Coordination and Efficiency: Hallmarks of St. Luke's Campus construction

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Any multifaceted task requires an effective process or workflow to achieve a successful outcome. The construction field, in particular, presents a unique challenge in workflow as a result of the extremely complex nature and variance of each project, including, but not limited to: specific requirements, delivery method, contract type, and team location. To design, build, commission, test and balance, and eventually turn over a building to facility operations, a massive amount of information must be created and shared, which generates myriad opportunities for inefficiencies, miscommunications, and rework. Looking at one successful project delivery in California can show the value of a unified workflow.

A new replacement hospital is currently under construction at Sutter Health California Pacific Medical Center's St. Luke's Campus in San Francisco. The replacement hospital is notable not only for its size—totaling 232,000 square feet, seven stories, and 120 beds—but its advanced technical and regulatory requirements, including compliance with California's Office of Statewide Health Planning and Development (OSHPD) standards. The project also includes many areas with unique requirements, including five operating rooms, two C-section operation rooms, 10 intensive care unit beds, 10 airborne infection isolation rooms, a pharmacy, advanced imaging, a preoperative area, and a postoperative recovery area.

Photos courtesy of Smith Group JJR and Associate Architect, Boulder Associates.

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From the outset, the team acknowledged the importance of analyzing both team dynamics and a defined workflow to efficiently deliver a successful project. As such, Sutter Health employed an integrated project delivery contract and project management approach and brought Southland Industries on board for its design-build project. Ultimately, the team challenged the traditional project delivery process by implementing a unified workflow for the mechanical and plumbing system design and construction.

Challenges of a traditional model

The first step to realizing opportunities for increased efficiency with a unified workflow is understanding the traditional project delivery that is commonly applied in design-bid-build and design-assist projects. Engineers and designers begin all projects with preliminary architectural plans and owner requirements to create the initial system layouts and designs. The contractual responsibility of the engineer is to produce a set of drawings that can serve as the permit and provide all the information a contractor needs to build. The contractors are brought onto the project at the end of this design phase when they receive the contract drawings from the engineering firm. This marks the start of the construction portion, where the contractor will begin to recreate the design in its company's modeling software and use these models for two purposes: to coordinate the systems in 3D with other trades and to fabricate directly.

The project management team uses the engineering contract drawings as the basis for the budget, equipment procurement, and manpower loading. If design clarifications are required during the course of construction, the contractor must contact the engineer, who, while required to be available, may have already moved on to other projects. This background serves to help analyze the inherent inefficiencies that exist in this style of project delivery.

In the traditional model, design and construction are two distinct and separate phases with few opportunities for the two to influence each other. As such, constructability is not a focus until after the design has been completed. Typically, engineers are not contractually obligated to coordinate the systems, so they have little incentive to design for constructability; rather, their primary effort is to produce code-required documentation and the design drawing deliverable. This leaves much, if not all,

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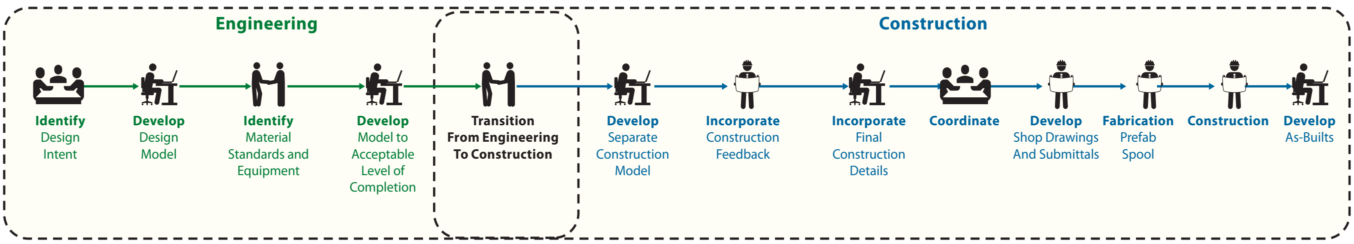
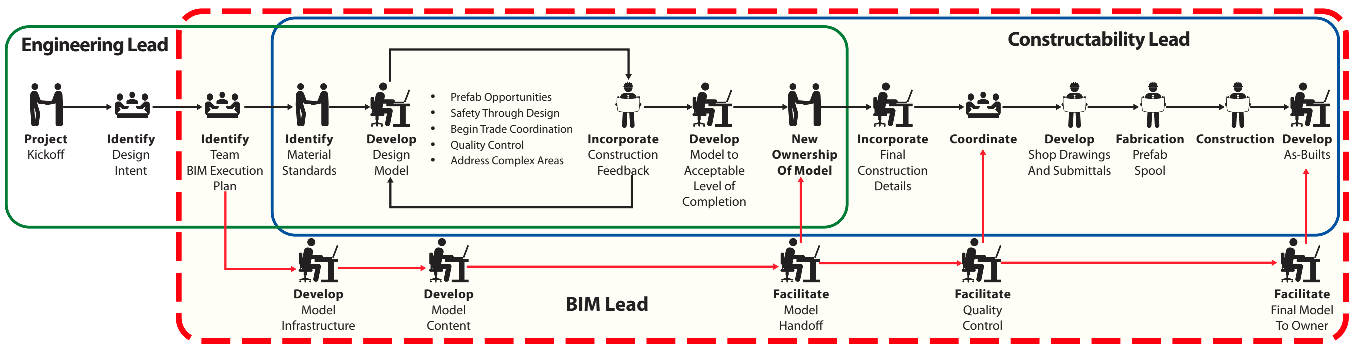
Traditional Work Flow



Unified Work Flow



of the spatial coordination to the contractors after the design has been completed and the project is well underway—thus making changes for coordination purposes more difficult and nuanced since they may alter the permitted design drawings.

