APPLYING LEAN HOME BUILDING PRACTICES BEYOND THE PLANT

FINAL REPORT

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ABSTRACT

The application of techniques from "lean production" to the sales and installation process of factory built homes was investigated and developed with the goal of proving that these techniques have the potential to dramatically reduce waste and improve housing quality, including energy efficiency. Lean techniques were implemented in partnership with Titan Homes, a producer of modular and manufactured homes in Sangerfield, NY, and a select group of their dealer customers. In partnership with these companies, researchers conducted value stream mapping exercises, lean training workshops and three rapid process improvement (RPI) efforts. The RPIs focused on the sales process, ship-loose materials configurations and installation efficiency improvements. Researchers conclude that there is great potential for using lean techniques to improve these processes; however, significant barriers exist to successful implementation. This report suggests strategies for overcoming these barriers and applying the lessons learned through this effort to other companies in the state, including factory and site builders.

KEY WORDS

Factory built homes, manufactured homes, modular homes, lean production, installation, sales process

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SUMMARY

Researchers worked with Titan Homes, a modular and manufactured home plant in New York, and three of its dealers to explore the potential of using lean techniques to improve the efficiency and quality of factory-built home sales and installation. The benefits of using lean in the housing factory were demonstrated by SBRA in prior research. The work presented here applied lean to activities that are less efficient than the factory building processes and offer greater potential for improvement, but are more difficult to change. Improving these activities can result in substantial cost savings, lead time reductions and quality improvements, but involve the coordinated actions of independent stakeholders with sometimes conflicting goals and fewer resources. The results provide a model for other companies in the factory- built home business and, to some extent, the site building community to emulate.

The primary goal in applying lean production methods to any process is to reduce waste of all types. Housing construction requires materials, energy, human effort, and other resources. In general, home construction is highly inefficient in its use of energy, labor, materials and time. The ability to wring out waste using lean methods can translate into lower costs, shorter lead times, greater durability and quality and reduced energy use.

To achieve these goals, researchers conducted a series of traditional lean activities including: value stream mapping to document and analyze the home installation process; a lean workshop to educate the dealers on the basics of lean production theory applied to factory built home sales and installation and three rapid process improvement (RPI) events to initiate the change to new modes of operation to eliminate waste.

RESULTS

Value stream mapping focused on home installation and service. It helped the dealers to view their process holistically and better understand the impact of delays and inefficiencies. It also focused the group's subsequent work on portions of the sales and installation process with the greatest potential for positive impact. Looking at the entire sales process, from initial contact through final service, it is apparent that installation is only a small part of the overall home sales/completion cycle. The sales and financing process at the front end and the service process at the back end are major components of total cycle time. This guided the selection of the first RPI to the sales process.

The primary goals of the workshop were to identify opportunities to eliminate waste and to generally explore how lean could be applied to the home sales and installation process. In one workshop exercise, dealers listed customer requirements/preferences, many of which related to the home sales process. The sales process represents a substantial portion of the cycle time and is a core dealer activity. The dealers felt that customer satisfaction with the sales process was the most important factor in their business success. Improving this process emerged as the top priority. Beyond the sales process, identifying examples of waste suggested opportunities to boost installation efficiency by improving the arrangement of loose items needed for installation shipped in the home and by making numerous other installation-related improvements.

Three RPIs were conducted to address opportunities identified during the workshop: sales process, ship-loose and installation efficiency. The sales process RPI covered the period from first contact with the customer to finalizing the order. This accounts for two-thirds of the total sales and installation time not including service. Because it directly involves the home buyer, it has a large impact on customer satisfaction. Errors at this stage here can lead to problems during installation. The existing sales process was documented to identify inefficiencies. A future state sales process was developed along with necessary implementation actions. An important theme in the future state process is an added sense of rigor and formality to ensure proper steps are followed to avoid miscommunication between customer, dealer and plant. Another key enhancement in the future state is a web-based pricing/order entry system that short circuits the existing error-prone and time consuming pricing and ordering process.

Ship loose materials are items that cannot be installed in the factory and are shipped with the home for installation in the field. The ship loose RPI resulted in guidelines for placing these materials in the home to minimize wasted time and motion by the installer and potential damage. The cost of implementing the recommendations is negligible, and the benefit is primarily the added convenience for the installer, resulting in faster work during the critical first day on the site when the goal is to get the home weather-tight and secure.

Recommendations to increase the efficiency of the installation process focused on simple design changes that can improve the constructability/installability of a design (safety, efficiency, quality including energy efficiency) and having the factory complete its work so that it simplifies the installer's work, thus improving overall building performance. Together, these recommendations have the potential to realize substantial savings per home. Cycle times could be reduced by speeding installation and more significantly by reducing the service period. The quality of design and construction will also improve, resulting in greater customer satisfaction and safety.

While researchers hoped to implement and evaluate all the RPI recommendations, this proved challenging in the deteriorating housing market environment. Some of the lower-cost recommendations were adopted, but others were deferred.

BARRIERS

One project goal was to identify and characterize barriers to implementing lean in this segment of the industry. Some fundamental barriers exist to reaping the benefits of lean, including:

- **Stability–**A process must first be stabilized before it can be streamlined. Even during good market periods, the flow of homes through a dealer is often uneven and highly varied in terms of design and foundation type. The current environment, with a severe drop off in sales, is particularly unstable.
- **Repetition–**Repetition of activities is important in order to analyze and modify processes and assess the impact of changes. Compared with factory production, sales and installation activities

- **Cross-organizational conflicts–**Many waste reduction actions require cooperation between plant, dealer and installer and may incur costs for one party (the plant) in order for others to realize savings (the dealer and/or installer).
- **First-cost mindset–**Buyers (dealers and their customers) are accustomed to focusing on first cost without factoring in the downstream benefits, often discouraging up-front investments in new methods and staff training.
- **Lean leadership–**The most likely person to take responsibility to facilitate the overall process is a manufacturer representative possessing experience with lean. Most dealers lack the staff and skills required to see a lean implementation through with the persistence and dedication required.

CONCLUSIONS

The research results yield valuable lessons for any company involved in home sales, installation or services, including site builders. As with home manufacturing, application of lean tools and techniques can dramatically improve the factory built home sales and installation, resulting in lower costs, greater quality and a better home buying experience. Through the course of this work, dozens of small changes were identified that can improve quality and lower cost with minimal investment. It was apparent that communication between plant and dealers related to common tasks could be improved.

Of even greater significance was the realization that there is a great opportunity to compress the sales cycle time and enhance the customer experience. This could be turned into a competitive advantage for factory-built housing and help the industry further leverage the promise of quick, customized, affordable, high quality homes. Another area ripe for lean improvement, but not addressed in this research, is service. Researchers noted, for example, that fixing relatively minor items sometimes required five or six visits over the course of three to six months. These two improvements—compressing the sales time and the service time, could halve the overall cycle time for factory built homes and lead to a much more satisfying customer experience.

1. INTRODUCTION

OBJECTIVE

This research builds on and is a logical and appropriate next step to earlier SRBA research that successfully applied lean production concepts in the housing factory.[1] This research extends the use of lean concepts beyond the housing factory to dramatically improve post-manufacturing activities that take place on the site and at the builder/dealer. These activities are generally considered to be far less efficient, offering substantial opportunities to trim costs, compress lead time and enhance quality. Nevertheless, they are also more resistant to change and improvement, since they involve the coordinated actions of otherwise independent stakeholders with conflicting goals and fewer resources. The results of this work directly benefited project partner Titan and its network of builder/dealers. Still the primary goal of this research was to demonstrate the potential of lean methods to improve the efficacy of building-related activities conducted jointly by the factory and dealer and the dealer and installer. By doing so, the results of this work provide a model for other factory builders and, to some extent, the site building community to emulate.

The primary goal in applying lean production methods is to reduce waste in all forms. Housing construction requires materials, human effort, time, energy and other resources. Even relatively efficient home building operations waste these resources. The ability to eliminate this waste using lean methods translates into lower building costs, greater durability and quality, shorter lead times and reduced energy use. Reducing material waste also benefits the environment because fewer resources are needed to construct the same housing products.

Specific project goals include:

- Extend implementation of lean production practices for factory building to the site in partnership with a leading factory builder and select builder/dealers;
- Reduce the use of energy in factory built homes by improving the design and installation of energy-related building elements, such as HVAC systems, envelope construction, air tight design and insulation;
- Produce and install homes with zero defects by boosting the efficiency and reliability of the on-site set and finish process and thereby lowering long term home operation and maintenance costs;[2]
- Eliminate waste on the site in all forms, including cycle times, building materials and labor utilization, partly through streamlining customer-factory communications;
- Establish through the use of lean methods a culture of continuous improvement within a network of builder/dealers;

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[1] Manufactured Housing Research Alliance, *Pilot Study: Applying Lean Principles to Factory Home Building*, U.S. Department of Housing and Urban Development, Affordable Housing Research and Technology Division, Washington, D.C., July, 2007.

[2] The potential for using lean concepts to improve the modular home installation and finish process was demonstrated by Michael A. Mullens and Mark E. Kelley, III in **Lean Homebuilding Using Modular Technology**, *Housing and Society,* Volume 31 No 1, 2004.

- Develop, test and disseminate lean techniques that eventually can be used to improve the construction of the majority of homes across the state, including site built homes.

Among other outcomes, the effort demonstrated how lean methods can be used to improve information flow between the home building plant and their dealers (design and customization, cost estimating, specification development, contracting, change orders, scheduling, production document preparation) and site construction activities (site work, foundation, setting the home, utilities, HVAC, finish work, etc.).

BACKGROUND

Lean production is a business process originally developed by Toyota that strives to eliminate all kinds of waste (time, money, materials, etc.) from manufacturing, construction or office operations, while developing a culture that strives for continuous improvement. Lean processes have long been used in other industries, notably automotive, to improve quality while reducing the overall cost of production. Still, lean is relatively new to home building.
The goal of lean production is to satisfy the customer by delivering the highest quality at the lowest cost in the shortest time, using less of everything. This is accomplished by continually eliminating waste in all forms: defects, overproduction, transportation, waiting, inventory, motion and processing. Originating with the Toyota Production System, lean production is the result of decades of development by automobile manufacturers, who have reduced average labor hours per vehicle by more than half, with one-third the defects. Other industries have followed the automobile industry's lead, achieving similar results. SBRA's ongoing work suggests similar opportunities for housing manufacturers.

Lean production focuses on the *value stream*. A value stream is the flow and transformation of materials and/or information from its raw state to the end user. There are two types of value streams: product flow and production flow. Product flow involves the development of a new product or service and is the flow from concept to launch. Production flow involves an existing product or service offering and is the flow from raw materials or information to the customer. Lean encourages the mapping of the material and information flow within these two value streams to identify the value-added and non-value-added steps and processes. Non-value-added steps are considered waste. After identifying the non-value-added waste in the value stream, a process of continuous improvement is established to eliminate that waste and improve safety, quality, and productivity while reducing cost. Improvement may be made on an ongoing gradual basis or via rapid process improvement (RPI) events.[3]
Specific lean techniques and tools that may be applied to the factory built home delivery system[4] include: pull systems; just-in-time materials delivery; continuous flow of materials, operations or information; rapid process

[3] RPI events are intensive workshops conducted over the course of a few days to a few weeks focused on developing and implementing solutions to previously identified problems and/or opportunities. Participants generally include a cross section of employees representing a wide range of points-of-view and experience.
[4] The term "home delivery system" and "home delivery process" as used in this report refers to the entire set of tasks that fall under the builder/dealer's responsibilities including: sales, design, project documentation,

improvement (RPI) events to solve quality and/or productivity issues; and value stream mapping to envision the entire product and information flow and identify improvement opportunities.

Speed is one of the primary advantages of factory building. Unfortunately, this benefit is diminished because pre-construction activities and site work typically extend project duration substantially. While about 80% of a home's value is created in the plant, only 10% to 30% of the cycle time is devoted to manufacturing. The remaining activities that precede production and then follow later at the site consume 70% to 90% of the time required to deliver the home—from commitment by the buyer to final closing.[5] One of the main precepts of lean production is that the compression of time across a process reduces many forms of waste by reducing the opportunity for that waste to occur (damage, redundant handling, errors, inventory costs, financing expense). This suggests a remarkable opportunity to improve the home delivery process, including the customer experience, by applying lean concepts to the elements of the process under the joint control of the plant and the builder/dealer.

Factory home building, particularly with the advent of lean manufacturing, is one of the most advanced methods of building. Over the last few years, major strides have been made nation-wide in improving factory building through the application of lean methods. For the past three years SBRA, with the support of NYSERDA and the US Department of Housing and Urban Development's PATH program, has worked to develop and introduce lean production to the factory home building industry, focusing on the activities that occur within the plant. This research piloted and evaluated lean techniques in ten plants across the country, including Chelsea Modular Homes in Marlboro, NY.

Still, completion of the home at the building site continues to rely on traditional approaches to construction methods of building that, when compared to factory building, are far slower, use resources far less efficiently and are subject to wide variation in the quality of workmanship. Although the advances propelled by lean have thus far been limited to the factory floor, this work builds on this success by expanding the use of lean methods to the building site; a major leap toward improving the efficiency of the overall home sales, construction and delivery process.

WORK PLAN

In this work, lean was applied in a manner similar to SBRA's successful earlier work with manufacturing plants. The main steps in applying lean are the same and include an orientation/training workshop for industry participants, value stream mapping of the key business processes and RPI events. The work focused on the portions of the value stream under the joint influence of the plant and the builder; that is, the part of the building process that follows plant manufacturing. The effort included recruiting builder/dealers; tapping their experience to map the value stream from initial sales contact to closing (focusing on information flow and site activities); assembling a group of

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coordinating with the manufacturer, facilitating lending, arranging home transport, hiring and managing installers/contractors (that perform site work, set and finish), and other customer services.

[5] The process of customizing a home design and preparing plans and specifications for production can take months, as can completing site work and finish activities on a factory-built home.

builder/dealers to evaluate and refine the value stream map and to identify and prioritize customer needs; conducting a series of RPI events based on priorities identified during the workshop; evaluating the results of the RPIs with the builder/dealers and plant; documenting results; and, disseminating lessons learned through a workshop open to all New York factory builders and their builder/dealers.

This report describes the work conducted and results. The material is presented in four sections; three of which describe lean activities conducted with Titan Homes and Titan dealers, and the fourth summarizing overall conclusions of the research. The sections are as follows:

1. **Value stream mapping (VSM)**. This exercise was undertaken to document the flow of value through the part of the building process under the control of the dealer using a representative cross section of dealer business types. VSM was used to help dealers visualize their businesses as a sequence of linked steps with the objective of adding value for their customers.
2. **Lean workshop**. A workshop was conducted to provide three dealers with the basics of lean production theory applied to factory built home sales and installation, and to learn from the dealers how lean concepts might potentially apply to their business practices.
3. **Rapid process improvement (RPI) events**. A number of RPI events were conducted to test the potential for this lean technique to effectuate improvements in the factory built home sales and installation process.
4. **Conclusions**. While the results of each of the three preceding sections stand alone in conveying the benefits of lean to factory built home sales and installation, they yield valuable lessons for any company involved in home sales, customer services and home completion, including site builders. This section describes the most significant of these findings and general observations about the benefits of and challenges of applying lean practices in the field.

2. VALUE STREAM MAPPING

Breaking down a business into a series of discrete steps and applying metrics to measure value added at each step is an effective way of understanding and analyzing its efficiency. Lean practitioners refer to this as value stream mapping, and it is often one of the first steps taken in an effort to understand and improve a business process. Specifically, to better understand the home installation process as practiced by manufactured home dealers, SBRA worked with Titan Homes and three of Titan's dealers to create cross-organizational value stream maps for shared operations (such as, home sales) and for those activities conducted at the site.

