as a fighter plane, this requires regular and recurring gatherings with focus on integration issues. Constantly examining and improving communication is critical to establishing clarity across the organization.

4. Manage Variability

The development of the Gripen E fighter is highly complex with more than 1000 engineers

grouped in more than 100 teams. Scrum and Agile practices provide tools to manage the variability. The transparency inherent in the Scrum framework surfaces those variances quickly and regularly.

At Saab, the Agile teams have a common rhythm and a stable pulse. All teams have Sprints of three weeks and they begin and end on the same day. Saab also found the need for synchronization beyond single Sprints, and developed a method for iterations in quarterly cycles; Increments.

The project master plan is broken down iteratively. At the top level is the Development Step, a well-defined functional target for a larger release, typically towards a specific test aircraft. The Development Step synchronizes activities in several of the major disciplines such as airframe, installation, system development, support systems etc. Additionally it defines what is important to achieve during, e.g., the corresponding test flight period. A Development Step is in turn divided into several Increments with smaller more manageable functional and product deliveries. The Increment is time boxed to a quarter which leads to a Sprint pace of four three-week Sprints.

Increment targets are established each quarter. These targets are established with a top-down meet bottom-up approach. Functional targets are broken down using anatomies and other techniques and before committing to targets set by management the teams go through all targets, make rough sprint plans and check what is feasible and not. There is a structured system of meetings to identify dependencies on the team-level and make them visible across the project. These meetings are echoed every three week Sprint. In those smaller time boxes targets and dependencies are identified in a more detailed and actionable fashion.

Each increment ends with a very well-defined delivery in order to validate and verify the product. Those formal releases also drive process improvement each quarter. But each and every week during the Increment, smaller releases are made to assure frequent feedback on product integration and design. Most of the problems that arise in any large product

development occur at the integration stage. By testing integration on a cycle even shorter than a single Sprint, Saab is able to make those issues visible early and take corrective action quickly.

5. Prioritization

These regular cycles or Increment/quarter and 3-week Sprint give a pulse and rhythm to development. But simply identifying what needs to be done is in some ways the far simpler effort in an Agile environment. Now the critical act of prioritizing the product backlog comes into play, for a very simple reason: team workload is most often greater than team capacity. Prioritization brings clarity on what should be done next, and what are the most valuable things for the team to be working on. Without prioritization the curses of so many projects rise up: multitasking, unfinished work, unneeded stress. Team efficiency and productivity plummet. As does that crucial sense of commitment.

The Gripen E program uses Scrum to drive team-level prioritization. The Product Owners, deviating from core Scrum in that each covers 4-8 development teams, set the priority of the workload in the Product Backlog, a single ordered list of all the work to be done. This is *not* a top down process, team knowledge and learning are taken into consideration. Included in this backlog are not only features to be developed but risks to be mitigated and process improvements to be acted on.

The Product Owners' challenging task is to act as the interface between the upper management functions and the team level. An extensive amount of coordination needs to be carefully managed in such a large project. It is essential that at the time of the teams' Sprint Planning at the start of each Sprint, the backlog is complete and ready for the team to immediately execute. The team is perfectly clear on what needs to be delivered, what dependencies exist, and can begin the Sprint with confidence. The Product Owner is responsible for creating clarity for the teams as to what the internal customers want, while at the same time leveling out the inevitable noise to make sure teams are clear on what needs to be done.

6. Strategic Planning

At Saab, in contrast to some Agile implementations, a key element for success is rigorous strategic planning. The strategic plan is a vital constraint. It forces teams to visualize their current road-map and how it fits into that plan. That visualization is an important communication tool between Product Owners. However, strategic plans must be seen as living documents in constant need of modification based on feedback.

In reality, the strategic plan is one of the more notable areas where Agile practices are connected with traditional project management. The need for a strategic plan should however not be confused with a micro-managed Gantt-chart laying out detailed work for years to come. Instead the granularity of the plan differs depending on focus. The current development step contains many more details than future steps.

By continuously incorporating team learning and practice, milestones become more detailed over time and less prone to movement once they reach the correct development step. The development steps are subdivided into increments or quarters, those increments into three week iterations or Sprints. In practice, Saab has found that the total number of milestones actually increases with Agile. As teams approach the time horizon they will break down those large milestones into manageable, actionable, and sensible pieces.

6. Continuous Improvement

Kaizen, the Japanese term for continuous improvement, has been a corner-stone in Lean production for many years, and Saab aims to achieve the same relentless systematic approach to improvement also in the development process. Fortunately the foundation for doing this is a core practice in Scrum: the Retrospective.

The Retrospective, held at the end of each Sprint, delivers a process improvement for the team to implement the following Sprint. Over the years Saab has evolved Retrospective to include not only the team perspective. There is also a Retrospective of Retrospectives, across

teams. This is a scaled version to address feedback from the teams, common problems and solutions, as well as leadership issues and management aspects from the Sprint.

As vital as the short feedback loop on product is, the feedback loop on process is no less important. Many teams, or groups of teams, use daily Kanban-boards for impediments and improvements in order to shorten the feedback loop even further.

7. Agile Catalysts

To understand how Saab can break the escalating cost curve that seems to be industry standard we need to look at pre-requisites for an Agile framework. When setting up the Gripen E program a modular architecture and thus flexibility for future updates was a driving focus. Modularity of design allows modularity of organization. Conway's Law [6] shows that organizational structure drives product structure. At Saab the product is aligned with the organization. Each team has a clear-cut responsibility for one or several of the modules. This contributes to those vital qualities discussed earlier, clarity and commitment.

Due to the modular design and the fact that test airplanes are very costly and time-consuming to produce Saab has focused on building state-of-the-art simulators. These allow for those short feedback cycles. The teams can immediately evaluate a design choice in desktop simulators.

In addition to virtual simulations, Saab has their pilots on the same site in Linköping in southern Sweden as the Gripen E development teams. This allows close interaction between the development teams and pilots. Feedback is provided every sprint. Validation also takes place with pilots from the customers.

Saab's focus on autonomous teams both reduces bureaucracy and encourages decision making at the lowest possible level in the project organization. There is a system to escalate issues on a daily basis to remove hindrances as quickly as possible, and solve them at the lowest possible level.

8. Conclusion

Scrum creates a good framework to organize teams, and provide transparency in order to improve and enhance communication. Saab adds constraints such as common pulse in order to scale and enable multiple teams to play in tune. At the same time Saab provide degrees of freedom for individual progress, enhancing autonomy.

The Agile practice at Saab focuses on enabling teams to continuously improve their performance. The goal is for every engineer, every day, to carry out the highest priority task with a minimum of obstacles. This creates an environment of clarity for the teams, maximizing their sense of commitment.

Through Agile practices Saab can manage variability and drive performance with clarity and commitment. The result is an aircraft delivered for lower cost, with higher speed, and greater quality.

9. References

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