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Chapter 19

Integrated Facility Design at Seattle Children’s Hospital

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Strategic analysis of Seattle Children’s Hospital’s (SCH) market position and patient access challenges in early 2000 pointed out the need to expand accessibility and services offered to the rapidly growing “Eastside” of the Seattle metro area. The board approved the building of a clinic and surgery center off of the main campus in Bellevue, Washington, in order to improve access to pediatric subspecialty services, create additional capacity for the main Seattle campus by shifting outpatient clinic volume and procedures to the new building, increase SCH’s presence for Eastside growth, and improve inpatient referral volume. The facility would be designed to support a universal clinic, outpatient surgery and recovery, infusion, imaging (magnetic resonance imaging [MRI], fluoroscopy, and radiology), a lab, and a pharmacy, with a 240-space parking garage.

Lisa Brandenburg arrived on the scene at SCH’s shortly after the board’s decision and was handed the assignment to “get Bellevue built.” Shortly thereafter, Lisa had a conversation with Pat Hagan, SCH’s COO, which went something like this: “We’ve done CPI [continuous performance improvement] in almost every area of our enterprise, except facilities. Let’s design and build this facility using Toyota methods. When can you go to Japan?” Before she knew it, Lisa was bound for Japan with SCH’s CEO and other members of the senior team to participate in a factory production preparation process (3P).

Upon returning from Japan, Lisa and her executive leadership colleagues agreed to approach the design and construction of this new facility in a new way, staying true to the CPI philosophies and building on what the team had learned in Japan. Lisa laid down the challenge: deliver a facility that meets customer demands, occupies a smaller footprint, uses fewer design and build resources, is constructed in less time, and reduces the total ownership cost. To achieve these results, a very different process was needed.

Early estimates for the Bellevue project indicated the facility would need 110,000 square feet at a cost of $100 million to meet the desired program needs. The response to that estimate was simple: cut the square footage by 30 percent, reduce costs to $75 million, but keep the program requirements the same. As if the challenge was not great enough, the board of directors subsequently asked for an additional reduction to a $70 million total cost level or the project would be put on hold.

In the end, the eighty thousand square foot (a 30 percent reduction) Seattle Children’s Bellevue Clinic and Surgery Center will run under the allocated budget.
by $3 million and open one month early. This is the story of how this was accomplished by SCH and its partners.

The Approach

As a new space design for an efficient facility was envisioned, so was the supporting design process. The traditional approach of industry benchmarking, parametric sizing, protracted user group input, and the separation or siloing of the owner, project manager, architect, general contractor, and subcontractors was purged and replaced with a concurrent set of design activities through a sponsor and project management (PM) group, a facilities team, and a core team. The sponsor and pm group maintained strategic direction and removed barriers. Included in this group was SCH (owner), Joan Wellman & Associates (lean counsel), the Seneca Group (design manager), NBBJ (architect), and Sellen Construction (general contractor). The facilities team provided guidance on specific design and construction issues and connected the owner, architect, and contractor throughout the project. The core team acted as stewards of the lean principles, assured alignment as decisions were made, and defined the intersection between the functional work design and the physical construction. The core team integrated strategic plans and daily operations by blending user and designer desires from inception to delivery. Core team members acted as advocates and champions, subject matter experts, and inspired designers responsible for meeting project targets and assuring success.

The process of design for the core team spanned four phases that included (1) a project management and governance phase, (2) a conceptual design phase, (3) a functional design phase, and (4) a detailed design phase. The overall core team project phasing is shown in Figure 19.1.

Phase 1: Project Management and Governance

The purpose of the project management and governance phase was to assure alignment on time frame, select the core team membership, and develop solutions or countermeasures for the issues that would impact core team launch. A key element was the interview and selection of the architect and the general contractor. Joan Wellman & Associates (JWA) collaborated with SCH in the selection of the core team and the internal project manager, charter development, and sponsor expectations. An initial data set was gathered that included process lead times and cycle times, resource requirements, and specific medical specialty requirements.

