New Expectations in Delivering Sustainable Buildings

From occupant to inhabitant

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ABSTRACT: This paper examines a shift from viewing building 'occupants' as passive recipients of pre-determined comfort conditions to 'inhabitants' who may play an active role in the maintenance and performance of their buildings. These are examined using the three major principles that frame the design of the UBC Center for Interactive Research on Sustainability (CIRS) currently under construction - the desire to be Green, Humane and Smart. Moving beyond the proposed reframing of comfort and comfort provisioning, the paper explores the potential ways and extent that these guiding principles and goals have shaped the physical design of CIRS but also have substantially influenced the building process, the social and economic context of CIRS and UBC and moved all those involved in the CIRS process from being occupants of yet another building project to being inhabitants of a regenerative innovation for sustainability.

INTRODUCTION

Conventional approaches to comfort assume that 'occupants' are passive recipients of indoor conditions that are maintained within narrowly defined margins by automated, centralized systems. Building performance in conventional buildings is often invisible to the end-user who in turn is given little opportunity to control or provide feedback on their experience of the indoor environment.

Sustainable buildings aspire to far superior environmental performance compared to their conventional counterparts, many relying on natural conditioning (e.g., thermal mass, passive solar heating, natural ventilation, daylighting) to meet comfort needs of users. Interior conditions are more closely linked to daily and seasonal variations in conditions outside, and building inhabitants are more directly involved with building systems and operation by opening and closing windows, blinds, switches and other accessible manual controls. The indoor environment can be considered a creative achievement shaped by the interaction of building inhabitants with control systems in response to changing external conditions and the changing needs of inhabitants. This process has been described as "interactive adaptivity" [1] and refers to the ongoing, bi-directional dialogue between building and users in which the outcome is not predetermined by building design parameters or performance metrics, but is rather an evolving practice that takes into account dynamic and participatory aspects of building occupancy. Here building inhabitants (as opposed to occupants) play an active role in the maintenance and performance of their buildings.

The extent to which shifting from the notion of 'occupant' to 'inhabitant' shapes the design and delivery of sustainable building becomes a focal point for this paper, examined through the lens of the Center for Interactive Research on Sustainability (CIRS) project.

From the outset, the design of CIRS—anticipated to be completed by late 2010—has been guided by the desire to be Green, Humane and Smart. These overarching notions have defined a set of specific performance goals. This paper will explore the potential ways and extent that these guiding principles and goals have shaped the design of CIRS and the subsequent direct and indirect consequences for the anticipated building inhabitants. Moreover, since CIRS aims to be highly replicable, the paper will identify the extent to which these approaches are different from conventional practice and transferable to other situations and building projects. Although the CIRS program extends beyond sustainable building technologies and practices, this paper focuses on the building design and implementation.

CENTER FOR INTERACTIVE RESEARCH ON SUSTAINABILITY (CIRS)

The Center for Interactive Research on Sustainability (CIRS) is striving to be North America's most sustainable building, including net-positive water and energy consumption, and zero carbon. Located at the University of British Columbia Point Grey campus in Vancouver, B.C., the building is designed to be a living laboratory of sustainability, with continuous research on building systems integration and inhabitant interaction to occur over the lifetime of the building.

CIRS is a multi-institutional initiative bridging four academic institutions and numerous industry partners [2]. Inhabitants will range from UBC's Vice President Research Office to the School of Architecture and Landscape Architecture's Design Centre for Sustainability to UBC's Office of Sustainability. The array of inhabitants requires a breadth of services and accommodating design elements to meet the diverse needs of its inhabitants.

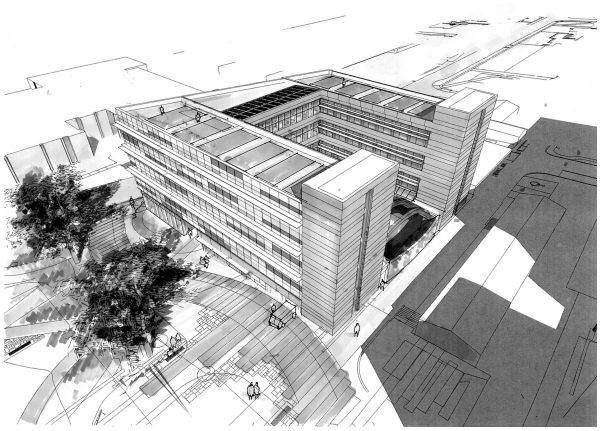

Figure 1: CIRS - Ariel view (Busby Perkins & Will)

To meet the CIRS vision and agenda, the building itself will be used as a research laboratory for operations, monitoring and assessment of energy and water use, daylight harvesting, indoor environmental quality and inhabitant behavior. The design process includes active participation of the user community, including researchers as well as public and private sector partners. The CIRS progressive regenerative process stands as an example of an explicit recognition of the need to engage social and behavioral dimensions of comfort, as well as the potential for improved dialogue and communication to improve building performance.

