

claudio saurin

THE AGILE FACTORY

**Hardware Product Development
in the Age of Uncertainty**



foreword by joe justice



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Operational headquarters: Via Malaga, 4 – 20143 Milano
info@ayroseditore.it
www.ayroseditore.it
Tel. (+39) 0236558853

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To Martina and Cecilia

Foreword

Tesla introduces 60 or more new parts into production and sale every day, 365 days per year. This includes the manufacturing processes, certifications, the embedded software, the support and maintenance procedures, the logistics, the supply chain management, and more. Tesla deletes 61 or more parts every day, the total part count continues to be simplified and complexity reduced.

As of this writing, all other automotive manufacturers instead use a phase gate multi-year budgeting, scheduling, and review process to introduce change on a 2 to 10 year cadence.

Tesla is growing in production numbers, profitability, customer loyalty, and measured quality faster than any automotive company in history, and already more valuable on the public markets than the next 10 automotive companies combined.

The secret is Agile. Finally Claudio Saurin has published this landmark book to explain what to do, and how to do it. Claudio explains why Phase Gate multi-year cycles are good, but also why Agile processes are so much better, faster, cheaper, and higher quality. Claudio explains how to move design and production and vendor management and logistics towards the agile world, step by step, or all at once. Claudio introduces xM, or eXtreme Manufacturing, for Agile production operations from a small site to a global multi-factory mega company like Tesla.

I am Joe Justice, I operated Agile at Tesla as an employee at the global headquarters, and I am very pleased to introduce you to this book on Agile Hardware.

Joe Justice
September 5, 2022

Introduction

*Man thinks he wants freedom.
He's actually very afraid of it.
Why? Because freedom forces
him to make decisions, and decisions involve risks.*

Erich Fromm

This book has been written primarily for entrepreneurs, technical managers, R&D managers, project managers and all those who are directly involved in a product development process and want to shake it up with the agile approach.

Dear reader, this book is for you

- If you think that improving your business doesn't depend solely on increasing the efficiency of your processes.
- If you think it's more important to develop the "right" product, even if it is imperfect, than to develop an unpromising product to perfection.
- If you think that the cost of the delay involved in introducing a new product to the market is too great for your company.
- If you really think that people come before processes.
- If you think that not everything can be automated.
- If you believe that in today's world it's still essential to be very pragmatic.
- If you really want to change and you know that to do so, you have to start with yourself.

Custom manufacturers can benefit greatly from the agile approach, which is also essential for learning how to move in the highly digitalized context of the fourth industrial revolution.

This is a very concrete book, aimed at providing operational tools that a person with sufficient organizational and agile skills can use immediately.

In recent years, while working as a manager and as a consultant, I have realized that custom manufacturers are mainly characterized by their ability to develop customized solutions for their customers. This approach is often activated in response to orders or requests from the customers themselves, while in other cases it's related to actual research and development projects for new products.

Along with these companies, there are also those that develop mass-produced products and employ a process that is still too rigid for today's world, which is characterized by Volatility, Uncertainty, Complexity and Ambiguity (VUCA) as never before.

Actually, the world has always been complex. What has changed is our perception of this complexity, which has been internalized only in recent times, when the mechanistic view has shown clear evidence of its limitations.

A VUCA world requires flexibility and the ability to adapt to an increasingly complex and unpredictable reality. It's necessary, as never before, to manage risks by taking small steps in possibly unexplored terrain, and to move with great dynamism to seize the volatility of situations and the disruptive challenges that lie ahead.

The traditional approaches – Waterfall and Lean – have not been able to provide an adequate response (or at least not a full and satisfactory one), as they cannot guarantee the necessary change or the speed required.

For many years, companies – supported by management and engineering schools – have focused on the search for process efficiency, which is also known as Exploitation. At the same time, the term “Innovation”, applied to anything from products to processes, has become one of the most frequently used management words. The companies that are truly innovative in the development of new products know how to be explorers and engage in Exploration.

These are actually two synergistic processes, and being able to implement them at the same time is an art.

For many years, production has been nourished by methodologies and tools that have greatly improved its performance thanks to Exploitation.

The time has come for new product development to go beyond the powerful digital tools introduced to support design – such as three-dimensional design systems, calculation and simulation systems, and digital twins in general – so as to radically rethink the entire product development process, taking inspiration from what has been happening for a few decades in the world of software with the Agile approach.

It's an approach that really puts people at the centre, so they are able to express their talents in the best possible way by working in teams with other people with different skills, in order to generate products of great value for customers and the company – and all in a very short time.

This has been the case in software development organizations for a few decades now – which is precisely what has enabled them to assume the prominent position they now occupy in our society.

The people involved in the creation of today's smartest products often belong to different generations. That's because, unlike in the past, nowadays no single individual is able to meet the challenge of developing such products, which integrate different technical disciplines – both hardware and software – and therefore require unprecedented cooperation.

