BUILDING SCIENCE ROUNDTABLE SPRING 2015

SHAPING THE FUTURE OF BUILDING IN ONTARIO

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Building Science Roundtable 2015: Shaping the Future of Building in Ontario

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ROUNDTABLE PANELISTS

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Report prepared by Building Science Consulting Inc.

EXECUTIVE SUMMARY

The Building Science Roundtable was initiated by a group of concerned building science educators from the University of Waterloo, the University of Toronto, George Brown College and Ryerson University. Why the concern? As our cities change and grow, needs and expectations grow with them. Even now, the demands on buildings are different than in the past. There is a strong need to meet reasonable standards for energy efficiency, durability, and comfort; there are also more design options than ever before to understand and choose between. Anticipated growth will exacerbate this situation, with Ontario's population projected to grow by over 4.2 million over the next 28 years[1]. Thousands of commercial, industrial and institutional buildings, along with hundreds of thousands of housing units will be newly constructed and/or substantially retrofitted over the next quarter century. If we are going to meet changing expectations and demand for growth, we need to take steps to be prepared. The necessary transformation will take time – the time to start is now.

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[1] *Ontario Population Projections Based on the 2011 Census*, Ontario Ministry of Finance, Fall 2014. http://www.fin.gov.on.ca/en/economy/demographics/projections/projections 2013-2041.pdf

Building science is directly relevant to addressing these issues. The building science community, speaking with one voice, can have a significant impact on our cities' future. The Building Science Roundtable is a first step in developing that shared voice.

The Roundtable Process

The first Roundtable proceeded through three stages. First, a small "think tank" group of roundtable panelists was formed, including the founding organizers as well as several industry representatives. Each panelist produced a brief position paper about significant challenges and potential solutions for managing the built environment in the GTA and beyond (see appendix).

The second stage was to meet to explore and expand on the issues identified in the position papers. The panelists convened on April 30th, 2015. Summary notes were prepared to share with the plenary audience (page 10).

The building science roundtable process is intended to bring together leading experts to engage themes and issues that the larger building industry community has deemed significant.

Thirdly, a plenary was held to bring together leaders within the local building science community and the wider building industry. Over 50 participants attended the plenary session, including prominent academics, association board members, municipal government staff, management and building science specialists from within construction companies, and principals from architecture, engineering, and building science consulting firms.

This report is based on the panelists' position papers, notes made during the roundtable and plenary sessions, and input received by email. The intention is to share the report and seek additional feedback, which will help to focus subsequent roundtable events.

Emerging Themes

Collectively, the building science community in the GTA comprises internationally recognized experts in the design, procurement, construction, commissioning, operation, maintenance, retrofit and rehabilitation of buildings. This expertise needs to grow and to be effectively utilized. However, building scientists are only "one piece of the puzzle." Through dialogue between a variety of stakeholders, the Roundtable process aims to facilitate connections, encourage cooperation, and ultimately support coordinated, effective action.

Values and Quality. Roundtable panelists and plenary participants stressed that quality is an important issue underlying many other challenges. There is an urgent need to develop a shared culture of quality, so that stakeholders have a common understanding of what is important and how to measure it. Quantifiable performance measures encourage effective communication, allow rational evaluation of design, and provide a fair basis for regulation. Measures should be included for durability, energy efficiency, and occupant comfort. More broadly, participants noted the importance of attention to detail and taking care in building design and construction; one participant described this as "value engineering in a true sense". The roundtable panelists noted that there are many people in the industry today who are interested in improving building performance; however, motivation and good intentions are frequently eroded by financial disincentives and lack of knowledge.

Effective Feedback and Adaptation Loops. Roundtable panelists identified a strong need for more effective data-gathering mechanisms and knowledge transfer. Currently, information is not openly shared about either building failures or systems that work. The industry could avoid many costly mistakes by creating effective feedback loops, so that lessons learned from past projects could influence current practice. If there is a failure, enough information about it should be easily available to prevent the same design being used again. There is also a need for improved feedback loops between research and practice.

Regulation. Panelists and plenary participants expressed concern that there is a great deal of activity in retrofits and renovations without adequate guidance from the codes. Examples were given where codes and regulations have successfully brought about change. Several people with experience in code development noted the need for building science experts to become more involved. However, it was also pointed out that there is a lack of basic data to assist in planning and recommending specific changes. For example, we currently do not have an inventory of the building stock in a given area (including types of buildings, age of buildings, retrofit status, etc.). As well, codes are not always well-understood, and enforcement is underfunded.

Training & Education. There was a broad consensus that improved education and training are necessary to ensure that we have enough people with the right knowledge and skills to design, construct, commission, operate and maintain buildings properly. Roundtable panelists and plenary participants described a change in architectural training in particular, with reduced and wholly inadequate attention paid to technical skills and building science. Some participants suggested that it may be appropriate to add "building scientist" as a standard specialist on most projects. Even if building science specialists are included on a project, however, architects will still need a basic level of building science expertise, as will other building professionals (tradespeople, building code officials, building operators). There needs to be a common language and understanding of the building-as-a-system approach. Education is also needed for stakeholders such as real estate agents, developers, and the general public, in order to allow informed decision-making and create market conditions that support better building practices.

Practice and Procurement Models. Practice models and procurement models can also act as structural barriers to achieving better performance. Some panelists noted a tendency to constantly re-invent the wheel, bringing in consultants and sub-contractors on a project-by-project basis; it was felt that this reduces long-term efficiency, information-sharing, and accountability. Another issue with current practice models is the ineffective recycling of project information. Panelists described how building components are often designed and specified based on successful prior use, without adequate consideration of current project requirements (e.g., mis-sized HVAC systems). At the same time, several panelists noted that some components can and should be standardized. Participants also discussed shifts in the role of the architect and the need to develop the role of the building science specialist.

Summary & Outcomes

There are several definite outcomes from the Roundtable, as well as many possibilities for future action. Immediate outcomes include this report and a planned second Roundtable.

Report. The Building Science Roundtable Report, "Shaping the Future of Building in Ontario", is the first tangible outcome of the roundtable process. This report will be distributed to all invitees (including those who could not attend) and to other select decision-makers and media contacts.

Second Building Science Roundtable. A second Roundtable and Plenary is being planned for late October 2015. Consistent with the process to date, attendance will be primarily by invitation, with the goal of stimulating discussion among industry leaders and forming a plan for next steps. In order to move towards concrete action, discussion will centre on a single topic: meaningful building performance metrics and indicators. To broaden the conversation further, the second Roundtable and Plenary will be held in conjunction with a one-day conference that is open to a larger audience. The BUILD Ideas Toronto conference is being organized by Building Science Consulting Inc., Construction Specifications Canada (Toronto Chapter), the University of Toronto, Ryerson University, and the University of Waterloo. The second Roundtable plenary session will be held during the conference reception.

Looking towards the future, many ideas for positive action were proposed and discussed. Depending on the direction that the Roundtable group chooses to take, some of the following actions may be appropriate goals.

1. ***Improve building science education for both new and existing professionals.***
2. ***Enhance public awareness and consumer knowledge about the questionable quality and performance of new buildings, and more broadly about the value of science-based building practices.***

3. ***Compile, solidify and make widely accessible fundamental building science knowledge.***

4. ***Advocate for change to building codes and regulations to improve the actual performance of new and retrofit buildings.***

5. ***Support coalition-building and increasing the effectiveness of existing initiatives among industry players.***

As evidenced by the variety and breadth of these ideas, the first Building Science Roundtable provided a rich beginning for ongoing dialogue. The second Roundtable will begin to solidify the group's direction and move towards initial actions.

The organizers extend sincere appreciation to all involved and look forward to continuing this process. Building scientists approach each building as a system. The building industry is also a system, and we believe that building scientists can contribute a great deal to bringing about system-level change.

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PARTICIPANTS

The plenary session was attended by **over 50 leading members of the building science community and the wider building industry**. Participants included prominent academics, association board members, municipal government staff, management and building science specialists from within construction companies, and principals from architecture, engineering, and building science consulting firms.

Below is a partial list of attendees, providing a sense of the range of stakeholders involved.

