IDEASS

Integrative Data-Enabled Approaches to Sustainability Across Scales

CIRS RETROSPECTIVE

Laura Fedoruk
Devon Miller
Mike vander Laan
August 2012

TABLE OF CONTENTS

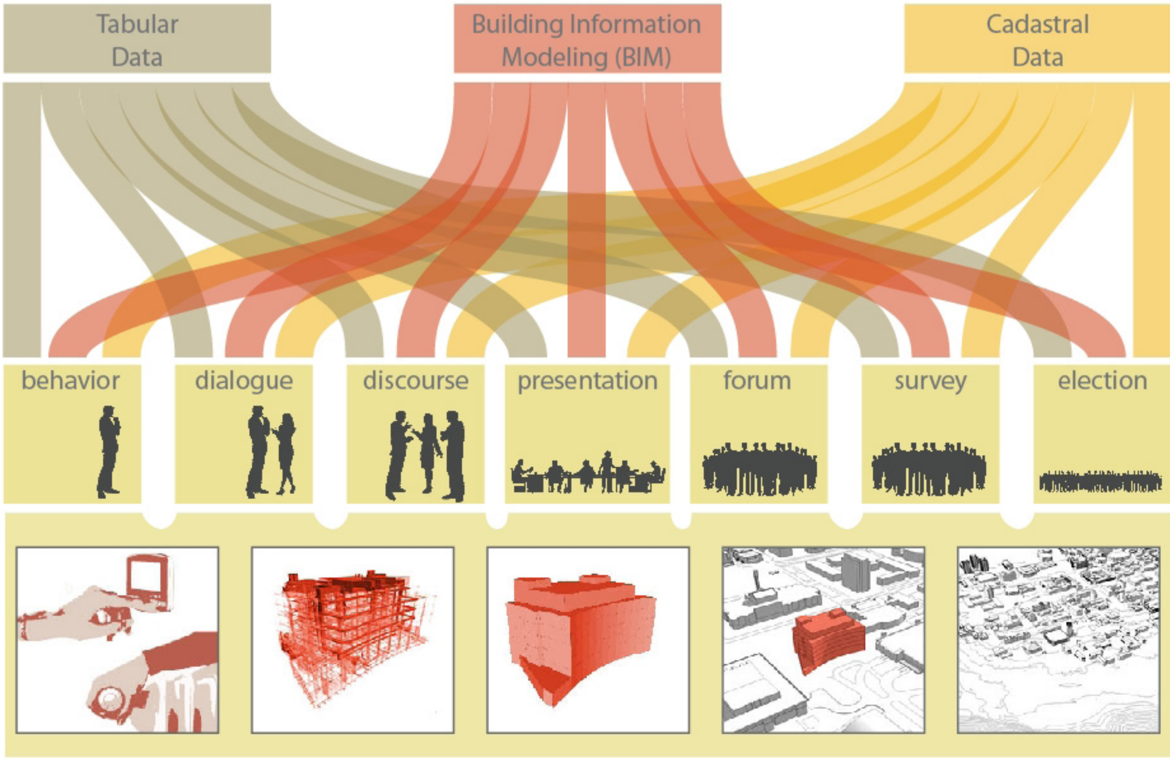
INTRODUCTION

Integrative Data-Enabled Approaches to Sustainability Across Scales (IDEASS) is a collaborative project "to develop innovative processes, technologies, and methods" to inform decision-making for sustainable design projects - from conception through operation.

As part of this project, a retrospective study was undertaken on the Centre for Interactive Research on Sustainability (CIRS) at the University of British Columbia (UBC). CIRS provides a case study to test decision-making frameworks and concepts, and through which further work can be undertaken in the field of sustainable design.

A primary goal of IDEASS is to help projects improve the ability to get data in the right format, at the right time, and in the right context in order to better influence decision outcomes towards design goals. A retrospective study of a high-profile, innovative building such as CIRS helps to address this goal as it offers the opportunity to learn from the design process so that future projects can make more efficient and effective decisions.

Recognizing that the design process for CIRS took place across various venues, and included multiple stakeholders, the CIRS retrospective case study has evolved to be an examination of the meetings, people, and information that led to the finalized outcomes of the energy systems in CIRS. Of particular interest to the research team is the CIRS Energy Charrette, and this therefore has formed the basis for this research.



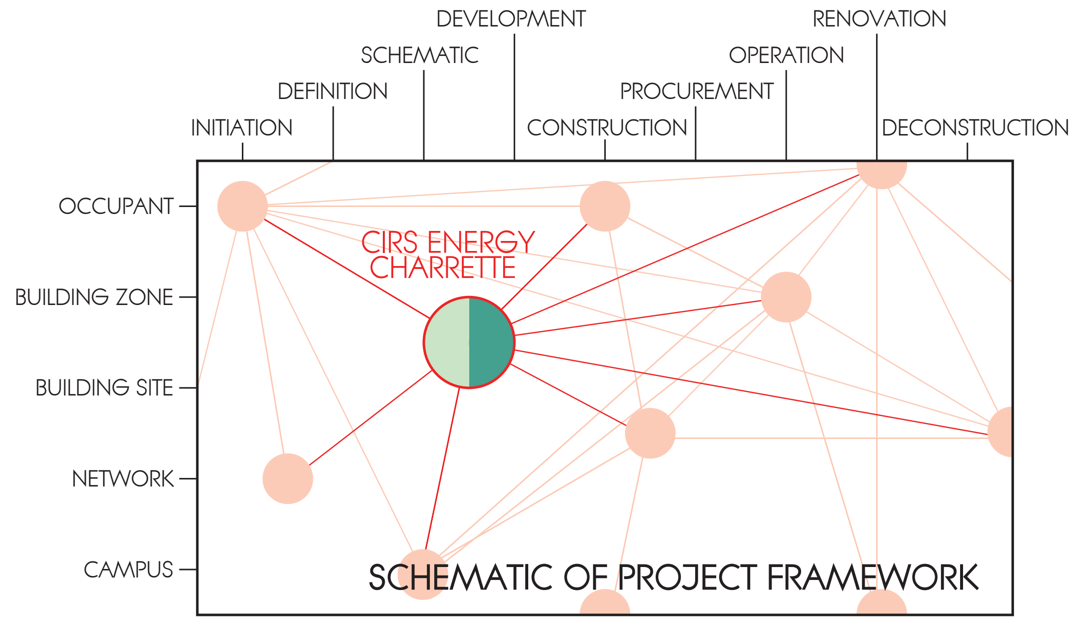
This report will describe the decision-making process that took place with regard to the energy systems design for CIRS, and will focus on the period of time leading up to, including, and following, the energy charrette. Specifically, this report will look at the following decision-making factors:

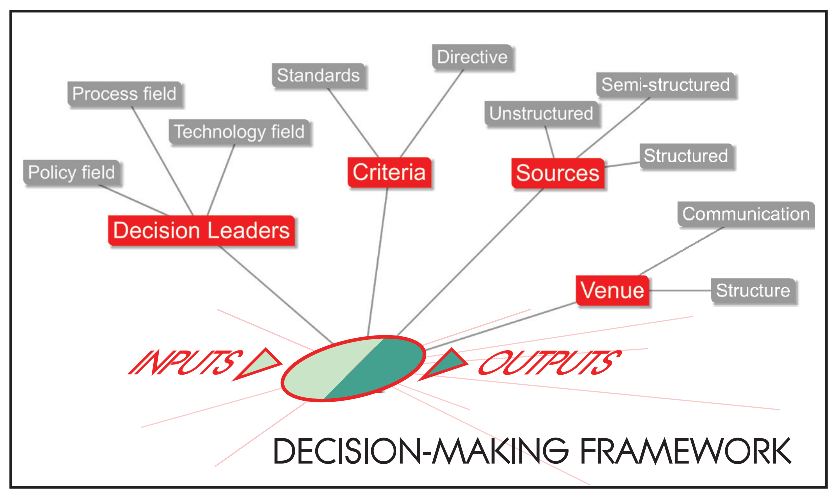
- **DECISION-MAKING VENUES (WHERE AND WHEN?)**
- **DECISION-MAKING LEADERS (WHO WAS PRESENT?)**
- **DECISION-MAKING CRITERIA (WHY THIS DECISION?)**
- **DECISION-MAKING SOURCES (WITH WHAT INFORMATION?)**

The report will also include assessments of the design process, including:

- **DESIGN BREAKTHROUGHS**
- **DESIGN CHALLENGES**
- **LESSONS FOR FUTURE IDEASS PROJECTS**

The top figure to the right shows how the CIRS Energy Charrette fits in with the other scales and design phases that will be looked at in IDEASS. The bottom figure shows how the CIRS Energy Charrette will be analyzed: in terms of the decision-making factors (decision leaders, criteria, sources, and venues) as well as in terms of its inputs and outputs.





