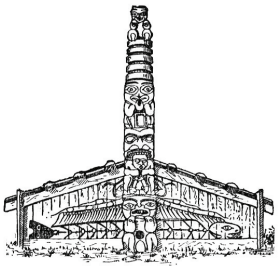
Vol. 7, No. 1

The Engineering Explorations Newsletter

Harmonics

What is building engineering?

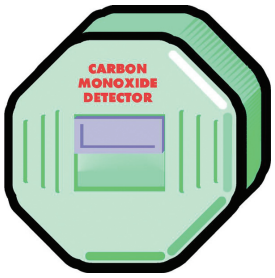


Long ago people started looking for and making shelter for safety and comfort. A shelter as simple as a cave or a lean-to was warmer, drier and safer than the outside because it provided protection from the weather, the wildlife and other people. As time went on, people all over the world devised 1000s of solutions for habitation; moving from basic shelter to more elaborate structures. In the Americas, ingenious solutions included tipis, iglus, longhouses, and mound houses. Each structure met the specific needs (portability, easy access to materials etc.) of the people who built it, but each also continued to fill the basic needs of providing more safety and comfort than the outdoors.

Today, we usually design and construct buildings for permanent or long-term use. When people are going to use a structure for a long time, they want to know that it is safe and comfortable. And, if they own the building or are responsible for its maintenance, they probably also want to know that it is economical to run. Building engineering is all about meeting these needs. It is a holistic approach to building design, management and maintenance that ensures the safety and comfort of building users. Building engineers are not just interested in how a building looks, but in how it functions. They look at a building as an integrated system, where each part is affected by and impacts on the others. To take this holistic approach, they combine knowledges from civil, mechanical and electrical engineeering, as well as architecture, biology, chemistry and physics. In any project, they begin by carefully studying the intended use of the building so that its safety features, environment and looks properly serve its function. Building engineers specialize in a number of different areas.

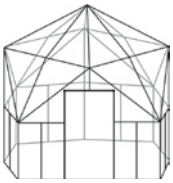
Building safety

Building safety includes ensuring the use of fire resistant materials, as well as control of air and water quality.Building engineers also look at the strength and rigidity of the structure to make sure it won't fall down, or sway to much in heavy winds. In a school, building safety would be installing a sprinkler system to control fire. In a home it would be installing smoke and carbon monoxide detectors.



Building environment

Unlike the outdoor environment, the indoor environment can be controlled. Building engineers design heating and cooling systems that allow for control of temperature, ventilation and humidity. So, in most homes we have thermostats that allow us to control the temperature all year round.



Building economics

In terms of economics, building engineers make sure that a building is made from long-lasting materials and components, and that it has reasonable operating and maintenance costs. So, in a school, building enginers would recommend using floor tiles instead of carpet; tiles are easier to clean and last longer.

Building aesthetics and comfort

Looks do play a role in building engineering, because nice surroundings always make people feel better. Building engineers also ensure aesthetics and comfort through odour, sound and vibration control, as well as appropriate lighting. For instance, a building engineer might suggest that rooms next to a gymnasium be used for storage, so that no one will be bothered by the vibration caused by running and jumping.

Now that you have an idea what building engineers do, think of how you could contribute to your community if you became a building engineer.

Native Engineers & Scientists

A place to meet people from your community.

Name: Wanda Dalla Costa
Nation: Saddle Lake First Nation, Alberta
School(s) Attended: University of Calgary, University of Alberta
Degree(s): Master of Architecture, Bachelor of Arts
Job Title: Intern Architect
Favorite thing about job: "I specialize in First Nation's architecture and sustainable building. My job is to design buildings for our ceremonies, gatherings, and activities that reflect our culture and respect the environment."

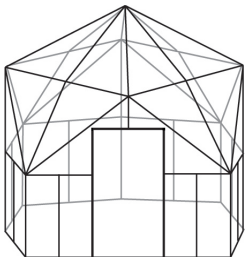
At some point in her life Wanda Dalla Costa wanted to be a jewelry designer. Inspired by design, Wanda applied for graduate studies in architecture. As an intern architect at Waugh and Busby Architects, an aboriginally owned architecture firm in Calgary and Vancouver, she does get to design some pretty big jewels. "At this time we are working on a cultural centre, a community centre and an alternative energy initiative," she explains. A member of the Saddle Lake First Nation in Alberta, Wanda is responsible for design, construction administration and project management.