***Alen Vrabec**, P.Eng., BSSO*	*Project Manager*	*Facilities Management, City of Toronto*
***Alex Lukachko,** M.Arch.*	*Senior Associate*	*Building Science Consulting Inc.*
Bill Stamatopoulos	*District Manager*	*Inspections, City of Toronto*
Craig England	*Associate Architect*	*Coolearth Architecture Inc./OAA*
Dave Andre	*Principal and Building Science Specialist*	*Morrison Hershfield*
***Ehab Naim Ibrahim**, MRAIC, BSSO, LEED AP*	*Building Science Consultant*	*WSP I Halsall*
***Ian Miller**, P.Eng., LEED AP*	*Branch Operations Director*	*Pretium Anderson Building Engineers*
	Director at Large	*OBEC*
***Jeremy Nixon**, P.Eng., BSSO*	*Managing Engineer*	*Brown & Beattie Ltd.*
	Director	*OBEC*
***Miljana Horvat**, M.Arch, Ph.D (Bldg.Eng.)*	*Associate Professor and Director, Graduate Program in Building Science*	*Department of Architectural Science, Ryerson University*
Paraic Lally	*North American Specifications Manager*	*Roxul Inc.*
Ronald Rivet	*Director, Tenant Coordination*	*Morguard Investments Ltd*
Rosemary Martin	*Vice President and Chief Sustainability Officer*	*FCR Management Services LP*
Scott Armstrong	*Manager – Building Performance*	*MMM Group Ltd.*

Scott Wylie	*Principal*	*Wytech Building Envelope Solutions Inc.*
Sonja Winkelmann	*Director*	*Net Zero Energy Housing, Canadian Home Builders' Association (CHBA)*
Stephen Pope	*Principal*	*S.F.Pope Sustainability Consulting*
Tad Putyra	*President & COO*	*Great Gulf Low-Rise*
	Chair	*Rescon*

The attendees listed above are representative of the larger group of over 50 participants.

BACKGROUND

The Building Science Roundtable was initiated by a group of building science educators from the University of Waterloo, the University of Toronto, George Brown College and Ryerson University. The founding committee was made up of academics who are also practicing consultants, and who had become concerned about the challenges facing the built environment – both in the GTA and more broadly across Ontario.

Why the concern? As our cities change and grow, needs and expectations grow with them. Even now, the demands on buildings are different than in the past. There is a strong need to meet reasonable standards for energy efficiency, durability, and comfort; there are also more design options than ever before to understand and choose between. Construction technology and building systems are becoming more complex and specialized. New materials and systems are constantly introduced to the market, but the necessary expertise is not in place to make effective choices. In many cases, innovation only leads to unnecessary complexity and higher failure risks compared to traditional building technology that observed the importance of producing durable goods with proven performance.

The primary goal of the Roundtable is to open a dialogue between different stakeholders about future needs and the role of building science in addressing these needs.

Anticipated growth will exacerbate this situation. According to census data, Ontario's population is projected to grow by over 4.2 million over the next 28 years, from an estimated 13.5 million in 2013 to almost 17.8 million by 2041. The Greater Toronto Area (GTA) is projected to be the fastest growing region of the province, with its population increasing by almost 3.0 million, or 45.8 per cent, by 2041.[2] Both new construction and existing building stock will be affected: thousands of commercial, industrial and institutional buildings, along with hundreds of thousands of housing units will be newly constructed and/or substantially retrofitted over the next quarter century.

If we are going to meet changing expectations and demand for growth, we need to take steps to be prepared. The challenges ahead will require changes to our education systems, skilled labour force, and industry regulations, each with their own processes and change cycles. The careers of educators, building professionals and skilled trades span decades and without periodic updating to keep pace with science and technology, the best available

[2] *Ontario Population Projections Based on the 2011 Census*, Ontario Ministry of Finance, Fall 2014. http://www.fin.gov.on.ca/en/economy/demographics/projections/projections2013-2041.pdf

knowledge cannot be brought to the building industry. Codes and standards lag far behind building science and need to adapt more effectively to raise minimum standards for building performance. Life-long learning, technology transfer and progressive regulations must be integrated within a building industry that continues to resist change. The necessary transformation will take time – the time to start is now.

Building science is directly relevant to addressing these issues. The building science community, speaking with one voice, can have a significant impact on our cities' future. The Roundtable represents a first step to initiate a group discussion and start to build a forum for further exchange of ideas and coordination of action. Key to this process is the idea of evidence based advocacy for improving the quality, durability and performance of buildings incorporating the best available building science knowledge.

Goals

The primary goal of the Roundtable was to open a dialogue between different stakeholders about future needs and the role of building science in addressing these needs. The ultimate aim of this dialogue is to facilitate connections and encourage cooperation, in order to support coordinated, effective action.

More specific goals include:

- To develop an initial list of key issues that could form the basis for future discussion and action (such as research, development, and policy initiatives);
- To gauge interest among building industry leaders in being part of an ongoing process aimed broadly at defining and acting on specific goals;
- To disseminate key points (and ultimately recommendations) to decision-makers and influencers (building code officials, MPs, media); and
- To educate the public and broader building industry about the need for better buildings and the responsible development of the built environment.

THE ROUNDTABLE PROCESS

The Roundtable proceeded through three stages. First, a small "think tank" group of roundtable panelists was formed, including the founding organizers as well as several industry representatives. Panelists were:

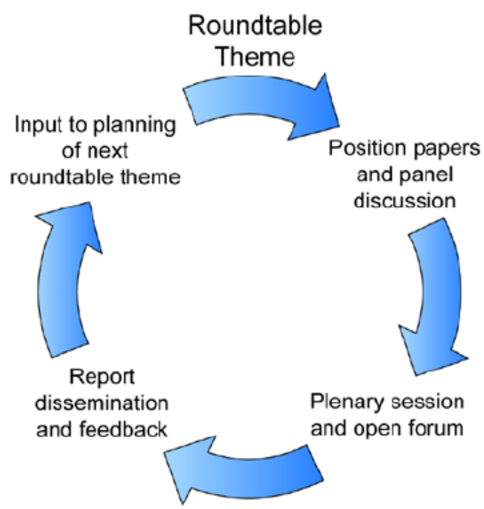
- David De Rose, Synergy Partners
- Jamie Goad, Cityscape Development

- Mark Gorgolewski, Ryerson University
- Ted Kesik, University of Toronto
- Lori O'Malley, PCL
- John Straube, University of Waterloo
- Chris Timusk, George Brown College

Each panelist produced a brief position paper about significant challenges and potential solutions for managing the built environment in the GTA and beyond. All position papers, as well as more information about the panelists, are available in the appendix.

The second stage was to meet to explore and expand on the issues identified in the position papers. The panelists convened on April 30th, 2015. Summary notes were prepared to share with the plenary audience, including key themes and a "word cloud" of related ideas and topics (page 10).

Thirdly, a plenary was held to bring together leaders within the local building science community and the wider building industry. Over 50 participants attended the plenary session, including prominent academics, association board members, municipal government staff, management and building science specialists from within construction companies, and principals from architecture, engineering, and building science consulting firms.



The building science roundtable process is intended to bring together leading experts to engage themes and issues that the larger building industry community has deemed significant.

Ted Kesik opened the plenary and acted as moderator throughout. He began by presenting some background on the Roundtable's process to date and the concerns that initiated it. Dr. Kesik then outlined key ideas emerging from the panelists' session, and invited the plenary audience to comment on and add to these ideas. After the plenary, a reception was held so that participants could continue the discussion informally. A follow-up email was also sent to gather additional feedback from both attendees and invited participants who could not attend. Plenary participants echoed many of the points brought up by the Roundtable panelists, while also adding new information and perspectives.

This report is based on the panelists' position papers, notes made during the roundtable and plenary sessions, and feedback received by email. The intention is to share the report and seek additional feedback, which will help to focus and set goals for subsequent roundtable events.

EMERGING THEMES

As discussed elsewhere in this report, population growth and technological complexity will put pressure on already inadequate systems in Ontario's cities. The building science community widely believes we can achieve better value for our building dollar, and deliver better buildings that will be a legacy rather than a liability to future generations. Collectively, the building science community in the GTA comprises internationally recognized experts in the design, procurement, construction, commissioning, operation, maintenance, retrofit and rehabilitation of buildings. This expertise needs to grow and to be effectively utilized.

However, building scientists are only "one piece of the puzzle." The primary goal of the Roundtable was to open a dialogue between a variety of stakeholders about future needs and the role of building science in addressing these needs. Where can we have the biggest impact? How can we support existing efforts to improve industry practices and the performance level of our shared building stock?

Through dialogue, the Roundtable process can facilitate connections, encourage cooperation, and ultimately support coordinated, effective action. The themes described below are a summary of important points made during the panelists' session and the plenary, as well as other feedback received before and after these events. Outcomes and suggested actions are outlined in the following section (page x).

To encourage open discussion, the plenary audience was advised that no names would be attached to specific comments in this report; hence, quotes are not attributed except for panelists.

Values and Quality

Roundtable panelists and plenary participants stressed that quality is an important issue underlying many other challenges. **There is an urgent need to develop a shared culture of quality**, so that stakeholders have a common understanding of what is important and how to measure it. Quantifiable performance measures encourage effective communication, allow rational evaluation of design, and provide a fair basis for regulation. Measures should be included for durability, energy efficiency, and occupant comfort. More broadly, participants noted the importance of attention to detail and due diligence in design and construction.

