Background and Acknowledgements

The objective of this project is to gather state-of-the-art information to enable builders and framers to better integrate steel-framed wall panelization methods and processes into their construction systems, designs, and business models. This stage of the project consists of a series of case studies on builders, framers, and panel fabricators who are successfully using panelized construction in concert with cold-formed steel.

This report addresses a case study conducted on the use of cold-formed steel wall panels by a contractor who both manufactures panels and frames homes and commercial buildings. This case study focuses on the experience of the fabricator/framer and the builder they support. Although the framer works for a variety of builders, in this case, the builder and framer are affiliated companies with significant overlap in ownership.

This case study and report were prepared by Matt Hawkins and Mark Nowak of Newport Partners LLC. We extend special thanks to Todd Setter from the Steel Framing Alliance for collecting the on-site information throughout late 2007 and early 2008. Scott Shaddix from Craftsmen Homes and Debbie Adams from Lane Framing also provided significant assistance throughout the project. Funding was provided through a cooperative agreement between the Steel Framing Alliance and the U.S. Department of Housing and Urban Development’s Office of Policy Development and Research.
Section 1 – General Information and Summary of Process

This case study is based on the observation of three model homes framed by Lane Framing Systems using steel wall panels fabricated on-site for Craftsmen Homes.

Lane Framing Systems (Lane Framing) is based in Anaheim, California and is a regional framing contractor serving the residential and light commercial building market. Lane Framing specializes in framing commercial, single-family, and multi-family buildings using cold-formed steel wall panels. They also frame homes with wood and hybrid steel-wood framing systems. Lane Framing has built thousands of homes since its inception in 1987.

Lane Framing utilizes the Lane System®, a proprietary integrated construction and budgeting software program that maximize efficiencies in all aspects of its operations. The Lane System provides precise procedures, predetermined protocols, computer-generated calculations, and budgetary controls to monitor and evaluate real-time performance.

Craftsmen Homes builds custom and semi-custom homes in the California market. Their homes are framed in steel by Lane Framing. Although the two companies are closely affiliated and have overlapping ownership, Lane Framing works with other residential and commercial builders. They apply the same approach described in this report independent of the builder on the project.

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Housing Characteristics
The three homes in this case study are part of Craftsmen Homes’, Citrus El Dorado development located within the La Quinta Resort & Golf Club community in La Quinta, California. When completed, the development will consist of 29 semi-custom homes based on three standard floor plans. The three observed model homes include:
- Home 1XB: Two-story home with 3,493 square feet
- Home 2XB: Two-story home with 3,767 square feet
- Home 3XB: Two story home with 4,195 square feet.

All three homes have slab-on-grade foundations with attached garages. Sales prices are expected to range from $940,000 to $1,400,000, depending on the model and level of up-grades selected.

Surrounding Housing Market
La Quinta, California is located west of Palm Springs, off Interstate 10. The city’s main economic base rests on the area’s natural beauty and outdoor activities, such as golfing and hiking. La Quinta has approximately 42,000 residents and the population is expected to grow, predominantly through relocation of older residents to the town’s resort-based communities.

In 2004, La Quinta’s median new home price was $554,747 and the median price of all homes was $307,045. In 2006, there were 18,726 homes in La Quinta. The 2006 median household income was $64,844, slightly higher than the region’s average.

Summary of Process
The first step in the framing process is to enter the home’s details into the Lane System software program. The computer program not only determines the home’s material needs but also focuses on efficiently designing openings for doors and windows.

The Lane System produces a preliminary framing plan, which is then evaluated by the project’s lead layout person. A lead layout person makes adjustments to the layout configuration as needed.

For most projects, a model home is then framed using the revised preliminary layout. Lane Framing conducts a walk through of the home with various stakeholders, including the framing crew, builder, and sub trade representatives. The goals of the walk-through are to identify potential conflicts and to look for construction and framing efficiencies. Any changes identified during the walk through are then made to the panel layout configuration in the Lane System software program before the home’s production-ready framing layout and cut-sheet are produced. The home’s final cut-sheet, detailing every stud’s height, width, and thickness, is then sent to cold-formed steel providers for bidding.
Lane Framing fabricates, or produces, the home’s wall panels at the job-site with steel studs and tracks that arrived cut-to-length from a cold-formed steel supplier. The panels are fabricated either on a vacant slab or on a dry, flat section of the ground within the development. The builder doesn’t use a framing table or other framing jigs commonly seen in off-site fabrication plants. To inform fabricators on each panel’s dimensions and characteristics two coils are produced, one for the bottom track and one for the top track. The coil is secured on a spool and unrolled. The fabricators build the panels based off the guidelines and markings listed on the coils. Each home’s coil is produced by the lead layout person, using the model home as a guide.

