

THE GREEN FACTORY

CREATING LEAN AND SUSTAINABLE MANUFACTURING



Andrea Pampanelli • Neil Trivedi
Pauline Found



CRC Press

Taylor & Francis Group

A PRODUCTIVITY PRESS BOOK

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Foreword by John Bicheno

Steven Johnson, in *Where Good Ideas Come From*, described the “Adjacent Possible” as being a central way in which innovation has progressed. This approach takes good ideas from “adjacent” areas and modifies, adjusts, adapts, and integrates them so as to produce significant steps forward. Much of Lean and its precursors followed similar paths. Henry Ford took concepts from meat disassembly, division of labor, scientific work and work standards and, enabled by newly developed electric motors that increased quality and power, created the assembly line.

It was a logical step therefore that led Lean into “Lean is Green.” Energy conservation has been the concern of mechanical engineers for decades. Perhaps Lean’s entry into the area began with transport and reject wastes. Quick attempts focused on the modification of the seven classic wastes to include wasted energy, water, and materials. Predictably, the Green value stream concept began. Books and reports followed.

With the publication of *The Green Factory*, Andrea and her coauthors have pushed the boundaries even further. The book extends the “adjacent possible” of Lean and Green to develop the Lean and Green Business Model, taking as it does the best from “planet, people, and profit” and showing the application at cell, factory, and “extended product” areas. Of particular importance is the eminently practical guidance material on how to do Kaizen activities in such areas. Extending the already great value of the book, the authors have gone further to include key implementation lessons (different from standard Lean), and an extremely valuable section on preconditions for success.

Although it is based on Andrea’s PhD studies, the book is not an academic treatise but an extended case study of implementing the Lean and Green Business Model in a major international company. This makes it uniquely valuable.

Andrea pursued her PhD research, and the application of the research, while an associate of Lean Enterprise Research Centre. It was my good fortune to meet her there. In her work, she was assisted by Neil, a full-time manager within her company, but also a graduate of the MSc Lean Operations program, and by Pauline as one of her PhD supervisors.

Alongside the meaty “how-to” material, Andrea’s journey of Lean and Green discovery is described. Like several good innovations, this was not a linear path. Andrea, being Andrea, tells it like it is. That should be an encouragement to all who set out along the Lean and Green path. It is not a simple, straightforward journey and obstacles will be encountered—methodological, political, economic, and human. There remains much to learn, but this practical work will remain the standard reference for years to come.

John Bicheno

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Foreword by Robert W. “Doc” Hall

In this book, the authors add a great deal of experiential insight into a subject that should be attracting much more attention—the merging of Lean process improvement with environmental process improvement. Unfortunately, in most companies, a big gulf still separates Lean initiatives from environmental ones. Efforts by a few environmental practitioners to tag onto the surge in Lean programs in the United States have not gained much traction.

Much of this book details Andrea Pampanelli’s experience with Lean and Green Kaizens in the Brazilian factories of GKN, a 256-year-old British manufacturing company with a bent toward environmental responsibility. As it is related, those projects not only improved the environment but also reduced GKN’s costs. One reason for success was that GKN managers both understood and supported the projects. Lack of top management interest, or even awareness, is the bane of many improvement initiatives of both the Lean and the environmental kinds.

A strength of this book is that it characterizes failed and mediocre projects as well as the kind that proponents like to tout. The authors present no formulas; the book is not an engineering handbook; it’s a managerial guide to Lean and Green improvement. However, the details of execution from a managerial view have value, so managers risk missing some key lessons if they don’t dig into the details.

The authors note that compared with Green projects, improvement projects that eliminated environmental wastes by piggy backing on the improvement disciplines of Lean showed better results, including bottom line results. Lean improvement often concentrates only on value streams whereas environmental improvements must often address processes that feed multiple value streams. I have been personally frustrated by the separation of the Lean and the environmental communities. They have much to learn from each other. The authors’ observations blaze a pathway leading forward in this collaboration.

This pathway is summarized in the 5-step “Lean and Green Business Model.” For practitioners eager to avoid the pitfalls in the pathway, the authors also summarize seven prerequisites for implementing the five steps.

The prerequisite that struck me was #4: A supporting management team operating by leadership standard work and by Gemba leadership. Translated from Lean lingo, this means that senior leaders can’t just bless a program and wish it to happen; they have to be involved, clearing pica-yune organizational system obstacles, authorizing resources, and demonstrating that they too are doing their part to make projects succeed. By coincidence, a big global survey crossed my desk a few days ago, and topping the list of reasons for Lean program failures was this same lack of leadership by senior managers.

