



Lean at Hardwood Lumber Inc.

Urs Buehlmann, Professor, Sustainable Biomaterials, Virginia Tech

Adrienne Andersch, Former Graduate Research Assistant, Sustainable Biomaterials, Virginia Tech

“I tend to forget how bad things used to be. I tend to forget how far we have come. I only see how far we still have to go because we are only scratching the surface of it.”

— Martin Palmer, general manager of Hardwood Lumber Inc.

As Martin Palmer, general manager of Hardwood Lumber Inc. — a subsidiary of Global Hardwood Inc. — returned to his office after the March 31, 2014 announcement of GHI’s acquisition by Hardwood Inc., he took a minute to retrace what had just happened. To him, there was something bittersweet about this acquisition, even if it represented progress.

During the last recession only six years ago, Jeff Huber, CEO of GHI, hired Palmer as the continuous improvement manager at the company’s subsidiary, Hardwood Lumber Inc. Due to the economic downturn in 2008, customer demand for hardwood products had sharply decreased, forcing hardwood manufacturers to tighten their operations, lay off employees, reduce shifts, or close businesses. Huber realized that in this environment, the company would have to go beyond such typical short-sighted measures for the company to survive. He set out to fundamentally change the way GHI operated, knowing that he needed to take bold action to ensure the survival of the company entrusted to him by its owners.

Huber had heard from business friends about the power of lean manufacturing to fundamentally change operations and employee mindsets while instilling discipline into a team, so he started exploring the promises of lean manufacturing. Huber now admits, “I didn’t know what lean manufacturing was all about, but I knew we needed some of it — or actually, a lot of it.” He took a leap of faith and hired Palmer, a lean expert, to start the company’s lean transformation.

Almost six years after Palmer started to implement lean manufacturing practices at Hardwood Lumber,

the results of his team’s efforts are visible throughout the plant, and the company’s results have improved greatly. Despite measurable improvements however, there are still gaps to be bridged, routines to be improved, and processes to be “leaned” before the transformation becomes self-sustaining.

After the announcement about GHI’s acquisition, Palmer’s mind reeled as he wondered what consequences the acquisition would cause. Will his lean efforts continue under the new ownership? Will the Hardwood Inc. leadership team take over key positions? Will the new leadership recognize the value of Hardwood Lumber’s lean system, and will they respect his team members and allow him to continue to grow strong and knowledgeable employees?

Palmer knows that lean manufacturing requires constant attention and a never-ending determination to keep the lean effort alive and thriving. Thus the years ahead look exciting but terrifying.

Industry Background – The U.S. Hardwood Sawmill Industry

In 2007, hardwoods accounted for approximately 43 percent of the 403 billion cubic feet of total growing stock of trees in the United States, 90 percent of which grows in the eastern part of the country (Smith et al. 2009). The U.S. hardwood sawmill industry is a highly fragmented industry that consists of mostly small, family-owned businesses. The approximately 1,300 hardwood sawmills located in the U.S. specialize in sawing dimension lumber, beams, bolts, poles,

shingles, siding, and other related products. They also produce byproducts such as bark and wood chips, sawdust, and bark slabs from logs (U.S. Census Bureau 2012). The vast majority of these hardwood sawmills employ fewer than 50 employees and cumulatively generate approximately \$5 billion in value of shipment annually (Manchester et al. 2009).

Customers of hardwood sawmill products come from many segments of the economy. Businesses such as manufacturers of furniture, flooring, millwork, and cabinets are examples of high-end customers that buy better quality material. Industrial users of hardwoods such as packaging, pallet, railroad tie, and mat timber manufacturers use lower quality material that results from the sawmilling process. Also, the export of U.S. hardwood lumber is critically important to the well-being of the industry because more than 20 percent of the total production volume is shipped abroad.

Historically, the U.S. construction-related industry segment accounted for at least 40 to 50 percent of U.S. hardwood consumption (Buehlmann and Schuler 2015). Starting in 2007, however, the U.S. hardwood industry was negatively impacted by the collapse of the U.S. housing market when housing starts fell from a peak of 2.3 million in 2006 to 550,000 in 2009 (Buehlmann, et al. 2010; Manchester et al. 2009). At the same time, increased competition from offshore producers and the increased use of nonwood substitutes worsened the situation. Thus, beginning in 2007, U.S. hardwood lumber consumption dropped precipitously due to the challenges of the U.S. housing market and

the ensuing financial meltdown culminating in the resulting global recession (table 1; fig. 1; Hardwood Market Report 2012, 2013, 2014a; Espinoza et al. 2011a, 2011b; Buehlmann et al. 2013, 2010).

By 2009 dramatic declines in hardwood lumber consumption were observed in the domestic furniture industry (down 75 percent), the molding and millwork industry (down 69 percent), flooring (down 67 percent), and cabinetry (down 56 percent). As weaknesses in residential and commercial construction-related markets accelerated through 2009, the industrial packaging and pallet industry, the railway ties industry, and mat timber producers became more important users of U.S. hardwoods and started to consume a larger percentage of the total hardwood lumber production. The industrial packaging and pallet industry experienced relatively moderate declines (down 21 percent) during the recession compared to the construction industries due to its noncyclical business and the wide range of customers. The railway ties and the mat timber industries even managed to grow slightly (up 4 percent).

Throughout most of the 20th century, hardwood sawmills in the U.S. produced primarily for the vast domestic market. However, when globalization expanded in the 1990s through the early 2000s, structural changes occurred in the hardwood industry value chain, especially for value-added products such as furniture, flooring, and millwork (Buehlmann and Schuler 2009; Schuler and Buehlmann 2003). Countries such as China and Vietnam experienced

Table 1. Consumption of U.S. hardwoods in board feet between 2005 and 2013.

