Achieving Green Buildings Using the Design-Build Process

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1. INTRODUCTION

The design-build process offers several advantages: one responsibility for design and construction, shorter design and construction process and potentially lower construction cost. The main disadvantage with design-build is that the resulting building often just meets minimum standards and there are few quality features. This often puts the design-build process at odds with trying to achieve a green building where the goal is to greatly exceed minimum standards.

Canada’s Department of National Defense (DND) has developed the concept of “Quality Design-Build” to get the benefits of design-build while still providing a quality building. In the Quality Design-Build process, performance specifications are developed and design-build teams are invited to submit designs that meet the requirements. The submissions are developed enough so that the teams can bid a firm price and the client can evaluate the designs. Approximately half the points are awarded for price and half for quality features. The team with the highest score is awarded the contract. The unsuccessful teams are paid an honorarium for their efforts.

The Quality Design-Build process was recently extended to incorporate sustainability. The process was field tested on two DND accommodations/messing facilities: one in Halifax, Nova Scotia and one in Victoria, British Columbia. Both of these buildings were mess (dining) and accommodation facilities of 16,000 and 8,000 square metres respectively. This paper describes the techniques for integrating sustainability into the tendering and evaluation process and case study results for the Halifax project.
2. THE PROJECTS

2.1 CFB Halifax Mess and Accommodation Facility
The Halifax project is a replacement of an existing mess and accommodation facility. The mess portion of the building, referred to as the “Ward Room”, was considered a heritage building and is being preserved and renovated. The Ward Room is a two-storey 2,000 square metre building with four large dining halls. The accommodation facility is being demolished and a new facility constructed. The new facility is connected to the Ward Room and contains a large kitchen and an accommodation tower of 160 suites. The functional plan called for a total floor area of approximately 16,000 square metres.

2.2 CFB Esquimalt Mess and Accommodation Facility
Canadian Forces Base Esquimalt is home to Canada’s Maritime Forces Pacific. Located on the western outskirts of Victoria, on Esquimalt Bay the base has a military and civilian contingent of 6,000 personnel. The Department of National Defense (DND) is currently constructing a new accommodation building and a dining room/galley at the base.

The accommodation building has 86 double-occupancy residence rooms plus common space for a total developed area of 6,250 square metres over six floors. The dining room/galley has full kitchen, servery and dining hall with a capacity to seat and feed 250 people per sitting. The dining room/galley floor area is 1,740 square metres.

3. RATING SUSTAINABILITY IN DESIGN-BUILD

3.1 The DND Quality Design-Build Process
The Department of National Defense has recently begun to use the “Quality Design-Build” process as a means to better control schedule and costs while producing a quality building. DND hires an advocate design team (architect and engineers) to prepare a performance specification and a building functional plan. The specifications define a minimum level of quality and limit the use of certain materials, systems and equipment. For example, through the wall Heating Ventilation and Air Conditioning (HVAC) units are typically not permitted in favor of more robust central systems. The design-build contractor is free to propose any general arrangement of rooms and building systems that meet the performance specification. The specifications also describe what must be included in the design-build submission, typically floor plans, some elevations, typical room layouts and finishes and descriptions of the proposed building systems. The design-build teams are generally given an honorarium to prepare their submissions.

What differs from many design-build projects is that evaluation points are given to bids that go beyond just meeting the minimum performance standards and add quality features. As one example, 50 points are given for price and 50 points for quality, with the bidder receiving the highest number of points being awarded the job. The price points are allocated with the low price receiving the full 50 points and all other bids receiving points according to the ratio of the low price to their price. Quality points are allocated in several areas including functional performance, building character, and design of systems. Where the design exceeds the minimum requirements of the specifications, quality points are assigned. A design that just meets the performance specifications...
would not receive any quality points and would not likely win the competition since the best possible score they could get is 50 (for price). This scoring system encourages design-build teams to incorporate those quality features that can be added at modest cost: best bang for the buck.

After the contract is awarded, the advocate design team monitors the design-build team throughout the remaining design and construction process to ensure they deliver what was promised in their bid.