I was lucky enough to work as a product developer for many years, and in my continuous search for possible alternative approaches I came across the agile approach in 2008.

I was immediately struck by such a genuine paradigm shift in project management and teamwork.

Since I was also involved in software development, I had the opportunity to experience its effectiveness, which gave me the idea of trying to apply it to the development of hardware products, or rather physical products.

The results proved to be extraordinary, both in terms of speed of development and of quality of what was developed. However, my amazement stemmed from an even more fascinating aspect.

I was blown away by the Outcome, i.e., what comes out of it in terms of results for the people involved in the development process.

The most significant result is the construction of an environment where mutual respect and cooperation (which is much more than mere collaboration between people) enable effective self-organization. Thus, your work environment becomes a relational and value-based place where you feel the urge to go every day in order to plan and exchange ideas with your team.

All this goes hand in hand with a noticeable and tangible increase in team performance, which translates into a win-win situation for workers and management.

The hierarchical and pyramidal relationships that still characterize many organizations are no longer adequate to cope with a complex world.

Switching to a self-organizational approach requires some training for supervisors at all levels, but it's an approach you cannot do without once you've discovered it.

You can no longer expect to have everything under your control – you have to live with the fact that trained and empowered people will be happy and proud to take on the responsibilities that are necessary to achieve greater autonomy.

The opportunity to work in cross-functional teams is also a powerful way of disseminating knowledge and increasing skills.

This is how organizational learning is fostered, which lays the foundations for a Learning Organization.

Content guide

The first chapters contain a more detailed explanation of why the current and future increasingly complex and VUCA context requires a change of approach in product development (Chapters 1 and 2).

I will then elaborate on the meaning of “Innovation” and the conditions for it not to be just lip service but to really permeate the company (Chapter 3). To reap the benefits of innovation indefinitely, we have to be like gardeners who sow, tend and harvest. And here we are not talking about plants but people, who need a special humus to flourish.

Developing products nowadays is a real challenge, as it requires an approach that allows us to adapt to the changes that occur during development. That's why I'm going to analyze 4 approaches to project

management (Waterfall, Lean, Project Management 2.0 and Agile), identifying which peculiarities of each approach are most useful in order to make adaptive planning sustainable – a necessary requirement for product development in a VUCA context (Chapter 4).

Once I have clarified why this is necessary and which conditions are needed to make innovation sustainable, I will propose a minimalist, no-nonsense approach to developing a product, starting with an idea and focusing on it more and more until we understand the meaning of the product itself (Chapter 5).

This is accompanied by the need to manage development priorities with a focus on innovation rather than invention (Chapter 6), and by the consequent opportunity to manage a portfolio of ideas and projects (Chapters 6 and 7).

For each idea, both in the early stages and during development, it is very important to focus on the value our product brings to the customer and user (Chapter 8).

The development process that I'm going to outline is "elastic", in that it is flexible in adapting to change and in being able to appropriately integrate all the advantages of the development methods that have so far been employed for physical products (Chapter 9).

The use of Canvases – i.e., paper or digital boards for visualizing business opportunities related to the development of a new product – helps to bring the idea that lies behind it into sharper focus. Canvases are built by a team involved in product development, marketing and management, and in general by people who have the domain (i.e., product, market and production) knowledge needed for research and to make decisions.

In the development of new products, it is much more important to focus on identifying the most suitable one for the target market than to concentrate on the search for efficiency in the development itself.

It is therefore essential to carefully explore ideas before throwing yourself headlong into development.

With this in mind, particular attention will be paid to whether or not to build "Pretotypes", which are real forerunners of prototypes to be used as bait to quickly verify the market response to our ideas, as inspired by the Lean Startup logic (Chapter 9).

I will tell you how the “iterative” and “incremental” approach of developing in small steps with continuous course adjustments, which underpins the agile approach, can actually be successfully applied to hardware products.

A process is iterative when, once it has been developed, you can go back over it to rework it – think of the various possible layers of paint that can be superimposed with oil paints.

On the other hand, a process is incremental when it develops from what has already been built and consolidated – in this case, think of watercolor painting, which after a first and single layer only allows brushstrokes in new areas of the sheet.

This application or extension must of course take into account the peculiarities that characterize hardware products compared to software products, as well as the multiplicity of objectives involved in sustainable design.

In the development of a physical product, a multitude of factors must be considered, including, by way of example, design to minimize environmental impact (at the construction stage, during use, and in the process of disposal at the end of its life) and design to simplify assembly and constructability. The approach that integrates these different aspects is called “Design for X” and covers at least 11 of them (Chapter 9).

In a nutshell, the product development project consists of breaking down the project itself into the many things that need to be done, tackling and refining them at the right time and associating them with the value we bring to the customer through the product.