The roundtable panelists noted that there are many people in the industry today who are interested in improving building performance; however, **motivation and good intentions are frequently eroded by financial disincentives and lack of knowledge**. There is a sense that "if you care, you will spend the money to do it right", but the right people (i.e. those who have a vested financial interest) have to care. Where there is no long-term financial interest, motivation to focus on quality is low. For example, the owner of an office building who plans to operate the building may value long-term durability and energy efficiency. But an owner who builds to sell will focus on what increases the sale value – which for many buildings, is not high performance. Condos were cited as an example of development where short-term economic interests and trendiness strongly influence development practices.

This dynamic underlines **the importance of knowledge in promoting industry-wide change**. One plenary participant commented that "until we tie the market and consumer education together we won't have change". It was pointed out that consumers can and do handle complex information to make informed choices in other areas, such as nutrition or mutual fund investments. Some building owners (for example, institutional owners) have enough knowledge to care about building science and pursue higher levels of performance. But most consumers do not. A typical homeowner, for example, may be interested in environmental issues, but can't make an informed choice without a simple way to connect those values with their housing and renovation choices.

Several participants suggested that **there is a role for government** in elevating the minimum legal requirements for builders, to ensure reasonable standards even in the absence of an informed, quality-oriented market.

Extending beyond the construction phase, **performance often depends on building operators and occupants**. Again, knowledge is critical: a building operator who doesn't understand the building's HVAC system is unlikely to operate it at maximum efficiency, regardless of how good the system looks on paper. Several solutions were discussed for this dilemma, including the use of simpler systems and the development of owner-occupant training resources.

Effective Feedback and Adaptation Loops

Roundtable panelists identified **a strong need for more effective data-gathering mechanisms and knowledge transfer**. Currently, information is not openly shared about either building failures or systems that work. The industry could avoid many costly mistakes by creating effective feedback loops, so that lessons learned from past projects could influence current practice. If there is a failure, enough information about it should be easily available to prevent the same design being used again. Workable mechanisms for this type of cyclical learning must be developed.

Several panelists mentioned other industries (e.g., the automotive industry) that collect warranty information and feed it back into their processes. Although buildings are a very different kind of product, there are examples of similar feedback loops in the building industry in several Canadian and U.S. jurisdictions. **Opportunities should be identified to replicate and adapt processes that have been successful**.

There is also **a need for improved feedback loops between research and practice**. Researchers could make more effective recommendations if they had better access to data from the field. At the same time, it is important that available research is translated into clear and effective practice guidelines. In particular there is a need for wider data on enclosure details.

The remediation, restoration and retrofit of existing buildings will become an increasing trend in the building industry as our building stock continues to age.

Regulation

Panelists noted that building code requirements for renovations are significantly weaker than those for new construction. At the same time, existing buildings in the GTA (and other cities) far outnumber new ones being built. These existing buildings may be poorly insulated and often have outdated HVAC systems, lighting and controls. The opportunity for improved comfort, durability, and energy efficiency is enormous, and the cost of inaction potentially high: continued high energy costs along with severe deterioration, leading eventually to much more significant retrofits or demolition. At the same time, retrofits can actually cause poor performance and failures if the people involved do not have the requisite knowledge to conduct appropriate assessments, and to design, inspect and carry out appropriate retrofit plans. Plenary participants echoed the concern that **there is a great deal of activity in retrofits and renovations without adequate guidance from the codes**.

Examples were given where codes and regulations successfully brought about change. It was noted that the condo crisis in British Columbia, for instance, led to significant new code requirements and water penetration warranties, which supported market transformation and a real change in building practices.

Some participants commented that with codes and regulations "change happens at a glacial pace". However, others asserted that "**building codes *can* change**". Several people with experience in code development noted the need for building science experts to become more involved. One participant said of a code development project that "the feedback with respect to changes is non-existent ". Another participant stated that changes to the building codes are often reactive rather than proactive, and can sometimes be driven by external processes such as a change in provincial government. Code officials need and want building science experts to provide the science to respond to reactive initiatives constructively.

However, it was also pointed out that **there is a lack of basic data to assist in planning and recommending specific changes**. For example, we currently do not have an inventory of the building stock in a given area (including types of buildings, age of buildings, retrofit status, etc.). Without baseline data of this type it is difficult, if not impossible, to accurately assess needs or evaluate the effectiveness of current practices or industry-level interventions. Mandating the effective collection and accessibility of this data might be a useful step.

As well, **codes are not always well-understood, and enforcement is underfunded**. Therefore, building science experts can play an important role as an objective, science-based voice to advocate for responsible choices, both within existing codes and in terms of code development.

Training & Education

There was a broad consensus that **improved education and training are necessary to ensure that we have enough people with the right knowledge and skills to design, construct, commission, operate and maintain buildings properly**. Roundtable panelists and plenary participants described a change in architectural training in particular, with reduced and wholly inadequate attention paid to technical skills and building science. With the increasing complexity of building materials and systems, this gap is critical: at present, most architects do not have the technical knowledge required to design most buildings.

Some participants suggested that it may in fact be unrealistic to expect the architectural profession to take on building science as a specialist body of knowledge. As the architects' role changes to more of a coordinator of specialists, **it may be appropriate to add "building scientist" as a standard specialist on most projects**. In this instance, more highly trained building scientists will be needed. Currently, there is no required education to call oneself a building scientist. One participant cited the BSSO. designation overseen by the Ontario Building Envelope Council as a program that could be expanded or used as a minimum qualification.

Even if building science specialists are included on a project, however, architects will still need a basic level of building science expertise, as will other building professionals (tradespeople, building code officials, building operators). **There needs to be a common language and understanding of the building-as-a-system approach**. Expanded building science training opportunities are therefore critical for both new and existing professionals throughout the construction industry. Continuing education opportunities need to be high-quality, easy to find, and affordable (preferably free).

Education is also needed for stakeholders such as real estate agents, developers, and the general public. As discussed above, inadequate knowledge about how buildings work limits consumers' ability to make informed decisions and creates market conditions that don't support better building practices.

Practice and Procurement Models

Practice models and procurement models can also act as structural barriers to achieving better performance. Some panelists noted a tendency to constantly re-invent the wheel, bringing in consultants and sub-contractors on a project-by-project basis; it was felt that this reduces long-term efficiency, information-sharing, and accountability. Examples were discussed of firms that have had success using **coordinated long-term teams** (in-house or as consortiums). P3 is another model that has the potential to improve performance – as noted by one plenary participant, "one body takes over a project and makes sure things get done". However, other participants had observed P3 projects that were less successful.

Another issue with current practice models is the **ineffective recycling of project information**. Panelists described how building components are often designed and specified based on successful prior use, without adequate consideration of current project requirements (e.g., mis-sized HVAC systems). At the same time, several panelists noted that some components can and should be standardized. For example, many architectural practices serve niche markets and it would make sense to invest in very specialized building science knowledge and reusable details particular to their clients (e.g., schools in a particular area).

Shifts in the role of the architect were also discussed. As noted above**, there is an observed move away from technical knowledge, towards a model of the architect as a coordinator of specialists**. One person commented that "architects are busy shepherding the project through approvals", and need building science specialists to ensure that details are properly designed, specified, and constructed. This leads to a further need to develop the professional role of the building science specialist and quantify the value involved so that there is an allowance in project budgets.

Values. Adjust to changing needs.

Recognize the importance of **quality**. Define quality. Expectations extend to operation, not just installation.

Performance measures (e.g., EUI, durability, resiliency) to communicate about performance, allow rational evaluation of design, and a fair basis for regulation.

Feedback from in-situ performance to design, construction, and operation.

Regulation to raise the bar and level the playing field.

Building science **knowledge base** including performance and building demographics. Allow basis for reasonable planning and regulatory decisions. Must include wider data on enclosure details.

Education public (regulators, consumers), professions (professional degree and continuing education), trades, and building operators.

Practice Model and **Procurement Model** improvements. Better match practice and procurement models to owner project requirements (OPR). Exercise real value engineering, not just cost cutting.

New building construction sets the bar for restoration, rehabilitation and retrofit of existing buildings. High quality and performance will deliver long term value by avoiding high operating and maintenance costs.

SUMMARY & OUTCOMES

There are several definite outcomes from the Roundtable, as well as many possibilities for future action.

Immediate Outcomes

Immediate actions will focus on continuing the dialogue started by the Roundtable and Plenary, and moving collectively towards consensus on future plans.

Report

The Building Science Roundtable Report, “Shaping the Future of Building in Ontario”, is the first tangible outcome of the roundtable process.