A second finding, although not surprising, is very important. Information systems and data collection are crucial. In Lean improvements, we may improve process visibility without having much data—but the purpose of the visibility is to make hidden issues more obvious. One cannot know how well improvements are progressing without having a baseline of measurement from which to compare. This is even more crucial for environmental wastes. Unless waste is gross, electricity use, water consumption, toxic releases, and volatiles in the air escape notice. We don’t fix what we don’t see.

A general methodology for Green improvement is the same as for Lean. Set a standard; stabilize. Improve the process; set a new standard and restabilize, meaning that all details and support needed to hold the standard are worked out. And make the process visible so that deviations from standard and “sore spots” stick out. Problems get attention when they can’t be put out of mind.

The model sets a baseline of general knowledge about how to do this. I hope that you enjoy the book, and more than that, that you are inspired to do Lean and Green yourself, in your factories. A glimmer of a dream is that practitioners into Lean and Green will form a group to share their experiences and learn from each other. That has worked well in many places for Lean practitioners, and everyone is better off for it. It should continue to work well when the scope of improvement is enlarged.

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Prologue: A New Way of Thinking

We cannot solve our problems with the same thinking we used when we created them.

But in real life, how many times have you tried to see the same problems using different ideas, applying different lenses, trying to understand different paradigms, applying different ways of thinking?

Systems thinking is the process of understanding how things, regarded as systems, influence one another within a whole. As a culture, we are discovering that we cannot understand the major problems of our time in isolation. These are systemic problems; they are by nature interconnected and interdependent. In this sense, systems thinking means thinking in context. It is a way of thinking that emphasizes the whole rather than the parts. While classical science insists that the behavior of a complex system can be best analyzed in terms of the properties of the parts, systems thinking reverses the equation by showing that the properties of the parts are not intrinsic but can be understood only within the context of the larger whole.

According to Capra (1996), an understanding of reality based on the essential interdependence and interconnectedness at the heart of things restores our human connection to the entire web of life. Living systems exhibit the same basic principles of organization. They are networks that are organizationally closed, but open to the flows of energy and resources. Their structures are determined by their histories of structural changes and they are intelligent because of the cognitive dimensions inherent in the processes of life. In business terms, the interchange of ideas and concepts exists even though there is no real intention for them to occur.

Rooted in systems thinking, sustainability grounds the development debate in a global framework, within which a continuous satisfaction of human needs constitute the ultimate goal (World Commission on Environment and Development, 1987). When transposing this idea to the business level, corporate sustainability can accordingly be defined as meeting the needs of a firm's direct and indirect stakeholders (such

as shareholders, employees, clients, pressure groups, communities, etc.), without compromising its ability to meet the needs of future stakeholders as well. Toward this goal, firms have to maintain and expand their economic, social, and environmental capital base while actively contributing to the sustainability in the political domain. From this definition, three key elements of corporate sustainability can be identified: integrating the economic, ecological, and social aspects in a “triple bottom line.”

In this sense, human well-being and progress toward sustainable development are vitally dependent upon improving the management of Earth's ecosystems to ensure their conservation and sustainable use. But while demands for ecosystem services such as food and clean water are growing, human actions are at the same time diminishing the capability of many ecosystems to meet these demands. Sound policy and management interventions can often reverse ecosystem degradation and enhance the contributions of ecosystems to human well-being, but knowing when and how to intervene requires substantial understanding of the characteristics of the systems involved in a holistic way, including the ecological or environmental aspects, the social systems involved, and the business or economic issues.

What happens when we try to solve this problem looking at sustainable principles inside a manufacturing business operation? From the 1980s, many models of “how to run” an efficient and effective manufacturing organization have been developed. This process was to yield a new and post-mass production model of manufacturing that has been termed “Lean production” and more recently “Lean thinking.” The origins of the “Lean approach” can be traced to U.S. fears in the 1970s that newly emerging Japanese assemblers held a competitive advantage over their established Western counterparts. Those fears promoted benchmarking studies of the global automotive industry to test these fears and find the causes of such an advantage. The publication, *The Machine that Changed the World* (Womack et al., 1990), reported the results of this study. A follow-on book titled *Lean Thinking* (Womack and Jones, 1996) established the five Lean principles upon which a “more efficient” manufacturing business, viewed through the lens of quality, delivery, and cost, can be based. For the last 25 years, companies have tried to establish their business models based on these principles of establishing what customers value, creating streams of value-adding product or services that flow at the pull of the demand from the customer, while striving for perfection.

Einstein also stated:

Learn from yesterday, live for today, hope for tomorrow. The important thing is never stop questioning.

