How the Current Sustainability Movement Impacts the Enclosure: A Look at the VanDusen Botanical Garden Visitors Centre

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ABSTRACT
Shaped like an orchid flower, the VanDusen Botanical Garden Visitors Centre will be an innovative landmark building that will welcome residents and visitors alike to the botanical garden. Currently under construction in Vancouver, British Columbia, the project aims to achieve environmental and sustainable excellence in its design and construction. To meet this target, the building needs to receive both LEED Platinum and Living Building Challenge (LBC) certifications, a first for the Lower Mainland of B.C., while maintaining a unique and impressive architectural design. Although sustainability and durability are always goals the enclosure, having to meet the LEED Platinum and LBC objectives impacted the building enclosure significantly and brought several challenges from a design and construction perspective.

Impact of the governing bodies on the design
Being constructed in the City of Vancouver requires that the project adhere to the city's Green Building Strategy and Building Code as well as British Columbia's Wood First Initiative. Although the green building strategy would be exceeded by meeting LEED Platinum, the utilization of wood products in support of the lumber industry would be a new layer added to the project. These initiatives have driven the design of some enclosure elements, the main one being the wood roof structure, a system of pre-manufactured panels consisting of plywood, glulam beams and posts were assembled on site to form each of the roof's 'petals'.

Requirements of the Living Building Challenge
As a step further from LEED's point system, the LBC requires all of its twenty imperatives be met for a project to receive certification. Stringent criteria set by the LBC have affected the selection of products and composition of enclosure assemblies. From IGU setting blocks and metal flashing to large scale waterproofing membranes and manufacturing of curtain wall, the LBC has touched the enclosure with its 'Red List of Materials' and 'Appropriate Sourcing'. The balance of meeting the LBC imperatives while not sacrificing the durability of the enclosure can be difficult to achieve.

This paper will discuss the considerable impacts 'green' legislative initiatives and certification programs have on the realization of a building and its enclosure from start to completion. In particular, we will look at how the initial design decisions affect the overall complexity of the project, with choices, such as rammed earth walls, that are seemingly appropriate on their own but trigger complications for the enclosure. We will also explore the challenges in achieving the balance between a well-functioning and durable building enclosure and the current sustainability movement.

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INTRODUCTION
Located in the heart of Vancouver, British Columbia, Canada, the site for the VanDusen Botanical Garden was originally owned by the Canadian Pacific Railway in 1910. For the next 50 years, the land was operated as the first full-links golf course of the city by Shaughnessy Golf Club. Following the golf club's relocation, the railway company lobbied to convert the land into a residential subdivision. Opposition to the redevelopment proposal lead to the 55-acre property being purchased jointly for the estimated sum of $3 million by the City of Vancouver, the Government of British Columbia and Mr. W. J. VanDusen, from whom the garden takes its name (Vancouver Board of Parks and Recreation, 2011). The VanDusen Botanical Garden officially opened its doors to the public in the summer of 1975. Rivalling international calibre botanical gardens, VanDusen is now the home of over 7,500 different types of plants from six continents (VanDusen Botanical Garden).

Fast forward 30 years later, we are in the midst of constructing a new Visitors Centre, a 1,858 m² (20,000 ft²) building that will house educational, volunteer and interpretive services, a library, classrooms, a gift shop, and a restaurant. With construction costs estimated at $18,700,000, the facility aims to achieve environmental and sustainable excellence through its design and construction practices.

