THE TRAINING OF CANADIAN ARCHITECTS FOR THE CHALLENGES OF CLIMATE CHANGE

John Mummé
Karen Hawley

ACW | Adapting Canadian Work and Workplaces to Respond to Climate Change

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John Mummé
Architect

Karen Hawley
Research Assistant

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For more information, contact:

Adapting Canadian Work and Workplaces
York University - Ross N819
4700 Keele Street, Toronto, ON. M3J 1P3
(416) 736-5895 | acwinfo@yorku.ca | adaptingcanadianwork.ca

Introduction

This paper is funded through a SSHRC-funded project: Adapting Canadian Work and Workplaces (ACW). ACW's central goal is "To contribute to transitioning Canada to a lower-carbon economy using social science and applied science research to link adaptation of workplaces and work to mitigation of greenhouse gases in key Canadian industries: construction, public and private services, energy, manufacturing."[1]

The paper examines an often-overlooked dimension of the reduction of greenhouse gas emissions (GHGs) in the built environment: the training of construction professionals to participate most effectively in the large-scale reduction of GHGs. Architects are one of the key construction professions and this project explores the training of students at Canadian architecture schools – the professionals of the future.

The built environment sector is a crucial element in the struggle to reduce greenhouse gases in the face of climate change. Recent studies show the sector to be responsible for as much as 44% of GHGs and energy use[2]. As a result, the importance of the sector in both the production and the potential reduction of GHGs makes the question of how construction professionals in general, and architects in particular, are trained for climate-literacy both pressing and important. There is, however, surprisingly little research on the education of Canadian construction professionals for climate change.

To begin to fill this gap, this study examines how Canadian architecture schools are training the next generation of architects in regard to climate change. This study looks at the training of architects in the eleven schools of architecture in Canada whose programs have been accredited by the Canadian Architectural Certification Board, and how these programs deal with the issues of climate change in their curricula.

It also looks, for international comparison, at a number of major non-Canadian architecture school programs recognised as substantially equivalent to those of the Canadian schools.

Website analysis and a number of discussions with program heads, faculty, and students from a number of schools were conducted on the program requirements and course offerings from the various schools, to see whether and what type of courses on climate change are offered, and through which conceptual lens the issue is viewed.

The reduction of GHGs in the building sector is "low-hanging fruit" of great importance that should be

[1] Lipsig-Mumme, Carla. (2014). [Adapting Canadian Work and Workplaces: Goals and Project Description]. Toronto, Canada. Unpublished submission to the Social Sciences and Humanities Research Council, SSHRC #895-2013-1002.

[2] Estimates vary widely, as there are differences in the methodology and the country(s) or regions studied. As well, some studies do not include the emissions from the production or transportation of building materials. Nevertheless, the buildings sector is responsible for a very high proportion of greenhouse gas emissions.

The range of sources include:
Stern, N. (2007). *Stern Review on the Economics of Climate Change, Annexe 7 e.* "Emissions from Buildings Sector. P.1. Retrieved from http://webarchive.nationalarchives.gov.uk/20100407172811/http://www.hm-treasury.gov.uk/stern_review_report on 10 april 2017.
United Nations Environmental Programme (2009). *Buildings and Climate Change.* Paris: United Nations Environment Programme.
Architecture2030. "Why the Building Sector". (Data source given as US Energy Information Administration 2012). Retrieved from http://architecture2030.org/buildings_problem_why/ on 10 April 2017.

addressed as rapidly as possible. Through their decisions regarding design, drawings, specifications, choice of materials and installation methods for both new buildings and the renovation of existing ones, architects are in a critical position to make significant reductions in level of GHGs produced in buildings.

In the recently-adopted Pan-Canadian Framework on Clean Growth and Climate Change[3], the federal and provincial governments have agreed that making new buildings more efficient and retrofitting existing buildings will be two of the key approaches for the Built Environment sector. However, as the document notes, in the year 2030 75% of the building stock will be composed of buildings standing today. The main effort, therefore, must be in the direction of the retrofitting of existing buildings. The framework agreement does not set out specific methods in this regard, though hopefully the provinces will implement a retrofit program along the lines of the Deep Energy Retrofit program proposed by the Ontario Association of Architects to the provincial minister in May 2016[4].

The future architects graduating from Canada's architectural schools will be, in large measure, the architects who will design and specify the requirements of this stock.

The Semantics of Climate Change

Some 15 years ago, concerns about the viability of the natural environment were generally expressed in terms of the concepts of "sustainability", "ecology" or "environment".

At that time, there was much discussion of the need to conserve and sustain the resources of the natural world, and not to misuse or overuse these resources – vital for all living things on the earth. There was little broad realisation in our society that these resources and the world as we know it, were under immediate threat from human activity since the industrial revolution.

Very few were the interventions which referred to climate change and its effect on both the natural world and on the human community. Climate scientists and a small number of knowledgeable and concerned activists were, in general, the only voices speaking up on this new issue.

Since then, of course, climate change has become a subject of worldwide concern, spreading through the almost unanimous voices of climate scientists and other scientists[5], through the media, through international organisations and national politics, through business and community organisations, and in the discussions among ordinary people.

The choice of words is telling. For those who see global warming as less than urgent, "sustainability" and "the environment" are often the terms of choice. Both terms signal likely positive outcomes: human

[3] "Pan-Canadian Framework on Clean Growth and Climate Change", Government of Canada, 9 December, 2016. Ottawa.
[4] Letter from Toon Dreeson, President of the Ontario Association of Architects to Glen Murray, Minister of the Environment and Climate Change of Ontario, 19 May 2016. Retrieved from http://www.oaa.on.ca/oaamedia/bloaags/text/2016_05_19_-_moecc_letter.pdf, 2 January 2017
[5] "Multiple studies published in peer-reviewed scientific journals show that 97 percent or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position". Retrieved from "Scientific consensus: Earth's climate is warming" (n. d.) National Aeronautics and Space Administration on 11 February 2017.

action will be a major green force to aid the process of making the planet sustainable again. But these are not terms of urgency. In contrast, for those who stress the critical urgency of responding to the planet's rapid warming, the term of choice is generally "climate change".