This report will be distributed to all invitees (including those who could not attend) and to other select decision-makers and media contacts.

Second Building Science Roundtable

A second Roundtable and Plenary is being planned for late October 2015. Consistent with the process to date, attendance will be primarily by invitation, with the goal of stimulating discussion among industry leaders and forming a plan for next steps. In order to move towards concrete action, discussion will centre on a single topic: meaningful building performance metrics and indicators.

As well, to broaden the conversation further, the second Roundtable and Plenary will be held in conjunction with a one-day conference that is open to a larger audience. The BUILD Ideas Toronto conference is being organized by Building Science Consulting Inc., Construction Specifications Canada (Toronto Chapter), the University of Toronto, Ryerson University, and the University of Waterloo. It will address the core challenges that initiated the Building Science Roundtable and will feature expert speakers giving short, focused talks of 15-20 minutes, followed by moderated discussion. The Roundtable plenary session will be held during the conference reception.

Possible Future Actions

Many ideas for positive action were proposed and discussed during both the panel and the plenary session. There was interest in developing a coordinated voice for building science. Several plenary participants broached the idea of forming a political or advocacy organization.

However, it was also pointed out that many organizations and projects already exist with related mandates. From OBEC's BSSO program to the Net Zero Energy Housing Council, there are numerous allied organizations in the building science cause. The Roundtable group could play a valuable complementary role by facilitating coordinated action between these existing initiatives. Another important role could be to act as a conduit for information, building consensus among experts and feeding these deliberations to various media and regulatory organizations (much as the medical community makes statements about nutrition). Further discussion is needed to come to consensus about the best framework for action.

Depending on the direction that the Roundtable group chooses to take, some of the following actions may be appropriate to work towards. All were suggested by either panelists or plenary participants.

1. ***Improve building science education for both new and existing professionals.***
    - Advocate for education reform, particularly at schools of architecture. Demand a re-institution of technical training, evaluation criteria based on quality of execution, and a focus on architecture as a practice rather than a purely intellectual pursuit.
    - Work with professional associations to provide deliberate, structured, and high-quality training opportunities for practicing architects, code officials, realtors, etc.
    - Develop new, informal training resources for post-grad professionals that are easy and free to access (possibly with continuing education credits and levels of certification for various practitioners). Part of this could be training to support mentorship with practicing professionals.
2. ***Enhance public awareness and consumer knowledge about the questionable quality and performance of new buildings, and more broadly about the value of science-based building practices.***
    - Issue press releases and act as an expert source for media outlets. Focus on topics that will generate interest and support "a case for caring", clearly demonstrating what the challenges are and how a building science approach can benefit individuals, economies, the environment, and society at large.
    - Work with associations and the private sector to develop tools to help consumers make more informed decisions (for example, a "lemon-aid guide" for housing).
3. ***Compile, solidify and make widely accessible fundamental building science knowledge.***
    - Develop and seek funding for new, targeted applied research, for example to develop and analyse an inventory of existing building stock.
    - Seek out and integrate data from novel sources into the building science knowledgebase. For example, insurance companies regularly present aggregate data at loss prevention conferences and in other forums that could be useful to a building science analysis.
4. ***Advocate for change to building codes and regulations to improve the actual performance of new and retrofit buildings.***

- For example, advocate for requirements regarding enclosure commissioning, or a requirement to meet current codes (vs. allowing projects to be grandfathered in under past codes).
- Consider methods and make recommendations for reporting of construction details to a centralized database, in order to build an inventory for planning.
- Support increased funding and requirements for inspections.
- In general, encourage the use of empirical performance data as a fair basis for regulation.

5. ***Support coalition-building and increasing the effectiveness of existing initiatives among industry players.***

- Act as a forum for exposing and reconciling different technical approaches within the building science community.
- Urge product manufacturers to depict their materials within the context of complete enclosure systems, to promote the concept of the building as a system.
- Develop joint committees with sector-specific organizations to promote improvement in targeted areas; for example, form a committee between Builders Associations (e.g. Rescon) and the Building Science Roundtable group.
- Form a committee to work with insurers to share concerns and identify how risk could be reduced. This committee could include PEO, OAA, etc.
- Work with local municipalities, starting with Toronto, to develop a clear vision of how our built environment should perform. This unifying vision could influence zoning, codes, taxation, development etc.

As evidenced by the variety and breadth of these ideas, the first Building Science Roundtable provided a rich beginning for ongoing dialogue. The second Roundtable will begin to solidify the group's direction and move towards initial actions. The organizers extend sincere appreciation to all involved and look forward to continuing this process.

Building scientists approach each building as a system. The building industry is also a system, and we believe that building scientists can contribute a great deal to bringing about system-level change.

APPENDIX: PANELIST POSITION PAPERS

Delivering Value More Efficiently and at a Greater Scale

David De Rose, M.A.Sc., P.Eng., Managing Principal, Synergy Partners Consulting Ltd., Part-Time Professor, Ryerson University

David has worked on more than 500 projects over a 17 year career in building renewal and enclosure design. He started as a project associate at Halsall Associates in 1999 and took on increasing responsibilities culminating in being the Executive Vice-President and Building Enclosure Practice Leader before founding Synergy Partners in 2014. David applies the lessons learned in evaluating building enclosure performance in existing buildings to new building enclosures or building renewal to optimize building performance and durability.

David is a member of Professional Engineers Ontario and a certified Building Science Specialist Ontario (BSSO). He is a member of the CSA A440.4 subcommittee that deals with Window Installation. He is a past President of the Ontario Building Envelope Council (2007-2008). David is currently a Part-Time Professor at Ryerson University where he teaches Building Envelope Restoration for the Masters of Building Science Program in the Department of Architectural Science.

In his paper, Mr. De Rose discusses his experience as both a consultant and instructor. As a consultant, he has observed the difficulty of finding experienced and capable practitioners. As an instructor, he has seen success in using in-house company training and college-based programs to transfer lessons learned and build human resources.

As a practitioner, there are plenty of opportunities to help with existing building repairs and to provide advice to design teams constructing new buildings. The growth of the firms that I have worked with during my career has been limited by the number of qualified resources available to step in and support service delivery. Finding experienced and capable practitioners is difficult and expected to get increasingly more difficult with the forecast growth in building construction and repairs.

In order to address the skills gap and manage company growth, one of my past roles included organizing teams and company knowledge to create tools, templates, and training modules to build skills and provide service consistency, efficiency and value.

These training modules have also been delivered externally at the university level. So far the training has been well received as students get exposure to lessons learned from case studies in repairing building performance and durability issues. They have also been learning how to: evaluate and diagnose building performance issues, provide repair options, critique detailing, design repairs, review repair work and administer contracts. Providing more of these modules at more institutions should build more resources that can step in and support service delivery.

Having a larger impact at a greater scale will mean developing more modules and tools for practitioner use. Academia and industry should identify and develop key modules/tools to improve building performance and durability for new and existing buildings. These could include tools summarizing measures that could be implemented to achieve specific energy intensity levels for various building vintages and types.

Policy will also be required to motivate change with respect to improving building energy intensity levels for new and existing buildings. Mandatory energy intensity level reporting or allowing owners to unlock potential on undeveloped lands by meeting specific energy benchmarks for their existing buildings (on the same land) could be strong motivators for change.

Building Industry Challenges

Jamie Goad, OAA, MRAIC, Architect and Partner, Cityscape Development Corp.

As an architect and construction coordinator, Mr. Goad manages Cityscape's design and construction projects. Most notably Mr. Goad has overseen the construction and restoration of The Distillery District, the largest historic restoration in the country. Prior to joining Cityscape, Mr. Goad was the managing partner of Matsui Baer Vanstone Architects, for which he worked from 1985 to 1991. He had previously worked as an associate at Arthur Ericson Architects. Mr. Goad was involved in the design of many major international projects and has extensive experience in all aspects of architecture, from private residential, to multiple residential low and high rise, to hotel and hospitality and institutional.

A number of economic and logistical factors are identified in Mr. Goad's paper, from sourcing quality products and materials to the way that market preferences can influence energy-intensive building designs. He emphasizes the importance of building science knowledge for both design professionals and end users.

As our climate shifts and as we build higher, severe weather becomes an increasingly big issue. Current code mandated performance levels in building envelopes are inadequate in high rise residential buildings in exposed locations. Codes are not keeping pace with evolving requirements. Current window wall manufacturers are not producing sophisticated window systems and offshore manufactures are stepping into the gap. This also has its challenges as offshore producers have had delivery and installation issues in our market. We need to get our local industry more engaged in producing a better engineered product.

