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# **A Case Study in Lean Construction: KHS&S**

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## Summary:

KHS&S has been successful in their deployment of lean through a balance of ongoing, disciplined training in lean fundamentals and core methods for field operations, with the development of a lean culture that not only empowers but encourages all employees to strive for improvement and innovation. By defining key lean principles and methods in their Lean House and designing a training curriculum correlated to each of these concepts, they provide a platform to spread their lean culture to the entire organization. Under this mindset, their lean core values, including communication and collaboration, respect for people, continuous improvement, and leadership, are embedded in all their divisions and departments, from the field personnel and project management to IT and Payroll.

They employ a thoughtful array of lean methods in their organization by combining them into daily routines and ongoing training. They have embedded several practical concepts, such as material mapping and color-coded weekly work plans, into daily huddle routines to empower employees to look for waste in their activities. This results in transparent procedures for their tasks, better communication of the plans, and empowerment of the workforce. Numerous examples of these techniques were observed in their office, job site, and production shop facility. They do not limit lean methods and concepts to their construction processes; rather, the training and lean concepts are merged with the daily activities of various departments, such as IT.

In addition to these strategies, KHS&S is seeking innovative methods to extend the use of lean outside of job site constraints through efforts such as prefabrication and modularization. By adopting creative solutions, they continuously seek improvements in their activities, resulting in time and cost savings and a reduction in the workforce.

# Company Overview

KHS&S established a west coast company in 1996 as a regional wall and ceiling contractor and has grown into a trade contractor focused on the installation of wall systems, inclusive of framing, sheathing, plaster, and drywall finishing, along with specialty façades and unique scenes for casino and entertainment venues. KHS&S has six (6) offices around the country, namely Anaheim, Denver, Las Vegas, San Diego, San Francisco, and Seattle, generally positioned in their core markets that are entertainment, casino, and related complex architectural designs or interiors work. ENR's top 600 specialty contractors list put KHS&S at the 59<sup>th</sup> rank in 2019. With their consistent commitment to a culture of safety, they have won many safety awards, such as the "WACA Safety Award" and Excellence in Construction Award for all their 2019 West Coast Projects, cumulatively. They currently hold the Gold level for the ABC Safety Training Evaluation Process.

KHS&S defines its core values as:

- **Direction:** Setting their own direction and refuse to be defined by others
- **Results:** Being solution-oriented and results-driven
- **Opportunity:** Offering opportunities and recognize performance
- **Pride:** Taking great pride in who they are and what they do

## Services:

**Delivery Methods** - KHS&S projects include a wide range of project delivery methods, from traditional design-bid-build contracts to more integrated delivery methods, such as design-build and IPD. They have more than 12 years of design-assist experience, collaborating with a project's design and construction team. In this respect, they provide services such as identifying and providing solutions for constructability issues, ensuring design intent by identifying appropriate construction materials and processes, and developing drawings and construction documents to expedite the construction process. As a result, project needs and expectations can be clarified, leading to minimized delays and conflicts.

**Construction Scopes** - KHS&S has many years of experience in all scopes of creating ceiling and wall finishes, including interior, exterior, theme finishes, and rockwork. As a theme contractor, they have completed projects like theme park attractions, casinos, and retail/entertainment complexes.

Their main markets can be listed as follows:

- Commercial
- Healthcare
- Retail
- Education
- Gaming
- Public
- Hospitality
- Entertainment
- Data centers and network operations centers

# Case Study Process

The case study was undertaken through a two-day visit to the KHS&S Anaheim region and included visits to a project, headquarters, and production innovation facility. During the visit, the researchers conducted interviews with personnel from the field, project management, and company leadership, along with leaders from several departments, including payroll, IT, and construction design.

In addition to interviews, the tours of the project site, office, and production facility served as observational data collection to watch ongoing operations, document how methods were implemented, and observe the behaviors of personnel in the implementation of lean methods.

## Overview of Lean Construction Implementation

The goal of the case study is to attempt to understand what it means to successfully implement lean methods and principles with a trade contractor. Each company or organization is unique, and thus no two companies will implement principles and methods in precisely the same fashion. Thus, the depth of the research is in understanding how the principles of lean can be framed or aligned to any trade contractor and how that framework can be operationalized to support the elimination of waste and continuous improvement in delivering customer value.