PROJECT METHODOLOGY

Acquisition Process

Data used in this report were collected through six interviews with stakeholders and design team members from the design process for CIRS, as well as through data-mining of technical drawings and models, meeting minutes, feasibility reports, charrette reports, and letters of intent and memorandum of understanding documents.

Interviews

Interviews were held with six key individuals from the design process for CIRS. Five of the six interviews were held at the offices of those interviewed, and the sixth was held via telephone. All interviews were kept confidential and anonymous, and were transcribed by one of the researchers. A copy of the interview questions used can be found in Appendix 1.

Data-mining

Atlas.ti qualitative analysis and research software was used in the organization and coding of primary documents. A list of documents used in the researching of this report can be found in Appendix 2.

How data were used

Interviews

Interviews were structured such that interviewees were asked to recall their impressions of how the design process for CIRS was undertaken. Questions were designed to elicit feedback with regard to decision-making venues, leaders, criteria, and sources with a focus on assessing successes and challenges experienced in the design process. As well, questions were designed to elicit thoughts regarding how the design process could have been improved for future projects, with a focus on decision-making processes and structures.

Data-mining

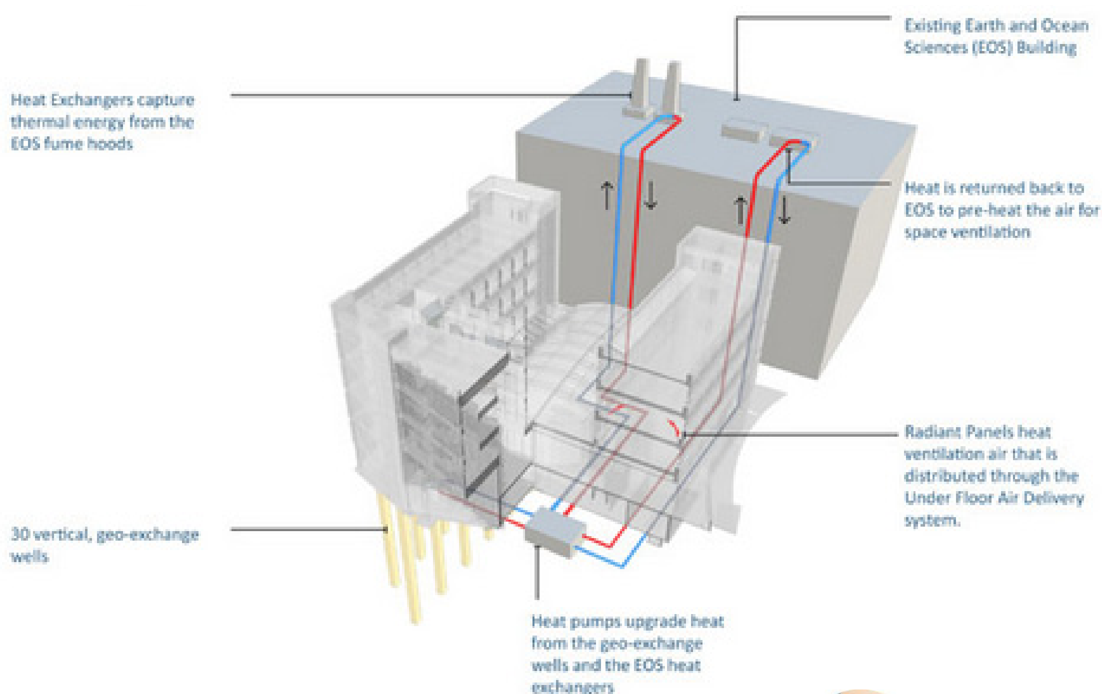
Data-mining was primarily used to 'tell the story' of CIRS and to provide researchers with adequate background information of the project prior to the interviews. Specifically, data mining provided researchers with information regarding when project approvals occurred, when funding was released, when grants were secured, and how the energy system evolved over time. This information is shown in the timeline for the design process for CIRS in Appendix 3.

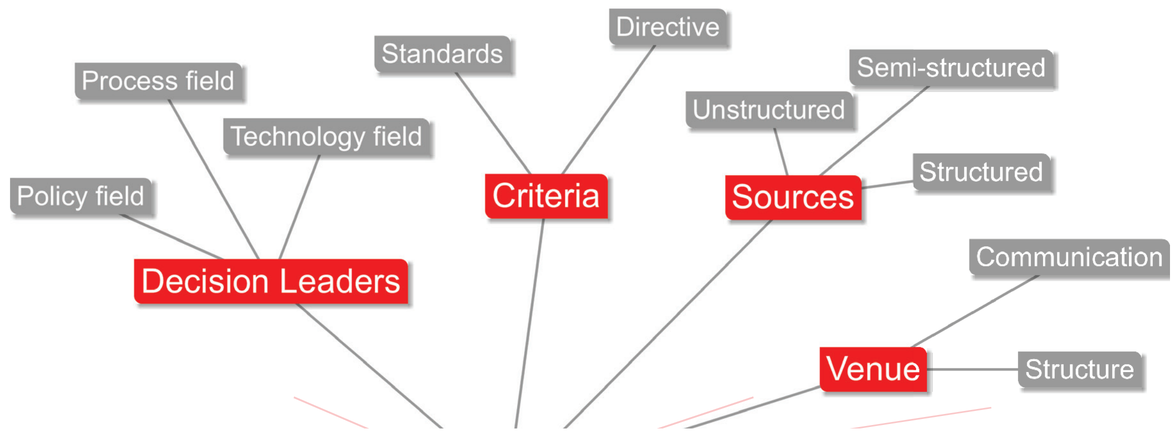
CIRS ENERGY CHARRETTE

The CIRS Energy Modeling Charrette was held between 8:30 am and 2:30 pm on July 4th, 2008 in the CK Choi Building on the University of British Columbia's (UBC's) Vancouver campus. The Energy Modeling Charrette was the last of four charrettes held in 2008, with three previous charrettes having been completed on: revised design goals, water systems, and daylighting and solar strategies. All of the charrettes that took place in 2008 were funded by Natural Resources Canada (NRCan) as part of a grant which enabled the use of the Integrated Design Process (IDP) in the design of CIRS (CIRS IDP Report - Dec 27).

The groups in attendance included the representatives of the architects (Busby Perkins + Will), the mechanical and electrical design consultants (Stantec, BC Hydro, BCIT, Brooks Coming, Corix, Haworth), the controls consultant (Honeywell), and The University of British Columbia (Academic, Properties Trust, Plant Operations, Sustainability Office, Utilities, Office of the AVP, and Campus and Community Planning).

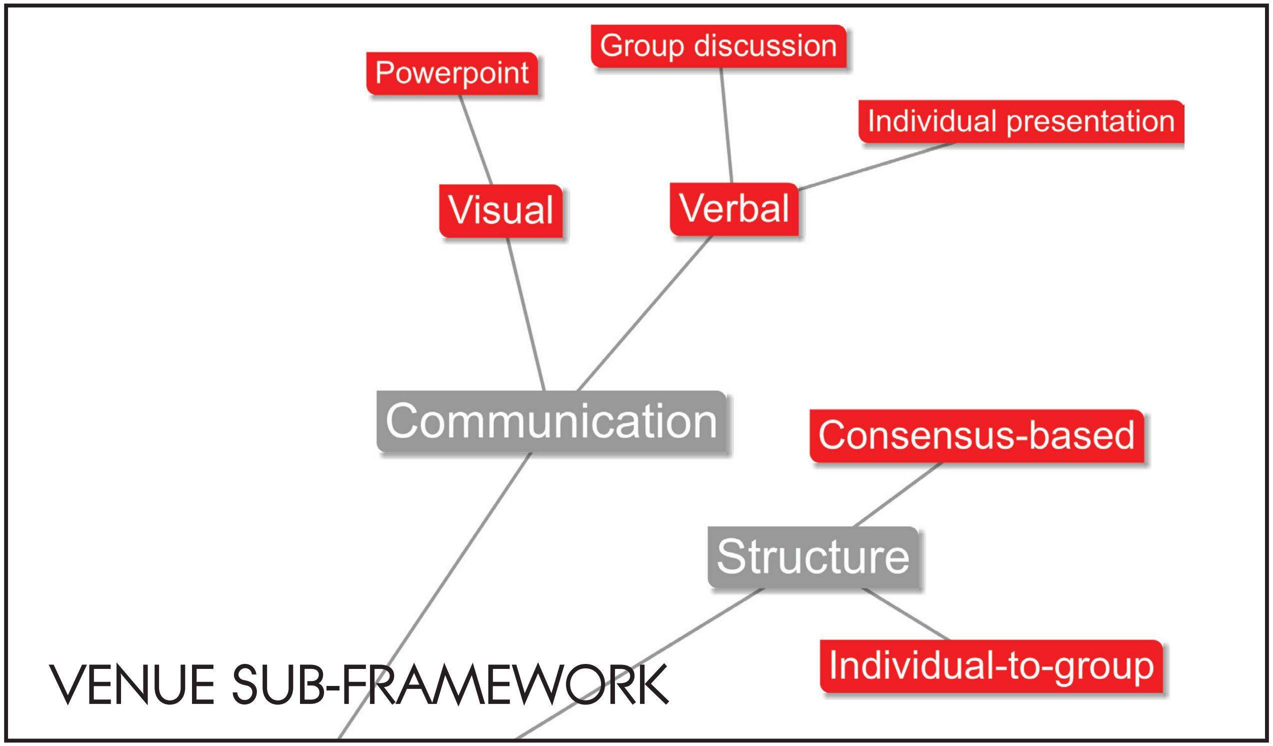
The session was chaired by Blair McCarry of Stantec whom also made a presentation on the latest energy model of the building, and Z. Smith of Busby Perkins + Will whom presented information from the previous daylighting charrette as well as lessons learned from the previous design iteration of the project when it was located at Great Northern Way campus. While not specifically stated in the agenda or report for the Energy Modeling Charrette, subsequent interviews with attendees have shown that the main goal of the charrette was to decide on a path forward for the project's energy system and to gain buy-in from stakeholders present.