The resulting value stream maps document the way value is added at this stage of the home building process including the information flow and product flow associated with construction activities conducted at the site. The maps include estimates of relevant performance data such as duration, delays and resource requirements. Individual value stream maps were developed for each dealer, incorporating data from a cross section of their projects.

An SBRA researcher and the Titan Homes continuous improvement manager met with each of the dealers to introduce lean concepts, focusing on practical aspects relevant to home dealers. Each dealer provided information on its typical home installation process and other aspects of their business operations that enabled SBRA to develop the value stream maps. The value stream mapping exercise exposed differences in how dealers operate and began to reveal opportunities for improvement.

All three dealers are located in New York State and place the majority of the homes they sell within New York. They represent, a representative mix of Titan's customers and project types: high and low volume dealerships, complex and simple homes (e.g, hinged and non-hinge roofs; modular and HUD-code homes), extensive and limited site work, etc. The three dealers are as follows:

- **American Homes**, a large, multi-location retail operation based in Richfield Springs, NY
- **Hawkins Homes**, a mid-sized single location dealer located in Harpursville, NY
- **Geneva Homes**, a low-volume single location dealer and community owner based in Waterloo, NY

The three dealerships are described below along with the results of their VSM evaluations.

AMERICAN HOMES

American Homes is a retailer with eight locations in New York State. The Richfield Springs installation manager handles installation and service for three of those sales centers and one company-owned community. In 2008, he was responsible for the installation of approximately 180 homes. American Homes sets and trims out the home, using its own crews for exterior and interior work. Site work, including preparing the foundations, construction of

decks, and landscaping, etc and utility hook-up are performed by others, either contracted directly by the homebuyer or subcontracted by a general contractor. Their typical installation steps are as follows:

1. **Site inspection–**Conducted four to six weeks before home delivery.
2. **Delivery–**Homes are usually shipped direct from the plant, but occasionally are shipped from the dealer's lot. This is less desirable because it involves two delivery operations instead of one.
3. **Set–**American Homes' goal is to set the home no more than two weeks after delivery, preferably on the same day as delivery. After set, the home will be level on its piers or foundation, bolted together, tied down and weather-tight. In some cases the sewer lines and furnace vent may also be connected during this operation.
4. **Interior trim–**Interior trim may be applied before or after exterior trim, but it usually is not done at same time. It includes finishing the interior work, such as moldings and door adjustments, and making crossover connections. If exterior trim has already been completed, the interior trim crew does a pre-service walk-through with the customer upon completion to make adjustments and repairs possible with available parts.
5. **Exterior trim–**Exterior trim may be done before or after interior trim, but it usually is not done at same time. It includes exterior siding, trim and skirting. If interior trim has been completed, the exterior trim crew does a pre-service walk-through with the customer upon completion to make adjustments and repairs possible with available parts.
6. **Final inspection–**An American Homes' inspector conducts a walk-through with the customer to identify any problems and creates a punch-list of service items. If they agree the customer signs off on the list, indicating that it is comprehensive of all items needing work. Photographs are taken of the completed home to document delivery condition. The walk through is typically scheduled before move-in, but after utilities are connected. If service problems are found, follow up work includes the following:

    - Generate service order. The American Homes service manager divides the service items between the dealer and factory and makes a parts list for those items that are the responsibility of the dealer.
    - Perform service. The first factory service visit generally occurs within 14 days. The factory service personnel also make an average of three service visits to each house. The first dealer service generally happens within three weeks (parts may take a week to receive). Dealer service averages three visits per house to correct problems discovered on the initial punch list or others discovered after the homebuyer moves in. The dealer may make a courtesy visit to assure the homeowner that they have not been forgotten.

Figure 1 shows the current state VSM for a typical home installation. Each step in the process is shown as a box containing data about that step including crew size, lead time and cycle time (if relevant and available). The typical

range of delay times in days is shown in the large "D" between steps. Dashed lines with arrowheads represent information flow. Solid lines represent the flow of materials.

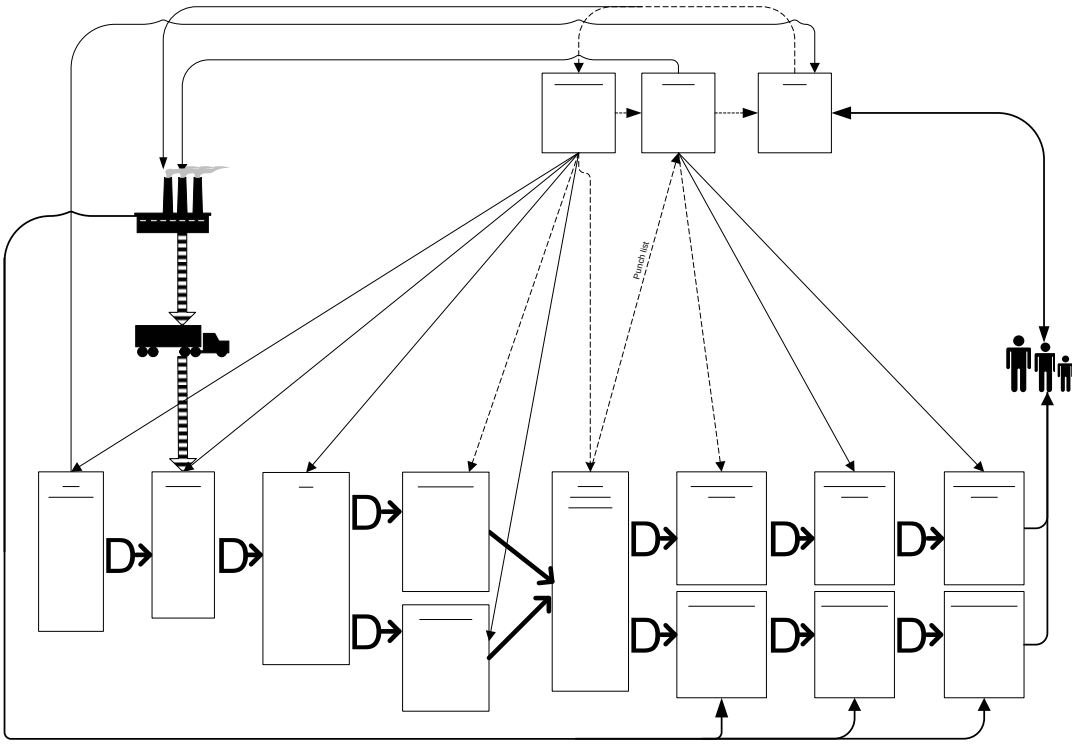

Figure 1 American Homes current state value stream map

American Homes' target cycle time from delivery to completion (i.e., ready for occupancy, but not necessarily all service items complete) is 30 days. The major obstacle in meeting this target is availability of skilled labor when needed. As a result, the schedule often has periods of no activity followed by times of intense workload.

The American Homes installation manager maintains a list of milestone dates for each house. He estimates cycle time for each activity taking into account crew ability, house type, travel distance and weather. An administrative assistant generates delivery and set schedules that are provided to the sales staff and through the sales staff to the customer. These schedules must be coordinated with the work of the owner's contractor to ensure that required activities are completed (e.g., foundation is completed before scheduled set date).

American Homes provided additional data on their 2008 home installations. The following histograms show the duration from home delivery to completion (Figure 2), from delivery to set (Figure 3), and from set to trim out (Figure 4 and Figure 5). Lead times between activities vary widely. While some homes are set, sided or trimmed just a few days after the previous activity, many homes wait far longer. The majority of homes are completed within American's 30-day target, but many take far longer, as much as 75 days after set. The data does not reveal how

much of this variation results from activities, such as site work and utility installation that are outside the control of American Homes. Setting aside these externalities, the data suggests that many homes have longer than required completion times (an indicator of waste in the process) and that the company's 30-day goal could be compressed.

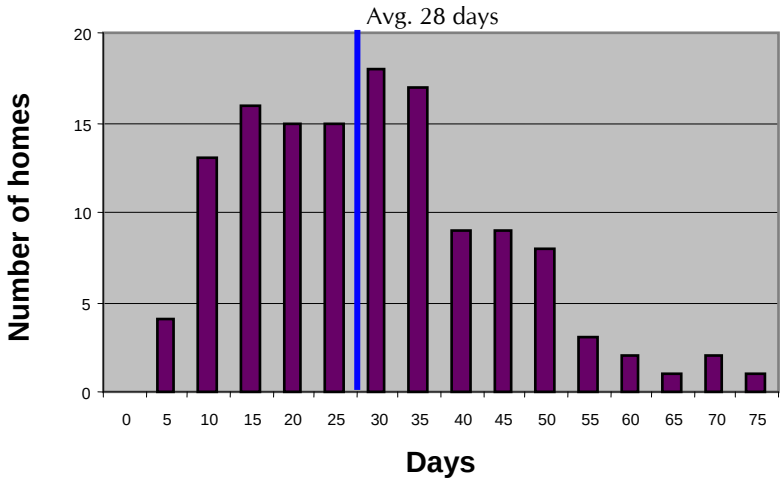

Figure 2 Duration from delivery to completion of all siding and trim-out

Longer completion times also open the door to quality issues and service calls. Only when set is complete is the home weather-tight and secure. Prior to completing set on a multi-module home, exposed marriage walls and roof elements are protected only by plastic sheeting. The home is not yet tied down or supported for long-term stability and is therefore vulnerable to shifting. Exposed components may be vulnerable to theft or vandalism. About half of American's homes are set within a week of delivery, but a significant number sit waiting up to three weeks or more (Figure 3).

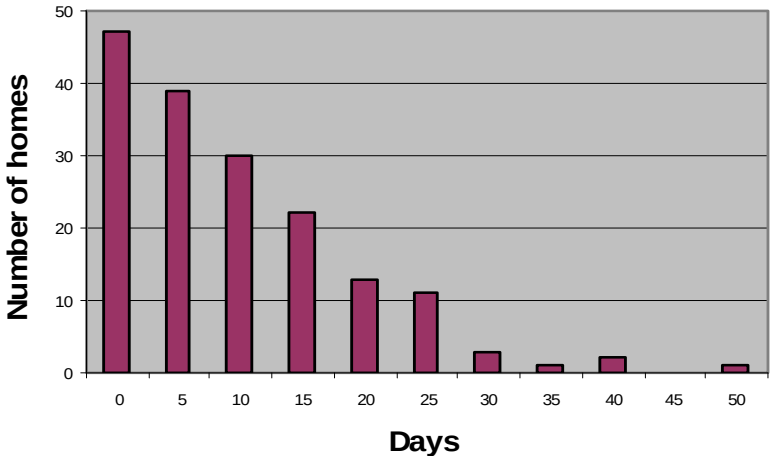

Figure 3 Duration from home delivery to start of set

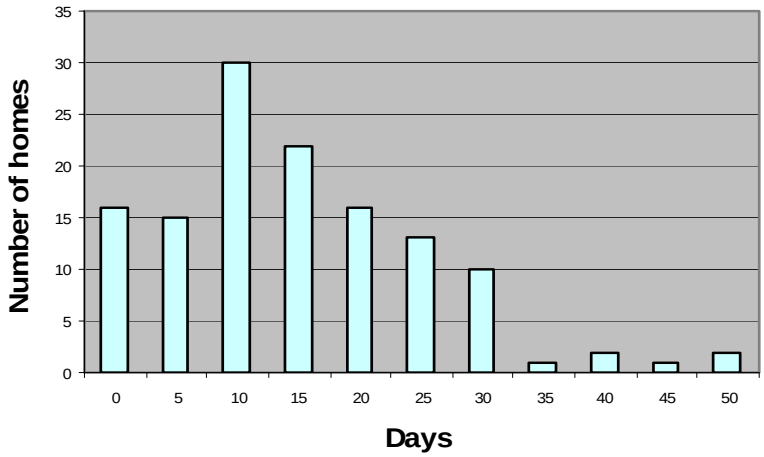

Figure 4 Duration from completion of set to siding completion

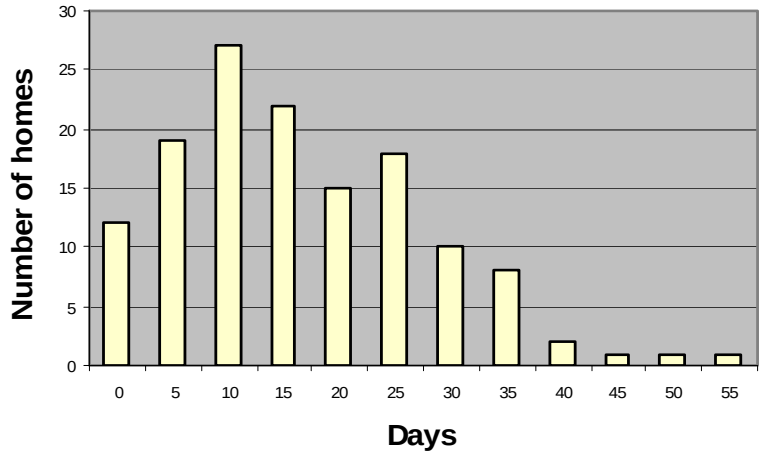

Figure 5 Duration from completion of set to start of interior trim-out

HAWKINS HOMES

Hawkins Homes completed about 85 installations in 2008. Sixty percent of these were manufactured homes (90% of which were multi-section) and 40% were modular homes. Of the modular homes, about five were two-story and the remaining one-story. Approximately 25 of the 85 homes were set on basements with the remaining on slabs. Hawkins does turnkey installations, conducting or arranging for 90 to 95% of all work required to complete the home including the foundation and utility connections. They primarily use their own separate crews for setting and trimming out the home. Hawkins Homes' typical installation steps are as follows:

1. **Site work.** This included excavation, grading, preparation for pouring the slab, installing drainage and the driveway.
2. **Foundation/slab construction.** For basements, Hawkins uses the proprietary Superior Wall system installed by an authorized subcontractor, for its speed and reliability. Hawkins uses another subcontractor to pour slabs for the slab-set homes.

3. **Basement slab.** The concrete subcontractor pours basement slabs before or after the home is set.
4. **Delivery.** Hawkins picks up the home at the factory using company trucks and drivers. They deliver the home to the site and "spot" it on site using a Remote Trax, a remote controlled tractor specially designed to install factory built homes.
5. **Set and weatherize.** Hawkins attempts to make the home weather-tight within one or two days following delivery, if weather allows. They level home on piers/foundation, connect water and sewer lines, and install tie-downs.
6. **Interior trim.** This includes moldings, drywall patches and repairs, and other interior fit-out items.
7. **Exterior trim.** This includes siding and trim boards. This step can precede interior trim.
8. **Walk-through.** A representative from Hawkins examines the home with the homeowner to identify any needed repairs.
9. **Post walk-through repairs.** Hawkins immediately completes repairs that can be done with the materials and parts available on site. Any repairs that cannot be completed immediately are put on a service list.
10. **Generate service request.** Hawkins asks the homeowner to live in the home for 30 days before sending in a service request list. Hawkins then divides this list into two parts, for the dealer and factory, based on responsibility.
11. **Service.** Hawkins typically makes two visits per house and the factory makes three. Hawkins does not have a dedicated service technician. Rather, trim crews stop at homes needing service when they are in the area. Factory service reps or factory service subcontractors make separate visits to the home to complete the items they are responsible for. During these visits, service staff sometimes identifies additional items needing repair. If they do not have the required parts, an additional visit must be made.

The typical time from home delivery to the walk-through (not including service) ranges from three to four weeks. Figure 6 shows the current state value stream map for a typical home installation.

