

INTEGRATION AT ITS FINEST:

Success in High-Performance Building Design and Project Delivery in the Federal Sector, Volume 2

Research Report
January, 2018

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Sponsored by Office of Federal High-Performance Green Buildings, U.S. General Services Administration

Executive Summary (1 of 2)

The importance of an integrated design process using integrated teams has long been recognized as a core concept in creating high-performance green buildings. This study is Volume 2 of *Integration at Its Finest; Volume 1*, a report released in 2015, explores integrated design processes in three high-performing federal buildings. Volume 2 examines the collaboration processes of two recently completed GSA projects to link high-performance outcomes and other building-innovation outcomes with integrated decisions made during the design and construction processes. This study identifies best practices and lessons learned for future project teams.

In Volume 1 of *Integration at Its Finest*, we covered three high-performing federal buildings. We found that these high-risk projects required complex solutions that included commercial strategies, leadership strategies, and logistical and process tactics. The key to these tactics leading to successful collaborative project delivery was an investment in developing and maintaining a culture of collaboration. The GSA's leadership in promoting collaborative practices at the start of RFP development, during team selection, and in the development of the contract often set the foundations of a collaborative culture for project teams. When teams and the GSA used communication and process tactics to align a broader range of stakeholders (e.g., suppliers, subcontractors, consultants, tenants), there were clear behavioral changes that promoted trusting working relationships and that helped to mitigate competing agendas between team members and to clarify drivers for decision-making. As a whole, our findings pointed toward the importance of using formal and informal tools—from project initiation to completion—to create a team culture that would lead to a high level of innovation and high-performance building solutions.

In Volume 2, we document two additional high-performing buildings and tell the stories of their project teams. Keeping in mind the three cases from Volume 1 as we collected data to develop the two new case studies, we came to realize that successful collaborative team cultures needed to focus more on the voices and concerns of tenants. In both of these

projects, tenants were clearly key stakeholders. We found that it was important for teams and the GSA to invest in tenant alignment with project goals and integrate them into the collaborative team culture, which would help during challenges that could potentially lead to tensions between tenants and other stakeholders. Additionally, when tenant needs were clear requirements around which the team must align and act accordingly—as was the case of the renovation of an occupied building—limiting the impact of construction on tenants was a key driver for decision-making. When tenant concerns are central to project outcomes, it is necessary for teams to invest in developing strong, trusting relationships with tenants and to provide transparent and well-communicated processes and logistics around their management and move coordination during construction.

The Los Angeles Courthouse (LACH) represents the GSA's first use of design-build delivery for a courthouse of this size. In general, federal courthouses are among the most challenging program types. Balancing the need for public access with security and control appropriate to court functions is difficult. Meeting the particular needs of judges and building users creates security and coordination issues throughout the building. For the LACH project team, achieving a high-performing smart building added another layer of complexity, requiring input from operations staff and building users. Technical challenges to achieving a high-performing building revolved around the design concept: a glass cube suspended over the entry plaza. This floating cube, a metaphor for the courthouse's function as a transparent civic space for justice, required that the team manage heat gain from extensive use of glass in extreme solar conditions. The designers created a serrated wall where glass panels could be angled for optimal sun shading.

The George Thomas "Mickey" Leland Federal Building is located on a prominent site near one of the main entry points into Houston's downtown. The existing building had a history of poor enclosure performance, and analysis indicated that air and water infiltration could be corrected with modernization.

There were several key challenges on the Leland project, which included the logistical complexities involved in installing cladding over the sawtooth corners while the building was 95% occupied during construction. The building also had multiple tenants with particular public access needs and security requirements

Since both projects were highly complex, they needed to leverage an array of strategies to succeed. (This aligns with the finding from Volume 1 that high-risk projects require complex solutions, which combine team performance, cultural attitudes, managerial strategies, logistics and tools, and commercial strategies all working in concert.) One major finding in this study was the importance of building and maintaining relationships between tenants and the team, relationships that would maintain resilience during project tensions and challenges. In both cases, tenant management was more than a case of logistical strategies (i.e., tenant-move schedules, swing-space design), it entailed key leadership strategies successfully aligning tenants with project goals and integrating them into collaborative decision-making processes with team members and with the GSA leadership. For example, in the case of Leland, the design-build team met the logistical challenges of moving tenants through the use of a highly coordinated tenant-management team that involved tenants in decision-making and kept them up to date on schedule changes and other logistical concerns. These practices increased trust between the tenants and the team, leading to tenant flexibility regarding move changes, resilience in tenant-team relationships, and a willingness to do what was needed to complete the project in the fastest way possible.

The findings of this study support the use of collaboration processes on future projects and, in particular, the value of collaboration between tenants and teams. We seek to influence improvements to government procurement processes and offer lessons learned for project teams looking to implement integrated processes and performance contracting.

(continued on next page)

Executive Summary

Executive Summary (2 of 2)

Overall

- Recommendation: Educate End Users on Building Operations of High-Performing Buildings**

An information packet sets up user expectations about how the building operates and describes how to use the building within these constraints. This is particularly important for smart buildings where systems like timed outlets are not readily apparent. Development of this packet can be assigned to the architect or to the move-management scope of work but needs a responsible point of contact to ensure it is completed. The lack of this document can cause challenges during the turnover process.

- Recommendation: Coordinate with Smart-Building Initiatives**

Coordinating with Smart Building Initiatives can ensure a smooth process for tenants, including access to the internet on move-in.

- Recommendation: Invest in an On-site GSA Leader or Construction Manager during Construction**

Many project stakeholders commented on how valuable it was to have GSA personnel available to resolve issues in a timely way and how well the communication worked with strong GSA facilitation. If assigning an on-site GSA personnel is not possible, there are alternative ways to achieve benefits. For example in Los Angeles, the GSA project manager was based out of a different region, but he was able to establish a strong and consistent presence on-site.

- Recommendation: Have Clear Decision Milestones**

It's critical to set milestones for decisions that have an impact on change orders. LACH team believed more clear and firm end dates for decisions on betterments would have been helpful. Also clarifying if the item could be paid out of savings or contingency funding. Decision milestones need to include both stakeholder and GSA decisions.

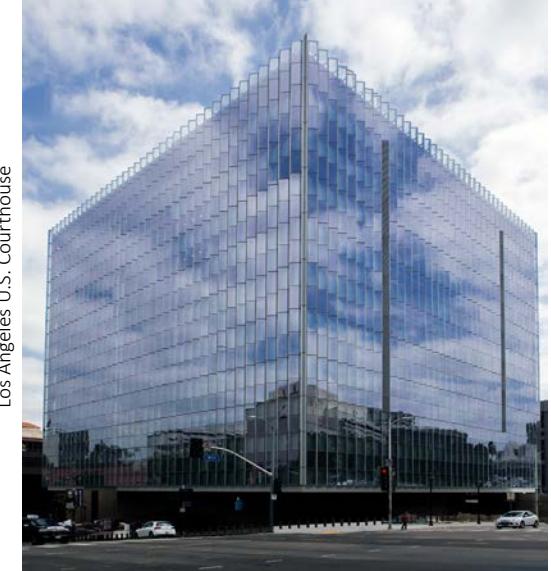
Educating and informing tenants about these milestones will eliminate the need for late change orders and reduce tensions between tenants and the project team.

- Recommendation: Effectively Use Mock-ups**

Mock-ups can help with team decision-making and can be essential for identifying problems early – such as technical performance issues or inefficient construction sequences. Mock-ups are also effective for engaging tenants during design and prevent the need for major tenant-requested changes after construction. In LACH, small and large adjustments that were made to the designs after tenants reviewed the mock-ups, such as plug placement or views from one part of the courtroom to another.

- Recommendation: Engage and Build Goodwill with Tenants Early and Often**

Tenant engagement is critical to GSA project success and should begin early in the project, either incorporating tenants into the team-selection process, or bringing tenants into early partnering sessions. In the cases we studied, having a strong tenant-management team on the project team side that assesses tenant needs and concerns proved to be crucial for maintaining relationships with tenants during challenging times. There should also be clear expectations around owner and team roles for tenants to help them understand communication expectations—who they can turn to for specific questions about a project. Furthermore, teams and owners should have a clear communication strategy to inform tenants about project updates and changes, such as to a website or regarding an assigned contact.



Los Angeles U.S. Courthouse



Mickey Leland Federal Building

Overview

High Performance

Commercial Strategies

Leadership Strategies

Logistical & Process Tactics

Building Innovations

Research Methodology

Research Methodology (1 of 3)

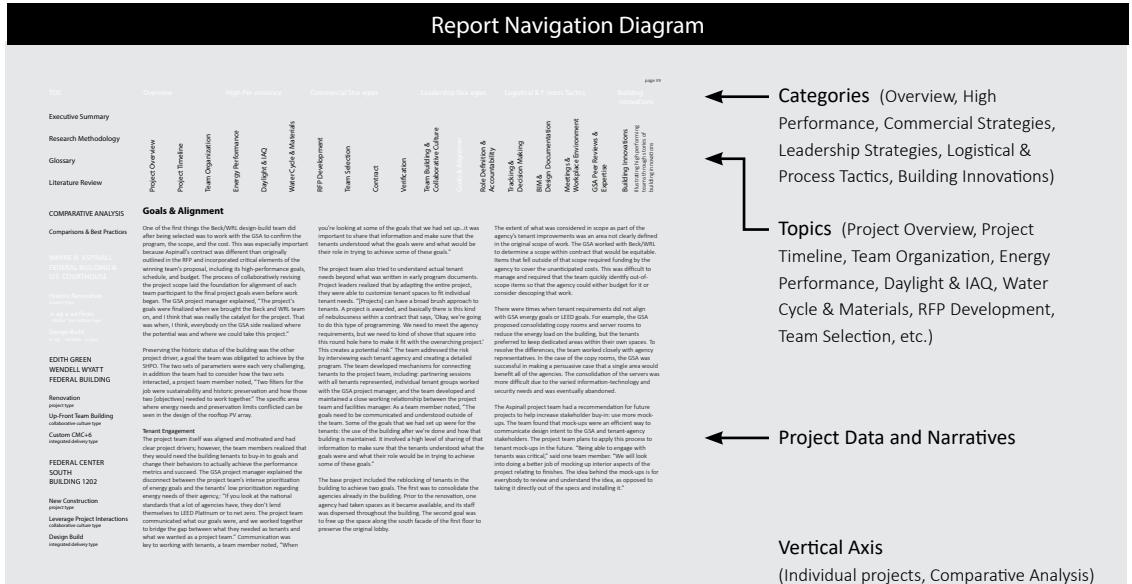
Research Goal for This Report

We seek to influence improvements to government procurement processes and offer lessons learned for project teams looking to implement integrated processes and performance contracting.

Development of Case Study Categories and Framework

The research team has experience with several studies on integrated project delivery (IPD), high-performing buildings, and collaborative practices. For the analysis of the cases in this report, we adapted Case Study Categories from the prior report, [Integration at its Finest \(2015\)](#): context, key ingredients, team outcomes, and building outcomes. This framework functioned as a guide for data collection and shaped interviews during the research process.

Categories identified by the research team as key ingredients are organized as horizontal bars along the top of each panel. Tabs for specific topics are grouped beneath those bars. Tabs running on the vertical axis help the viewer navigate within each of the two cases as well as compare the cases. Team Outcomes are integrated into the text under a variety of topics. Building Outcomes are addressed in the High Performance category, and the Building Innovation category provides specific examples from each project. For more information about category tabs, please see [Integration at its Finest](#).



Research Methodology

Research Methodology - Data Collection and Analysis (2 of 3)

Data Collection

Framework for Study

Based on our experiences and previous research on collaborative teams, we set up a framework (see Development of Case Study Categories) that identified variables to be studied and evaluated. These variables shaped interviews during the research process.

Interviews

For the George Thomas "Mickey" Leland Federal Building, the research team conducted five one-hour interviews with core team members that represented the architect, contractor, and CMa, as well as representatives from the owner (the GSA). For the Los Angeles Federal Courthouse (LACH), the research team visited the project site and sat in on a GSA Lessons Learned session with core team members. This session consisted of group interviews between a GSA representative and different stakeholder groups (e.g., design-build team, CMa, tenants). The team then conducted four one-hour interviews with core team members representing the architect, contractor, and CMa, as well as representatives from the owner (the GSA). For both cases, follow-up interviews were conducted with specific team members.

Documents

Documents, such as GSA peer-review reports, were collected from each team in the study as a source of data verification and supplemental information.

Analysis

Interviews and Document Data

Interviews were transcribed, and the texts were sorted into lists of strategies, tactics, and team-collaboration and performance outcomes that structure the research narrative into Overview, High Performance, Commercial Strategies, Leadership Strategies, Logistical & Process Tactics, Building Innovations.

Discussion

Since both projects were highly complex, they needed to leverage an array of strategies to be successful. One major finding in this study was the importance of managing tenants to maintain resilient relationships between tenants and the team during project tensions and challenges. In both cases, tenant management was more than a case of logistical strategies (i.e., tenant-move schedules, swing-space design), it entailed key leadership strategies successfully aligning tenants with project goals and integrating them into collaborative decision-making processes with team members and with the GSA leadership.

Research Methodology

Research Methodology - Credits (3 of 3)

Research Team - University of Minnesota, School of Architecture

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Primary Participating Projects and Team Members Interviewed

Los Angeles U.S. Courthouse
 Duane Allen, GSA, Design and Construction Division, Region 10, Project Manager
 Charlie Atkinson, Jacobs, Senior Project Manager
 Greg Groleau, Clark Construction, Vice President
 Jose Palacios, SOM, Design Director

George Thomas "Mickey" Leland Federal Building

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 Dawn Han, GSA, Property Manager
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 Thom Shelton, Gensler, QAQC
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 Diane Hess, Gilbane, Transition Project Executive
 Jim Penland, Gilbane, Senior Project Executive
 AB Blaloch, Jacobs, Commissioning Manager
 Craig Trimble, Jacobs, Program Executive/Senior Project Manager

Literature Review

Literature Review (1 of 2)

Review of Relevant Literature

To better understand the commercial strategies, leadership strategies, and logistical and process tactics of the two projects in this study (Leland, LACH), it is helpful to understand the theories developed in management and social science on team resilience, partnering, and swift trust. Research on these topics addresses the need for the development of culture and of trusting social relationships between project participants, from potentially diverse backgrounds and with individual work scopes. The participants put aside their personal interests for the purpose of collaboration through the use of artifacts (e.g., contracts and other written or visual documentation) and effective communication techniques. When teams are able to develop strong, trusting relationships and a strong team culture, they are more resilient and able to bounce back from project challenges. The following section describes literature on these theories.

Team Resilience

According to social scientists who study teams, a team's response to a challenge reflects their brittleness or resilience. A characteristic of brittle teams is ignoring issues for some time. This compromises their overall team health, leading to longer recovery times and making them vulnerable to responding poorly when new challenges arise. Resilient teams, however, are more adept at addressing challenges quickly and effectively in a manner that strengthens team health. These teams quickly bounce back from challenges, emerging with readiness to meet the next challenge (Alliger et al. 2015, 178). In order to establish resilient teams, you need strategies to establish strong team relationships and team culture. Some key strategies are found in literature on partnering and swift trust.

Partnering

The concept of partnering focuses on building long-lasting business relationships in which risks and benefits are shared equally between two or more partners. A part of developing strong partnering relationships is the use of formal and informal tools. Formal tools include artifacts, which are the physical materials used to engineer social connections between

different stakeholders and to cultivate trust. Likewise, informal tools, such as the development of an agreed-upon set of cultural values and expectations and effective communication skills, also establish positive social connections, build trust, and provide a sense of culture between diverse actors (Bygballe, Jahre, and Swärd 2010).

The Construction Industry Institute definition of partnering (Construction Industry Institute 1991, iv), establishes the importance of trust in partnering relationship development. A lack of trust can have negative consequences. Researchers Kristian Bohnstedt, Kim Haugbølle, and Erik Bejder (2013) suggest that perceptions of low trust between partners is one of the reasons behind the construction industry's high levels of cost and low levels of productivity. In their survey of various participants in the construction industry, the researchers found that trust was developed through experiences of control mechanisms, mutual respect, repeated cooperation, shared understanding, and communication. Perceptions of trust varied depending on the type of partner: clients were viewed as the most trustworthy and contractors the least trustworthy. The survey respondents prioritized mutual respect, effective dialogue, control mechanisms, and shared understanding as some of the most important factors in facilitating trust between partners. Respondents viewed breach of contracts, economics, prejudice, lack of communication, and control mechanisms negatively, demonstrating that formal tools and informal tools can impact social relations in terms of trust.

Swift Trust

Swift-trust literature provides further evidence and insight into the importance of informal tools in developing positive relationships. Swift-trust theory, which focuses on temporary teams, describes how trust occurs in short-term relationships—specifically, how to rapidly develop trust among actors with highly differentiated skill sets and personal goals to achieve a single collaborative goal. Whether or not swift trust develops in teams depends on a variety of factors that include the size of the labor pool and the presence of clearly defined roles and a clear leader who sets expectations of goodwill (Meyerson,

Weick, and Kramer 1996). Like partnering, swift-trust theory places trust as a central part of a project's success. The production of swift trust is also what can help build resilient teams.

Literature Review

Literature Review (2 of 2)

Sources

Alliger, George M., Christopher P. Cerasoli, Scott I. Tannenbaum, and William B. Vessey. 2015. "Team Resilience." *Organizational Dynamics* 44 (3): 176–84. doi:10.1016/j.orgdyn.2015.05.003.

Bohnstedt, Kristian, Kim Haugbølle, and Erik Bejder. 2013. "Trust Factors Affecting Cooperation in Construction." Paper read at the International Conference on Construction and Real Estate, Karlsruhe, Germany.

Bygballe, Lena E., Marianne Jahre, and Anna Swärd. 2010. "Partnering Relationships in Construction: A Literature Review." *Journal of Purchasing & Supply Management* 16: 239–53.

Cheng, Renée. 2015. "Integration at Its Finest: Success in High-Performance Building Design and Project Delivery in the Federal Sector." http://arch.design.umn.edu/directory/chengr/Integration_at_its_finest.pdf.

Construction Industry Institute (CII). 1991. "In Search of Partnering Excellence." In *CII Special Publication 17 (1)*. Austin, Texas: Construction Industry Institute.

"Integrated Project Delivery: A Guide, AIA Contract Documents Group and AIA-CC." <<http://www.aia.org/contractdocs/aias077630>>

Meyerson, Debra, Karl E. Weick, and Roderick M. Kramer. 1996. "Swift Trust and Temporary Groups." In *Trust in Organizations: Frontiers of Theory and Research*. Edited by Roderick M. Kramer and Tom R. Tyler, 166–95. Thousand Oaks: Sage Publications.