DECISION-MAKING FACTORS

DECISION-MAKING VENUES



What were they?

Throughout the design process for CIRS, there were bi-weekly meetings held with the design team at Busby, Perkins+Will's downtown Vancouver office. These meetings typically involved updates from the various consultant parties (architects, mechanical and systems engineers) as well as from the project manager (Alberto Cayuela). These meetings also served as one of the venues where decisions were made with regard to energy systems. The other main venue for making decisions throughout the CIRS project was at the charrettes, although this was not the case for the energy system.

The format of the Energy Modeling Charrette was more of a presentation of explored design possibilities and a selection of a strategy for going forward rather than the traditional brainstorming-workshop format.

A key finding discovered through interviews and the deconstruction of the Energy Modeling Charrette was that many of the design specifications that resulted in the finalized systems for CIRS did not occur within the energy charrette itself. These decisions, however, were galvanized through the presentation of design iterations in the charrette, and the charrette served as a way to disseminate knowledge and choose pathways for future avenues of exploration.

How did they impact decision-making?

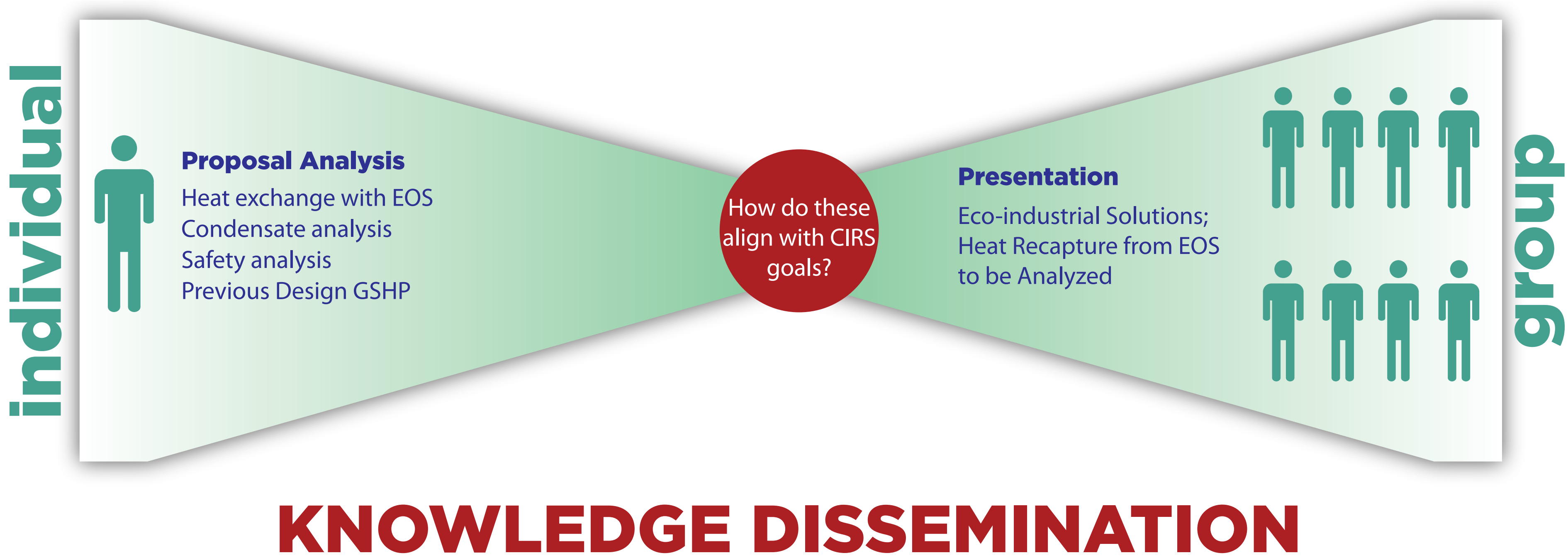
CIRS followed an IDP, and one of the aspects of such a process as it relates to decision-making venues is the fact that design team meetings are intentionally more streamlined and expert-oriented as the design process evolves. This means fewer stakeholders are present, and the project consultants take more of a leadership role in the process. This occurred over the course of the design process for CIRS, with meetings and charrettes becoming less about brainstorming and more about making decisions with regard to the systems.

The structure of the meetings and charrettes therefore had significant impacts upon decision-making, as design team members knew that these were the venues where their arguments could be made with regard to a particular system. In other words, the decision-making venue was an environment where a member of the design team would make the case for a particular system, drawing upon

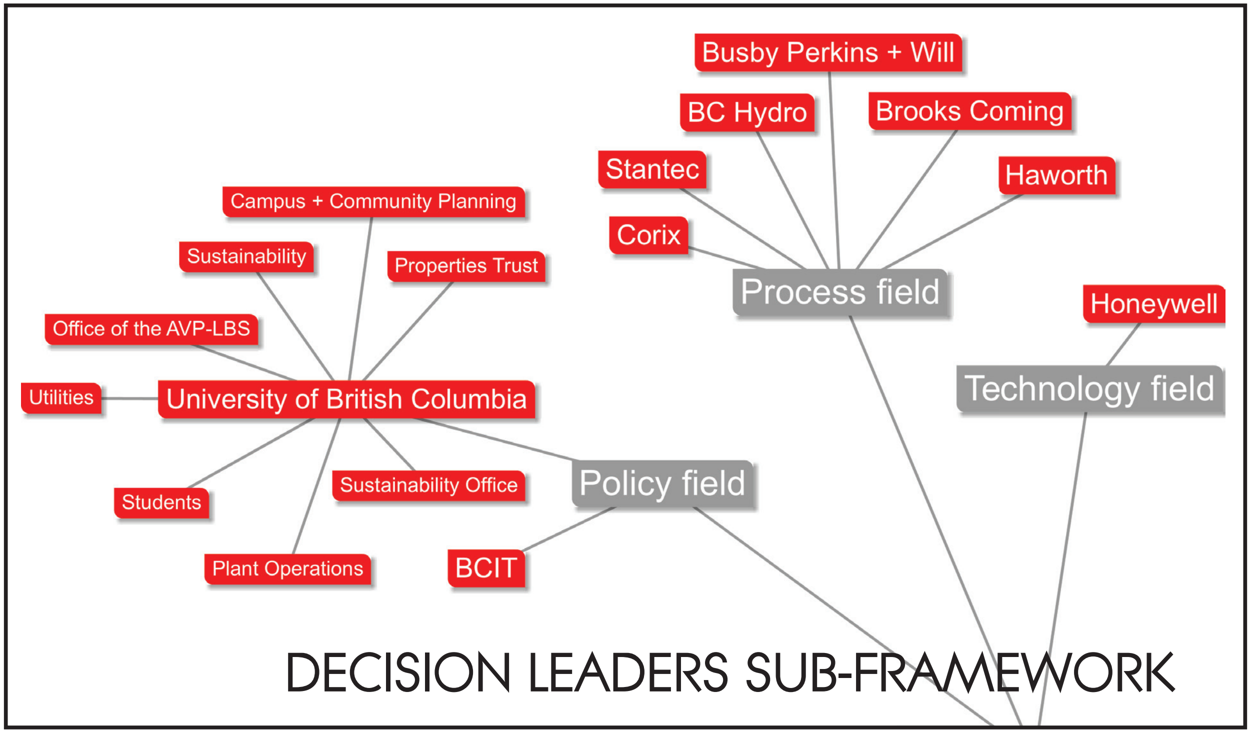
DECISION-MAKING VENUES

work done to date, and the decision would be made by the group present at the meeting or charrette. This individual-to-group knowledge dissemination and decision-making structure is summarized in the figure below.

