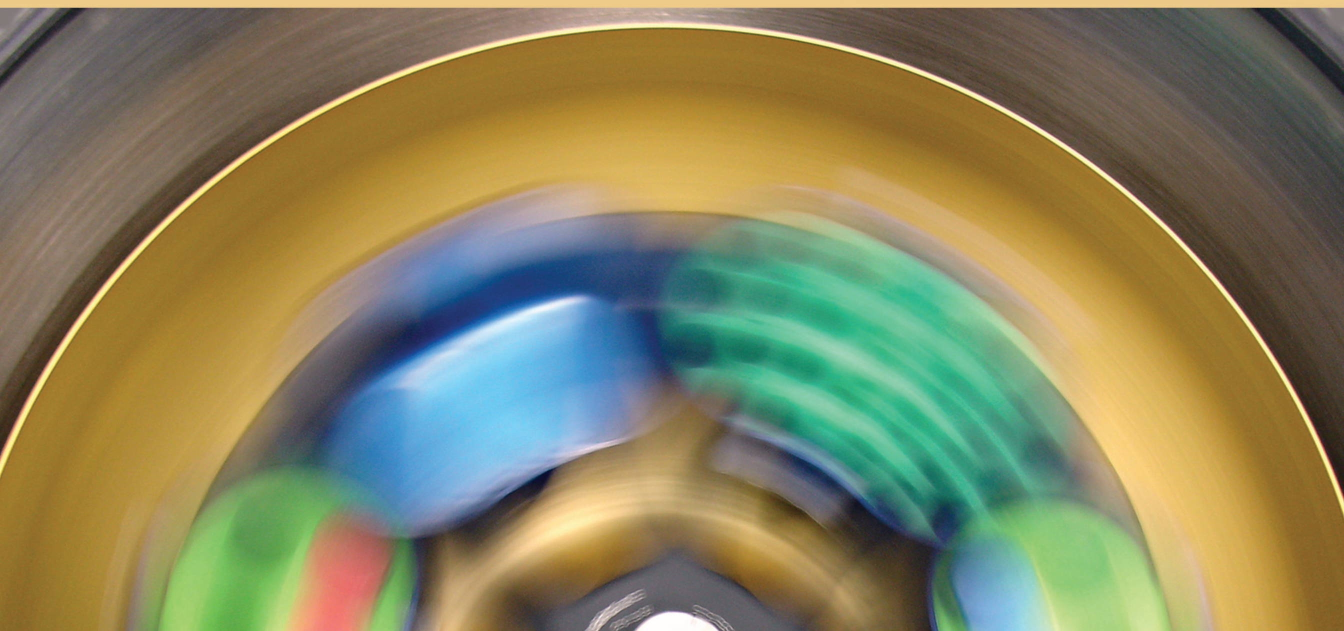
The Lean 3P Advantage

A Practitioner's Guide to the Production Preparation Process

Allan R. Coletta



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To Mom Kate and my family—

the real "Kathryn's Finest"

Contents

Preface

Why 3P?

My first recollection of the impact of flawed engineering design came while I was a young engineer working in Operations in the chemical process industry. An engineering team was developing a new railcar off-loading operation for a hazardous material. Railcars would be rolled onto an unloading spur and lines hooked up in order to pump the liquid material into a storage tank. Two operators had to drag a hose coming from a pump about 50 feet away, connect it to the bottom of the railcar, and then start the pump and transfer the material.

The design engineer, a seasoned veteran with 30 years experience, designed the system to complete the full transfer of the railcar in a few hours. To accomplish this he sized the pumps and related piping and also selected a 50-foot long, 6-inch diameter braided stainless steel hose to make the transfer. This diameter hose was necessary to satisfy the pressure drop requirements on the intake and discharge sides of the pump in order to achieve the recognized pumping rates without "starving" the pump.

Unfortunately the engineer never considered that this massive hose weighed hundreds of pounds and was certainly not flexible enough to easily attach while lying on your stomach, suited up in a rubber protective suit, underneath a railcar. It was an impossible task to ask of typical production operators. Ultimately that design was abandoned before the stainless steel hose was ordered. However, the redesign wasted thousands of dollars and the project delivered late.