A few years ago DND made a commitment to incorporate sustainability into their procurement process. The two projects described in Section 2 were chosen as examples to see what could be done within the DND quality design-build procurement process. The two projects have different advocate teams, and design-builders are at opposite ends of the country. A sustainability consultant was included as a part of each advocate team. When the performance specifications were being developed (2001/02), it was decided that it was premature to use the Leadership in Energy and Environmental Design (LEED) Green Building Rating System as is. At that time there was little knowledge of LEED in the construction industry and there were no LEED certified buildings in Canada. Rather each advocate team came up with sustainability requirements based on relevant LEED credits and other sustainability issues. These requirements are discussed in the remainder of this section.

3.2 Energy Efficiency
In LEED and American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) 90.1, the energy efficiency of the proposed building design is defined relative to a hypothetical “reference” building. The reference has the same building shape, orientation function, operating schedules and ventilation rates as the proposed design. The objective is to achieve as large a percentage energy savings relative to the reference building as is technically and economically viable.

A major disadvantage with comparing designs on the basis of percentage savings is that no credit is given for minimizing building area or orientation to take advantage of solar availability. From a sustainability perspective, the goal is to reduce overall energy consumption not energy use as a percentage of a reference building. The design-build process presents an opportunity to correct this problem in that several teams are designing buildings to the same functional plan for the same site.

For both projects, design-build teams were required to submit an energy simulation of their design as part of their bid package. To ensure consistency between submissions, teams were required to use the same software (EE4 – a DOE 2.1 variant [NRCan, 2003]), competent energy simulators and perform simulations in accordance with the rules defined by the Commercial Building Incentive Program (CBIP). CBIP is a national program that provides incentives for designing new energy efficient buildings (web site: www.cbip.nrcan.gc.ca ). CBIP maintains a list of qualified energy assessors and has a manual describing acceptable simulation procedures [Enermodal, 2002].
Both projects required that as a minimum, the building designs achieve a 25% energy savings to be consistent with national objectives. However, quality points were awarded for the simulated total energy use of the design (not percentage). For the Esquimalt project, quality points were awarded for achieving certain energy intensity (in kWh per square meter of floor area). The Halifax project went one step further and based quality points on the predicted annual energy bill in dollars. (Bidders were given the utility rate structure to use.) Since all teams were required to meet the same functional program, teams that could reduce energy cost through efficient building massing and orientation would get credit.

A common problem with developing sustainability projects in large organizations is that there is often a disconnect between the funds allocated for construction and funds for operation and maintenance. Projects have a fixed construction budget that cannot be exceeded. Cost-effective energy efficiency measures often get cut when a project goes over budget. It has long been argued that a means of linking these two budgets together is critical to achieving energy efficient buildings. The Halifax project addressed this issue head on.

Since the design-build teams submitted the projected annual energy cost and the construction cost, it was possible to compare bids on the basis of life cycle costing. For the purposes of scoring, the predicted annual energy cost was multiplied by 10 years and added to the construction bid price. The lowest combined price represented best value to DND and would get the most price points. Energy performance moved from being assessed with quality points to being part of the 50 points assigned to price. From the design-builder’s perspective, this simplified the design process: including energy efficiency measures that have a payback of under ten years would result in a higher score. The contract with the design-builder would, of course, be for the construction price only.

3.3 Other Sustainability Issues

Because LEED is a credit-based system, it is well suited to the competitive bidding process. If a submission meets the requirement of a credit, it earns a quality point. This is a much cleaner system than giving subjective scores based on write-ups describing intent or philosophy of the sustainable design.

For both projects, quality points were given if the design met LEED credits. The list of LEED credits was reduced to those where the design-build team had control and to those relevant to the project. For example, LEED issues such as green power and site selection were not given quality points. Bidders were required to submit write-ups, calculations and/or sketches showing how they intended to meet the LEED requirements. The list of sustainability issues was expanded to cover issues not directly addressed by LEED including operation and maintenance and building durability. These issues had to be scored on a relative basis since there is no quantifiable means of comparing these issues.

For the Halifax project, sustainability (excluding energy efficiency) accounted for 15 of the 50 available quality points. These 15 points were then sub-divided into issue areas (site development, construction waste, etc.). Each issue area was then scored on a scale of
0 to 4. A score of 1 represented standard practice, 0 represented below standard practice and 4 represented the best possible approach to addressing the issue.

As discussed in Section 3.1, bidders would likely have to include some quality features to win the competition. The reverse was also a concern. Bidders might try to win the competition by going overboard on quality features (to score close to 50 quality points) and get part marks on the price score for their high construction price. DND would get a nice building, but one that would be way over budget. The scoring system had to provide a balance between quality and price. If quality scores could range from 0 to 50, then the price scores should also range from 0 to 50. The winning bid should be a reasonable compromise between price and quality.