Not every goal for CIRS may be achievable with present technologies at reasonable cost on opening day. But the CIRS facility is not 'finished' the day it opens; it is designed for change over time, adopting and adapting new technologies. The overall goal is continuous improvement over time in human and environmental conditions.

CIRS as 'Green'

Moving beyond providing a building that is "less bad" than conventional practice, CIRS goals are to have a positive impact on both the local and global environment, while living within, and contributing to, the biophysical flows available on its own site. The specific Green goals for CIRS are:

1. Design with time in mind:

- *Climate Change:* Heating, cooling and water systems are designed to adapt to anticipated changes in climate over the next 100 years.
- *Life Cycle Analysis:* Building structure and systems are to be evaluated and designed over a time frame of 100 years.

2. Zero materials waste:

- Design for assembly, modification, and disassembly.
- Avoid toxic materials.
- Materials choices informed by life-cycle analysis of environmental impact, including embodied energy and greenhouse gas emissions—minimize CO_2 emissions associated with construction.
- Design a materials-handling strategy for supplies and components entering the building over their life that seeks to eliminate solid waste going to landfills.
- Process all liquid 'waste' into pure water and useful feed-stocks.

3. Energy use has a net positive impact on ecological health

- CIRS facility will reduce the *overall* UBC campus energy use.
- Direct energy consumption target: 75 kWh/m^2/yr overall, 15kWh/m^2/yr for heating).
- Building operation should be greenhouse gas neutral.
- Efforts will be made to balance the scale and quality of the energy used with that required for the task.
- All energy used in the building should come from clean and renewable or scavenged energy sources.

4. ecological health

- The facility should be able to live on the budget of the rain falling on its site.
- Efforts will be made to balance the quality of the water with that required for the task.
- Water leaving the site should be as good or better quality than when it arrived.

- Site design should provide a net positive impact to the ecological health of the surroundings.
- Net increase of biomass on site.
- Zero net runoff from site.

Many of these demanding performance requirements, while context dependent, extend beyond the footprint of the building to embrace the larger campus. The consequences of the Green goals and strategies on building inhabitants are captured in the following "Humane" and "Smart" sections.

CIRS as 'Humane'

CIRS aims to provide a socially and biophysically healthy environment for human habitation which adapts to changing needs and uses over time, and which contributes to a continuous improvement in the health, productivity and happiness of building inhabitants. Specific goals include:

1. Ongoing assessment of inhabitant comfort

- On an ongoing basis, assess the interaction between the environment provided by the building and the health, productivity, and happiness of those who work and visit it.

2. Outstanding IEQ

- Provide a comfortable, healthy environment for inhabitants, under local control to adapt to individual differences and differing activities:
  - Air that meets or exceeds outdoor air quality.
  - Light levels and quality appropriate to tasks, with the option of relying on natural light whenever available and appropriate to the task.
  - Provide for acoustic separation and privacy.
  - Provide areas for the preparation and sharing of food: deal with food human waste in ways that recognize them as an environmental opportunity

3. Connections within and beyond

- Provide opportunities for inhabitants to connect with each other and the world
  - Connect to the natural world: views to living things, breezes.
  - Connect to others in the facility: promote informal meetings and interactions.
  - Connect to the campus and world: be permeable to campus pathways to invite people to pass through parts of the facility and share food and ideas:
    - on site café (emphasizing 100-mile diet options when available).
    - conference, teaching centre, walk-through accessible.

The physical form of CIRS has been profoundly shaped by these humane concerns:

- Narrowed floor plates ensure that all workspaces are daylit.
- A pleasant view of the green roof of the atrium is visible from office and lab spaces on upper floors.
- Inhabitants have access to ventilation, lighting and temperature controls.
- A breezeway cuts through the lobby and atrium, providing a covered pedestrian walkway and promoting public access.
- A café located on the entrance level will engage the campus community and disperse the sustainability values of CIRS while providing an interaction hub for building inhabitants.
- A 60-seat auditorium will present visualizations of regions and communities in future climate scenarios, drawing the public to CIRS and to UBC campus in the interest of sustainability research.
- 1,000 monitoring points inside the building will consistently monitor and assess how the building is meeting inhabitant needs and comfort standards.
- The innovative strategies will be visible, accessible and understandable to inhabitants and visitors.