Industry	Board feet (billions)									% change (2005-09)	% change (2009-13)
	2005	2006	2007	2008	2009	2010	2011	2012	2013		
Pallets	3.80	3.70	3.60	3.50	3.00	3.20	3.26	3.27	3.57	-21	+19
Furniture	1.20	1.10	1.00	0.70	0.30	0.35	0.29	0.30	0.37	-75	+23
Exports	1.30	1.30	1.20	0.90	0.80	1.07	1.20	1.32	1.44	-38	+80
Millwork	1.30	1.20	1.00	0.70	0.40	0.43	0.24	0.26	0.31	-69	-23
Cabinets	1.60	1.50	1.30	1.20	0.70	0.40	0.34	0.36	0.39	-56	-44
Flooring	1.50	1.40	1.30	0.80	0.50	0.59	0.51	0.55	0.64	-67	+28
Railway ties	0.85	0.96	0.92	0.94	0.89	0.89	0.98	1.04	1.00	+5	+12
Mat timber	N/A	N/A	N/A	0.20	0.05	0.08	0.12	0.16	0.25	N/A	+400
Total consumption¹	11.55	11.16	10.32	8.74	6.59	6.93	6.82	7.10	7.72	-43	+17

¹Total consumption does not include mat timber.

Source: Reprinted by permission from Hardwood Market Report (2014a).

aggressive economic growth, which considerably increased demand for U.S. hardwood lumber (Buehlmann and Schuler 2013; Luppold and Bumgardner 2013). Given China and Vietnam's comparative advantages in manufacturing, numerous U.S. furniture and flooring manufacturers outsourced their operations to these Asian countries (Buehlmann and Schuler 2013; Luppold and Bumgardner 2013; Buehlmann et al. 2007). As manufacturing moved offshore, hardwood log and lumber export markets grew dramatically (e.g., U.S. exports of hardwood lumber to China grew 759 percent between 1999 and 2006; fig. 1). By early 2006, however, the emerging worldwide economic recession negatively impacted exports and reduced hardwood lumber demand by 38 percent from 2005 to 2009 (table 1).

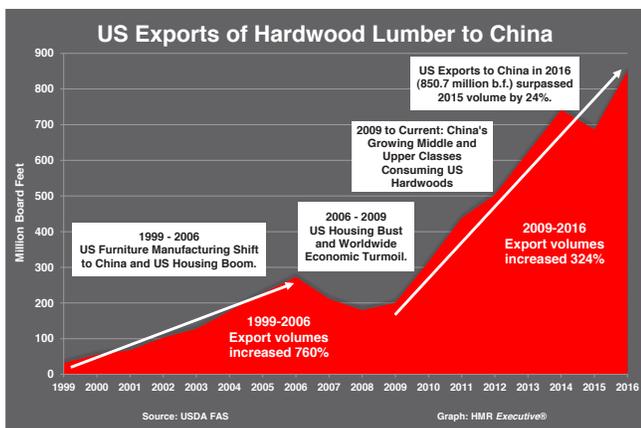


Figure 1. U.S. exports of hardwood lumber to China between 1999 and 2016.

Source: Reprinted by permission from *Hardwood Market Report (2017a)*.

The sudden decline in hardwood demand resulted in the accumulation of large hardwood lumber inventories (IBISWorld 2013), with corresponding reactions to hardwood lumber pricing. Between 2005 and 2009, prices for most hardwood species declined by 30 to 35 percent (fig. 2; Luppold and Bumgardner 2010; Johnson and Caldwell 2013). Landowners became more hesitant to sell timber due to low profit margins, causing supply shortages for hardwood sawmills (Hardwood Market Report 2012). In response to this sudden decline in demand for hardwood lumber during the recession and its prolonged recovery period, numerous hardwood sawmill businesses filed for bankruptcy and ultimately exited the industry because they were unable to

generate sufficient sales to cover operating expenses (Timber Harvesting & Wood Fiber Operations 2011; Damery, Yadav, and Zhao 2008). It was estimated that 25 to 35 percent of the total U.S. hardwood sawmill capacity would be permanently lost by 2012 (fig. 3; Hodges et al. 2011; Manchester et al. 2009).

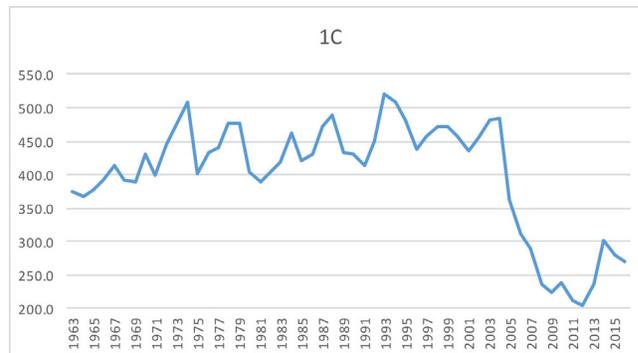


Figure 2. Composite price for green 4/4 No. 1 Common grade Appalachian hardwood lumber.

Source: Reprinted by permission from Luppold (2017).

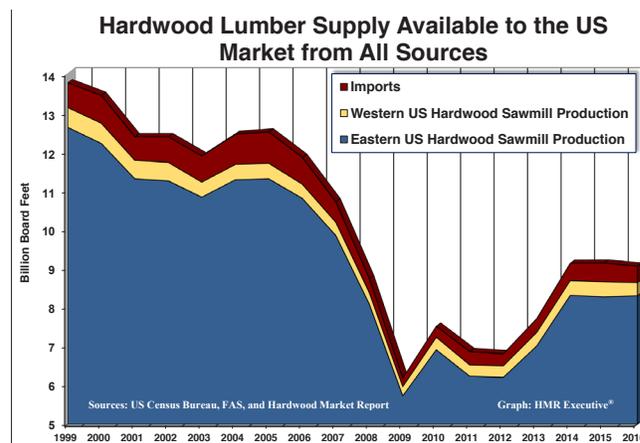


Figure 3. Hardwood lumber supply in the U.S. between 1999 and 2016.