Reed, Bill and 7group. 2009. *The Integrative Design Guide to Green Building: Redefining the Practice of Sustainability*, New York: Wiley.

| | Overview | High Performance | Commercial Strategies | | | Leadership Strategies | Logistical & Process Tactics | | Building Innovations | | | | | | |
|--|------------------|------------------|-----------------------|----------------|-------------------------|-----------------------|------------------------------|----------|------------------------------|---------------|---------------------------------|----------------------------|-----------------------|-------------------------|--|
| | Project Overview | Project Timeline | Energy Performance | Daylight & IAQ | Water Cycle & Materials | RFP Dev | Team Selection | Contract | Team Building & Collaborativ | Goals & Align | Role Definition & Accountabilit | Managing Schedule & Budget | BIM & Design Document | Meetings & Workplace En | |

COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction project type

Design-Build project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation project type

Design-Build project delivery

Project Overview - Projects at a Glance

| | | Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics |
|--------------------------------|---|--|---|---|--|--|
| Two Projects | Los Angeles U.S. Courthouse | <ul style="list-style-type: none"> Projects selected by the GSA for this report for exemplary team and building outcomes Highly complex projects that met or exceeded budget and schedule parameters | <ul style="list-style-type: none"> Both projects became models for the GSA Project teams met increasingly stringent energy-performance goals as project developed | <ul style="list-style-type: none"> Design-build contracts pursued for different reasons Design-build collaboration seen by both teams as essential to success | <ul style="list-style-type: none"> Team alignment formed around most challenging technical issues Strong communication by the GSA project manager Excellent tenant engagement and buy-in | <ul style="list-style-type: none"> The GSA peer reviews used as resource Logistical challenges led to schedule compression |
| Los Angeles U.S. Courthouse |  | <ul style="list-style-type: none"> Large courthouse project on prominent site First use of design-build delivery for courthouse of this size Met challenge of highly transparent cube in extreme solar conditions | <ul style="list-style-type: none"> EUI goals became increasingly ambitious as the project developed Team proposed more aggressive target than RFP, later the GSA challenged them to go even further | <ul style="list-style-type: none"> Design-build chosen for cost efficiency and slow market Project became national model for use of design-build for large courthouse type RFP done in two phases with midstream feedback Performance-based incentives used | <ul style="list-style-type: none"> Team building facilitated by strong pre-existing relationships The GSA project manager managed strong presence despite geographic distance Alignment around achieving innovative structure | <ul style="list-style-type: none"> Intense site-work coordination in last months of construction Use of Last Planner System helped delivery and team culture Betterments used to manage wish lists Full scale mock-ups |
| Mickey Leland Federal Building |  | <ul style="list-style-type: none"> Multiple tenants, many with public-face and security needs Existing building with history of poor enclosure performance Prominent site, well known in the city | <ul style="list-style-type: none"> LEED goals became increasingly ambitious as project developed GSA requested LEED Silver, team early submittal of design was LEED Gold, got to LEED Platinum | <ul style="list-style-type: none"> Originally a CMC contract, scope and delivery type revised Design-build chosen to obligate funds, manage expenses, and support collaboration RFP done in two phases, an RFQ and RFP | <ul style="list-style-type: none"> Strong community pride Open communication among senior leaders Strong tenant communication created trust | <ul style="list-style-type: none"> Sawtooth corners created logistical challenges—resolved through strong tenant relationships Effective move-management process created flexibility in tenant swing spaces Unforeseen conditions affected schedule |

| Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | Building Innovations |
|------------------|---------------------|--------------------------|-------------------------|------------------------------|-------------------------------|
| Project Overview | Performance Metrics | Supply Chain & Materials | Leadership & Management | Logistics & Process Flow | Innovative Building Solutions |
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COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction
project type

Design-Build
project delivery

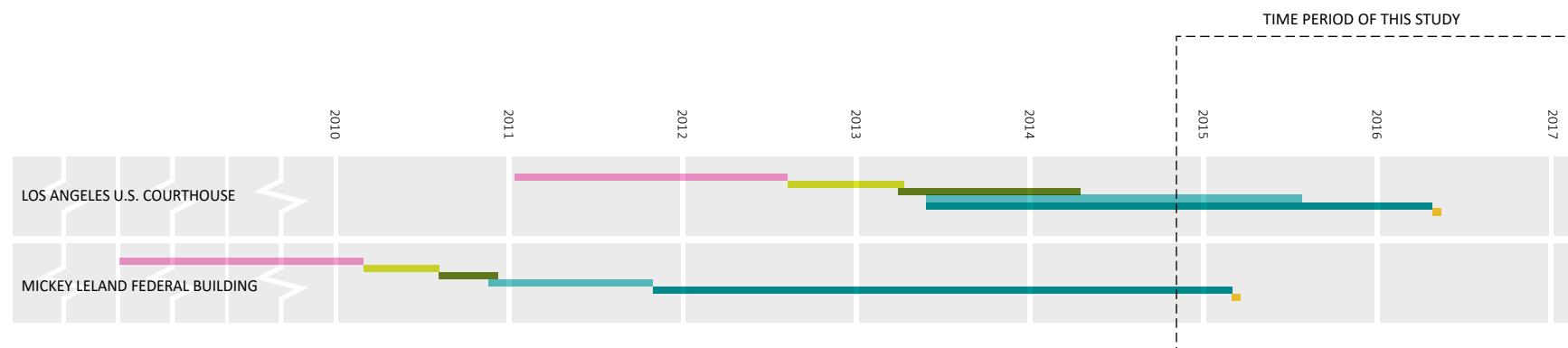
MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Project Timeline

Both projects went through an evolutionary process before the final project scope and delivery was determined. Leland was originally planned as CMc delivery under regular GSA funding, the time frame and contract delivery type was changed after inclusion in the American Recovery and Reinvestment Act program. The Los Angeles Courthouse project had been under development for over a decade with several delays and revisions to project scope.



Project Phases

- Planning/Procurement
- Concept Design
- Design Development
- Construction Documents
- Construction
- Move-In
- Project-Specific Events see graphic

| | Overview | High Performance | Commercial Strategies | | Leadership Strategies | | Logistical & Process Tactics | | | Building Innovations |
|--|------------------|----------------------|-----------------------|-----------|-----------------------|------------|------------------------------|-----------|---------|----------------------|
| | Project Overview | Performance Timeline | Energy Performance | IAQ & IAQ | Cycle & Materials | Leadership | Strategies | Logistics | Process | Innovations |
| | Project Overview | Performance Timeline | Energy Performance | IAQ & IAQ | Cycle & Materials | Leadership | Strategies | Logistics | Process | Innovations |

COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction
project type

Design-Build
project delivery

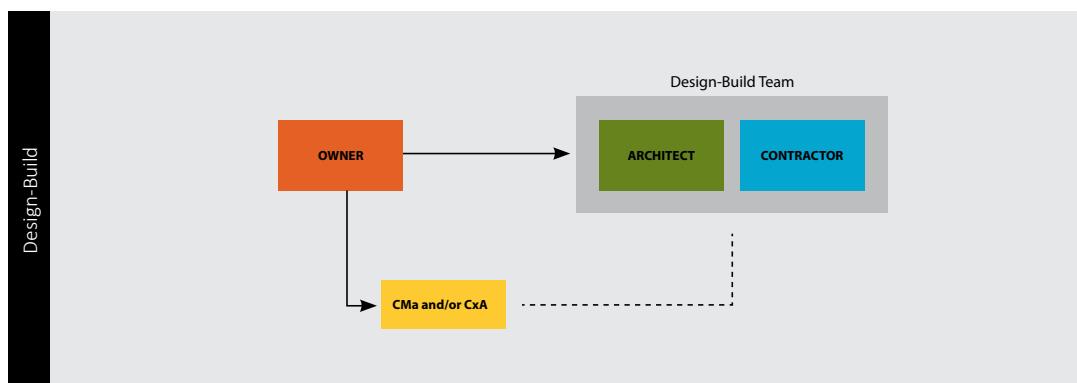
MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Team Organization

In these sections, the structure of the core project teams are graphically depicted, providing reference for the narrative description of the contracts, team selection, and request for proposals (RFP). In the tabs for each project, the project directory lists the primary team members and several of the subcontractors and consultants who were heavily engaged.



Key

- Owner
- Architect
- Contractor
- CMa and/or CxA
- Consultants
- Subcontractors
- Entity b is under contract to entity a
 Entity a <--> Entity b project interaction between entity a and b

| | Overview | High Performance | Commercial Strategies | | | Leadership Strategies | Logistical & Process Tactics | | | Building Innovations |
|--|----------|------------------|-----------------------|-----|-------------------|-----------------------|------------------------------|--|--|----------------------|
| | Overview | High Performance | Performance Metrics | IAQ | Cycle & Materials | | | | | |
| | Overview | High Performance | Performance Metrics | IAQ | Cycle & Materials | | | | | |

COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction project type

Design-Build project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation project type

Design-Build project delivery

High Performance

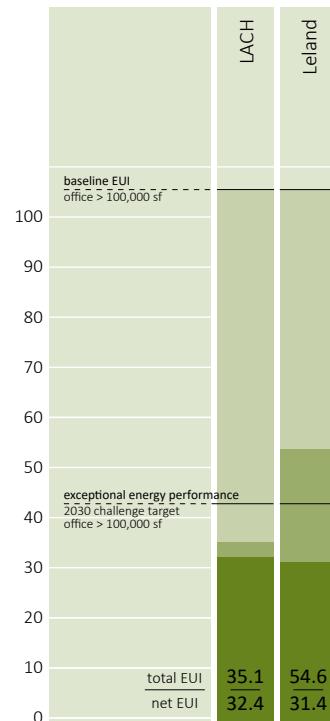
The GSA set general goals for performance, but developing the specific ways that the projects would meet or exceed those goals was the responsibility of the individual teams. Notably, entrusting the teams to set their own goals led to a higher level of specificity and expertise, revealed the potential for even more ambitious goals than originally imagined, and allowed an engagement with the project that yielded innovative ideas and cost savings. In all three projects studied, the aspirational high-performance goals provided clarity for the teams to align their work, advancing new methodologies and outside-of-the-box thinking to achieve the challenging goals.

Metrics from AIA Cote Top Ten Awards 2016-2017

- EUI before renewables (kBtu/sf/yr) - annual operating energy on a per unit basis.
- EUI after renewables (kBtu/sf/yr) - annual operating energy minus annual energy produced by renewable energy sources and purchased offsets measured on a per unit basis.
- % energy reduction (%) - % energy reduction compared to the national average for comparable buildings.
- Potable water reduction (%) - % reduction of potable water.
- Potable irrigation (Y/N) - does project use potable water for irrigation?
- Stormwater control (%)- % of rainwater from two-year storm event that can be managed on-site.

Energy

Lower numbers indicate improved building performance



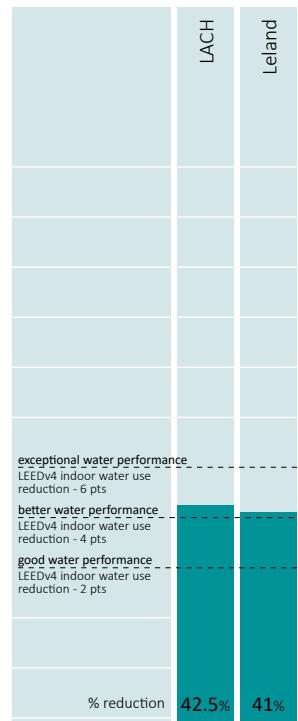
Energy Use Intensity

Energy Use Intensity (EUI) measures a building's annual energy use per unit area (kBtu/sf/yr). Each project's EUI is compared to a national average baseline EUI for office buildings of comparable size. A low EUI is an indicator of good energy performance as it represents an energy savings against the baseline.

| | | |
|-----------------------|-------|-------|
| EUI before renewables | 35.1 | 54.6 |
| EUI after renewables | 32.4 | 31.4 |
| % energy reduction | 69.4% | 70.4% |

Water Cycle

Higher numbers indicate improved building performance



Reduction of Potable Water

Water use reduction is simulated by comparing the amount of water used by a project's interior fixtures to a baseline (percent reduction). The baseline fixtures are determined by the Energy Policy Act of 1992 fixture requirements. Higher percentages indicate good water performance.

| | | |
|-------------------------|-------|-----|
| Potable water reduction | 42.5% | 41% |
| Potable irrigation | Y | N |
| Stormwater Control | 90% | NA |

| | Overview | High Performance | Commercial Strategies | | Leadership Strategies | | Logistical & Process Tactics | | | Building Innovations |
|--|----------|------------------|-----------------------|-----|-----------------------|--|------------------------------|--|--|----------------------|
| | Overview | Performance | Timeline | IAQ | Cycle & Materials | | | | | |
| | Overview | Performance | Timeline | IAQ | Cycle & Materials | | | | | |

COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction
project type

Design-Build
project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

RFP Development

The RFP for both projects listed project energy goals that were surpassed in the final delivered buildings. The RFP process for George Thomas “Mickey” Leland building was fairly conventional and indicated that the building was straight, plumb, and true. The actual geometry was discovered to be out of plumb, and this created several challenges for the team over the course of the project.

The RFP structure for the Los Angeles Courthouse (LACH) design-build was unusual for the GSA: it was a two-phase process with a midstream review and feedback. The feedback allowed for teams to raise red flags on any issues that were not covered; in this case, none were found.

Takeaways

- The LACH and Leland RFPs were in two phases, with Leland using an RFQ for the first phase to conduct a preliminary selection of design-build teams.
- Both projects listed energy goals in their RFPs, but using different energy-performance-target standards. The LACH RFP requested energy performance in EUI, while Leland’s RFP requested LEED.
- Leland was completed under the American Recovery and Reinvestment Act (ARRA), while LACH was one of the first projects completed in the post-ARRA time period.

“We required in the RFP that they[the team] provide resumes for key people, so we knew who they were going to be... We did review resumes. There wasn’t anyone we didn’t approve of.”
—LACH, GSA project manager

| | Overview | High Performance | Commercial Strategies | | Leadership Strategies | | Logistical & Process Tactics | | | Building Innovations |
|--|----------|------------------|-----------------------|-----|-----------------------|--|------------------------------|--|--|----------------------|
| | Overview | High Performance | Performance | IAQ | Cycle & Materials | | | | | |
| | Overview | High Performance | Performance | IAQ | Cycle & Materials | | | | | |

COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction
project type

Design-Build
project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Team Selections

In both cases, the teams had a high level of trust at the outset of their projects due to prior relationships. SOM and Clark had worked twenty years together on design-build projects prior to their work on LACH. Similar long-standing relationships were found at Leland—Gilbane and Gensler had worked on multiple design-build projects together. Both projects also demonstrated the importance of selecting key subconsultants early on in the process during team selection. In the case of Leland, Gensler and Gilbane anticipated there might be an RFP and did preliminary planning a year in advance. When the RFP was issued, they were able to quickly selected their MEP and curtain wall subs early in the process. At LACH, Clark and SOM selected their curtain wall consultant and engineering consultant during the competition process. One difference between the two cases was that the tenants were involved in the team selection process on LACH. This was a unique aspect in team selection in which a lead tenant stakeholder instigated an internal GSA team selection process, and Regions 9 and 10, with the tenants, selected the GSA project manager.

Takeaways

- In both projects, prior relationships helped to build strong teams with high levels of trust as well as a sense of respect for the different roles and disciplines of team members.
- In both cases, key subconsultants were selected early on in the project, which helped with team integration.
- At LACH, tenants became highly involved in selecting the GSA project manager.

"We had all done multiple projects together and some large projects very recently. So we already had a good working relationship and being able to transition into the next project it was helpful to have that basis of trust already established. You knew what you were getting."
—Leland, Gilbane project executive

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Contract

In both cases, the selection of design-build delivery was seen by the teams as essential to their successes. The rationale for the choice varied between the two projects: LACH chose design-build due to market conditions that were slow at the time of the decision but expected to rise. The GSA believed that awarding a design-build team would allow the team to manage costs better than design-bid-build, expecting construction costs might become volatile in a busy market. For the Leland project, passage of time and contextual changes led the project to a different delivery than initially planned, from CMc to design-build. The GSA anticipated the renovation would reveal unforeseen conditions and chose design-build so that a collaborative team could solve problems as they arose, without the need for extensive change orders. In both cases, the expected advantages were realized by the teams.

Design-build also provided LACH with the opportunity to integrate betterments into the project. The allocation of betterments was transparent to stakeholders throughout the project.

Takeaways

- The reasons for selecting design-build project delivery varied but were closely connected to the needs and context of each project. The reasons for selecting design-build included cost efficiency, a slow marketplace, speeding up time to obligate funds, flexibility in adjusting expenses, and maintaining a collaborative team.

"There was no way to do a traditional design, bid, build. You would've had so many change orders on this project, and I think it would have been fraught with a more negative atmosphere. I can't even conceive of doing that project this way, and neither could GSA, and I think that's why they did it the way they did it."

—Leland, GSA contracting officer

The betterment process works well within a design-build project because from the owner's perspective, we don't have a lot of risk. Once the building is out of the ground, there's very little in the way of differing site conditions that can reach out and bite us."

—LACH, GSA project manager

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Verification

At LACH, the contractor was responsible for verifying the EUI goal during the twelve-month post-construction occupancy period. However, there were challenges during the occupancy process. After tenants moved into the building, they had difficulties understanding how a smart building operated and how to use the building within its specific constraints. The project team and tenants agreed that an information packet on building operations would have helped set up user expectations about the building.

Leland did not have performance-based-contract terms, and they were not a part of the project's scope. While there has been discussion about performing verification, as of today that effort has not been initiated. However, after the modernization, the team verified that the building's enclosure was well sealed by conducting a blower-door test and measuring condensate from the units. Notably, the chronic envelope-leakage issues were so well resolved that there was no water infiltration when, shortly after completion, Hurricane Harvey arrived in Houston, bringing historic amounts of rain and wind.

- While verification was required for only one case, each team produced a high-performing building. However, a verification process of a building's performance should be a best practice.
- While Leland educated tenants around the new technologies that would be used in the building, the lack of education at LACH led to difficulties understanding how a smart building operated, creating challenges during the first year of occupancy. Preparing an information packet for future smart-building projects will set up user expectations about how the building operates and describe how to use the building within those constraints. The packet should include annotated images to describe the difference between regular and timed outlets. Development of this packet can be assigned to the architect or the move-management scope of work but needs a responsible point of contact to ensure it is completed.

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Team Building & Collaborative Culture

In both cases, the GSA and project teams created and maintained a highly collaborative culture through partnering, co-location, prior relationships, open communication, and having the right people. For example, both teams maintained an open line of communication between stakeholders, including tenants, even when tensions were high. Communication between stakeholders occurred beyond meetings and within informal discussions and interactions. Team members from both cases also believed they had the right people on the project: team members demonstrated professionalism and willingness to collaborate with other stakeholders.

Unique to Leland was the role community pride played in developing a collaborative culture. The firms that made up the design-build team had a presence in the area with leaders well known to the local community. For all local team members, working on the project meant that they were improving an iconic building in their hometown. Team members credit a strong group of experienced senior leaders from each stakeholder group for effective collective leadership.

At LACH, the GSA project manager played a key role in creating and maintaining a collaborative culture. All project stakeholders, from tenants to team members, recognized his leadership in laying the groundwork for trust and goodwill that would ensure strong relationships during project challenges.

Takeaways

- Open communication is key to building goodwill on a project. Teams should build relationships both inside and outside of project meetings.
- Having a champion for collaboration can help lay the groundwork for building a collaborative culture that can mitigate tensions during challenging times.

"It really comes down to the people involved...that's what made this project feel special. There was always a really strong force on each side that would hold things in line. Even when things got heated or tough, cooler heads would always prevail because we had some real strong people on the team."

—Leland, Gilbane project manager

"What made our partnering effective was [that] we looked at what was going right and we looked at what could be improved. It was a combination of both. It was, 'Okay, let's celebrate the things that we've done right and then let's dig in and find out what the areas of concern are.'"

—LACH, GSA project manager

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Goals & Alignment

Both cases had clear goals providing the team with known drivers for decision-making. For the LACH project team, maintaining the purity of the design idea expressed in the floating cube of glass became the “guidepost” for team decision-making. For the Leland project team, the goal of wrapping a poorly performing occupied building with a new envelope meant that all decisions revolved around the technical challenges of the existing building geometry and an overall goal to minimize the impact of construction on the tenants.

To align tenants with the project team and to project goals, the GSA and project teams had a high level of tenant engagement, demonstrated by having tenants attend partnering sessions, holding regular meetings with tenants, and engaging tenants in the decision-making process using mock-ups. At LACH, tenants took part in team selection, ensuring their voices were heard from the beginning. Additionally, the betterments list was an interactive and transparent way for the project team to track the tenants’ priorities for additional scope, if possible. A lesson learned on betterments was to tie it more clearly to decision dates, after which the item could not be considered for inclusion. Allowing items to linger created some tension between the team and tenants. Leland’s design-build team created a tenant-coordination team that actively engaged tenants through meetings, interviews, and surveys to better understand their needs. These tenant-engagement activities not only provided both teams with tenants input but also generated a high level of trust between the teams and the tenants that helped ensure that their relationships remained resilient, even during times of tension. The excellent communication uncovered important information about tenant willingness to change their footprint, leading the resolution of one of the most challenging schedule issues around the saw-tooth corner.

