

Preface

Executive Summary

As the world progresses toward Industry 4.0, how can your manufacturing concern successfully navigate your unique digital journey? In our conversations with manufacturers from across the globe and the industrial spectrum, Siemens has heard a sweeping array of thoughts about digitalization, Industry 4.0, the smart factory and related concepts. To some, digitalization is a golden opportunity; to others, it is a necessary evil. But to optimist and pessimist alike, there seems to be widespread puzzlement over the practical details of digitalization. To many manufacturers, digital transformation is a vague and confusing concept they nevertheless must grapple with in order to survive the Fourth Industrial Revolution.

The proliferation of digital manufacturing technologies adds to the confusion, leaving many manufacturers perplexed and unprepared, with little real insight into how emerging technologies can help them sustain a competitive edge in their markets.

Yet along with the confusion and challenges, digitalization also presents manufacturers with a great opportunity to grow their competitiveness, profitability, and responsiveness to consumer demand. More than that, digital transformation for many companies is evolving from an opportunity to an imperative, especially considering unprecedented world events (say natural disasters, global financial crisis, and disruptions due to global pandemics). Supply chain disruptions, rebalancing of manufacturing hubs, a greater need for remote interaction with manufacturing operations, and other impacts of global crises are occurring on an extraordinary scale, driving many toward accelerated adoption of digital technologies. Manufacturers whose products have become scarce during a global crisis are learning new ways to rapidly increase capacity. Manufacturers who have experienced great drops in product demand during a global crisis are learning new ways to agilely repurpose their idle plants and lines. In all cases, digital technologies are critical to successfully piloting through uncertain times.

In the midst of these complexities, challenges and opportunities, Siemens has found a unique position from which to help because of our multiple roles in the manufacturing space. On one hand, as a digital industries software provider, we are deeply involved in various business conversations with manufacturers. We have

listened carefully to your voices, issues, concerns, and challenges. We are intimately acquainted with the difficulties as well as the benefits of implementing digital solutions, having assisted manufacturers across the globe on this journey. On the other hand, because Siemens is a manufacturer, we have experience digitalizing our own factories and that has given us an even closer, direct experience of all that digitalization entails. We want to share the hard-earned knowledge we have gained, not only as we have innovated a broad array of digital technologies, but more importantly as we have successfully implemented them for the full spectrum of manufacturing enterprises around the globe – including our own.

We have set out in this book to effectively convey our knowledge and experience through a concept we call “Manufacturing 4.x for Smart Digital Manufacturing,” a stepwise approach to realizing the promise of the Fourth Industrial Revolution. The Manufacturing 4.x Smart Digital Manufacturing roadmap provides guidance and enables low-risk, high-reward adoption of new manufacturing software technologies through a series of tipping-point investment decisions that result in optimized manufacturing performance.

On a deliberately practical level, Manufacturing 4.x for Smart Digital Manufacturing helps manufacturers across industries to optimize their technology adoption based on return-on-investment (ROI), risk and relative competitive performance. The so-called tipping points are the points at which manufacturers should switch to a new generation of technologies, with each industry having unique considerations for their optimal path. This book focuses especially on tipping points for manufacturing operations, the critical domain where virtual and real production converge.

If this book fulfills its mission, our readers will gain a clear understanding of what digital technology has to offer them, and how and when to invest in these essential components of tomorrow’s factories.

A Note to the Industry Analyst

Though this book’s target readership is the manufacturing engineer, we have written it in a way that we anticipate will be helpful to analysts covering digitalization – especially manufacturing operations management (MOM). The Manufacturing 4.x for Smart Digital Manufacturing framework is designed to be useful across various technology platforms, industries and types of manufacturing.

The book is not meant to prescribe any particular vendor choices. Instead, it communicates Siemens’ perspective on how manufacturing leaders should create their digitalization roadmap in a very practical way. As industry thought leaders, analysts need to couple the practical with the visionary. We hope that our forward-looking way of evaluating technologies and their adoption will help you make that connection. We want to prepare manufacturers to anticipate the requirements of their customers and identify the right digital investment opportunities, the ones that will enable them to thrive in these new and emerging market conditions.

Like you, Siemens wants manufacturers to evaluate digital solutions not just on the basis of meeting a particular need today, but also on the basis of incrementally

building a digital ecosystem through which their technology choices today will continue to support them through tomorrow's challenges. We hope that you will find the Manufacturing 4.x for Smart Digital Manufacturing to be a useful tool as you perform your own analyses and evaluations.

A Note to the Manufacturing Executive

Tasked with both vision casting and drilling down into your manufacturing operations' detailed information technology (IT) needs, manufacturing executives must evaluate long-term IT infrastructure needs, anticipate new forms of technology and the skill sets needed on your IT team, and maintain an uninterrupted infrastructure on which your critical operations run. How do you reconcile the needs of the real-time manufacturing environment with the efficiencies of digital technologies? How do you determine the digital industries partners that will help you invest in manufacturing IT for the long haul? We believe the Manufacturing 4.x roadmap will help you to address these questions.

Like your manufacturing technologists and strategists, you are inundated with new digital tools, options, updates and modules – a cacophony that makes the orchestration of a sound digitalization plan all the more challenging. As you sit side-by-side with key manufacturing personnel, you must determine how best to meet the needs of various internal teams, and of course, the customers you serve. Manufacturing 4.x for Smart Digital Manufacturing provides a framework that can be used as a kind of filter to sift through the noise to the right digital investments for you.

A Note to the Student

Once you have studied the academic aspects of the Fourth Industrial Revolution, the question remains how this revolution is unfolding in the real manufacturing operations of today and into the future. It is of critical importance to us to help you find answers to this question. After all, the whole manufacturing ecosystem hinges on the education and development of the next generation of professionals. You will be contributing to economic growth and vitality, whether you work as a manufacturer, system integrator, consultant, analyst, or software vendor.

Unlike other transitions from academic to commercial endeavors, you may find yourself on the leading edge of near-term changes in industry. Up until now, most engineering professionals have begun their careers on one of distinct tracks: either they have a great foundation in IT and must learn how it relates to manufacturing technologies; or they mastered the subjects that fall under a branch of engineering and now must learn how manufacturers employ IT to manage and execute operations that produce real electrical, mechanical, chemical or even mechatronic systems. As one engineer put it, it seems as though plans and designs have to be thrown over a wall to production.

Today, the siloed worlds of IT and manufacturing engineering are being set loose to commingle and break down the barriers between the digital and real world. You are the first generation to start your careers with this holistic manufacturing approach. But many more barriers between digital and real manufacturing require dismantling.

Manufacturing 4.x for Smart Digital Manufacturing may empower you, the aspiring engineer, to help implement the changes that will bring about the convergence of virtual and real manufacturing; of a product's plan, design, manufacture, performance and maintenance; and of tools as-yet uncreated and the processes and products they will create.

To achieve this lofty vision, you need a handhold on the Fourth Industrial Revolution as it currently exists, as well as a down-to-earth framework on which to develop a roadmap to the digitalized future. We are convinced that Manufacturing 4.x for Smart Digital Manufacturing can provide you with just such a connection between beautiful yet abstract manufacturing ideas and the manufacturing floors of today and tomorrow.

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René Wolf
Raffaello Lepratti