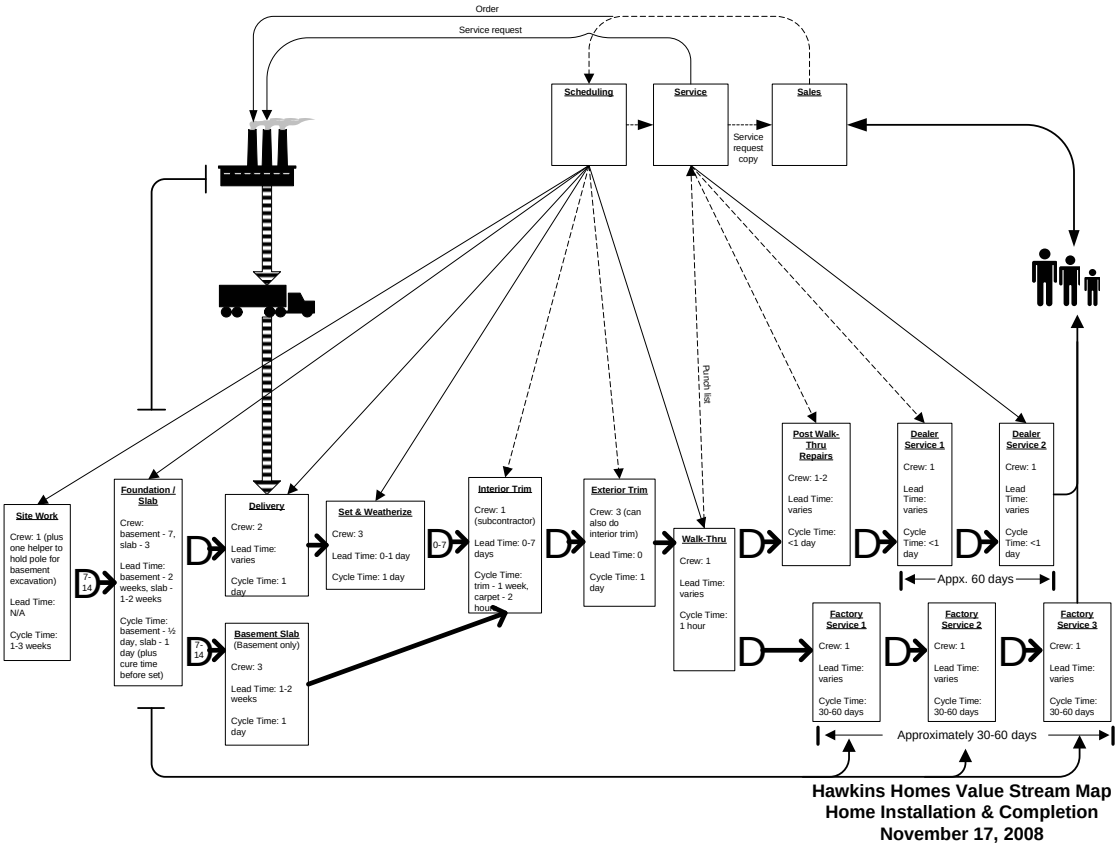

Figure 6 Hawkins Homes current state value stream map

GENEVA HOMES

Geneva Homes completed 27 homes in 2008. They manage or conduct all activities required to complete the home from site work to utilities. Most of their homes are single story ranches on concrete pads. They target completion of these simpler homes one to two weeks after delivery, working continuously from set to completion with a single crew. Geneva Homes' typical installation steps are as follows:

1. **Site analysis.** Geneva's site work subcontractor inspects the site and prepares an estimate for the work for inclusion as part of the sales proposal.
2. **Site work.** Geneva's site work subcontractor readies the site and foundation for the home set and coordinates all code inspections.
3. **Delivery.** A third-party transport company delivers the home modules, typically within two weeks of the slab being poured.
4. **Spot the home.** Geneva's crew locates the home on the slab (for basements, the modules are set in a staging area adjacent to the foundation) on the same day as delivery.

5. **Set.** Geneva's crew sets the home and makes it weather-tight. Geneva does this on the day following delivery for slab homes or, for crane-set homes, two days later to provide some leeway in crane scheduling in case the home is delayed.
6. **Trim.** Geneva begins trim work on the day after the home is made weather-tight. This includes siding gable ends, exterior trim and interior trim. Trim is generally completed on the second day after the home is made weather-tight. The site contractor returns to make final connections during this stage.
7. **Complete bottom set.** Work under the home is completed on the third day after the home is made weather-tight. This includes utility and service crossovers, marriage line piers and the dryer vent.
8. **Carpet seam.** The carpet subcontractor seams the carpet on the third day after the home is made weather-tight.
9. **Test and clean.** On the fourth day after the home is made weather-tight, Geneva energizes and tests all systems, and cleans the inside and outside of the home.
10. **Block wall.** A concrete block perimeter wall is completed by a subcontractor.
11. **Propane hook-up.** For propane fueled homes only, the propane company delivers and connects the propane service.
12. **Inspections.** This includes code officer inspection/tests, customer walk-through, generating a service punch list, instructing the homeowner on home operation and getting the homeowner to sign off on the punch list.
13. **Generate service list.** Geneva creates a service punch list that it divides by area of responsibility between their own crew and the factory.
14. **Service.** Geneva makes one to four service visits to each home. They attempt to make the first call within 4-to-6 weeks and to complete all service within 3-to-6 months. The factory makes one to three service visits. Many items are not easily noticed until after the home is lived in for a while. Most common service issues include problems with the plumbing system and doors not closing properly.

Figure 7 shows a current state value stream map for a typical home installation.

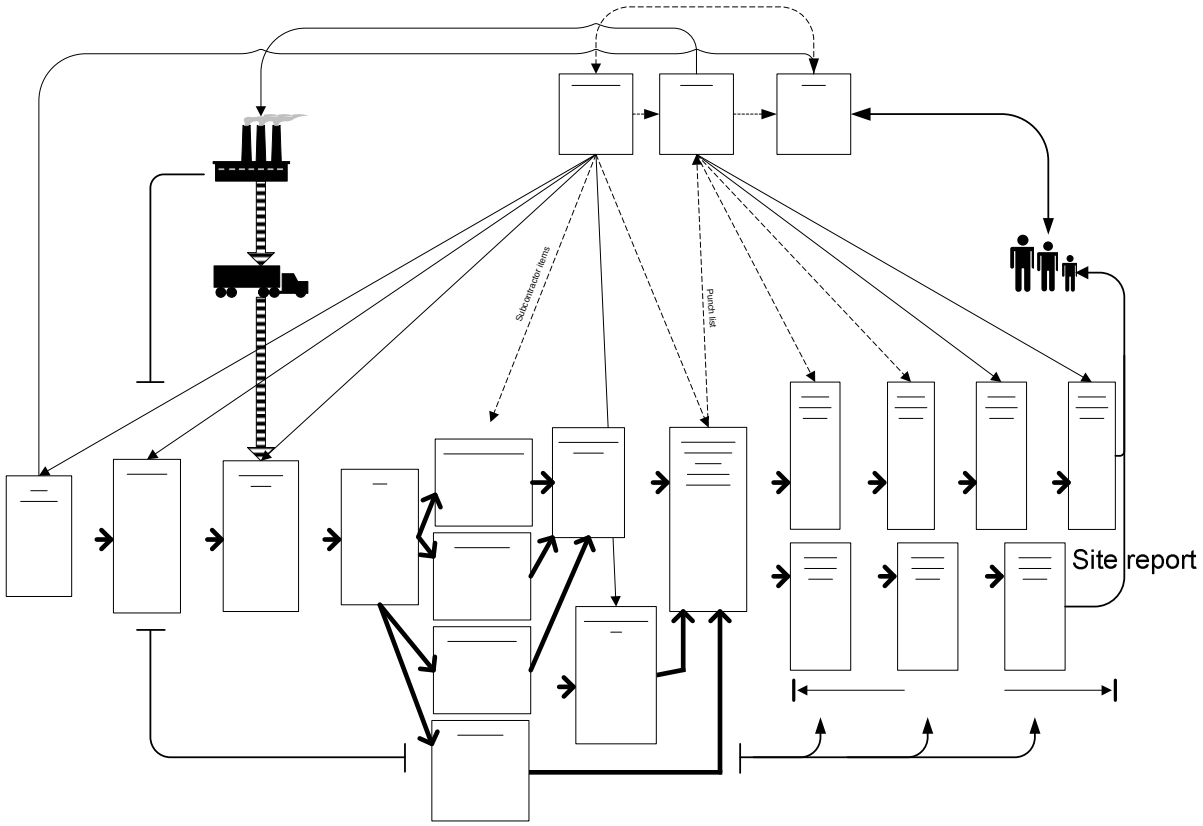

Figure 7 Geneva Homes current state value stream map

INTERPRETING THE VALUE STREAM MAPS

The value stream mapping effort revealed that even though the three dealers play the same general role in the factory-built home supply chain, their product lines, operating methods and performance differed markedly. These differences are summarized in Table 1. Geneva is the smallest operation with the simplest homes. Its small size and the simplicity of its product allow Geneva to use a single crew that performs or closely coordinates all site construction activities. The crew works continuously on a home from set through completion, allowing Geneva to deliver its homes fastest. At the other extreme, American has the highest volume with a moderate level of home complexity. To maintain its high volume, American relies most heavily on subcontractors, but uses its own specialized crews to set the home, trim the interior and finish the exterior. The need to schedule multiple internal crews and subcontractors over multiple homes inevitably results in delays and idle time, and American has the longest delivery time. Hawkins has moderate sales volume of the most complex product. It has adopted operating methods between the two extremes.

Site Analysis

Site work

Crew: 3

Delivery & Spot

Crew: 1 driver

Table 1 Descriptive summary of participating dealers

	Geneva Homes	Hawkins Homes	American Homes
Sales volume	Low	Medium	High
Home complexity	Low	High	Medium
Total cycle time	Low	Medium	High
Crew specialization	Low	Medium	High
Reliance on subcontractors	Low	Medium	High

Developing the value stream maps with the dealers enabled them to view their business process in a holistic, quantified manner as opposed to their normal focus on day-to-day issues. This 'big picture' perspective produced an important finding – installation is a relatively small part of the overall dealer sales process, which extends from initial contact with the homebuyer to completion of service after the home is delivered. Figure 8 shows that the sales and financing process at the front end and the service process at the back end are the major components of total cycle time. This finding provided focus for the group's subsequent activities, allowing dealers to concentrate on those issues that could have the greatest positive impact on their business.

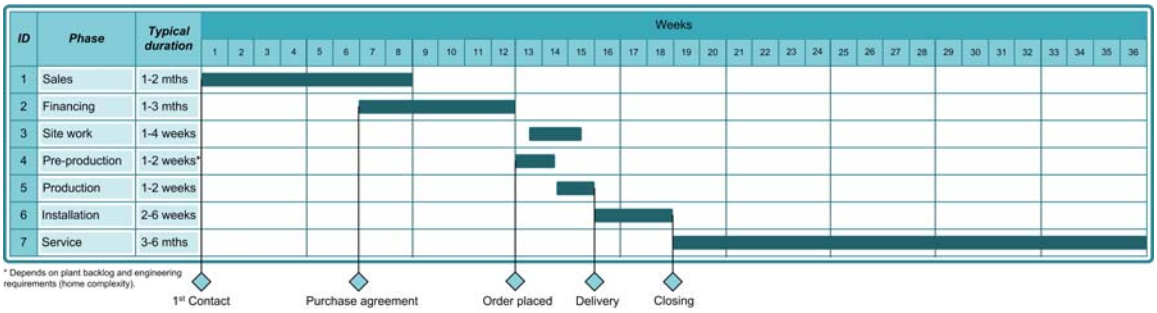

Figure 8 Typical home sales and installation schedule and milestones

3. DEALER WORKSHOP

A two-day dealer workshop was conducted by SBRA and Titan Homes. The purpose of the workshop was to identify customer (homebuyer) requirements and examples of waste in the home sales and installation process, and thereby begin to define potential process improvement activities. SBRA researchers began the workshop by introducing dealers to lean concepts that are applicable to factory built home installation. Topics included value stream mapping, listening to the customer, observation analysis, cycle time analysis, visual control, continuous flow pull systems, and specifying value from the standpoint of the customer. To identify customer requirements, researchers facilitated a brainstorming session with the dealers and Titan staff. Using their experience, the dealers spoke as the voice of the customer. The group identified, defined and ranked customer requirements. They also identified the relationships between customer needs and home delivery process activities. The output of this exercise was a prioritized list of potential improvement initiatives that could eventually become the basis for RPI events. The results of this exercise are shown in Table 2.

Table 2 Customer requirements exercise results

Customer goal	Metric
1. Value (size, features, quality) vs. cost	Installation cost
2. Quick move in	Total order to move-in cycle time
3. Understanding of the process	Customer satisfaction rating
4. One-stop shopping (dealer to perform most of work)	Portion of work done by dealer; number of subcontractors
5. Pampering	Customer satisfaction rating
6. A clean house upon move-in	Number of cleaning service calls
7. Speedy and accurate follow-up service	Time to repair
8. Clear lines of communication	Customer satisfaction rating
9. No defects or call backs	Number of defects
10. No third-party warranty issues	Number of issues

The exercise revealed that, while the customer is affected by the installation process, customer requirements extend beyond installation to the home sales process (Requirements 2, 3, 4, 5 and 8). As noted previously, the sales process consumes a substantial part of the overall sales/installation cycle and is a core retail center activity. As a result, the dealers concluded that customer satisfaction with the sales process was the most important factor in their business success and should be their top priority. This was true despite the very different characteristics and operating styles of the three dealers.

Next, the dealers reviewed the categories of waste and identified examples of waste in the factory built home installation process. Table 3 lists these examples of waste, potential solutions to these wastes and their priority based on significance and ease of implementation.

Table 3 Types of waste from the factory built home installation process

Waste	Potential solution	Priority
1. Excessive Inventory		
a. Too many homes built as specs or models	Only build to order	**Medium**
b. Leftover materials from site completion	Refine materials lists	**Medium**
c. Excess sewer parts (e.g., excess elbows)	Refine ship loose materials lists	**High**
2. Over Production		
a. Taking delivery of home before needed	Coordinate site work with home order	**Medium**
3. Excessive Conveyance		
a. Attic decking installation on site	Install attic decking in factory	**High**
b. Shipping home to dealer lot and then re-ship to site	Ship direct to site (most dealers do this now)	**Low**
c. End of month surge in production	Even out production over the month	**Medium**
d. Ship loose materials moving on site	Locate ship loose materials with care	**High**
e. Move refrigerator to install water line on site	Install refrigerator water line in plant	**High**
4. Unnecessary Movement		
a. Attic decking installation on site	Install attic decking in factory	**High**
b. Birdcage sheathing installation on site	Install sheathing in factory	**Medium**
c. Phone and cable jacks difficult to locate and not always in logical location	Install jacks in factory in common location	**High**
d. Dryer vent site installation for HUD units	Install in factory at uniform location	**High**
5. Correction		
a. Attic decking installation on site	Install attic decking in factory	**High**
b. Drywall crack repairs	Stiffen home to reduce cracking	**Medium**
c. Multiple trips for customer service	Have all needed materials on first trip	**Medium**
d. Stack installation at site	Install stack parts in plant	**Medium**
e. Misalignment of modules	Better tolerances in plant	**Medium**
f. Smoke detector problems	Better smoke detector	**High**
g. Deficient overall customer service process		**Medium**
h. Damage to floors and countertops lacking adequate plastic protection	Increase protective plastic covering	**High**
i. Confusion between dealer vs. factory service responsibility	Improve communication between dealer and plant	**Medium**
6. Delays		
a. Scheduling delays	Cross-train crews to perform multiple activities	**Medium**
b. Waiting for missing ship loose parts	Refine ship loose list	**Medium**
c. Waiting for replacements for defective parts	Inspect parts before shipment	**Medium**
d. Missing materials not available locally	Use locally available materials	**Medium**
e. Waiting for crane arrival and set up	Better coordination with crane operator	**Medium**
7. Materials		
a. Plastic wrap discarded on site	Alternative material or disposal method	**Medium**
b. Site waste and removal	Reduce packaging and excess material	**Medium**

Many opportunities were found to eliminate waste during the installation and service processes. These opportunities were divided into two categories: ship loose improvements (Items 1b, 1c, 3d, 7b, 7c, 7d) and other installation improvements (Items 3, 4a-d, 5a, 5d, 5h, 6a, 8a, 8b). These opportunities were addressed in separate RPIs described below. In addition to identifying potential RPIs to eliminate waste, Titan Homes got valuable and actionable input on its product from key dealers.