The governance activities established the core team’s roles, responsibilities, norms, and agreements, and solidified the project expectations. A set of lean guiding principles was developed to assure core team alignment in project purpose, method, and outcome. A summary of the guiding principles is shown in Figure 19.2. The core team operating norms and agreements and metrics were set.
Next, considerable time was spent with the core team to understand the hospital’s strategic plan. The process allowed the core team to fully understand the corporate strategy behind the project; become grounded in the data, logic, and policies that formed the project assumptions; and align with the performance parameters that would guide future decisions. Questions regarding the project timeline, whether primary or ancillary support services would be shared or dedicated, initial space estimates, demand estimates, and facility performance requirements were answered. Ultimately, the core team had to understand and “buy into” the strategic planning assumptions in order to define the facility’s ten-year programming requirements.

In addition to strategy review, the project team conducted an analysis of the current operating conditions. The voices of the patient, family, provider, and staff were recorded through a series of structured interviews and gemba walks in the current outpatient facility. This phase ended with core team feedback regarding what had worked well on similar projects, what should be avoided, and what should be improved for this project. With the project established and governance issues resolved, the group was ready for conceptual design.

**Phase 2: Conceptual Design (System Level)**

The conceptual design phase was accomplished through a five-day integrated design event (IDE) that delivered a conceptual design or theoretical description of
Values / Beliefs / Philosophies
➢ The design is Patient/Family/Staff/Provider centered.
➢ The facility is organic and adapts with the future – it is not obsolete upon opening.
➢ Environmental Sustainability is considered and permeates all design and construction decisions.
➢ The facility creates a unique experience as a healing environment.
➢ Children’s is an academic medical center with Bellevue in support of this intent.
➢ Patient safety is paramount.
➢ “Customers” include patients, families first. Our design must also support staff, and providers, Bellevue community.

Assumptions
➢ The space / structure is designed with future flexibility in mind. Facility barriers to change are minimal.
➢ The multiple usage of available space is maximized (e.g. giant stairs) and all spaces are considered candidates for multi-use. The exam rooms are universal and are designed for rapid reconfiguration and multi-use.
➢ Space is a function of need and is owned by the Common Patient Flow.
➢ The design maximizes the multidisciplinary model of care and supports the clinical research and teaching mission. Each service will determine the academic model that is appropriate.
➢ The facility is designed for high throughput (capacity and process meets demand).
➢ The clinical space is maximized and the office space is minimized utilizing a lean perspective.

Principles
➢ The Value Stream contain multiple services and processes to drive effectiveness and efficiency. The services (Dx / Tx) are physically embedded within the flows.
➢ Standardization is the source of efficiency and flexibility and is the foundation of improvement.
➢ Simple designs with fewer components make for reliable service. The larger the system scope, the less reliable the system. Simple is always better, processes must be intuitive, complexity is a veiled type of waste.
➢ The space is right sized to the task (monuments are avoided) recognizing that too much space is an enemy and drives waste.
➢ Build tents, not castles – flexibility in built in to allow for rapid reconfigurations
➢ There is a line of sight and visual management created that promotes flow and identifies abnormal conditions at a glance.
➢ Mess and infection prevention are high considerations in design – an ounce of prevention is worth a pound of cure (detection).

Concepts
➢ Continuous Flow Theory with the management of variability is used to achieve high throughput service. A pull system is fundamental to continuous flow and is used to minimize blocked or congested patient flow through the facility
➢ The work cell concept is utilized and promotes single piece flow and dedicated services.
➢ The concept of sub assembly production is used as it improves flow and throughput.
➢ The facility utilizes the modularization of internal components and the placement of modular components for future flexibility.
➢ The flow has ‘One way in / One way out’ at the system level and the ‘same exit and entrance’ at the work cell level. Materials enter from outside of the cell and handoffs are minimal. Location of services to entrance / exit must consider the process, service provided and hours of operation.
➢ Supplies, tools and equipment are at point of use and move from the dock to fingertips without storage.
➢ Flexible walls / partitions can be used so that exam rooms and team rooms can be created as required.
➢ Wayfinding is clear and apparent.
➢ There is point of care testing within the surgical suites.
➢ There are open area clinics with line of sight to exam rooms. Documentation / dictation will occur in the exam room. There are multi-use conference huddle spaces available for the Team Room function. There are Simple Cells / Complex Cells with Huddle Space
➢ Pre-op and Phase I and II recovery are the same space. Families are in this space.