In the agile approach, the “Stories” are the building blocks that make up the to-do list, or Backlog. They are called Stories precisely because they require a conversation between the customer or his/her representative and the developer.

The breakdown of the Backlog and its distribution in the various iterations by means of Story Mapping is a functional and powerful practice, fully employable for physical products as well.

The Agile approach is often identified with the word “Scrum”, meaning a structured way of phasing work in an iterative and incremental manner.

Scrum and story mapping – which were born in the world of software – are proving to be synergistic for physical products too (Chapter 10).

Not everything can be done within an Iteration (the term “Iteration” meaning any step in the iterative and incremental process), but this is not a limitation of the agile approach.

The application of the agile approach to the development of physical products is still in a pioneering stage, and I want to contribute to its application in this context by sharing my own original formulation of Hardware Stories (Chapter 10).

Moving from Canvases to product characteristics, and then from these to their impact on the backlog elements concerned or on a group of them, is not immediate. Therefore, I feel that it’s important for me to share an original method that we have developed ad hoc. It’s a structured approach by which product requirements (performance and others) are “transferred” to the relevant backlog elements. We have called the result of this process “Feature Impact Matrix” (Chapter 9).

An element that is common to most physical products – and differentiates them from software products – is the multiplicity of their possible modes of use.

Many of the physical products we use both in a business context and in our private lives have a main use for which they are designed, alongside other uses such as cleaning, maintenance, disposal, etc.

As a simple suggestion on how to manage the impact of this multiplicity of user experiences on the elements of the Backlog, I will share the visual approach of Experience Mapping, which complements the more traditional Story Mapping (Chapter 10).

If you don’t take risks, you will make an ordinary product, which makes new product development inherently risky. That’s why it’s essential to perform a careful analysis of all risks – from high-level risks to operational ones. The agile approach helps us a lot in this respect as well (Chapter 11).

In addition to the extreme usefulness of these Backlog management methods, my personal experience has taught me that when applied to design alone, the agile approach produces limited and not entirely satisfactory results: real change only occurs if you extend it to cover the whole factory (Chapter 12).

The direct experience I had over the years in a company where I was able to see both the effects and the results achieved and achievable by extending this approach to the whole factory was so rewarding and surprising that I have devoted a whole chapter to sharing the methods I experienced with my teams in this area. These effects and results have also been abundantly confirmed by similar experiences in other companies (Chapter 12).

The aim of this book is to be a very practical manual, which is why I have chosen to present three examples of design problems of increasing complexity and the different ways in which they can be handled (Chapter 13).

Last, but not least, comes the chapter dedicated to People in organizations, always keeping in mind the social and cultural context within which they operate (Chapter 14).

For the agile approach to achieve its deserved success, it's extremely important not to lose sight of the fundamental awareness that global manufacturers (and particularly European and Italian ones) and their employees do not operate in Silicon Valley, but in very competitive industrial districts.

This chapter is particularly meaningful to me, because it encapsulates a great deal of knowledge and personal experience concerning how to make this approach possible in our local contexts, taking into account the conditions in which manufacturers of customized products (and particularly Italian companies) operate, as well as certain characteristics, peculiarities and prerogatives that make them unique on the global industrial scene.

In this regard, I think it's essential to remember that a real Agile Transition requires an explicit and manifest commitment by the top levels of the company, without which it is destined to have limited results or fail. Although it's certainly not a problem if it originates "from the bottom", on the initiative of a head of department, in order to have a real impact on the entire culture of the organization, the leadership of the company needs to fully share the same objectives.

The new and innovative corporate roles of Product Owner (the Project Leader) and Scrum Master (the expert in the agile approach and team coach) have emerged in recent years, and still constitute a real challenge in the context of custom manufacturing.

Since the agile factory is a truly concrete concept, I will briefly recount four business cases that I believe exemplify how this approach can be successfully applied. I will focus on four Italian companies that in my opinion represent small, medium and large enterprises, and that develop products for industrial B2B and B2C use in a very competitive environment.

I hope that my significant experience in the field will give you ideas and inspiration to further explore your own work environment with as much agility as possible (Chapter 15).

Finally, in the last chapter I will summarize what the Agile Factory can be in its essence, which I've condensed in the 13 Fundamentals that represent it (Conclusions).

I have written this book riding on the long and intense wave of first-hand experience. What fills me with enthusiasm and encourages me to continue to promote the agile approach is that every day I see how well it manages to adapt to small custom manufacturers. All of this confirms my recent perception (which is recent and ancient at the same time, because “in the beginning there was only doubt”) that this method is extremely suitable for granting sustainability, today and for future generations, to a craftsmanship that has been “added to and augmented” thanks to the very powerful technological and digital tools that are increasingly available, combined with a mental approach and a work culture that are absolutely revolutionary.