The figure depicts an example of knowledge dissemination that occurred during the Energy Modeling Charrette. Drawing on knowledge created through previous designs and analysis, a presentation was made by the mechanical design consultant on possible energy systems to meet the heating needs of CIRS. These systems were then discussed and put in context through looking at their alignment with the overarching goals of CIRS. The outcome was a shared understanding of and path forward for further analysis on the possibility of heat recapture from the Earth and Ocean Sciences (EOS) building.



DECISION-MAKING LEADERS



As mentioned previously, because CIRS followed an IDP, many of the meetings involved a large number of stakeholders and consultants.

There is often a dynamic in group decision-making settings whereby certain individuals are looked upon to vet certain decisions or confirm a particular direction or avenue for exploration for the project. This dynamic is important to understand in decision-making so that projects can anticipate it and ensure that it does not disrupt the decision-making process. To help understand this, in this report, we differentiate between those individuals who were present in the design process from those that actively lead the design process.

Those individuals who were present during the energy charrettes and who were involved in making decisions but were not leaders in making the decision, will be referred to as "decision-making actors".

Those individuals who took the lead in making these decisions, and who were the individuals that the decision-making actors looked to for confirmation, will be referred to as "decision-making leaders".

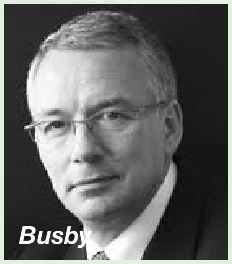
Who were they?

The decision-making leaders in the design process for the entire CIRS project were Peter Busby, John Robinson, and Alberto Cayuela. These three were looked to in order to enesure that a proposed design was in-line with the project goals and aspirations. For the heat exchange system with EOS, Blair McCarry was the decision-making leader.

Busby, Robinson, Cayuala, and McCarry were the individuals that the decision-making actors (i.e., the other stakeholders and members of the design team who were involved in the project but were not in a leadership role) looked to in order to provide final approvals or decisions.

How did they impact decision-making?

The table on the following page summarizes the roles that each decision-making leader played in the design process for CIRS as well as how they impacted decision-making.



Peter Busby's role as lead architect was to ensure that the design was as innovative as possible, and to drive the mission of accelerating sustainability agreed-upon with John Robinson.

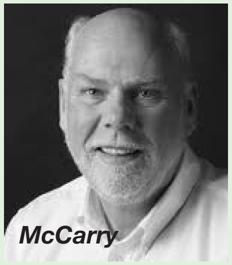
"I can remember Peter coming to one of the charrettes, I think it was the daylighting charrette, and his own staff presented this whole strategy, and he said 'that's not good enough, that's not sustainable, you've got to do way better' in front of everyone else. So there was that drive" - Interviewee 1

John Robinson's role as project champion was to ensure that the project vision and goals were maintained and realized throughout the course of the project. He was not specifically involved with decisions such as which systems would be used, but was looked to to ensure that the specific systems and results were in line with the goals of the project.

"...[John's] role was as, sort of, project champion. So, it was about trying to make the whole thing exist and survive. But [he] was also quite interested in some of the specific systems of the building, the energy ones in particular, actually, because [he had] more knowledge about that. So, [he] was a little bit at the periphery, but at the level of the principles and the design goals and the overall purposes, [he] was quite involved" - Interviewee 1

Alberto Cayuela's role as project manager was to liaise between the consultants, the university, and the project champion to ensure that the project was carried out on-time, on-budget, and that it represented the project vision and objectives. In many cases, Alberto was the representative of UBC's interests at the bi-weekly meetings, as well as ensuring that the design team knew when certain systems had to be included. He was involved in day-to-day decisions, and was responsible for translating the requirements of grants and partnerships into specific design deliverables.

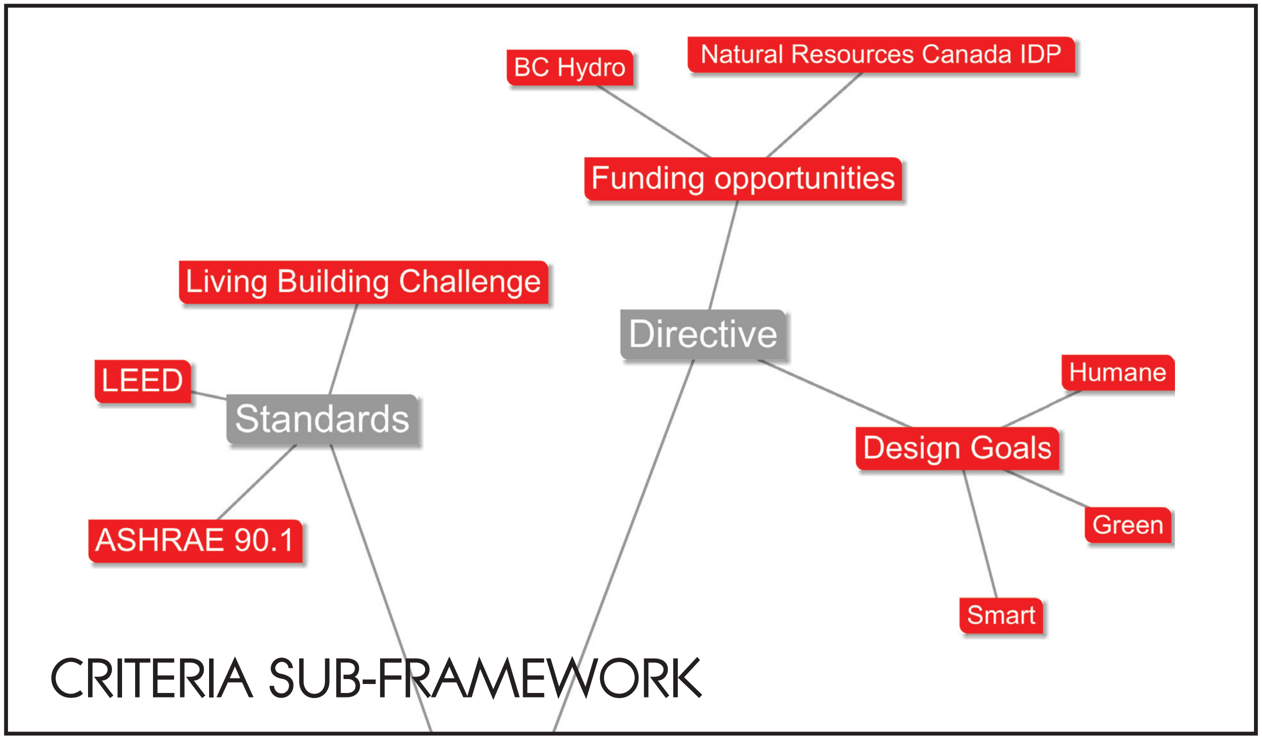
"[Alberto} was there, representing, to the best of [his] ability, say John's program and objectives with the operators and some of the others, [he] knew the grants and the requirements and so kind of became the link between the design team and the project" - Interviewee 2



Blair McCarry conceived the idea for the heat exchange, developed it with his co-workers at Stantec (despite what has been described as a lack of support or agreement that the system was feasible) and proposed it to the design team. All interviewees have pointed to the fact that without Blair, there would not have been the heat exchange with EOS and therefore the project would have been without one of its hallmark systems.

"I think that Blair's sort of collaboration with John and his, sort of, driving this innovation was really fundamental, because working close with the mechanical design team, I could sort of feel a bit of resistance to doing this unconventional design, where basically no one believed that this thing was going to work...with Blair pushing and driving this, he was really the one bringing this forward I think, all the way." - Interviewee 5

DECISION-MAKING CRITERIA



What were they?

There was no explicitly agreed-upon decision-making process for CIRS. While interviewees have described the process evolving into something resembling consensus, there was no formal adoption of a consensus-based (or other) decision-making model. Instead, the criteria used to make decisions came from the formation of the project goals and vision, and each decision was made in terms of its adherence to the goals and vision.

One of the first proposed locations for CIRS was the Great Northern Way Campus (GNWC). Prior to the project moving back to UBC's Vancouver campus (UBCV), design documentation was made for GNWC and the project goals and vision were put forth.