4. RAPID PROCESS IMPROVEMENT EVENTS

Rapid process improvement events (RPIs) are workshops that develop and implement changes to a business process to improve quality and/or productivity and reduce waste.

Participants include employees that perform the process as well as others across the company who can provide other perspectives. Participants are given the resources needed to effect the needed change, including time, funding and management support.

SBRA, with the support of Titan Homes, conducted RPIs with three Titan dealers. RPIs were selected to exploit opportunities identified during the value stream mapping exercise, the customer requirements assessment, and the identification of waste in the process. Improvements resulting from the RPIs were expected to be both measurable and repeatable. The dealers selected three RPIs that are at the nexus of factory building and retail sales/installation:

1. Streamlining the sales process: As noted earlier, the sales process consumes a substantial portion of the overall sales and installation cycle. The dealers also concluded that customer satisfaction with the sales process was essential to their business success. In addition, many of the examples of waste identified in the dealer workshop can be traced back to the sale process. This RPI is a major long-term effort with excellent potential for long-term benefits that can provide competitive advantage.
2. Improving ship loose materials configuration: This RPI developed protocols for placing ship loose materials within the units for transport and implemented a feedback loop to enable installers to better communicate with the plant to resolve issues related to ship loose items. Accuracy of ship loose items (the quantity of what is included) was expected to be good because Titan had previously focused on this in previous RPIs (historically missing items had been a common cause of problems at the site).
3. Facilitating installation efficiency: Many seemingly small inconveniences at the site could be eliminated by minor procedural changes in the plant. Taken together, these improvements offered the prospect of significant savings, and many could be implemented quickly with minimal cost.

The three RPIs required a cross-organizational process, with information exchanged between the plant, the dealer and the field. The sales process RPI, in particular, required intensive involvement of all parties. Dealing with the complexities of this issue and creating an action plan required developing detailed and fully articulated current and future state process diagrams. The ship loose and installation RPIs are more straightforward and the plant controls most of the actions that can benefit the dealers. These RPIs generated lists of recommendations for improvements.

The following sections provide a detailed description of the results of each RPI. It should be noted that measuring the impact of the RPIs was difficult since 1) The RPIs yielded a long list of improvements whose individual impacts are impractical or impossible to isolate, and 2) The changes are being slowly implemented and may take several years before their impact is fully manifest.

SALES PROCESS RPI

The home sales process RPI addressed all activities from first contact with the customer to finalizing the order. To cover the complete range of sales activities, the RPI focused on the sales process for manufactured and modular homes that were built to order (not sold from existing inventory). The dealers also believed that most of the opportunity for improvement lay in this scenario.

The sales process is a highly interconnected activity requiring frequent communication between the homebuyer and the dealer, and the dealer and the plant. It accounts for approximately two-thirds of the total sales and installation process cycle not including service. Because it directly involves the homebuyer, it has a large impact on customer satisfaction. Errors in the sales process can lead to problems during installation as well. The goal of this RPI was to increase accuracy (reduce errors), lower costs, shorten cycle time and improve customer satisfaction.

This RPI was conducted in two sessions, the first one at the Hawkins Homes sales center and the second at the Titan Homes plant. Staffs from Hawkins and Titan staff were present at both sessions. At the first session, participants addressed the sales process from the dealer's perspective. During the second session, participants addressed the sales process from the standpoint of the plant. In all other respects, however, a similar process was conducted during both sessions. The existing sales process was documented, identifying inefficiencies. Then, a future state sales process was developed along with necessary implementation actions, timeframe, responsibilities and evaluation criteria. The overarching goal was to identify opportunities to improve the sales and order process for homes sold through Titan's dealer network. While this process was described with Hawkins and Titan as the participants, it can be applied to the process linking any manufacturer and independent dealer.

Current state sales process

The current sales process is shown in Figure 9, it involves three main parties: the homebuyer (customer), the dealer and the plant. The process begins when the customer visits the dealer's sales center and makes initial contact with a salesperson. Ideally, the salesperson pre-qualifies the customer at the first meeting to make sure they are eligible for financing. Over the course of the next few days to few months the dealer and customer work together to select the home and options with price estimates based on dealer experience and listed prices. The dealer may also visit the site to estimate site work if that is within its scope of work. When they have settled on a home design and options, the dealer requests a quote from the plant. If the dealer has provided sufficient information, the plant provides a quote to the dealer for review with the customer. Any changes are communicated back to the plant. The process is iterative until the customer approves and signs off on the design. If the customer agrees to the purchase, they execute a purchase agreement with the dealer and then the dealer may assist them in obtaining financing. Once financing is in place, the home is ordered and scheduled for production. Any subsequent design changes due to customer requests are handled as change orders with the plant, if possible.

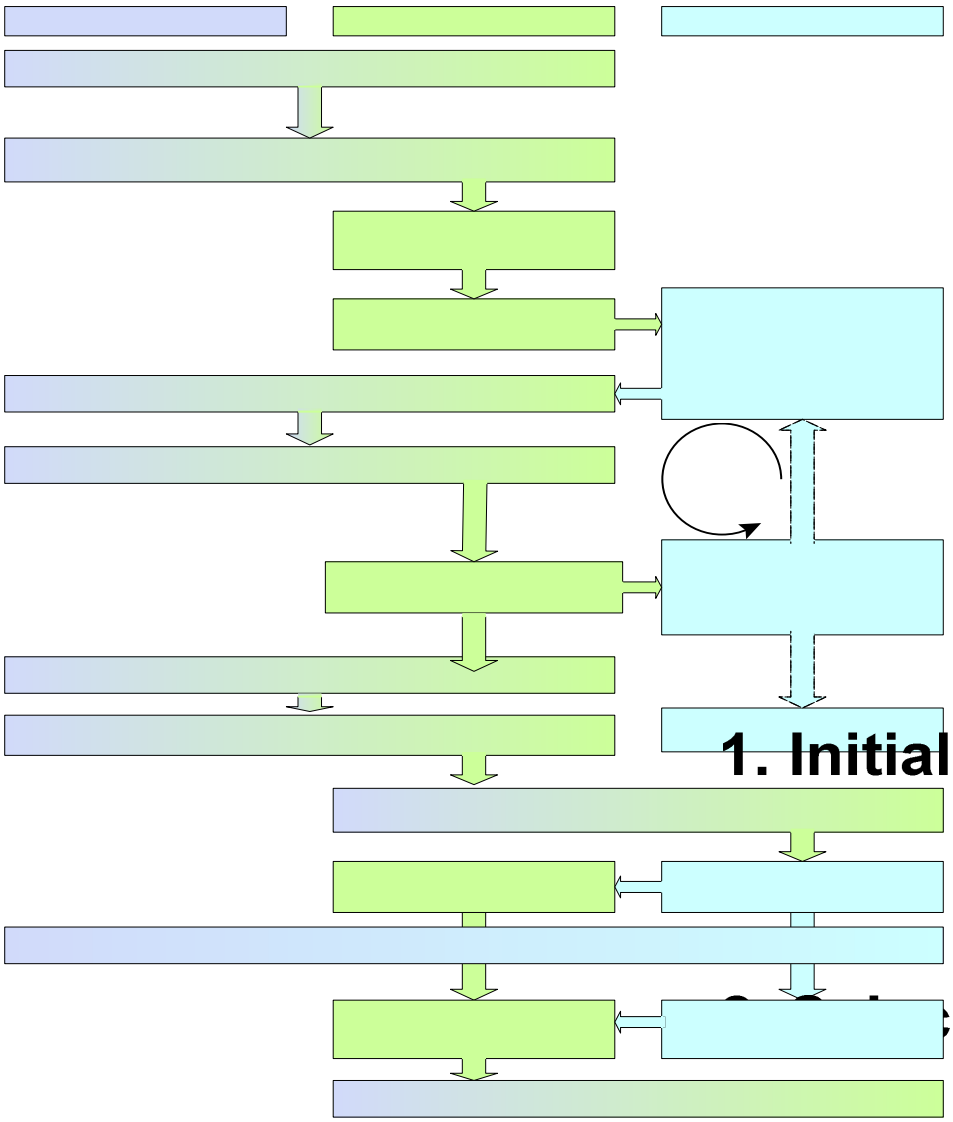

Figure 9 Current state sales process

Table 4 describes the current state sales process in more detail, as well as the main problems and improvement goals established by the RPI team for each step.

Table 4 Current state sales process details, problems and improvement goals

Current State Sales Process Step	Deficiency/ Improvement Goal	Cycle time
1. Initial contact a. Customer tours retail center model homes and speaks with salesperson b. Salesperson may or may not do credit application or pre-qualify the prospect	**Deficiency:** Sometimes salesperson does not run a credit application and wastes time with unqualified prospect. **Goal:** Avoid wasting time with prospects that would not qualify for financing by always running a credit application on initial contact. This ensures the prospect is a qualified buyer.	**1 hour**
2. Select home and options a. Select plan and choose options based on models, samples and drawings in literature b. Sometimes obtains financing approval	**Deficiency:** Lack of clear way of communicating design options to prospect. Time spent getting financing approval for prospect that the prospect can then use to shop around to other dealers. **Goals:** Have a comprehensive website showing options. Do not get financing approval until purchase agreement is signed (Step 11)	**1 day to 2 months**
3. Estimate site work a. Visit site b. Estimate site work costs	**Deficiency:** Site work estimating process inconsistent. **Goal:** Improve accuracy and reduce missed items by formalizing the site work estimating process.	**1 to 4 hours**
4. Determine home price Submit a Request for Quote (RFQ) to the plant or calculate price based using cost data book provided by the manufacturer. a. RFQ: Retailer submits an RFQ to the plant. Titan prefers that retailers use the Titan order form. Often each dealer (sometimes each salesperson) uses a different method and forms (email, fax, etc.). Some salespeople will submit request stating that the order is "like the previous order except …." b. Calculation: The salesperson starts with the wholesale base price from plant (includes fees and freight) and adds a profit margin amount based on home size and type. Each salesperson may prepare their own "retail" price sheet or may calculate it on the fly. The salesperson adds the option costs using the plant's wholesale price list or their own estimates based on experience. No mark-up is applied to options. For items not on the option price list, the salesperson calls the manufacturer to get the price.	**Deficiency:** The standard Titan order form is complicated. RFQs are often incomplete because dealers often use their own forms or none at all. When customer wishes are not accurately captured and conveyed to plant the first time, numerous 'change quote' and 'change orders' ensue. Each iteration increases total cycle time, reduces customer satisfaction, and increases the risk of losing the sale. Even if the customer places the order, each iteration increases the risk of an error on the home produced. The dealer may not have a Purchase Agreement with customer when RFQ is submitted. This could result in time wasted generating quotes if no purchase agreement is executed. **Goals, RFQ:** Improve training and supervision so salespeople follow intended quoting procedures. Dealers to obtain Purchase Agreement before asking the plant for a quote. **Deficiency:** Salespeople are often unable or unwilling to develop accurate price quotes on their own and resort to asking the plant for quotes. **Goals, calculation:** In the short term, enable salespeople to quickly and accurately quote prices with options by providing accurate, current and clear pricing information. Ensure salespeople are well-trained and use a formal RFQ form when necessary. In the longer term, restructure	**10 minutes to 2 hours**

Current State Sales Process Step	Deficiency/ Improvement Goal	Cycle time
	the sales process to explain all options available. Possibly add a mark-up to the options providing salespersons with an incentive to sell options.	
5. Prepare quote a. Plant sales person reviews RFQ, and if complete, enters data into quoting software. b. Manufacturer returns a price quote describing the home with options, colors and prices and sometimes a floor plan. Some plants also send a second copy without prices for presentation to the customer. If only a copy with pricing is sent, the salesperson redacts the pricing information before showing it to the customer.	**Deficiency:** Large backlog of RFQs or service requests reported by dealers may delay quote preparation. Zone manager time management may exacerbate this deficiency. **Goal:** Same day turnaround for quotes.	**10 to 30 minutes to prepare quote**
6. Schedule meeting with customer a. The salesperson calls the customer in to the sales center to review the order confirmation for accuracy	**Deficiency:** The salesperson may not review the quote prior to meeting with the customer, potentially wasting the customer's time and extending the approval process. **Goal:** Get the quote accurate before calling in the customer to reduce or eliminate unnecessary meetings.	**5 minutes**
7. Review quote a. Dealer and customer review the quote for accuracy b. If the quote is correct, dealer signs it and places the order once a purchase agreement and financing (if applicable) are in place c. If revisions are needed, the dealer corrects it on the quote and sends it back to the plant.	**Deficiency:** There are often dozens of line items in the order, many not understandable to the customer. Discrepancies get overlooked, especially when it is a missing item. Sometimes many revisions are required (five to ten revisions over a span of two to three weeks is not unusual). Revisions can mislead and irritate the customer. They must sign off on and take responsibility for each revision to the quote; it becomes more difficult to thoroughly review the quote with each revision. The time and aggravation of processing these changes increases the risk of losing the customer. **Goal:** As above, provide an accurate and timely quote.	**10 minutes (or until customer decides to place order)**
8. Revise quote (if necessary) or confirm a. Plant salesperson revises the quote and returns an amended confirmation to the dealer for reconfirmation. Five to ten revisions over a span of two to three weeks is not unusual b. Titan's computer system adds a revision number each time quote file is opened or modified.	**Deficiency:** Errors may propagate if the plant misses changes requested by the dealer or if the dealer and customer miss a change entered by Titan (in error or as a by-product of desired change). Excess revisions add to backlog of RFQs and may further delay quote preparation and revisions. Retail customer must sign off on and take responsibility for each revision to the quote (after a few revisions it becomes difficult to review the entire order thoroughly each time). Some dealers approve revisions without the retail customer's signature. Typically the customer never sees the final amended confirmation.	**up to 3 weeks**

Current State Sales Process Step	Deficiency/ Improvement Goal	Cycle time
	Goal: Eliminate need for corrections; ensure proper sign off when revisions are necessary	
9. Receive revision or confirmation a. The plant receives the revision or confirmation and logs it into the computer system. **b.** The plant issues a revised quote if necessary	**Deficiency:** N/A **Goal:** N/A	**10 to 30 minutes**
10. Follow-up on quote a. Zone manager follows-up on quote with dealer to determine whether the quote will be converted to an order.	**Deficiency:** Too few quotes become orders (i.e. sale is lost for unknown reasons) **Goal:** Increase the percentage of quotes that turn to orders	**10 to 30 minutes**
11. Execute purchase agreement a. Retailer and customer execute purchase agreement.	**Deficiency:** The plant would like the dealer to have a purchase agreement prior to spending time on generating quotes. The dealer too is spending time on a prospect that may never turn into a sale. **Goal:** Obtain purchase agreement prior to requesting plant for quote.	**less than 1 hour**
12. Secure financing approval a. Obtain financing approval from lender b. Close on loan	**Deficiency:** The dealer salesperson sometimes spends time getting financing approval too early in the sales process. **Goal:** Only get financing approval after purchase agreement is signed.	**up to 90 days**
13. Order home a. Once an accurate quote has been generated (Steps 4 through 9), the dealer places the order referencing that quote.	**Deficiency:** The dealer salesperson sometimes signs order with amendments rather than waiting for revised accurate quote. **Goals:** Accurately communicate what the customer wants and confirm accuracy by following set procedures: b. Always use the manufacturer's order form c. Provide order confirmations that are understandable to the customer and logically organized and formatted d. Only sign order confirmation when it is 100% correct. e. Provide the amended confirmation to the customer for approval and records.	**10 minutes if quote exists**