Which terms do Canada's architecture school programs use? Do the choices of language in curriculum material reflect/influence the degree to which climate change is seen as urgent, the role of architects in reducing GHG emissions as pivotal, and training for architects as a crucial instrument for slowing global warming[6]?

Programs Accredited in Canada

The pathway to architectural licensure in Canada for the vast majority of applicants begins with the obtaining of a Master of Architecture (M. Arch.) degree from an accredited architecture school program.

The body which is responsible for this accreditation is the Canadian Architectural Certification Board (CACB), established by the provincial/territorial regulatory organisations to accredit the professional programs of architecture schools and to certify the educational qualifications of graduates of these programs[7]. The CACB awards accreditation only to professional M. Arch. degree programs[8].

There are currently eleven accredited M. Arch. Programs[9] in Canada, and these can be grouped in two general types. Dalhousie University, Université Laval, University of Manitoba, McGill University, and Université de Montréal, University of Waterloo, and Ryerson University offer, as well as their professional Master of Architecture program, a pre-professional undergraduate degree devoted completely or in large part to architecture or a closely related discipline. These universities require applicants to the M. Arch. Program to hold a pre-professional undergraduate degree, either from their own pre-professional program or a program judged equivalent. These schools have a 2-year M. Arch. degree period, following the 4-year pre-professional undergraduate degree, except in Québec, where the three schools of architecture have a Masters program of 1.5 - 2 years following a 3-year pre-professional degree[10].

[6] The views of those who deny that climate change is occurring at all, or deny that it is fundamentally caused by human activity, are not part of the subject of this paper.
[7] "About CACB" (n.d.) The Canadian Architectural Certification Board. Retrieved 22 December 2016
[8] "CACB Conditions and Terms for Accreditation for Professional Degree Programs in Architecture"2012 edition, Canadian Architectural Certification Board, Ottawa, 2012 P11. While the CACB is also empowered to accredit certain Bachelor of Architecture programs, in practice it has not done so. All of the accredited programs are graduate level M. Arch. Programs.
[9] CACB Accredited Programs (n.d.). Retrieved from http://cacb.ca/en/accredited-programs/ on 27 November 2016.
These are M. Arch programs offered by:

- University of British Columbia,
- University of Calgary,
- Carleton University,
- Dalhousie University,
- Université Laval,
- University of Manitoba,
- McGill University,
- Université de Montréal,
- Ryerson University,
- University of Toronto, and
- University of Waterloo

[10] In Quebec, two years of study at a CEGEP (Collège d'enseignement général et professionnel) is a pre-requisite for admission to the university system. These are post-secondary collegiate institutions.

The University of British Columbia, University of Calgary, Carleton University, and University of Toronto, on the other hand, offer "stand-alone" accredited professional M. arch degrees of 3-3 ½ years. Applicants to these M. Arch. Degrees need only hold a general four year undergraduate degree, though holders of pre-professional undergraduate may be exempted from the first year.

This results in very varied requirements for the minimum number of years of architectural study required to gain a M. Arch. degree at the various Canadian schools. This minimum period is:

3 years	at the University of British Columbia, University of Calgary, Carleton University, and University of Toronto;
4 - 4.5 years	at Dalhousie University, Université Laval, University of Manitoba, McGill University, and Université de Montréal;
5 years	at University of Waterloo; and
6 years	at Ryerson University.

This range is surprising. All these universities are preparing their students for the same licensure examinations, but some universities teach all the material they deem necessary in 3 years, while others take as many as 6 years.

It does not appear, however, that the longer programs are more likely to include courses on the environment, sustainability, or climate change, since the three schools whose course descriptions and other online material place a great deal of emphasis on these issues are Calgary (3 years), Waterloo (5 years), and Ryerson (6 years) [11].

Are students required or even able to take courses devoted to the environment, sustainability and/or climate change?

A surprising and shocking finding is that not one of the eleven accredited M. Arch. Programs in Canada has a course devoted to climate change.

And only one of the accredited M. Arch. Programs in Canada has a required course devoted to the environment or sustainability in the broad sense. In the program offered at Calgary, "Sustainability in the Built Environment" is a required course in the first, or foundation, year. And, since at Calgary virtually all the entering students take the full 3 years and enter into the foundation year, nearly all M. Arch, students at Calgary graduate having taken this course.

However, things are not as bad as they may appear.

[11] The Ryerson program is a full 6 years of architecture-related courses, apart from a small number of breadth electives.

The M. Arch. programs at Dalhousie, Laval, McGill, Ryerson, and Waterloo ***do*** offer courses devoted to the environment or to sustainability, though these are elective rather than required courses. However, all five of these schools offer a pre-professional undergraduate degree as well as the M. Arch. Degree. All five schools require candidates for admission to their M. Arch. program to hold a pre-professional degree, and in each of these pre-professional programs there is a required course devoted to the environment or to sustainability, key elements of which are set out in the following pages.

So between these five programs and the Calgary program, there are six Canadian accredited programs in which all students ***must*** take a course devoted to the environment or to sustainability to graduate with a professional M. Arch. Degree.

Conversely, however, in five out of the eleven accredited architecture schools in Canada, it is entirely possible for architecture students to go through the education process ***without ever*** actually taking a course devoted to the environment or sustainability, let alone to climate change.