Over years spent in operations, I witnessed many examples of poor engineering design in plants across the United States and Europe. Many of the problems were eventually discovered, and the impact was seen largely in terms of costs and timing. In most cases the fundamental inefficiencies created in the initial design were embedded so deeply that only incremental improvements could be made after the fact. This reality creates significant loss in profitability over the product life cycle for materials produced in these production operations. Choices made during the development of these products and operations in terms of material selection, process method, machine limitations, and disregard for maintenance requirements result in gross inefficiencies, estimated to be as much as 75% to 80% of the "baked-in" costs that are nearly impossible to "Kaizen out" afterward.

Leaving the chemical process industry and working in the medical diagnostics business confirmed to me that suboptimal designs were not industry specific. "U"-shaped lines were built with the opening of the "U" facing the wrong direction and hindering resupply of raw materials or removal of finished product. Overdesign and the installation of highly complex and difficult to maintain solutions versus simple "fit for purpose" methods were very common and seen in different plants and operations. The greater abundance of profits and money to invest did not necessarily correlate to better designs, just more expensive ones. The additional regulation of the industry also created a level of conservatism and risk aversion that favored established previously validated approaches over improved new approaches, even when the benefits appeared obvious.

What is *your* "burning platform"? Is it simply a desire to continually improve how products and processes are developed? I suspect for many of us the threat of global competition and unyielding cost pressures are forcing us to consider alternate paths at the risk of extinction. One colleague shared a story of his East Coast plant that manufactured blood pressure diagnostic kits. They were facing significant competition, and profit margins were evaporating. In an attempt to salvage the business they developed a next-generation kit, with a greatly reduced cost. However, their great idea was developed using their standard product development process, and because of the time it took to reach the launch phase, they found in the 11th hour that this part of their business had been sold. The new product was never launched by them. A large portion of the plant was shut down and people lost their jobs.

Discussions with colleagues in every type of manufacturing operation in every conceivable industry revealed example after example of ineffective designs that created inefficiencies and issues that would likely never be corrected due to the cost or time required. Oversizing, undersizing, poor flow, inability to lubricate or clean, lighting problems, access problems, lack of consideration for nonroutine functions, and many other issues simply get missed in the haste to get projects done. No one ever thought to "ask the expert"—the operator, maintenance person, or material handler who physically interacts with the product and production process. It was simply the "engineer's job," often working tirelessly in isolation against unrelenting constraints and with no incentive to chance improvement. Innovation was sacrificed on the altar of expediency and risk aversion.

Small companies have some advantages in developing effective designs over their larger counterparts because communication is generally more open and decisions are made faster. However, they often lack the resources and are not willing to spend the time necessary to work through a defined process. Larger companies have the resources but are hampered by functional silos limiting their ability to develop cross-functional value-creating designs. The ability to take a product from inception on a Research and Development (R&D) department's whiteboard through to commercial product, ready to ship to customers, is highly complex. In every case opportunities are missed.

These phenomena are also seen in *Lean* operations. Typically Lean tools are applied individually rather than as part of a complete system. This often results in suboptimization of processes and operations. Value stream mapping is effective in identifying waste and inefficiencies and pointing to the best places to apply resources for improvement. However, value stream mapping is typically applied to *existing* product lines where all of the original design concepts have been implemented in a defined operating area, utilizing defined equipment and technologies, and optimized for a given lot size. Too often the potential business disruption and overall costs and effort required prevent significant improvement projects from being implemented, and only the most modest improvements are done, resulting in incremental improvements.

Total productive maintenance (TPM) is an excellent Lean process that intends to engage all of the stakeholders in maximizing the utilization of an operating asset. Maintenance, Engineering, Operations, Quality, Technical, and Facilities all influence how well an asset performs. During the course of a TPM event, a cross-functional team cleans and inspects every part of a line or operation and in that process tries to create countermeasures to improve reliability and mitigate failure modes. Very often minor design changes are suggested to improve performance. Unfortunately larger, more sweeping redesigns are not possible because the operations do not have the time, money, or space for dramatic step-change improvements.

All of us who have ever wandered around operating plants have our war stories of the suboptimal designs well-intentioned engineers have inflicted upon operations.

So why do well-intentioned, intelligent, and experienced people develop such poor designs? Why does it take so long to develop new products? Why do so many good designs fail to go further to become great ones? The endemic symptoms are everywhere. It is not exclusive to one industry or geographic location. It does not seem to be associated with skill level or experience. It comes from people who have good attitudes and bad attitudes, in big operations and small ones.