As a stack of panels is completed, it is moved away from the fabrication area to be stored until needed. A stack of panels is transported by forklift while individual panels are typically moved by three or four crew members. Since this observation was of three model homes, the panels were fabricated at another job-site and transported by flatbed truck to the framing site. Panel fabrication will occur on-site once full production begins.

The builder prefers to use an on-site fabrication framing strategy for developments with five or more homes. For projects under five homes, such as model home development, the builder will fabricate the wall panels at another job-site.
Section 2 – Business Model and Relationships

Lane Framing is a regional residential and light commercial framing company, who works on both steel and wood framed buildings. Lane Framing specializes in fabricating steel wall panels on-site with cold-formed steel studs and tracks. The studs and tracks are purchased from a third-party provider selected through a competitive bidding process.

Lane Framing enters into contracts with builders to frame homes and provide all the necessary materials and supplies. Lane Framing employs the framing crew and provides the tools, equipment, and supplies, including studs, tracks, and screws, necessary to bring a building from the top of the foundation to finished framing.

Lane Framing was formed to take advantage of the Lane Framing software program. The Lane Framing program creates material take-off sheets and develops the framing layout, but doesn't create structural drawings. Lane Framing is contracted by numerous builders in the region, not just Craftsmen Homes.

Framing Software
Lane Framing’s first task after securing a contract with a builder is to enter the home’s floor plan and elevations into the Lane System software program. This is a unique computer application developed by Lane Framing to design the wall panel layout, improve efficiency, and optimize framing material.

The program strategically places the window and door openings in locations that reduce the need for back-to-back studs or takes advantages of the increased load-bearing capacity of required back-to-back studs.

Lane Framing’s lead layout person evaluates the preliminary wall panel layout produced by the software and makes any necessary adjustments. These adjustments are entered into the program to produce the layout for a model home.

The software produces material take-off sheets for each home. These sheets are sent out to cold-formed steel providers for bids. This way the supplier knows the quantity of studs and tracks to provide and their respective lengths.

Model Home
Lane Framing will build a model home for each floor plan using the wall panel layouts produced by the Lane System software. During the model home’s construction, special attention is given to the fabricating and framing processes to identify areas that can be improved. When the model home is fully framed, Lane Framing conducts a walk-through of the home to discover and address potential issues.
After the walk-through is complete, the recommended framing modifications are re-entered into the Lane System to produce cut-sheets and panel layout designs that are used throughout the production of the remaining homes in a given development.

**Layout Coils**
Two coils are produced for each home, one for the bottom track and one for the top track. Made from 1 ¼ inch steel strapping, each coil is labeled with the panel’s design characteristics. After the construction of the model home, the lead layout person creates the coils using the home’s dimensions as the guide. The coils are then secured in a plywood spool box and unrolled as needed. The fabrication crew builds the steel wall panels using these top and bottom track coils as a guide.

The size of the fabrication area determines the length of the coil unrolled at one time. The fabrication crew prefers to build at least two panels at a time by unrolling thirty to forty feet. The coil system was developed by Lane Framing to easily accommodate and adjust to changing size constraints associated with on-site fabrication areas.

**Panel Fabrication**
Lane Framing has developed long term relationships with suppliers who can meet their specific needs. Thus, they are able to secure studs and tracks that are pre-cut to length by the supplier. Most suppliers have a four week delivery time from confirmation of order.

The fabrication crew frames the wall panels on an empty home lot or on a nearby vacant foundation pad with a total area of at least a quarter acre needed for fabrication and storage. The builder typically furnishes the area for fabrication.

Lane Framing’s crew does not use framing tables, jigs, or similar devices. All panels are built on the ground.

All the wall panels associated with one floor of a home are stacked together. Once a stack is finished it is moved out of the way until it is needed at the construction site. An all-terrain forklift is used to move the wall panel stacks to the waiting area.
Individual wall panels are carried by hand at both the fabrication area and construction site. The wall panels are taken off the wall panel stack by the framing crew as needed.