Specifically, twenty-two design goals were decided upon during this iteration, and these goals were upheld during the design process for CIRS at UBCV (see Appendix 4 for a list of the 22 goals). These 22 goals were then synthesized down to three summary goals: to be Green, to be Smart, and to be Humane (see sidebar). In addition, some of

CIRS GOALS*

GREEN: Look outward from the building to the health of ecological systems. What we build can be constructed, operated, adapted, and disassembled in ways that go on and on without using up non-renewable resources or burdening future generations with wastes. Moving beyond "less bad," CIRS goals are regenerative—leave our campsite better than we found it.

SMART: Apply human design intelligence augmented with monitoring and feedback to get the most out of the available energy and material flows afforded by the site and its surroundings. Feedback is key to ensuring that the system of the building and its inhabitants performs well. By taking this approach, CIRS aims to develop approaches towards meeting human needs at the lowest life-cycle costs, solutions that can be replicated and adapted into buildings worldwide economically.

HUMANE: The reason we construct a building is to provide a healthy environment for its inhabitants. CIRS aims to provide a healthy functional environment for human habitation which adapts to changing needs and uses over time.

*from Busby, Perkins + Will, CIRS Goals Summary, 2008

DECISION-MAKING CRITERIA

the decisions made for specific systems were tied to funding that had been secured on the basis of specific systems or performance targets proposed in this first iteration.

The 22 design goals were initially articulated by the team at Busby Perkins + Will and were used in a charrette held in November of 2004, the purpose of which was to confirm the goals and strategies of the project. These goals built upon the initial 2001 feasibility study, and the revised feasibility study of 2003/2004.

It was noted by a design team member that over the course of the project "some systems dropped out of the race" such as the opportunity for a wind turbine, fuel cells, or a small biomass demonstration (see quote 1 to the right). Presumably these options were determined to be unfeasible based on site conditions, budget, and other criteria.

How did they impact decision-making?

The twenty-two design goals carried forward impacted design decisions by providing a measure against which ideas could be judged. The overall vision of the design goals - to be Green, Smart, and Humane - provided the larger ideal for the project, and many discussions and decisions seem to have been made by judging whether or not specific ideas were congruent with the project's vision. When conflict arose during the design process, appeals back to overarching project goals were said to have been made.

The decision to move forward with the heat exchange with EOS provides an example of how a design feature allowed CIRS to realize its goals (see quote 2 to the right).

At the time of the Energy Modeling Charrette, the other energy systems for the building - PV, geoexchange, efficiency measures, and solar thermal - were already 'on the table'. In addition to the possibility of capturing waste heat from EOS, there was also the possibility of "retaining heat from the condensate return of the natural gas medium pressure steam system of the university" (Interviewee 2). However, this opportunity was deemed unfeasible from both "a cost and engineering perspective" (Interviewee 2).

Decision-making with regard to energy and water systems was constrained by the addition of the café and lecture theatre. The café added significant energy and water demands to the design, while the lecture theatre made mechanical ventilation and cooling a requirement of the new design. While this added constraints to the systems available, it also added significant budget to the project due to the provision of lecture space.

QUOTES

1 *"...we first analyzed based on the goals that John referred to, the overarching goals of the project. We want to become net-positive on energy, what options do we have, and those were revised and discussed at specific charrettes, so some of them were carried from the initial set of goals that survived from the charrette in November 2004 which was the first charrette for the project. For instance, PV and geoexchange, and hot water were the initial energy strategies for the project when it was conceived at a different location back in 2004" -Interviewee 2*

2 *"Well we had, on the table...the usual suspects. We had building integrated PV, we had the solar thermal, we had the geoexchange. We had the daylighting strategy and efficient, you know all the efficiency stuff. So that was already there, but that didn't get us to net-positive, right. So [the heat exchange] was a breakthrough in allowing us to make a huge step in the direction of regenerative sustainability. So it was an exciting moment." - Interviewee 1*

DECISION-MAKING CRITERIA

Grants forcing decisions

Some of the decisions made throughout the design process were effectively 'forced' by requirements of grants which CIRS had been awarded and which made up a large portion of the project budget. These considerations were brought to light frequently and impacted the design discussions (see quote 3 to the right).

Examples of grant requirements are shown in the sidebar. While these examples illustrate how some of the energy system decisions were the direct result of project grant requirements, the main energy system for the building - heat recovery from EOS - was not required by funding considerations but instead met the criteria of the overall project's vision and goals.

3 *"Now, through the design process, it was more on a weekly basis, OK what are we talking about this week, OK we are talking about energy. OK don't forget we have to have a PV system, we have to have a solar hot water, if we are doing the heat exchange system this is something that you know SDTC and CFI are going to fund." - Interviewee 2*

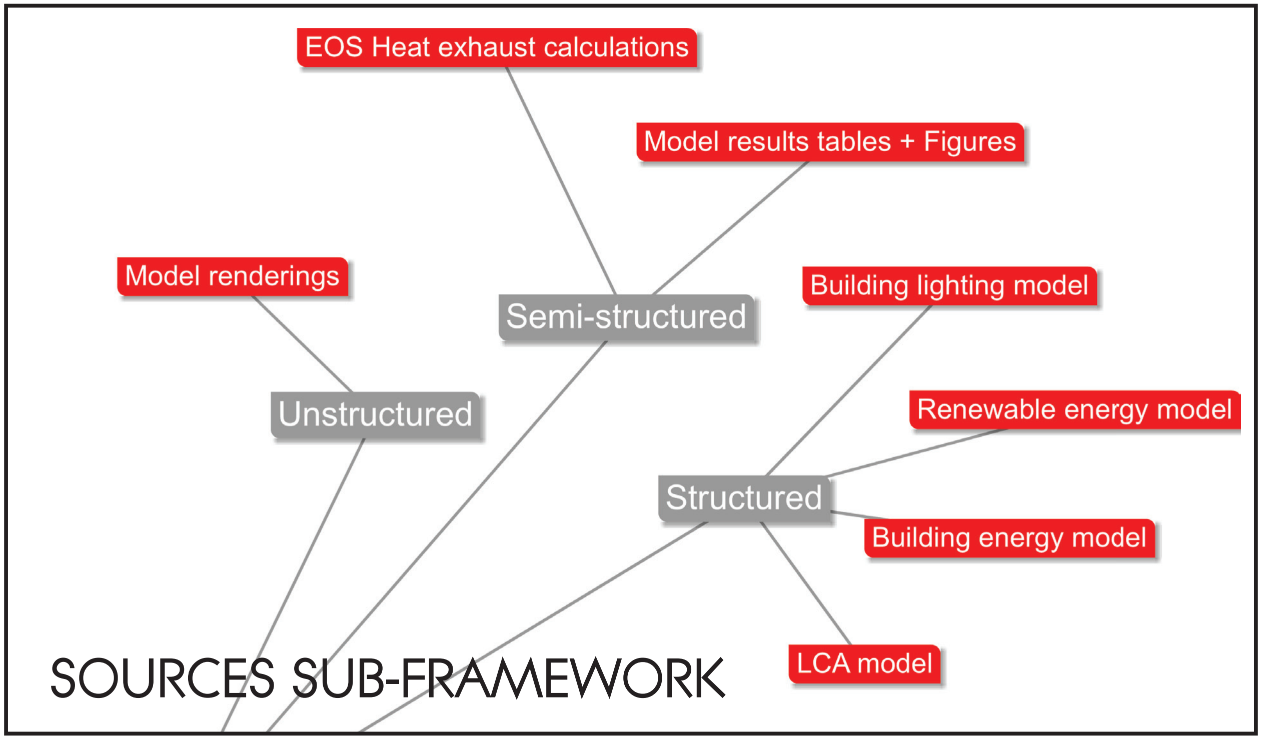
GRANT REQUIREMENTS

End-use smart monitoring capabilities and the use of 'non-commercially viable' products - this requirement was part of the funding agreement between UBC and the Canada Foundation for Innovation. The installed Honeywell Building Management System (BMS) would be considered part of this requirement (See final Design Charrette report, 2003/2004 = BCKDF/CFI).

Monitoring capabilities, energy efficiency, and an efficient building envelope - this requirement was part of the funding agreement between UBC and the Western Economic Diversification Program (see 'Funding WED 2009-03-25 UBC CIRS Signed Agreement.pdf').

Use of Visionwall in the building envelope, use of Honeywell instrumentation for sensing capabilities, and the use of photovoltaics - these requirements were part of the funding agreement between UBC and Sustainable Development Technology Canada (see 'Funding SDTC 2007-12-5.pdf').

DECISION-MAKING SOURCES



What were they?

Similar to other modern building design projects, CIRS involved large flows of data between stakeholder groups. However, unlike many other projects, the design goals put forward during CIRS's project definition laid a foundation to how data was managed, used and evaluated by stakeholders involved in the design, construction, and remaining life-cycle of CIRS.