A required duplication of modeling content and information is another inefficiency with this project delivery method. While it is common for engineering firms to model their systems in 3D software, the software is sometimes not compatible with the fabrication software that contractors use, and does not commonly contain the required information for fabrication. Therefore, the contractor often rebuilds the project to produce their deliverables and work out final details. A unified workflow is designed to eliminate this duplication of work and any issues that result from a lack of coordination early in the design phase.

Benefits of a unified workflow

Unified workflow is the concept that an entire team, including design, model coordination, and construction, works

toward a single deliverable. Essentially, it is the successful turnover of a working building to facility operations. Unified workflow is founded on several key principles:

- The participation and communication by all parties in each phase of the project will create a more efficient process
- "Designing it to build it" will result in an overall reduction in work and cost
- A "single model" results in reduction in rework
- Change in not only the process but the way that the team approaches a project
- Ideology that facilitates communication and flexibility within the team

For the St. Luke's project, the unified workflow streamlined internal processes and produced a project on budget and ahead of schedule.

Creating a unified workflow requires that all invested parties are included from the project's beginning through building turnover. The key players in this approach include the project manager, the engineering lead, the constructability lead, and the building information modeling (BIM) lead. Project requirements typically drive how the BIM lead will set up a project for delivery, which is very important in how the flow of information (the model) is transferred between team members.

The St. Luke's project team began the design using CAD software. It was determined that the design team would produce all initial ductwork and piping systems in 3D based on engineering considerations. To maximize this 3D work, the team's engineering and constructability groups combined to establish trade zones for each system. This minimized potential team conflicts and reduced rework. Another important step was to collaborate with the division constructability leads to discuss past health care construction and design issues and to discuss possible solutions before they arose. Special considerations were given to coordination of heavy areas, such as operating rooms, ICUs, and main entrances, where the combined experience dictated that the coordination effort would determine the appropriate design. By initially allocating the constructability resources to those areas, the design team was able to focus elsewhere until these locations were coordinated. This allowed the team as a whole to meet the project's aggressive timeline.

From design to coordination

The goal of the St. Luke's team was to "draw it once and draw it right." In other words, strive to produce a model with the least amount of manipulation required throughout the duration of the project. To achieve this, the team needed to coordinate the modeling software prior to developing the design model, and the model itself had to be developed with constructability as the primary focus. It was not simply enough to have the software and general trade zone elevations identified; important constructability concepts such as preferred routing and opportunities for pre-fabrication also had to be included in the model development. Incorporating constructability into the design reduces work, and the design team's continued presence in the construction and coordination process can also greatly benefit the team when changes do occur. In a perfect world, any changes after the initial design would be minor and uncomplicated; however, construction projects do not exist in a perfect world, and a unified workflow can streamline large and small changes alike.

For example, OSHPD reviewers of the St. Luke's project did not accept an alternate means of compliance for a morgue/autopsy room. When the team received its final judgment, it had to incorporate the new design quickly for OSHPD review, as well as re-coordinate sections of two floors and the underground that had already been completed.

To initiate this process, the engineers needed to understand the new requirements and how they would affect the rest of the team. This would include a brand-new exhaust system, new underground utilities, and a new shaft to discharge to the lower roof. After consulting with the architects about general locations where valuable floor space could be removed, the team began reviewing the 3D model to evaluate potential routes. A sketch then was produced and distributed to the detailing team to make constructible.

After the ductwork was routed and shaft dimensions were produced, both the engineer and detailer communicated their needs to the architect to finalize the location and secure the updated architectural plans for final verification. If this was a different type of project

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delivery, the routing would have been produced twice and typically without the initial spatial clairvoyance that a coordinated model provides. In a standard model, only the designers and architects would have been stakeholders for the submission. This means that a design would have been drawn, completed, and issued as a bulletin for the construction team to price and incorporate.

The unified workflow brought additional stakeholders into the initial design and allowed completion of a nuanced task from design to coordination in a week with minimal rework and a clear goal of constructible design intact—all while maintaining the original schedule and keeping manpower at the same levels.

The unified workflow also benefitted the St. Luke's project when design review led to the addition of humidity control to the post-operative recovery suite. This required changes to three designs: mechanical ducting, mechanical piping, and plumbing.

A typical workflow would have had the engineering team consider duct material, humidifier performance, steam condensate draining, and general routing, again, leaving coordination to a later date. Without using a unified workflow, this might have required a formal design document provided to the contractor, as well as possible requests for information (RFIs) from the contractor to the engineer if the design was not constructible. However, the St. Luke's unified workflow enabled the team to coordinate the multiple services to fit into a crowded ceiling space, while factoring in the accessibility of the humidifier for the Sutter Health Facilities team; and without the tedious back and forth of design revision documents and RFIs.

Any time-intensive project involves many milestones that must be completed for construction to begin. When a project spans multiple years and countless reviews, the design is particularly fluid, which inevitably creates a ripple effect that must be captured in both the engineering and coordination models (per the standard delivery). Typically, this includes multiple rounds of trade coordination, one or more rounds of user or owner review, and in cases such as hospitals in California, multiple rounds of OSHPD review. The St. Luke's project, which involved one permit for structural design and underground utilities and a second for the architectural and MEPF services, went so far as to require multiple rounds of review of each permit at the same time.

Between each of these deliverables, many changes were required and incorporated for review and coordination, but they extended far past the software and into the actual construction. Operating under a design-build contract with a unified workflow, the team was able to bring constructability into design and modeling at the start, resulting in streamlined project delivery and bucking the traditional model where design and construction are two distinct and separate phases.