This is not to say that students in these programs have no contact with this material. Many of the courses they are required to take, such as building construction, structures, building control systems, etc, will have environmental and/or climate related material embedded in them. However, it's likely that because of the broad overall nature of these courses, the environment and climate change portions will be approached as tools rather than needing to obtain an understanding of the physical mechanisms concerned. This approach is unfortunate in that if architects are to play their full potential role in this area, the need to actually understand these mechanisms is paramount. Once the students become architects, the interaction between the community, the changing climate, and the environment will be among the most important parameters of their future practice.

What is the organising principle of these courses? Environment, ecology or climate change?

The following extracts from the course descriptions of courses dedicated to the environment, sustainability, ecology, or climate change[12], give a perspective of the approaches and concepts principally used in the programs of the accredited schools with regard to these issues:

University	Extracts from course descriptions of courses offered in the architecture program(s) which are dedicated to Environment, Sustainability, Ecology, or Climate Change	Main concepts addressed in online material
University of British Columbia	None offered	Sustainability. (Ciimate change as a term is not used).
University of Calgary[13]	EVDS523 Sustainability in the Built Environment (required) *"The principle of sustainability recognizes people as temporary stewards of their environments … respect for natural systems …. regenerative ecosystems …. ecologically benign materials … renewable energies …"*	Ecology, Environment, Sustainability. (Climate change as a term is not used).
Carleton University	None offered	Sustainability

[12]These courses are offered either in the school's M. Arch. Program or in its undergraduate pre-professional program, in schools where a pre-professional degree is required for entry to the M. Arch. program. Unless noted as "Pre-prof" (pre-professional undergraduate program), the courses are offered in the M. Arch. Program.

[13]The concept of "Ecology" is used to create a philosophical framework for the MArch program. The overall program is described in the online material in terms of Ecological themes. The material of the 1st semester is set out as a Theme entitled Ecology 1. The later semesters are set out as Ecology 2, 3, 4, 5, and 6. Sustainability is a term used repeatedly in course learning objectives. "M. Arch. Program – Thematic Structure". Retrieved from http://evds.ucalgary.ca/content/march-thematic-structure 17 December 2016.

Dalhousie University	ARCH 5210 Life Cycle Analysis (elective)*" … range of environmental impacts associated with building materials and assemblies, from their raw state to the end of their useful life. It considers operating energy, embodied energy, and carbon sequestration ….."* (Pre-prof) ARCH 4212 Building Systems Integration (required) *"… Building systems are considered in relation to climate, urban situation, and the natural environment … physical and computational modeling methods are applied … to achieve defined performance standards and to consider issues of sustainability with regard to energy balance, water conservation, and component materials"*	Environment & Sustainability are the main terms used - but also operating energy, embodied energy, carbon sequestration. (Climate change as a term is not used).
Université Laval[14]	ARC 6037 Ambiances Physiques et Design (non-requis) … *"les méthodes de simulation des ambiances physiques, de même que sur l'intégration des systèmes de contrôle des ambiances dans le projet. Les projets sont abordés dans leurs dimensions architecturales et urbaines sous l'angle du développement durable".* (Pre-prof) ARC-2001 Architecture & Environnement_(requis) *« Ce cours présente les notions fondamentales des sciences de l'environnement … de même que le recours aux énergies renouvelables (passives et actives)".*	Environment & Sustainability are the main terms used - but also passive and active renewable energy. (Climate change as a term is not used).
University of Manitoba	None offered	Environment & Sustainability. (Climate change as a term is not used).

[14] Author's Translation: AR 6037 Physical Environment & Design (elective). "… methods of simulation of the physical environments, as well as the integration of systems of control of project environments. *Projects are tackled in their architectural and urban dimensions in terms of sustainable development".*
Pre-Prof ARC-2001 Architecture & Environment (required) "This course presents the fundamental notions of environmental science … as well as the use of passive and active renewable energy"

McGill University	ARCH 515 Sustainable Design (elective) *"This course will address sustainable design theory and applications …"* (Pre-prof) ARCH 377 Energy, Environment & Building (required). *"Sustainability, Assessment Tools, Integrated Design Process, Water Conservation, Energy Conservation, Renewable Energy, Materials & Embodied Energy", etc.*	Environment & Sustainability are the main terms used, but also renewable energy and embodied energy. (Climate change as a term is not used)
Université de Montréal[15]	(Pre-prof) APA 1130 Ecologie et développement durable (non-requis). *"Principes et concepts d'écologie générale. Concept de développement durable. Applications de l'écologie aux disciplines de l'aménagement pour la rencontre d'objectifs de développement durable".* Pre-prof ARC 3640 L'architecture verte (non requis) *"Études des diverses théories et pratiques liées à la conception de bâtiments qui sont autosuffisants et performants en termes d›énergie et d›opération … ".*	Ecology & Sustainability. (Climate change as a term is not used).
Ryerson University	AR8211 Ecology (elective) *" … basic dynamics of ecology through the study of varied and typical environments …"*	Ecology, Sustainability, & Environment. (Climate change as a term is not used).
University of Toronto	None offered	Environment & Ecology. (Climate change as a term is not used).
University of Waterloo	(Pre-prof) ARCH 125 Principles of Environmental Design (required) *" … environmental concepts and influences on design … sustainability, embodied energy, climatic influences, and microclimates …"* (Pre-prof) ARCH 126 Environmental Building Design (required) *"… environmental building practices ….. Energy-related issues … "*	Sustainability – Environment are the main terms used, but also passive design, embodied energy. (Climate change as a term is not used).