I was commiserating about this with a friend and colleague one day, determined to find a way to build more collaborative thinking and innovation into the front end of designs so that what we delivered *exceeded* expectations and better met the needs of the whole organization. I asked if she had ever seen a process for doing that effectively, a process where all elements of a line operation were considered and built into a highly effective holistic design.

She looked at me, smiled knowingly, and said simply, "3P."

And with that, a journey began.

Acknowledgments

True to the spirit of Lean 3P, this book is a testimony to the power of collaboration, rapid learning, and continuous improvement. Many people have given their time, talents, and wisdom freely to make this offering as accurate, practical, and useful as possible.

In 2009 a colleague and I had an opportunity to present on Lean 3P at the annual Association for Manufacturing Excellence (AME) conference. Afterward Michael Sinocchi, Senior Acquisitions Editor for Productivity Press, came up to me and asked me to consider writing a book on the subject, as there was very little published on the topic at the time. Over the months ahead, I continued to apply Lean 3P and develop a deeper understanding of the benefits. Eventually, I started writing and in the process, learning.

In the fall of 2010 I sent a rough draft of the manuscript to Maura May, a friend and former editor for Productivity Press. She provided honest feedback and encouragement and was a great sounding board for the approach taken in this text.

In early 2011 the manuscript was moving along but seemed to need something to pull the key points together. The idea of Kathryn's Finest was developed as a way to bring the concepts and philosophy of 3P together in a story that the reader might relate to. Carl Jarvis, an amazing designer and participant in numerous 3P events, offered to provide the sketches of the fictitious event and along the way convinced me that holding a mock event might be an even more powerful way to convey the concepts. To conduct even a mock 3P event required a lot of help and planning. Friends and colleagues all willingly volunteered their time and effort on a beautiful Saturday in May to help further the cause of Lean 3P.

My sincere thanks to Jim Burns, Alexandra Coletta, Rose Coletta, Matt Delaney, John Douglas, Charlie Fouraker, Jonathan George, Paul Greenwood, Tuan Huynh, Carl Jarvis, Carol Jarvis, Alan Montross, Bill Morse, Terryn Mozer, Philip Newman-Sanders, Al Risley, Loretta Stiglianno, Mike Szymanski, Earl Vaughn, Nancy Zeller, and Stuart Zeller. Thanks also to Dana Evans, of Evans Photography, for the excellent pictures that so richly augment the text.

As the draft manuscript was coming together I was able to receive input from some amazing subject-matter experts, and friends. The interchange between them became a true version of "catch-ball," as they challenged, disagreed, and affirmed the many concepts covered in the book. The results of those efforts are reflected in the pages ahead. In many ways this is a collaboration of ideas and practical examples that I hope will resonate with you, the reader.

Andy Johnson is a colleague and Operations Manager at Dentsply Caulk (Milford, Delaware), and a fellow 3P practitioner. He added greatly to the practical examples and pitfalls to watch out for. Drew Locher was one of the first to open my eyes to Lean and the power of continuous improvement. He has continued to serve as an informal mentor to me over the years and had great insight into this book. Maria Elena Stopher has worked with me for many years and was the person who first introduced the idea of 3P to me. She has been an amazing facilitator for many of our 3P events over the years. Ken Rolfes helped us through our first 3P event and provided many of the graphics and examples used throughout the book. His insight into the concepts and practical application of 3P is nothing short of profound. Ron Mascitelli has an amazing insight into Lean product development and project management. He painstakingly went through my text line by line, offering insight and developing the depth of the offering at every step. John Shook willingly read the manuscript and offered suggestions for clarification and positive affirmation. As I reflect on the time each of these people spent helping to make this book more complete, I am humbled by their brilliance, experience, and genuine desire to help bring these powerful concepts to light so that each of us will benefit.

I have been privileged to work for a great company with great management at Siemens Healthcare Diagnostics (Glasgow, DE) and with the finest Engineering and Facilities team in the world. They have challenged me and tested me and helped to refine the practical application of Lean 3P. We hope that our mistakes along the way will help you to avoid some of them.

The great people at the Delaware Manufacturing Extension Partnership, especially Lisa Weis, have also been a great asset to my personal education and helped influence this book.