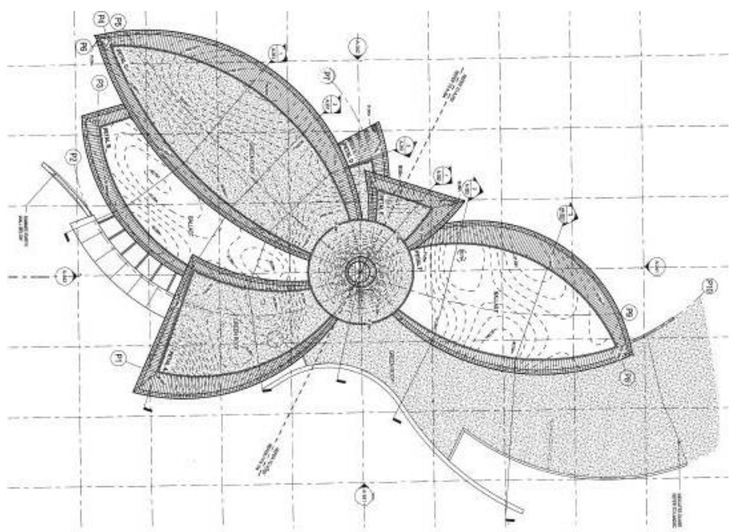

FIGURE 1: Roof Plan of Visitors Centre, courtesy of Busby Perkins + Will

The Visitors Centre's master plan was designed by architects Busby Perkins + Will and landscape architect Cornelia Hahn Oberlander. Albeit modest in size, the building is unique in its architecture: its shape draws from the delicate orchid flower, with a 'stem' supporting an array of 'petals'; see Figure 1. The complexity of the structure was not only selected for its pleasing and natural aesthetics, it was also dictated by the requirements of integrated design between all of the engineering disciplines, of local and provincial governing bodies' legislature, and of 'green' certification programs. The intent of each of these requirements is the same – build a sustainable building with the currently available technologies – but they also inadvertently challenge the building enclosure by influencing material selection, detailing and whole assemblies, sometimes with a narrowed view that ultimately affects the durability of the enclosure and good practice measures. We will explore each of these requirements and their effects on the enclosure.

BUILDING IN THE CITY OF VANCOUVER

In 2004, the City of Vancouver's Standing Committee on Planning and Environment studied the feasibility of mandating the LEED certification program for all new civic buildings, by targeting two pilot projects aiming to achieve LEED Silver. Other studies at that time found that building to LEED Silver represented a construction cost increase of 1 to 2%; however the choice to reach for LEED Silver for the two pilot projects was made well into their design phase, such that the total increase in construction costs was 12%. Understanding that it is difficult to accurately compare green buildings due to their specific performance goals, technologies used and intended pay-back terms, the committee was optimistic that incremental costs would be less significant as sustainable technologies evolve and become more widely available. It was also deemed that the economical and environmental long-term benefits to the city would outweigh the cost increases. Following the footsteps of pioneer cities like Portland and Seattle, Vancouver became one of the first Canadian cities to make it mandatory for all civic buildings with surface area greater than 500 m^2 (5,382 ft^2) to achieve LEED Gold certification.

In addition to LEED Gold requirements and per the province's recommendation, emphasis was made on reducing green house gas emissions as part of a 'Community Climate Change Action Plan'. In 2003, the City of Vancouver responded by requiring all new civic buildings to also have a 20% reduction in energy consumption, which was later raised to a 30% reduction in 2005 (Mikkelsen and Smith 2004).

The Visitors Centre needs to be an iconic, sustainable civic building; the design team is aiming one step above the minimum LEED Gold requirement for LEED Platinum (LEED Canada NC 1.0). The plan is also to achieve all 10 points allocated for Energy & Atmosphere Credit 1 – Optimize Energy Performance, thus exceeding the City of Vancouver's target of 30% reduction in energy consumption. Such high goals stress the importance for the mechanical design to be seamlessly integrated with other disciplines, as well as placing a focus on more passive approaches to energy conservation, which translates to an effective building enclosure.

Integrated design at the oculus

An example of the challenge in merging the mechanical, enclosure and architectural design together is the oculus, the prominent conical glazing feature rising above the centre of the roof 'petals'; see Figure 2. The oculus serves several purposes: an architectural rendition of a flower's stigma, a means for natural daylighting to the atrium space below (Indoor Environmental Quality Credit 8.1 – Daylight and Views), and passive cooling and natural ventilation (EA Credit 1.10 and IEQ Credit 2 – Ventilation Effectiveness).