**On-site Transportation**

Off-site versus on-site fabrication considerations are analyzed for smaller housing projects and model home construction in order to arrive at the most cost effective fabrication strategy. The framer prefers on-site fabrication for developments over five homes. Ideally, the fabrication area is located within the housing development in an area where fabrication can continue for a prolonged period of time.

For this case study, the panels were fabricated at another location and transported to the construction site because only three model homes were built.

Lane Framing secures the flatbed trailer and hauling permits, if necessary, when an off-site fabrication strategy is employed. However, off-site fabrication always occurs at another job-site in a similar manner. Lane Framing doesn’t fabricate wall panels in a warehouse or any other permanent structure.

**Joists**

The steel floor joists were purchased from a third-party provider and installed and sheathed with OSB by the framing crew. The duct layout was designed to run parallel to the joists to permit the use of standard C-section floor joists.

**Trusses**

The wood trusses were purchased from a third-party provider. Bids were accepted from both steel and wood truss providers. Ultimately, wood roof trusses were selected based on price. The trusses were installed and sheathed with OSB by Lane Framing.

**Framing Innovations**

Lane Framing began stick-building steel homes and gradually adopted a wall panel framing method. Throughout this evolution Lane Framing has experimented with all steel homes and with combinations of steel and wood. For the last six years, Lane Framing has been using the described on-site wall panel fabrication process and estimating projects with the Lane System software program.
Component Assembly
For larger projects a component assembly station is developed, near the panel assembly area to speed up panel fabrication times. Crew members are dedicated to assembling headers, footers, and back-to-back studs at the component station, effectively creating an inventory of these items for panel fabricators to integrate into panels as needed.

Crew Members
The framing crew consists of eleven individuals; one supervisor, one assistant, and nine crew members while the fabrication crew has ten crew members. Lane Framing’s framing crew is highly experienced, with the supervisor having over twenty years of experience. The assistant has twelve years of experience; and the crew has an average of twelve years of construction experience.

The fabrication crew operates separately from the framing crew. The fabrication crew consists of ten crew members, but the crew size fluctuates slightly depending on production level.

Archways
Wood archways were built and installed to accommodate curved architectural features. The arches were built on-site and slid into place once the walls were up and secured. Pictured here is a wood frame for an arched interior doorway.

Engineer Design
All new homes in La Quinta require a structural design by a registered professional engineer regardless of the framing material used. Lane Framing didn’t provide the structural engineering design for these homes.
Craftsmen Homes has been building with steel from many years and understands Lane Framing’s system and construction process. Most of the investment required to switch to steel was carried by Lane Framing. The builder simply contracts out the materials, supplies, and framing components of the home.

The builder and framer have worked together for years and continually improve the overall process. Below are some of the advancements and evolutions adopted over time by the builder and framer.

**Builder Issues**

**Plans**
To avoid costly plan modification charges, it is important to design the home to be built with steel from the beginning. Craftsmen Homes works with their clients early in the process to decide on the framing material to reduce costs associated with switching framing materials once the plans are finalized.

**Fabrication Area**
When evaluating a new development or project, Craftsmen Homes pays particular attention to the construction site’s space considerations to determine the feasibility of on-site steel wall panel fabrication. The ability to fabricate panels on-site not only reduces transportation costs but also offers the builder greater flexibility and response times with panel modifications and production.

At least a quarter acre is needed for on-site fabrication to handle material storage, the fabrication area, and completed panel storage. Lane Framing prefers to store the panels near the fabrication area until the construction site is ready for the panels. The further away the storage area and fabrication zone are from the construction site the more resources are expended transporting the panels, reducing one of the advantages offered by on-site panel fabrication.

**Framer/Fabricator Issues**

The framer and wall panel fabricator, Lane Framing, negotiates a contract with the builder prior to beginning a project. The framing responsibilities, as well as framing materials costs and total price are settled at this time.

**On-site Fabrication**
Lane Framing panelized the cold-formed steel wall panels at the construction site, with a third-party supplying the studs and tracks cut-to-length. The supplied steel framing members are stacked in piles to facilitate selecting the correct length and size during panel fabrication.
The framing crew prefers to fabricate the wall panels on a future home’s concrete slab. This way a flat surface is provided without having to use a framing table or other expensive equipment. The fabrication area and steel framing members are open to the environment and weather. However the framing supplies, such as screws, are kept in a storage locker.

For the observed homes, the wall panels were fabricated on-site at another development and transported by flatbed truck. Because the three observed homes are models and full home production will not begin for a few months, it was determined not to be cost effective to fabricate three homes at this site.