This period in which we live is marked by increasingly frequent and intense encounters of all kinds, with a global trend toward mixing and hybridization (Burke, 2006). Understanding that there are different ways to be sustainable in a manufacturing business, the intention of this book is to integrate two different ways of thinking: Lean thinking and Green thinking.

We know that walls, or organizational structure, cannot stop the flow of ideas but it does not mean that they are able to flow through so easily. Lean and Green thinking are rooted in different ways, have different meanings, and occupy different spaces inside the business world. The idea of this book is to see both ways of thinking and, based on different perspectives, understand its own characteristics, boundaries, and languages, yet be able to explain each one to each other and to create an integrated approach, applying important characteristics from both of them. The Kaizen events will be the moment where these two different ways of thinking meet. The Japanese word for “improvement,” or “change for the better,” Kaizen refers to a philosophy or practices that focus upon continuous improvement of processes. When used in the business sense and applied to the workplace, Kaizen refers to activities that continually improve all functions, and this involves all employees, from the CEO to the assembly line workers.

Therefore, the main objective of this book is to propose a new model, the Lean and Green Business Model (L&GBM), where the Green dimension, the environmental aspect of sustainability, is added to the pure Lean thinking concept in order to create a new way of thinking that contributes to and balances the three sustainability dimensions (people, profit, and planet) and one that uses a Kaizen approach for dealing with and improving mass and energy flows in a manufacturing environment that already possesses a deployment level in applying Lean. The model aims to have the following characteristics:

1. Lean thinking for dealing with manufacturing environmental issues in order to integrate environmental sustainable practices prerequisites of (1) impact reduction and (2) resources productivity with manufacturing ways of working

2. The use of the Kaizen approach for dealing with and improving environmental flows of mass and energy of a manufacturing cell and the value stream
3. The idea of improving operational sustainability by optimizing supporting flows performance—the mass and energy flows (everything that enters and leaves) of systems composed by a production for a cell and a value stream

Figure P.1 presents the main part of the study.

As Einstein once said,

No problem can be solved with the same level of consciousness that created it.

This book proposes a new framework, a model, that is able to translate the environmental language and the intention of the environmental sustainable practices of pollution prevention, improvement of environmental performance, improvement of mass and energy flows to the manufacturing world. In other words, it means looking at environmental issues with manufacturing eyes, in another way, and by understanding existing manufacturing practices and tools, adapting it based on environmental fundamentals and using it to support a sustainable business. L&GBM aims to translate the environmental language to the manufacturing world, through applying Lean thinking.

Along with the development of L&GBM, this book also describes the journey of implementing a new framework in global corporation.

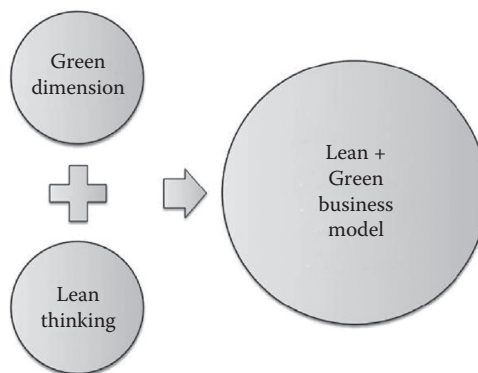


FIGURE P.1

The main objective of the study. (From Pampanelli, A., *L&GBM*, PhD thesis, School of Engineering, UFRGS, 2013.)

Therefore, this is the story of developing and implementing L&GBM in GKN, a major British multinational company with operations in more than 30 countries, more than 140 manufacturing businesses, and employing more than 50,000 people around the world. Founded in 1759 in South Wales, United Kingdom, GKN was one of the first companies to bring the modern industrial age to life. Today, after more than 250 years, this global British engineering company produces special systems and structures, with a focus on automotive, powder metallurgy, aerospace, and land systems markets.

GKN is a major first tier supplier to the automotive and aerospace industries with established solid foundations and policies in both Lean and environmental fields. In the Brazilian driveline plant this story is based upon, a strong focus on environmental improvement projects had been in place since the year 2000, with more than 83 environmental research and development projects established between 2000 and 2010, resulting in a 99% recycling rate, but also with significant further opportunities identified to reduce the environmental impact of the business.

Lean was introduced in 2004 in the GKN automotive sector to improve competitiveness in that market and one of the early significant milestones was the support by senior leadership for the Site Continuous Improvement Leader (SCIL) training program. This series of training workshops took promising manufacturing leaders and trained them to expert level over a period of a year. These leaders returned to their home sites and became the local Lean change agents for their factories focusing on the deployment of Lean to manufacturing processes. This structure became the backbone of Lean deployment at GKN.