Lastly, I have to recognize and thank my wife Rosemary, and daughter Alexandra, who sacrificed many hours of “family time” to allow me to burrow away in the mornings, evenings, and weekends to complete this work. Thank you. I love you.

Introduction

Life before 3P

History is strewn with stories of engineering designs that have resulted in expensive and sometimes fatal outcomes. Every story is different, but when the final analysis is done, every design problem had an understandable and preventable root cause.

The famous leaning Tower of Pisa, built in several phases over a 177-year period, has become a major tourist attraction due to the precarious manner in which it leans. To our modern eyes, the root cause is obvious—the 185 foot tall tower is anchored by a 10 foot thick foundation, built on sand, rubble, and clay.

In November 1940, the Tacoma Narrows suspension bridge collapsed into the waters of Puget Sound near Tacoma, Washington, due to sympathetic vibrations caused by the wind blowing from just the right direction at just the right amplitude. Video clips of the bridge show it flexing and heaving like a child's jump rope before it broke apart and crashed into the waters below after only a few months of operation. Better structural analysis would have prevented this catastrophe.

Few people will forget the tragedy of the space shuttle Challenger that exploded just after launch, killing seven astronauts and leaving a world in stunned disbelief on January 28, 1986. The cause of the incident was O-rings that failed to seat properly in the frigid atmosphere, allowing hot combustion gases to leak from the solid rocket boosters and burn through the external fuel tank. The O-rings were never tested at those temperatures, and the tragic result changed the course of the U.S. Space Program.

Anyone who visited Boston in the early 1970s would remember the infamous "Plywood Ranch." The John Hancock skyscraper was an architectural triumph, built with over 10,000 windowpanes as exterior walls. Designers quickly learned that those large, 500 pound, 4 feet by 11 feet panes crashed to the sidewalks below whenever the wind gusted to 45 mph. With no immediate solution to the problem, the glass was replaced pane by pane using sheets of plywood. It took years, millions of dollars, and a scale model study in Massachusetts Institute of Technology's (MIT) wind tunnel to determine the cause and eventually correct the problem.

Most design flaws are less dramatic; however, they can be seen everywhere. The pressures of time, money, and stretched human resources are often blamed for these problems, and they certainly all contribute. However, knowing that those pressures will always exist, how can we improve our probabilities of success?

In fairness, perhaps we should consider some great designs. What about the things that are designed and made so well that people flock to buy them? What is it about the proverbial "better mousetrap" that people will rush to your door to buy? How about the iPod or iPhone produced by Apple that has taken the world by storm and completely changed our thinking about how we listen to music or what a mobile phone should do? These devices represent breakthrough engineering on multiple fronts. Apple's innovation of inexpensive downloadable "apps" that provide entertainment and an incredible variety of practical and useful information right at your fingertips no matter where you are is changing how the world works, learns, and plays.

One of the most unique enablers of the success of the iPhone was its input interface using an "intelligent" capacitance-based system that interprets what you want the device to do based on the way you run your fingers across the screen. This breakthrough technology was developed by Wayne Westerman and John Elias, in their small company called FingerWorks, who had a vision of what this technology could do with the right software interpreting it. But it was not until Apple bought FingerWorks in 2005 that the technology they developed became incorporated into Steve Jobs' vision and the marketing, sales, software development, and other functions within Apple, and a great idea was transformed into a world-changer.

Great designs typically start out as good designs. How do we enable talented engineers and surround them with the right people so that they take good designs and develop great ones? Even though we should not expect every design to be a breakthrough, most designs simply stop when they reach "good" and never stretch further for the chance to become great. Wouldn't it make sense to pursue a process that is designed to capture the many voices that interface with a product and process, and take your good ideas and designs and make them much better with numerous breakthroughs along the way?

The pursuit of innovation and creativity is often considered the "holy grail" for new product development. Everyone hopes to be the next 3M, where Dr. Spencer Silver accidentally discovered how to make a low-tack, reusable adhesive that eventually became the blockbuster product "Post-it Notes." But accidental discovery cannot be counted on, and even at 3M, the transformation of the invention to a marketable product took a long and highly integrated journey before it arrived on our desktops.

How do we encourage invention and innovation? How can we foster innovation in a structured way that enables individuals to explore brilliant concepts, and then quickly utilize the collaborative genius of people knowledgeable of other functions to give it structure and viability? Is it possible to do this quickly and at a low cost? Even more importantly, can this be developed into a company culture, such that brilliant ideas are nurtured and pursued by cross-functional teams as a normal way of working? If this vision could be achieved, the potential impact would be staggering.