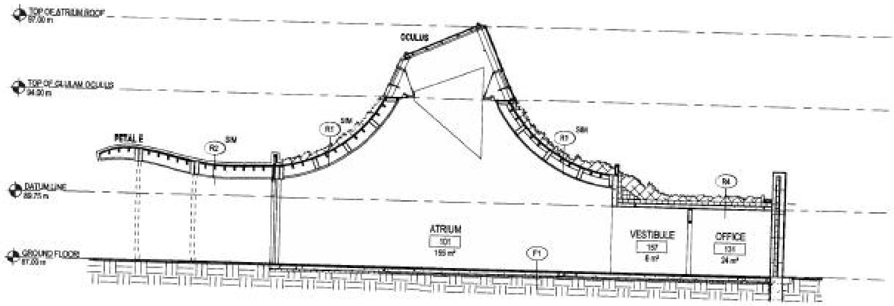

FIGURE 2: Section Drawing through Oculus, courtesy Busby Perkins + Will

The oculus' construction consists of heavy steel framing, clad with a double glazed skylight system with pressure cap purlins and SSG rafters. The original design vision was to have the low sloped glazing at the top open with a tilting mechanism. From an enclosure perspective, we were concerned that the tilting vent would not be able to achieve an adequate water penetration resistance rating of 300 Pa (6.27 psf) as required by CSA A440.1-00 (now NAFS). Being limited to local glazing manufacturers because of the LBC Imperative 14 – Appropriate Sourcing, we knew that a custom built tilting vent would have to be created and extensively tested in the laboratory to qualify its performance – a route the design team did not want to take. We recommended using awning style vents in the steeply sloped walls of the oculus instead, as these are a common vent configuration known to be able to achieve the water penetration resistance level required.

Well into the construction phase while reviewing the glazing manufacturer's shop drawings, it came to light that the awning vents were controlled by mechanical actuators linked to temperature sensors only. No rain sensors were included in the system's design, leaving the potential for rain water to come into the building. In fact, rain sensors could not be used as the vents were expected to be open often, including during rain events, which occur frequently in the rainforest climate of Vancouver. Although the passive cooling and natural ventilation approach was well intended, open vents allowing significant quantity of rain water to the interior poses a serious breach of the enclosure that would impact the owners, operators and visitors alike for the expected service life of the building.

The response was to redistribute the awning vents to the high side of the oculus as to limit their exposure to water cascading off the low sloped top surface, as well as to add baffles and overhangs, to essentially shield the vents from wind driven rain. While this is expected to mitigate the majority of rain water penetration, there remains a risk of incidental moisture finding its way inside. In addition, anchoring aluminum baffles and overhangs to the skylight negatively affects the overall thermal conductance of the system.

The mechanical, enclosure and architectural aspects of the oculus could have been better integrated and still meet the sustainable intent of LEED Platinum had communication been clear early in the development phase. Knowing the mechanical operation of the oculus could have led to an improved layout while ensuring rain water is kept out and the thermal conductance is not impacted. Without the benefit of changing the shape of the building, it is the sourcing of the appropriate system that becomes the salvation.

BUILDING IN THE PROVINCE OF BRITISH COLUMBIA

In 2009, the provincial government of British Columbia passed the Wood First Act, which mandates all new publicly-funded buildings to utilize wood as the primary building material. The idea behind this is to support the provincial lumber industry and the communities that depend on it, by generating a higher demand for wood products. The impact of the act is quite significant given that in an average year the provincial government invests $3 billion into the construction of civic buildings (Government of British Columbia).

While LEED and LBC also support wood products, the Wood First Act was the primary driver in the design of the Visitors Centre structure. More than half of the exterior walls and all of the interior partition walls are wood framed. All of the roof petals also consist of wood, however this approach was more innovative than the simple wall construction.

Each ‘petal’ is composed of a series of wood panels that are fabricated off site in a builder’s plant. Every panel is different and custom built to suit the aggressive and changing slopes of the roof. The typical panel construction consists of two glulam beams flanking each side of the panel lengthwise. Cross members include 38 mm by 184 mm (2 in by 8 in) joists strung between the glulam beams and diaphragm chords where required. Over the structure are two layers of plywood sheathing, with staggered joints.

Once constructed, the panels are transported to site on flatbed trucks and lifted with a crane onto wood posts capped with steel anchor plates, such that the glulam beams are side by side. The staggered plywood sheathing allows for the joints between panels to be stitched together with infill plywood.