Energy efficiency in building enclosures is an ongoing issue. The market preference for significant areas of glazing and wrap around cantilever balconies is generating a huge number of new buildings which are not energy efficient. Publicity related to programs such as LEED has not made a significant change to this market pattern. To change the nature of buildings being offered for sale to incorporate more energy efficiency, government legislation is required to mandate higher levels of performance while maintaining a level playing field for developers since energy efficiency is not perceived by the buying public as sufficiently important to be a significant determinant of which new product to purchase.

Residential building owners and operators are not keeping pace with the evolution of mechanical systems incorporating more sophisticated equipment and controls. Condominium corporations and managers tender operations and maintenance contracts based on price and in many cases where, for example BAS systems are installed, they are left to function at their most rudimentary level since the on site operators have no idea what they're for or how to use them to optimize building performance. Boards and managers must be trained to appreciate that in order to realize energy gains there must be an investment in operations and maintenance. Incentives for post construction energy audits and system tuning would help capitalize on the investment in better technology.

Commissioning is another huge hole in energy efficiency. Mechanical contractors produce commissioning documentation that makes everything seem perfectly in accordance with project specifications but somehow the systems never live up to their design potential. Third party commissioning should be mandated across the board.

Retrofitting of the stock of existing buildings is another significant challenge. At the Distillery we found huge damage to solid exterior masonry walls as a result of "upgrading" the wall assemblies here in the late 1980's with insulation and vapour barriers. They did not understand that a solid masonry wall is basically a water storage device and that when the rains stop, it needs to dry not only from the exterior but also from the interior. I know that the U of T and Waterloo have been doing work on how to improve the energy efficiency of similar wall assemblies while avoiding the susceptibility to spalling from freeze thaw in moisture laden non-rainscreen walls. This is an example of the knowledge gap which needs to be overcome as we try to re-engineer the huge stock of existing buildings in order to make them more energy efficient without precipitating another series of performance and environmental issues.

Why Don't We Learn? or: Our clients are crash test dummies for building designers[3]!!!

Dr. Mark Gorgolewski, Department of Architectural Science, Ryerson University, Toronto

Dr. Mark Gorgolewski is a Professor in the Department of Architectural Science at Ryerson University in Toronto. He has worked for many years as an architect, researcher and sustainable building consultant in Canada and the UK. He has been a director of the Canada Green Building Council and chair of the Association for Environment Conscious Building and is a LEED Accredited Professional. Mark has written many papers and books on the subject of sustainable built environments. Currently areas of research include building performance, reuse of components and materials in buildings, and design for urban agriculture. He was co-curator of the exhibition "Carrot City: Designing for Urban Agriculture," which has travelled around the world, and is co-author of a Carrot City book and web site. Mark has participated in various sustainable building projects, including a winning design for the CMHC Equilibrium (net zero energy) Housing Competition and is also co-recipient of the 2007-2008 ACSA/AIA Housing Design Education Award, and recipient of the 2012 H.A. Krentz Research Award from the CISC and the CMHC 2013 Excellence in Education Award.

Dr. Gorgolewski's paper details the need for better knowledge transfer and feedback loops in the building industry. Performance figures quoted by designers are usually based on calculation/ prediction rather than measured data. Yet, buildings often do not function as expected and therefore do not meet the expected/predicted performance levels. Rigorous research into actual building performance, with the results discussed publically, would create a feedback loop to inform future policy and practice.

Sir Andrew Derbyshire in a recent paper[4] quotes a comment of his own from the 1950's:

"…the architect who believes that his work is done as soon as the building is finished must be made to look as ridiculous as the scientist who believes *that his experiment is complete as soon as he has assembled the apparatus."*

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[3] Quote from Bill Bordass at the Closing the loop conference, Windsor, 2004,

[4] Derbyshire, Andrew, (2004) Architecture, *Science and Feedback*, Closing the Loop Conference, Windsor, UK

Designers are increasingly keen to quote performance figures for their buildings for energy use, carbon emissions, water use, indoor environmental quality and comfort, but these are nearly always aspirational - based on some form of calculation/prediction. For energy use, this is increasingly based on the use of complex simulation tools; for water use, calculations are carried out based on appliance specifications and typical occupancies; while for indoor environment usually some or other guidelines are assumed to have been met. Rarely is actual, measured, performance data publically quoted, possibly because this is regarded as sensitive information or perhaps because it is often embarrassing! All these "predictions" include many assumptions about how the building will be occupied, managed, maintained, as well as the quality of construction.

Yet, it is well known that buildings often do not function as expected and therefore do not meet the expected/predicted performance levels. UK engineer Bill Bordass talks about each building being a hypothesis but that as an industry we do not have a culture to test these hypotheses in any rigorous way to see how they perform. Significant gaps between predicted and measured performance of buildings arise from a variety of reasons such as modelling inaccuracies, envelope and systems integration problems, construction quality issues, occupancy changes, commissioning and handover processes, operational issues, motivation of occupants, and understanding of comfort (Figure 1).

To address this "credibility gap" we need to understand how buildings really perform when in use and to establish effective feedback loops that will inform their future policy and practice. In addition to improved energy performance, an investigation of these variations and discrepancies can improve occupant well-being and productivity helping building owners improve the performance of their buildings by better understanding how to optimise performance and prioritise upgrades, and can help designers integrate lessons from existing buildings into future projects. This can lead to economic benefits across the industry.

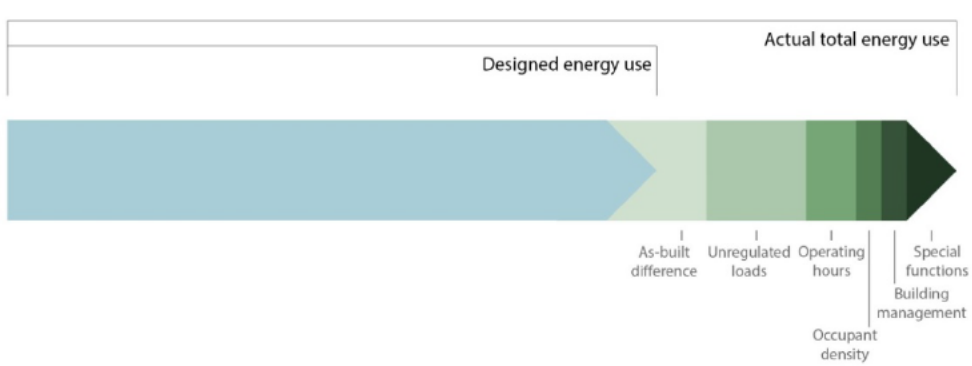

FIGURE 1 COMPARISON OF THE DESIGNED ENERGY USE AND THE ACTUAL TOTAL ENERGY USE OF A BUILDING, ADAPTED FROM CARBONBUZZ.

In the GTA, and in Canada, there is a conspicuous lack of rigorous research into actual building performance, where lessons are discussed and shared. This is illustrated by the lack of publications reporting results from evaluations, and the low number of Canadian buildings in the primary databases for performance of buildings (UC Berkeley's Center for the Built Environment, and Building in Use Studies). A recent study of Canadian buildings illustrates some of these issues[5]; Figure 2 shows a summary of modelled, measured and benchmark values for energy use intensity for the nine Canadian "green" buildings. This shows how the gap between measured and predicted performance varies significantly. All but one building uses less energy than the reference benchmarks and five are more than 50% below their reference benchmark. However, most use more energy than the design stage predictions, and three buildings do not meet their predicted performance by a significant margin. There is a need to understand the reasons for this and identify lessons for the industry.