Many of these design goals were specific enough to be evaluated by established industry workflows, standards and software applications. For example, standards such as ASHRAE 90.1 - 2004 or ISO 14040, were used to evaluate design goals surrounding building energy use and whole building life-cycle assessment. Furthermore, software applications were utilized to verify predicted building performance through simulated future scenarios (e.g. RETSCREEN for renewable energy potential, Ecotect/Radiance for interior daylighting conditions). See Appendix 5 for a timeline of the energy modeling process for CIRS.

Other design goals, however, put forward loftier data management ambitions. In particular, 2 of the 22 design goals (see Appendix 4 for a list of these goals) provided the foundation for both advancing the flow of data between stakeholders and highlighting the remaining data management challenges apparent in the AECOM (Architecture, Engineering, Construction, Operations, Maintenance) Industry and those perhaps more apparent in ambitious projects such as CIRS. These two goals were:

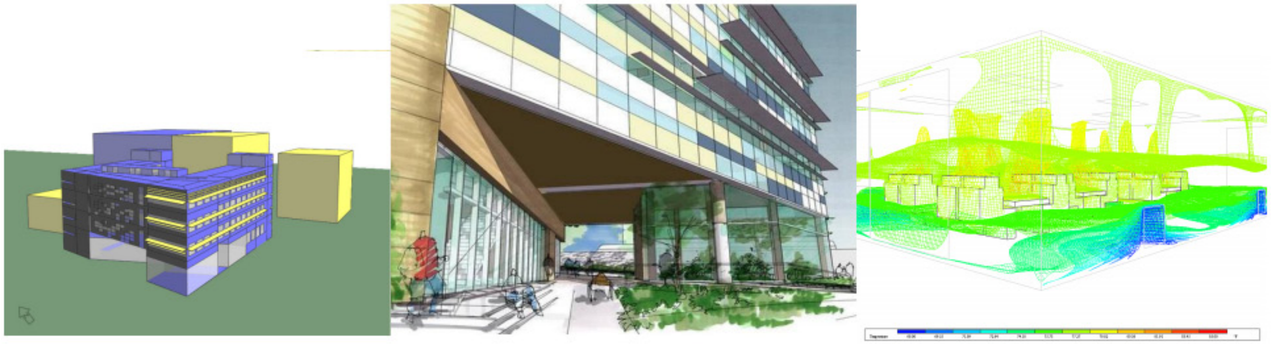
- Building designed through 3D virtual process
- Seamlessly integrate design and operation

Building designed through 3D virtual process

The first of these two goals allowed many of the other design goals to be conducted in a more streamlined fashion - albeit with challenges of their own (e.g. the data translation between 3D architectural models, energy models and life-cycle assessment software remains more of an academic pursuit than an established workflow in the industry. See quote 4 on the following page).

In addition to data translation issues between sub-consultants, there also remain workflow integration challenges between architectural,

DECISION-MAKING SOURCES



Some interviewees stressed the importance of having better integrated building models (energy, structural, etc.) in terms of improving the decision-making process for building design.

structural, and mechanical design teams. The 3D virtual environment is best used during an IDP and when conducted through a Building Information Modeling (BIM) application. This allows design conflicts between sub-disciplines to be resolved before construction starts. However, this workflow requires commitment from the entire design team and the extent to which CIRS utilized the virtual environment to resolve design conflicts is unknown.

Seamlessly integrate design and operation

The evaluation of the second of these two design goals is largely beyond the scope of this report and will unfold during the project life-cycle. In particular, the extent to which building operations data will parallel design goals is yet to be determined. This is highlighted by the differences between the tools used to predict building performance and the tools used to control building systems in operations.

For instance, integrating lighting, HVAC and domestic hot water systems with changing environmental conditions such as daylight, occupancy and incoming solar radiation are ongoing challenges to building operations and are not necessarily explicitly accounted for earlier in the design phase.

How did they impact decision making?

Going into the Energy Modeling Charrette, there was already an established repository of data available to the design team. For instance, the general massing of the building had already been decided upon and the charrette provided a context for which energy scenarios could be presented and evaluated.

> **4** *Well, in my world, I would like to have all of this, like BIM, model exchange, you know, between different software, working seamlessly. And that is kind of utopia, in a way, and it's not happening. I mean that would be really nice, where you can share so much information in one place. So, the idea is kind of there, but it's not working practically as it is right now. - Interviewee 5*

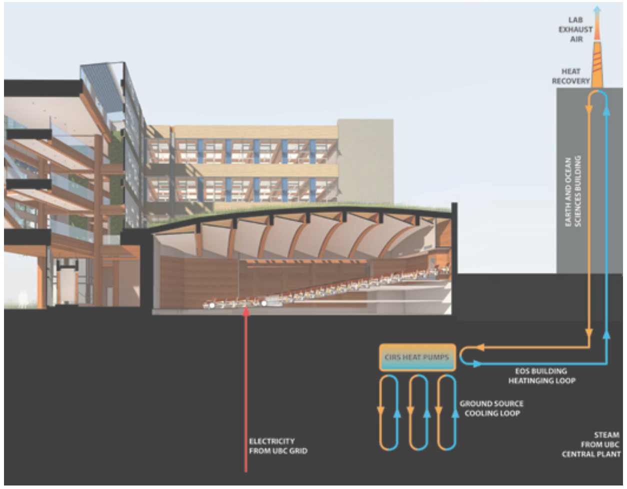
The bulk of the discussion centered on preliminary model results produced by the mechanical engineering team and followed a presentation/discussion format. Data extracted from the model was presented through powerpoint slides and formatted as tables and figures that compared CIRS against the industry standard (ASHRAE 90.1 - 2004 baseline).

The format in which energy data was presented highlights how many energy decisions were evaluated and acted upon.

For example, prior to the Energy Modeling Charrette a scenario was proposed to use a heat exchanger with EOS; data was collected to estimate the available heat, this data was input into the energy model, the simulation output was compared to an ASHRAE baseline, which was then presented to the group. This workflow highlights the importance of models when evaluating different scenarios and may also point to the maturity of the energy system design coming into the charrette. That said, the degree to which other scenarios were explored or how a design team can best consider all surrounding energy systems (i.e. not overlook a system such as the heat exchange with EOS) remains an unexplored aspect of how data is managed within a design project.

DESIGN BREAKTHROUGHS

HEAT EXCHANGE SYSTEM



The heat exchange system between Earth and Ocean Sciences (EOS) and CIRS became the main heating system for the building - providing thermal energy for CIRS while also making it possible for CIRS to 'give back' heat to EOS, thereby reducing the campus' carbon emissions through reduced natural gas consumption of EOS.

Decision-making leader

The initial suggestion to investigate the use of heat recovery from EOS was put forth by the mechanical design lead for CIRS, Blair McCarry (see quote 5 and 6 to the right).

Decision-making venue

Initial estimates were put forth about the possible heating that could be provided, and the ideas were presented at the Energy Modeling Charrette in May, 2008. The other option put forth at the Energy Charrette was to recover heat from the campus district heating system's steam condensate.

A decision was made to continue exploring the potential of EOS to provide heating for CIRS, and the mechanical designer became the main champion of the unconventional design throughout the design process. Steam condensate recovery was found to be infeasible from both a mechanical and budgetary standpoint, as the campus system was slated to be converted from steam to hot water.

Decision-making criteria

The decision to pursue an energy system that used heat recovery from EOS fit well with the project's overall goals, and helped the design to gain momentum because of its ability to realize the team's overall mission (see quote 7 to the right).

The opportunity to use heat recovery provided an avenue for the project to get to its net zero goal and thereby made other energy systems secondary in terms of meeting the building's overall heating demand. Grant requirements to have systems such as photovoltaics enabled these 'secondary' systems to still remain part of the project and provide research opportunities for UBC - meeting another overarching goal of the project.

QUOTES

5 *"...our consultant engineer, mechanical engineer ... came up with the idea of doing the heat exchange to provide 100% of the space heating required for this building using energy that, at the current time, was being wasted by the Earth and Ocean Sciences building." - Interviewee 2*

6 *"In terms of the energy systems, I think that [the mechanical designer's] ... collaboration with [the project champion] and his... driving this innovation was really fundamental, because... [there was] a bit of resistance to doing this unconventional design" - Interviewee 5*

7 *"...so for example one of the goals was to be net zero energy or net zero carbon. So a lot of the energy systems related questions and any changes for that, the question was always, 'OK, if we make this change, how are we doing with the energy balance?' That was always a question that came up. So, I would say having those aggressive targets in the beginning was fundamental to drive some of the decisions and certain direction." - Interviewee 5*

DESIGN CHALLENGES

MISSED OPPORTUNITIES

Through conversations and interviews with individuals involved in the design process, several missed opportunities have been raised, suggesting some items to consider for future innovative building projects. The missed opportunities can be categorized into three types: structural-related, design process-related, and data-related.