Takeaways

- Both cases effectively used mock-ups to align tenants with the team and the project. For example, the LACH project’s extensive interior mock-ups of courtrooms supported tenant decision-making and provided an opportunity for the team to build trust with the tenants, demonstrating that the team was listening to tenant concerns and interested in their feedback.
- Engaging tenants early and often on a project will build trust that will make relationships between team and tenants more resilient, keeping tenants aligned with team and project goals.
- Betterments can be an excellent mechanism for tracking tenant priorities and understanding tenant goals but needs to be managed with clear decision dates, after which items cannot be considered.

“Unless you’re a designer, most people aren’t very visual, they don’t see things well on paper, so we actually had to build mock-ups so that they could see them and touch them... And I think it was the right thing to do because the courtrooms are the signature of the building...”
—LACH, GSA project manager

“Gilbane had a great tenant team. They said, ‘okay, here is the floor we have to work with for your swing space. What do you need?’ ...They had a focused tenant team because they had a tenant move coordinator/furniture person. And they had an IT person. Those two roles were really critical in building trust with the contractor.”
—Leland, GSA building manager

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Role Definition & Accountability

Both cases had strong team consistency within the core team. This consistency included the on-site GSA project manager, which helped to maintain a strong flow of communication across stakeholders throughout the project. Even though the GSA project manager on the courthouse project was based elsewhere, he was able to establish a strong and consistent presence on-site.

At LACH, one of the best strategies for ensuring accountability was the use of Last Planner System (LPS). Clark's use of LPS helped to make a cultural change among trade partners and subcontractors in how they committed to the schedule. It also helped open up lines of communication between Clark and the project foremen.

In terms of accountability, the Leland case showed both the GSA and design-build team sharing the responsibility for the costs that resulted from incorrect as-builts and incorrect scans. The Leland team members also managed to mitigate a tense situation that occurred on the job site when an on-site worker harassed a tenant. Gilbane's quick response to remove the worker and making changes in their safety orientation, which included a review on cultural awareness, impressed the GSA building manager.

Takeaways

- Both projects had an onsite GSA project manager that established who helped support and strengthen relationships, and ensure fluid communication between different stakeholders.
- The effective use of LPS can improve communication with subcontractors and trades as well as improve accountability.
- When problems between tenants and onsite workers occur, a quick response is necessary to resolve tensions.

"I was working with an excavating contractor, a foreman who I had worked with on two or three jobs prior. After he had written down that he was going to be finished with a certain component of the work by Friday of that week, every day that week when he saw me he reminded me that he was going to finish on time. On Friday, when he was done, he said, 'Greg, I finished my task.' I remember thinking to myself—wow, it's that important to you because you wrote it down. Very early on I realized how that makes it more of a commitment to a person."

—LACH, Clark senior project manager

"Gilbane had to come in with the attitude that this isn't a jobsite. This is a fully occupied professional office building in which you are doing work....All of the subs had to take on that mentality...[the team had a] sense of ownership in this project, and all of the people that worked on it wanted to do the right thing for the project and for the tenants. And [they] understood that this was an occupied building. I felt like I was on the dream team."

—Leland, GSA building manager

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Managing Schedule & Budget

Both case studies had their own schedule challenges and methods of solving these challenges. The LACH design-build team's solution was to implement LPS to effectively communicate, collaborate, and empower the project team, subcontractors, and trades. Working together with LPS allowed team members to understand shared terminology, helped with accountability, and determine the amount of manpower needed for specific parts of the job, such as the hanging walls. In the case of Leland, the project required a tightly coordinated move-management plan to work on the sawtooth corners as well as to develop strong relationships with tenants.

In terms of budget, Leland used their strong team integration to lower costs, pooling expertise to solve project challenges. At LACH, the GSA set aside betterments to add enhancements to the project. The drawback to the betterments list, however, was that it could extend the time for decision-making and impact the schedule. The GSA project manager noted that tenants need to be clear about decision-making deadlines on betterments.

Takeaways

- Betterment lists work best when there are clear and firm end dates for decisions by all stakeholders to avoid late change orders.
- Budget savings in Leland came through innovative building systems, some of which provided solutions to several outdated existing systems.
- Use LPS to encourage collaboration and clear communication lines between stakeholders to keep the schedule and budget on track.

"The betterments process worked okay on this project. I think we needed to do a better job of maintaining that firm line that once a date has past, we can't go back. I don't think that was ever communicated as clearly and as effectively as it could have been."

—LACH, GSA project manager

"There had to be modifications made to the structural design in order to accommodate the new curtain wall system. It really proved to be a more complex process and it changed the duration of our cycle and doing the construction on the floors to a point where we had to rethink our approach to how we were building the project. It required, just resequencing the move schedules which was a pretty big move at that point and it impacted multiple tenants. Ultimately in the end it was better for everybody because it got the project done faster. And I think although tough at times we were able to make those adjustments with the tenants because of the good relationships that Diane had built with them and we had with GSA and understanding their needs."

—Leland, Gilbane project engineer/project manager

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BIM & Design Documentation

At LACH, the design-build team used Building Information Modeling (BIM) for phase planning and priority spaces that needed to be finished to keep to the schedule. The team also used mock-ups with real materials built at full scale for the curtain wall and interior courtrooms to help make project decisions. One challenge for the team was information exchange using the GSA proprietary software system, electronic Project Management (ePM). Documents from other team members would sometimes have inconsistent metadata, and it could be difficult for the team to find documents on ePM.

For the Leland case, BIM was used not only for design and construction but also to design the swing spaces for tenants to use as temporary office spaces within the building during construction. Design documentation challenges the team faced were incorrect as-builts from the GSA and the incorrect survey scans the team produced for the building. While the scans appeared to have some incorrect geometry, the team continued to work on the model to make sure they were reading the scans correctly. Once they understood the scans were incorrect, the design-build team had to reread the building and, as a result, realized that the actual geometry of the building required a redesign for the entire curtain wall.

Takeaways

- Determining accuracy of as-builts and survey scans takes time and may need documentation adjustments. Allowing time in the schedule until documentation is confirmed can be helpful so teams can manage this as a risk contingency.
- Use BIM for phase planning and to identify priority spaces to stay on schedule.
- Use mock-ups to test design ideas and align the team around project decisions.

"I think having the building in [3-D] helped us because it gave us a chance to model things and find out how to minimize the amount of additional steel we had to buy. It gave us the ability to play what-if games in a way that doing it just in 2-D would not have allowed us."
—Leland, GSA senior project manager

"We didn't have to go back in and make a lot of changes in the courtrooms. It was a very smooth process because once the mock-up was done and correct, everybody knew what they had to do. They went into the building and built twenty-four of them, and we had very few changes."
—LACH, GSA project manager

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| | Overview | High Performance | Performance | IAQ | Cycle & Materials | | | | | |

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Meetings & Workplace Environment

Both cases also used co-location and had other team members located nearby on-site (when not co-located). This allowed team members greater opportunity for informal conversations that helped improve collaboration as well as efficiently keep the lines of communication open.

A unique way that the Leland team also encouraged a sense of equal partnership between team members was through the use of a large square table intended to encourage a sense of equality. Leland also had the GSA holding regular meetings with tenants with extended invitations to tenants to sit in on the GSA and project team's meetings. This encouraged a strong working relationship between tenants, the GSA, and the team that helped maintain relationship resiliency during times of stress. Leland also ensured a culture of safety using Jacob's Beyond Zero safety program. This program involved a monthly walk through of the site by Jacob's inspectors, who would then talk to Gilbane's safety officer about site issues.

Takeaways

- Regular meetings between the tenants and the GSA improved relationships with tenants, leading tenants to feel like their concerns were being heard and considered, increasing the level of tenants trust with the GSA and with the team.
- Both teams implemented cultures of safety on their jobsites. Regular site safety walk-throughs were conducted by team members. The team and the tenants created strong shared goals around safety.

"I think it speaks well to the team's chemistry that [when the CMA stopped contractors' work to address a safety issue, the contractor] never said, 'You can't do that. You can't stop work.' Instead, it was, we all were going to step into this culture of safety."

—Leland, Jacobs regional manager

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Peer Review & Partnering

Both projects used what is now the GSA standard practice of peer reviews during the design and construction process. This uniquely GSA practice brings industry experts outside of the project team for intensive meetings. Since LACH was the first GSA pilot project for a design-build courthouse, it also piloted the design-peer-review for this project-type delivery. Design peer reviews involve a panel of design experts to help teams with key design decisions. GSA construction peer reviews are part of the [GSA Construction Excellence Peer Program](#). Both processes are intentionally collaborative, intending to bring all project parties together to identify challenges and come up with solutions.

The two teams had vastly different experiences. For the LACH design-build team, the pilot design peer review ran longer than anticipated and added extra layers of complexity to the design. Alternatively, since Leland was a renovation project, the Leland team's design peer-review process had limited scope, focused only on mechanical design. The Leland team also found the construction-peer-review process to be a positive experience that reassured team members of their strengths and known challenges. At Leland, construction peer reviews were seen as helping the team to form a plan of action during project challenges.

While not unique to GSA, partnering is another GSA standard practice. GSA partnering includes kick-off meetings focused on aligning project stakeholders (including building users), as well as gaining alignment within the agency/tenants. Initial partnering sessions are focused predominantly on building a collaborative team culture, often resulting in the creation of a project charter. Partnering sessions may also be led by a third-party facilitator trained in collaborative team building. After these initial meetings, teams may have later partnering sessions that are more focused on problem solving specific project challenges. Both cases used partnering sessions to build team alignment. The design-build team on the LACH case had a partnering session every three to six months around project milestones. The Leland team started with a partnering session and had continued communication and planning in weekly and monthly meetings.

Takeaways

- Partnering sessions and other opportunities for team building and solving project problems help to build team relationships and encourage open communication about project problems.
- Peer reviews need to be managed so that input has clear scope and timing.
- Effective peer reviews can help the team set deadlines for resolving known issues.

"The peer-review process seemed to go on and on, and when it felt like we were addressing the needs, more items were stacked on that the team of engineers would have to address.... [They are] bringing up good questions, but to go through the process of calculations and supply with data...added another layer of design review that extended our own design further than anticipated."

—LACH, design-build team member

"The [peer review] process gave us the opportunity to pin down and force team members to do a bit more deliberate planning, because some of stuff we would say we needed to work on but it would fall by the wayside. Peer review did give us the opportunity to tell team that they had to send a report back with a plan of action."

—Leland, GSA senior project manager

"There were some instances when things came out of the partnering that made us think, 'Wow, we really didn't know that that was a problem, and thank you for sharing that.' [Those insights] came from everybody. This is the key to partnering—we had all of the stakeholders involved, so it wasn't just the GSA and the contractor."

—LACH, GSA project manager

"I remember the first partnering session was very reserved. We didn't know each other well, didn't know what the objective was. It took until the end of the second session before everyone realized 'Okay, I can speak honestly here at the partnering session.'"

—LACH, Jacobs team member

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Building Innovations

For each of the two case studies, we focused on one story that illustrates a range of successful leadership strategies, logistical tactics, and process tools. The strengths of the teams are evident in how they handled the situations described in their stories, which are full of evidence revealing their alignment around clear goals and the effective use of the right expertise, mutual trust, and respect.

Both cases had challenging curtain-wall-enclosure issues that required intensive coordination and collaboration. Successful resolutions hinged around resolving issues of building enclosure, including: technical issues like waterproofing, geometry, sequence of construction, coordination with structure, and coordination with the MEP. Highlighted in the detailed narratives are the ways that the project teams used a range of expertise to resolve problems.

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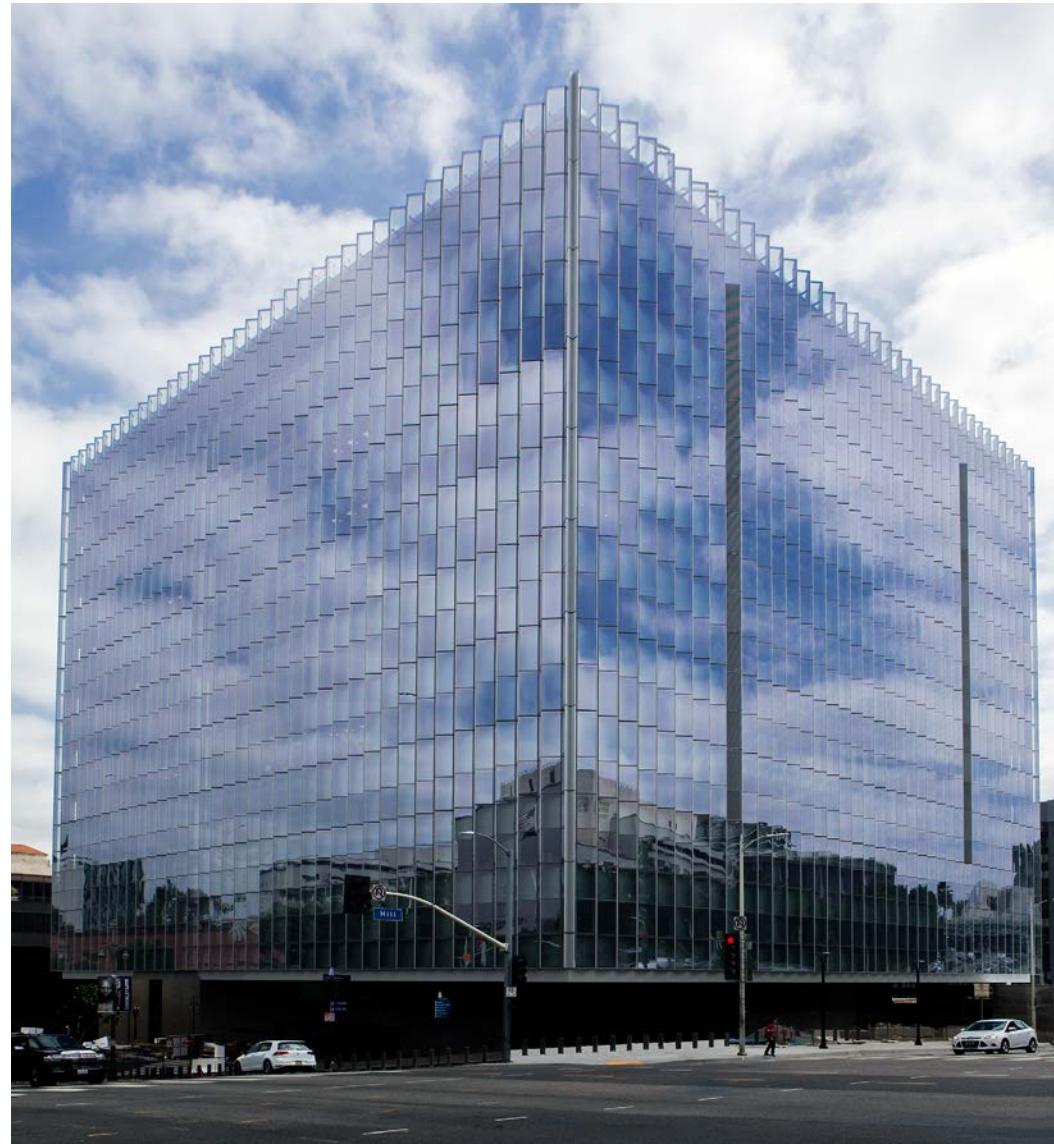
MICKEY LELAND FEDERAL BUILDING

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Project Overview

| | |
|--------------------|---|
| Project | Los Angeles U.S. Courthouse |
| Location | Los Angeles, California |
| Project Type | New Construction |
| Contract | Design-Build |
| Owner | U.S. General Services Administration – Region 9 |
| Design Architect | Skidmore, Owings & Merrill LLP (SOM) |
| Contractor | Clark Construction Group-California LP |
| Project Start | July–September 2012 |
| Project Completion | August 2016 |
| Project Size | 632,000 SF |
| Project Height | 220 FT |
| Original Budget | \$399,635,000 |
| Final Budget | \$389,113,099 |



| Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | Building Innovations |
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Project Timeline

There were several schedule related challenges on the Los Angeles Courthouse (LACH) project resulting from a complex building structure, unexpected site conditions, and quality control and oversight issues with the electrical subcontractor.

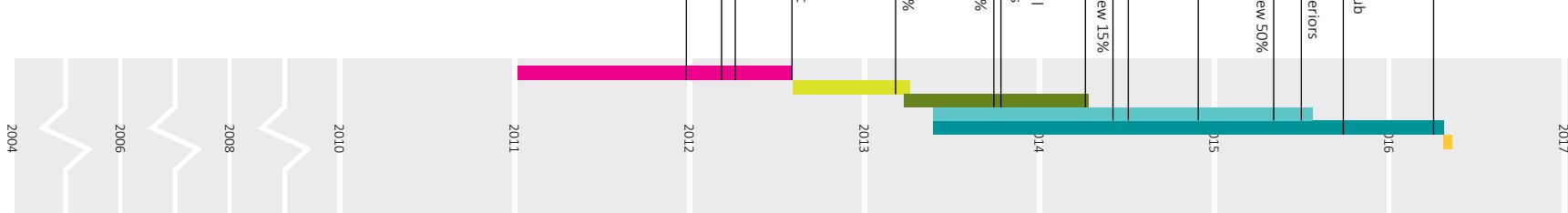
Challenges with the Schedule

The team intended to start excavation at the beginning of June 2013 but was asked to revise their proposal to decrease the square footage of the building and reduce two levels of the basement to one. Sixty days were lost due to the redesign. The schedule was further affected by the structural complexities of hanging the perimeter structural bay and the discovery of unfavorable soil conditions. The structural design of the cube and its concrete sheer walls resulted in a construction sequence in which the roof structure had to be completed first before the curtain wall could be hung from the roof trusses.

This strategy created an atypical construction process in which the curtain wall assembly was not installed until later in the project.

In addition, unexpected soil conditions delayed the start of construction. The shallower-than-expected excavation meant that foundations would be placed on a different layer of soil than originally planned. The soil conditions at the revised foundation level were unsuitable, and the soil at that level had to be removed and replaced with more stable material. While challenges occurring early in construction can be difficult for a team to manage, the team used these obstacles as opportunities to test their ability to work together and to develop a different solution for the foundation system. Because of the soil issues and a government shutdown in October 2013, the GSA negotiated a sixty-day time extension.

While the electrical subcontractor was given adequate time to complete the work (since the schedule was adjusted to accommodate the changes in scope issued by the GSA), the subcontractor failed to manage its labor pool efficiently with the proper quality control and oversight. This created a number of re-work items before the work was completed and accepted. With the schedule related issues noted above, the timeframe in which to complete the punch list, commissioning, and close out activities was compressed. This resulted in less time to educate tenants about the operations of a modern high performing building. As one tenant noted, "We have an energy-efficient building, but we have to live with a condition that wasn't fully explained to us."



Project Phases

- Planning/Procurement
- Concept Design
- Design Development
- Construction Documents
- Construction
- Move-In

— Project-Specific Events see graphic

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project delivery

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FEDERAL BUILDING

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Design-Build
project delivery

Team Organization

SOM and Clark had extensive experience partnering in Design-Build projects. Other long-term relationships included Jacobs with GSA and Benson with SOM.