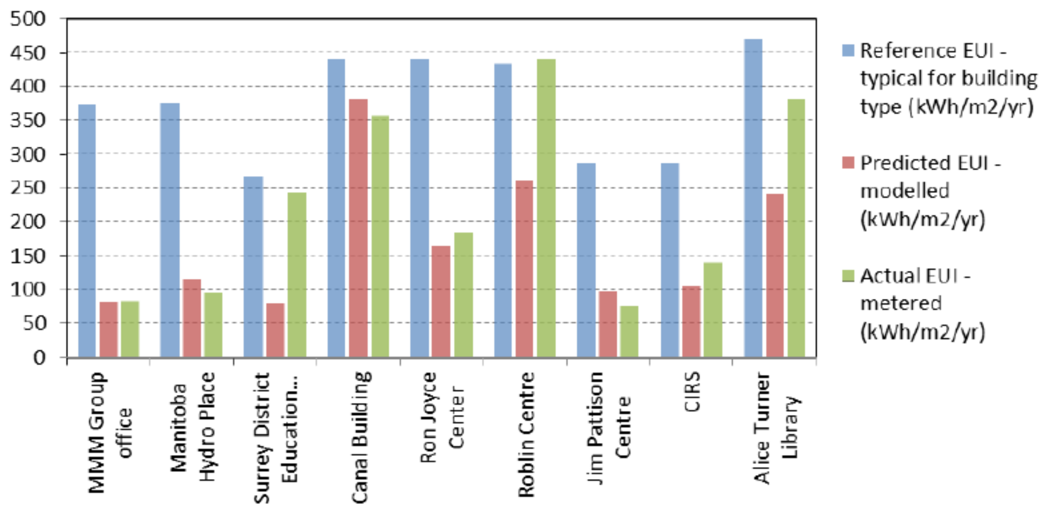

FIGURE 2: COMPARISON OF BUILDING EUI PREDICTED, ACTUAL AND BENCHMARK

One of the key findings of this project was that each building has its own individual "story" that provides an important context for effective management and improvement of the building in its ongoing life, and needs to be understood. Reasons for discrepancies are varied and contextual. For example, a building such as the Roblin Centre may not meet its energy or water targets because it is being used more intensively (more occupants or for more hours). Despite higher energy and water use this may be beneficial as it avoids the construction and operation of additional space. In contrast, some buildings met their energy targets, but were underused, with lower occupancies. In some building types determining actual occupancy can be very difficult if not monitored and recorded on an ongoing basis.

[5] Posters for each building, and a summary paper about the project, are available at http://iisbecanada.ca/sb-14/

This is a key aspect that needs to be better understood since changes in building occupancy from original design assumptions, can lead to operational issues and underperformance.

An important aspect of better understanding buildings in use is to combine quantitative data such as metered energy use and spot measurements of environmental conditions (such as temperatures, lighting, and acoustics) with qualitative data from occupant-generated feedback about satisfaction levels for various aspects of the building (collected through questionnaires). As Gary Raw speculates "people are the best measuring instruments, they are just harder to calibrate". Analyzing occupant satisfaction with buildings is important because it provides an alternative lens to highlight shortcomings in the performance. Also, building owners do not want to have buildings that are largely unsatisfactory places to live and work, and this shortcoming can affect occupant well-being, productivity, health, and business competitiveness.

AREAS OF RESEARCH

Below is an incomplete list of suggestions for discussion about research needs related to this subject:

1. Actual building occupancy (i.e., hours of operation and occupant load) is often different to what was expected and can be very difficult to determine for some building types. We need to establish how buildings are actually used and how this affects performance.

2. What information is needed to evaluate buildings and how can this be easily made available by making appropriate provisions at the design stage? What documentation (of design assumptions, etc.) and provision for collecting performance data for later use can be considered at the design stage?

3. What is the interaction between energy performance and appropriate indoor conditions? How to break the spell of greater glazing areas (WWR) by establishing that this leads to poor indoor environments?

4. The role of building management and operational staff. How does building complexity and management knowledge correlate with performance?

5. The role of occupant feedback in understanding buildings. How can the occupant perspective be most effectively utilized.

6. The need to recognise context and each individual "building story" that provides an appropriate framework for effective management and improvement of the building in its ongoing life.

7. Understanding appropriate control systems

In the absence of detailed data about actual building performance there is no virtuous feedback between policy and practice. This is particularly true with leading edge innovative buildings that use new ideas and technologies that are not yet well understood.

Stewardship of the GTA's Existing ICI Buildings

Professor Ted Kesik, Ph.D., P.Eng., University of Toronto

Ted Kesik is a professor of building science in the John H. Daniels Faculty of Architecture, Landscape and Design at the University of Toronto. He entered the construction industry in 1974 and has since gained extensive experience in the various aspects of building enclosure design, systems integration, quality assurance, commissioning and performance verification.

Professor Kesik's research interests include high performance buildings, durability, life cycle assessment, systems integration and sustainability. Dr. Kesik continues to practice as a consulting engineer to leading architectural offices, forward thinking enterprises and progressive government agencies. He remains actively involved in technical organizations and is the author of numerous books, studies, reports and articles related to his areas of research and professional practice.

Dr. Kesik's paper focuses on the institutional-commercial-industrial (ICI) stock of buildings. Several areas of concern are outlined. First, research is needed to create an inventory of existing building stock and determine the most feasible retrofit strategies, methods and materials, as well as costs and benefits. Second, current training and education has not provided an adequate level of human resources to meet the industry's needs, either in quantity or quality of personnel. Third, professional and industry engagement must be increased. Fourth, the Ontario Building Code is too vague about minimum levels of energy efficiency that should be achieved when performing a comprehensive building retrofit. Finally, demand management programs need to be re-thought.

OVERVIEW

This position paper is set in the context of the Greater Toronto Area, but it is largely applicable across all of Canada's urban regions. Its focuses on the institutional-commercial-industrial (ICI) stock of buildings, recognizing similar issues are being faced by the housing stock.

The vast majority of building science consulting is aimed at dealing with performance problems in existing buildings rather than taking a proactive approach to prevention. Unfortunately, seldom is a formal feedback loop established between forensics and new building design, hence the same problems reoccur for the same reasons. It is obvious there is a great deal to be learned about new building design from our existing building performance problems.

Our existing building stock far outnumbers the new buildings being constructed but so much of the training of architects and engineers focuses on new building design, and does not benefit from the accumulated wisdom regarding the historical performance problems facing existing buildings. Repeating history is most likely when driving ahead in the dark with no headlights and no rear view mirror.

As the performance requirements in new building codes and standards advance, the opportunity to wring life cycle savings out of buildings becomes increasingly difficult. The law of diminishing returns limits how much impact more sophisticated building science will have on actual performance. However, below the new building tip of the building stock iceberg lies an immense body of existing buildings, many with obsolete enclosures, HVAC systems, lighting and controls. Many of these are at a critical point in their life cycle where modest interventions can considerably improve their durability and performance. The alternative is to watch the onset of severe deterioration, greatly escalating the future cost of comprehensive building retrofits, while devaluing the real estate assets.

In summary, buildings have been treated like commodities, but they actually represent cultural resources, like our waterways and forests. They need to be responsibly managed because as a society we can neither afford to demolish and replace them, nor to continue inhabiting them in their present condition. Every year, more buildings join this cohort of existing buildings and the accumulation of deferred maintenance and retrofit escalate unabated. This is a significant issue requiring the concerted effort of all stakeholders.

ESSENTIAL BUILDING SCIENCE RESEARCH

One of the most important aspects of resource management is to take inventory of the existing building stock in order to understand typologies, characteristics, energy profiles, etc. *If you can't measure it, you can't manage it.*

A triage of sorts can be performed once the vital statistics of the existing building stock have been collected. There are buildings that must be immediately remediated or face demolition (both for reasons of durability and functional obsolescence), buildings that have time to spare before a comprehensive retrofit is required, and those where only relatively minor tweaking is needed to modernize environmental quality and performance.

For each existing building typology/cohort, research into the most feasible retrofit strategies, methods and materials is required to avoid the burden of each building owner having to retain consultants to carry out a comprehensive cost-benefit analysis of alternatives. The fact remains these buildings were built of a time using a limited palette of methods and materials and their pathology is practically identical.

To conclude the research cycle, a series of demonstration projects need to be conducted in order to verify estimated costs and benefits. This is also an opportunity to invite the deployment of innovative methods and materials to help control costs while ensuring acceptable performance.

TRAINING AND EDUCATION

There is little that can be accomplished in the absence of skilled and capable people. The management of building health, the comprehensive retrofit of buildings, and ongoing operations and maintenance all require highly qualified personnel. Universities and colleges continue to focus on specialization, but a *building-as-a-system* perspective is needed to successfully engage the aging building stock challenge. From the entry level trades through to construction, project management, all the way to conditional assessment, design, contract documentation, quality assurance, commissioning and facilities management, the GTA simply does not possess the quality and quantity of personnel needed to manage our existing building resources. The same is true for many other aspects of infrastructure supporting our built environment.

PROFESSIONAL AND INDUSTRY ENGAGEMENT

Without the interest and support of building owners, constructors, architects, engineers and a variety of stakeholders such as the energy utilities, governments and financial institutions, the ongoing deterioration of building assets is inevitable. Professional engagement implies the involvement of academia to provide entry level interns with the knowledge and skills needed to deal with the challenges. Industry can also involve academia in developing innovative technical and financial solutions to accelerate the uptake of comprehensive building retrofits.

CODES AND STANDARDS

At present, the Ontario Building Code is too vague about minimum levels of energy efficiency that should be achieved when performing a comprehensive building retrofit. Many restoration and renovation projects still do not explore improvements in energy efficiency and remain, for the part, cosmetic in nature. The high costs of staging to access the enclosure, and the disruption associated with restoration and renovation, suggest that when such work is carried out, it is the most cost effective opportunity to include performance enhancing measures.