Structural-related

Structural-related 'missed opportunities' have been found since CIRS has been occupied and operational. Structural related issues are those that may have been avoided through design considerations but which progressed past the design phase such that they became unable to be resolved without significant changes to the structure or operation of the building. An example of this includes the missed opportunity to recover waste heat from the solar hot water system, and a missed opportunity to increase the effectiveness of heat transfer between CIRS and EOS.

Heat recovery from solar collectors

Two interviewees suggested that although there were several structural-related opportunities missed in the project (for example, one cited the fact that the rooftop garden is not openly accessible to the public due to health regulations, and that they would work towards fixing this), a main energy-related item was the fact that they did not create a system to recover heat from the solar collectors (see quote 8 to the right).

Design Process-related

Design process-related opportunities missed were those opportunities which were mentioned by interviewees that related to how the design process was conducted and how undertaking different processes during the design process may have resulted in optimized design outcomes.

Conducting LCA earlier in the project

One interviewee mentioned that life cycle analysis was too often used as a retrospective, or confirmation, tool, and that it is most effective when it guides the design process. This interviewee suggested that LCA be used earlier on in future projects (see quote 9 to the right).

BIM from the start of the project

One of the interviewees mentioned that it would have been extremely useful to have used Building Information Modeling throughout the project from the beginning. This interviewee suggested that operations would be more efficient had CIRS used a BIM

QUOTES

8 *"...there are a ton of things that we didn't do that we should have done, and through oversight or whatever. The one I always remember [being mentioned] is the heat recovery from the solar collectors, right, I mean just an obvious thing that just got somehow missed." - Interviewee 1*

9 *"I mean, a little bit more time at the front end to get the environmental consultants on board, so you know, whoever is involved with the architects, engineers, the people that are going to be involved with the energy modeling and the environment impact modeling, if they could be brought in really early, I think that's useful. What seems to happen quite a bit is that the design just steams ahead, and decisions are made with sort of intuition and just experts opinion from the primary consultants. Which is fine, I mean these people have years of experience and its just fine, but some of it feels like life cycle approaches are a bit of a retro activity, just to confirm some of the decisions made with green features." - Interviewee 6*

MISSED OPPORTUNITIES

from the start of the project (see quote 10 to the right).

Data-related

Data-related opportunities for improvement were those opportunities mentioned by the interviewees that related to how information and data were shared during the project.

The use of a more efficient document sharing program

One interviewee mentioned that the document sharing program used (Buzzsaw) was inaccessible and disorganized, which yielded difficulties when it came to deadlines or other times when a certain file was immediately needed. This interviewee suggested that a more intuitive program with an administrator would be a useful addition to future projects (see quote 11 to the right).

Better integrated energy/BIM models

One of the interviewees mentioned that a goal for BIM and energy modeling should be to have better integration between these and other models such as mechanical, structural and electrical. They suggested that if there was a way that all of the information could be compatible and stored in one place, the benefits of efficiency of design would be considerable (see quote 4 on page 16).

Why were these opportunities missed?

The structural-related opportunities that were missed with regard to the energy system seem to have occurred simply through oversight. Interviewees described how, in retrospect, having a heat recovery system on the solar collectors seems obvious, but that it was a system that was not considered or brought up during the design process.

The missed opportunities with regard to energy modeling, BIM and LCA seem to have occurred due to a lack of awareness of their importance or utility during the project. While energy modeling and LCA were used (and therefore there was a budget for them), according to those involved they were not always incorporated or used at the most opportune time in the project. This suggests that there was a lack of awareness concerning when these analyses should be undertaken within the project timeline. BIM, on the other hand, was incorporated at the beginning of the CIRS project, but then was abandoned due to a lack of knowledge and familiarity of BIM on behalf of the contracted teams.

It is important to note these missed opportunities and the reasons behind them

QUOTES

10 *"...if I had the opportunity to do a project like this again I would do 100% BIM...from the get-go. With the right protocols and the right tools and then make sure that all the design information is embedded as intelligent objects in the design fields themselves so that when it gets time to operate the asset, your facility, you have something really useful for your operators to follow." - Interviewee 2*

11 *"...I didn't find [Buzzsaw] super intuitive. So maybe it was the way it was structured, I'm not sure. But yes, that is another useful tool, I think, in terms of sharing information, but there has to be someone that takes the lead on organizing it and making sure, like basically pushing the designers to actually do the uploads and share the information." - Interviewee 5*

MISSED OPPORTUNITIES

so that future projects are aware of potential scenarios which may arise that would lead to similar missed opportunities. Some of these missed opportunities are relatively easy to look out for in future projects (such as the heat recovery from the solar collectors), while others will require extensive research and effort in order to improve upon (such as better integration of energy and BIM models).

HOW CIRS CASE CAN INFORM FUTURE IDEASS PROJECTS

FUTURE PROJECTS

Decision-making Venues

All of the interviewees spoke to how vital the IDP was to making CIRS the innovative project that it became. All spoke to the importance of the multiple charrettes and having all of the stakeholders 'at the table' as being extremely important in identifying opportunities for synergies in the design.

Also, none of the interviewees mentioned that there were significant challenges with regard to communication or decision-making. While some mentioned that there were some minor disagreements throughout the design process, they were quick to state that all of these disagreements were overcome through dialogue. It is possible, however, that these interviewees exhibited selective memory to a certain extent with regard to these challenges and instead focused on the successes of the project during the interviews.

This finding suggests that the use of an IDP is desirable in future projects, but that strategies for overcoming communication challenges may need to be explored further, and at the beginning of the IDP, in order for the process to be more effective.

Decision-making Leaders

There was not an explicitly agreed upon decision-making process for CIRS. While decision-making actors (consultants and others involved in the process that were not project leads) were involved in these decisions and input from other stakeholders was considered, the decision-making leaders (those individuals who had final say) tended to have more power in the decision-making process.

This is not atypical of high-profile, innovative projects and should be expected as IDEASS becomes involved in future projects. It also suggests that the presence of a non-partisan facilitator could potentially benefit such projects, so that the facilitator would not be at risk of forcing decisions due to the fact that they have a stake in the process.

Decision-making Criteria

Throughout the interviews conducted on the CIRS design process, the theme of goal setting and the narrative of going 'beyond' sustainability was consistently linked to the project's success. This finding has interesting implications for future project work in that it indicates the importance of creating an overall project vision with multiple stakeholders early on in the design process.

Data sources

Several of the missed opportunities had to do with data integration, storage, and organization, and these missed opportunities confirm the importance of the mandate for IDEASS to improve data integration. Follow-up interviews with energy modelers, and those who were involved with the BIM or LCA for CIRS may provide more direction in terms of how best to approach this question.

APPENDICES

APPENDIX 1 - INTERVIEW QUESTIONS USED

Interview questions used in data acquisition phase of project.

1. How were you involved in the decision making process for the energy systems (heat exchange with EOS, PC and solar thermal, GSHP) for CIRS?
2. How was the decision made to move ahead with this system?
    a. Who were the leaders in making this decision?
    b. What was the decision-making process used (e.g. was it consensus, value focused thinking, voting, cost benefit analysis, etc.)?
    c. Were criteria formed and used to make these good decisions?
    d. In what setting was the decision made (i.e., charrette, meeting, out of office conversation)?
    e. What data was used to support the decision?
    f. Were competing options considered?
    g. How did you know if you made the right decision?
    h. In your opinion, should additional people have been involved or contributed to making the decision?
3. Relative to other systems or energy systems in other projects how much time/effort would you say was spent making this decision?
4. Was information technology was used in making any decisions? (Buzzsaw?)
    a. How were they used?
    b. How could you imagine using information technology to help make these kinds of decisions in the future?
5. The decision to look beyond the scale of the individual building was an important one for CIRS in terms of becoming net-positive on energy. How would you apply this thinking to future projects?

Integrated Design Process questions

6. How did the IDP impact the team's ability to make decisions with regard to the energy systems?
7. What strategies were employed in the IDP in order to foster good communication amongst stakeholders?
8. Did you experience or witness any difficulties with regard to communication as a result of following an IDP? If so, what was the problem?
9. How would you apply some of the successes of CIRS' decision-making processes to another project?

Regenerative Design questions

10. Beyond the 7 principles, in what ways is CIRS a regenerative building?
11. In what ways did the goal of being a regenerative building influence the decision-making process?
12. Looking back, are there ways that you could have made CIRS more regenerative?
    a. How would you apply this to future projects?

APPENDIX 2 - DOCUMENTS USED

List of documents accessed and used in writing of report (note that important documents are in the dropbox file and can be accessed by the research team).