Source: Reprinted by permission from *Hardwood Market Report (2017b)*.

Due to the economically challenging times, the remaining hardwood sawmills were forced to reduce their manufacturing capacity utilization from a high of approximately 81 percent in 1999 to 52 percent in 2009 (Manchester et al. 2009). As a result, the supply of hardwood lumber also decreased from nearly 14 billion board feet in 1999 to 8.6 billion board feet in 2008, a 39 percent decrease (fig. 3; Hardwood Market Report 2013).

By 2014, the U.S. economy had recovered slowly after the turbulence that started in 2007 with problems in the U.S. housing market (Hardwood Market Report 2014b). Capacity utilization for the industry has improved from its low point in 2009, and U.S. gross domestic product growth has been mostly in positive territory since the third quarter of 2009 (Hardwood Market Report 2014a). However, lackluster U.S. demand, especially housing demand, coupled with a slow job market, weak income growth, and high debt levels by households and public entities, pose continued challenges for the U.S. economy. Demand for U.S. housing, albeit gaining strength after the bust in 2007, remains well below the record levels set in 2006 and is considered below what is needed to match demand over the long term (Buehlmann and Schuler 2014; Irwin 2014).

In response to the challenging market conditions since 2007, the pace of industry consolidation and plant closures accelerated. Struggling businesses were either acquired by larger industry participants or were so financially weakened that they were forced out of business altogether. In some cases, smaller hardwood sawmills reinvested into the long-term viability of their operations, while some mid- to large-size hardwood sawmills in close geographic proximity combined into a “super regional entity with significant timber supply and production capabilities to increase market share through attrition and optimize cost structures to further enhance profitability” (Manchester et al. 2009, 11).

The Evolution of Hardwood Lumber Inc.

Daniel Thomas founded Hardwood Lumber Inc. in 1955 as a small, family-owned business in Richlands, Virginia. Fifty years later, the company consisted of two major divisions — a lumber division and a flooring division — that employed 390 full-time employees. The lumber division operated five sawmills in Damascus, Stickleyville, Emory, Austinville, and Franklin, Virginia, and procured hardwood lumber throughout Virginia and the surrounding states, while the flooring division was located at the headquarters in Richlands. By 2005, the company was Virginia’s leading manufacturer and supplier of hardwood lumber. At this time, approximately half of the company’s production (2,000 containers annually) went overseas with a heavy concentration on Asian and European markets.

In 2006, a New York-based private equity firm, Capital Inc., acquired and recapitalized Hardwood Lumber, preparing the company to grow further. Daniel Thomas, founder and CEO of Hardwood Lumber, said at that time, “There will be acquisition opportunities over the next few years, and we look forward to working with Capital Inc. to execute our expansion plans.”

Only one year later, Capital Inc. announced the simultaneous acquisition and recapitalization of Hardwood Investment Company Inc. (holding company for Lumber Manufacturing Inc., Town Lumber Inc., and Valley Hardwood Inc.) out of Midland, Michigan, and Industrial Hardwoods Manufacturing Inc. of Franklin, Virginia. Combining these new acquisitions with Hardwood Lumber’s operation created Global Hardwood Inc. — an umbrella organization of manufacturers of Appalachian and northern hardwood lumber, logs, and byproducts. Jeff Huber, CEO of GHI, acknowledged that by becoming a subsidiary of GHI, Hardwood Lumber was able to “more than double its revenues, upgrade its equipment, invest in business processes, develop new brands, and expand its international reach to establish the company as one of the leading exporters of U.S. hardwoods.”

By 2014, GHI had three subsidiaries — Hardwood Lumber Inc., Hardwood Investment Company Inc., and Industrial Hardwoods Manufacturing Inc. Thus, GHI owned 10 facilities in five states in the eastern U.S., and employed more than 500 full-time employees. Together, GHI’s sawmills generated more than 110 million board feet of hardwood lumber annually, while its pre-drying and kiln operations generated approximately 86 million board feet of hardwood lumber annually.

By 2014, Hardwood Lumber Inc. still consisted of two major divisions — lumber and flooring. The lumber division owns more than 50 million feet of standing timber with log yards in the Appalachian region, and it produces more than 60 million board feet of graded lumber at its six sawmills annually. Hardwood Lumber sells a wide variety of hardwood species (including red oak, white oak, poplar, ash, walnut, cherry, hickory, hard and soft maple, basswood, beech, elm, sap gum, and cypress) and grades (including Selects and Better, No. 1 Common, and No. 2 Common) to its North American and international customer base.

The company also sells hardwood chips and mulch as byproducts. The flooring division, founded in the 1990s, uses raw materials from GHI's sawmills and produces more than 10 million square feet of flooring annually.

Hardwood Lumber During the Great Recession

When Palmer joined GHI as continuous improvement specialist at its Hardwood Lumber Inc. division in 2009, external factors like the troubled global economy, the collapse of the U.S. housing market, and the resulting decline in demand for U.S. hardwood products, combined with the growing competition for unprocessed hardwood logs from international buyers, were throwing a relentless string of challenges at GHI. Throughout the first 50 years of Hardwood Lumber Inc., the company's way of doing business could be described as "trading lumber in a large market and making good money, but not investing much back into the business," admits Huber. This business mentality, coupled with command and control style management and limited communication across the company, was considered the traditional way of doing business for most hardwood sawmill businesses in the days before the great recession.