Current State Sales Process Step	Deficiency/ Improvement Goal	Cycle time
14. Complete engineering and schedule production a. Upon receipt of order , plant schedules home for production b. Plant generates engineering prints to send to dealer for foundation requirements and permits c. The production schedule may also be affected by availability of materials	**Deficiency:** Materials may be lacking. Titan does not have bills of materials by product and does not know the availability of all materials until orders are placed or even until the home is on the production line. Supplier inventories are typically low because they are all striving to operate on a just-in-time basis. The lack of an order backlog means that homes go on line immediately after they are ordered, leaving little time to obtain needed materials. As a result, many homes on the production line are incomplete because of missing materials and must be completed later off line. Although this can delay delivery, Titan reports this has not been a major issue. **Goal:** Obtain all required materials to avoid production delays and incomplete shipments	
15. Prepare site a. The dealer prepares the site for the home installation if within its scope of work.	**Deficiency:** Engineering prints needed for foundation construction are not always available in time. **Goal:** Provide engineering prints in time for foundation preparation.	
16. Process change orders a. Customer may verbally ask a salesperson to modify an order. Hawkins has no formal change order procedure b. The dealer submits changes to the plant via fax or email (no standard form exists) c. Titan changes the order and sends a change order confirmation to the dealer for signature d. Dealer signs (some dealers have the customer sign also) and returns the confirmation to Titan	**Deficiency:** Flaws in the change order process can lead to issues with the home. Sometimes customer change requests are not relayed to the manufacturer promptly, accurately or at all. Dealers often wish to make a verbal change order which can be misinterpreted or documented inaccurately, Titan may fail to make the change (or respond to a change order request) and the dealer may not follow-up. The change order may be submitted too late – after the home has passed the relevant production station. **Goal:** Establish a formal change order process for the dealer. Clearly and accurately communicate and confirm changes to the plant when possible via a formal change order process.	**5 minutes to typically 2 days**

Many of the most egregious problems associated with the sales process relate to pricing. The loss of contact with the customer between steps, such as while waiting for quote revisions and confirmations from the plant, gives the customer additional time to shop other dealers and to rethink their purchase. The customer is inconvenienced by having to review and approve the quote in a separate meeting or via phone/fax and again for each revision. Numerous back and forth communications between the dealer and plant increase the overall sales process cycle time. Often the salesperson is not thorough with the RFQ. They do not always use the factory form, leading to incomplete information. This leads to even more loops through this process, as clarifications and changes are made to align the order with customer intentions (five to ten iterations is common). The RPI participants identified customer pricing (Steps four through nine) as particularly in need of improvement. As a result, the most significant recommended change described in the future state is to develop a web-based pricing system.

To quantify the impact of these problems, Hawkins researched two years and identified problems in 36 out of 120 new homes sold (30%). These results are summarized in Table 5. These problems cost over $75,000 to repair, shared by Hawkins and the supplying factory. This represents a minimum estimate of the cost impact in that indirect costs such as the time required to resolve the issues is not included. Perhaps the greatest untracked cost is: the loss of customer satisfaction. In many cases, even where substantial costs were incurred to correct problems, the customer was still not happy because of the delay, inferior result, or simply because of the disappointment of having a problem with such a major and emotion-laden purchase as a new home. Where no direct cost is shown in the table, substantial indirect costs such as these may have been incurred.

Table 4 Problems with homes

Problem	Cost ($)[6]		Problem	Cost ($)	
	Dealer	Factory		Dealer	Factory
Foundation wrong size	12,000	8,000	Baker rack not usable	0	600
Siding, roofing, trim, doors wrong	12,000	0	Wrong kitchen hardware	0	500
No dormer, A/C, carpet	8,000	0	Pantry missing	0	500
Home vandalized in rest area	5,000	0	Furnace door, showerhead, faucet	0	500
Porch wrong configuration	0	7,000	No dishwasher hook up	0	300
Water damage to house	0	5,000	Ship loose kitchen drawers missing	0	200
Shingle color wrong	2,000	4,000	Cap shingle not match	0	0
Home should have been four-box unit	0	2,000	Unapproved slab by sub	0	0
House plan flipped wrong	0	1,800	Furnace undersized	0	0

[6] Where the cost is listed as 0, other non-monetary accommodations were made to the homebuyer or no accommodation was made and the homebuyer accepted the home as is.

Problem	Cost ($)[6]		Problem	Cost ($)	
	Dealer	Factory		Dealer	Factory
TV jacks installed improperly	0	1,500	Sink in utility room wrong type	0	0
Front door and trim wrong	0	1,200	Sliding door not installed	0	0
Home shipped without windows	0	1,000	Kitchen island installed too close to fridge	0	0
Factory changed porch design	1,500	0	Wall board in bathrooms	0	0
Awning over slider missing	500	0	Fireplace not in proper location	0	0
Total				**41,000**	**34,100**

After a discussion of the root causes of these problems, and the relationship of those causes to the sales process, the team concluded that much of the cause lay in choppy communications between Hawkins, the customer, and the plant throughout the process,:

- Order confirmation difficult to get accurate…
- Design options not properly confirmed and integrated into the base plan
- Options/change orders not implemented by the plant
- Factory design changes not communicated to the dealer
- Engineering drawings not accurate or missing
- Home shipped prematurely

These problems and goals shaped the development of the future state sales process described below.

Future State Sales Process

RPI participants discussed ways the sales process can be modified to achieve the desired goals described above. The result is the future state sales process summarized in Figure 10. A more detailed description of the future state process follows:

1. **Pre-Contact**

   - **Website**. Offer a website consistent with new product strategy focusing on small modular homes. Currently, Hawkins has its own website and a website hosted by Champion Enterprises, parent company of Titan Homes. Neither website is adequate. Ideally, Hawkins should have a website showing home offerings, including options, that allows customers to view and select options, and save a "wish list" with their preferred options. The website product presentation should reflect Hawkins' product focus on modular homes.

- **Sales models**. Provide a sales lot with appearance and focus driven by the new modular product strategy. Sell existing HUD models and replace with modular homes, with the eventual goal of showing six modular and two HUD homes.

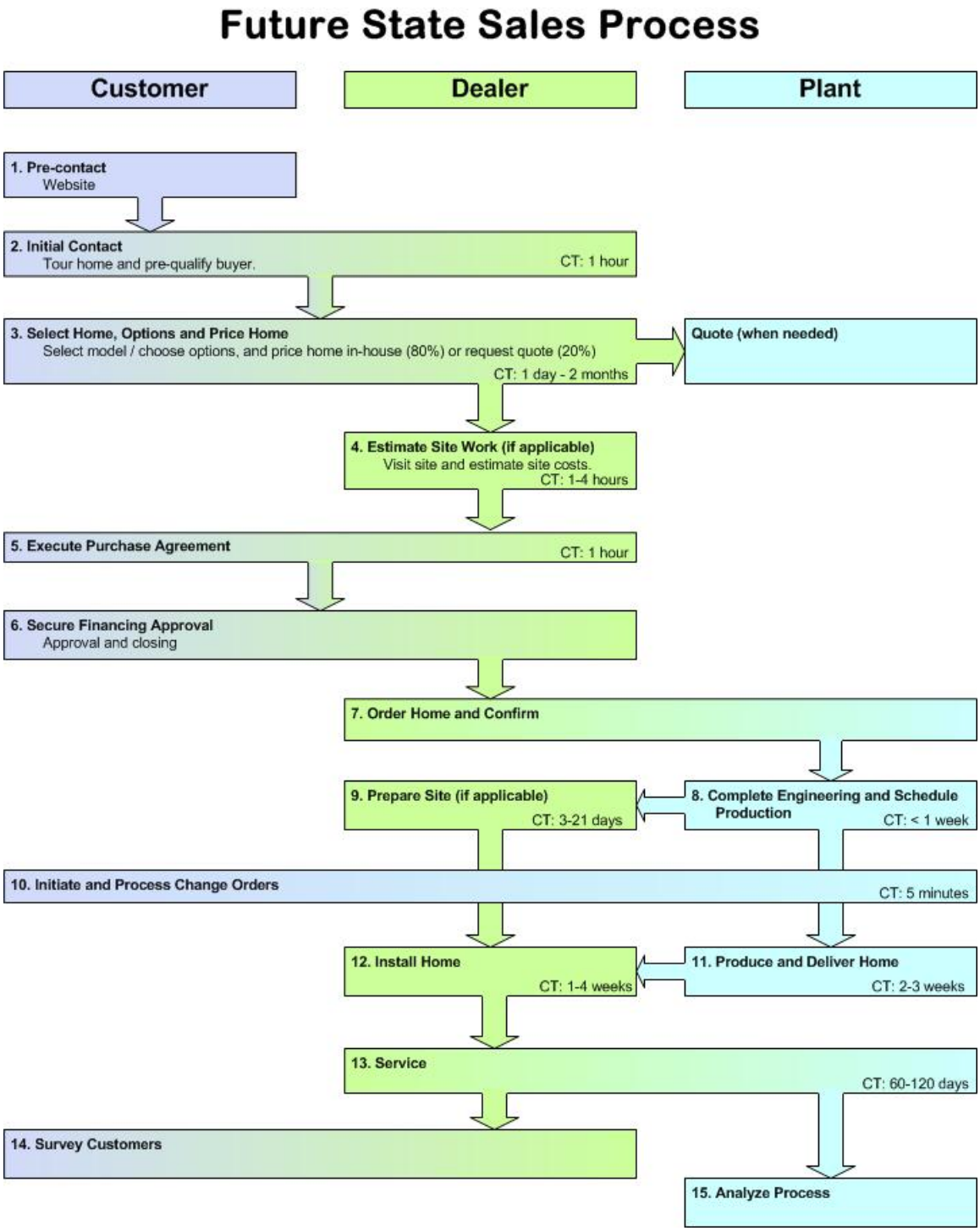

Figure 10 Future state sales process diagram

2. **Initial contact**
   - Assign customer to a dealer salesperson
   - Capture contact information for mailing list
   - Complete credit application to pre-qualify the customer
   - Introduce products to customer
   - Show the customer the design center to give an idea of the options available. A new design center should include products from all manufacturers offered by Hawkins.

3. **Select home with options and price home**
   - Provide product guidance to customer based on budget. Use a new model comparison matrix to explain differences between manufacturer model lines
   - Direct customers to new website with options to help them make selections
   - Use new options catalogs reflecting product focus on modular homes, along with the new design center and material samples to help the customer make selections
   - Price home and options to provide a pre-quote that the dealer can give to the customer at their first meeting. Use a pricing tool to develop exact price in-house (80% of homes). The pricing tool may be a well-maintained price book, an electronic spreadsheet, or a web-based tool.
     - **Price book.** Maintain the price book using a defined procedure. Plant to notify dealer a set number of days before price changes become effective and/or implement changes on a regularly scheduled basis to avoid surprises. Notification should include an explanation of the change, the effective date, and the new price and/or product information. There should be one person at the dealer responsible for updating all copies of the price book to whom the plant sends changes. This person should also ensure that salespeople know of the change.
     - **Electronic pricing worksheet**. In place of price books, use an Excel-based pricing spreadsheet into which the dealer salesperson can input base prices and an escalation factor for option mark-ups, if desired. It should have separate tabs for printing with and without prices. The dealer would enter quantity (number, square or linear foot) for applicable option prices. The option sequence would match the plant's order confirmation format. The dealer would e-mail the spreadsheet to the plant to confirm the quote and for ordering.
     - **Web system.** A more advanced pricing tool would be a web-based order form with pricing. Initially it would generate an e-mail with the order to the plant sales representative; in the future it may be directly linked to the plant's corporate computer system.

- Use a formal quote request process (approximately 20% of homes). Employ improved RFQ forms developed as simple Excel spreadsheets that can serve as input for the plant's computer system
- Notify the homebuyer of any pending price increase, and provide a written expiration date on price quotes to reduce the chances of the dealer having to absorb price increases.
- Possibly add mark-up to options. Decide whether to mark-up options and, if so, by how much.
- Train salespeople in product and pricing. Training of all dealer sales staff at an off-site location by manufacturer. Training to include product info, options, pricing, ordering and change order processes and materials (forms and books).
- Institute a 'Change Quote' Form to formalize the quote revision process.

4. Estimate site work

- Visit the site
- Identify and price any unusual set-up details
- Create a plot plan and site the house on it
- Price the site construction work using a formal process
- Conduct zoning/code research
- Take pictures and/or obtain aerial photographs to document the site

5. Execute purchase agreement

- Dealer sales staff to pre-qualify customers and try to execute a purchase agreement before submitting an RFQ to the plant. Assumes that a sound pricing tool is in place that can be used by the sales person in real time in collaboration with the homebuyer; and that the sales person is trained and uses the tool.
- Obtain down payment from customer
- Review terms and product (price increases after this point are absorbed by Hawkins)
- Outline expected schedule with customer

6. Secure financing approval

- Obtain financing approval from the bank
- Close on the loan

7. Order home and confirm

- Accurately communicate the homebuyer's order and confirm the order accuracy via a standardized ordering process as follows:
- Confirm and finalize specifications and option choices with customer

- Submit order to manufacturer via a standardized method, including diagrams if necessary. Order method may be one of the following:
    1. Plant order form faxed or e-mailed
    2. Revised plant form that aligns with the plant confirmation sheet - faxed or e-mailed
    3. Electronic version generated from pricing tool (see above)
- Receive confirmation including diagram if necessary
- Internally review the confirmation for accuracy
- Revise as necessary until 100% correct by marking up and returning to manufacturer unsigned
- When 100% correct, but not before, show to customer for review and signature
- If necessary, revise per customer change requests by marking up and returning to manufacturer unsigned
- When 100% correct according to customer and dealer, have customer sign, then sign by dealer salesperson and dealer sales manager
- Dealer administrative staff to review P.O. checklist (see below), and if acceptable, submit order and P.O. with delivery date request
- Use a P.O. system to place order:
    - P.O. number required for order
    - Checklist must be complete before issuing P.O. Checklist items include: purchase agreement signed, signed order confirmation (all signatures), construction estimate completed, closing on financing completed
- Throughout the ordering process, use a revision tracking system. Note latest revision number on client folder

8. Complete engineering and schedule production

- Plant to create and provide engineering drawings to dealer
- Schedule production

9. Prepare site

- Foundation design created based on engineering drawings
- Dealer (if turn-key) to file for and pull permits based on manufacturer prints and foundation engineering drawings
- Prepare site and foundation for home delivery

10. Initiate and process change orders

- Rigorously adhere to standard format and process to request order changes accurately:
    1. Submit change request on standard change request form

2. Receive and review the manufacturer's confirmation for accuracy
3. When 100% correct, show to customer for review and signature
4. Have formal review of original quote and each change with customer, and when 100% correct according to customer and dealer, have customer sign, then sign by dealer salesperson

- Follow up with plant if plant does not send a formal change order confirmation
- Throughout the ordering process, use a revision tracking system

11. Through 13. Produce, deliver, set, service

- Install the home

14. Customer feedback survey

- Steps 14 and 15, are added to gather feedback on the effectiveness of the sales process in an effort to initiate continuous improvement.
- Dealer to gather customer feedback as follows:
  - Call each customer six months after occupancy
  - Caller should not be a salesperson – ideally should be top manager (owner) at the dealer
  - Ask the homebuyer to rate on a scale of one (strongly disagree) to five (strongly agree) how much they agree with the following statements: I am satisfied with my new home; I was satisfied with my overall experience with the dealer; and, I would recommend the dealer to a friend or relative.
  - Ask for and document details if less than a rating of four for any question.
- Survey buyers from previous year for baseline and going forward
- Review/compile survey results
- Use results to guide continuous improvement of the sales process

15. Process efficiency analysis

- Identify process problems and problem dealers with pareto analysis by collecting and analyzing the following data:
  - Quotes vs. orders
  - Change quotes vs. orders
  - Change orders vs. orders (paper copies)
  - Cycle time from initial quote to accepted order
  - Customer satisfaction with dealer (from direct customer survey or data from dealer's feedback survey)
  - Service visits and expense

The future state sales process requires an accurate and instant pricing process, such as the web-based system described above. Such a system would require the dealer to enter complete information, relieve the Titan zone managers from making corrections to incomplete RFQs and eventually eliminate the zone manager's involvement in standard quotes altogether. It would benefit the dealer because there would be no loss of customer contact, more accurate communication with the customer and a shorter overall cycle time. The dealer and customer would spend less time on corrections and revisions. Another potential benefit is that the dealer and customer would be able to quickly explore many options of home features and prices during their first sitting without consulting the factory. This could eventually result in greater satisfaction and fewer change orders. If a web-based pricing tool were developed, it would have the following characteristics:

1. Dealer management would have access to customer data for tracking and follow up.
2. Customer data would be dealer specific (other dealers would not be able to see the data).
3. All data would be visible to the plant sales manager for review (the web tool may e-mail an RFQ to the plant salesperson as an interim step before eventually generating the quote automatically).
4. Ability to add a dealer mark-up on option prices. It should permit the dealer salespersons to choose their own mark-up and print a version without pricing for the customer.
5. Dealer would be able to save quote file and revise in future.
6. Dealer would be able to click on options to see description, picture and color choices.
7. The system should have a simple, intuitive interface. This would be critical to ensure that dealer salespeople use the system (i.e. check boxes for options rather than pull-down menus). It should not require extensive training.