Model Home
Model home construction focuses on the construction sequence and minor design modifications that can reduce material costs. The model home also offers an opportunity for the trade crews to walk-through the home to identify and address any potential areas of conflict.

The model home is also used as a guide to produce layout coils. Each panel’s design characteristics are marked on two 1 ¼ inch coils of strapping, one coil for the top track and one coil for the bottom track. The coils are then used by the fabricating crew to construct the panels. The wall height of the panels dictates how far apart the coils are placed. The coil is unrolled as far as space constraints dictate and the crew builds the panels between the coils based on the markings on the coil.
Section 4 – Capital Requirements and Inventory

Builder

Lane Framing is set up to allow the builder to use of cold-formed steel framing without requiring the builder to make new capital or inventory investments. In this case study, Craftsmen Homes contracted all the framing and sheathing activities to Lane Framing.

Lane Framing is responsible for supplying and installing wall panels, floor joists, roof trusses, and sheathing for the walls, floors, and roof. Besides supplies and materials, the Lane Framing contract included panel design and associated engineering costs, but not structural design. Craftsmen Homes hires another contractor who attaches the one-inch exterior foam board to the wall panels and applies the stucco finish.

The following section outlines additional tools needed to frame with cold-formed steel over wood. Tools and equipment already needed to frame with wood are not considered additional tools.

Framer

Lane Framing has been framing homes with cold-formed steel for nearly twenty years. Over this time, Lane Framing has evolved its framing process from stick-building with steel studs and tracks to the current process of fabricating wall panels on-site. The following provides a brief overview of the capital and inventory requirements necessary to fabricate and install cold-formed steel wall panels, based on Lane Framing’s business model.

Panel Fabrication

Lane Framing fabricated the wall panels for the observed model homes at a nearby construction site and transported the panels to the building site. Once the model homes are approved, all future wall panels will be fabricated at their construction site. The tools necessary for the ten person crew for on-site fabrication include those in the following table.

<table>
<thead>
<tr>
<th>Tool or Equipment</th>
<th>Application</th>
<th>Average Cost</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Gun</td>
<td>Attaches studs and tracks together</td>
<td>$100</td>
<td>8</td>
</tr>
<tr>
<td>Chop &amp; Skill Saws</td>
<td>Cuts tracks and studs as needed</td>
<td>$175</td>
<td>2</td>
</tr>
</tbody>
</table>
Only the cut-to-length studs and tracks and the screws were stored at the fabrication area. There are no accommodations for other stock or excess material.

Occasionally, a welder is hired for piece work. The welder suppliers his own equipment and is paid a prevailing wage rate. The welder is hired to create steel support beams, as pictured here.

**Land Area**

The panels are fabricated outside and uncovered on a vacant lot either within the new development or a neighboring lot. Ideally, Lane prefers the fabrication area to be within approximately one hundred yards from the home sites to minimize transport activities. The fabrication area also serves as the storage area for completed wall panels. Before a contracted is agreed upon, the land details for wall fabrication are discussed.

**Transportation**

Completed wall panels for each home are stacked together. These stacks are transported with an all-terrain forklift to the foundation. For the observed homes, the panels were fabricated at another construction site and transported via flatbed truck to the home site, and positioned by a forklift once the panels arrived. Lane Framing hired an outside firm to haul the panels between sites.

**Erection/Framing**

Lane Framing is responsible for framing the homes and applying the wall and roof sheathing. The tools necessary for these tasks include:

<table>
<thead>
<tr>
<th>Tool or Equipment</th>
<th>Application</th>
<th>Average Cost</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Gun</td>
<td>Attaches wall panels together and sheathing to wall panels</td>
<td>$100</td>
<td>8</td>
</tr>
<tr>
<td>Plasma Cutter</td>
<td>Cuts steel members</td>
<td>$450</td>
<td>1</td>
</tr>
<tr>
<td>Shear Snips</td>
<td>Cuts steel members</td>
<td>$12</td>
<td>8</td>
</tr>
<tr>
<td>Chop Saw</td>
<td>Cut steel tracks and studs</td>
<td>$180</td>
<td>1</td>
</tr>
</tbody>
</table>
Machinery
The wall panels are moved at the job-site with an all-terrain forklift. The forklift is used to place the panels near the foundation slab for the framing crew to easily carry. For bigger and/or heavier panels the forklift assists in placing the panels. The forklift also places steel joists on the first floor walls, OSB flooring on the joists, second floor steel wall panels on the second floor, and wood trusses top of the wall panels. Lastly, the forklift moves heavy items like red-iron support beams. Lane Framing rents a forklift for each project.