FIGURE 3: View of Roof Petals from the East

Considering the extreme and always varying slopes of the roof as seen in Figure 3, wood makes sense as a building material to achieve the desired petal effect from an architectural perspective. However using wood for the roof structure as driven by the Wood First Act poses serious complications for the roof assembly, for construction sequencing and for quality control especially when built through the winter in a wet climate.

Wood roof in a wet climate

From a roof assembly perspective, the decision was made early in the conceptual design phase to insulate the wood structure from the underside by applying closed-cell spray polyurethane foam to the surface of the plywood sheathing, without having a full understanding of what this means for the enclosure. The motivation was ease of installation on a curved substrate; alternative board products would have been labour intensive and more wasteful as they would involve numerous layers and cuts to fit tightly to the top of the panels. The higher thermal resistance value per inch of thickness was also attractive given the stringent energy conservation goals. The concern lay in that the plywood sheathing would in fact be sandwiched between two vapour retardant layers, i.e. the spray foam below and the waterproofing membrane above. The risk was that moisture in the wood would not be able to dry, which depending on the quantity of water and length of time, would likely result in deterioration of the structure. The rate of drying was also expected to be poor given the multi-layer build-up of wood. Considering the complex shape of the roof, venting of the assembly was not an option.

It became clear that the design of the roof would not be changed and as such the wood needed to be kept continuously dry from the prefabrication process until the permanent roofing membrane is applied. This is especially important given the construction schedule shifted to the fall and winter months, which represent the peak in the rain season. Efforts needed to be made by all parties involved in the project, starting with the suppliers of the wood products. The plywood sheathing was stored indoors at arrival to the builder's plant. The glulams were fully wrapped in protective plastic and placed in the builder's yard until panel fabrication, seeing as they would remain exposed to the interior environment of the Visitors Centre and maintain the ability to dry, unlike the plywood sheathing.

Once the panels were fabricated, the spray foam insulation applicator came to the plant to spray the underside of the sheathing, as seen in Figure 4. Concurrently, the roofing installer applied a bituminous self-adhered waterproof membrane to the top of the panels all the while ensuring that all wood elements were in a dry state, as seen in Figure 5. This membrane's role was solely to waterproof the panels until the permanent roofing. Additional protection lapped down the sides of the glulams and wood fascia, which was essential for transportation on the flatbed trucks. Once the panels were raised onto the wood post supports, protection of the joints was required until the final stitching was done. This was a challenge because stitching is a multi-step process involving different trades: spray foam insulation was applied first within the gap, followed by the plywood infill and then the self-adhered membrane. Temporary protection of the joints, proper sequencing of the trades, and care by the workers on site were critical during this process. The flow of work was frequently interrupted by poor weather.

FIGURE 4: Spray Polyurethane Foam Insulation Applied to Underside of Panels

FIGURE 5: Individual Panels Protected with Membrane

Moisture content readings were taking at the various stages from wood delivery at the builder's plant up to the installation of the permanent roofing membrane, as a means of verifying the wood did not get exposed to external moisture.

The risk of water ingress beneath the roofing membrane remains with workmanship error, construction damage, and membrane failure over time. There were concerns that with the somewhat water resistant spray foam to the underside of the sheathing and the thick build-up of the wood itself, it would take a long time before leaks would be detected from the inside, likely only after considerable deterioration of the structure has occurred. The green roof overburden and placement of solar panels over the roofing membrane also makes it difficult and costly for future interventions. It was pushed to implement a leak detection system between the self-adhered membrane and the roofing membrane as well as moisture content pins at the underside of the sheathing. The leak detection system not only helps find discontinuities in the roofing membrane as it is being applied, it will alert the operators of the building as soon as moisture is detected. This will allow for repairs to happen as soon as possible. This added level of redundancy was also supported by the third party roof warranty provider for the project, who also influenced many other roofing details on site.