[15] Author's Translation: APA 1130 Ecology and Sustainable Development (elective) "Principles and concepts of general ecology. Concept *of sustainable development. Applications of ecology to the planning disciplines for the meeting of sustainable development objectives"*
(Pre-prof) ARC 3640 Green Architecture (elective) "Studies of theories and practices related to the design of buildings that are self-sufficient and efficient in terms of energy and operation …

What this scan reveals is that the concept of climate change is not mentioned in a single course description of the courses offered by the schools. Mention of global warming and greenhouse gases are noticeably absent as well. The concepts used are Ecology, Sustainability, and Environment – not climate change.

And in an ironic note, the ***only*** course specifically devoted to climate change at a Canadian university is offered at Laurentian university, in a recently created 4-year pre-professional Bachelor of Architectural Studies program whose first cohort of students graduates in the spring of 2017. Laurentian will be starting a professional M. Arch. Program in 2017.

University	Extracts from course descriptions of courses offered in the architecture program(s) which are dedicated to Environment, Sustainability, Ecology, or Climate Change	Main concepts addressed in online material
Laurentian University	(Pre-prof) ARCH 2306EL Design for Climate Change (required) *"This course reviews the science and considers the implications for responsible practice and due diligence in reducing the emission of greenhouse gases, and adapting to the impacts of change in building systems and infrastructure at all scales in northern environments. The importance of recognizing and protecting the role of ecosystem services in communities is examined in the context of changing climate in all of its aspects: changing normal conditions, variability, seasonal, and extremes. Special northern challenges … are given particular attention".*	Climate change, greenhouse gas emission, environment, ecosystem.

It should be noted that the course descriptions examined above do not necessarily reflect the material actually presented in the course in a particular year. However, the course descriptions do appear to reflect the reality that while the effects of the physical environment on buildings are generally taught across a number of subject areas, such as building construction, environmental controls, etc., there are very few courses specifically devoted to explaining the nature of the environmental mechanisms involved.

How does this situation arise? In part, of course, it arises from choices made by the schools themselves. The schools are free to set their own curricula, and none of them have found it sufficiently important to require their students to take a course devoted to climate change in either their M. Arch program or in the pre-professional undergraduate programs most of them offer. Nor, indeed, in the case of half of the schools, do they offer a course devoted to the environment, ecology, or sustainability. However, the situation does not only reflect the choices made by the schools. In part the situation can be explained by the fact that the regulator does not require them to do so.

Regulatory Context for Architectual Education in Canada

Architects in Canada are trained in three separate stages:

- first, education (generally through an accredited Masters of Architecture program at a Canadian school of architecture),
- second, experience (through an Intern Architect Program), and
- third, by examination through standardized examinations.

In Canada, licensing of professional architects is a provincial/territorial responsibility, and each of the ten provinces, as well as the Northwest Territories, has an Association of Architects[16] empowered by the provincial or territorial government to regulate the profession in the public interest and to license architects.

These provincial regulatory bodies are represented at the national level for licensing purposes by the Canadian Architectural Licensing Authorities (CALA)[17]. Through CALA, the Canadian architectural regulators develop and adopt nationally recognized standards and programs that help to meet their regulatory responsibilities[18].

The body which administers the Education component of the training process is the Canadian Architectural Certification Board (CACB)[19], which was created by CALA and receives its mandate from CALA and the Canadian Council of University Schools of Architecture"[20]. Its main function is twofold: First, the CACB administers the Accreditation of professional programs in the Canadian University Schools of Architecture (the Accreditation Program). Accredited programs must meet established professional qualifications and educational standards through initial and periodic evaluations. Conditions, terms, and procedures for accreditation are cyclically reviewed and updated. And second, it administers the Certification of educational qualifications of individual architectural graduates (the Certification Program). It assesses and certifies that the educational qualifications of individuals holding professional degrees or diplomas in architecture meet the standard. The CACB has, therefore, an extremely important role in determining what knowledge is necessary for licensed architects in Canada.

[16] These associations are:
- Alberta Association of Architects (AAA)
- Architects' Association of New Brunswick / Association des architectes du Nouveau-Brunswick (AANB)
- Architects Association of Prince Edward Island (AAPEI)
- Architects Licensing Board of Newfoundland and Labrador (ALBNL)
- Architectural Institute of British Columbia (AIBC)
- Manitoba Association of Architects (MAA)
- Northwest Territories Association of Architects (NWTAA)
- Nova Scotia Association of Architects (NSAA)
- Ontario Association of Architects (OAA)
- Ordre des architectes du Québec (OAQ)
- Saskatchewan Association of Architects (SAA)

[17] "About CALA" (n.d.) Retrieved from http://cala-roac.ca/about-cala/?lang=en 27 November 2016.

[18] Gage, A (nd). Professionals and Climate Change. West Coast Environmental Law Centre. 2011.
This publication makes a useful contribution by examining the responsibilities that licensing professional associations in a variety of fields might place on their members (architects, engineers, accountants, lawyers, etc.) to consider the environment, and the environmental effect of their actions, in the course of their work.

[19] "About CACB" (n.d.) The Canadian Architectural Certification Board. Retrieved 22 December 2016

[20] Mandate (n.d) Canadian Architectural Certification Board .Retrieved from http://cacb.ca/en/mandate/ 11 February 2017

There is also a third component in which the CACB administers the certification of professional qualifications of Broadly Experienced Foreign Architects (BEFA Program) or of architects from countries whose licensing bodies have reciprocal agreements with the CACB (USA and Canberra Accord countries)[21].

Each architecture school is at liberty to determine its own curriculum for its M. Arch. degree. However, they do so within a framework set by the CACB, which accredits the M. Arch. programs in the various schools. The CACB sets out the terms and conditions for compliance and then conducts on-site inspections to ensure compliance is achieved.