Lean 3P, an acronym for the Production Preparation Process, is a systematic design approach that encourages creative thinking within the framework of a fairly structured process. It helps individuals think openly about new concepts and innovative ideas, and then provides a support team with many different perspectives to quickly develop the concept and then compare it to other ideas using an established protocol.

Lean 3P design embraces and works in conjunction with all of the proven Lean methods. The essence of 3P is to use people effectively to concurrently develop products and production operations that will create customer satisfaction and lower total costs over the life cycle of the product, while ensuring consistent quality throughout an efficient supply chain. The concepts were pioneered at Toyota, but 3P is gaining acceptance in many other industries as a means of driving innovation, avoiding costly mistakes, and creating long-term value.

Lean 3P is like the Plan, Do, Check, Act (PDCA) cycle "on steroids." It speeds around that continuous improvement circle over and over during the course of the event, eventually arriving at a plan that will go forward for further development and execution. The concept of "fail fast and fail cheap" captures the spirit of 3P. Event participants work long hours at a high energy level, constantly brainstorming, try-storming through rapid experimentation, and converging onto more and more effective designs for both product and process, and in the utilization of people.

The high-level goals of Lean 3P are big. Research into the approach to 3P goals at various companies shows differences, but in every case they are looking for radical benefits. Ken Rolfes of KDR Associates (San Diego, California) proposes a "4-¼-4" rule be used when comparing 3P to traditional "monument" design. Traditional thinking suggests building one massive plant that can handle the peak load, with full staffing all the time, and at high capital cost. Lean 3P thinking challenges us to utilize fewer resources, energy, materials, space, people, and equipment. It suggests we create four small cells capable of producing one-fourth of the demand, built for a total of one-fourth of the capital cost, and operating with a fraction of the labor, thus creating a four times multiplier on productivity per labor hour. The 4-¼-4 is a good starting point to set the bar high for the team. Other companies expect a 30% or better reduction in the price-to-earnings benefits of the project. In every case the one constant is a high expectation of tangible economic impact when using the 3P process.

Every project and every production operation have three common factors that influence their success: initial capital cost, ongoing cost, and time. Time seems to be the least variable factor, given that most products and new processes are desired sooner than practical and committed to later than they should have been. Time pressure is a significant factor in most projects. 3P results in quicker launches and shorter time to attain standard quality and standard costs for product coming off a new line.

Capital cost versus ongoing costs is a typical trade-off in projects. Higher automation should mean lower labor. More manual operations tend to cost less initially, but ongoing expenses will be higher. The trade-offs go much deeper, however. An automated line might require a more expensive software technician to troubleshoot it versus an operator or traditional mechanic. Manual lines may rely more on inspection by people versus machine intelligence and vision systems. In 3P the expectations and goals are set high and create a type of crisis within the team as they recognize that without very different thinking it will be impossible to be successful. To be clear, the changes proposed could represent additional risk through the addition of new technologies or processes, but they do not have to. Lean 3P often results in much simpler designs that can lower risk to the project and lower the ongoing costs to support and maintain the operation.

The goal of this book is to demonstrate the value of 3P and cover the key elements of the process so that the reader can begin applying it immediately. It focuses on the practical application of 3P so that you can use it to make the design of new products and operations highly effective. You will see how the 3P Production Preparation Process hears the "voice of the customer," engages all of the stakeholders involved in the product or process, and not only helps avoid poor designs but indeed fosters innovation, taking good designs and evolving them to great. Finally, we recognize that every project and design will be unique. We spend some time developing "why" 3P works so that over time you are able to successfully adjust the process to match your own needs and company culture, while pointing out some simple-to-follow methodologies that are proven to work.

Chapter 1

Lean 3P Design Concepts

What Is 3P?

Lean 3P is an integral element in Lean Product Development; however, it is not a holistic Lean Product Development process in and of itself. Depending on how it is applied, it can expand or contract to meet the needs of the organization either receiving input from other Lean Product Development elements or pushing outward into them.