Owner

U.S. General Services Administration – Region 9

Design-Build Team

Skidmore, Owings & Merrill LLP (SOM)
Clark Construction Group-California LP

Construction Management Agent

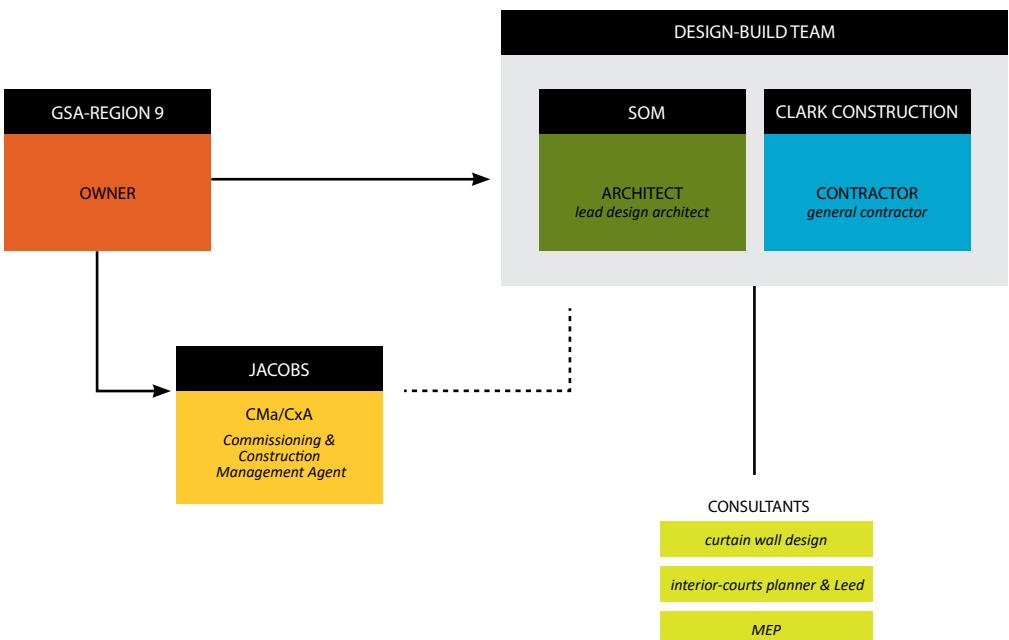
Jacobs

Commissioning Agent

Jacobs

Consultants

Curtain Wall Design: Benson Industries, Inc.
Interior-Courts Planner and LEED: AECOM
MEP: Syska Hennessy Group



Key

- Owner
- Architect
- Contractor
- CMa and/or CxA
- Consultants

- a → b Entity b is under contract to entity a
- a ⇢ b Project interaction between entity a and b

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Energy Performance

Drive to 35 Goal

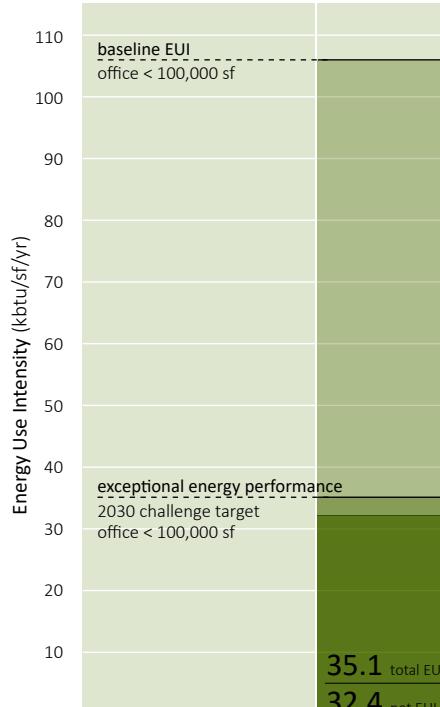
The original request for proposal (RFP) specified 48 EUI for the building. In their RFP entry, Clark Construction Group and Skidmore, Owings & Merrill (SOM) proposed a goal of 42 EUI. Knowing that the biggest challenge to achieving any EUI goal was the glass curtain wall, the designers hired the mechanical engineers, Syska Hennessy Group, and the curtain-wall consultants, Benson Industries. Their expertise was invaluable during the first few weeks of the competition process as the orientation and cube design were decided.

Syska's thermal-heat analysis indicated that the team had to make the curtain wall more responsive to the solar orientation of the site. Syska and the design team came up with a pleated facade, with the transparent glass facing north and south and the opaque panels facing east and west. To respond to the cube having a hot side (east and west) and a cool side (north and south), Benson created a "unitized system," which has components that plug in and out of a unit of the building and respond to the needs of specific orientations while keeping standard sizes. The team could vary specific types of glazing in the unit systems, such as translucent or clear glass, where appropriate for program requirements. With the pleating and unit standardization in place, the team integrated the building's design inspiration with the programming needs and responses to sunlight and thermal gain.

After the project was awarded, the GSA regional administrator reduced the EUI goal to 35 to use the building as a model of a high-performance courthouse. The team coined this goal as the "drive to 35." Final energy solutions included LEDs design and controls, demand-controlled ventilation, load-based air-handling zoning, displacement ventilation, dedicated outdoor air system (DOAS) , enthalpy airside economizer, cascaded ventilation for holding cell-makeup air, enhanced building management system (BMS) with monitoring and diagnostic instrumentation, roof-mounted photovoltaics (PVs), and high-efficiency cooling and heating plants.

Key

- Net Energy Use Intensity after Renewables and Offsets
- Total Energy Use Intensity before Renewables and Offsets
- Baseline Energy Use Intensity for Similar Building



Energy Use Intensity

Energy Use Intensity (EUI) measures a building's annual energy use per unit area (kBtu/sf/yr). Each project's EUI is compared to a national average baseline EUI for office buildings of comparable size. A low EUI is an indicator of good energy performance as it represents an energy savings against the baseline.



| | |
|---|--------|
| EUI before renewables (kBtu/sf/yr) | 35.1 |
| EUI after renewables (kBtu/sf/yr) | 32.4 |
| % energy reduction (from average building type EUI) | 69.4 % |

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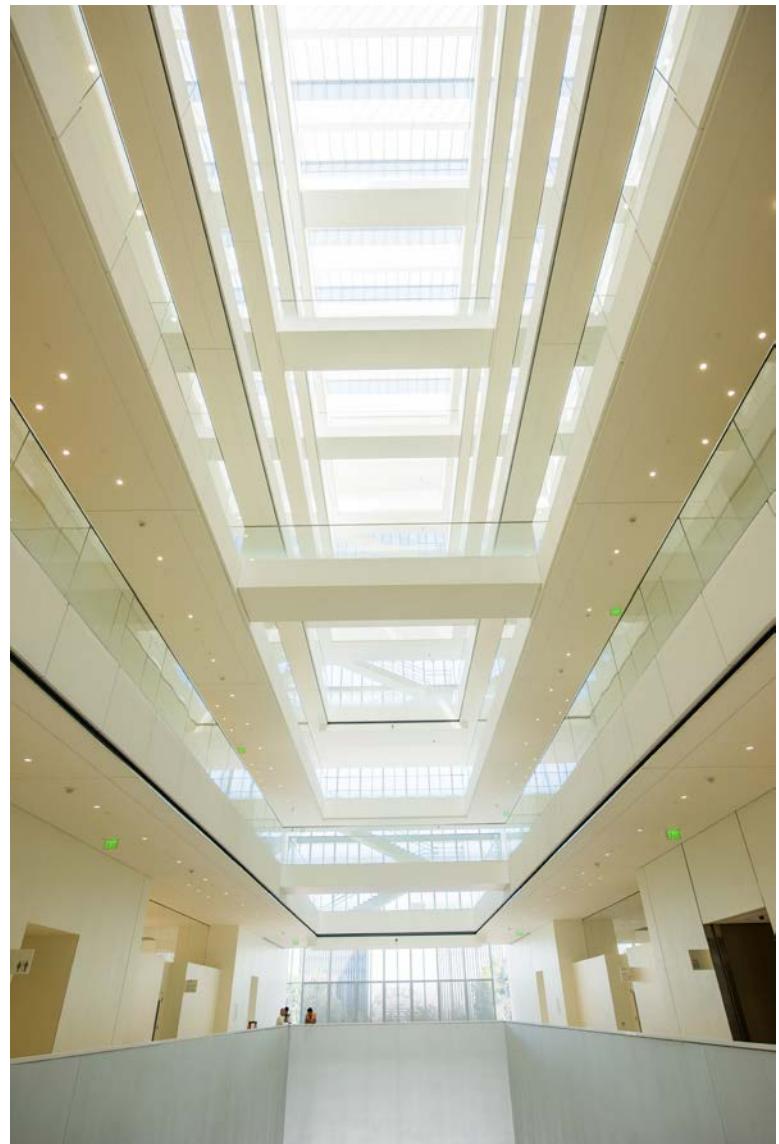
Daylight & IAQ

Daylight

Ensuring the connection between occupant and environment was a driving factor of the selection of the cubic form: not only do the primary occupied spaces have access to natural light but also does nearly every courtroom in the building. Highly controlled daylight is provided to the courts through high transoms above the judicial bench and from the light court behind the gallery. The light-court skylight includes daylight reflectors to dynamically distribute sunlight deeper into the narrow atrium, and the judicial suites take advantage of the high floor-to-floor heights and floor-to-ceiling windows to provide abundant natural light.

IAQ

Indoor air quality (IAQ) is enhanced through preflushing of the building, use of displacement air delivery, entrance walk-off grates, and use of low-VOC materials. Additionally, a green cleaning program and pest-control program are being utilized. Fresh air enters the air-handling rooms through louvers that are integrated into the facade design on the east and west sides. The air serves the DOAS units distributed through variable air-volume boxes serving each zone. Demand-controlled ventilation and load-based air handlers provide ventilation on an as-needed basis. MERV 13 filters and UV lights are used at the DOAS units to maintain a high level of air quality.



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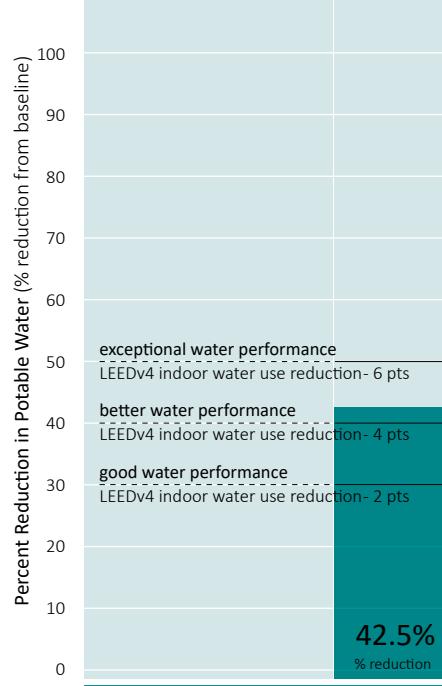
Water Cycle & Materials

Water Cycle

High-efficiency plumbing fixtures are utilized throughout including .125 gpf urinals, 1.1 gpf water closets, and .35 gpm metered faucets. The projected water savings over the Energy Policy Act (EPAct) of 1992 is 40%. A 105,000-gallon cistern is located below the sloped plaza gardens, collecting rainwater and cooling-tower condensate. The harvested water will provide all of the irrigation needs for the drought-resistant native species. A green roof, with a cactus garden, tops the lower roofs above the jury-assembly and cafeteria areas.

Materials

Material conservation is used to minimize environmental impacts. The optimization of the composite-steel-and-concrete structural design, including the innovative use of suspending floors from the roof hat truss (a 3-D truss configuration at the roof level), resulted in approximately 20% materials savings over conventionally framed structures. Low-VOC materials are used to enhance air quality. Approximately 75% of all wood materials are FSC-certified wood. In addition to Buy American materials, regional materials and materials of high recycled content are extensively used. Approximately 90% of construction-waste materials are recycled. Prefabrication and off-site assembly of building elements, such as the unitized curtain wall and cast-gypsum wall panels and light reflectors, further contribute to the reduction in material use.



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RFP Development

The GSA made the decision to use design-build delivery for cost efficiency and to avoid cost increases in a slow construction market. Performance-based incentives were used to motivate the team to achieve specific EUI goals that would be verified during the first year of operations.

During Phase II of the selection process, the GSA conducted a midstream review, a process not always used in the GSA's design-build projects. During this review, the GSA interviewed each team about their progress to discover if there were any "red flags" with the RFP, such as a potential problem with their estimated budget. There were no major issues with the RFP terms.

The GSA selected Clark/SOM during the RFP selection process after considering several criteria. Among the considerations was that Clark/SOM's proposed design would achieve an energy target of 42 EUI and meet LEED Platinum requirements, an improvement from the initial RFP requests of 48 EUI and LEED Gold.



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| Strategic Focus | Market Overview | Performance Metrics | Product Line A | Product Line B | Product Line C | Team Structure | Leadership Style | Supply Chain | Process Flow | Innovation Initiatives | |
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Team Selection

The RFP required that the contractor provide the GSA with the resumes of key team members. While this did not drive any team-selection decisions, it did provide a chance for the GSA to identify any concerns. The GSA noted some positive personnel changes early in the project: "There were a couple of folks that had personalities that didn't click, and Clark moved them out in first six months before we had to say anything. Clark brought an A-Team to the table." Overall, the project benefited from low turnover of key personnel.

Prior Relationships

The team's highly collaborative culture was centered on prior working relationships between SOM and Clark and between SOM and Benson. SOM and Clark had a very strong relationship, already having worked together for twenty years on design-build projects. As the Clark project manager noted, SOM and Clark are "like family. We know each other's idiosyncrasies...we know what is important to them and what to push back on." Benson also had worked together with SOM on another courthouse project: the Long Beach Courthouse.

These strong working relationships were enhanced by a GSA project manager, who was well respected by all team members. Prior working relationships and respect among team members provided the team with built-in trust from the start, helping the team to find common ground even through major challenges, such as the punch list and board-form concrete construction. One of the SOM architects described how Clark and SOM saw their respective roles and maintained a productive form of conflict. "We [SOM] are responsible for the design. And our job is to work hard to deliver the best possible outcome from a design perspective. And they [Clark] are responsible for delivering the building, cost, and budget on time. Those are sometimes opposing views, but there was never a time when they wanted to exert control over what we do. It was always a good sort of contentious at times, because we're passionate about what we do and they are passionate about what they do. But never disrespectful..."

Primary Team Selection

While Clark and SOM had an extensive relationship prior to the

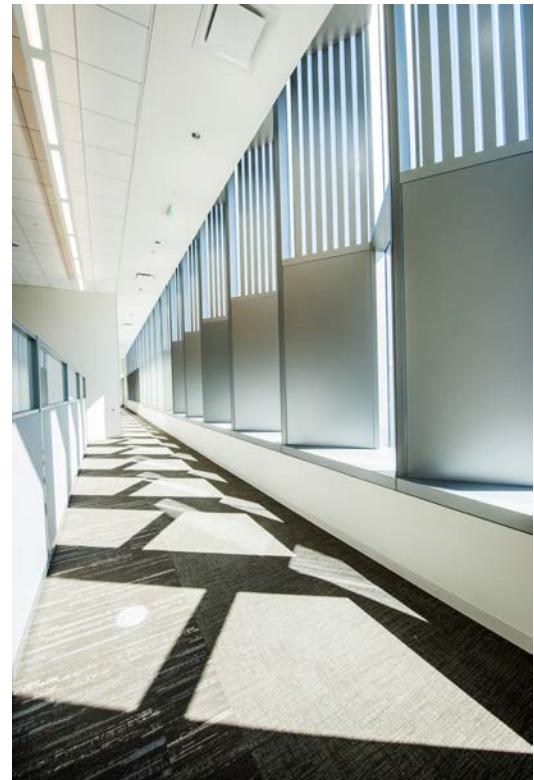
project, tenants also took the lead in ensuring that the right people were on the job. When the building was announced as a design-build project, a lead tenant stakeholder went to meet with the public-building service commissioner and asked him to put together a national team of experts in design-build from Region 9 and 10. From this list, the tenants, in conjunction with the GSA, selected their lead project manager and the experts from Region 9 and Region 10. The GSA project manager was committed to being a GSA resource at the jobsite on a regular basis, which helped with communication and coordination on-site.

The design-build team from SOM and Clark had an extensive twenty-year work relationship prior to this project. Benson (the curtain wall consultant), who was brought on early during the competition process, also had experience working with SOM on the Long Beach Courthouse. These strong team relationships helped SOM and Clark work sufficiently close together to enable Clark to start getting the structure erected while they were still in design.

Syska (engineers) and Benson were brought on during the competition to help with energy performance. SOM selected Benson to work on design in competition with Clark as SOM and Benson had previous work-history experience.

Consultant and Subcontractor Selection

There were some challenges involved in the use of the subcontractors that did not have previous working relationships with the project team. This led to communication and coordination problems between the subs and the contract team. For example, the AV subcontractor was brought into the project toward the end of completion. Since so many trades were doing work in the same area at that time, the AV group had limited and specific windows of time in which to do their work. As a result of these schedule limits, they were unavailable during the courtroom mock-up to help tenants make decisions. In another example, there were issues around quality control with the electrical subcontractors. A final challenge was coordinating subcontractor quality control (QC) inspectors.



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Contract

The GSA's decision to pursue a design-build contract over other possible delivery methods occurred at the national level. The state of the building-industry economy was one of the primary factors for selecting this type of contract. The construction market was at a low point, and the GSA wanted to capture cost efficiency to avoid a potential increase in construction costs when the market recovered. A secondary factor for selecting design-build was to drive design quickly, preventing the potential for a lengthy period of tenant design changes, which could raise the costs of the project. Selecting design-build instigated the need to choose an experienced GSA team to support this delivery. The GSA searched for experienced GSA contract officers and project managers from across the United States, instead of limiting their choices to the regional assets. While the GSA had successfully used design-build on smaller projects, they had limited experience with this contract type on large courthouses. They used LACH as a proof of concept using design-build on a large project with a demanding tenant.

The project proved that design-build could be used to construct a building of design excellence and created a major shift in the GSA. Now, more courthouses are considering/using this contract type. The GSA's Office of the Chief Architect gathered a national team to rewrite a section of their design-excellence guide to add design-build, using LACH as a model.

While the vast majority of the contract was not performance based, the contract had performance-based criteria in relation to energy performance. The RFP requested that teams achieve an energy goal of 48 EUI (later revised to 35 EUI). The contract also included a requirement for the contractor to prove that the building would operate at or below 48 EUI within a twelve-month period. To incentivize this requirement (and the later revision), the GSA offered a quarter percent of total construction cost, amounting to \$750,000, if the contractor achieved the requirement. If not, the GSA would retain that sum.



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Verification

The 50% design development peer review suggested an extensive analysis of the curtain wall's performance. Several reviewers raised concerns that the large amount of glass could make it difficult to achieve the energy goals. Analysis models and mock-ups helped to allay those concerns. In the preliminary post-occupancy feedback, some issues with heat gain on the east corridor are being addressed with new shading and adjustments to the HVAC system.

Clark is responsible for verifying the EUI goal during the twelve-month post-construction occupancy period. While the initial signed contract requested 48 EUI and Clark submitted a 42-EUI design during the RFP process, the GSA Regional Administrator at the time pressed the need to achieve a higher-performing building. The GSA then set an energy target of 35 EUI. After Clark and the GSA's design charrettes, the GSA spent approximately \$3 million to redesign the building from 42 EUI to 35 EUI. The GSA also maintained the performance requirement that Clark had to verify the building's post-occupancy EUI, which was revised to include the new 35-EUI goal.



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Team Building & Collaborative Culture

Any complex building design and program will experience some challenges, but the LACH project team had many key strengths that helped them achieve their design goals, complete the project on schedule, and meet energy-efficiency goals. One of the primary strengths of the team was their collaborative culture, demonstrated by their high level of trust and supported by strong pre-existing relationships.

Outside of these previous work relationships, the team's collaborative culture was established and maintained through co-location between Clark and SOM, continuity of core team players from start to finish, and partnering sessions established by Jacobs, the CMa. These partnering sessions involved stakeholders from design, construction, owner, tenant, and subcontractor groups to promote open communication, air grievances, and find to team-generated solutions to project challenges. These partnering sessions also allowed the team to rate project goals and values, assuring team alignment. For more on partnering, see Meetings & Workplace Environment.