Accrediation Requirements for Architecture School Programs in Canada

In its Conditions and Terms for Accreditation, the CACB sets out a number of areas that must be addressed by school programs applying for either initial or continuing accreditation[22]. In its application, a university and its program must submit an Architecture Program Report (APR) which responds to these areas. Many of these relate to the way in which a university sets out its architecture program, such as courses offered, staffing levels, budget, library, etc. However, the program must also respond to two other areas:

First, the program must respond to the relevant interests of the constituencies that make up the CACB: educators and regulators, as well as practicing members of the profession, students and interns, and the general public. The CACB has brought together these interests into five broad CACB perspectives and the program in its submission for accreditation must include a discussion as to how it addresses each of the perspectives. One of these perspectives is set out in terms of "Architecture Education and Society",

> E. Architecture Education and Society
> "The program must demonstrate that it equips students with an informed understanding of social and environmental problems and that it also develops their capacity to help address these problems with sound architecture and urban design decisions. Given its particular mission, the APR may cover such issues as: how students gain an informed understanding of architecture as a social art, including the complex processes carried out by the multiple stakeholders who shape built environments; the emphasis placed on generating the knowledge that can mitigate social and environmental problems; how students gain an understanding of the ethical implications of built environment decisions; and how a climate of civic engagement is nurtured, including a commitment to professional and public service".

The CACB therefore requires of architecture programs that they equip students with an informed understanding of environmental problems, and how to mitigate these, and it encourages them to equip

[21] "Accredited Programs in Canada" (n.d.) The Canadian Architectural Certification Board. Retrieved 22 December 2016

[22] CACB. Conditions and Terms for Accreditation for Architectural Programs in Canada 2012.

students to gain an understanding of the ethical implications of built environment decisions.

And second, the program must address student learning outcomes. The institution is required to address a total of 31 Student Performance Criteria (SPC's). Each program is required to ensure that all its graduates possess the skills and knowledge defined by the performance criteria. The program must provide evidence that all its graduates have satisfied each criterion through required course work.

Of the 31 SPC's, only one includes specific reference to the Environment, Sustainability, or Climate Change.

> B4. Sustainable Design
> "Ability to apply the principles of sustainable design to produce projects that conserve natural and built resources, provide healthy environments for occupants/users, and reduce the impacts of building construction and operations on future generations".

It should be noted that there are other SPC's that clearly have environmental implications, but these are not spelled out as particular requirements in the SPC's.

We see nowhere any mention of climate change, no recognition of the overwhelming consensus among climate scientists that global warming is a crucial challenge for humanity, and no mention of the crucial role that architects are in a position to play in the critically important task of reducing greenhouse gases.

We do see, though, an awareness of the importance of the ethical implications of built environment decisions, and that the schools are encouraged, though not required, to ensure students can gain an understanding of the issue.

And while SPC B4 is worded broadly enough that it could perhaps be said to imply climate change issues, the clear emphasis is on the environment and the conservation of resources. Climate change as such is not mentioned. The phrase "reduce the impact of building construction and operation on future generations" might be interpreted to refer to the preservation of the world's resources (e.g. water, timber, etc). The meaning could perhaps be extended to refer to climate change, but there is nothing specific at all to refer to this crucial issue for the survival of society as we know it. Indeed, the nature of the wording is such that one might feel that SPC B4 was worded in this way to avoid mentioning climate change.

The lack of engagement with climate change is disturbing, but perhaps not surprising. The current Conditions and Terms are approximately 10 years old and date from a period where Canadian society was far less aware of, or concerned by, the issue of climate change. And the CACB is currently approaching the end of a review and update process which may see a new and updated document approved and in place in 2017. Hopefully, the updated requirements will explicitly deal with climate change, the need for greenhouse reduction, and will discuss the role of architects in this regard. However, it is of great concern that such an important issue has had to remain unaddressed for such a long period, since SPC B4 in its current form, is the only accreditation issue the school programs are required to address concerning the environment. It is certainly positive that the CACB proposes to review and update the Conditions and Terms every 5 years from now on, rather than the 10-year cycle which

has pertained up till now[23].

Architecture Program Reports and Visiting Team Reports

As discussed above, a school wishing its program to be accredited prepares a major document called an Architecture Program Report (APR) setting out its view of the way in which the program meets the CACB accreditation requirements and makes available student work from the various courses. A CACB Visiting Team performs a site visit, reviewing the findings it makes on site against the APR and the student work, and prepares a Visiting Team Report (VTR). These reviews are carried out both for an Initial Accreditation application and also for applications for Continuing Accreditation. Continuing Accreditation reviews are carried out, in general, on a rolling 6-year cycle.

As part of the site visit, the Team makes its evaluation of whether the program meets or does not meet, the various Student Performance Criteria. Starting approximately 3 years ago, the CACB makes publicly available the schools' APR's and also the Visiting Team Reports.

The APR's and VTR's from the last site visits for four accredited M. Arch. programs are now available (with partial documentation for a fifth), and it is possible to examine both the schools' presentations and also the Visiting Team findings regarding SPC B4 "Sustainable Design", the only Performance Criterion which refers to the Environment. As discussed above, the CACB currently has no requirements for students to have an understanding of climate change, but they are expected to have an understanding of sustainable design.

It is perturbing, then, to discover that of the four schools for which APR's are available, *there is virtually no mention at all of climate change or greenhouse gas emissions.* And in none of them is there any mention of the important issue of the ethical implications of built environment decisions, which the CACB encourages them to address. And it is very worrying that of the five university architecture school M. Arch. Programs for which VTR's are publicly available, in two of the five programs the Visiting Team evaluations were that *the requirements for SPC B4 were not met, and that the student's work did not demonstrate an adequate understanding of sustainable design.*

[23]Personal communication from Mr. Mourad Mohan-Said, Executive Director CACB, 22 December 2016

International Comparisons of Accreditation Requirements in Selected Countries

It is worth looking, for comparison purposes, at accreditation programs outside Canada that the CACB recognises as substantially equivalent to accredited Canadian programs. These equivalencies were formalised in the Canberra Accord of 2008[24], in which each of the parties recognised the substantial equivalency between the programs it accredits or validates itself and the programs accredited/validated by the other parties in their own countries. There is in fact a certain degree of commonality between the various countries' Conditions and Terms, and Procedures for accreditation. For example, between the accreditation documents issued by the CACB and those of the accrediting bodies in the USA and the UK, there is a high degree of very similar requirements and even of common vocabulary.