Wanda says that combining traditional knowledge with modern science has been an important part of her job. "When I think about ventilating a building I think about how air entered/exited our traditional structure, the teepee. The buildings have changed, but the principles remain the same," she explains. In every aspect of her work she gets a chance to incorporate cultural symbols, consult with Elders, and choose natural or traditional materials. What she is most proud of about her work is "being able to sit with an Elder and have their words guide a project."

Wanda always enjoyed art and design. When she was younger, a teacher told her that there was a need for Aboriginal people in the area of architecture. "To create buildings or landscapes that reflect our ways of viewing the world is precious. There are less than 10 Native architects in Canada!" Through studying architecture she has learned how to design and build, and has had the opportunity to study and learn from many cultures in Canada and internationally. During school she also learned that critiques, or having others comment on your work, is a vital part of architecture. Comments provided by your professors and/or colleagues' challenge you to find the best solution to each problem.

Wanda notes that as Native students "you are in a unique position to be able to use traditional knowledge and apply it to contemporary studies. Imagine the rewards of combining traditional botany with contemporary medicine, traditional ecology with contemporary environmental science. The combinations are endless. Our history and knowledge offers a rich counterpart that will support and even propel your career in sciences or engineering."

In her spare time, Wanda likes to travel, paint and make Native crafts. Occasionally, she even gets the chance to make jewelry.

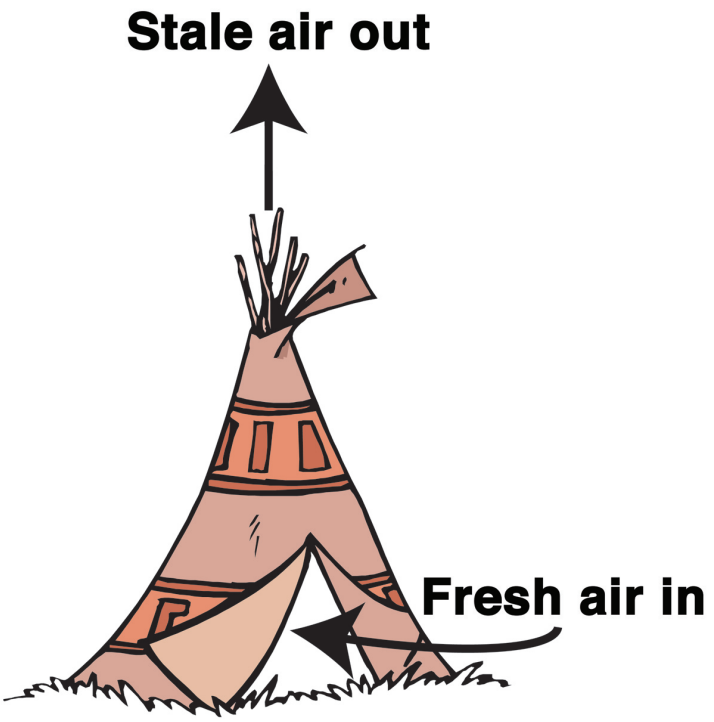


The air inside

How much time do you spend indoors? In cities, during the winter, people can spend up to 90% of their time inside. No matter where we live, nearly all of us spend a lot more time inside today than our parents, grandparents and great grandparents did when they were our age. Its not surprising, then, that we have become concerned with indoor air quality (IAQ).

Believe it or not, the air inside our homes, schools and work places can be more polluted than the air outside. When the air in a building becomes extremely polluted, engineers say it has Sick Building Syndrome (SBS).

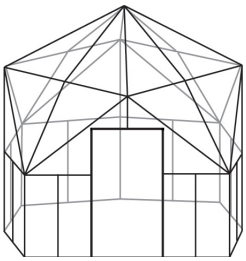
SBS isn't usually caused by one element in a building, but a combination of things. Many of the activities we do, like cooking, and products we use, like carpeting, give off gases, fumes, chemicals and/or dust that create air pollution. Cleaning products, cigarette smoke, paint, fire places, carpeting, new furniture, heating or motor oil etc. can all add harmful compounds to the air we breathe inside. Some of these compounds (like carbon dioxide, carbon monoxide and ozone) aren't bad in small amounts, but can become extremely dangerous – even life threatening – in high concentrations. When high levels of these compounds are combined with poor ventilation (air flow through a building) SBS can occur.



All traditional structures were designed to create a through-flow of air. Fresh air entered through doors and or windows, and used, stale air was usually expelled through roof top holes that acted like chimneys.

In order to provide good IAQ, buildings need to be able to breathe. By taking in fresh air and expelling used or bad air, buildings, and the people in them, can remain healthy. Buildings breathe through their windows and doors, and even through their walls. Really large buildings breathe with the help of heating, ventilation and air conditioning (HVAC) systems. There is a whole sub-section of Building Engineering which concentrates on HVAC design.