KHS&S teams are committed to delivering better value and eliminating waste through actively participating in lean construction practices, principles, and philosophies (Coordination, Collaboration, Communication, and Accountability). All team members participate in ongoing lean training and are experienced in enhancing collaboration with other building team members. KHS&S is an active member of the Lean Construction Institute (LCI).

The lean operations within KHS&S are led from their Anaheim office, with a lean director and supporting production analyst who both help develop and deploy lean education and resources. In addition, each regional office has a lean champion. At the time of the case study, they were working to transition leadership for core 'bronze' training responsibilities to the regional offices.

### **Lean house:**

KHS&S crafted a framework for defining and communicating their approach to lean. The lean house captured the core Lean methods and principles they have found to be consistently valuable in their lean implementation. At the lowest, foundational level, they characterize the lean methods that support their field operations, such as 5S, visual management, and the eight wastes. As you move up the house, the 'pillars' are made of the underlying thinking and application to problem-solving that comes from expanding the principle to higher-order processes and challenges in construction. At the top are the 'ideal' implementations that are pursued but are hardest to achieve, such as true Just-in-time (JIT) processes.

Through this framework, they present and communicate fundamental concepts and ideas, such as respect, improvement, leadership, and collaboration, to parallel KHS&S Core values with lean. Respect for every individual is at the core of KHS&S' culture. This respect is shown through all project teams. They are of the opinion that an engaged and satisfied workforce produces superior results on all levels. In support of this idea, leadership empowers teams to do everything better, encouraging innovative thinking and creative solutions. Continuous improvement is their constant focus, from fostering two-second improvements to identifying large-scale prefabrication opportunities. A good example in this respect is

the simple change they made to how the job box doors open; in an earlier version, a worker needed to stop his coworker to access items below, but could not open the door. However, by simply changing the order of closing, there is no longer a need to stop ongoing activities to access equipment or tools in the lower portion of the job box. This empowerment of workers and willingness to continue to iterate and improve was seen extensively throughout the case study visit and interviews.



KHS&S Lean House

## Balancing intention with training

The core to KHS&S' success appears to stem from their ongoing dedication to training, notably field leadership, in lean principles and a shortlist of core methods they deploy on a consistent basis for their projects. The training is defined into three levels, in alignment with their 'Lean House.' The core or fundamental training that is targeted for all employees is their bronze level. The Continuous Improvement Plan (CIP) an employee engages in when starting the training process contains a list of 46 training topics, tasks, and mastery items each employee must complete before receiving their bronze certification. Approximately half of these items are addressed by completing the six-module course training, and several further are assessed through their demonstration that they have mastered the defined methods, such as consistency in leading stand-up meetings over a series of observations. The final items for completing their certification are performed through independent reading and research of a lean topic that is to be presented back to the lean trainers or appropriate leadership.

The training for the bronze, in class, consists of six modules, three with primary content delivery and three that are focused on application and reflection, as summarized in Table 1. It is noteworthy to mention that training is not limited to their in-house personnel. KHS&S is willing to share and has extensively presented on what they have found in years of their lean journey with others, demonstrating their commitment to broadly expanding the use of lean for the benefit of the entire construction industry.