Open Communication

A collaborative culture means having an open line of communication between stakeholders, especially when tensions between stakeholders are apparent. Open communication occurs not just in meetings but also during ongoing interactions between stakeholders.

For example, Clark and Jacobs had some initial tensions, when the CMa began work on the project. However, the open communication between the two stakeholders throughout their interactions on the project demonstrated that the CMa was there to help Clark with their observations and "give praise where praise was due."

For instance, when the CMa would do safety observation reports (SOR), they made sure the SORs would identify concerns as well as highlight what Clark was doing to solve the problem and how they were working in a complex safety context. Jacobs also noted when Clark's construction crews were taking all the necessary precautions to maintain a safe work site.

Right People

Tenants indicated that the staffing from the contractors was also excellent, stating that when the tenant construction committee was asked to weigh in on decisions, they could tell a lot of thought and effort went into what was presented.

Champion

The GSA project manager was described as the primary champion for the project. The contractor, tenants, and the GSA stakeholders all noted his strong leadership and communication skills, mentioning that he was always available and adept at orchestrating internal and external aspects of the project to keep all stakeholders informed. Although the project manager was based in Seattle, he visited the site regularly and was present during the mock-ups for the tenants. He worked to coordinate across stakeholder groups and engaged in regular meetings with the contractor and the tenants. This ensured strong relationships between tenants and the project team, which helped lay the groundwork for trust and goodwill when challenges, such as around the operations of a smart building, arose.



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Goals & Alignment

Meeting Early Challenges

Early on during construction, the team met with a significant challenge in unforeseen site conditions, and meeting this challenge may have helped the team quickly align around project goals. Jacobs senior manager commented that early timing of the site challenges had a positive effect on the team. He believes, that its only “until you get to know people and work with them for a while that you realize where they’re coming from. Working through these unforeseen conditions, it gave us the opportunity to get to know each other.”

Clear and Known Drivers for Decision-Making

One of the unique aspects of the form of LACH was the cube of glass suspended over an entry plaza. This floating cube was a metaphor for the courthouse’s function as a transparent civic space for justice. Many of the team’s decisions aligned around how to achieve the cube’s geometry. During the competition phase, the SOM/Clark team accepted the technical challenges of the cube, knowing that the unique design would deliver a civic presence with an identifiable form for the city residents. Additionally, the design team wanted to change the traditional “dark” design of courthouses, transforming the building’s programming needs with light from all sides. The expansive glass would help save energy on lighting costs, while also communicating the metaphor of a transparent place of justice.

A key to creating a sense of transparency and daylighting was a glass facade that would appear to float. To achieve this structurally, the glass needed to hang from the roof trusses. Core team members understood that this structural and design decision was the primary driver of the project. The architect and structural engineer had direct access to the lead contractor, which was essential for maintaining project objectives. This was especially true during the buyout of the job and when the building market was rising in Los Angeles, creating challenges for finding the right people for the job.

The architect noted the importance of the design to achieving the project’s goals, stating the building maintained the spirit and massing depicted the original renderings because those illustrations formed the “guidepost” for decision-making with the contractor.

Tenant Engagement

Federal courthouses are among the most challenging program types: balancing public access with the level of security and control appropriate for court functions is difficult. The particular needs of judges and building users creates security and coordination issues throughout the building. For the LACH project team, achieving a high-performing “smart building” added another layer of complexity, requiring input from operations staff and building users.

Due to these challenges, tenant engagement was a priority for the design-build team and the GSA. Judges, staff, and facilities managers were engaged during team selection and during key decisions around the curtain wall and courtrooms, including glass distribution, coloration, sunshades, materials, and interiors. Tenants were also included in the partnering sessions with the project team and in biweekly meetings with the contractor during the review of interior finishes and when finalizing millwork for the courtrooms. The GSA also held bi-weekly or monthly calls with the tenants early on in the project, which helped to build a strong rapport between the owner, team, and tenant. When project challenges occurred, such as issues with the smart building’s features post-occupancy, these earlier activities helped to keep tenants on board.



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Role Definition & Accountability

Role Definition and Accountability

During the last eight months of the project, under pressure to hold the schedule, noticeable tension arose between the electrical prime contractor and their subcontractor. As the CMA described it: "Because the government had a very strong interest in minority participation, Clark hired a non-union subcontractor as the prime, who then in turn subcontracted with a union contractor to do the work in the field. We had issues with the performance of the electrical subcontractor, and there were many times when they were called in to discuss their lack of performance and the low quality of some of their installations. The electrical became a concern probably in the last eight to nine months of the project. Up until that time, we knew we had an issue with the structure and that it was going slower than anticipated. Then near the end, the electrical really added to it, and there were a lot of overtime hours and extended workdays. We even had a second shift for a while to maintain the schedule."

Team Consistency

The team noted that the consistency of the core team contributed to their success. As the lead contractor noted, "Everyone we started with, we ended with." Furthermore, the GSA and Jacobs had someone full time on the site.

Trade partners and subcontractors:

Last Planner System, led by Clark, became a mechanism for trade partner and subcontractor accountability. The Clark senior project manager had used some aspects of Last Planner System (LPS) in the past, but not the full process. After completing some reading, attending training, and consulting with experienced peers, he committed to fully engage in leading the team to leverage LPS on this project. Almost immediately, he saw the value in written commitments: "I was working with an excavating contractor, a foreman who I had worked with on two or three jobs prior. After he had written down that he was going to be finished with a certain component of the work by Friday of that week, every day that week when he saw me he reminded me that he was going to finish on time. On Friday, when he was done, he said, 'Greg, I

finished my task.' I remember thinking to myself—wow, it's that important to you because you wrote it down. Very early on I realized how that makes it more of a commitment to a person."

The Clark senior project manager also noted that the drywall company had been making commitments but struggling to meet them. The Clark project manager had a conversation with the company leader and realized that the company leader's commitments were not shared with his foremen and he was not getting their input to set the promises. The Clark project manager then challenged the drywall leader to create a LPS for his own company, anchored by his company's commitments posted in the contractor's version of LPS. After following this advice, the drywall company leader reported back his amazement that LPS opened up a line of communication with the foremen about previously undiscussed problems and issues they were having on-site. Between the eight foremen, they found ways to resolve those issues and beyond that, the foremen began to routinely shift personnel between their teams so that each individual foreman could meet his commitment on the company LPS. As a result, the company became much more predictable in meeting their commitments to the overall project.

LPS also helped make a cultural change around how a tradesman committed to the schedule. The Clark senior project manager recalled that the foremen had been hesitant at first to make commitments, which resulted in the addition of extra days to the schedule. The senior project manager used LPS to have candid conversations around their apprehension and their concerns and to find out how they could work together to commit to the finish dates on the schedule. For more on LPS, see Managing Schedule & Budget.



| | Overview | High Performance | Commercial Strategies | | Leadership Strategies | | Logistical & Process Tactics | | | Building Innovations |
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| | Overview | High Performance | Timeline | Performance | IAQ | Cycle & Materials | | | | |
| | | | | | | | | | | |

COMPARATIVE ANALYSIS

Comparisons & Best Practices

LOS ANGELES U.S. COURTHOUSE

New Construction
project type

Design-Build
project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Managing Schedule & Budget

This schedule compression led to commissioning delays on the project and delays in the punch list. The punch list was still ongoing after occupancy, particularly around electrical and interiors. To help ensure that the punch list was completed at the end of the schedule, Clark allowed the GSA to walk through the space and make additions to the punch list after the date when the project was declared substantially complete. The schedule compression also did not allow for enough time to educate tenants around the operation of the smart building's design, leading to confusion around why certain outlets did not work after hours.

Successful Strategies for Managing Schedule

Last Planner System

Throughout the project, LPS functioned as a tool for communication, collaboration, and empowerment: it allowed stakeholders to visualize the schedule, ensured accountability around project responsibilities, and provided subcontractors a way to measure their individual goals on the project. The Clark senior project manager implemented LPS on the first day of the project. The schedule was kept in their conference room, with the project manager working three weeks ahead of the schedule. Meetings on the schedule occurred weekly. LPS initially started with the daily work plan, with foremen writing down their commitments about completing their tasks on post-it notes for everyone to see. This also resulted in the contractor validating subcontractor commitments and setting clear expectations. LPS then evolved to include boards for phased planning, make-ready plan, daily work plans, and the learning process.

The Clark senior project manager immediately saw the effects of LPS, specifically the value of the foreman writing down their commitments onto the schedule. This was crucial for daily coordination and assessing manpower between eight different locations on the project site, with tight sequencing around structural steel, carpentry, and other trades.

LPS was particularly helpful for solving a specific scheduling

challenge with the electrical subcontractor. Through a series of performance meetings and daily huddles as a part of LPS, the senior project manager found that the electrical sub had difficulty meeting and making commitments. The senior project manager solved the issue through a series of meetings at the company leadership level and by setting up a contract with the subcontractor so that they could hire another contractor. This second subcontractor was able to bring in resources to help oversee the work and through regular ongoing meetings about the schedule this scheduling challenge was resolved and the project could get back on track.

In another example, the LPS helped a subcontractor struggling to fulfill their commitments when working on a critical part of the structural system, causing delay in the work of others. The team did a "deep dive" with the subcontractor, and realized that his manpower commitment varied significantly from day to day. This was unrealistic since his typical team size did not vary. The Clark team then shifted some of their expectations for his work to even out demand for his manpower. After the shift, the demand was more stable, but it became clear that he was understaffed to meet the need. When he realized additional workers could be steadily employed, he added ten workers and was able to radically improve his performance, meeting every commitment for the subsequent two weeks. For more on LPS, see Role Definition & Accountability.

Budget

Betterments

The GSA set aside contingency (betterments) for stakeholders to use for improvements or enhancements. They began with a list of things that the stakeholders were looking for that fell outside of the original RFP. These items could not be major programmatic changes, but improvements to areas (such as finishes), functionality, and energy efficiency. The list remained dynamic throughout the project, updated and developed, and items had costs attached to facilitate GSA decision-making. The contractor tracked the list of betterments requested by the

tenants, design team, and the GSA. Each stakeholder group had a specific budget for betterments, and these budgets were transparent for all stakeholders. Betterments were used to enhance the courtrooms for tenants, reconfigure walls, ceilings, marble-topped benches on the building's exterior, and to push for the aggressive 35-EUI energy goal.

One drawback to the betterments list was that at times it took a while to make a decision on a specific item, which impacted the schedule. Tension also developed after a GSA management change—new management and the tenants held different expectations about what contingencies were allowed on the project. The new GSA management did not believe that further design changes through contingencies should be allowed after design was finalized. However, tenants had, through the project's process, developed expectations about contingencies being an ongoing part of the project. Getting the new GSA management to agree to enhancements and to extend the design period prolonged the project. The GSA project manager noted that in future projects, the list needs to be developed early in the project and tenants need to be clear about the firm deadline on contingency decision-making. He reflected, "the betterments process worked okay on this project. I think we needed to do a better job of maintaining that firm line that once a date has past, we can't go back. I don't think that was ever communicated as clearly and as effectively as it could have been."

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| | Overview | High Performance | Performance | IAQ | Cycle & Materials | | | | | |

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BIM & Design Documentation

BIM

The use of building information modeling (BIM) was not extensive, but it was a key tool that supported phase planning and priority spaces that needed to be finished first to keep the mechanical and electrical work on schedule. The Clark project manager recalled that a BIM-coordination session helped reveal a critical electrical chase space that had not been identified as a priority space but needed to be finished out to keep to the electrical supply schedule. BIM was also used extensively in the steel fabrication and testing of the unique structural sequence: the columns were in compression during construction and shifted to tension when the temporary supports were removed.

Mock-ups

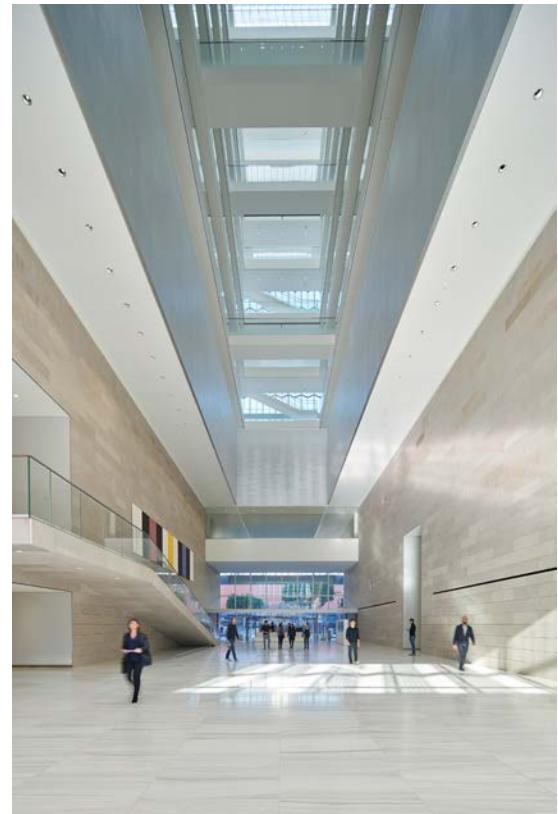
Mock-ups were key for assessing the curtain wall and interior courtrooms. Mock-ups helped to test design ideas and align teams and building consensus around project decisions. The first mock-up was of the curtain wall. SOM, Clark, and Benson built and designed the mock-up, which was about one floor length in height, and it was used to test the performance of the pleated curtain wall (seismic and filtration outflow) as well as to allow for tenant feedback on the structure. As one tenant noted, the curtain wall mock-up helped them better imagine the entire design: "when I could see a section of the curtain wall, it was the first time I could visualize what the courthouse would be like when it's done."

The Clark/SOM team also developed a highly detailed mock-up of the interior courtrooms for tenants to determine appropriate layout and site lines. The contractor decided that they needed to build a full-scale mock-up to minimize the possible number of changes that the tenants might request for the twenty-four courtrooms. Clark built and funded a full-scale mock-up of a complete courtroom in a warehouse that included all the finishes, such as carpet, and furniture. The architect also fine-tuned the lighting and paint selection for the mock-up. The GSA project manager noted that this activity helped to integrate the betterments into the courtrooms and prevented the need for major changes after the courtrooms were built. "We didn't

have to go back in and make a lot of changes in the courtrooms after the fact. It was a very smooth process because once the mock-up was done and correct, everybody knew what they had to do. They went into the building and built twenty-four of them, and we had very few changes because of that."

Information Management

The GSA uses a proprietary software system called electronic Project Management (ePM). In this project, the contractor was not encouraged to use ePM directly, but Jacobs, the CMA, would get documents from Clark to upload to ePM. During this information exchange, there was some inconsistency in data descriptions (metadata), and it could be difficult to find documents. Furthermore, it was not always clear how to structure the project ePM, especially as Clark had its own construction management project management system, and each office engineer at Clark had their own submission method. The Jacobs staff was largely able to support the team's interaction with ePM, but had some difficulty coordinating documents with Clark.



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| | Project Overview | Performance Metrics | Supply Chain & IAQ | Construction Cycle & Materials | Leadership & Teamwork | Logistics & Scheduling | Process Automation | Innovation in Construction |

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project type

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project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Meetings & Workplace Environment

Co-Location

Co-location was used primarily between SOM and Clark and lasted over two years. A Clark representative was at the architecture office and at all meetings. While at the architect's office, Clark started some initial scheduling work using LPS. The GSA, Jacobs, Clark, and SOM also were located in adjacent trailers at the job site during construction, with Clark and the GSA's trailers connected by a porch. Clark's trailer had a physical space for the LPS whiteboard and post-it notes, and the subcontractors and foremen would regularly go into the trailer to go over the LPS board outside of LPS meetings.

Cleanup Issues on Job Site

Due to the schedule demands of the project, which led to multiple trades working at once on the site, cleanliness issues developed on the site. Clark and Jacobs would meet every morning on-site and go through the cleanup related items. At one point, after Jacobs and Clark discussed the site cleanup issues at a partnering session, Clark shut the job down to clean up the site, but it was difficult to keep up with the pace of the accumulation of trash. The day of cleaning improved the site, but maintaining an uncluttered site continued as an issue throughout the job.

While the project had ongoing issues with site cleanup, Clark had no accidents that caused lost work-time after 2.3 million man-hours. Clark also had full-time medics on-site and could directly address first-aid issues and offer clinic assistance. Clark has a "stop-talk" policy in the field that was employed on this project: if someone sees unsafe work practices happening on-site, then the work stops and the team talks about solutions. Everyone that worked on the site had to go through a thirty-minute safety-training session and a follow-up training discussion, which concluded with them receiving a sticker to put on their hardhat.



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LOS ANGELES U.S. COURTHOUSE

New Construction project type

Design-Build project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation project type

Design-Build project delivery

Peer Review & Partnering

LACH was a new construction project that was the GSA's pilot project for design peer reviews using design-build project delivery. These design peer reviews focused on the design itself with the intention of helping teams hone in on design decisions. However, applying this new type of peer review process led to some frustration and stress for project team members. The design-build team believed that the peer review process ran longer than anticipated and the inclusion of peer reviewers outside of the initial peer review team added additional layers of considerations which increased the complexity of the design requirements. As one team member said, "The peer-review process seemed to go on and on, and when it felt like we were addressing the needs, more items were stacked on that the team of engineers would have to address....[They are] bringing up good questions, but to go through the process of calculations and supply with data... added another layer of design review that extended our own design further than anticipated."

Partnering

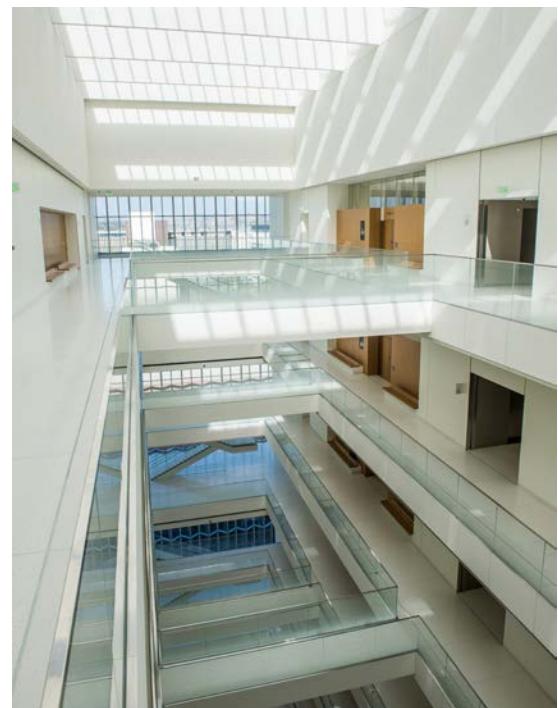
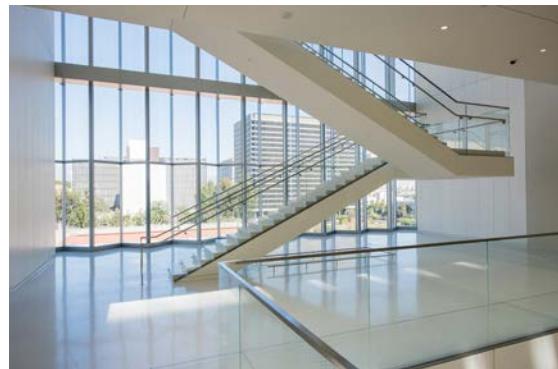
Partnering sessions were key to the project's success. These sessions were intended to clarify team objectives, identify team challenges, align team goals, and promote a collaborative team culture. These sessions occurred every three to six months around milestones, such as the finish of design and on-boarding subcontractors. While there was some initial pushback on partnering from the GSA project manager, by the third one, team members could see value of the sessions as a safe space for team members to be open and honest about concerns. As a whole, the sessions helped to air concerns while celebrating team and project achievements.