ACCREDITATION REQUIREMENTS IN THE USA (NAAB)

In the USA, the National Architectural Accrediting Board Inc. (NAAB) is the body generally responsible for accrediting architecture school programs, equivalent to the CACB in Canada. (The NAAB-accredited degree is required for registration in 37 of the U.S. jurisdictions and accepted in all of them).

NAAB sets out in Part 1 of its Conditions for Accreditation[25] a number of Defining Perspectives. The institution must demonstrate how it is responsive to these Defining Perspectives or forces that affect the education and development of professional architects. One of the five defining perspectives is:

> "Stewardship of the Environment. The program must describe its approach to developing graduates who are prepared to both understand and take responsibility for stewardship of the environment and natural resources".

A number of major elements of the accreditation submission relate directly to this concept of environmental stewardship.

In Part 2 of the Conditions, relating to educational outcomes and curriculum, a number of Student Performance Criteria (SPC's) have been set out, in each of four realms and programs must demonstrate that each graduate possesses skills in Student Performance Criteria (SPC's) which relate to the Student learning aspirations in each realm.

In Realm B: Building Practices, Technical Skills, and Knowledge, one of the four Student learning aspirations is "Integrating the principles of environmental stewardship". Of the SPC's in this realm, two refer

[24] "Canberra Accord on the Recognition of Substantial Equivalency Between Accreditation/ Validation Systems in Architectural Education". 9 April 2008. The parties to the Accord, after NAAB in the USA joined in 2013, are:
the Australian Institute of Architects;
the Canadian Architectural Certification Board;
In China, the National Board of Architectural Accreditation;
the Commonwealth Association of Architects (with 33 member countries, including the UK);
the Korea Architectural Accrediting Board;
in Mexico, the Acreditadora Nacional de Programas de Arquitectura y Disciplinas del Espacio Habitable; and
in the USA, the National Architectural Accrediting Board Inc.

[25] 2014 Conditions for Accreditation, approved 18 July 2014, National Architectural Accrediting Board Inc, Washington D.C.

specifically to Environment, Sustainability, or Climate Change:

> "B.2 Site Design:
> Ability to respond to site characteristics, including urban context and developmental patterning, historical fabric, soil, topography, ecology, climate, and building orientation, in the development of a project design".

> "B.7 Building Envelope Systems and Assemblies:
> Understanding of the basic principles involved in the appropriate selection and application of building envelope systems relative to fundamental performance, aesthetics, moisture transfer, durability, and energy and material resources".

In Realm C: Integrated Architectural Solutions, one of the four Student learning aspirations is "Responding to environmental stewardship goals across multiple systems for an integrated solution". Of the SPC's in this realm, one refers specifically to Environment, Sustainability, or Climate Change:

> "C.3 Integrative Design:
> Ability to make design decisions within a complex architectural project while demonstrating broad integration and consideration of environmental stewardship, technical documentation, accessibility, site conditions, life safety, environmental systems, structural systems, and building envelope systems and assemblies".

These criteria clearly address environmental issues, but are expressed only in a general way. In fact, there appears to have been a step backwards in recent years. In the previous 2009 edition of NAAB's Conditions for Accreditation[26], there was a much more specific criterion relating to the environment and also to the need to deal with climate change, though this was not mentioned specifically):

> "B. 3. Sustainability:
> Ability to design projects that optimize, conserve, or reuse natural and built resources, provide healthful environments for occupants/users, and reduce the environmental impacts of building construction and operations on future generations through means such as carbon-neutral design, bioclimatic design, and energy efficiency."

As in Canada, other SPC's in this realm clearly have environmental implications, but these are not spelled out as particular requirements.

Through its Defining Perspectives, Student learning aspirations, and Student performance criteria, NAAB clearly sets out a more rigorous set of expectations relating to an architect's role regarding stewardship of the environment than does the CACB. But in a parallel to the Canadian situation, there is no direct mention of climate change. And while, as in the equivalent CACB document discussed above, the language used seems somewhat older style, it is more surprising in that in the US case, the earlier version was more specific.

[26] 2009 Conditions for Accreditation, approved 10 July 2009, National Architectural Accrediting Board Inc, Washington D.C.

ACCREDITATION REQUIREMENTS IN THE U.K. (ARB-RIBA)

In the UK, the Architects Registration Board (ARB) is responsible by law for prescribing the qualifications and practical experience required for licensure in the UK, while the Royal Institute of British Architects (RIBA) carries out the Visiting Board validation process. (RIBA uses exactly the same criteria for membership as the ARB uses for licensure). The Visiting Board makes a formal report, similar to the Canadian CACB Visiting Team Reports. These Visiting Board reports are a key element of a university program's application for accreditation.

The ARB has established General Criteria[27] to set out the subject material that must be covered by students gaining qualifications that are prescribed by ARB at Part 1 and Part 2 levels. Students normally proceed through a pre-professional Bachelor degree (e.g. a B. Sc. Arch. program accredited by ARB/RIBA for the Part 1 level, then on to an M. Arch program accredited for the Part 2 level. Like a Canadian M. Arch. degree, its holder is enabled, after having completed an approved Period of Practical Experience similar to the Intern Architect programs in Canada, to proceed to the Part 3 professional practice examination for licensure.