Although the intention of the Wood First Act is a good one, the application of using wood products for a roof structure coupled with a wet climate leads to several complications that challenge the durability of the enclosure. Many added measures were required to limit risk over the course of the project and for the lifetime of the building. The design of the roof assembly triggered a much higher level of involvement for all parties: the design team, the material suppliers, prefabrication builders, construction team, roofing trade, insulation trade, monitoring system installers, warranty provider, and the owners / operators of the Visitors Centre.

ONE STEP FURTHER – THE LIVING BUILDING CHALLENGE

The concept of a 'living building' originated in Montana, US, in the mid-nineties, when a team attempted to build "the most advanced sustainable design project in the world"

(International Living Future Institute 2010). In 2000 started the study of the economical and environmental implications of the concept of the living building and the LEED certification program on buildings. It was determined that while the concepts mean high front-load costs, they are the most economical choice over the long-term. Jason F. McLennan created and based the Living Building Challenge on this concept and originally launched the first version in 2006.

Unlike LEED which is point-based and offers several levels of certification, the LBC is a performance-based program with a total of 20 requirements, or ‘imperatives’, that must be met for certification to be awarded. The imperatives are spread across 7 categories: Site, Water, Energy, Health, Materials, Equity, and Beauty. The LBC also goes one step further by qualifying the performance of a building after 12 months of operation rather than relying on anticipated results, before deeming it a Living Building. Ultimately the LBC’s goal is narrow the gap that lies between current practices and ideal solutions, by building the ‘greenest’ buildings possible with the technologies readily available now (McLennan and Brukman 2010).

To date, only two projects have received the title of Living Building (both in the US) and one project was honourably recognized for achieving part of the imperatives (in Victoria, BC). Approximately 60 other projects are working towards getting certified throughout North America, including the Visitors Centre at VanDusen Botanical Garden.

Of the 20 imperatives, there are two that directly impact the building enclosure: Imperatives 11 – Red List, and 14 – Appropriate Sourcing, both of which fall under the Materials category. Their influence on the enclosure design was far reaching, from whole assemblies to the smallest of components.

Materials Banned by the Red List

The Red List of Materials currently itemizes 14 different chemicals that must not be used in the building, due to their links to severe negative effects on the environment and/or health. This list is continuously evolving as research studies determine the impacts of other chemical families. For example, the US Department of Health and Human Services recently declared that styrene is “reasonably anticipated to be a carcinogen”. Styrene of course is the chemical used in the fabrication of extruded and expanded polystyrene rigid insulation – a product widely used throughout the world. Styrene is not currently on the Red List but could very well be soon.

Ensuring products do not include the Red List elements is an onerous task. Thankfully there are databases such as the web-based tool “Pharos Project” that compile health and environmental information on various products, their uses and their end of life. These are important resources in cross-referencing banned materials and construction products that are commonly used in the industry. However without transparency from the manufacturers there are still many unknowns. Determining the products that are banned is one thing, but finding substitutes for them is another.

Neoprene is on the Red List, yet it is often used as setting blocks in curtain wall systems. Cadmium is also banned, and it is found in galvanized metal and stainless steel, both of which are viewed as durable when considering fasteners, sheet metal and secondary structural attachment systems. When looking at small components such as these, the LBC has an exclusion that allows their use given that they are one of a minimum of ten components of a manufactured system, and that they represent less than 10% of the total weight and volume of that system. This eased some of the challenges because some materials are difficult to replace when evaluating them from a durability perspective. For example, stainless steel fasteners are often used in areas exposed to the elements in various wall claddings; current alternatives would have a shorter service life and/or require significantly more maintenance and renewal. Is it best to have one fastener last the 50 year lifespan of a building, or one that must be replaced every 10 years because it has deteriorated from exposure to the elements?

Although there may be exclusions for small components, there are banned products that affect the enclosure on a larger scale. For example, mineral wool insulations contain formaldehyde, a known carcinogen, therefore it could not be used on the project. Instead spray polyurethane foam was used because it is currently accepted by the LBC. According to the US Environmental Protection Agency, spray polyurethane foam insulation can also pose health risks, but these are at the time of application and for a short period afterwards so it is acceptable for use in the building according to the LBC (US Environmental Protection Agency 2011). As discussed earlier the spray foam triggered a number of complications when considering its impact on the drying capacity of the wood structure above. Without considering the Red List, mineral wool would have been a logical option for the roof insulation: the roof panels could have been entirely exterior insulated. The advantages are that mineral wool would have conformed to the varying slope of the panels compared to board insulation, while keeping the inside surface of the roof sheathing exposed to the inside environment and maintain some ability to dry.