The GSA project manager shared his thoughts on partnering: "What made our partnering effective was [that] we looked at what was going right and we looked at what could be improved. It was a combination of both. It was, 'Okay, let's celebrate the things that we've done right and then let's dig in and find out what the areas of concern are.' It became an open forum where everybody was comfortable opening up and sharing their concerns about the project. In many instances there was not a lot of surprise. I think we knew what the problems were."

But there were some instances when things came out of the partnering that made us respond, 'Wow, we really didn't know that that was a problem, and thank you for sharing that.'" Partnering sessions were coordinated by the CMA, who hired Ventura Consulting to lead and facilitate partnering. For each session, the GSA, Jacobs, Clark, and Ventura worked together to determine the agenda and the attendee list. Attendees included tenants and major subcontractors. Having subcontractors in the sessions helped to ensure that their teams also had a shared understanding of the project's schedule, deadlines, and goals.

Before the meetings, the facilitator provided all of the attendees with a survey to score different concerns or values to ensure goal alignment and to identify project challenges that needed to be discussed at the meeting. During the meetings, the teams would break out into smaller groups. Each small group focused on a specific identified concern, the time frame in which an issue would be resolved, and assigning responsibility to someone at the session to assure it would be addressed. The first two sessions were full days; the third session was a half day.

Partnering sessions were also essential for managing and improving stakeholder relationships. For example, there was some initial tension between Clark and Jacobs. However, after their summer partnering session, Jacobs scheduled a meeting with Clark management to discuss the two firms' cultures to see how they could improve their corporate processes. Furthermore, when change orders were delayed in 2015, Clark, the GSA, and Jacobs used their partnering-session time to establish weekly meetings for developing a schedule and a process for change orders, setting deadlines for change order decisions, and reviewing the impacts of missed decisions. GSA's project manager believed the sessions were very valuable. He commented, "There were some instances when things came out of the partnering that made us think, 'Wow, we really didn't know that that was a problem, and thank you for sharing that.' [Those insights] came from everybody. This is the key to partnering—we had all of the stakeholders involved, so it wasn't just the GSA and the contractor."



| | Overview | High Performance | Commercial Strategies | | Leadership Strategies | | Logistical & Process Tactics | | | Building Innovations |
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| | Overview | High Performance | Performance Metrics | IAQ & Materials | Commercial | Leadership | Logistics | Process | Innovations | |
| | Overview | High Performance | Performance Metrics | IAQ & Materials | Commercial | Leadership | Logistics | Process | Innovations | |

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MICKEY LELAND FEDERAL BUILDING

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Building Innovation

Hanging the Curtain Wall

Both aesthetically beautiful and structurally complex, the hanging curtain wall governed schedule parameters and drove many other decisions throughout project. The floating-cube design of the building occurred during the ten weeks of competition for the GSA's RFP. Clark engaged Benson, the curtain wall consultant, approximately two weeks into the ten-week competition process to integrate design with costing and to validate the design. The architect indicated that bringing Benson's cost expertise to inform the design allowed the team to manage the risk associated with the daring geometry. The architect noted that the final design is "pretty much exactly what was designed during the competition stages, with a lot of refining of the goals along with the process. [Bringing in Benson] was one important decision because then we were able to validate that what we drew was achievable."

While the appearance of the finished cube remained very similar to that of the competition entry, the structural strategy used to cantilever the cube volume was different than originally planned. After the project was awarded and the construction schedule was fine-tuned, the team determined that their original structural strategy would be too slow. They had planned on building the core shear structure, adding a steel hat truss (a 3-D truss configuration at the roof level), hanging each floor and each floor's curtain wall. To speed the construction, they decided to build the floors from the ground up (with temporary columns to support the cantilever), remove the temporary supports, and then, lastly, hang the curtain wall from the roof hat truss. The SOM engineers calculated the change in position of the floor (about 1.5 inches), as the permanent columns went from resting on the temporary columns in compression to their permanent position as hangers in tension. The removal of the temporary supports took three days, employing a carefully choreographed sequence, jacking up columns and removing shims. Additional team members, Hassett Engineering and Herrick Corps, a steel fabricator/erector, were brought in to add expertise for the temporary support. Numerous refinements to the structure during the course of early design allowed for significant weight reduction

while still meeting seismic needs. The cantilevered volume provides excellent security for the building, since the perimeter columns are not accessible from the street.

Serrated Curtain Wall Design

The decision to serrate the curtain-wall facade was primarily to optimize the solar orientation of each panel. The complex geometry was economically possible due to Benson's development of a triangle-based geometry that would accommodate all conditions of the curtain wall. The designers commented on the difficulty of envisioning such a large and varied array of glass: "When you do an all-glass building, it's difficult in the sense that it's hard to know what it's going to look like just by looking at a twelve-inch by twelve-inch sample." The base geometry was about six feet tall, and to aid the design team, Benson created a mock-up frame mounted on a box. Benson provided several different types of glass with different coatings. The team could then roll the box outside in the yard and rotate it at different times of the day to see how the light would move through the building. This helped the team make decisions regarding the aesthetics of the glass.



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| Project Overview | Performance Metrics | Renewable Energy | IAQ & Indoor Air Quality | Sustainable Materials | Supply Chain | Employee Training | Facility Management | Logistics | Process Optimization | Innovation Initiatives |
| Project Overview | Performance Metrics | Renewable Energy | IAQ & Indoor Air Quality | Sustainable Materials | Supply Chain | Employee Training | Facility Management | Logistics | Process Optimization | Innovation Initiatives |

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LOS ANGELES U.S. COURTHOUSE

New Construction
project type

Design-Build
project delivery

MICKEY LELAND FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Project Overview

| | |
|--------------------|---|
| Project | George Thomas "Mickey" Leland Federal Building |
| Location | Houston, Texas |
| Project Type | Renovation |
| Contract | Design-Build |
| Owner | U.S. General Services Administration – Region 7 |
| Design Architect | Gensler |
| Contractor | Gilbane Building Company |
| Project Start | March 30, 2010 |
| Project Completion | February 2015 |
| Project Size | 366,000 GSF |
| Project Height | 22 stories |
| Original Budget | \$109,053,000 |
| Final Budget | \$91,843,000 |



Space Type Key
1- Office
2- Elevator Lobby
3- Building Entrance

Typical Floor Plan



| Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | Building Innovations |
|----------|------------------|-----------------------|-----------------------|------------------------------|----------------------|
| Review | improve | idle & Materials | 1 & IAO | Performance | Review |

Project Timeline

Located at a prominent site near one of the main entry points into Houston's downtown, the George Thomas "Mickey" Leland Federal Building was originally built as a speculative office building with a detached six-story parking garage in 1983. After the GSA purchased the building in 1987, an energy performance analysis documented that air and water infiltration could be corrected with modernization. After a preliminary study, the GSA awarded a design contract in 2006, and a Construction Manager as Constructor (CMc) contract in 2008. When, in early 2009, funding for modernization to meet high-performing federal-building goals became available through the American Recovery and Reinvestment Act, both contracts were terminated. The project scope was then revised,

and in late 2009 a request for design build proposals was issued. The modernization scope included a complete facade replacement to address air and water infiltration and energy conservation as well as structural upgrades to meet the wind-load requirement recently changed in the building code.

There were several key challenges on the Leland project, including logistical complexities involved in installing cladding over sawtooth corners, and a deviation from the geometry of the exterior skin expected from laser scans. In addition, the building was 95% occupied during construction.

The final completion date of the project was revised several times. When the design-build contract notice to proceed with design was issued on April 2010, the final completion date was June 2014. In their proposal, the design-build team proposed an earlier completion date around November 2013. As the project unfolded, logistical issues for the recladding of the sawtooth corner created delays to the schedule. In the end, the GSA declared the work substantially completed and accepted in December 2014. The GSA accepted final completion in February 2015, including completion of all commissioning and punch-list items

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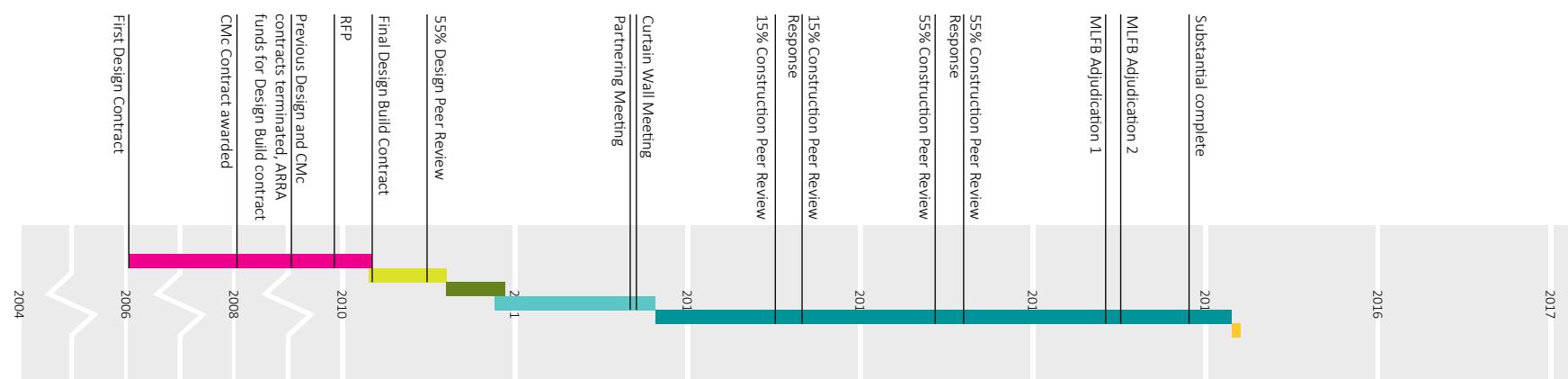
New Construction
project type

Design-Build
project delivery

MICKEY LELAND FEDERAL BUILDING

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project type

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Project Phases

- Planning/Procurement
- Concept Design
- Design Development
- Construction Documents
- Construction
- Move-In

— Project-Specific Events see graphic

| | Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | Building Innovations |
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COURTHOUSE

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project delivery

MICKEY LELAND
FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Team Organization

There was an established relationship between Gensler and Gilbane as firms and many of the senior managers in the project team were well known and respected in the community.

Owner

U.S. General Services Administration – Region 7

Design Build Team

Gensler
Gilbane Building Company

Construction Management Agent

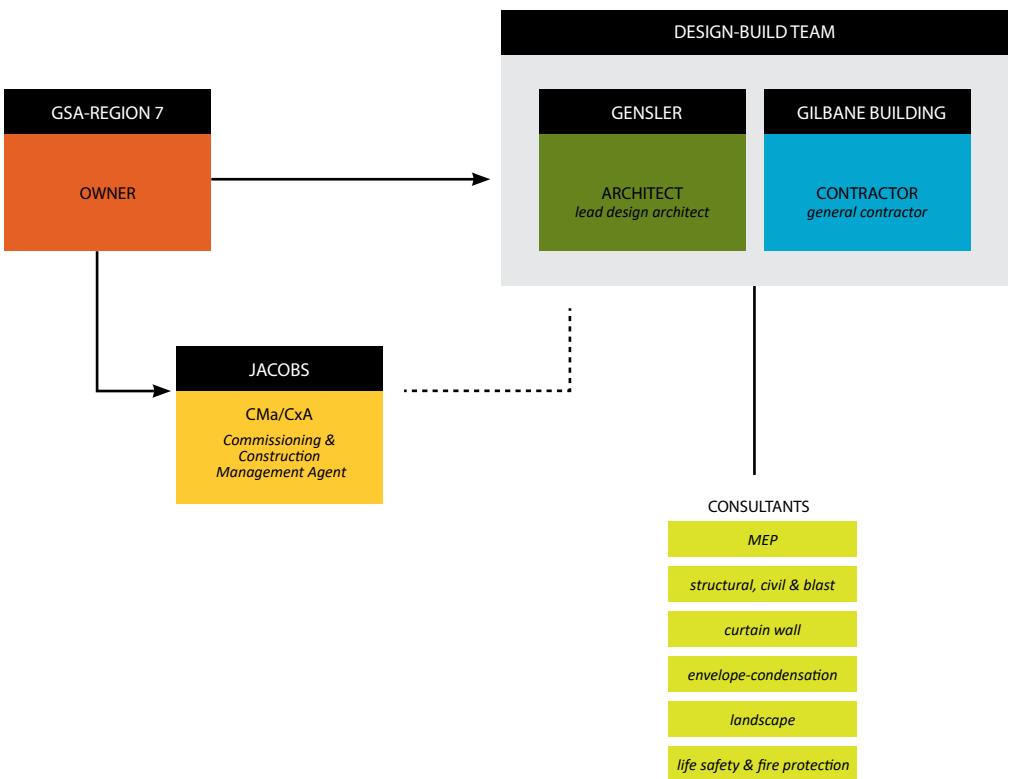
Jacobs

Commissioning Agent

Jacobs

Consultants & Subcontractors

MEP: CHP (now Stantec)
Structural, Civil, and Blast: Walter P Moore
Curtain Wall Consultant: Gordon Smith
Envelope-Condensation Consultant: SGH
Landscape Consultant: Office of James Burnett
Life Safety and Fire Protection: Andre Garabedian



Key

- Owner
- Architect
- Contractor
- CMa and/or CxA
- Consultants

- a → b Entity b is under contract to entity a
- a ⇢ b Project interaction between entity a and b

| | Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | Building Innovations |
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| | Overview | Performance | Cycle & Materials | | | |
| | Timeline | Performance | Life Cycle & IAQ | | | |
| | Key | Net Energy Use Intensity after Renewables and Offsets | Total Energy Use Intensity before Renewables and Offsets | Baseline Energy Use Intensity for Similar Building | | |

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New Construction
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MICKEY LELAND
FEDERAL BUILDING

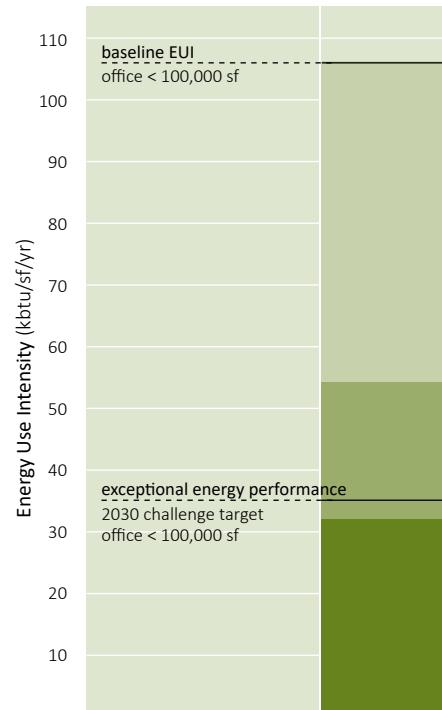
Renovation
project type

Design-Build
project delivery

Energy Performance

From LEED Silver to LEED Platinum

The original Leland Building had poor energy performance, mostly due to air and water infiltration through the building enclosure. Both Gensler and the GSA were motivated to achieve the American Recovery and Reinvestment Act (ARRA) energy goals and improve the performance of the building. While the GSA initially requested that the project attain LEED Silver, early submittal of the design indicated that the building would achieve LEED Gold. Gensler monitored LEED points throughout the project. The team also had to assess if the building would meet several sustainability criteria: 1) LEED, 2) Statement of Work, 3) Minimum Performance Criteria, 4) P100, 5) the Energy Independence and Security Act, 6) EUI targets. By the end of construction, the project had met all criteria surpassed its goals and achieved LEED Platinum, with an approximate 45% reduction in energy use. While the original building's EUI was 54.6, the remodel, renewables, and offsets reduced the building's EUI to 31.4. For comparison, a typical Houston office building, of any scale, achieves an approximate EUI of 90. Energy solutions include the photovoltaic panels installed on the roof of the parking garage, which defray utility use from the power grid and generate 4.21% of the site's power needs.



Energy Use Intensity

Energy Use Intensity (EUI) measures a building's annual energy use per unit area (kBtu/sf/yr). Each project's EUI is compared to a national average baseline EUI for office buildings of comparable size. A low EUI is an indicator of good energy performance as it represents an energy savings against the baseline.

| | |
|---|--------|
| EUI before renewables (kBtu/sf/yr) | 54.6 |
| EUI after renewables (kBtu/sf/yr) | 31.4 |
| % energy reduction (from average building type EUI) | 70.4 % |



Key

Net Energy Use Intensity after Renewables and Offsets
Total Energy Use Intensity before Renewables and Offsets
Baseline Energy Use Intensity for Similar Building

| | Overview | High Performance | Commercial Strategies | | Leadership Strategies | Logistical & Process Tactics | | Building Innovations |
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| | Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | | | |
| | Overview | High Performance | Commercial Strategies | Leadership Strategies | Logistical & Process Tactics | | | |

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project type

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MICKEY LELAND
FEDERAL BUILDING

Renovation
project type

Design-Build
project delivery

Daylight & IAQ

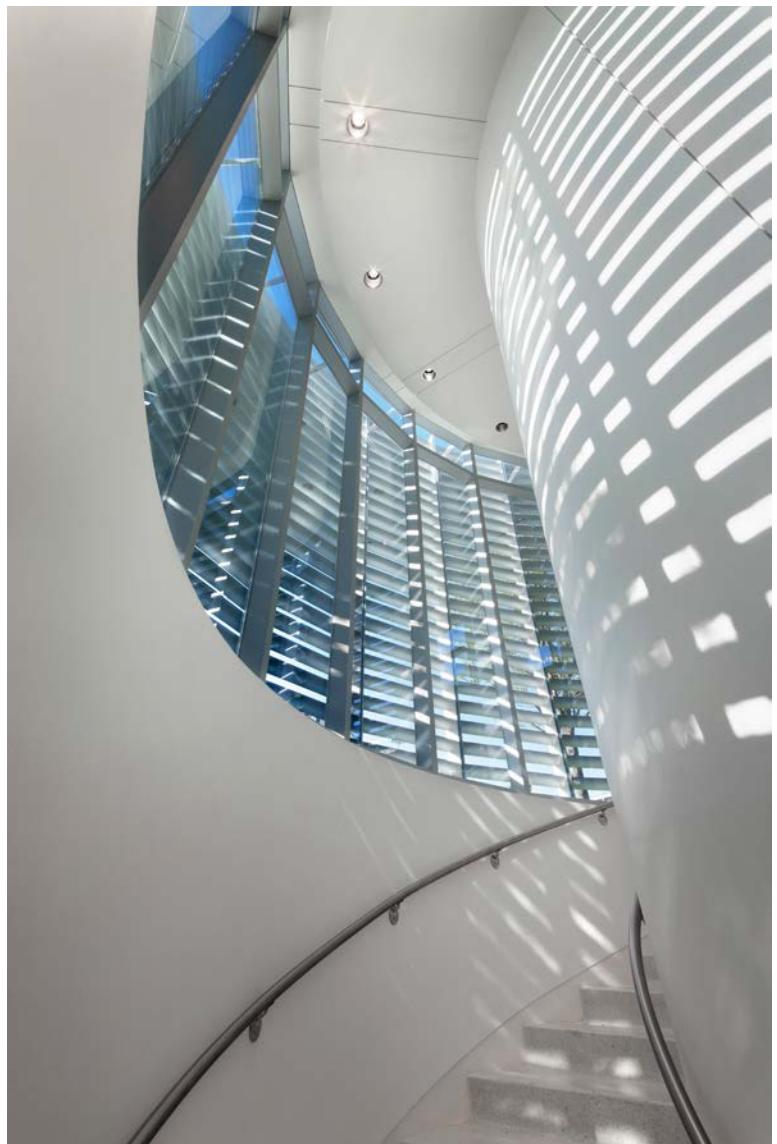
Daylight

The Leland building used daylight harvesting to better take advantage of sunlight. The team replaced the exterior curtain wall to eliminate air and water infiltration, which both improved energy consumption and increased the daylight available for building-tenant use.