In addition to the wide-reaching humane goals noted above, every person working in CIRS will sign a Sustainability Charter. Signing the charter commits the building inhabitant to positively contributing to the success of the regenerative building process through their actions and choices. In return for their commitment and behavior, the charter assures inhabitants individual control of ventilation at their work stations, access to real-time feedback and monitoring of the building's technical systems and performance (including the opportunity to express preferences about operating conditions), improved air quality, and access to natural light. Inhabitants will thus play a crucial role in the success of the building and its community while enjoying the benefits of a humane workplace that optimizes inhabitant comfort and productivity.

CIRS as 'Smart'

CIRS seeks to integrate building performance with the performance of inhabitants in an ongoing interactive dialogue intended to improve the green and humane features of CIRS over time. The CIRS building process will apply design intelligence augmented with monitoring and feedback to engage building inhabitants to get the most out of the available energy and material

flows afforded by the site and its surroundings. 'Smart' is defined in terms of four key attributes: adaptive, responsive, effective and economical.

Feedback is considered key to ensuring the building systems and inhabitants are responsive and adaptive to changing internal and external conditions and needs. Detailed, ongoing monitoring will be instrumental in meeting the 'living lab' vision and research agenda for the building, allowing for the assessment of existing and future building systems and technologies.

CIRS will develop approaches towards constructing, operating and maintaining the building and meeting human needs at the lowest life-cycle costs, providing solutions that can be economically replicated and adapted into buildings worldwide. The Smart goals for CIRS include:

1. *Provide instrumentation and controls to allow feedback and learning*

- The building should learn from its inhabitants.
- Deliver comfort where and when it's needed.
- The inhabitants should learn from the building.
- Provide feedback to building operations staff for identifying systems performing poorly.
- Provide feedback to inhabitants as to how their behavior affects energy, water, and material use.
- Allow building inhabitants to express preferences for building operating conditions and procedures

2. Produce a core building that exemplifies replicable, economical solutions

- Make design and operation choices based on the lowest life-cycle costs.
- Allow for experimentation with approaches that may not yet be cost-effective.

Elements of the Smart goals for CIRS which have had a direct expression on building design process and form include:

- Inputs from UBC campus stakeholders led to insights into potential synergies with neighboring buildings, existing campus policies, infrastructure constraints and future growth plans for CIRS and for the UBC campus.
- Detailed, ongoing monitoring to:
  - Understand the energy and water flows through and within CIRS, both from quantitative and qualitative standpoints.
  - Understand the interaction of building inhabitants with the range of advanced green strategies and technologies.
  - Understand the impact of immediate and distant contexts on energy and water flows, e.g., heat exchange with a neighboring laboratory building.
  - Compare between building design and actual performance, and feedback on the operational performance of individual and collective systems and technologies.
- The use of a 'biofilter' approach to water treatment based on the compelling nature of the biofilter as an educational tool.
- A daylighting system that establishes a hierarchy of control over shading devices to accommodate inhabitants and different program uses.

Smart attributes of CIRS will have direct and indirect consequences for anticipated building inhabitants, particularly in the ways that inhabitants engage with adaptive opportunities provided to them and received feedback on their actions.

REPLICABILITY

From the outset, CIRS was intended to be replicable in other contexts and jurisdictions, and to contribute to commercialization and market transformation processes aimed at the widespread adoption of sustainable technologies and practices. The focus of CIRS on creating a process that expresses the green, humane and smart goals meant that the process through which CIRS has been proposed, designed, funded and approved has not been typical. A number of lessons can be drawn from this experience [2].

Every aspect of the CIRS vision—the inter-institutional academic partnerships, the nature of the relationship with non-academic partners, the governance structure, the sustainability goals for the building process, the building design process, obtaining funding for the building and program, negotiating the divide between capital and operating costs and revenues—involved going beyond standard operating procedures for UBC and other partners. The main challenges in achieving the CIRS vision can be divided into five categories:

1. Path Dependence: CIRS did not fit the existing institutional pathways for creating buildings and academic programs at UBC, which were well-established and contained many steps and requirements. For example, there were multiple offices at UBC with full or partial veto power over different aspects of CIRS, none of which had responsibility for making CIRS happen. This led to an almost continuous process of articulating and confirming new goals, and the renegotiation of roles and responsibilities, which in turn meant that virtually every aspect of the implementation

process had to be created from scratch. In effect new paths had to be created.

2. Coordination: Because of the inter-institutional and inter-sectoral nature of CIRS, responsibility for many aspects of the process was distributed among many different departments and offices, which were often not used to coordinating decisions. As such much time was spent in building communication bridges, and demonstrating that the success of CIRS also contributed to the specific goals of each decision-maker and partner organization.