Figure 19.2 Bellevue Project guiding principles. Lean guiding principles developed to guide the design process.
a facility that achieved the guiding principles. This overarching conceptual model provided a consistent vision from the strategic plan through to construction. The core team's involvement in this five-day event ensured that its members were the “keepers of the design concept” from early inception to the operation of the facility on move-in day.

During conceptual design, a work flow analysis was performed that considered the type of service demanded; the patient, family, staff, and provider routings; the lead time and cycle time of each process; and the associated resource requirements. Utilizing group technology (a methodology that balances cycle time, customer demand characteristics, and resource use similarities), the integration of programs yielded common routings and the logical grouping of similar services with shared resource solutions. From this work, common patient flows or value streams were identified and confirmed against the facility’s program requirements. For example, the procedure-centric clinic specialties of ophthalmology, otolaryngology, dermatology, urology, and plastics would share space, while the longer cycle time and consulting nature of pulmonary, neurology, psychology, and adolescent medicine would be collocated. Likewise, the shorter cycle time clinic visits of urgent care, general surgery, gastroenterology (GI), nephrology, and cardiology led to the grouping of these specialties. These services would traditionally occupy separate and larger spaces. The conceptual design is shown in Figure 19.3.

Participants in the conceptual design IDE were asked to think “out of the box,” without the square footage or building footprint constraints. The IDE outcomes from this phase included (1) a definition of patient flows that addressed the performance needs of the facility, (2) a performance specification and capacity analysis for each identified common patient flow or value stream, (3) a conceptual space design with room allocations in support of the value streams, and (4) a rough space plan with block diagrams and a schematic of the “seven healthcare flows.” An example of the conceptual design with multiple flows is shown in Figure 19.4.

Phase 3: Functional Design (Value Stream Level)

During the functional design phase, the overall utility of the facility was defined. The constraints and requirements established adjacencies and necessary connections between value streams, resulting in an overall stacking and space plan. Through the construction of and experimentation with macro mockups, the group demonstrated how the value streams would operate, resources would be utilized, and people would interact in the proposed space. The realities of the structural and mechanical limitations were introduced at this point to ensure that the realities of the site, code, and other constraints were recognized.

During a five-day functional design IDE, the core team physically modeled seven healthcare flows in action so that a descriptive text of the functionality or operational composition of each value stream could be generated. The seven
healthcare flows were patients, families, staff, supplies, equipment, medications, and information.

A full-scale “macro” mockup allowed the team to test space shape, size, and adjacencies. The mockup walls were easily repositioned to test new ideas within seconds. For example, the core team mocked up virtually all of the surgery space as part of the macro-mockup functional design. After experiencing the full-scale mockup, the team substantially changed the initially accepted two-dimensional paper design. Repeated scenario testing of the seven healthcare flows with stopwatches and simulated patient, family, provider, and staff “actors” demonstrated the strengths and weaknesses of the design. In addition to the mockup, a discrete event computer simulation of the value streams supported decision making regarding space relationships, final adjacencies, and

Figure 19.3 Conceptual design. Lean concepts were used to analyze and recommend floor layout to minimize space.
Figure 19.4 ASC conceptual design. With an efficient overall floor plan, the next focus became patient flow through clinics.
functional affinities. An example photo of one of the macro mockups is shown in Figure 19.5.

**Phase 4: Detailed Design (Operational Level)**

The detailed design phase was completed through a series of highly focused IDEs, combining the best thinking of staff, patient families, and designers. The purpose of these micro-IDE sessions was to define the working-level detail (e.g., interior equipment, services, work surfaces, storage, and utilities) for each area. Using “7 Flows of Medicine” and waste analysis, the IDE participants generated interior room details. An example photo of a room interior is shown in Figure 19.7. Figure 19.6 shows the output of the detailed design event for a clinical floor.