Indoor Air Quality

The building mechanical system was completely updated, improving indoor air quality (IAQ). The HVAC system introduces ample fresh air into the building and outside air intakes have all been raised to the second story of the building. This system has improved indoor temperature control as well as air quality. The new building's exterior envelope also eliminated the water-infiltration problems of the previous building, thus reducing chance of mold.

IAQ improvements also included environmental tobacco-smoke control, outdoor air-delivery monitoring, and controllability of lighting and thermal comfort. Gilbane was responsible for a construction IAQ plan and received LEED credits for using low-emitting material (L.E.M.) adhesives and sealants. The building also used L.E.M. paints and coatings, flooring systems, and composite-wood and agrifiber products.



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project type

Design-Build
project delivery

Water Cycle & Materials

Water Cycle

The building uses a water-recovery process in which water condensate from cooling coils is collected and stored in a 1,000-gallon underground-cistern tank, meeting 100% of the irrigation demands for the project and contributing to the project's LEED points. The configurations of the existing building, city block, and open space preclude storm-water capture or treatment. The team used integrated water-efficient landscaping. At street level, the public plaza along Louisiana Street was transformed, with extensive rainwater-irrigated planted areas covering over 50% of the open space around the building—both at grade, in planter shells, and with green roofs.

The result was a building with 40% reduction in water usage. The team also improved water consumption by employing low-flow appliances and by using condensate as the sole source of irrigation water. All the restroom facilities were retrofitted with low-flow plumbing fixtures throughout the remodeled floors—the fixtures reduced the potable-water consumption from a baseline of 1,611.94 Kgal per year to 952.84 KGal a year.

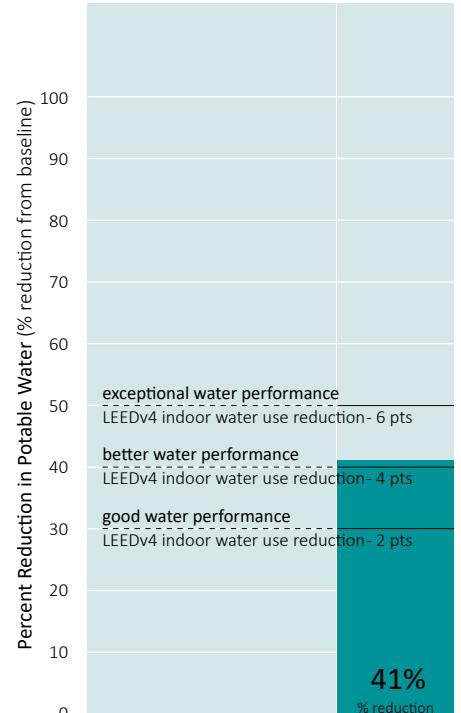
Materials

The team used a new glass curtain wall with high energy-efficiency characteristics to aid in meeting LEED credits and HVAC-renovation requirements. Steel was used extensively for special sawtooth connections to the curtain wall on each floor and on the plaza level's new structures. The new skin design included a large "wind sail" area. The structural engineer, Walter P. Moore, modeled the structural behavior of the building using a performance-based analysis that accounted for the nonlinear behavior of materials, a practice used in seismic design. This alternative approach reduced the quantity of members requiring strengthening, which saved on demolition and on new materials. Savings were approximately 1,500 tons of concrete, 175 tons of reinforcing steel, and 350 tons of cradle-to-grave CO₂ emissions. This achieved a 30% reduction in material quantities in the lateral load-resisting system.

Analysis of Curtain Wall

To analyze the curtain wall, Gensler hired Gordon Smith as the curtain wall consultant. His expertise ensured that the curtain wall's shop drawings would be approved and meet the criteria of the project. One challenge was designing the process for installing and integrating the window-washing-equipment track system. The team made a full-scale mock-up of the curtain wall and window-washing assembly. They tested it to prove that the window-washing system was viable and to ensure that it was watertight.

The team also hired an additional consultant to analyze the dew point of the curtain wall system for condensation. This helped the team guarantee that their water-proofing membrane was located correctly.



Reduction of Potable Water

Water use reduction is simulated by comparing the amount of water used by a project's interior fixtures to a baseline (percent reduction). The baseline fixtures are determined by the Energy Policy Act of 1992 fixture requirements. Higher percentages indicate good water performance.

| | |
|---|------|
| Potable water reduction (% reduction from baseline) | 41 % |
| Potable irrigation (potable water used for irrigation?) | N |
| Stormwater Control (% rain managed onsite from 2 yr storm) | N/A |

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RFP Development

Several years before the design-build RFP was issued, the GSA had awarded a design contract and a CMc contract. Both of these were terminated when the project scope was revised to meet the goals of the ARRA. The project delivery method was switched from CMc to design-build. This decision was in part to speed the time to obligate funds, a key ARRA goal to stimulate the economy, and also to maintain a collaborative team that could address the many unforeseen conditions likely to arise in modernizing a building from this era and with this history. When asked if other delivery methods were considered, the GSA project manager reflected, "There was no way to do a traditional design-bid-build. You would've had so many change orders on this project, and I think it would have been fraught with a much more negative atmosphere. I can't even conceive of doing that project this way."

The design-build RFP was developed in two phases: a Request for Qualifications (RFQ) and preliminary selection of design-build teams and an RFP competition and selection. The first phase took place on September 15, 2009, and the second phase on December 15, 2009. The RFQ selection criteria included past performance, prior experience with design-build projects of a similar scope, and ability to deliver design excellence. The RFP evaluation process was open for teams to propose betterments and the criteria for selection included design and quality of materials, project execution and schedule, project team, and sustainability (LEED Silver).



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Team Selection

Many of the team members were selected based on prior relationships between firms or between individuals within firms and the GSA. The project had a prominent location in Houston, and several team members commented that the team took pride in working on such a visible building that so markedly improved the envelope of the old.

Prior Relationships

While the team engaged in partnering sessions early on in the project, there was already a high level of trust between project team members on the design-build team. Gilbane and Gensler had worked on multiple design-build projects together, including large projects, such as the Hess Tower. Gilbane's project executive and Gensler's lead architect had worked on the Hess Tower project and knew how to successfully work through challenges together as a team.

While Gilbane and Gensler had not worked with the GSA before, Gilbane's quality-control person on the team had worked for the GSA on Indefinite Delivery/Indefinite Quantity (IDIQ) projects as a construction manager. This helped establish trust between the GSA and the design-build team. Likewise, Jacobs has a history of working with the GSA as Construction Manager as Advisor (CMA).

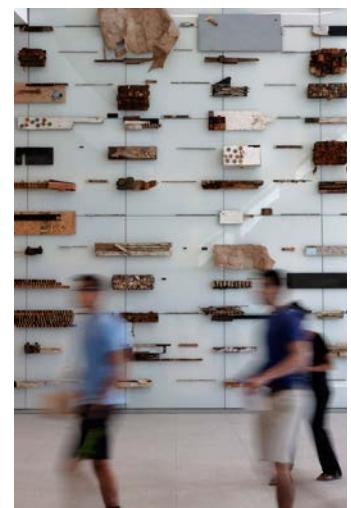
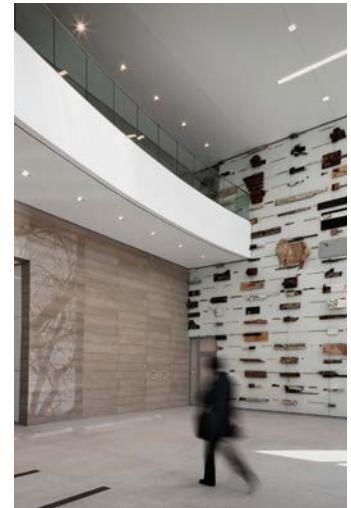
As a team, prior working relationships helped establish trust at the start of the project and a thorough understanding of their partner's internal agendas, working processes, and measures of success. A Gilbane executive describes their positive perception of Gensler, "We already had a good working relationship [from our work on the Hess building], and transitioning into the next project it was helpful to have that basis of trust already established. You knew what you were getting...You knew how your teammates were motivated, what they needed to be successful, and they knew what you needed to be successful." Gensler's lead for quality assurance/quality control appreciated the respect they received from Gilbane in the design-build relationship, "I think one of the nice things is that Gilbane let us be the architect. They didn't treat us like we were draftspeople."

They expected us to do our role as a designer, almost as if we weren't working for them [in a design-build-contract setting]."

Primary-Team Selection

Gensler and Gilbane were aware of the project almost a year before the RFP and had planned to submit a proposal. The team had previous experience with providing best value to the GSA and believed they were well positioned to succeed if they were chosen. Gilbane chose their MEP and curtain wall subs after teaming with Gensler; this allowed their team to integrate early in the process and identify challenges in design and construction.

In parallel to the selection of the design-build team, the GSA selected Jacobs as their CMA. The GSA contracted them to access their technical capabilities and personnel to conduct inspections of the construction site and also to help manage the technical aspects of the project. In addition, Jacobs served as the commissioning agent.



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Contract

The GSA had initially chosen CMC as the delivery method for the project prior to the shift to the ARRA. One of the ARRA goals is economic stimulus by obligating as much of the budget as quickly as possible. Design-build contracts allow for both design and construction money to be obligated very early, which is why the project was switched to this delivery method.

The GSA also preferred the design-build method as it would help fold logistic and coordination issues into design. As the building would be fully occupied during construction and the team had to work around unknown conditions, the GSA wanted the construction team to provide their expertise on the impact of design on logistics. While a design-build contract means that the owner has less control over design, the high level of teamwork and local pride in the project helped to deliver a good design.

One of the other benefits of a design-build contract is that the team had some flexibility to adjust their expenses within the total contract when handling unforeseen conditions on the project. Adjusting the contract required Gilbane to be audited to ensure costs were legitimate but that the overall costs remained the same.

Because of the need to make adjustments, design-bid-build delivery was never seriously considered, even though it was common in that market. The Jacobs regional manager and others on the project team shared the opinion that the collaborative nature of design-build project delivery was essential to the success of the project. They believe the changes caused by unforeseen conditions – well managed by the team – would have led to numerous change orders and a contentious atmosphere in a traditional delivery.



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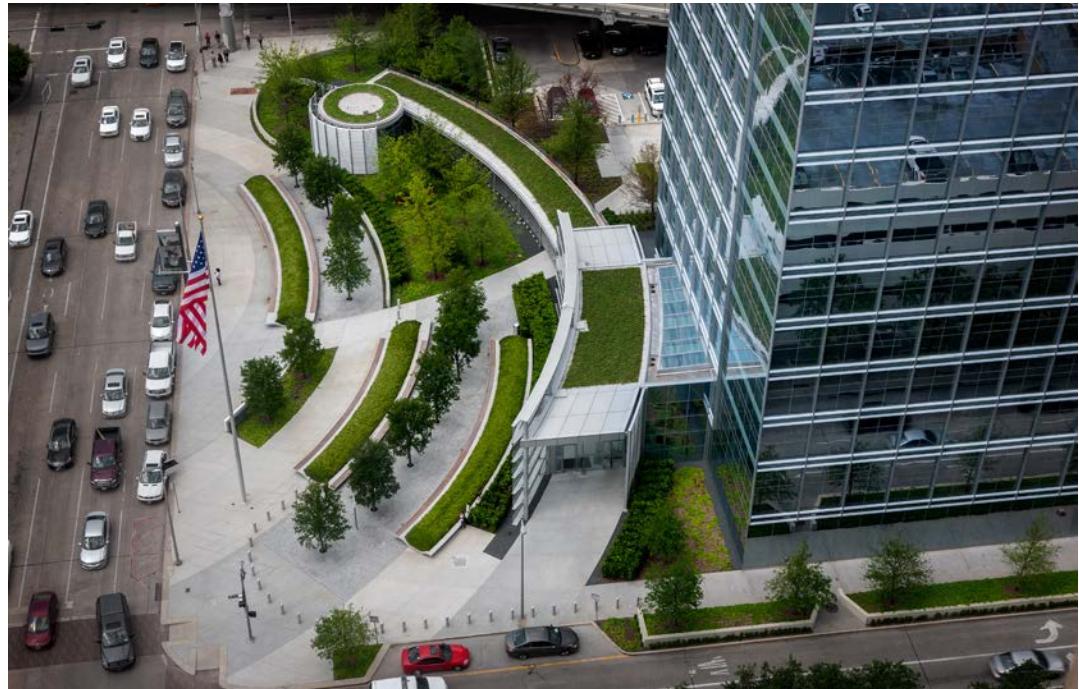
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Verification

This project did not have performance-based contract terms; therefore, measure of verification was not a part of the project's scope. While there has been discussion about performing verification, as of today that effort has not been initiated.

Because of the problems with the building's enclosure prior to renovation, after the modernization was complete the team conducted a blower-door tests and measured condensate from the units to ensure that the building was well sealed.



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Team Building & Collaborative Culture

Community Pride

A high level of trust and a collaborative culture of the team were greatly facilitated by the fact that the key design-build firms had a presence in the Houston area and most of the leaders were well known in the local community. Gilbane had a regional office in the area, and all of their staff came from the Houston office. Gensler had an office only several blocks from the jobsite. For these local individuals, working on the Leland building and improving it for tenants and the city was a source of pride. The team was working on an iconic building that served as a welcome sign to downtown Houston. The GSA senior project manager recalls the positive interactions among the team: “There was a lot of pride in the job.... Everybody looked at it, and said, ‘Hey, this is our hometown.’ [When there were challenges, the discussion] was never about whose fault is it. Or whose problem is it. It was, ‘How do we make this work? What can we do? How can we come up with a new way to try to solve this?’”

Open Communication

The project team members at the executive and project management level, including the GSA team members, all engaged in open communication during formal meetings and informal interactions. For example, the project team members viewed the on-site GSA project manager as easily approachable. The Gilbane project executive recalled that he did not use a lot of email communication but relied mostly on face-to-face communication. He noted he could easily walk over to the on-site GSA project manager and have an open and honest discussion about project challenges. In turn, the GSA team could informally approach Gilbane team members to discuss project challenges and how to mitigate them.

Tenant Communication

Gaining the goodwill of the tenants was a priority for the team since the building would be occupied during construction. The GSA’s primary strategy with the tenants was to be transparent about the work, schedule, and impact of construction. The

GSA’s building manager worked with the on-site GSA project manager to create weekly newsletters to help set tenant expectations about what parts of the building would be affected during the coming week and how that would impact tenants. When something unexpected happened on the jobsite, the GSA building manager would send a quick email or an emergency newsletter to tenants to update them. The newsletters were also posted online on a GSA project website, which also included tenant packing and moving guides. This website also functioned as a “user manual,” educating tenants about the new building’s appliances.

Gilbane’s tenant-coordination team learned about tenant needs while building trust with the tenant-agency representatives. These efforts would prove beneficial when the team had to resolve the logistical challenges for completing the enclosure around the sawtooth corners. Having strong communication and trust help make tenant-project team relationships resilient even during times of tension. For more on tenant engagement, see Goals & Alignment.

Right People

Another key to team building and collaborative culture was having the right people on the project team and the GSA team. Team members noted that there were experienced leaders across the project, including at the GSA, Jacobs, Gilbane, and the main subcontractors. The Gilbane project manager observed, “at the end of the day, when you ask how come a project is successful, it really comes down to the people involved...that’s what made this project feel special. There was always a really strong force on each side that would hold things in line. Even when things got heated or tough, cooler heads would always prevail because we had some real strong people on the team.”

In particular, the on-site GSA project manager was considered a strong asset for the team due to his open communication, knowledge, and experience. The GSA building manager noted

that the on-site project manager openly communicated his needs to her for tenant communication and coordination while ensuring that he did not interfere in her management of the building. The Gilbane project engineer/project manager recommended that the GSA invest in an on-site project manager for all their large, complex jobs.

Offsite Inventory

Since the Leland building was an ARRA project that intended to circulate funds into the economy quickly, the GSA decided to purchase some materials before they were ready to be installed. Within the first month or two of the project, 80% of the drywall was purchased. However, as the building was fully occupied, there was insufficient storage space on-site. While most materials were stored in Houston, others were stored close to the manufacturers—in Alabama, for example. Due diligence required, through inspections, that the GSA verify that materials were not being used for other projects. Jacobs, which has regional offices throughout the United States, was asked to inspect materials wherever they were being stored. Using their local representatives avoided travel costs.

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Goals & Alignment

Clear and Known Drivers for Decision-Making

The logistics around the sawtooth curtain wall was the primary driver for decision-making, particularly around keeping the project on schedule. The structural complexities of the curtain wall's construction pushed out the schedule and required shifting tenant-move schedules. A potentially tense situation between tenants and the project team remained amicable since tenants were aligned with the overall goal of an updated and aesthetically beautiful building that could be a source of community pride. Gilbane's project engineer/project manager recalled that many of the tenants were affected by the change in the move sequence, and "although tough at times, we were able to make those adjustments with the tenants because of the good relationships that [Gilbane's transition planner] had built with them and [because] we had with the GSA. We had an understanding of their needs."

Minimizing the impact to tenants was one of the clear and known drivers for decision-making for the project team. This goal meant that the design-build team had to strongly invest in tenant engagement, maintain open communication with tenants, and take tenant needs into constant consideration when designing and planning the swing spaces.

Tenant Engagement

The project team exhibited strong tenant engagement at the start of the project, which they, along with goodwill and trust, maintained throughout the project. Tenant engagement began with a partnering session that included Gilbane and the tenants. The partnering session was viewed as an opportunity for the design-build team to begin developing positive relationships with the tenants. The GSA building manager was cited by many team members as a key champion of tenant communication. She was new to the role and saw the construction coordination as an opportunity to establish personal contacts with all of the tenant agencies as a basis for long-term relationships.

The design-build team (Gilbane and Gensler) then began a structured process of tenant engagement to help align tenants with project goals, uncover tenant needs, and set expectations.

This process consisted of the design-build's tenant coordination team contacting and setting up meetings with representatives of the twenty-two agencies that occupy the building. The coordination team also conducted interviews and surveys with the tenants about their needs for their swing spaces. Gensler then spent several months designing the swing spaces for each phase of the project, taking into consideration each agency's restrictions on moving dates, IT, security systems, weapons and ammunition, and chain of file custody. The GSA and each tenant agency then needed to approve and sign off on the swing-space design. This process helped the project team get to know tenant stakeholders and representatives and prevented potential complications and frustrations for the tenants.

During construction and move-management process, the team worked closely with the GSA building manager to ensure that everything was installed or removed as needed, including proper locks and security systems. There were also several all-hands meetings with the project team and move-in leaders and coordinators. After these meetings the tenant representatives would then return and coordinate within their own agencies to prepare for the move.

The GSA also aligned tenants to project goals by holding community events. For example, prior to using the first floor as a swing space, the GSA hosted an open house for tenants on the newly built-out first floor. They used the open house to preview the swing space's lighting and furniture for the tenants. Another milestone event that GSA celebrated with tenants was a mini-event that the GSA held to raise the first flag on a pole—the local fire department was invited to raise the flag. The building manager described the flag raising event in the

following way: "[It] was super simple, but it was like people felt they belonged and [saw it as] one more milestone—this [project] is happening, our plaza is coming together....And we tried to create moments of excitement and anticipation. [To say to tenants], 'We know this has been tough, but this [great result] is what's coming.'"

Another form of tenant engagement involved educating tenants around the new technologies that would be used in the building—in particular, the sensors and override switches for automatic lighting. The GSA on-site project manager, the building manager, the move coordinators, and Gilbane all met together to plan out tenant education about the lighting. While Gilbane's team members provided technical information about the lighting, the building manager could provide her input and expertise about how to best communicate and educate the tenants in the building. For more on tenant communication, see Team Building & Collaboration.