3. Momentum: The perceived implausibility of CIRS meant that its success did not seem to be an obvious outcome to many decision makers and stakeholders. It was critical to instill a sense of forward momentum by securing 'anchor' partners and funding early on, and then to show concrete progress on a continuous basis through frequent updates and continuous follow-up.

4. Partnerships and Team-building: The inter-institutional and inter-sectoral nature of CIRS' partnerships and the range of researchers, designers, consultants, etc., involved in the project have been both the greatest strength and also the greatest vulnerability of CIRS. Mobilization of the various partners has required the development of new partnership models, based on mutual benefit and synergy of goals.

5. The Role of the University: Universities have not typically seen themselves as initiators of social change and partner commercialization. In addition, disciplinary silos and strong separation of the academic and operational roles of the university militate against the kind of integrated approach adopted by CIRS. Our response was to promote the idea of the university as an active agent of sustainability in the community, to develop forms of governance based on collaboration, and to search for ways these new roles would reflect creditably on the university.

Addressing the above issues gave rise to a fundamental insight: the barriers to creating CIRS have never been technological and, despite the fact that they were almost always expressed in economic language, they have not, in the end, been economic. In every case the real barriers turned out to be institutional: challenging the standard rules of the game involved in funding, financing and constructing academic buildings, creating and funding new research programs, setting up governance systems, and creating new forms of partnerships with other academic and non-academic partners.

The degree and scope of changes required to make CIRS happen have required a fundamental rethinking of the goals of the institution and the roles of the various actors and decision-makers. What has been required for university administrators, researchers, designers, and CIRS partners alike is an acceptance of these new goals and a corresponding reconfiguration of the rules that govern the implementation of buildings and programs on campus. This reconfiguration has required actors to take a more active and adaptive stance in articulating new roles, responsibilities and rules for themselves to create CIRS. Instead of simply responding to academic needs and government funding opportunities, university administrators have taken an active role in articulating and approving a new vision for how research can be combined with partnerships with private, public and NGO sectors. Instead of undertaking a conventional design process, CIRS has needed a strong form of the integrated design process, requiring consultants and researchers from different disciplines to work together throughout the design process. [3] In face of all the changes, challenges and remaining uncertainties, one of the most impressive aspects of CIRS is that it has been possible to follow through with the project *while keeping the goals intact*.

DISCUSSION AND CONCLUSIONS

The most significant conclusion emerging from this exploration of the CIRS goals and implementation process is the need to shift from a notion of 'occupant' to 'inhabitant' in a broader way than initially envisaged. The shift from 'occupant' to 'inhabitant', originally applied to those who would work within CIRS, must also go beyond the physical building, among the community of actors involved in its funding, design, implementation and eventually operation. In general terms, this represents a shift from a more passive role of accepting as given the conventional manner of doing things to a more interactive process of engagement and adaptation where the rules of the game are in part created through such interactions.

The concept of 'inhabitant' connotes an active process of engagement with the systems that make up CIRS, in this case the other partners and the institutional rules and procedures that govern the creation of buildings and establishment of programs at a university, in a process of mutual accommodation and ongoing adaptation. This suggests that the shift from occupant to inhabitant can be expanded to the process of creating a sustainable building of this kind and its accompanying research program and partnerships. Metaphorically, the shift from passive occupant to engaged inhabitant has in fact been experienced as a transformation by the stakeholders, partners, and institutions involved in the conception, design, construction and implementation of CIRS as they began to realize and fulfill their critical role in the integrated design process.

CIRS is designed to interact constructively with surrounding buildings on UBC campus contributing a net positive impact on the ecological health of the campus and acting effectively as a sustainability beacon on campus that signals a pro-sustainability transformation for the university as a whole. In this way, CIRS is no mere occupant of its site; it is an active inhabitant working to improve the ecologic, economic, and social life of UBC and CIRS industry partners and stakeholders.

The shift is evident in the larger process of campus planning in which CIRS has become enmeshed. Partly as a result of the discussions engendered by CIRS' plans to scavenge heat from a neighbouring building, and partly because of a strong tradition of sustainability analysis and planning that has been established at UBC over the past decade, UBC has adopted an approach to campus planning that envisions the whole campus as a test-bed for sustainable energy and water systems. In a recently issued Request for Proposals, UBC stated that:
UBC's long-term goal is to showcase the Vancouver campus as the world's first net positive energy and water campus. An effective, integrated energy and water plan will be critical to success in that venture. [4]

A goal to convert the 269 core buildings of the UBC Vancouver campus to net positive energy and water status is truly transformational, offering huge potential for innovative design, planning, research, teaching and implementation. Such a commitment, if followed through, would require and truly reflect a shift from being a passive occupant of the campus lands to being an engaged and aware inhabitant of the ecological and social systems on campus.

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