**From IDEs to Construction**

The use of lean thinking did not stop when the IDEs were completed. Far from it! For example, when it came time to do construction detailing, three-dimensional modeling and further mockups and test fits were used along with weekly design workshops with experienced leaders from all disciplines. During construction, offsite prefab of facility components improved cost and schedule performance. A triparty
Figure 19.6 Detailed design of clinical floor. Finally, the team knows where everything goes.
contract agreement was used to align the owner, architect, and general contractor
with a mutually beneficial common goal and shared “risk pool.” This arrangement
promoted teamwork and alignment in a way that traditional contracting had not and
set the tone from the beginning that infighting and poor cooperation would only
lead to everyone’s misfortune. Lean construction principles were applied through-
out the construction period, including the use of “pull planning” with subcontrac-
tors. The cumulative results of these innovations are described below.

The Payoff

The Bellevue project met the goals laid out by Lisa Brandenburg for cost reduction,
space reduction, and on-time delivery. The space reduction from 110,000 square feet
to eighty thousand square feet was achieved primarily by (1) the successive review
of the mocked-up physical space by the core team, and the core team’s agreement
to minimize space requirements through multipurpose use; (2) data-driven capac-
ity analysis based on lean processes, not current practice; and (3) physical mockup
and computer simulation of patient, provider, and staff flows to strip unnecessary
square footage and travel distances that did not support efficient activities. The
traditional approach of using industry benchmarks was rejected, and a zero-based
methodology challenged all current-state baselines. The volume data, process flow

Figure 19.7 Exam room interior. As detailed design concludes, lean principals
are part of the design and nearly every detail has been considered. There should
be little uncertainty or surprises at this point.
analysis, and functional descriptions justified the requested space, not the personal or experiential preferences of the users.

One of the key validation measures of the success of the integrated project delivery or lean design and build project is the cost performance. The target value design was set at $45 million and performed at $40 million. The cost model was based on benchmarks, while the target budgets were established through team collaboration. Each discipline had ownership of the costs and tracked its individual budget. Budget status was shared weekly and collaborative cost management caused a reduction, as shown in Figure 19.8.

How does the Bellevue project compare to other projects of similar size and scope? Table 19.1 shows a comparison of key metrics to demonstrate the success of the lean approach.

It is well known in the design and build world that the amount of change activity over the life of a project and response time for the acknowledgment and resolution of issues are major drivers to total project costs. In reference to Table 19.1, an RFI is a request for information generated by the general contractor, a CIW is a change in work produced by the architect, and an owner-requested change (ORC) is written by the owner. There was a stark contrast between the Seattle Children's

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**Figure 19.8** Cost target achievement. Estimating categories of cost at various points in the design process. Lean principals drove down cost. *Source*: Courtesy Jeff Giuzio, partner, Seneca Group. Unpublished intellectual property of the Seneca Real Estate Group Inc.
Bellevue Clinic’s (SCBC) change activity and that of the comparison project. Also, the number of submittals (confirmation by the contractors to the architect’s specs) is shown in Figure 19.9. The submittals indicate the relative ambiguity of the design and incompleteness of the information as each stage on construction progresses. The low number of submittals received (primarily at the front of the project) was a demonstration of the high quality of the design. This had a strong positive effect on lowering the cost. The rapid turnaround of the submittals also helped maintain excellent schedule performance.

The RFIs are requests from the general contractor and indicate the level of project rework. The RFI performance shown in Figure 19.10 was startling because of the low quantity, which further demonstrates the robustness and collaboration of the design and build processes.