ENERGY UTILITIES AND FINANCIAL INSTITUTIONS

The need to reduce our carbon footprint and demand for capacity expansion of energy sources requires a re-thinking of our demand management programs. Typically, comprehensive building retrofits do not pass the prevailing cost-benefit tests established by government agencies and the energy utilities. Financial institutions stand to gain a large untapped market by creatively financing existing building retrofits and permitting owners to assign their energy savings to pay back loans directly through their utility bills. The barriers to financing the building improvements are just as significant as not having suitable personnel available to carry out the work.

SYNOPSIS

Building science is a necessary but insufficient condition for the management of our existing building resources. If the building science community can take a leadership role and work with other sectors to transform the current disregard into a harmonized strategy across the region, it is possible to achieve the social, environmental and economic goals for enhancing the sustainability of our existing buildings and their surrounding communities.

BIG QUESTIONS/ISSUES

1. Who should be responsible for maintaining an inventory of existing building stock and associated vital statistics – the province, the municipality or some other agency (i.e., MPAC)?

2. Who will develop the metadata structures needed to capture the vital statistics of our building stock – what will be the process of engaging and procuring the expertise to establish this information framework?

3. How do we best train technicians, technologists, architects and engineers in building condition assessment, feasibility studies and implementation of comprehensive retrofits or strategic remediation/re-commissioning of existing buildings?

4. What kind of certification of service providers is needed to protect the public from incompetent and unqualified individuals and/or companies?

5. What is the most appropriate way to regulate minimum performance levels of retrofits to existing buildings?

6. Is there a need to institutionalize buildings infrastructure management data and programs by establishing a permanent stakeholder group as watchdog/coordinator/repository across the GTA?

7. Are there market levers that can help accelerate a more responsible and effective management of existing building assets?

Building Envelope Round Table - Bridging the Gap

Lori O'Malley, M.A.Sc., P.Eng., LEED® Green Associate, Building Envelope Engineering Specialist, PCL Constructors Canada Inc.

With more than 18 years of experience, PCL's Building Envelope specialist Lori O'Malley provides technical building envelope expertise during both the design and construction phases, while protecting design integrity and the vision for the project. In addition to identifying material, constructability, and sequencing concerns of building envelope design and installation, Lori also actively participates in value engineering efforts, offering solutions for achieving more LEED® credits, and improved building performance and maintenance.

Ms. O'Malley's paper underlines the importance of understanding how the building envelope functions and interacts with each of the other building systems, especially the mechanical systems. It suggests that improvements could be made to the credentialing and qualification requirements for all parties involved with the building envelope, and that a detailed quality program must be developed and implemented at all stages. Transitions and product compatibility are identified as two areas where problems can easily occur.

The potential success of a construction project is related to the design and construction of the building envelope. Should issues with the building envelope arise during the construction process, schedule delays, cost overruns and performance problems can occur. As such, it is essential that this risk is minimized by controlling the following items:

- <u>Understanding of the Fundamentals of Building Envelope Design</u>: All parties involved in the building envelope, including the architects, consultants, contractor and subcontractors, must have a strong understanding of the building envelope fundamentals. Although it is generally accepted that the aesthetic of the building envelope is important, the technical aspects of the design must be respected as well. It is essential that all parties understand how the building envelope functions and interacts with each of the other building systems, especially the mechanical systems. In some instances, this strong understanding of the building envelope and the relationship with the other building systems is not present in all of the team members and the potential for discontinuities and performance issues in the building envelope is increased. As such, an improved knowledge of the building envelope fundamentals by all parties would be beneficial to the industry. Consideration should be given to improving the credentialing and qualification requirements for all parties involved with the building envelope.

- Focus on Quality: It is essential that all parties involved in the design and construction value quality. A detailed quality program must be developed and implemented at all stages in the project. Only when quality is valued by all parties will the potential for a successful building envelope be maximized.

- Transitions, Transitions, Transitions: Most discontinuities in the building envelope occur at the transition between two or more dissimilar systems. As such, it is essential that the appropriate materials are selected, design thoroughly reviewed and developed, and inspected during the installation process. The transitions between the elements of the building envelope often can be challenging due to the dissimilar materials and changes in plane of the air barrier, vapour retarder and moisture barrier. It is essential that these transitions are carefully reviewed at all stages in the project to minimize the potential for discontinuities and performance issues.

- Compatibility and Adhesion of Materials: There are a multitude of building envelope products available for use, each of which are manufactured using a variety of materials and compounds. Unfortunately all of these materials are not chemically compatible and / or will not adhere to all of the other products, which results in discontinuities in the building envelope. To minimize the potential for such issues, it is essential that all parties confirm that all materials in contact with each other, including the transitions between dissimilar systems, are compatible with and will adhere to each other.

When these risk items are controlled and minimized, the potential for a successful building envelope can be improved. Through proper planning and review by the team, a durable and constructible building envelope can be designed and built that meets the owner's requirements.

Challenges for the Building Design Professions

John Straube Ph.D., P.Eng., University of Waterloo

John Straube, Ph.D., P.Eng., is a Principal at Building Science Consulting Inc., where he heads forensic investigations and leads research projects in the areas of low-energy building design, building enclosure performance, hygrothermal analysis, and field monitoring of wall assemblies.

In addition to his work with BSCI, Dr. Straube is a cross-appointed faculty member in the School of Architecture and the Department of Civil and Environmental Engineering at the University of Waterloo. Dr. Straube's leadership as a building scientist and an educator has been recognized with multiple awards, including the Lifetime Achievement Award in Building Science Education from the National Consortium of Housing Research Centers (NCHRC).

Dr. Straube's paper discusses the need for measurable performance standards and evidence-based design. It notes that many of the necessary tools are already available, but the knowledge and will to use them is missing: "in-service performance must become a prerequisite to building design just as fire resistance and structural stability have become."

Part of any improvement in the design, construction, and operation of our buildings must involve a change to the design professions, i.e., largely architects and engineers. Largely this means a focus on actual in-service performance (including durability) rather than a focus on merely producing a building.

The knowledge and building products are largely available to make low-cost, durable, low-energy buildings—we simply need to choose to design our buildings to achieve performance. Simply put, this means choosing appropriate window-to-wall ratios, effective insulation, continuous air and water barriers, and simple, efficient HVAC systems. This is not meant to suggest that the larger goals of producing a good building (from urban context to occupant enjoyment) should be, or need be, subservient to performance, merely that in-service performance must become a prerequisite to building design just as fire resistance and structural stability have become. Including real energy and comfort targets in design briefs along with structural loading and fire ratings should be the norm.

In far too many cases, design professionals choose not to follow the established and demonstrably effective approach described, and deploy supposedly "innovative" green roofs, double facades, natural ventilation, living walls, chilled beams, cladding screens, and other trendy technologies without being able to assess if they move the design closer to performance goals. Innovation does not mean "new" or "different", although one might be excused for thinking this is the meaning of innovation in building design. Almost anyone can come up with new approaches to buildings, materials, construction processes, etc. What is needed, and what is challenging, is to be better[6]. Designers proposing to use a different material, assembly, product, or method should be required to provide some physics or evidence-based analysis before it is used.

This is the crux of the problem: most design professionals currently do not have the ability to predict actual performance, either by direct experience or physics. There are few who can predict the rate of condensation of an air leak into a roof, the thermal bridging of a specific window installation, or the amount of ventilation that enters a suite in a new apartment or condo[7].

A common refrain in the building industry is that every building is a prototype. There is some truth to this, but if it were a perfect analogy, designers would carefully study and measure the performance of the prototype and incorporate the knowledge gained in the next version of the prototype. This is almost never being done and hence mistakes are repeated over and over, inaccurate computer energy models are used again, and non-durable products continue to be specified. Of course, most of a building is *not* actually a prototype, nor need it be: enclosure assemblies, interior finishes, HVAC components and layout with well understood performance can all be used. The building design community needs to recognize the catalog of good information we have and draw on it. And we need to help them.

Production home builders have driven both costs and warranty claims down by using as many common components as possible. However, those assemblies and systems are rarely chosen based on a rigorous analysis, they are usually chosen based in incremental changes and experience. We need bigger changes to performance faster, and hence a more scientific approach. In the commercial, institutional, and high-rise residential market there is a temptation to choose new systems without analysis, or continue to repeat the use of systems known to have poor performance. We will need to help this too.

In short, the design professions must:

1. Accept, and embrace the idea that measurable performance, energy, comfort, health, and durability, are a fundamental part of the buildings they design, in the same way that fire control and structural integrity are today

[6] In many cases this does not require new technology, it requires a change, a change in approach, attitude or values.