By 2009 after the third consecutive year of financial losses, Huber had considerable concerns that the company might not survive the recession. Sharply decreasing demand, the demise of suppliers and business partners, and limited access to additional financing forced Huber to examine the fault lines of the business. Given the global nature of the economic recession, Huber could blame the company's challenges and its financial stress on external factors, but instead he focused his search on causes closer to home. Huber realized that the recession and the volatile market conditions provided the company with a unique opportunity to uncover its own shortcomings, thereby offering opportunities to fundamentally improve its business models, processes, team behavior, and organizational structures. He chose to use the ongoing recession as the motivator to drive transformational change in the company.

Huber decided to recruit someone with a strong background in continuous improvement (i.e., lean manufacturing) to help him plan and lead the transformation he envisioned for Hardwood Lumber.

He was looking for a change agent proficient in value stream mapping and cycle time analysis to verify current and future production rates. The person would also have to be able to identify and target areas of improvement, work with production teams to advance the working environment, improve product throughput and quality, and most importantly, raise the level of awareness within his team for the principles of lean manufacturing and continuous improvement throughout the entire organization. That's when he was referred to Palmer by an associate. Palmer was searching for a new opportunity to use his experience gained as production manager at Slater Wood Products Inc. in Winchester, Virginia — a company that provided him with considerable insights on the cultural and managerial implications of lean manufacturing. In fact, Palmer considered the human implications to be more important than the actual tools or methodologies of lean.

Welcome to Hardwood Lumber

It was a beautiful day in March 2008 when Palmer started his job as director of continuous improvement at Hardwood Lumber. His first decision was to go on the "gemba," a Japanese term meaning "actual place" (i.e., to go and see the operation), to see where value was created and where waste occurred, and to get more familiar with the company's production processes. He was also interested in collecting insights from operators and other team members.

Hardwood Lumber's manufacturing process started with its logs being transported from the company's wood yards to its sawmill facilities, where the logs were stored in the mill's log yard for grading and sorting. Once the logs were ready to be processed, a moving conveyor chain carried them up a chute into the mill, where a debarker removed their bark before they reached the head saw. The debarker consisted of rough metal bars or knives that rub off or chip off the bark. Once the logs were debarked, they were moved onto a platform called a "carriage," where a band saw sawed boards from four sides of the logs, leaving a square called a "cant." Moving belts then carried the boards (also called "green lumber") to the edger — a set of circular saws. These saws trim the rough edges from each board and straighten its edges. Next, the edged boards went to the trimmer where the ends of the boards were cut square to specific lengths. The trimmer also cut out unusable sections

of the boards and sent the rough lumber to a moving belt where graders examined each board carefully and assigned a grade — a set of quality rules drafted, issued, and enforced by the National Hardwood Lumber Association (2011). Grade classes were assigned depending on the location, frequency, and size of defects in each board. Boards of the same grade were bundled together, which allowed buyers to make informed decisions as to the quality and suitability of a given volume of lumber they were buying. Graders — who inspected every board that passed on a conveyor belt in front of them for defects such as splits, knots, faulty edges, stains, or machining defects — marked each board with its pertinent grade information. Boards were then sorted according to grade, size, and species. Finally, as a last step in the sawmill value chain, offbearers physically pulled lumber from the moving conveyor coming from various lumber processing points and stacked the lumber in piles according to the information marked on the board by the graders. The stacked lumber was then moved to storage areas to be either sold as green lumber or to be dried to a specific moisture content by exposing the lumber to the open air environment for an extended period of time or by drying the lumber in dry kilns. Hardwood Lumber offered green, air-dried, and kiln-dried lumber to its customers.

During his gemba walk, Palmer realized that Hardwood Lumber's problems were larger than he thought when he accepted the job. He observed frequent machine breakdowns, and machine changeovers took hours instead of minutes. Problems were being patched just so the patch lasted long enough to no longer be that particular employee's problem: One shift handed over its problems to the next one without anybody ever trying to permanently solve issues. The resulting unpredictability of what was being produced when and by whom forced the team to run large batches of like products, creating an unnecessarily large inventory of possibly useable products. Constantly fighting fires wore Palmer's team members out; they were stressed and frustrated. Overall employee morale was low and deteriorating, contributing to poor product quality, frequent production problems, high absenteeism, and excessive employee turnover. Team members kept running out of spare parts, though the facility was cramped with parts — just not the ones needed. Moreover, because there was no measurement system in place, "no one knew what a good day was or what a bad day was,"

Palmer explained. In essence, nobody knew what was happening or what needed to happen when.

The Beginning of Hardwood Lumber's Lean Journey

After returning from the gemba, which included informal conversations with his manufacturing team, Palmer decided to start Hardwood Lumber's lean journey by instilling a lean way of thinking in all employees. According to Palmer's vision, the lean way of thinking meant that all members of his team were committed to highlighting problems instead of hiding them; teamwork was encouraged among employees, suppliers, and customers; and a culture of continuous improvement was developed.

Palmer knew that educating the company's management about the lean way would result in a shared understanding of a lean transformation and create management buy-in. His goal was to make company leaders aware of the potential that lean offers in terms of growth, profitability, and market penetration. Once this awareness existed, Palmer assumed, the leadership team would embrace lean principles, practices, and behavior as they realized how much they could gain from it. Supported by Huber, Palmer demanded that his top management colleagues actively participate in the lean transformation, promote the transformation, and lead by example. Palmer also started educating shop floor employees about lean in order to develop a common understanding and to foster a continuous improvement mentality for the transformation. He aimed to teach the varying levels of skills needed to support the transformation by having employees learn about lean principles — the central one being the focus on creating value for the customer. This relentless, never-ending pursuit of creating value for the customer is supported by a set of specialized tools such as value stream mapping, waste elimination, supermarkets, kanban, heijunka boxes, two-bin systems, replenishment cycles, and leveling of process steps.