Sourcing from site for rammed earth walls

The other major influential imperative on the enclosure is Appropriate Sourcing, which provides maximum travel distances for various contributors to the project. For example consultants must be within a 2,500 km (1,553 mi) radius from the project, and high density materials must come from within a 500 km (311 mi) radius. Primarily chosen for its potential for high insulating value, it was the idea of sourcing locally that solidified the choice to build rammed earth walls at the Visitors Centre. Rammed earth is basically taking the native soil from the site and combining it with approximately 10% cement and other admixtures, and then ramming it into place against formwork. Manual tools are used to pound the earth to bring up layer upon layer of earth. The rammed earth wall is actually a sandwich panel, with spray polyurethane foam insulation in the centre, as seen in Figure 6. Because of the application procedure of spray foam, one side of the wall was rammed first, followed by spray foam insulation applied directly to it, and then the other side of the wall rammed against the spray foam. The wall is capped with puddled earth, which is similar to the rammed earth mix but with 20% cement content. The final look is of a mass cementitious wall with striations across it from the soil.

Rammed earth walls have been constructed in the British Columbia before, but they were found on single family homes, or in the Okanagan region which has a desert climate. For the Visitors Centre this was a new technology performed on an institutional building located in a wet climate, which meant several aspects needed to be considered. The rammed earth technology is rustic; installers were not used to having to comply with more stringent requirements. The trade was not used to accommodating an elaborate structural design, so a structural engineer needed to step in, incidentally at the shop drawing phase after the design intent was already determined. Without having reliable information on the structural behaviour of rammed earth and having the quality of installation highly dependent on workmanship, the structural design became conservative. Instead of relying on the rammed earth wall itself as the primary support element, as would be the case with a concrete mass wall, a steel structure was designed within the rammed earth to support the roof above. The rammed earth itself became structurally benign. This approach was new to the rammed earth trade, and created challenges not only for the ramming process and spray foam application process, but also for the energy model given the reduction in effective R value and the building enclosure given waterproofing needs.


FIGURE 6: Installation of Rammed Earth Sandwich Wall Assembly

The original intent was to protect the rammed earth walls with a roof above; however in the schematic design phase the focus was on respecting the form of the orchid rather than on implementing the imperatives of LBC at the same time. The overhead protection was deleted and the rammed earth walls became fully exposed to the elements. The response was then to apply a waterproofing membrane to the top of the walls before the puddled earth cap was poured, all in an effort to reduce the risk of moisture penetration. This approach needed to change due to the structural design. There were concerns about the waterproofing membrane affecting the bond between the rammed earth and the puddled earth cap, as well as the practicality of waterproofing the vertical steel members as they extend from the rammed earth into the puddled earth cap. The waterproofing membrane needed to be relocated to the top of the puddled earth cap.

Several complications ensued, including the compliance with the architectural intent to not have visible waterproofing or cap flashing, the unknown behaviour of the puddled earth cap triggering the need for a robust membrane that can bridge cracks, and the requirement for that membrane to be UV stable, and to adhere to an unfamiliar substrate. With so many factors to consider, the choice of compliant products was limited, not to mention the influence of the Red List. One possibility was to use a fully reinforced poly methyl methacrylate (PMMA) membrane as it can be a close enough colour match to the puddle earth cap, is durable, robust, and UV stable. Verifying adhesion remained the most critical factor, and the manufacturers in the area had never seen it used on puddled earth before. A mock-up of the rammed earth wall and puddled earth cap was built, and the PMMA membrane applied to the top surface, with different surface preparations as seen in Figures 7 and 8. Adhesion was determined to be sufficiently good to move forward with finalizing the new design, which in the end is likely more risky than the original intent, but was deemed acceptable by the team in order to respect the architectural expression.