[7] Most high-rise residential buildings still use a pressurized corridor system, which cannot provide predictable ventilation rates. Almost all commercial VAV systems have the same problem.

2. Make design decisions that are based on evidence or physics, rather than opinion, sales pitches and conjecture
3. Endeavour to track, study, and even measure, the performance of their projects to inform future projects.

While these changes should start at the schools of architecture an engineering, there is little faculty wide support, especially in architecture. Given the immediacy and scale of the need, the existing professions must respond and start the change by requiring continuing education in these areas.

Renovations/Retrofits to Part 9 (Housing and Small Buildings)

Chris Timusk, Ph.D., George Brown College

P. Christopher Timusk, PhD, is a specialist in the areas of Building Science and Wood Composite Materials, with particular expertise in the areas of moisture physics and the durability of building materials, involved as an educator, consultant, expert witness and researcher.

He is a faculty member in the Center for Construction and Engineering Technologies at George Brown College where he teaches courses in Building Science and Material Science, and is Principal Investigator of the Argile $3million MRI funded research project on the exterior retrofit of solid masonry walls. As a consultant in Building Science for over 20 years, Chris has worked on numerous cases involving forensic investigations of building failures, hygrothermal computer modeling of building envelopes, and the performance evaluations of new designs and retrofits. He also taught at the University of Toronto, Faculty of Applied Science and Engineering, in the Certificate program in the area of Building Science for over 10 years.

In his position paper, Prof. Timusk discusses renovations/retrofits to Part 9 residential buildings in Ontario. These "often fail to meet the broad objectives of optimizing energy efficiency, durability, and occupant comfort while achieving cost efficiency… because such renovations/retrofits are largely unregulated." The proposed solution is to develop and deliver a concise, manageable and partly hands-on building science training program for renovators and building code officials. Long-term, regulations will need to change, balancing optimal performance with affordability.

OVERVIEW

Renovations/retrofits to part 9 (housing and small buildings) residential buildings in Ontario often fail to meet the broad objectives of optimizing energy efficiency, durability, and occupant comfort while achieving cost efficiency. It is suggested that this is because such renovations/retrofits are largely unregulated, even when the requirements for a building permit are triggered, for two reasons:

First, there is a lack of suitable training, required or not, for both the personnel performing the retrofits (the renovators) and for those overseeing the retrofits (the building code officials), and second, the building regulations/codes, (the National Building Code, the Ontario Building Code and the municipal codes), have almost no requirements for renovations/retrofits other than as pertain to occupancy, plumbing, electrical or structural changes. As a result, consumers don't have any tools or practical means of selecting renovators or of assuring that their renovation dollar is optimally invested.

PROPOSED SOLUTION

My proposed solution is to develop and deliver a concise, manageable and partly hands-on training program for renovators (and regulators) which would cover the bare minimum Building Science basics, including but not limited to:

- Heat transfer basics (conduction, convection, radiation),
- Moisture (forms and properties of, transport and storage mechanisms)

- Air (and associated moisture)
- Material science (basics of wood, masonry, glazing etc.)

Once the basics are covered, then we focus on applying it to buildings. How do we manage and control the flow of heat, moisture and air? What materials and methods are best suited to different retrofit applications? How and when does the code apply? It would also be very important to have a case studies component, where we could analyze an array of failures and associated solutions. Also, a component would include best practices of materials, methods and assemblies. A hands-on component to all of the above is also critical, where students could touch materials, examine models of as well as full scale assemblies, try applying materials and methods in a materials lab, and perform lab experiments to reinforce the basics.

Upon completion of the training, there should be some kind of associated certification or recognized designation that allows for distinction from non-trained/certified renovators to assist the consumer in making an informed decision. Code officials may simply have the training as part of their professional development.

As for the lack of regulation form the national, provincial and municipal codes, this will need to change gradually over time. The challenge will be to balance the emphasis of optimal performance with affordability so as not to discourage renovations.

Hopefully, through the combination of better education for those performing or overseeing the renovations, combined with a gradual improvement in the minimum building code guidelines, our existing building stock will also improve to better suit the needs of the people and the planet for generations to come.

BACKGROUND INFORMATION AND RELATED QUESTIONS

What are the requirements for being a renovator?

- Need a business license (eg. valid City of Toronto License), and insurance, but no other demonstrated expertise or certification.

How many "registered" renovation companies are there in the GTA?

What is the dollar $$$ value of renovations in the GTA or Canada?

- "Total spending associated with residential renovations and repairs has more than doubled since the late 1990s to nearly $64 billion last year, or nearly four per cent of Canada's GDP, according to a recent report from Altus Group, a Toronto-based property consulting firm. And it has almost nothing to do with a growing population or the increase in the number of houses over that time. In fact, three-quarters of the gains can be directly attributed to Canadians' willingness to open their wallets ever wider, if it means getting a cathedral ceiling in the master bedroom or a heated floor in the basement loo."[8]

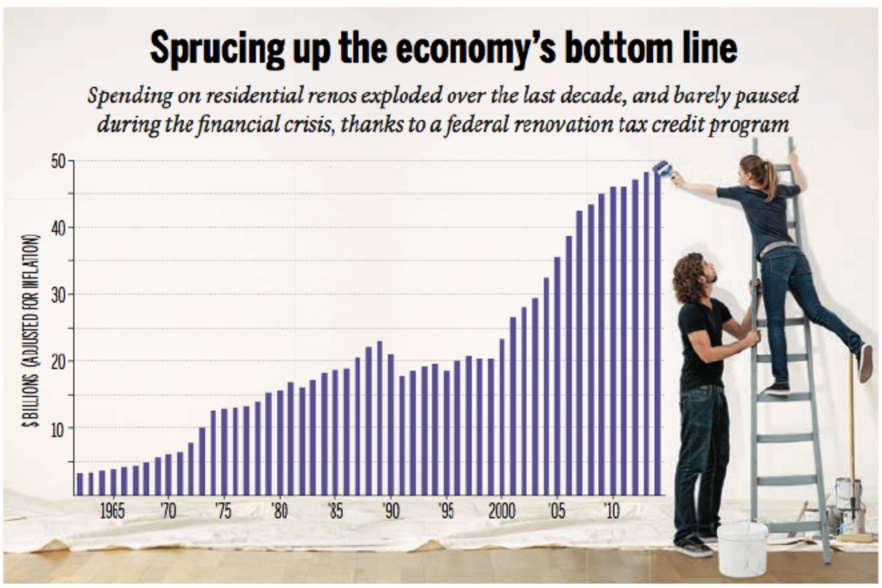

IMAGE SOURCE: MACLEAN'S MAGAZINE, JULY 28, 2014:

Are there any training programs in Building Science Basics for renovators in the GTA? What if any?

- UofT has a Building Science Certificate program through their Con-Ed programs, which on completion gives the BSSO (Building Science Specialist of Ontario)

[8] Maclean's Magazine, Chris Sorenson, July 28, 2014. Available at http://www.macleans.ca/economy/realestateeconomy/the-dark-side-of-the-renovation-boom/

designation (backed by OBEC), but it is NOT for renovators or anyone other than graduated and experienced engineers and architects (I taught it for 10 years).

What are the triggers for a building permit?

- Electrical, plumbing and structural need a permit
- Changes to occupancy (going to higher density) triggers permit requirements
- Adding to (extending) a building or demolishing all or part of a building

Excerpt from the Ontario Building Code

11.3.3. Renovation, 11.3.3.1. Basic Renovation

(1) Except as provided in Sentence (2) and Article 11.3.3.2., ***construction*** may be carried out to maintain the existing ***performance level*** of all or part of an existing ***building***, by the reuse, relocation or extension of the same or similar materials or components, to retain the existing character, structural uniqueness, heritage value, or aesthetic appearance of all or part of the ***building***, if the ***construction*** will not adversely affect the early warning and evacuation systems, ***fire separations*** or the structural adequacy or will not create an unhealthy environment in the ***building***.

11.3.3. Renovation, 11.3.1.1. Material Alteration or Repair of a Building System

(1) Where an existing ***building system*** is materially altered or repaired, the ***performance level*** of the ***building*** after the material alteration or repair shall be at least equal to the ***performance level*** of the ***building*** prior to the material alteration or repair.

As our cities change and grow, needs and expectations grow with them. Even now, the demands on buildings are different than in the past. There is a strong need to meet reasonable standards for energy efficiency, durability, and comfort; there are also more design options than ever before to understand and choose between.

Building science is directly relevant to addressing these issues. The building science community, speaking with one voice, can have a significant impact on our cities' future.

The Building Science Roundtable represents a first step to initiate a group discussion and start to build a forum for further exchange of ideas and coordination of action.

Building Science Roundtable 2015: Shaping the Future of Building in Ontario