The coordination of the design and build groups from the very beginning of the project, with fewer change requests occurring early in the process, helped keep the

<table>
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<th>Metric Description</th>
<th>Seattle Children’s Bellevue Clinic</th>
<th>Project X</th>
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<tr>
<td>Completion date</td>
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<td>June 2004</td>
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<td>Project duration</td>
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<td>Quantity of changes in work (CIWs)</td>
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<td>Quantity of owner-requested change (ORCs)</td>
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<td>Total CO amount (% of total)</td>
<td>2.32% @ 80% complete</td>
<td>7.6%</td>
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Critical Leadership Implications for Facility Development

Seattle Children’s Bellevue Clinic gave the partners an opportunity to collaborate in very new ways to achieve remarkable results. The following are reflections on the “must haves” for successful integrated facility design.

Lean Experience

The integrated facility design (IFD) process is best used in an organization that already has lean thinking as part of its operational philosophy and a natural way of
thinking. The belief that much of what the processes contain is waste; that single-piece continuous flow of work is the goal; that waiting and idle resources are waste; that too much space is waste; and that travel, multiple handoffs, and searching should be reduced are foundational building blocks for an IFD process to deliver significant results. Attempting to do IFD and lean design in an organization without prior experience with lean would likely fail.

SCH’s CPI experience and knowledge helped resolve many design issues. Any of the issues could have been resolved differently if thinking had not been guided by a number of key lean concepts. For example, the principle that all of the space should be flexible and usable for multiple purposes helped the core team break down the traditional departmental thinking and generated designs with more standard and shared spaces. The idea of “building tents, not castles” brought in a deeper understanding of flexibility and rapid reconfiguration in contrast to hunkering down into one’s own space. Initially, few believed that too much space was an enemy until they saw how it promoted excess travel time and impaired “line of sight.” The lean principles permeated the mind-set of the participants from concept to construction so much so that waste was equally attacked in the design process and in the physical product.

Figure 19.10  Request for information (RFI) frequency. Do you know what you want? With lean design principals, you do, and rework required during design is vastly reduced. Source: Courtesy Jeff Giuzio, partner, Seneca Group. Unpublished intellectual property of the Seneca Real Estate Group Inc.
Project Leadership

It is crucial to have strong, experienced leadership guiding the project. This process changes how people perform their work. The leader needs to continually bring the team back to their guiding principles and objectives over and over again and not allow the work groups to slip back into “traditional” facility design or decision-making practices. For example, it was a foundational principle that the determination of the number of clinic rooms required for various specialties should be based on verifiable data (i.e., expected volumes, cycle times, and work-in-progress [WIP] calculations). There was a tendency to make the room decision based on personal beliefs (“I think this is how many I need” or “I need more than I have”) or on architectural planning calculations guided by industry benchmarks. This tendency requires leaders to rely on quantitative analysis and computer simulation models when demonstrating that the building is “big enough.” Strong and experienced operational leadership paired with strong facility-building leadership are critical in order to “stay the course” with lean thinking.

Core Team

The core team should be composed of the organization’s best lean thinkers rather than populating the team with the “usual suspects” needed for political acceptance.
The core team must “own” the design rather than simply react to the architect’s design. In the Bellevue project, the core team lived the project from concept to becoming members of the operations team. Team members knew that they were accountable as stewards of the design from beginning to end. The core team needs to include all key parties from the start, including the architect, the general contractor, and other key construction partners.

**Logical Sequence**

It is common for groups to rush to a detailed layout prematurely. Applying a logical sequence for the development of the end user space meant moving from an abstract, unconstrained perspective to a detailed design by progressively adding constraints. Understanding the clinical and surgery center functional requirements, establishing critical adjacencies, and defining operational workflows before bringing in the constraints of the building and building site allowed the core team to design the building to fit the work rather than fit the work into a preconceived notion of the building. This may not always be feasible, but when building a new site it is an optimal approach.