Custom plans, which are increasingly common, would be a challenge for a web-based pricing tool. The dealer may be able to estimate a price based on square footage, number of bathrooms, and other home characteristics, but a firm price would likely require a quote from the factory.

Implementation

In late 2009 Champion Homes filed for bankruptcy protection. While Titan Homes continues to operate, this event effectively halted major efforts to implement the RPI recommendations. Most significantly, the web-based pricing and ordering system which had begun development at Champion's corporate offices was halted. Smaller scale changes, however, were implemented.

In 2009 Titan revised their product literature, combining all three product series (Pinnacle and Brentwood manufactured homes and Adirondack modular homes) in a single plan book with a model comparison chart in the back to clearly explain what features are standard with each series. This reduced the number of plan catalogs from three to one and clarified a source of confusion among dealers. Hawkins would still prefer a

single base product to which it could add options rather than sets of prepackaged options in the form of a product line series.

Hawkins Homes, continued to implement a number of the sales process RPI recommendations and has experienced dramatically reduced problems with homes (none since the changes began implementation) and reduced service costs by about two- thirds.

Pricing of homes is now done exclusively in-house, using a price book maintained by a designated administrative staff person. Requests for quotations from the plant are virtually eliminated. The price book lists the selling price and price per square foot of each Titan home model and their standard features. Once Hawkins executes a purchase agreement with the customer, Hawkins provides the customer with the option price list. Any options selected are then added to the purchase agreement. One of Hawkins selling points is that it provides options at their cost (they elected not to mark these up). Although not as convenient or flexible as a web-based system, Hawkins is able to complete a transaction in one sitting without involving the factory.

With the exception of one salesperson who insists on doing things his way, Hawkins is now delaying getting financing approval until the customer has signed a purchase order. One side effect is that the customer may not be approved for the full amount of the purchase agreement, in which case the customer has to look at lower cost options.

Hawkins has improved the rigor of its ordering process, insisting that the customer and the sales manager sign off on the plant's order confirmation without exception. They have found that familiarizing the customer with the confirmation from the start helps eliminate later errors. The sales manager's signature confirms that everything that is necessary to order the home including customer financing and the purchase agreement, has been completed. They feel that this system is sufficient and a P.O. system is not necessary. Likewise, Hawkins will not confirm a change order without receiving an accurate confirmation of the order from the factory.

One reason that service costs have been reduced is that the big ticket service items (such as the problems listed in Table 4) have been virtually eliminated. For example, Hawkins no longer picks up homes that are incomplete (due to material shortages). Titan no longer pushes Hawkins to accept incomplete homes , even if it negatively affects the plant's month-end books.
Hawkins has succeeded in shifting its sales lot presentation toward modular homes. In 2009 Hawkins had two modular homes in a total of ten models, and now have three modular homes in a total of six models and plan to add one more modular and one more HUD home for a total of four modular and four HUD homes. This will result in two more HUD models than envisioned in the future state, primarily due to the improved financing climate that has begun to emerge for HUD homes in 2010. Hawkins also dropped one of its three manufacturers itcarried, leaving just Titan and a higher-end modular plant.

It is difficult to gauge how much of the reduction in problems and service costs is attributable to these changes versus other market forces. During this time, the housing market experienced a drastic slowdown (Hawkins volume fell from eight million dollars in 2006 to two million in 2009). With fewer homes passing through the system, staff can spend more time checking each one, and material shortages at the plant are less likely. Nevertheless, these changes – particularly in-house pricing and a rigorous ordering system – position Hawkins to take advantage of the inevitable housing upturn.

The web-based pricing system remains a goal (albeit on hold for the moment). Such a system would reduce the continuing confusion regarding what features are standard with each product series and eliminate errors such as pricing and ordering an "option" on a home that already comes standard – a recent mistake that the current system does not prevent.

SHIP LOOSE RPI

Ship loose materials are uninstalled items provided with the home by the factory for use in setting up and trimming out the home. They may include interior and exterior trim, roofing and siding, and materials to connect the home to utilities. If not properly secured and handled, these items can be damaged or cause damage to the home during transport. Once on site, they may require time to locate and access and can be an obstruction for finish work, increasing the time needed to complete the home.

Earlier Titan lean improvement efforts developed a process to more accurately determine ship loose material quantities needed and to minimize the time required to load them into the home at the plant. The current RPI focused on the location of materials in the home and its effect on installation efficiency. Table 5 lists some examples of waste related to the quantity and location of ship loose materials on the home site.

Table 5 Waste examples related to ship loose materials

Type of Waste	Example for ship loose	Quantity RPI (previously completed)	Location RPI (new)
Defects	▪ Damage to ship loose materials		✓
Inventory	▪ Too many materials	✓	
Over processing	▪ N/A		
Waiting	▪ Delays because of lack of materials ▪ Delay while waiting for materials to be located/accessed	✓	✓
Conveyance	▪ Pick up, put down, repeat…		✓
Transportation	▪ Travel to get missing materials ▪ Travel to replace damaged materials	✓	✓
Over production	▪ Too much material	✓	

The goal of this RPI was to enable the plant to locate the ship loose materials in the home so that damage to the home and materials is avoided and efficiency of home installation is maximized. Specific goals for this RPI included:

- Needed materials can be quickly located by installers
- Needed materials can be accessed by installers without disturbing other materials
- Handling of ship loose materials during home installation is minimized
- Ship loose materials do not impede work on the home
- Neither the home nor ship loose materials are damaged during transport

To develop an understanding of the effect of ship loose materials, researchers observed the loading of materials in the plant and their handling and use on the building site. Researchers also interviewed installers who handle and use the materials. Researchers used these findings to develop a strategy for locating materials in the home to achieve these goals. Table 6 describes the locations of ship loose materials observed in several homes at the plant, the implications for the installer and recommendations for improvements.

Ship loose RPI recommendations

The following general guidelines for ship loose placement in the home were established based on these observations and discussions with plant personnel:

1. Load items in rooms where used.
2. Load larger items used on exterior in main living area. Place bulky items near exterior doors to provide unloading options.
3. Load easily damaged items away from major traffic paths. Larger items can be located along walls in rooms with no cross traffic. Smaller items in boxes can be located in closets.
4. Protect flooring by stacking materials on protective cover (carpet pad or plastic wrap).
5. Protect walls and other materials by strapping and/or providing bumpers on heavy materials that can shift.
6. Locate items used first by installers, such as those crucial to making the home weather-tight and secure, so they can be accessed easily without the need to move other items.
7. Include a packing list of ship loose items included with the home so installers know what to expect in terms of items and quantity (see Section 3, Installation Efficiency RPI).

The total cost of implementation of these recommendations is negligible. The benefit is primarily added convenience for the installer resulting in quicker work during the critical first day on the site when the goal

is to get the home weather tight and secure. Quantifying the potential cumulative impact of these changes is difficult because of the great variations in home designs, ship loose needs and configurations, current practices and installer crew makeup. Therefore, it is difficult to collect data allowing meaningful comparison.

Table 6 Ship loose observations and possible improvements

Observed materials loaded at Titan	Potential improvements	Photo
Kitchen The only materials loaded on the wet module (kitchen) were cabinet drawers, toilet tops and a small box of miscellaneous small materials (light globes and dryer venting parts). The drawers and toilet tops were loose loaded on the floor with carpet pad to protect vinyl.	Install cabinet drawers in cabinets, using temporary clips to secure for shipping (this is standard practice; a shortage of clips prevented this for the observed house). Separate boxed materials by trade, segregating globes from dryer venting parts. Load box(s) in closet.	
Door skin Door skin (jambs for marriage line walls) loaded into room where used without protection for vinyl floor.	Protect flooring from door skin damage using carpet pad.	
Drywall Vinyl-faced drywall sheets loaded face up into main living area.	Protect flooring from drywall damage using carpet pad. Turn drywall face down to protect vinyl face.	

Observed materials loaded at Titan	Potential improvements	Photo
Siding Vinyl siding components including J-channel (in boxes and loose with strapping) loaded into main living area, unbundled, with carpet pad to protect vinyl. Stretches from marriage wall to side wall. No protection against damage to side wall if vinyl slides.	Anchor to prevent sliding or fit with bumpers to prevent damage to sidewall drywall. Bulky materials used on exterior should be unloaded before set or placed nearest door for ease of access after set. Strap together to prevent shifting during transport.	
Interior trim Finish interior trim loaded bundled in main living area with carpet pad to protect vinyl. Trim can easily be damaged, especially by workers walking across to access other materials.	Move to another room and lay on floor lengthwise along wall.	
Pipe Large diameter black PVC drainage pipe loosely loaded (unbundled) in main living area with carpet pad to protect vinyl.	Strap together to prevent shifting during transport. Bulky materials used on exterior should be unloaded before set or placed nearest door for ease of access after set.	
Fireplace Fireplace interior ducting stacked in main living area on top of PVC pipe.	Fireplace ducting can shift during shipment and cause damage. Load directly on carpet pad on floor near fireplace and away from exterior items.	

Observed materials loaded at Titan	Potential improvements	Photo
Small items Small components (plumbing, electrical, caulk and fasteners) placed in shipping carton and loaded in main living area.	Load into different cartons by trade. Place smaller cartons into larger ones if useful. The cartons should be placed in closets.	
Lighting Lighting fixtures (boxed) loaded in main living area and one bedroom.	Load together in closet	
Chimney cap Chimney cap (boxed) loaded into bedroom	Load with other materials used on exterior	
Log siding Log siding for the gable ends of the home is shipped loose inside the home. Because the siding is heavy, it is loaded as close to the axle area as possible to minimize stress on the floor structure. The plant also attempts to place the siding so it can be taken out of the large marriage wall openings. Still, often the home is mated with the siding still inside, either because of space constraints on the site, sequencing of the job, or lack of protection to store siding outside. Workers typically unload the siding by sliding it out of a window onto the ground one board at a time. Siding pieces are 20 feet long (the preferred length for use	For log sided homes, locate log siding so one end is near a door (preferably) or window, and ship smaller pieces rather than 20 foot long pieces. The plant is now following this revised loading procedure and ordering eight foot long pieces for ship loose, reducing labor to unload siding.	

Observed materials loaded at Titan	Potential improvements	Photo
in the plant), making them very difficult to maneuver inside the home. Unloading can take 20 minutes involving two workers; wasting labor.		
Log siding smalls Small pieces of log siding and trim boards were loaded into the home for application of siding and trim in small areas, such as between windows. In one home observed, there were no such areas and the installers had no use for these materials and simply discarded them. This wastes materials, labor and disposal fees to dispose of the unneeded materials.	For log sided homes, consider whether the home needs the "smalls" and include the appropriate amount (if any) in the shipment. The plant has made this change to its process. As a result, installer labor to discard the material and associated floor protection is reduced and the plant saves some labor associated with loading the smalls into the home.	
Ship loose list The driver that delivers the home gets a list itemizing everything in the shipment including all ship loose materials. Still, this list rarely reaches the installer. Without a ship loose list, it is difficult for installers to know if parts are short and they typically do not discover it until they need to use them. Installers may also receive items for which they do not know the purpose. Lacking a list, installers do not know if these items were shipped intentionally or in error. One example is the short metal straps that come with some homes. On one observed site, installers used them for roof strapping but it is not clear that this is their intended purpose. The lack of a list results in wasted time to remedy material shortages; time to search for and determine use of ship loose items; and possibly improper use of materials.	For multi-section homes, include a second list of ship loose parts in the home for the installer. The plant now does this, enabling installers to determine if items are short and obtain replacement parts without delaying work, and facilitating proper installation of the home. The next step would be to include on the list a brief explanation of each item's use.	 Are these straps intended for the ridge?

Observed materials loaded at Titan	Potential improvements	Photo
Exterior parts location In one observed home, exterior parts such as the roof stack and exterior lights were located in an interior part of the home far from a doorway. After mating the sections of the home, the installation crew relocated these parts to the laundry room near the side door where they could easily reach in and grab them from outside. This resulted in wasted labor to relocate ship loose materials within the home.	For multi-section homes, the plant should locate exterior trim and parts separately from interior items near a doorway when the floor plan allows. The plant has established a new ship loose loading standard that directs the loader to do this.	 Exterior parts relocated near door
Ship loose pipe Dealers claim that they are not receiving enough ABS pipe with homes to complete plumbing, resulting in wasted time and labor to obtain additional ABS pipe.	Checks the plans of every home to determine the pipe requirements. The plant is now doing this. Additionally, better communication between the plant's engineering and plumbing departments now enables engineering to know when the plumbing department makes a change that affects pipe ship loose requirements, and the plumbing department realizes that it cannot make unnecessary changes because of plans for the septic system on site.	 ABS pipe

INSTALLATION EFFICIENCY RPI

The goal of this RPI was to reduce waste on the installation site by modifying procedures at the plant or altering the design of the home. In discussions with dealers and installers it became apparent that there were numerous issues that caused inconvenience or delays (i.e., waste) at the site, but were not significant enough to draw the attention of plant management. Researchers hypothesized that much of this waste could be eliminated by minor procedural changes in the plant, and that together these improvements had could yield significant cross-organizational savings that could flow through to the homebuyer.

Researchers identified these sources of waste through interviews with the participating dealers and other installers and by site observation. Table 7 contains a list of the opportunities identified and the plant response or action taken to eliminate the waste. In some cases, a problem is identified with no clear solution.

Table 7 Opportunities for waste reduction in the installation process

1. Plumbing drops at ends of home

Background: Plumbing drops can be damaged if they are above an axel or at the very end of a home. An axel may rise up on its suspension when the wheels go over a large bump in the road, contacting the pipe. On homes that traverse steep grades in transport plumbing drops can contact the ground as the home is pulled onto an uphill grade. Contact with an axel or the ground can pop the toilet up (e.g. in a master bathroom at the end of the house), breaking tile and potentially damaging the pipe.

Waste: Labor to re-set toilet, repair tile and plumbing; materials to replace broken tile and other parts; potential undetected leaks in waste line

Applicability: Homes with plumbing drops within 10 feet of rear or front ends or near axle area.

Solution: On HUD homes, the plant is cutting drops 1.5" shorter so they project no more than 6" below the floor joists. On modular homes, drops are cut so they project no more than 2" below floor decking and not at all below the floor joists. On all homes, drops are moved away from axel areas.

Who is impacted: Plant and installer

Benefit: Reduced potential for damage and repairs to plumbing and bathroom flooring.