Table 1: Summary of Lean Bronze course modules

Class 1 – Intro to lean at KHS&S	<ul style="list-style-type: none"> <li>- Defining lean / tie to KHS&amp;S core values</li> <li>- Tie between lean and safety</li> <li>- Introduction of standard lean methods and techniques</li> <li>- Focus on Last Planner System implementation</li> </ul>
Class 2 – Last Planner System (LPS) application and reflection	<ul style="list-style-type: none"> <li>- Review and reflection from Class 1</li> <li>- “Hands-on” Weekly Work Plan (WWP)</li> <li>- Stand-up meeting procedures and elements</li> <li>- Lean thinking examples/videos</li> </ul>
Class 3 – 5S and Visual Management (VM)	<ul style="list-style-type: none"> <li>- Detailed overview/application of 5s</li> <li>- Explanation of visualization vs. visual management and examples</li> <li>- Constraints logs (LPS/WWP)</li> </ul>
Class 4 – Applying 5S & VM	<ul style="list-style-type: none"> <li>- Review and reflection from Class 3</li> <li>- Static (SAAG) vs. real-time boards &amp; tracking</li> <li>- 5S numbers game</li> <li>- Kims game</li> <li>- How to hold effective meetings &amp; meeting etiquette</li> </ul>
Class 5 – 8 Wastes & Weekly Work Planning maps	<ul style="list-style-type: none"> <li>- First run study example</li> <li>- Application/mastery of 8 wastes</li> <li>- Standard work for leaders</li> <li>- Foreman’s (Gemba) Walk</li> <li>- Weekly work plan map</li> <li>- Materials map</li> </ul>
Class 6 – Stand-up: Bringing it all together	<ul style="list-style-type: none"> <li>- Review and reflection from class 5</li> <li>- Forms and assessments (completing training)</li> <li>- Forms for stand-up meetings</li> <li>- Video examples</li> <li>- Stand-up meeting practice</li> </ul>

## Lean Methods emphasized

In adopting Lean, KHS&S focused its efforts on targeted lean methods that support field production planning and organization.

- **Weekly work plans / LPS** – the use of the Last Planner System was a fundamental method applied consistently in projects. Beyond the training and understanding of all elements, KHS&S took the weekly work plan as a key element for engagement with field personnel. The planning builds from standard LPS activities but is used to align budget information to field activities, plan detailed crew and location assignments, as well as map work areas and material deliveries.



- **Weekly work plan maps:** KHS&S' field supervision and crews participate in pull planning sessions, weekly work plans, weekly work plan maps, and progress maps with the General Contractor and affected MEPs to discuss sequencing, milestones, and safety. Even in the absence of GC or trade involvement, they routinely engage their crews in these efforts through their daily huddles.



- **Stand-up boards/meetings:** Daily huddles or stand-up meetings are conducted each morning before work begins to track the progress and activity of each worker or crew. In addition, using a standard work agenda, there is time spent discussing each group's production goal, identifying any current or expected constraints, as well as key safety planning for their activities. Before wrapping up, a 3-minute lean topic is used each day to maintain the emphasis on continuous improvement, and there is a daily stretch and flex, as well as a safety discussion.

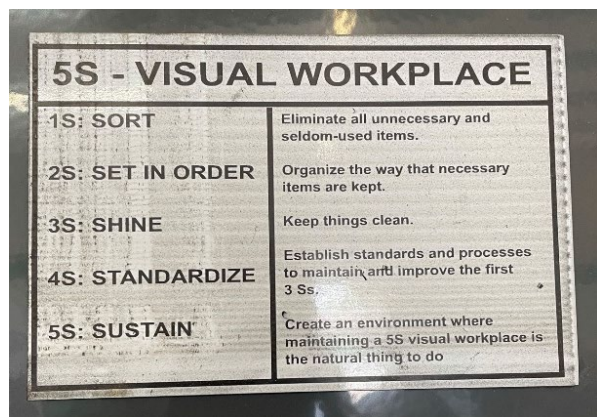


- **Materials maps**

Due to the importance of material inventory control, KHS&S uses material maps to control and track material ordering and logistics. This simple technique helps them track which types of materials have been delivered to the job site and where they will be installed. It also communicates the schedule using color-coding by day and visually portrays to the workforce where materials will be delivered.

- **5S** – the use of 5s (sort, standardize, set in order, shine, sustain) was consistently applied in the field, shop, and office to organize and streamline the use of materials, tools, and equipment. KHS&S has developed the standard, but custom job boxes for their carpenters to

improve the ergonomics of field material cutting. It further offered the organization and storage of standard tools. During the observations of a daily stand-up meeting, the foreman gave a brief demonstration with two workers preparing to do their work – one with an organized box and one that was disorganized to demonstrate the impact on time simply to get their tools and standard consumables for starting their daily tasks.



**Visual Management** – visual management was applied in several ways across operations to support simple, effective communication or tracking. Bundled materials kits at the Production Innovation facility were tagged with colors to make it easy to load only those materials for a given job.