Of these, General Criteria, two include specific reference to the environment and sustainability, though not to climate change:

GC1 The graduate will have the ability to: …

1.2 "understand the constructional and structural systems, the environmental strategies and the regulatory requirements that apply to the design and construction of a comprehensive design project;"

GC5 The graduate will have an understanding of: …

5.2 "the impact of buildings on the environment, and the precepts of sustainable design …"

Like the Canadian requirements, the UK and US accreditation requirements include a general understanding by the students regarding the environment, sustainability, etc. However, again as in Canada, there is no mention of climate change in the listing of requirements for accreditation.

International Comparison of Selected Architecture Schools

USA

Two major US schools were chosen for a comparison with the Canadian schools discussed above, the schools of architecture at Harvard and at the Massachusetts Institute of Technology (MIT).

The M. Arch. Programs at Harvard and MIT are both 2-year programs. MIT has a pre-professional

[27] Prescription of Qualifications: ARB Criteria for Parts 1, 2, and 3. Architects Registration Board, January 2010. London

program, while Harvard does not. Both schools require applicants to hold standard B. A. or B. Sc. undergraduate degrees, but both schools will allow entry directly into the second year of the program to holders of a 4-year pre-professional degree if they have completed courses equivalent to the courses of the first year of the M. Arch. Program.

The Harvard M.Arch. program has two required courses devoted to the environment, sustainability, etc, as well as electives. The MIT M. Arch. Program has one required course as well as an elective in these areas. The pre-professional program also includes an elective.

The following extracts from the course descriptions of courses dedicated to the environment, sustainability, ecology, or climate change, give a perspective of the courses offered in the programs of the accredited schools with regard to these issues:

University	Extracts from course descriptions of courses offered in the architecture program(s) which are dedicated to Environment, Sustainability, Ecology, or Climate Change	Main concepts addressed in online material
Harvard University	GSD 6125 Environmental Systems in Architecture (required). *"The primary focus … is the study of ecological considerations in architectural design….Gain a better understanding of global sustainability issues and the role of buildings within this context……Develop analytical and creative thinking regarding sustainability and energy issues in building design."* GSD 6122 Energy in Architecture (required) *"… introduces students to energy and environmental issues An overview of the basic principles of energy generation and energy use will be provided … the fundamental climatic precursors and patterns will be discussed … Building design issues in relation to basic energy needs and interior environmental requirements …the underlying complexity of developing solutions that address a wide range of local and global concerns. In addition, the technological response to interior environmental control will be contextualized within the larger framework of the scientific and socio-cultural influences that shaped the building systems we currently use".* GSD 6452 Building Simulation: Performance Prediction Methods for Design and CFD (elective) … *"The course will provide students with 1) An understanding of building simulation methods and their underlying principles 2) Hands-on experience in using environmental computer simulation models. State-of-the-art computer models for thermal, ventilation (Computational Fluid Dynamics) and solar analysis will be introduced. Innovative techniques on how to use these models in architectural design will be explored. … A series of analysis projects will be assigned after each topic presented to provide students with hands-on experience in using the computer models introduced. A final project will use all the techniques studied to redesign an existing building to optimize its energy use.* SCI 6470 Energy Simulation (elective) *"In this course, students will acquire skills in energy simulation while simultaneously using these skills to explore fundamental design issues such as building massing, daylighting, and envelope design."*	Environment, sustainability, ecology, climate change.

Massachusetts Institute of Technology	4.464 Energy in Building Design (required) *"Presents concepts and methods for energy-efficient and environmentally responsible building design. Topics include climate, thermal comfort, heat flows through building materials, natural ventilation, passive, active and renewable energy systems, and environmental implications of building. Emphasizes practical applications for environmental design through analysis of precedent buildings and design projects".* 4.433 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods (elective) *"A fundamental focus of the course … is the impact of the urban microclimates on the built environment … in dense urban settings buildings strongly interact with each other, thus creating microclimates that significantly alter their energy use and comfort … Microclimatic effects, which students will learn how to model, include shading from neighboring buildings, localized wind patterns, and urban overheating or "urban heat island effect". Furthermore, predicted climate change projections from the Intergovernmental Panel on Climate Change (IPCC) over the coming 70 years will be simulated as well, enabling students to evaluate their projects under current and future climate scenarios".* (Pre-prof) 4.42J Fundamentals of Energy in Buildings (elective). *"This design-based subject provides a first course in energy and thermo-sciences with applications to sustainable energy-efficient architecture and building technology…"*	Environment, sustainability, renewable energy, climate change

The 2012 Visiting Team Report on the Harvard M. Arch. program noted that, while the 2006 Visiting Team Report gave the program a "criterion not met" grade for sustainability/energy conservation, since then the program had hired faculty specifically to implement improved academic coverage of all sustainability issues, and that these criteria were now met[28].

The 2015 visiting Team Report for the MIT M. Arch. Program found that the criteria were indeed met, and noted that "in the student projects of Core Studio III, research concerning embodied energy and the carbon footprint was thoughtful, relevant, and exemplary[29]".

UNITED KINGDOM

A major British school was also chosen to provide an international comparison with the Canadian schools.

The Masters in Architecture and Urban Design program at Cambridge is a 2.5 year programs, though

[28] Harvard University Graduate School of Design Master of Architecture Visiting Team Report, National Architectural Acrediting Board, 4 April 2012, P2.
[29] Massachusetts Institute of Technology Department of Architecture Master of Architecture Visiting Team Report, National Architectural Accrediting Board, 4 March 2015, P19.

it include a significant period of "fieldwork" in an architectural practice or other approved organization. Cambridge has a pre-professional program and it requires applicants to the Masters program to hold a pre-professional undergraduate degree in architecture.