Plumbing drop after ground contact

This toilet bolt has been popped off

2. Modular home plumbing drops at perimeter

Background: Modular homes are often set on perimeter bearing foundation walls (over a basement). Plumbing drops close to the edge of the home can be obstructed by a perimeter bearing wall foundation, making access to them for connection to services difficult. This problem can be worse on gable ends where floor joists can also be an obstruction.

Waste: Labor and materials to rework plumbing drops at edges of home that are obstructed by foundation or floor components.

Applicability: Primarily modular homes set on perimeter bearing

Plumbing drop close to foundation wall

foundation walls (such as basements).

Solution: New standard established by plant: plumbing drops to be a minimum of 16" in from edge of the home.

Who is impacted: Plant and installer/plumber

Benefit: Reduced site labor/time for plumbing connections.

3. Flue stack

Furnace closet clearance

Background: With the factory now installing furnace closet doors (previously the furnace closet was left as an open alcove) there is insufficient head room above the furnace to reach in and properly connect the stack and fire-caulk the opening from the inside. Sometimes installers are forced to install the stack and caulk from above the roof. Doing so, it is not possible to install the caulk per code.

Waste: Excess labor to install stack; risk of improper, non-code compliant, installation

Applicability: Homes with hinged roofs

Solution: The plant established a new standard opening above the furnace doorway and provides instructions for the installation of the stack using the opening for access, and to close up and properly fireproof the opening. The plant also offers a new option ($150-$300) to install a full-width door on the furnace compartment rather than a standard furnace closet door. This now popular option improves aesthetics and eases future furnace maintenance.

Who is impacted: Plant and installer

Benefit: Reduce site labor and ensure proper code-compliant stack installation

4. Return air

Return air grill in utility room door

Background: In houses where the furnace is in a laundry room, when the laundry room door is closed there are a total of four return air louvers between the main living area and the furnace (one on each side of the laundry room door, one on the furnace closet door, one on the furnace front panel). Each of these restrictions must be accounted for in the return air calculations. When the furnace is starved for return air it automatically shuts off and must be restarted by pushing a button. This can cause major problems (e.g. freezing pipes) when occupants are away for extended periods in winter (in the case of vacation homes).

Waste: Potentially severe damage to the home from freezing pipes

Applicability: Houses where the furnace is in a laundry room

Solution: Plant is now rigorously checking return air requirements on all homes as part of its engineering standard. Modifications were made to the design of certain models to ensure sufficient airflow back to the furnace.

Who is impacted: Plant, homeowner

Benefit: Reduce chances of furnace shut down and possible sever damage to home

5. Pressure tank

Background: Many homes are placed on private property and connected to wells with pressure tanks. Pressure tanks should be located inside the house with the most logical location being above the hot water tank; however it can be difficult to get the pressure tank into this space because of low clearance through

the opening into the water heater compartment.

Waste: Labor to get pressure tank into water heater compartment or wasted space from less ideal location of pressure tank in the home

Applicability: Homes with wells

Solution: The plant has formalized a new option to provide a shelf with electrical connection above the water heater ($150) or a double-door compartment with shelf and electrical connection ($300) for installation of the pressure tank. Both versions would provide clearance for the tank installation. The availability of this option needs to be effectively communicated to dealers.

Who is impacted: Plant and installer

Benefit: Reduced labor to install pressure tank and shelf

6. AC circuit

Background: Often air conditioning is installed aftermarket because the home buyer exhausts their funds on the house purchase and forestalls the AC purchase for a year. A pre-wired circuit would eliminate the need for a homeowner to hire an electrician in addition to the AC installer when they are ready to put in the AC (in fact, sometimes the AC installer arrives only to inform the customer that he cannot complete the work until they hire an electrician).

Waste: Expense to field-wire the AC circuit, potential wasted visit by AC installer if circuit is not installed

Applicability: Homes not ordered with AC

Solution: The plant will optionally install electrical junction boxes for many applications (AC, exterior lighting, etc.). The dealer should request a 30-amp circuit pre-wired to a box outside the home for air conditioning. The availability of this option must be more effectively communicated to dealers.

Who is impacted: Plant, homeowner, AC installer

Benefit: Save homeowner cost of wiring the circuit

7. Modular home floor cavity

Background: Many modular homes go over finished basements, in which case the bottom board is removed. When the installer removes the bottom board the insulation tends to fall out in strips hanging from the joists and the electrical wiring also hangs loose in a disorganized mess. The installer may try to re-fit the insulation, but this is generally not within their work scope. They often leave it for the homeowner to make presentable, perhaps by putting up chicken wire.

Waste: This presents a poor impression of the home's quality, is an inconvenience and a potential detriment to customer satisfaction. Additionally, when third party trades people are called in to complete work on the home, they may criticize the construction quality to homeowners because they are unfamiliar with modular construction.

Applicability: Homes over basements (mostly modular homes)

Solution: The plant has established a new standard practice to strap floor insulation (including plumbing, heat duct and wiring) tightly on any homes that are going to be placed on basements.

Who is impacted: Plant, customer, subcontractors

Benefit: Improved quality and product perception

8. Crane sets

Crane set

Background: Modular homes are often set on basement foundations by a crane. The crane lift points should not coincide with joints in the home's rim boards. Lift points are typically at fixed locations based on the length of the home. Plumbing and ducts under the home should also be built to avoid being crushed by crane straps.

Waste: Labor to temporarily reinforce rim joints, locate fragile under-floor components, and/or to lift home using sub-optimal procedures

Applicability: Crane set homes

Solution: The plant can design floor rails to avoid joints at the desired

locations if this information is relayed to the engineering department. This option needs to be more effectively communicated to dealers. A better solution that the plant is investigating is to install PVC tubes under the home for the crane cables. The tubes would be located away from items that could be damaged.

Who is impacted: Plant, installer

Benefit: Safer crane installations, reduced labor to work around this problem, reduced damage to the home.

9. Hinge roof

Background: The hinged roof connection method is difficult and time consuming. The kneewall studs often do not align with the ceiling joists, and installing six fasteners per bracket is cumbersome. If the roof could be raised and fastened before the home sections are mated, then access from the open side would make this connection easier. Still this is generally not possible due to lack of space on the site and in the case of HUD homes where roof jacks rather than a crane is used, the home must be positioned on the slab to provide a stable footing for the jack (which extends from the ground up to the roof).

Waste: Excess labor to complete the roof connection

Applicability: Homes with hinged roofs

Solution: To address the cumbersome fastener issue, the plant now provides nails instead of screws and recommends the use of a pneumatic palm nailer, which is easier to use in the confined attic space. Cost-effective solutions to the alignment difficulties are not yet available.

Who is impacted: Plant, installer

Benefit: Reduced labor and better working conditions for the installer

10. Home alignment

Background: To achieve proper alignment of the home sections, the manufacturer's installation manual recommends a racking procedure that the installers do not believe works with Titan's heavily built and stiff homes. Titan does have a specific recommended procedure for achieving better alignment on its homes (i.e. setting the home from the back towards the front). Nevertheless, this recommendation is not in the corporate installation manual.

Waste: Excess labor to obtain home alignment, inability to achieve proper alignment

Applicability: Multi-section homes

Solution: In order to reduce alignment problems, the plant has implemented a series of improvements to floor, wall, and ceiling framing procedures including the use of new pneumatic squaring jigs at these stations.

Who is impacted: Installer

Benefit: Reduced installation labor and time; better installation quality

11. Ridge close-up

Background: The installer is generally unable to close up the ridge to within acceptable tolerances on the plant's homes. In one observed house, the end walls were tight, the floor was level (confirmed with a laser), and the sidewalls and marriage wall were plumb, however there was a 1-1/2 inch gap between the blocks along the ridge. According to the installers at this site, this is a typical occurrence.

Gap at ridge

The installers were reluctant to jack up the sides of the home to close the ridge (as suggested in the installation manual) because they did not think the house would settle back to level without tearing out the ridge lag bolts. The installers are also skeptical that installing lag bolts at an angle through the 5/8 inch thick ridge boards (which would still have a 1-1/4 to 1-1/2 inch gap between them if the ridge were to close up properly) as indicated in the manual, is a secure fastening method. They believed the thick lags would crack the

boards, even with pre-drilling, especially at the sharper angle required to install them in a low sloped roof.

A proper close-up is made more difficult by the marriage line gasket which compresses to only about 25% of its full size (1.5 inches at full size) according to the installers. Their solution to this situation is to leave the gap at the ridge and fasten metal straps across it (doubled over) at each truss location.

Additionally, presumably because of the roofline gap, the marriage line joint does not properly seal (on one home there were at least eight locations where light shown through the marriage line, indicating that the gasket was not filling the gap – mainly along the ceiling).

Installing straps across ridge gap

Waste: Excess labor trying to get the ridge closed up; energy waste and reduced occupant comfort due to increased air infiltration

Applicability: Multi-section homes

Solution: After investigating the ridge gap, the plant found a small discrepancy in the mate wall top plate construction. On 3-in-12 roof pitches with OSB mate walls the rafter design does not accommodate the added thickness of the 7/16" OSB and can create a 7/8" gap at the peak. This gap can be filled with lumber in a manner that does not restrict airflow through the ridge vent. This does not account for the entire gap, however, and investigations continue and will be focused on during the set-up of four homes at the plant in Sept. 2010.

Gap remaining at ridge

To address any marriage line gaps, the installer should apply spray foam sealant into gaps in marriage line.

Who is impacted: Plant, installer, homeowner

Benefit: Less installation labor and time; reduced air leakage

12. Roofing at ridge line

Background: The plant installs shingles all the way up to the ridge line with the expectation that the ridge vent will be sufficient to bridge the gap between home sections. Because the ridge gap is often wider than planned, the vent does not always bridge the gap sufficiently, potentially leading to leaks.

Shingles extend fully to ridgeline

Waste: Potential roof leaks requiring repair by the dealer

Applicability: Multi-section homes

Solution: The plant now includes in the ship loose materials, extra shingles for one row on each side of the ridge. This would be unnecessary if the ridge close-up problem (above) were resolved.

Who is impacted: Plant, installer, homeowner

Benefit: Improved customer satisfaction, reduced service

13. Roofing at hinge line

Background: The plant leaves shingles off of two rows on each side of the hinge, but installs the roofing underlayment paper over the entire roof. The roofing underlayment paper buckles when the hinged roof is unfolded and cannot be flattened out. Also, the installer often cannot complete the shingles on the first day of installation, risking water intrusion overnight.

Waste: Excess labor to install the shingles, ripples under shingles negatively impact aesthetics

Applicability: Homes with hinged roofs

Solution: If shingles are pre-installed continuously over the hinge line, buckles in the shingles could be fixed by sliding a flat bar underneath them and walking on them (the sun's heat would seal them). Still, many installers prefer the existing system to having to fix the buckling shingles (which was a previous

procedure).

Who is impacted: Plant, installer, homeowner

Benefit: Improved customer perception

14. Fascia

Background: At gable end walls, often the fascia piece shipped loose for site-installation is too small and looks odd. Fascia pieces should be at least 1-1/2 feet long for proper aesthetics.

Waste: Poor customer perception

Applicability: Multi-section homes

Solution: The plant has changed its process to use longer fascia pieces at the peak, which are now temporarily screwed to the fascia rather than being shipped loose in the home.

Who is impacted: Plant, installer, homeowner

Benefit: Improved aesthetics

Fascia boards at gable end

15. Corner posts

Background: For vinyl sided homes where the corner posts are left off for site installation, the siding is typically too short, leaving a gap between the siding and corner post (rather than tucking into the post). As a result the installer has to re-side at all four corners.

Waste: Excess labor to re-side the home

Applicability: Vinyl sided multi-section homes

Solution: The plant now makes more accurate measurements and has standard gap dimensions at the corner for both standard and premium vinyl siding.

Who is impacted: Installer, plant

Benefit: Reduced siding labor/time at the site

Vinyl siding

16. Marriage line opening

Background: The header along the marriage line opening in the main living area is too shallow. The vertical dimension should be approximately four inches instead of only 1½" (the thickness of the 2 x 4) to facilitate trimming. After the ceiling sheetrock is installed, there is barely enough room for the crown molding. If everything is not perfectly straight, there will be an uneven reveal between the bottom of the crown and the opening.

Waste: Excess labor to trim the marriage line opening; poor finish aesthetics

Applicability: Multi-section homes

Solution: The plant will build the header down to a depth of 3" upon request. The plant also offers an option for a flush header which is priced per house. The flush option has become very popular despite not being on the standard option list.

Who is impacted: Plant, installer, homeowner

Benefit: Reduced labor to trim the home, improved customer perception

Marriage line opening prior to trimming

17. French door

Background: Titan does not install the French door in this home design because when closed it could reduce return air to the furnace below acceptable levels. The door is undercut by two inches so the dealer believes that return air is accommodated. When Titan ships the door loose the installers usually have to re-fit it, which they write up as a service issue for the plant.

Waste: Excess labor and time to install doors; service cost incurred by plant

Applicability: Floor plans with ship-loose French doors

Solution: The plant has revised its process to install the doors and casing inserts and then remove the pins from the doors and ship them loose. The return air issue is model specific. For some models a grille above the French doors is necessary for adequate return air, but dealers and homebuyers resist this because of aesthetics.

Who is impacted: Plant, installer

Benefit: Reduce labor and cost to install French doors

Ship loose French doors

French door opening out of plumb

18. Range hood

Background: Stainless steel range hoods are shipped with plastic wrap to protect them against scratching during construction in the plant. The protective wrap is difficult to remove in the field because the plant-installed crown moldings cover portions of it so the corners of the wrap are inaccessible. The installer often leaves scraps of wrap in place rather than risk scratching the hood.

Waste: Labor to remove wrap

Applicability: Homes with stainless steel range hood

Solution: The plant is now removing the wrap at the factory after the hood is installed.

Who is impacted: Plant, installer

Benefit: Reduced labor to remove protective wrap; no scraps of wrap left for the homeowner to remove

Range hood with protective wrap

19. Patio door

Background: The operable panel on a patio door should always be toward the kitchen to facilitate traffic from kitchen to deck. The operable panel is often on the wrong side if not expressly indicated by the dealer.

Waste: Sub-optimal home design

Applicability: Homes with patio doors

Solution: The plant will install the operable panel on the side requested by the dealer. A more foolproof process would be to require the dealer to select a patio door operation panel when the home is ordered or always install the operable panel on the kitchen side of the door unless otherwise requested.

Who is impacted: Plant, dealer, homeowner

Benefit: Superior home layout and customer satisfaction

Floor plan with patio door

20. Formaldehyde notice

Background: Titan puts a formaldehyde notice on modular homes. This notice is a HUD regulation for manufactured homes and is not necessary for modular homes. The plant is investigating this issue.

Waste: Potential to negatively affect customer perception.

Applicability: All modular homes.

Solution: Plant no longer includes the formaldehyde notice in modular homes.

Who is impacted: Retailer

Benefit: Improved customer perception of home quality.

21. Site plan

Background: The customer for one observed home thought it was going to be set at ninety degrees from its installed position because the smaller home originally on the site was oriented in that direction. They did not understand the actual orientation until they visited the site after the home was installed. This was the only orientation possible for the larger home; however this had never been communicated to the home buyer.

Waste: Potential misunderstanding/disagreement with customer over home site and orientation.

Applicability: All homes on private property

Solution: Provide a simple site plan to the home buyer

Who is impacted: Dealer, homeowner

Benefit: Improved customer satisfaction, cost to produce site plan

22. Floor protection

Background: During installation, set crews must go in and out of a home numerous times and many sites are muddy. Normal drywall repair and other installation activities create dirt and sanding dust that can contaminate floors, carpets and other furnishings.

Waste: Labor to clean installation-related dirt

Applicability: All homes, particularly multi-section homes

Solution: Plant will provide floor protection if requested. The cost will be determined on a case-by-case basis. Concerns with making this a regular offering include the inability to see floor damage before shipping if the plastic is left on from early in the production process, and potential damage to the flooring when the plastic is removed in the field (typically with a razor). Other solutions such as special sticky plastic for carpeted areas may also be considered.