The contractor also developed an O&M manual to provide to the GSA maintenance staff. Jacobs reviewed the document toward the end of the project. In spite of tension generated by schedule delays, the GSA senior project manager commented that the team remained positive and focused on solutions: "Everybody was invested in the project. Even when things were bad, there was never any fear. The attitude was always 'okay, how do we solve this?' Not 'whose fault?' or 'whose problem is it?' It was 'all right, what tools do we have in our disposal to make this work?'"

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Role Definition & Accountability

Responsibility for Redesign

Due to incorrect as-builts—which was compounded by incorrect scans by Gilbane—the team had to redesign the curtain wall, a major setback early in the project. There were several discussions with the GSA and the design-build team about who would bear the cost of the additional work. The resolution was that Gilbane was responsible for the incorrect scan and that the GSA would be responsible for paying for the additional steel required for the new design. For more information about scans see BIM & Design Documentation.

Managing Problems between On-site Workers and Tenants
While the relationship between tenants and the project team was strong, there were a few moments of tension between on-site workers and tenants. In those situations, Gilbane responded swiftly, such as removing a worker that had problems with tenants. One primary example of Gilbane's management of on-site problems was when one of the movers made inappropriate sexual or racist comments to a tenant in the public passenger elevator. While other workers took the man aside to police his behavior, the tenant told an on-site manager, who spoke to Gilbane's transition planning and management lead.

Within minutes, Gilbane told the movers to remove the individual from the site. After the worker was removed, Gilbane created a new policy, instructing all workers to use the freight elevators rather than the passenger elevators. Gilbane purchased a hand wand so that GSA security could add an entry point for construction workers at the loading dock next to the freight elevator, separate from front door security gates. The GSA on-site project manager held an immediate all-hands construction meeting within forty-eight hours to discuss behavior on-site. The incident led to Gilbane changing their safety orientation, adding training on cultural awareness and conscientiousness about offensive behaviors and language around tenants.

There are particularly challenging issues for the contractors working in an occupied building. The GSA building manager commented that understanding the challenges was essential for all the trades: "Gilbane had to come in with the attitude that this isn't a jobsite. This is a fully occupied professional office building in which you are doing work....All of the subs had to take on that mentality." The building manager added that she found it satisfying to be on a team that had a "sense of ownership in this project, and all of the people that worked on it wanted to do the right thing for the project and for the tenants. I felt like I was on the dream team."

Team Consistency

There was strong team continuity among the senior members of the project team. For example, the GSA on-site project manager was a part of the interview team and oversaw the process from start to finish. Senior members of the design-build team, the project engineer/project manager and project executive, engaged for the full duration. Jacobs's team members and the designers were also consistent.

Roles

Organization of the team and point of contacts were clearly understood. The GSA clearly defined the roles and responsibilities of their team members to the tenants, which made for smooth and efficient communication between the tenants, the GSA, and the project team. GSA had two project managers on-site: the on-site project manager and the senior project manager. The senior project manager joined the project after the on-site manager, at that point, the two project managers determined how to define their roles and responsibilities to tenants. They agreed that they did not want the tenants to feel like their communication processes had changed. Additionally, they wanted the tenants to be clear about the distinction between the two project management roles and who to contact for specific project questions. They introduced the on-site project manager to the tenants as the

"project manager," responsible for interfacing with the GSA building manager and the GSA property manager, and for any questions that tenants had about project issues occurring "inside the property line." The senior project manager was introduced to tenants as the "program manager" and would handle project issues occurring "outside the property line." In reality, their work was more intertwined, but this distinction was clear to tenants.

A congresswoman, who had an office in the building, had a well-established practice of communicating any concerns she had about the building through the GSA property manager. The GSA team did not want to disrupt existing practices and kept this communication channel unchanged during the project. The GSA senior project manager described the unified GSA team : "I said to everyone, 'We talk about one GSA, so let's be one GSA.' I wanted to leverage everything that we already had in place." On occasion, the collaborative nature of the working style was so rooted that project stakeholder roles blurred into one another. This was particularly the case for the GSA building manager and the GSA on-site project manager. While the two had well-defined responsibilities on the project, their ability to work closely together and rely on each other's strengths and areas of expertise and authority helped make the tenant newsletter and tenant decision-making (e.g., choosing carpets) a success.

There were also times when specialized roles were very helpful in establishing credibility and trust about highly technical topic, such as information technology. The GSA building manager observed, "[Gilbane] had a focused tenant team, a tenant move coordinator/furniture person and an IT person. Those two roles were really critical because the contractor's team [was able to] immediately build trust with the tenant agency representative." For more on tenant engagement see Goals & Alignment.

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Managing Schedule & Budget

Schedule

The construction plan was to have the work crews handle two floors, complete the work, and then move on to two more floors with tenants moving into swing space during renovation and then back into their spaces after completion. The design-build team needed to monitor completion dates very closely: when one set of floors was finished, the team had to move the next set of tenants quickly to begin the next phase of construction.

A series of complications affected and lengthened the tight timeline. These complications included logistical challenges related to the sawtooth corners, managing and moving tenants, and unforeseen conditions. These challenges were mitigated by the design-build team having straightforward, informal conversations with the GSA and tenant stakeholders about schedule changes. In the end, the GSA agreed to provide the team with a time extension but without an increase in costs to the budget.

Sawtooth Corner Schedule Challenges

Although the design-build team anticipated that the construction sequence for glazing the existing sawtooth corners would be complex, it was even more complicated than expected. The geometry of the corner, the need to provide safe support for workers, and the multiple steps needed to mount the structure for a new enclosure system all contributed to the construction challenges. Additionally, the timing of construction at the corners was constrained by tenant needs. To accommodate the time to move tenants, the curtain wall construction had to be discontinuous, and progress suffered as craftworkers cycled off the project. At the time the project was under construction, there was a scarcity of welders. That limited labor market meant that when the welding work paused to move tenants, welders moved on to different projects and it was difficult to get them to return to the job when the work resumed.

The GSA brought up the scheduling issue in their weekly internal meeting with major tenant groups, the GSA team members, and Jacobs. During one of these meetings, the IRS tenant group informed the GSA they were considering reducing their space to a smaller footprint. This opening created more flexibility for construction, allowing the team to separate the schedule for the sawtooth curtain wall from the more straightforward flat curtain wall. Keeping the office spaces at the sawtooth corner unoccupied allowed the team to schedule work in those areas independent of the main floors and keep the welders working continuously.

Managing and Moving Tenants

Planning and managing the move of tenants to the swing space was difficult. Each tenant group had certain days or times of the year during which they could not be moved. Furthermore, the paper files of certain offices required a secure chain of custody. The project team talked to each tenant group to identify those that had the largest constraints and scheduled them first, filling in others as appropriate. Gilbane's transition planner then met with the tenants about the swing-space layout, construction plan, and schedule. The project team believes this process created tenant buy-in that later helped when plans needed to be adjusted. If changes in schedule planning occurred, the design-build project team collaborated with the GSA and the tenants to find solutions. While sometimes tenants pushed back against the impact of construction, they eventually agreed to the changes and worked with the team in planning sessions. For more on tenant engagement strategies, see Goals & Alignment.

The GSA has a policy that swing spaces must match the square footage of the current work space. The design-build team talked to the GSA for several months about removing the restriction for greater flexibility and to improve the project schedule. The GSA had made it clear at the beginning that a primary goal was minimizing impact on tenants. However, the GSA finally acquiesced and talked to the tenant representatives,

who agreed to compressing some tenants into slightly less square footage in order to speed up construction.

Unforeseen Conditions

As-built documentation was not reliable. The GSA had bought the office building from the Resolution Trust Corporation during the savings and loan crisis. The first floor was well documented, but assumptions were made about the uniformity of connections throughout the rest of the building. The GSA had mapped and created as-builts for the AC and power connections over the time they had owned the building, but it was difficult for the team to anticipate conditions on ceiling configurations, sprinkler systems, and skin with the information they had.

As the extent of the unforeseen conditions unfolded, the GSA created a schedule adjudication process to document unanticipated conditions and tied each one to a schedule modification. This process required the GSA to adjust benchmark measurements appropriate to the actual conditions found.

Budget

The project team's integration helped to save costs when addressing outdated existing systems and implementing innovative new systems. Since many of the building systems had been inaccurately documented, the team often had to pool expertise to understand what was there and how it would fit with the modernization goals. For example, the original security cameras, which were intended to be reused, were abandoned when an assessment showed that they were outdated. The smart diffuser system that the team wanted to use for the HVAC and lighting could incorporate security, and the team was able to reduce the budget and save time that would have been lost on replacing the cameras. The architect describes it as "really nice that the team was able to, through the process of collaboration, come up with a better way to give them a better system very economically."

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BIM & Design Documentation

BIM

Building information modeling (BIM) was used on the project, not only for design and construction of the new building elements, but also for the design of the temporary swing spaces. The building was designed in Revit, and the swing spaces were drawn in CAD by Gensler's Houston office, which does tenant-development work. The GSA senior project manager found the BIM beneficial, "I think having the building in [3-D] helped us because it gave us a chance to model things and find out how to minimize the amount of additional steel we had to buy. It gave us the ability to play what-if games in a way that doing it just in 2-D would not have allowed."

While the team documented formal correspondences when there would be changes, submittals, and request for information (RFIs), the team still relied on informal communication when trying to solve a problem. The Gilbane project engineer/project manager noted that, even at the engineering level, it was always best to solve a problem by first calling the subcontractors to have them explain the issue and then contacting the architects and engineers to discuss the issue. He noted, "A lot of human interaction definitely helps and solves the problem faster." The documentation process would come at the end to record final decisions around what had already been discussed informally by the team. Gilbane's project executive shared the belief that trust and communication make the documentation process easier: "If you're convinced that everyone is trying to do what's best for the project and getting it wrapped up in the most effective way, it's pretty easy to sit down and have a straightforward conversation—'These are the challenges we have.' And it did not feel like I had to consistently worry about what was documented. [Documentation is] always important—you've got to take care of business. But it's very nice to be able to just sit down and have an honest conversation and then go back and figure out what we need to do next."

Design Documentation

Survey Scans and the Need for Redesign

The RFP for design-build services had indicated that the building would be straight plumb and true; however, that was not the case. The design-build team conducted an initial laser scan of the existing building early in the design phase and built their BIM using this information. The design-build team noticed that some aspects of the geometry seemed incorrect, but they continued to work on their model to make sure they were reading the scan correctly. They came to understand that the scan was incorrect, and the design-build team rescanned the building toward the end of design. The correct scan revealed that the building was out of plumb and twisted. The team then rescanned several sections of the building, verifying that the building was significantly out of plumb, and also discovered elements that exceeded the property line.

After discovering the building's imperfect geometry, the architects and engineers had to redesign the curtain wall very quickly to accommodate the varied dimensions. This process of redesign incurred costs for both the design-build team and the GSA. The design-build team took responsibility of the costs of the redesign work, as they had conducted the initial scans and had not caught the problem with the geometry earlier. The GSA also incurred costs by having to purchase more steel and longer pieces of steel for the revised design.

The property-line infraction was resolved through negotiations between the GSA and the city of Houston. Through the work of the GSA's real estate staff and the civil engineer of the project, who had a working relationship with the city of Houston, the team was able to negotiate an encroachment easement to extend the building down to the public right of way without extra cost.

Despite these tense circumstances, the project team remained amicable. While there were initial tensions when the team realized the extent of the design problem and potential impact to time and cost, the team did not focus on assigning fault but on discovering the best solution. Through their amiable collaboration, the team managed to redraw the project schedule, which mitigated the schedule impact of the redesign.

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Meetings & Workplace Environment

The project team engaged in an initial partnering session and kept up communication and planning in a series of weekly and monthly meetings (e.g., monthly senior-management meetings, weekly construction-coordination meetings). The GSA and Jacobs conducted weekly internal meetings with tenants. Gilbane also provided the team with a basement co-location space.

Review Meetings

The team held monthly review meetings, which had approximately twenty attendees. The room was set up with a large square table that eliminated a head of the table, making everyone equal partners. The tenor at the meetings was consistently one of respect and trust. The team recalled that occasionally someone would "have a burr under their saddle" about an issue and act in a combative way, typically a less-experienced team member discussing a difficult issue. In these situations, the senior managers used nonverbal communication to indicate that the senior member supervising the less-experienced team member should mitigate the tension. A team member recounted, "Pretty much every senior manager could indicate with body language to another senior manager, 'okay, that was a low blow,' and give [a look that meant] 'reel him in.'" In this way, the rapport between the experienced senior leaders and leveraging each firm's internal hierarchy were used to support the whole group. Gilbane often led the meetings, but the project team also looked to the GSA team for feedback and leadership. The agenda of these meetings included schedule impact, risk, and safety.

During the design stage, there were also a number of meetings held to review the documents. Gensler would convene and facilitate these meetings, and the majority of these meetings were held at the Gensler office in Houston.

Tenant Meetings

The GSA team held regular tenant meetings with the CMa firm and the GSA contracting officer. These phone meetings with tenants provided them with the opportunity to ask questions

and discuss issues. This open forum provided tenants with the sense that their concerns and questions were being heard. In turn, the GSA team informed tenants how certain decisions about these concerns could impact the project's schedule as well as the schedule for moving tenants. At the end of each meeting, the GSA team stated that they had heard the tenants' concerns and offered them the opportunity to stay on the phone if they wanted to listen in on the meetings about the contract or other project-related issues with the design-build team and others.

Partnering

At the onset of the project, the design team, the GSA, and the key subcontractors had a partnering session. The session was deemed useful, although some team members felt that trust had already been established by the working history of team members. For more on partnering process see Peer Review & Partnering.

Co-Location

Gilbane rented a parking-garage space and used it as their on-site office for their company and as a co-location space. The space was used for monthly meetings and during the design process for clash detection. The space had desks for other senior team members to work whenever they wanted to drop in.

In the same parking garage, the GSA shared a space with Jacobs early in construction, allowing the two organizations to have daily communication about the project. While the GSA/Jacobs team and the design-build team were both located in the parking garage, they did not share an interconnecting door.

Safety

Gilbane only had three recordable incidents and no lost time. Gilbane only had three recordable incidents and no lost time during the entire four years of the project. One of the challenges to safety on the project was the high turnover of work crews in the busy construction market; another was the inherent risk of installing

curtain wall overcladding. Jacobs brought its Beyond Zero safety program to the GSA and onto the Gilbane job site. This program involved a monthly walk through of the site by Jacobs inspectors, who would look for and point out safety issues and flaws. The Jacobs team would then notify the Gilbane safety officer about the issues or bring them in to fix the problem.

Gilbane worked with Jacobs on safety issues, and there were immediate improvements at the job site. For example, working on the curtain wall required a hook-up-tie-off process. However, one subcontractor was not using this process. Jacobs took the subcontractor aside and showed them how to do it properly, and after the demonstration asked the sub to repeat it. The safety issue was then reported, and Jacobs worked with Gilbane on a safety stand-down and education procedure. One lesson learned was that for a project with this level of safety issues, because of the nature of the overcladding, a full-time fall-protection supervisor in addition to safety officer might have been warranted.

A tribute to the team's level of commitment to safety, there was no tension when members of any one company pointed out safety issues to another company. The senior leader of the commissioning agent described the positive reaction when he stopped work of a subcontractor: "It shows a culture of caring. It's not about lost time or money. It's about 'I want you to get home and back to your family safely'. That was a good thing, and the team responded well."

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Peer Review & Partnering

The Leland project team had a 15% construction peer review in 2012 and a 55% construction peer review in 2013. The 15% peer review provided many positive comments about the team's high level of commitment to project success and strong working relationships as a team. Concerns involved the impact of the change order process on the budget, early concerns about the schedule, maintaining strong communication with tenants for coordination and planning, and the need for tenants to understand how building is operated and how their behaviors will affect the sustainability of the design. The 55% peer review described a highly collaborative and experienced team with clear roles and open communication. The primary concern of the review was around the schedule, as slippage had begun to occur on the project. In response, the project team set up a Schedule Workshop with the subcontractors involved in the sawtooth corner work to help inform their schedule revisions.

These peer reviews did not involve the technical aspects of the project; instead they identified risks and were often things the team had stated were challenges. In this sense, peer reviews helped reassure the team about their strengths and challenges rather than telling the team something new. While the team had found in the past that their identified concerns would not always lead to the team following through with solutions, the peer review process provided the team with the opportunity to clearly identify concerns and force team members to engage in a deliberate planning process. Peer review helped the team to work out a plan of action that they would have to follow through and state that they would follow through in their report response back to the GSA. Some examples of how the peer review process impacted the team was pushing them to develop a plan for sawtooth corners and VAV boxes, how to address concerns with tenants (e.g., addressing punch list items).

The GSA senior project manager found the construction peer reviews an effective means to focus the team on responses for issues that might otherwise have remained unresolved. Using the peer review report as an incentive, "I would be able to tell the [project] team, I need to send back a report with a plan of action."

The design peer reviews are intended to support design decision-making. Since Leland was a renovation project, their design peer review focused on supporting mechanical design decision-making. For example, the innovative multi-fan array in the air handling units and VAV smart diffuser design was discussed in the Mechanical Peer Review. Support for the idea allowed the Mechanical Engineer to take the idea, first proposed as an enhancement option, to one of the most exciting technical achievements of the project.



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Building Innovation

Managing the Sawtooth Corners

The complex choreography for replacing the enclosure around the sawtooth corners evolved after earlier attempts were deemed too time consuming and quality too difficult to maintain. The design-build team realized that the sequence needed to change after the first two cycles of the project when the first four floors were completed. The two-floor cycle was supposed to take twelve weeks; however, it was taking the team as much as twenty weeks to complete a cycle. After two cycles with longer than expected schedules, the design-build team knew modifications needed to be made.

The eventual solution resulted because of a high level of communication and alignment within the project team and in partnership with the tenants. The design-build team presented a new sequence to the GSA that would shift tenants and allow a more complete utilization of spaces throughout the building, freeing up the sawtooth corners. After completing the third cycle—and the third that missed its target schedule—the GSA agreed to adopt the new sequence. The team blocked off a portion of the corner to enable the tradesmen and construction crews to continue working on the corner while tenants in other parts of the building remained. The ground crews would then build a temporary wall on floors that had not been finished out to get ahead of the work and maintain an enclosure for security and hurricane preparedness. Temporary construction also occurred via vertical frames on the exteriors on all four sides and at each of the two sawtoothed corners, which were anchored at every other floor. Mast climbers on the exterior of the walls were used to move materials up and down. The masts attached to the building through the curtain wall, and sections of the masts had to be disassembled as the curtain wall was completed. Additionally, the old precast panels had to be removed and the steel subframe for the curtain wall erected in a careful sequence to avoid overloading the floor during construction.

The logistical solution was effective in keeping the building crews steadily manned, avoiding the loss of expertise encountered early in the project when the work on the sawtooth had to stop and start as tenants moved. The project team knew from the outset that there would be safety hazards associated with the sequencing of the work and took great care to train and monitor work. The team was unified in their commitment to safety, and team members noted that any member of any company felt comfortable giving or receiving safety feedback even in cases when work had to be stopped. The Jacobs regional manager noted, “Gilbane can’t be everywhere at once, and sometimes our eyes would catch [safety concerns] when their safety officer was somewhere else. I think it speaks well to the team’s chemistry that [Gilbane] never said, ‘You can’t stop work.’ [They knew] we all were stepping in to create a culture of safety.”

The key to revising the logistics for a successful sequence was decoupling the schedule for renovating the floor area around the sawtooth from the rest of the interior space. The communication and trust between the tenants and project team were critical to coming up with this solution. In thinking of ways to solve the project schedule and project team personnel problems posed by the stop-and-start sawtooth work, the team realized they needed to have unoccupied floor space around the sawtooth corners. Parallel to internal project team discussions about their needs, regular communication with tenants revealed that one major tenant was interested in reducing their footprint, freeing up space around the sawtooth corner. The project team’s communication within their team and with the tenants created clear pathways for the disparate pieces of information to be connected, leading to a solution that unblocked the bottleneck in the project.