FIGURE 7: Rammed Earth Wall Mock-Up

FIGURE 8: PMMA Membrane Test on Puddled Earth Cap

The fact that all imperatives must be met to receive the LBC certification means it must be held on the same pedestal of importance as other criteria when designing a building. For the Visitors Centre, the vision of the orchid was the primary goal in setting the form of the building. This meant that in some cases the design approach was more reactive than proactive, like how to mitigate risk when using alternative products like insulation and new technologies like rammed earth, to meet the Red List and Appropriate Sourcing imperatives.

DISCUSSION

The various governing bodies' and certification programs' stringent requirements touched the Visitors Centre as a whole and not only influenced but in some cases dictated many design decisions along the way. They all have the common goal of bettering the design and construction of buildings today. On the surface this is a straightforward concept, but when looking at it more critically it becomes clear that challenges stem from it. For example, the logistics of waterproofing a prefabricated wood roof structure in a wet climate translated into an enormous effort for all parties to heighten quality control, sequencing and planning measures throughout the process to minimize the risk of compromising the building enclosure.

Centering the design of buildings on sustainability puts even more emphasis on the criticalness of discipline integration. Incorporating modern technologies that are still considered cutting edge rather than the norm bring complexity to green buildings, complexity that is not encountered when construction a generic concrete high-rise condominium for example. Communication between all disciplines must happen to gain an understanding of the non standard systems and how they affect other elements. This is key in the conceptual phase, because once decisions are made it is often too late to revisit them and we are left to make last minute alterations to components rather than being able to do the "right thing", which is to take into account all key driving forces at the first stage so the design aspects are complimentary to one another . This was the reality for the natural ventilating and heat dissipating oculus, versus keeping the envelope watertight once the building is in full operation.

Meeting the criteria set by LEED and the LBC invites the use of new 'green' technologies. While there must always be pioneer projects implementing such technologies, the lessons learned need to be passed on to others for future improvements and development. They can also quickly snowball into important design considerations that affect many facets of the building. For example, the LBC's imperative for Appropriate Sourcing solidified the decision to construct rammed earth walls at the Visitors Centre. However to honour the architectural vision for the building, the rammed earth walls were fully exposed to the environment and required a new waterproofing strategy to be implemented. This was further complicated by the conservative structural design required to counter the rustic installation and behavioural unknowns. In addition the effective thermal resistance of the assembly was negatively impacted. Now that we know what their construction really entails means we can better weigh this option versus others in future projects.

Sometimes typical construction practices are so well embedded into the industry that we automatically use the same products time and time again without any question. With the LBC, we needed to think twice of the material selection for every detail. Ultimately it was an eye-opener in terms of why such a material could or could not be used, what its impact is on the environment, whether there are alternatives, and what it means for the enclosure.

We are also still limited in terms of the products that exist on the market today. It is only in recent years that alternative solutions are being developed. This is important because so many products are used for their specific properties and can sometimes be difficult to substitute with what is now readily available. For example, we know spray polyurethane foam, polystyrene, polyiso and mineral wool insulations all contain chemicals that are either on the LBC's Red List and are contemplated to be, yet each of have properties that make them desirable, whether for their moisture resistance, vapour permeability or impermeability, ability to self-drain, fire resistance, or air resistance. These are all critical elements to consider, and until appropriate environmentally-friendly substitutions are invented, they cannot be sacrificed to simply gain a point or meet legislative incentives. In the big picture, it could mean sacrificing a well performing enclosure and ultimately the durability of a building. Nothing is gained in sustainability if frequent renewals or premature widespread repairs are necessary to salvage a building because of choices made for the wrong reason in the design phase. A fine balance needs to be found between the LBC and how to build a durable, well performing building enclosure.

CONCLUSION

That being said, effort to build buildings sustainably is the road that must be taken. The industry is still learning how to achieve this, and challenging projects such as the VanDusen Botanical Garden Visitors Centre will continue to be developed. As we gain more and more knowledge of concepts and materials that work and those that do not, we will be able to determine how they can be properly applied to the building enclosure. This will push for further research and production of the better solutions and alternatives to our current practices, and effectively narrow the gap.

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