Storage
Screws and other weather sensitive supplies are stored in a metal storage shed located at the construction site. Lane Framing supplies its own storage shed specifically for the framing and fabrication crews.

Power
Fabrication and framing activities receive electrical power from the city grid to operate the screw guns, welding equipment, air compressors, and saws. Temporary power polls are set-up by the electrical provider and the energy bills are paid by Lane Framing.
Craftsmen Homes, the builder, has delegated all responsibility for framing to the framing contractor, Lane Framing. Before construction began, Craftsmen Homes entered into a contract detailing the exact responsibilities to be performed by Lane Framing.

According to the contract, Lane Framing was responsible for designing the homes’ framing plan, supplying all the framing material, and framing the homes. The following describes the framers responsibilities and tasks associated with framing the observed homes.

**Panel Fabrication**

The studs and tracks arrived to the fabrication area cut-to-length, according to the sizes dictated by the cut-sheet. The third-party cold-formed steel supplier was selected through a competitive bidding process, and has about a four week delivery time. The material was separated by length and thickness and stored near the fabrication area. The fabrication crew selects the studs and tracks as needed. The studs, tracks, and completed panels are stored outside with no cover, while screws, bolts, and other smaller accessories are stored in a metal container near the designated fabrication area.

**Panel Framing**

**Foundation Preparation**

The anchor bolts were wet-poured into the concrete slab by another contractor. The framing crew places chalk lines on the slab detailing the location of each load-bearing and non-load bearing wall. Before the panels are erected a layer of foam was attached to the foundation; to serve as a moisture barrier.

**Standing and Securing Wall Panels**

The wall panels were unloaded and carried over to the foundation by hand. Once a section of wall panels was laid out the framing crew began standing the wall panels. Most panels were maneuvered by five crew members, occasionally longer panels required up to eight crew members. Heavier panels, often with wood components already attached, were hoisted into place by the forklift.
The wall panels were temporarily secured using steel studs as bracing and nails with washers driven into the foundation. Immediately after being stood up, the panels were attached to adjacent panels using screws. Anchor bolts and hold-downs permanently secured the panels to the foundation. The size and location of the anchor bolts and hold-downs are determined by the engineer.

Standing and securing the first floor wall panels took about a day and a half to complete.

Second Floor Joists
The second floor steel joists were placed on top of the first floor wall panels by the forklift. The floor joists were arranged and sheathed by five members of the framing crew.

Second Floor Walls
After the steel floor joists were sheathed with OSB the forklift placed the second floor wall panel stack on the second floor. The wall panels were sheathed after they were erected.

One of the observed model homes changed from a one-story home to a two-story home after the first floor wall panels were fabricated. For this home, the second floor wall panels were stick-built instead of being panelized and took slightly more time than the other panelized homes.

The complete second floor took roughly two days to complete, including installing and sheathing the floor joists and second floor walls. The trusses for the first floor were installed simultaneously as the second floor was being framed. The second floor crew consisted of five individuals.

Trusses
The first floor roof trusses were installed at the same time as the floor joists and second floor walls were installed. The fully sheathed low-sloping first floor trusses provided workers with a platform when sheathing the second floor walls. The trusses were placed on the walls' sills by the forklift, in accordance to California law.
Installing the trusses took about two days to complete. The truss crew consisted of five individuals.

**Crew**

Lane Framing’s fabrication and framing crews each consisted of ten individuals with one supervisor overseeing both crews. Every crew member worked from 7:00 a.m. to 3:00 p.m., five days a week. The lead supervisor has over thirty-five years of framing experience; twenty of those have been with steel. The rest of the crew averages twelve years of framing experience.

The crew members are divided into these four categories; Field Operations Manager, Journeyman Carpenter, Assistant or Apprentice Carpenter, Laborer. The Field Operations Manager’s, or lead supervisor, salary ranges from $25 to $30 an hour and is responsible for supervising the framing and fabrications crews and overseeing on-site activities. The Journeyman Carpenter’s salary ranges from $18 to $22 an hour and is highly skilled. The Assistant or Apprentice Carpenter’s salary ranges from $10 to $16 an hour and needs minimum guidance and has a medium skill level. The Laborer’s salary ranges from $8 to $10 an hour and is considered unskilled.