Job boxes were marked and codified with standard tools or equipment to make them easy to find or note if they were missing. Custom safety stickers were created to quickly convey which foreman or craft had completed set training (e.g., Certified to drive a forklift). All served to shorten the time needed to take in and process the information needed for effective planning or communication. Color-coding the daily tasks within the weekly work plan created a quick visual link between the crew, task, area, and materials across the different visuals used to plan and coordinate work.

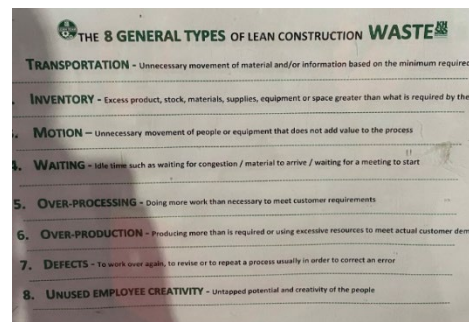


Coding Job boxes



Color-coding of daily tasks within WWP

**8 wastes – (DOWNTIME)** – In addition to educating their employees on eight types of waste in their training curriculum, KHS&S emphasized enhancing the field personnel's awareness of the waste and how to identify and eliminate it. They leveraged visualization techniques to demonstrate these non-value-adding activities in the job site by giving short explanations on waste on stand-up boards, job boxes, and other locations. As a result, workers are constantly exposed to this concept and try to implement their training knowledge to eliminate waste. They also have daily waste walks performed by field supervision to focus on the eight types of waste and also help them identify safety and areas of quality.





**Standard work** – standard work was used in creating consistent approaches, resources, agendas, or other processes that could be easily ported across projects. A standard agenda was created for daily stand-up meetings to ensure all key topics are touched on related to daily planning, constraints, lean thinking, and safety. Similarly, the continuous improvement plans for training were standardized for core elements, with some targeted flexibility for individualized learning and improvement specific to each individual’s role. Weekly work planning documents were standardized to keep them simple but structured to align with budget and material planning needs.



**Prefabrication** – In their production shop facility, they have the equipment to roll flat steel into studs and runners, which reduces the material waste from on-site cutting to less than 3%. In a typical job site, this waste is about 10%; however, by this technique, they can cut it substantially and save time and field labor. They also use a cutting machine for shaping gypsum boards. Using glue to fasten the shaped gypsum, it takes substantially less time to shape features that are often slow and labor-intensive in the field, often assembled while working on a ladder or other platform.



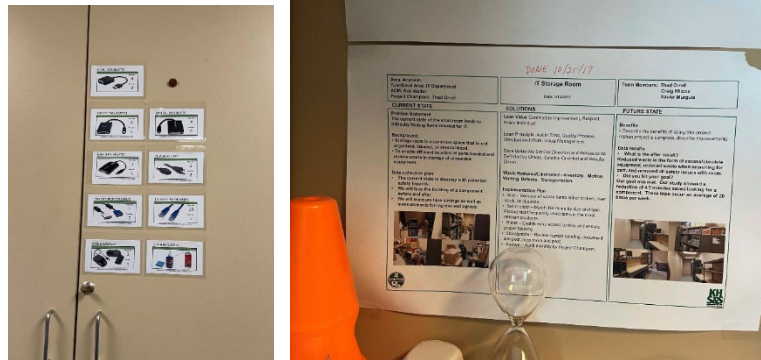
In addition to these improvement strategies, they currently have a prefabrication area in their innovation facility, where they build complete modular residential suites with all components installed. These prefabricated modules can be easily installed in the location within a week. Therefore, they can gain remarkable time-saving, as well as reduce the total costs by 30-40%.



### Engaging of everyone

While the pursuit of lean emphasizes the support of field operations and construction tasks for improving production, the processes and culture of lean permeated the office, departments, and processes at

KHS&S. The training was widely offered and taken throughout the company, from Preconstruction and estimating to payroll and IT. In addition, the certification process encouraged these groups to take and apply the methods and principles to the processes of each working group. The use of visual management was observed in the organization of visual and Kanban elements in the IT organization of project supporting technology. Similarly, payroll had mapped their processes and sought waste that negatively affects fieldcraft time related to how they interact with the payroll process. These simple concepts showed how the entire organization had an understanding of how KHS&S adds value to their clients and focuses on improving their production, reducing waste, and continuously improving.