Who is impacted: Plant, installer

Benefit: Reduced labor for cleaning; cleaner home

23. Refrigerator water line

Background: Refrigerator icemakers must be connected to a water line. On some homes the installer must pull out the refrigerator to hook up the icemaker. Moving the refrigerator can lead to scratches in the linoleum floor and dents/scratches in appliances or cabinetry.

Waste: Excess labor to move refrigerator to install water line; potential damage to floor, appliance or cabinets

Applicability: Homes with refrigerator with icemaker

Solution: Plant has trained the ship loose department (that loads the refrigerator) to connect the refrigerator water lines

Who is impacted: Plant, installer

Benefit: Reduced labor to install water line; reduced chance of damage

Refrigerator strapped for shipment

24. Attic decking

Background: On homes with high pitched roofs the attic area can be used as storage once decking is installed. The home is delivered without decking installed so installers must work there by walking on the tops of the ceiling joists/truss bottom chords. To install the decking, installers must first lift it up into the attic by hand.

Waste: Excess labor/time to complete work in the attic, safety hazard and potential damage if installers step through ceiling

Applicability: Homes with high-pitched roofs and attic storage space

Solution: The plant now offers as an option ($1,500) for modular homes to install attic decking in the plant (except in areas where access is needed for home installation) for homes where the roof can be raised in the plant. On homes where the roof is too high to raise in the plant, standard procedure is to pre-load attic decking onto the ceiling.

Who is impacted: Plant, installer

Benefit: Reduced labor and chance of accidents and damage

Attic decking

25. Dryer vents

Background: Clothes dryers in manufactured homes must be vented directly to the outside, either through the wall, or though the floor in which case the vent duct must continue to the perimeter of the home and pass through any skirting or perimeter wall.

Waste: Labor to install vents in field; potential damage from neglecting to install dryer vent

Applicability: Manufactured homes with clothes dryers vented through a wall

Solution: For HUD homes, the plant now installs dryer vents that pass through an outside wall. For vents that pass through the floor, the plant now provides vent installation instructions as an addendum to the manual along with the kit of parts (flex duct, vent, fasteners, etc.).

Who is impacted: Plant, installer

Benefit: Reduce potential chance of missing dryer vent; reduced field labor to install vent

26. Smoke detectors

Background: Smoke detectors are too sensitive – alarms often sound without cause. Procedure for resetting the alarms (removing and reinstalling backup batteries in all alarms and resetting circuit breaker) does not always work.

Waste: Poor customer satisfaction, complaints to dealer

Applicability: All homes

Solution: The plant now offers options for two choices of upgraded smoke detectors, which have become very popular.

Who is impacted: Homeowners, dealer

Benefit: Improved customer satisfaction, fewer complaints to dealer

Smoke detector in HUD unit

Table 8 summarizes the benefits, per home average cost and savings and status of each of the installation efficiency improvement items. In the "status" column a check indicates that the plant has implemented the change; "Opt" means that the plant can provide the service to a dealer as an option upon request (although an effective means of communicating this to the dealers is essential for its effectiveness); and "Inv." means the plant is investigating the issue. Cost and savings numbers are estimates for a typical home for homes

where the item is applicable (i.e. where there is an incidence of damage or where a home has the applicable feature).

Table 8 Summary of benefits, costs (per double section home) and savings from installation efficiency improvement items

Item	Main benefit	Cost	Savings	Status
1. Shorten plumbing drops at ends/axles	Reduce damage	$0	$750 per occurrence	✓
2. Keep mod plumbing drops away from edges	Install time	$0	$50 per drop	✓
3. Provide access for stack installation	Install time, fire safety	$0	Unknown	✓
4. Confirm adequacy of return air	Home performance	$0	$0	✓
5. Accessible pressure tank shelf	Install time	$150-$300	$33	Opt.
6. Pre-wire AC circuit to outside	Homeowner cost	$100	Unknown	Opt.
7. Strap mod floor wiring and plumbing	Appearance	$25	$0	Opt.
8. Floor joints, etc. avoid crane pick points	Install time	$75	$300	Opt.
9. Revise hinge roof design to be user friendly	Install time, quality	TBD	Up to $3,000	Inv.
10. Improve home alignment	Quality, install time	$7.33	Unknown	✓
11. Eliminate ridge close-up gap	Install time, quality/safety, home performance	TBD	$111	Inv.
12. Roofing at ridge line	Service	$33	$132 per service	✓
13. Fix buckling roofing along hinge	Appearance	N/A	N/A	N/A
14. Use longer fascia pieces	Appearance	$0	$0	✓
15. Avoid siding gaps at corner posts	Install time	$0	$278 per occurrence	✓
16. Deeper marriage line opening headers	Appearance	$0	$16	Opt.
17. Pre-hang French doors	Install time	$0	$55 per occurrence	✓
18. Remove range hood wrap at plant	Appearance	$0	$0	✓
19. Confirm desired patio door operation	Customer satisfaction	$0	$0	Opt.
20. Remove formaldehyde notice from modular homes	Customer perception	N/A	$0	✓
21. Provide purchaser with site plan	Customer satisfaction	$0	N/A	
22. Install comprehensive floor protection	Install time, reduce damage	TBD	Unknown	Inv.
23. Connect refrigerator to water line	Install time, reduce damage	$35	Unknown	✓
24. Install attic decking at plant	Install time	$1,500	$500	Opt.
25. Install wall dryer vents at plant (HUDs)	Install time	$0	Unknown	✓
26. Improve smoke detectors for HUD homes	Home performance	$100	$0	Opt.

Installation efficiency RPI conclusions

Taken together, these items have the potential to save as much as two-to-three thousand dollars per home depending on the features in the home and occurrence of problems. Savings would include direct labor and/or materials savings for the dealer/installer on the site and indirect savings to the plant from fewer service problems. The savings could be passed through to the homeowner to lower the housing cost and/or partially retained by the plant and/or dealer.

Cycle times could be reduced by speeding installation and potentially more significantly by reducing the service period. The quality of design and construction would also improve, resulting in greater customer satisfaction and safety. Energy efficiency would also be improved due to superior completion of the thermal enclosure resulting in a tighter home envelope.

As indicated above, a number of improvements have already been implemented and still others are being researched by the plant at the time of this writing. This is an ongoing process that will require a focused and sustained commitment from the plant and field staff.

While many of these installation efficiency improvement items are under the control of the plant, a number relate to communication between the plant and dealer or installer. These fall into two categories:

- **Sales options.** These options must be known by the dealer at the time of sale (for example items 5, 6, 16, 19, 24 and 26) and must be integrated into the sales process, perhaps by including them on the list of options available to the dealer. Alternatively, they could be on a separate list of installation-related options that are of specific interest to the dealer or installer, but not a homebuyer.
- **Installation guidance.** Resolving certain items (such as 16 and possibly 19) would require additional communication from the plant to the installer, beyond what is included in the standard installation manual. This information could be included as an addendum to the installation manual and in dealer and installer training.

Mechanisms to improve communication between the plant and dealers and installers could include dealer roundtables such as the dealer workshop that were part of this effort, visits by plant representatives to building sites and installer training sessions where a group of installers come together (perhaps at the plant) to install a home with plant representatives. Each of these mechanisms offers the opportunity for two-way communication between the plant and the workers installing their homes. The latter two provide a hands-on experience that is likely to draw out additional issues, and would be valuable vehicles for problem solving in addition to training.

Because the homes and their installation methods are similar, most plants would find that a limited number of sessions – even one a year –with a few of their more thoughtful dealers and installers would provide the substantial benefits to be gained from this activity.

5. CONCLUSIONS

The primary objective of this research was to demonstrate the value of lean techniques when applied to the factory-built home sales and installation process and provide a model for other companies to emulate. Lean activities were conducted with three home dealers in partnership with their supplying factory. These activities included value stream mapping, lean training and rapid process improvement events. The plant, Titan Homes, had extensive experience with lean, having conducted dozens of RPI events under the direction of a seasoned lean manager. Having experienced the benefits first hand, they were strongly motivated to extend the benefits of lean down the value chain to their dealers and installers, who can directly influence the homebuyer experience.

The dealers selected for the project were interested in learning about lean and the benefits that could be gained. They enthusiastically participated in the value stream mapping exercises and the dealer workshop, freely describing numerous examples of waste and opportunities for improvement in the sales and installation process. The most significant opportunities, expressed by all three dealers, lay in the sales process. Not only does this phase consume a large portion of the sales/installation cycle, but decisions made during the sales process can dramatically affect the efficiency and quality of the resulting installation and, as a result, the customer's satisfaction with the home buying experience. This last point – the home buying experience – seemed to be at the heart of what the dealers' wanted to address. They felt that by attacking the sales process with the lean toolkit, they could unlock hidden value, avoid unhappy customers and thereby gain advantage over their competition.

Therefore, researchers elected to focus on the sales process for the first RPI, placing great emphasis on it. Researchers working with Titan and one of the dealers, Hawkins Homes, identified many examples of waste in the process. These included errors and delays that often afflicted the sales process and resulted in higher costs, reduced profits and unhappy customers. Some of the recommended solutions were relatively simple to implement, but required management discipline, while others could involve significant cost, but have the potential to radically improve the buyer's sales experience.

Implementation of the sales process recommendations and, to a lesser extent, efforts to evaluate the recommendations of the other two RPIs, were stop-and-start, because the housing industry nearly came to a halt during the course of the research. Sales of factory built homes were hit particularly hard. Some of the easiest to apply and least costly recommendations were implemented. Work that had commenced on the web-based ordering system, the strategy with potentially the greatest potential to improve operational efficiency, was put on hold indefinitely. Nevertheless, Hawkins, Titan and its parent company Champion Homes all believe in the value of the project and expect to continue pursing lean goals when resources are available.

BARRIERS

The poor market was certainly a factor in slowing implementation. Still, other more fundamental barriers exist to reaping the benefits of lean in this segment of the industry. Implementation of lean in home manufacturing plants is most successful when it is a priority of company leaders and is not in conflict with compensation/bonus plans or other company policies (such as rigid job descriptions). Lean also requires a very "hands on approach." Indeed, one of the first acts of a lean manager is typically to "walk the value stream" to see the process firsthand, from incoming raw materials to finished product and to talk to the people on the production line to understand their daily struggles. In a factory, a manager can do this by walking the production floor each morning or even several times per day to gauge the results of changes and gather feedback from workers. When the process takes place at a number of scattered installation sites, it is much more difficult to monitor. If the manager facilitating the lean implementation is from the plant, , it becomes difficult to effectively research opportunities, train workers, oversee RPIs and evaluate changes in a cost and time-effective manner. This is more difficult when the people and businesses that need to change are under a separate corporate umbrella.

Another foundational principle of lean is stability. A process must first be stabilized before it can be streamlined. Even during good market periods, the flow of homes through a particular dealer is often uneven and highly varied in terms of design and foundation type and even manufacturer (dealers often source homes from two or three plants). By contrast, most homebuilding plants have production line flow. Activities are repeated numerous times each day by the same dedicated workers, making them ripe for lean improvement. Moreover, plant activities take place in dedicated workstations. For the purposes of lean implementation, these can be addressed individually, greatly reducing the scope of each effort. This is especially important in the initial stages of an implementation when the value of lean is yet to be proved. Activities in the sales and installation process proceed at a slower pace, often separated in time and space. Therefore it requires more patience and cooperation to get results. The actions of as many as four independent parties (plant, dealer, installer, home buyer) may be involved.

This leads to one of the key problems of any cross-organization process improvement effort–many of the waste reduction actions require cooperation between the plant, dealer and installer, and require effort or incur costs for one party (the plant) in order to reap larger savings for others (the dealer and/or installer). The plant may choose to incur these costs to win favor with dealers as compared to other plants. They may choose to pass these costs on to the dealer, who presumably would still gain a net overall saving because the purchase price of the home would be higher, but reduced installation costs would offset this higher price. Nevertheless, dealers are accustomed to focusing on first cost without considering downstream benefits Success with lean in the field will require breaking through this mindset. Dealers that implement lean must make the leap of faith, investing up front to achieve overall gain.

Finally, in order to identify and realize lean improvements, someone must take responsibility to facilitate the overall process. The most likely candidate would be someone from the manufacturer who has experience with lean at the plant. The implementation of lean practices will improve the customer experience and lead to higher profitability for all parties. This is strong motivation for the factory to drive the process. Although an aggressive dealer could achieve some of the improvements on its own with cooperation from the factory, it is unlikely that it would have the staff or experience to see a lean implementation through with the persistence and dedication required. As discussed above, it would take an extraordinary level of commitment by a plant to devote the time and resources to see this through. Perhaps the most feasible model is one where a manager from the plant provides expertise and guidance to a designated lean manager at the dealer who is in daily touch with the sales/home completion process. This could be either on the site (an installation supervisor/leader) or in the sales office (a sales or other manager). Of course the dealer will need to make lean a top priority, assigning a staff lean manager with authority and time to oversee change.

OPPORTUNITIES

The results of this study clearly indicate that lean tools and techniques are applicable to factory built home sales and installation, as they are for home production in the factory. There are many opportunities for improving operations, quality and homebuyer value. Many small changes can improve home quality and lower cost with minimal investment. Communication between dealers and the plant offers great opportunity for improvement. Although in the past Titan made an effort to tap into the experience of installers through hands-on workshops and site visits, these were curtailed primarily for budgetary reasons. The lean initiative helped restart these activities and, by quantitatively measuring performance, demonstrated the potential for generating significant benefits.

More significantly, the sales process RPI revealed that there is a great opportunity to compress the sales cycle time and enhance the customer experience. This could be turned into a competitive advantage for factory-built housing and help the industry further leverage the promise of quick, customized, affordable, high quality homes. Another ripe area for lean improvement, not addressed in this research, is service. For example researchers noted that fixing relatively minor items sometimes required five or six visits over the course of three to six months, enormously wasteful and expensive. A lean approach to after-sales service should aim to make all repairs in one visit within a few weeks of home completion.

APPLICABILITY TO SITE BUILDERS

While specific practices differ, the results of this study suggested that lean might also be a valuable tool for site builders. The most applicable elements of this RPI to site builders are those that address the sales

process. The customer-facing components of the sales process are very similar for site builders. More structured and well-documented interactions between the sales force and homebuyer throughout the sales/installation/service cycle can reduce the occurrence of errors and misunderstandings that can raise costs, extend lead times and lessen customer satisfaction. Tools such as a customer focused website that showcases the product line including models, comparative features, and available options can better equip the homebuyer and strengthen the sales process. Customer satisfaction surveys of all customers, both buyers and non-buyers, can reveal strengths and weaknesses of the current process.

The supplier-facing components of the sales process, such as pricing and contracting, may be more complex for site builders due to the number of subcontractors that may be involved. Once again, streamlined methods for pricing homes can compress decision time, reducing the risk of losing the sale. Developing and nurturing relationships with key subcontractors can assure the stable pricing and scheduling necessary to allow the sales force to promptly price a standard model with popular options. A price book, electronic pricing worksheet or web-based system can formalize the pricing process, increasing pricing accuracy and reducing cycle time.

Although a site-built home does not have to be 'installed', the results from the installation RPI are relevant to the site builder. The fundamental findings are that: 1) simple design changes can improve the constructability of a design (safety, efficiency, quality) and 2) preceding contractors must complete their work so that it simplifies the work of subsequent contractors, thus improving overall building performance. This is vitally important for the site-builder that must manage numerous subcontractors for quality, schedule and cost. Still, it is also far more difficult for the site builder to identify and implement the needed tradeoffs, due to the complex web of relationships between independent subcontractors.

The difficulty in applying lean concepts increases for site builders that specialize in custom homes and for builders who cannot rely on a stable group of trusted subcontractors. They must deal with the additional complexity introduced by the variation in their building projects and their production resources. Note that while complexity makes the application of lean more difficult, it also increases the opportunity commensurately.