Fortunately, by the time all employees concluded their basic lean training, top management decided to procure two new pieces of equipment. Palmer used the arrival of the new machines to create more lean awareness in his team and made their installation a lean pilot project. Before the machines arrived, the

first step in this pilot improvement event involved observing and documenting the current state of the company's processes. Palmer and his team made observations, collected the relevant data necessary, and mapped out the process, thereby creating a current state value stream map. Mapping out the sequence of processes not only allowed them to see where and how the new machines would fit but also provided them with a basic understanding of how material flows through the processes, where value is added, and where problems and bottlenecks are located. The team conducted brainstorming sessions and evaluated ideas, which were used to develop an ideal state map — a representation of the ideal, albeit unrealistic way the processes would be set up in an ideal world. Using the ideal state map, the team created the future state map, which represented the achievable, reorganized, improved value stream that included the new equipment.

Once the team agreed on the future state of the process, its implementation started. First, the team developed a new layout of the process for all existing and new machines involved. This allowed them to put the processes into proper sequence with minimal yet realistic buffers between them. Using the current state value stream map, they identified operational procedures that are wasteful (i.e., procedures that use resources but do not create value for the customer). They used this understanding to redesign individual processes such that little or no waste occurred and process steps could be executed without interruption. Improvements to expedite maintenance activities, such as labeling spare parts with color codes for different functions and hanging them on a shadow board located next to each machine to reduce the time to identify the correct part when needed, were also implemented. After the installation of the new equipment, the team used trial runs to perform time studies and balance the work content, and continuously improved the process's flow.

Hardwood Lumber — having been a traditional manufacturer until the arrival of Huber and Palmer — was used to manufacturing its products in large batches and then storing them in finished goods inventory facilities. This process minimized the need to change over their production processes from one product to another, and it was easier to cope with unforeseen events such as machine breakdowns or supply problems. Among the negative consequences

of this practice to run large batches are long lead times, high inventory costs, low quality, and low per-employee productivity. Therefore, Palmer and his team aimed to change Hardwood Lumber's production method from making lots of the same product in infrequent intervals to producing only what needed to be shipped the next day. However, as machine breakdowns and changeover time limitations still existed at Hardwood Lumber, the team — instead of adopting a one-piece flow production method — chose to implement a small-batch system based on the principle that every product is produced every day instead of infrequently in large batches.

The daily improvements made by Palmer and his team showed results after a short time. The team's hard work resulted in a more balanced and leveled production process enabling shorter lead times (down 47 percent), a smaller work-in-process inventory (down 53 percent), and an increase in per-employee productivity (up 29 percent). The more consistent, reliable flow of materials/products through the process also resulted in more consistent quality.

When Palmer was satisfied with the results of the team's efforts, he made sure the team members understood that they were successfully conducting "kaizen" (a Japanese word meaning "good change") events and helped them celebrate their accomplishments. Given the success supported by the enthusiasm displayed by believers of the lean way of manufacturing, additional kaizen events were scheduled and executed in short order. Most of these events focused on "5S" events — named for the first letter of five terms describing good workplace practices: sort, set in order, shine, standardize, and sustain. The 5S principles are used to ensure a work environment that is uncluttered (sort), organized and working properly (set in order), clean (shine), and standardized. The fifth S — sustain — ensures that the work environment stays uncluttered, organized, clean, and standardized (the fifth S sustains achievements from the first four S's). Other kaizen events that focused on visualization (making processes visible), error prevention, or team support for solving problems at the root cause were also conducted regularly. Each kaizen event conducted would also — as a standard operating procedure — involve the execution of mini 5S events to continuously improve the team's work environment. Kaizen events that focused on reducing changeover time (a lean technique known as "SMED"

— single minute exchange of dies) were conducted regularly to reduce the changeover time of the process lines when switching from one product to another. SMED kaizen events, conducted frequently in 2009, enabled the company to reduce its work in process and finished goods inventories, thereby freeing up cash and speeding up the changeover of their production lines from one product to another. The faster changeover time allowed for the more frequent production of different products in smaller batches and was a source of pride and improved morale for the employees.

Flooring

In 2010, the general manager of Hardwood Lumber’s flooring division retired and Palmer was promoted to the position. Becoming general manager of the flooring division allowed Palmer to rethink his lean transformation strategy by focusing on the door to door value stream of the facility (i.e., all the internal processes) and to extend his efforts to the company’s internal and external suppliers and customers (the extended value stream). Up to this point, Hardwood Lumber’s lean transformation efforts were conducted at individual facilities, making it a fragmented lean application. In fact, Hardwood Lumber’s flooring division was the only division at GHI that had a general manager who understood continuous improvement. To make himself intimately familiar with the flooring manufacturing process, Palmer went on the gemba once more. Lean practices encourage all involved to “go see” in order to understand the actual situation (going on the gemba) and to base any decision and action on this firsthand knowledge. Then, together with his team, Palmer started to draw the current value stream map of the flooring division’s processes.

The flooring division relied on raw materials provided by GHI’s lumber operation. The lumber operation delivered 1-inch-thick hardwood lumber in random lengths and widths to the flooring division, where they were kiln-dried to the appropriate moisture content, a process that took 10 to 35 days, depending on the species. Then the kiln-dried hardwood lumber was “defected” — a term used to describe the cutting out of undesired characters (called “defects” by some) — from the rough lumber using a chop saw. Boards were then moved on to a double-sided planer where the machine planed each board on both the top and bottom faces to allow easier visibility of small defects

and to achieve uniform board thickness. Next the boards are moved to a gang rip saw where they were ripped lengthwise into edged strips of specified width, depending on product specifications. Each individual strip was marked with a pen to indicate cut lines for an optimizing saw that cuts out minor defective areas, thereby creating shorter, random-length pieces of flooring containing no defects. From the optimizing saw, the strips were graded, sorted, and stacked in a work-in-process inventory area. Next, individual strips were moved into a molder that cut a variety of profiles, including a tongue and groove along the edge of the strip to allow for the assembly of the floor. Throughout the process, the strips were randomly inspected for fit and quality. Inspected strips entered the end matcher — a machine that created the same profiles with a tongue and a groove as the molder did — along the edges at both ends of the strips. After that, the strips that were to be sold as unfinished flooring were graded by an experienced grader and sorted according to quality, then tallied to ensure consistent quantities in each pack before being packed into cardboard boxes and moved into the finished goods warehouse. Strips that were to be sold as pre-finished flooring (strips whose top has been sealed with stains and varnishes for protection and beauty) were moved into the finishing area for sanding followed by finishing. Throughout the finishing process, the strips were randomly inspected under natural light for any discrepancies. Lastly, the pre-finished flooring boards were nested together, placed into a cardboard box, and moved into the finished goods warehouse until pickup or delivery.