## Concluding Thoughts

Throughout the visit, interviews, and discussions, there were practices and supporting ideas that personnel and project team members noted as barriers and enabling concepts to the use of lean. The following sections capture a few of these items:

1. Keep it simple – while it could be argued that the structure and components that have been created at KHS&S appear to be many and complicated from the outside, the core message and training delivered in-house and notably to field leadership is kept clear and simple. The focus is put on supporting the craft and their leadership in effectively planning their work. The planning engages the field leadership and the craft workers to focus on the upcoming weeks’ work, locations, crew and tool needs, and identification of constraints that will keep them from being successful. Each worker, pair, or similar workgroup has to report out daily. They share their goal and progress from the previous day and their current day’s goal, along with any noted constraints or safety concerns they need to work through. All of the other elements put in place are subordinate to doing this well. Within the methods applied, the focus is on a few targeted methods taught in a simple, straightforward, and applied fashion – how to organize your workspace and tools, how to plan your work and to support material locations, and how to look for and remove waste in the process.
2. There was an explicit understanding that KHS&S needs the methods to apply lean principles. Still, it’s not about the methods but about empowering the people and providing the methods and resources to allow them to be effective. Often within the implementation of lean in a firm, there is a great deal of emphasis on the culture of lean, whereas others emphasize the technical methods for applying lean principles. KHS&S seems to have struck the right balance. In order for lean culture to be useful, there need to be methods for applying the principles. However, if you focus solely on the methods, you lose the intent provided by the principles and culture. KHS&S has focused their training on using certain methods in a standard fashion, but with a strong

emphasis on the intention of the methods and the need for flexibility in how they are fit to a given project or task.

3. Re-learning and re-building the foundation – Construction, specifically field workers, are made up of an itinerant workforce. In simple terms, it means that no two projects will have the same team of craft workers working together. To create and sustain a lean approach and culture, there needs to be an intentional and ongoing effort to educate field personnel and leadership.
4. Building consideration of lean into crew and project team routines – the emphasis on lean was incorporated into the standard agenda for a daily huddle, both in focus on production as part of the weekly work planning as well as a brief 2–3-minute discussion of lean every day. Similarly, the discussion of the effectiveness of meetings through a plus/delta process was included at the conclusion of project management team meetings. The consistent incorporation of lean as a topic of discussion keeps the topic and supporting principles as a constant theme of all efforts within KHS&S projects and operations.

## Other Observations

**Knowledge sharing** - an ongoing challenge of any construction firm is how to best harness the array of knowledge distributed throughout its people and then find and apply it when and where necessary. As a construction company grows, this challenge grows exponentially. KHS&S does a great job with training, standards, and ongoing efforts to identify when project teams need support or resources. Still, effective knowledge sharing, similar to continuous improvement, is about the constraint pursuit of perfection with the recognition that it is a journey rather than a destination. Companies are, in some senses, a network of people. In project-based industries, like construction, that network is often pooled into project teams. Knowledge sharing occurs through these networks and connections. Finding methods to increase the interconnections in meaningful ways creates the ‘infrastructure’ and expands the capacity for knowledge sharing when and where needed.

**Documentation** - While much documentation should be streamlined, there are a few areas where documents should be created that were not observed. For example, when project teams experiment with new tools, processes, approaches to prefab, or other ideas – these need to be captured and shared. If an idea works, you want to be able to share it quickly and easily, as well as make sure methods or processes that do not work are not repeated by others.

**Visual Management** – The organization of materials was strongly demonstrated. The next step in improving the flow of materials is making the need for their purchase/delivery obvious. Finding simple ways to convey when consumables, such as screws, have reached the level of needing more can be conveyed or using pictures rather than text to track tools that should be in a job box. While a simple example, methods for employing visual management in simple but effective ways is one of the ongoing challenges of autonomation / jidoka in lean efforts. These techniques help reduce miscommunication, especially in multi-lingual job sites.

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