Technical Drawings and Models:
BPW CIRS Architectural Drawings August 2005
Development Permit Space Program Summary May 2006
CIRS 'Final' Space Program June 2006
CIRS Scoping Document for Development Application for GNW May 2006
CIRS Architectural Drawings (IFC 2009, Oct 16)
CIRS CIVIL Drawings
CIRS Electrical Drawings
CIRS Landscape
CIRS Mechanical Drawings
CIRS Specifications
CIRS Structural
IFC Electrical & Mechanical Specifications & Drawings (10/09)
CIRS IFC Floor Plans October 2009
CIRS Monitoring Network Control Points
CIRS Presentation Boards
BIM Model
CIRS functional program organized by space type June 2009

Meeting Minutes and Appendices:

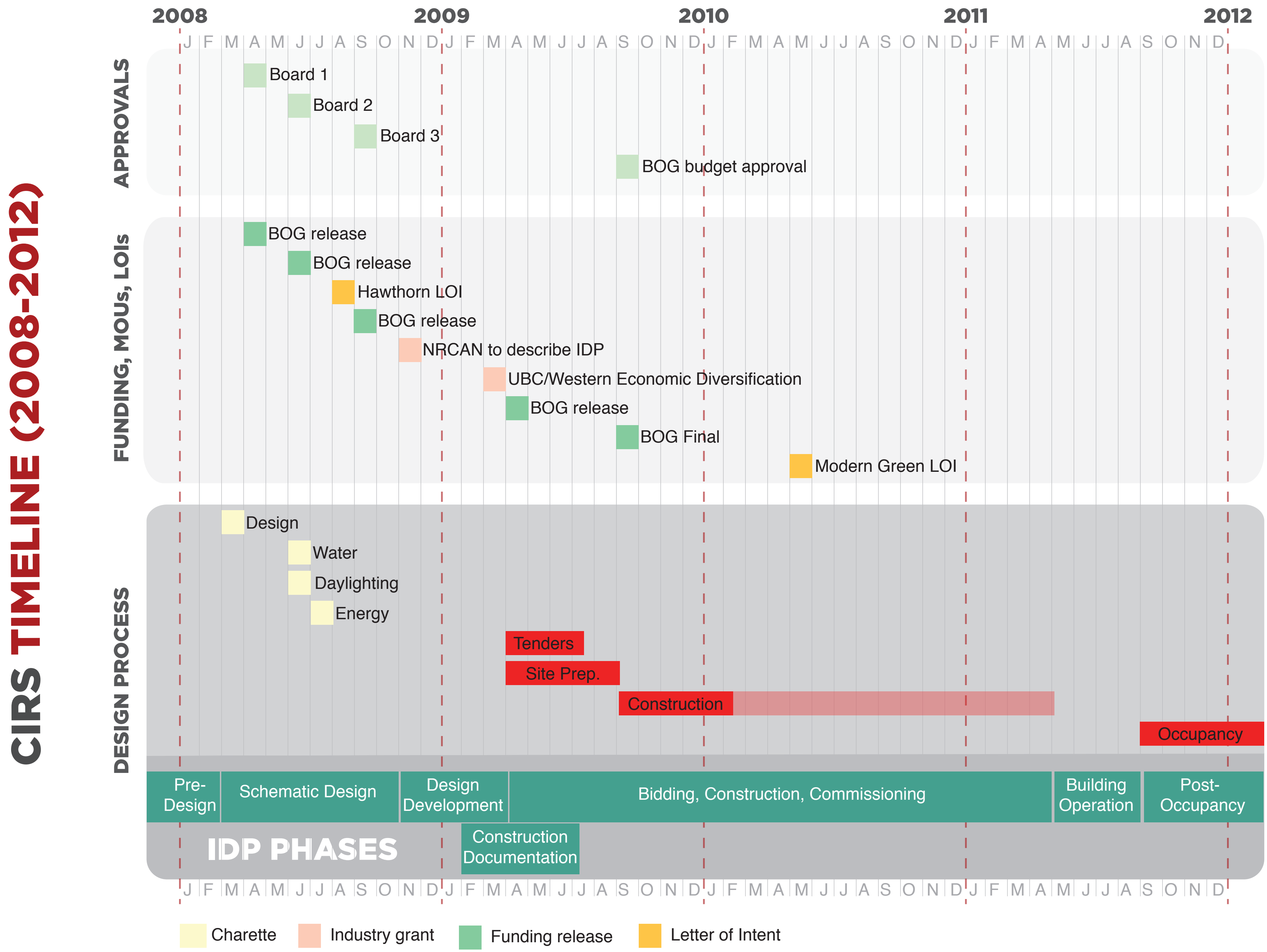
Consultants Meeting Minutes (5/1/08, 5/7/08, 5/14/08, 5/21/08, 6/11/08, 9/10/08, 3/4/09)
CIRS Site Meeting Minutes #10 (3/4/10)
Board Approvals (Board 1 Revised Approval 4/10/08, Board 2 Approval 6/6/08, Board 3 Conditional Approval 9/25/08) 7
CIRS Agenda and Minutes (24 September 2008 to 8 April 2009)
BOG 5 April 2011 Open Minutes (Lease of CIRS space to BCHydro)
BOG CIRS Final Funding Release BOG 9/24/09
Board of Governors Capital Projects Update 6/3/09)
UBC 2010/2011 Board Budget Presentation

Charrettes:
Design (03/08)
Water (06/08)
Daylighting (06/08)
Energy Modeling (07/08)

Funding, MOUs and LOIs:
Funding Proposal to Canada Foundation for Innovation May 2003
Funding Proposal for Sustainable Development Technology Canada June 2004
MOU between UBC and BC Hydro April 2005
LOI between Honeywell and UBC November 2007
Sustainable Development Technology Canada Contribution Agreement December 2007
Sustainable Development Technology Canada Agreement Draft September 2007
CIRS – Hawthorn LOI August 2008
Proposal to Western Economic Diversification August 2008
Funding agreement between UBC and Western Economic Diversification March 2009
LOI between Modern Green and UBC May 2010
(Note that some of these documents are not able to be public and will have to remain confidential to the group)

Other:
CIRS IDP Report (12/27/08)
IDEAS Meeting (1/24/12)
BIM Guide Series Faculty Management
NSERC Case Mockup
CIRS Case Info Scope
CIRS Timeline
Goals Summary bubble diagram May 2008
CIRS Sustainability Goals Design Matrix November 2005
CIRS Goals Summary May 2008
John Robinsons CIRS Short Presentation September 2009 (Timelines)
Cayuela CIRS Monitoring Network Talk
CIRS LEED Canada NC Scorecard (draft)

APPENDIX 3 - CIRS TIMELINE



APPENDIX 4 - 22 GOALS FOR CIRS

The original 22 goals for CIRS (from Appendix B of CIRS IDP Report, December 27, 2008).

1. The building will be designed using 3D virtual design technologies.
2. A life cycle assessment will be conducted on the whole building design.
3. Neutralize ecological impact on site by increasing the net positive biomass and oxygen provided on-site, and eliminating runoff from the site.
4. Maximize sustainable contributions to the local community.
5. CIRS will supply all building energy requirements from on-site sustainable and renewable energy sources, become a net annual power generator, and will be Greenhouse Gas neutral.
6. CIRS will be designed to be as passive and simple as possible, and demonstrate that all strategies to have the lowest possible energy requirements.
7. CIRS will integrate daylight systems that provide 100% of the illumination required through the building during the day to minimize lighting power consumption at other times.
8. 100% of potable water requirements will be met with on-site collected rainwater.
9. All wastewater will be collected and treated on-site or within the 'sustainability precinct'.
10. 100% of stormwater will be controlled, disposed of, reused and discharged on-site.
11. Minimize resource consumption and GHG impact of building construction by maximizing the life, flexibility, and recycling potential of the building. Target 50% of typical building ecological footprint & GHG profile of construction.
12. Eliminate solid and food waste leaving the site.
13. Maximize hours of operations and density of use.
14. CIRS workspaces will be 100% daylit.
15. The building will provide the purest possible indoor air quality, and where needed, provide for user control over comfort conditions.
16. The building will oxygenate indoor and exterior environments O2 >= CO2 on an annual basis.
17. Provide for healthy bodies and mind in design of workspace.
18. The building will seamlessly integrate the design and ongoing operations.
19. Utilize the building and resources in partnership with manufacturers and authorities to advance knowledge of sustainable design strategies.
20. CIRS will bave be a living lab for building researchers and software companies to test predictive software for : thermal mass, ventilation models, IAQ and daylighting effectiveness.
21. Minimize external and community environmental impacts of CIRS's staff and visitors.
22. CIRS will disseminate sustainable design practices, knowledge and experience as widely as possible.

APPENDIX 5 - ENERGY MODELING TIMELINE

(FROM SODERLUND BC HYDRO PRESENTATION, 2010)