If Lean can be defined as the engagement of people in the act of continually increasing value creation in our processes, then Lean Product Development must focus on that goal as related to the myriad of processes that take place as clever ideas are translated into successful products in the hands of happy customers. The focus of product development is largely about learning and then applying that knowledge to the targeted application. Market analysis, voice-of-the-customer, technology development, and even project planning and management are critical elements of product development and like all processes, they can be improved by applying Lean thinking.

Lean 3P should be inserted early in the Product Development process, as we'll explain later, and will be used to align all of the many vertical functions in our horizontal value stream, in order to optimize the new product concurrently with the operation that will produce it, in consideration of the people who will interact with it. Readers interested in a broader look at the full Lean Product Development process are encouraged to read *Lean Product and Process Development* (Ward 2009), or *Mastering Lean Product Development* (Mascitelli 2011).

The output of the product development process provides the recipe that sets the stage for a profitable value delivery system, which satisfies the needs of the targeted customer. The 3P (Production Preparation Process) process provides a collaborative and concurrent framework to link the product and process design. Most companies utilize new product development processes that treat product design and process design as independent and discrete entities. Integration of the two improves both and reduces the time and costs required to bring the product to market. Lean 3P is event-based team activity that employs a broad range of stakeholders from many different functional areas, including product design, process design, operations, procurement, and representatives from other internal groups. It could also include customers, suppliers, and outside experts.

If the product is in the early conceptual design stage, the 3P event will focus on understanding customer wants and will work to create numerous prototype models depicting different features that satisfy those wants and needs in different ways, using a rapid, iterative process to get feedback and direction. With every prototype, manufacturability is considered. As the product becomes more defined the balance shifts to design of the process, developing many alternatives for each functional step of the process. Changes to the product, including packaging, are considered as manufacturing alternatives and are evaluated before collapsing down to the better alternatives. Physical prototypes are created for the best alternatives, and every feature of the proposed new process is evaluated and compared. The tension between product design and process design continues throughout the event, and both are refined as the design concepts are tested, improved, and retested over and over again.

3P is a Lean design process that provides opportunity to achieve the lowest overall product life-cycle cost because it encourages innovation and collaboration with all of the key stakeholders very early in product development, utilizing all of the tools in the Lean toolkit. This in itself is atypical because Lean tends to be the approach we take to solve problems, not prevent them. Most of our Lean experience involves Kaizen efforts aimed at improving existing processes. In a very real sense, Lean 3P is no different. We are simply applying the same methodology to the design process. Perhaps the real difference is that we are applying the Kaizen discipline methodology to two processes, product design and process design, concurrently. By avoiding problems and pitfalls very early in the product development process, costs can be minimized, quality can be designed in, and many future headaches are avoided.

This is not intended to imply that new product and process development is simple. The fact is that both aspects of design are very complex and fraught with pitfalls. The people part of the equation is a third dimension that is often overlooked or discounted. The people element includes understanding what will really delight a customer. It also considers other groups who will interact with the product or operation. This includes people like the maintenance person who will be charged with keeping the new line going, and the operator, ensuring that he or she will be fully engaged in value-adding work while running the operation, and many more.

Caution: Lean 3P proactively employs the many elements of the Lean toolkit. To be successful the team must be well versed and experienced in Lean application.

Development of the 3P process is attributed to Chichiro Nakao, a former Toyota group manager and the founder of Shingijutsu Company, a Japanese consulting firm. The accepted meaning of 3P is *Production Preparation Process*. As more and more companies have begun to use 3P this definition seems to have become established. 3P allows a group of people to codevelop a product and the operation that will manufacture it in a way that adds value to both aspects—essentially a robust, well-thought-out production, preparation process.

3P is sometimes referred to as *Product, Process, People*, and this definition probably captures best the spirit of 3P. It focuses and attempts to optimize the collective design of the actual product and the production operation that will produce the product, with strong input from and consideration of the people who will interface with it from all the many different functional areas. Figure 1.1 represents the balance between product, process, and people that Lean 3P endeavors to attain.

The *Product* reference defines the necessary product attributes via analysis with deep understanding of the true functions and features that the customer desires, in conjunction with the impact on its overall manufacturability. We tend to think largely of functional benefits when considering a product, but the way it is packaged, displayed, and labeled can influence customer acceptance, and profitability. Developing a product this way could sound limiting and restrictive, but the process of collaboration and incorporation of other viewpoints should only make for a better product *and* a more profitable one.

Process looks at the means of physically moving materials, interactions of people, and producing product in a commercial operation by first