The Cambridge program has two required courses devoted to these issues, one of which is directly concerned with climate change, as well as several electives.

The following extracts from the course descriptions of courses dedicated to the environment, sustainability, ecology, or climate change, give a perspective of the viewpoint of the courses offered in the program with regard to these issues:

University	Extracts from course descriptions of courses offered in the architecture program(s) which are dedicated to Environment, Sustainability, Ecology, or Climate Change	Main concepts addressed in online material
Cambridge University	10.3.1 Environmental Design Strategy (required) *"Buildings urgently need to become more resilient to a changing climate whilst using very much less energy but post-war designers have made less and less resilient buildings more and more dependent on energy intensive artificial environments. The majority of recent buildings, however audacious their form, broadly conform to a standardized pattern: framed and highly glazed with substantial service voids lined in lightweight materials piping conditioned air and refrigerant. What are the implications of this formula in regions where the environment is predicted to warm? Can it be adapted to acquire greater resilience to a more volatile climate? … recent work in Cambridge on climate change … We will examine these challenges by investigating alternative environmental design strategies … in various climates … As climates shift, designers in Temperate zones should benefit from experiences in Mediterranean climates ….* *… We will review completed buildings with innovative environmental design strategies … We will review their actual recorded performance. The post-occupancy reports, peer–reviewed, are candid about their successes and failures. Through this we will develop a sense of how to evolve an authentic environmental design strategy and how difficult it seems to be …"* "10.6 1 Resilience, Modeling and Policy (required) *… a broad spectrum of topics in sustainability … explore different performance aspects, including energy efficiency, resilience, thermal comfort … and research methods (both quantitative and qualitative)".*	Environment, sustainability, climate change

The 2015 Visiting Board Report[30] found that the program did meet the environmental criteria.

All of the three US and UK schools have both required and elective courses devoted to climate change, the environment, sustainability, and/or ecology. In all three schools, one can see in the course descriptions an emphasis on climate change, as well as more general environmental issues.

Conclusion

The training of architects in Canada is carried out through a national system. The eleven accredited architecture programs are required to comply with criteria set out by the national accrediting body, the CACB, to receive the accreditation which permits their graduates to proceed on to licensure.

It is most unfortunate that there is no mention of climate change in any of the CACB criteria. Only a single criterion refers to an associated issue, that of sustainable design, but there is nothing specific at all to refer to the issue of climate change.

And the schools have responded in kind to the lack of regulatory involvement. As we have seen, in half of the eleven architecture schools in Canada, it is entirely possible for architecture students to go through the education phase of their training *without ever actually taking a course devoted specifically to the environment, let alone to climate change.*

In the available Architecture Program Reports there is little or no mention of climate change, and in the CACB Visiting Team Reports it is the same. And, as we have seen, in all of the eleven university websites, there is hardly a mention of climate change in the online program descriptions and course material. The importance of the issue for Canada and the world's communities, and the crucial role that architects can play in significantly reducing greenhouse emissions is simply absent. This is not to say that in it is completely absent from the material actually presented to the students, but its absence from the online program and course descriptions is astounding.

The situation in both the USA and UK is somewhat different. In both the US and UK, while the regulators do not require the schools to address the question of climate change and they do not require the students to have gained an understanding of the issues involved, they do require considerably more of the schools and their programs in terms of understanding environmental issues and, in the US, of taking responsibility for environmental stewardship.

However, the three major US and UK schools examined above have all gone a good deal further than the regulators' requirements. And they have also gone much further than the accredited Canadian schools in terms of having both required and elective courses which deal with climate change. The course descriptions quoted above from Harvard, MIT, and Cambridge, are exemplary in this regard.

In this period of climate crisis, there is no requirement from the Canadian regulators for the architectural school, programs to even address this crucial issue for the survival of the world's communities. *This*

[30] Report of the Visiting Board to the University of Cambridge Department of Architecture, confirmed by the RIBA Education Committee 17 April 2015, Royal Institute of British Architects, London

needs to change.

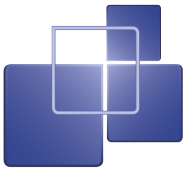
It is profoundly to be hoped that the issue is adequately addressed in the upcoming revised edition of the CACB's "Terms and Conditions for Accreditation", expected to be released in 2017. This is a crucial societal issue, and the provincial regulators charged with the protection of the public interest need to ensure that it is addressed in the education of student architects. It is crucial, given the importance of the role that architects are in a position to play in reducing greenhouse emissions, that firm criteria are set out in the next edition regarding the necessity for the students to obtain an understanding through the course material of the phenomenon of climate change

It is also imperative that the schools incorporate into their curricula, courses that enable their students to both develop the understanding required, and to master the range of methods and approaches for reducing greenhouse emissions through the materials they specify, the construction of the buildings they design, and the lifetime energy requirements of these buildings.

Architects need to have a high degree of construction-related climate literacy, in the sense that they need to be knowledgeable about:

- the actual nature of climate change and what is driving it,
- the significance of the sector in reducing GHGs,
- requirements of building code and LEED or other certifications,
- practical approaches by which architects can bring about significant GHG reduction,
- ethical options in relation to their future clients, to ensure these clients are themselves sufficiently "climate-literate" to make informed decisions.

Whether or not the upcoming revision to the CACB accreditation requirements directly addresses climate change, *it is incumbent on all Canadian schools of architecture* to do what the major international schools quoted above have done, and seriously address the issue of climate change and to equip their students with an adequate theoretical understanding of the issues, a developed notion of what constitutes responsible practice concerning climate change, and a practical ability to contribute to society's efforts to preserve the environment we live in.



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