To address this issue, an innovative formula for the price score was developed. The formula is

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\text{Price Score} = 50 - [37 \times (\text{Total Cost} - \$27M)/\$27M]^2
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As discussed earlier, the total cost is the construction cost plus 10 times the annual energy cost. Based on cost estimates, it was felt that the lowest construction price for the project (excluding any quality items) would be $27 million. The “37” in the equation is a project-specific constant that determines how quickly price points are lost for going over the minimum price. Because of the squared term, up to $2 million of quality features can be added with little loss in price points. Increasing the cost further results in an increasingly larger loss of price points to the point where all price points are lost. The objective was to end up with a winning bid that provided a balance of quality and price.

4. THE BIDDING AND IMPLEMENTATION PROCESS

The remainder of the paper deals with how the sustainability bidding and implementation process worked on the Halifax project since the authors had the most involvement with that project.

4.1 The Bidding Process

After an initial review of team qualifications, four bidders were short-listed to prepare submissions. Bidders were given three months to prepare their submissions. To simplify and speed up the bidding process, bidders were given a general arrangement of rooms that met the functional plan. Bidders were encouraged to use it as a guide and improve upon it as they saw fit.

Of the four bids, one did not meet the tender conditions and was removed from the competition. Perhaps not surprisingly, the three remaining bids had similar building massing and room layouts to the general arrangement provided with the tender. Thus to a large measure, the selection of the winning bid came down to total price and quality points for sustainability. The result was that the winning Halifax design had the lowest annual energy cost and the highest sustainability score at a cost only marginally above the lowest bid price (see Figure 1).
The winning team used good sustainable design practices to develop their design. All members of the design team participated in brainstorming sessions and discussing ideas (even though team members were located across the country). The team quickly realized the benefit of reducing energy costs and implementing measures with a payback of under 10 years. The building was rotated to maximize and control solar gains even though this had negligible impact on the percent energy savings. A wastewater heat recovery heat exchanger was included in the design because its payback was under 10 years, whereas triple glazed windows were rejected because they were over 10 years.

The winning bid had an annual energy cost that was 12% lower than the second place bidder, this despite the fact that the second place bidder had a percentage energy savings that was 12 percentage points higher. In other words, efficient building massing and orientation and minimizing building area can overcome the energy benefits of more insulation and more efficient equipment.

The winning bid also scored highest on sustainability. The bidder assembled a competent team with experts in construction waste management, material selection and LEED implementation. There was disagreement among LEED accredited professionals about what measures were required to meet LEED credits and what constitutes “innovation” under LEED. Interestingly, the other bidders scored zero or “below standard practice” in some of the sustainability areas. In these cases, their descriptions were a simple repeat of LEED credit wording and did not show how they meet the mandatory sustainability requirements. This project has indicated the need for more education, interpretations and design guides for LEED—even for LEED Accredited Professionals.
4.2 Implementation
As of September 2003, the demolition process has been completed and the design-builder was able to achieve a 99% landfill diversion rate, with carpet being the only material going to landfill. The final design drawings have been submitted for approval and the design is on track to meet the requirements of a LEED Silver building. Although this process was a new experience for the design-builder, they were happy with the process and support using it on future DND projects. They provide two cautions for future projects. First, the performance specifications must be consistent in terms of content and message. Discrepancies between sections in performance specs cause confusion, create uncertainty and result in wasted effort. Second, the performance specifications should not be so prescriptive or limiting as to restrict design choices to one option.

5. CONCLUSIONS AND LESSONS LEARNED
DND has successfully integrated sustainability into their design-build process. Design-builders, if given clear direction on how sustainability will be scored, can develop cost-effective sustainable solutions.

Incorporating annual energy cost into the price portion of the evaluation leads to an optimized design and bridges the gap between construction and operating budgets.

LEED can be an effective tool in the bidding process by providing clarity to the owner’s intent and on how the submissions will be scored. LEED credits that are not applicable or relevant to the project should be removed from the process to avoid teams delivering unacceptable designs. Further education and supporting documentation is required to remove ambiguities in the LEED system.

6. REFERENCES


7. ACKNOWLEDGEMENTS
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