After Palmer completed the value stream map with his team, he realized that the amount of waste embedded in the process was much larger than expected. One reason for the flooring division’s large amount of wasted time, material, and products was that processes were segmented into clearly separated, individual compartments, each one working on large batches of material with stacks of inventory between each compartment. As Palmer walked the gemba, he realized the inappropriateness of this compartmentalization: There were long distances between machines, clutter from inventory and unused materials, an ineffective use of space, time-consuming transportation between processes, and a general lack of standards to execute individual tasks. Also, due to the large batches of material that were typically processed by the flooring division at the time, large amounts of

flooring products were produced in excess of demand, creating excess finished goods inventory and adding greatly to the cost of doing business. Palmer also realized that while the company was producing excess product for which there was no demand, the capacity needed to produce products in demand by paying customers was not available. Palmer also recognized that his employees were often underutilized, waiting for machines to complete their cycles, for raw material to arrive, or to have processed products moved. He noticed the missing safety devices on machines, the non-existence of personal protective equipment for his employees, and the arduous efforts of his team members who were bending and stretching to stack, unstack, and handle heavy materials.

Palmer's first efforts as a general manager were to rejuvenate what had been started already. Together with his new continuous improvement manager, he started continuous improvement events, conducted basic lean training for all employees, and conducted 5S, overall equipment effectiveness, total productive maintenance, and quality improvement events. Palmer and his team even developed an internal educational program for employees. Thanks to clear focus and hard work, the flooring division became the showcase of all the GHI divisions — not because everything was perfect, but because his team focused on continuously doing things better, one step at a time.

To encourage safety, for example, Palmer introduced a cash drawing each month the company experienced no recordable accidents (employees put their names in a hat and three employees won \$50 gift certificates). Every three months that the company went without a recordable accident, management catered lunch for the entire facility. Every year without a recordable safety event, employees received a jacket with the company's logo on it. This way, Hardwood Lumber improved its safety outcomes with limited costs. A new policy to protect internal whistleblowers (individuals who report a situation or event that poses a safety hazard) also helped improve safety outcomes and allowed managers to act proactively.

Generally, the focus of all improvement events is on making employees aware of their contributions to success while involving and engaging them in shaping a more effective, more efficient, and safer operation. When employees see their work environment change in a positive direction, it contributes to a

markedly better relationship between employee and management. And when mistrust is turned into the knowledge that everyone is in the same boat and each individual win is a win for everyone, making changes in the plant becomes easier and results improve.

Once trust was established between management and employees, Palmer knew that by creating an accurate measurement system, he could achieve a better allocation of his team's efforts on what needed to get done on a daily basis to achieve better results.

The team also invested heavily in the quality of the product and the processes needed to produce it. Palmer and his team developed a set of 20 attributes for lumber that needed to be measured and controlled throughout the flooring manufacturing process to guarantee the outcome, that is, the product's quality. These attributes included overall thickness, squareness, size of the tongue and groove, moisture content of the plank, the grade, square footage filled into each box, top coat thickness of the finish, shine of the finish, color conformance, and finish cure, among other things. These metrics were closely watched using statistical process control tools, and the results were discussed daily in the managers' meetings. Hardwood Lumber's flooring division managers also reviewed these attributes every Monday morning in their weekly production meeting to find trends and to respond early to problems. Changes to the measurement system are made as frequently as needed.

After three years of relentless efforts and thanks to a recovering business climate, Hardwood Lumber's flooring division started to see benefits from its unwavering investment in its team members, facilities, and equipment as profits recovered from dismal results of 2011 and 2012.

As an outcome of all the continuous improvement efforts that were undertaken, "We sold \$1.3 million of products from inventory, and we were able to reassign 20 full-time employees to other tasks in the company," Palmer said. "We probably cannot impress anyone with our machinery, but I believe our operations team is great considering the very slim budget we worked with."

Yet because there is always room to do better, Palmer asked his team to keep improving. His current focus is on increasing product quality to the point where the company's measurable quality performance is set by

the limitations of the division's equipment. Beyond that, Palmer envisions more continuous improvement efforts being undertaken throughout his operation and forming a culture that focuses on cost-effectiveness with more communication between the team members who collect the data and the team members who run the processes.

Hardwood Lumber's Lean Business Mentality

With the continuous improvement activities of the flooring division being deployed with a focus on the company's internal processes, Palmer started to shift his attention to the external processes of the division — specifically to the division's suppliers and customers.

Focus on the Suppliers

In 2013 Palmer started to develop an internal signaling system — called a “kanban system” — to trigger actions based on actual events. In a kanban system, replenishment of materials and supplies is based on consumption. Thus, in theory, when a team member takes a stack of lumber from inventory for processing, another team member replenishes this stack by producing the equivalent amount of lumber taken. In other words, the kanban system pulls materials and supplies throughout the internal and external supply chain with the help of visual signals.