**The Value of Mockups**

Mockups are frequently used during the design process, but rarely at the scale done for this project. The importance of mocking up not only individual spaces but also the relationship between spaces is critical to lean design and can lead to considerable breakthroughs. In the Bellevue project, mockups promoted early rapid prototyping, and participants often made their spaces smaller, changed traditional adjacencies, or completely changed their design thinking after “seeing and using” their paper design brought to life. Renting empty warehouse space for large-scale mockups was worth the investment, resulting in an improved design, reduced change order activity, and minimal friction between owners and architects. In the traditional design process, the parties would be looking at blueprints and attempting to resolve conflicts or downsize without truly understanding how the proposed space would function.

**Alignment of Incentives**

As discussed earlier, a triparty contract agreement was used to align the owner, architect, and general contractor with a mutually beneficial common goal. A contingency fund was established so that if common goals were met, the pool would be split three ways. As shown in Figure 19.12, the design team performance contingency (DTPC) line represents an acceptable project but without the distribution of an award. The initial team target line represents full incentive distributed. The “actual DTPC use” line shows that almost the entire contingency was received. It
should be noted that there was also a risk element that balanced the reward. It was possible for the project to go above the DTPC line and for all parties to be required to fund the overage if costs were not controlled.

While an integrated form of agreement requires significant effort to develop, the payoffs in cost reductions resulting from collaborative decision making and integrated problem solving are considerable.

**Conclusion**

Not everything was perfect. It was said many times that “we learned as we progressed,” The group did not “make it up as we went along” but rather traveled together on a project of new ideas and discovery as guided by a reliable process. The lean, healthcare, project management, architectural, and construction expertise converged on new problems and solved them as they arose. For example, a traditional equipment-planning process was layered on top of the lean design structure. In retrospect, equipment planning should have been integrated into the work early on. In the end the equipment budget was met, but it required more energy to complete than if integration had been comprehensive.

The project targets and methods were strategically driven from beginning to end. Traditionally, similar projects are viewed by many as a facilities responsibility and cost reduction expectations are expected to be generated well after the concept and functional decisions have been solidified. In this project, the new process
changed the role of the facilities department, forcing much earlier and much deeper joint decision making with operational leaders in the room. While these were not uncomfortable changes, given SCH’s history with CPI, they were nonetheless changes that required modifications to past practices.

SCH set the culture and expectation of excellence and the way work would be done. This approach changed the job for everyone, especially the architects and contractors in relationship to the owner’s involvement. The core team became intimate with the design and “owned it,” a role usually played primarily by the architect. The adjustments were not “drama-free,” but when the team successfully emerged on the other side, there was agreement that the old way would never be used again.

Deeper education on the lean principles was needed by all team members. For this project, the traditional sequential or “waterfall” model of design development was replaced by an integrated or iterative methodology. Concurrent engineering or the parallel and overlapping processing of conceptual, functional, detailed, construction, sustainability, and life cycle design activities was not understood by all and caused conflicts. Selecting a core team with lean experience was not enough. Process experience with the lean concepts was an insufficient replacement for specific lean design and concurrent engineering knowledge. Also, there was the belief that the non-SCH team members could learn as the project progressed, but the mismatch in levels of lean understanding caused friction and delay. The architects and contractors were selected because of their lean experience, but as the project unfolded more education was needed than initially imagined.

“We Did It!”

The Achilles’ heel of traditional facility design with user groups has been the inclusion of a select few, resulting in design disagreements by the eventual operational residents who were never asked. The process used throughout this project was very transparent. Great effort was made to solicit constant feedback at every decision point. With newsletters, daily updates, open houses, mockup tours, structured interviews, surveys, and countless tie-in meetings, every avenue of outreach was employed. The input was incredible. Patients, families, providers, and staff were involved every step of the way. The goal was to exhaust the users with requests for feedback and then ask them again. The results were worth the effort. Hundreds of people “touched” the design in some way. The outcome is truly the product of a shared vision.

Although the quantitative evidence demonstrates undeniable success, some of the emotional aspects spoke louder. The sense of accomplishment—“We did it!”—is palpable. Core team members frequently expressed their enthusiasm for being included in the project. Other non-SCH team members saw this as one of the best projects of their careers. Still others keep asking, “When are we going to do this again?” Such comments are the reward for the lean leader.