This book investigates the next stage for GKN in becoming a sustainable manufacturer with the integration of Lean and the concepts of sustainability, Lean and Green, by developing a model (L&GBM) that can be applied to manufacturing. By using Lean thinking to solve environmental problems, L&GBM will be focused on the improvement of the manufacturing supporting flows (water, energy, material, effluent, chemicals, and wastes) with the ultimate goal of optimizing the overall process performance by reducing costs and significant environmental impacts. Further, in order to create the basis for the L&GBM deployment, this book explores some of the fundamental building blocks of operations management, Lean thinking, sustainability, and Green concepts. It proposes the model structure and dynamics and reports the application of the developed model in a major engineering international corporation. The results of the applications are presented, analyzed, and conclusions are proposed.

BUSINESS CHALLENGES THAT LEAD TO LEAN AND GREEN

In a classic Lean deployment, one of the ways to initiate the system is through a value stream map that identifies the key wastes and impediments to flow. The teams seek to eliminate the classic seven wastes and improve the flow of value for the product. Once this cycle has been completed, the same pattern follows across the factory while smaller incremental improvements are made in the original value stream through the deployment of continuous improvement systems. The efforts are focused on getting the improvements to stick and setting up methods to check-act the different elements of deployment.

Once these systems are mature, the question “where to next” can simply arise or perhaps the team cannot see any further opportunities to unlock efficiency. They may be limited in their paradigm by sticking to the seven wastes and not considering them in a wider context to encompass mass and energy inputs and wastes. The introduction of Green thinking to this mindset can stimulate a whole new avenue of efficiency. A simple example of one site we visited who thought they had “done Lean” identified that they left most of their machines running when there was no product. They gained immediate savings by switching them off when idle.

Lean has many entry points, but one of the negative points is that it has often been (mis)associated with cost reduction. At one site visited, there was a high degree of hostility to Lean as it had been used in the past to cut costs. However, introducing Green thinking to the group stimulated a high degree of motivation and they subsequently identified numerous environmental savings. They felt they were doing something for the environment rather than the company—which they resented for a number of reasons. It could be argued that using Lean and Green will be the new entry point for Lean.

One of the sustainment questions that occurs during the mature phase of deployment is how to keep the stimulus for new ideas and engagement. One way is to introduce new environmental parameters to consider and provide a new stimulus to the improvements.

Manufacturing organizations are under continual pressure to reduce costs. Although Lean can provide a step change in performance, Lean is now commonplace in many manufacturing organizations. So the question is how can they differentiate further their product? Adding Green credentials not only reduces costs but also enhances their public image.

One aspect, which can drive Lean and Green thinking, is the noncompliance to environmental legislation. This can often be caused by a failure of plant, equipment, or excessive scrap and/or poor disposal. While many of these can be resolved by direct intervention and a spot fix, the introduction of Lean thinking into this arena allows for a more comprehensive systematic approach to solving the problem.

In the large organization we operated in, similar to other manufacturing organizations, there was a clear boundary between manufacturing and other functions. Manufacturing typically being the dominant function in terms of size and responsibility took the lead on what initiatives it would deploy and what it would support. Clearly traditional Lean is well within these functional boundaries; however, consideration for environmental improvements was often seen as compliance-led rather than efficiency-led and hence not embraced as comprehensively as Lean.

Although there was specific training for nonmanufacturing functions in Lean, this focused on the office and accidentally excluded most of the EHS managers. Although attempts were made to create a training workshop for this group, it never materialized. As a consequence, the environment, health and safety (EHS) managers were on the periphery of the site-based change process through a lack of knowledge of how the Lean system worked. The EHS managers therefore struggled to get a foothold in the factory cycle of improvement and change and used compliance as a way of increasing pressure for environmental change. Bringing together Lean and Green broke down these organizational barriers and enabled a conduit for environmental thinking to enter the factory.

When the environmental deployment background is considered, a number of issues and challenges are identified. Figure P.2 presents some of the challenges faced.

In GKN, there were a number of factors that came together to suggest that the deployment of environmental thinking was not fully integrated into the business. Although included in the business excellence assessment criteria, environmental deployment was seen only on the periphery of the core of operations and perceived as a legislative necessity rather than a commercial advantage. The original main focus of change and the improvements for factories was the changes generated through traditional and Lean thinking that could be made to operations to generate savings or improve efficiency. The direct benefits of environmental deployment to the business were not fully understood and therefore not fully integrated within the organization and operations.