Hardwood Lumber's flooring division implemented a pilot program by inviting one of its external suppliers — a corrugated box manufacturer with no experience with lean, to join its lean journey. In essence, Palmer was extending the company's lean transformation efforts beyond its corporate boundaries. Hardwood Lumber provided some initial lean training for the corrugated box supplier and made efforts to develop a kanban system to trigger replenishment shipments from the supplier's facility. While not without challenges, they managed to put together a system that was easy to use and functioned reliably. In fact, the collaboration functioned so well that Hardwood Lumber's management immediately started working on extending the lean transformation efforts to other suppliers, and the company now collaborates with several of their suppliers on lean improvements.

Focus on the Customers

In 2010 when Palmer became general manager of Hardwood Lumber's flooring division, GHI was earning a profit companywide, which gave the company the opportunity to expand its business. GHI's outlook got even better the following year when lumber prices recovered thanks to an upturn in lumber demand, but higher lumber prices created enormous challenges for the flooring division. Within one year, prices for the lumber used by the flooring division increased by 48 percent, while the division had limited pricing flexibility on the sales side of the product. No amount of continuous improvement can possibly make up for such steep increases in materials costs in such a short time if material accounts for 75 percent of the division's total variable costs. However, the division's relentless continuous improvement efforts — especially its efforts to reduce batch sizes and finished goods inventory — allowed it to maximize, to the extent possible, the production of products that were still barely profitable.

Another challenge presented itself when the flooring division's main customer changed its senior management in 2012. This customer's new management team was focused primarily on price, making its flooring suppliers vulnerable. In response, the management of Hardwood Lumber's flooring division decided to expand its customer base.

“We identified companies we wanted to target, we inquired about their unique needs that we may be able to meet, and we started to do business with them,” Palmer explained. “It is amazing that three years ago we served only one customer that naturally had too much influence over us. Now we have a larger customer base that gives us some leeway to react to events when they happen. In fact, in about 10 months, we reduced our exposure to our main customer by 60 percent.” Palmer is understandably proud of his team's achievements.

With prices in the flooring business changing on a weekly basis, Hardwood Lumber's flooring division redefined its pricing policy as well. Since 2013, the company has only accepted orders based on the price at the time of shipment rather than at the time of the order. This allows the company to reduce its risks due to the volatile cost of purchasing raw materials.

The flooring division introduced a slate of new products to take advantage of its newly gained flexibility. Historically the flooring line had offered only pre-finished hardwood floors in a wide range of species (including red oak, white oak, hickory, ash, maple, cherry, and walnut), finish colors, and grades. Typically, customers of pre-finished flooring are do-it-yourselfers and small contractors. However, with the pronounced rise in raw material prices over the past years, selling pre-finished flooring wasn't profitable enough to achieve the division's financial goals. The company decided to look into the unfinished flooring business, which is more of a large-volume commodity business but still offers adequate margins. In 2013 the flooring division added an unfinished flooring line available in the same species as its pre-finished flooring — something made possible by the production facility's increased capacity and flexibility that was gained thanks to the continuous improvement efforts undertaken over the years.

Another outcome of the continuous improvement activities was the freed-up space and the underutilized resources in the facility, which allowed the company to introduce a new product line made from what was formerly considered scrap wood that was used for energy generation. These scrap pieces that result from the flooring production cutoffs are now used to make butcher-block countertops available in four species (white oak, maple, cherry, and walnut). The butcher-block countertop components are hand-selected and inspected and then assembled into panels before the block is sanded on the top and bottom and polished on its better side. Using scrap from the flooring production allows Hardwood Lumber to make a profitable product, which would not be viable if virgin lumber were used to make the blocks.

Due to the efforts that began in 2009 and despite many ups and downs, Hardwood Lumber's flooring division slowly became a cleaner, brighter, and more organized workplace and a more effective and efficient production facility. By 2014 Hardwood Lumber's flooring division was the showcase division for the entire GHI group of businesses. "Many people from our organization are brought here to see what they should be doing in their divisions," Palmer said.

GHI's top management also began bringing customers to Hardwood Lumber flooring for marketing and sales purposes. "We had a customer come in approximately

one year ago who gave us great compliments on what we have achieved. He said that this is one of the best flooring plants he had ever visited. When I asked what made him say that, he acknowledged that our employees were as passionate about the changes and improvements we made as I am," Palmer said. The customer started doing business with Hardwood Lumber's flooring division because he admired what the Hardwood Lumber flooring team had achieved.

Moving Forward

As a whole, Hardwood Lumber Inc. has undergone considerable changes during the past six years, including successfully launching its lean journey in the manufacturing arena and extending it to its business operations. The company's success was validated recently when Hardwood Inc. agreed to purchase the entire Global Hardwood company for an undisclosed sum. But for Hardwood Lumber's flooring division, this acquisition resulted in more questions than it answered: Will the company be able to continue its focus on continuous improvement under its new ownership? Will Martin Palmer be able to navigate his team through the combination of structural, cultural, and strategic challenges that are to come?

One thing is for sure: Martin Palmer started his job in interesting times back in 2008. However it never got dull and recent events have ensured that it never will.

Acknowledgements

The publication was based on work funded in part through a grant awarded by the Wood Education and Resource Center, Northeastern Area State and Private Forestry, USDA Forest Service; Virginia Cooperative Extension; and Virginia Tech. The authors would like to thank anonymous industry supporters for sharing their insights and for reviewing this manuscript. Also, the support of four unidentified reviewers is sincerely appreciated.

Disclaimer

All persons and companies referred to in this work are fictitious. Any resemblance to real companies or persons is purely coincidental.

References

- Buehlmann, Urs, Matthew Bumgardner, Al Schuler, and Mark Barford. 2007. "Assessing the Impacts of Global Competition on the Appalachian Hardwood Industry." *Forest Products Journal* 57 (3): 89-93.
- Buehlmann, Urs, Matt Bumgardner, Albert Schuler, and Karen Koenig. 2010. "Housing Market's Impact on the Secondary Woodworking Industry." *Wood & Wood Products* July: 21-29.
- Buehlmann, Urs, Omar Espinoza, Matthew Bumgardner, and Bob Smith. 2010. "Trends in the U.S. Hardwood Lumber Distribution Industry: Changing Products, Customers, and Services." *Forest Products Journal* 60 (6): 547-53.
- Buehlmann, Urs, and Al Schuler. 2009. "The U.S. Household Furniture Industry: Status and Opportunities." *Forest Products Journal* 59 (9): 20-28.
- . 2013. "November 2013 Housing Commentary." *Monthly Housing Update*. Blacksburg: Virginia Tech. <http://woodproducts.sbio.vt.edu/housing-report/casa-2013-11-november.pdf>.
- . 2014. "March 2014 Housing Commentary." *Monthly Housing Update*. Blacksburg: Virginia Tech. <http://woodproducts.sbio.vt.edu/housing-report/casa-2014-03-march.pdf>.
- . 2015. "January 2015 Housing Commentary." *Monthly Housing Update*. Blacksburg: Virginia Tech. <http://woodproducts.sbio.vt.edu/housing-report/casa-2015-01-january.pdf>.
- Damery, David, Lava Yadav, and Yuxi Zhao. 2008. *Finding and Removing Barriers to Sustainable Harvest and Primary Processing of Massachusetts Native Woods*. USDA Federal State Market Improvement Grant Report. Amherst: University of Massachusetts-Amherst. <http://bct.eco.umass.edu/wp-content/uploads/2009/04/barriers.pdf>.
- Espinoza, Omar, Urs Buehlmann, Matthew Bumgardner, and Bob Smith. 2011a. "Assessing Changes in the U.S. Hardwood Sawmill Industry With a Focus on Markets and Distribution." *BioResources* 6 (3): 2676-89.
- . 2011b. "Manufacturers and Distributors in the U.S. Hardwood Lumber Supply Chain: Perceptions of Industry Trends." In *Proceedings of the 3rd International Scientific Conference on Hardwood Processing*, edited by Urs Buehlmann, 125-34. Blacksburg, VA: ISCHP.
- Hardwood Market Report. 2012. "The North American Hardwood Marketplace 2012 Mid-Year Update." *HMR Executive* 6 (8): 1-6.
- . 2013. "Market Analysis for North American Hardwoods." Available at: http://www.nhla.com/assets/1603/combined_slides.pdf. Accessed on: April 6, 2014.
- . 2014a. "Wrapping Up the North American Marketplace for 2013 – Part I of II." *HMR Executive* 1 (8): 1-9.
- . 2014b. "Wrapping Up the North American Marketplace for 2013 – Part II of II." *HMR Executive* 2 (8): 1-7.
- . 2017a. "US exports of hardwood lumber to China." *Hardwood Market Report*. April 17, 2017.
- . 2017b. "Hardwood lumber supply available to the US market from all sources." *Hardwood Market Report*. April 17, 2017.
- Hodges, D. G., A. J. Hartsell, C. Brandeis, T. J. Brandeis, and J. W. Bentley. 2011. "Recession Effects on the Forests and Forest Products Industries of the South." *Forest Products Journal* 61 (8): 614-24.
- IBISWorld. 2013. "Sawmills & Wood Production in the U.S." NAICS 32111. *IBISWorld Industry Report*. www.ibisworld.com.
- Irwin, Neil. 2014. "Why the Housing Market Is Still Stalling the Economy." *New York Times*, April 24. www.nytimes.com/2014/04/27/upshot/the-housing-market-is-still-holding-back-the-economy-heres-why.html?_r=0.
- Johnson, Judd, and David Caldwell. 2013. "Market Analysis for North American Hardwoods." *Hardwood Market Report*. www.nhla.com/assets/1603/combined_slides.pdf.

- Luppold, William. 2017. "Composite price for green 4/4 #1C grade Appalachian hardwood lumber." U.S. Forest Service. Princeton, WV.
- Luppold, William, and Matthew S. Bumgardner. 2010. "An Analysis of Declines in Hardwood Lumber Price of the Past 40 Years." *HMR Executive* 4 (4): 1-7.
- . 2013. "Factors Influencing Changes in U.S. Hardwood Log and Lumber Exports From 1990 to 2011." *BioResources* 8 (2): 1615-24.
- Manchester, Bruce, Adrian West, Jason McGaugh, and James Tai. 2009. *The Hardwood Sawmill Market – A Time for Consolidation*. Costa Mesa, CA: McGladrey Capital Markets, Basic Industries Group.
- National Hardwood Lumber Association. 2011. *Rules for the Measurement & Inspection of Hardwood & Cypress*. Memphis, TN: NHLA. www.nhla.com/assets/1603/2011_rules_book.pdf.
- Schuler, Albert, and Urs Buehlmann. 2003. *Identifying Future Competitive Business Strategies for the U.S. Furniture Industry: Benchmarking and Paradigm Shifts*. USDA Forest Service, Northeastern Research Station, General Technical Report NE-304. Newton Square, PA: USDA Forest Service.
- Smith, W. Brad, Patrick D. Miles, Charles H. Perry, and Scott A. Pugh. 2009. *Forest Resources of the United States, 2007: A Technical Document Supporting the Forest Service 2010 RPA Assessment*. USDA Forest Service General Technical Report WO-78. Washington, DC: USDA Forest Service.
- Timber Harvesting & Wood Fiber Operations. 2011. "2011 Logging Business Survey: Big Squeeze." www.timberharvesting.com/2011-logging-business-survey-big-squeeze/.
- U.S. Census Bureau. 2012. Sawmill (NAICS 321113) Industry Definition. <https://www.census.gov/econ/isp/sampler.php?naicscode=321113&naicslevel=6#>.