Many IAQ problems occur in winter when we tightly shut doors and windows to keep heat inside. But, even in winter, houses need to breathe. Our ancestors recognized the need for proper ventilation in their housing designs. All the buildings they constructed - long houses, tipis, iglus, mound houses etc. - incorporated effective ventilation that allowed fresh air to enter a building and used (often smoky) air to leave it. They were building engineers long before the term ever existed.



Sources:
US Environmental Protection Agency:
http://www.epa.gov/iaq/pubs/insidest.html#Intro1
Fort Nelson Traditional Aboriginal Homes,
http://www2.sd81.bc.ca/~fnap/fnapstudents/fnhomes/homes.html.

Community Profile

Tyendinaga, Ontario

You probably wouldn't notice anything special about the houses on the Tyendinaga Mohawk Reserve in southern Ontario. They all look like average suburban homes; but some of them have won awards for energy efficiency and technical excellence.

Built by the Mohawks of the Bay of Quinte Council, the houses actually exceed R-2000 standards, meaning they are some of the most environmentally friendly, energy efficient homes anywhere in the country. The R-2000 Healthy Housing Program sets performance standards for design and construction of energy-efficient homes. Houses constructed using this method are considered as entire systems, where overall comfort, low maintenance, energy efficiency, water conservation, indoor air quality and longevity all play key roles in keeping occupants healthy and happy.

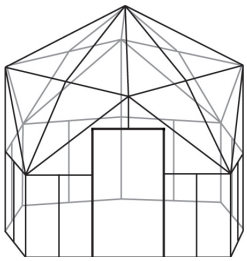
R-2000 homes cost 4-7% more than regular homes to build, but are 30% cheaper to operate. Owners make back their extra inital investment in 4-7 years. One award-winning home in Tyendinaga has insulated concrete forms under the concrete in its basement. This type of construction keeps the basement, which would normally be cooler than the rest of the house, quite warm, and leads to even bigger energy savings on winter heating bills.

Only groups that are certified, trained and licensed by Natural Resources Canada are allowed to design and build R-2000 homes. The Mohawks of the Bay of Quinte are one of a select group of contractors and builders across the country with such certification. It is helping them meet local demands for housing. Through the R-2000 Healthy Housing Program, they have built more than 65 homes in Tyendinaga over the past 10 years, and more are in the planning stages. The programme has allowed local people to gain skills in construction, project management and planning, and has supported local businesses, like the lumber yard. Their expertise in energy efficient construction means Tyendinaga builders are in high demand not just at home, but also in surrounding communties.

Tyendinaga's success with the R-2000 Healthy Housing Program isn't just due to technical expertise. The houses on reserve are built in consultation with Elders, to ensure they meet community needs. So, houses for grandparents always have rooms for grandchildren, and front doors often enter into kitchens, the focal point of the home. Tyendinaga's success is encouraging other Aboriginal communities to follow its lead. Lac la Croix First Nation (Ontario) and the Mohawks of Akwesasne (Ontario) will soon start building R-2000 homes too.

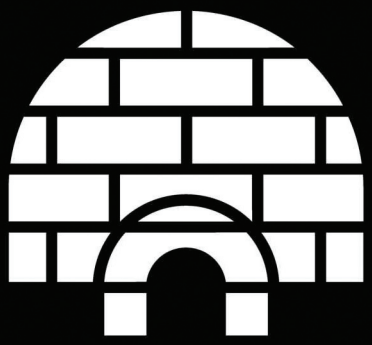
Houses in Tyendinaga have received the EnerQuality Corporation R-2000 Excellence Award for Technical Excellence and a 2003 Canada's Energy Efficiency Award.

Sources:
Building Houses, Building a Community
http://oee.nrcan.gc.ca/awards/housing_mohawks.cfm?text=N&printview=N
Canadian Mortgage and Housing Corporation
http://www.cmhc-schl.gc.ca/en/News/nere/2001/2001-03-02-1530.cfm
Indian and Northern Affairs Canada
http://www.ainc-inac.gc.ca/nr/nwltr/bae/sum03/sum06_e.html
Natural Nesources Canada - R-2000
http://oee.nrcan.gc.ca/r-2000/english/public/index.cfm?PrintView=N&Text=N
R-2000 on Reserve
http://temagami.carleton.ca/jmc/cnews/04042003/connections/c2.html



Fun facts and things to think about

Did you know…



…in igloos, seal skins are hung inside the dome to prolong the life of the shelter? By insulating the snow walls from the body heat of occupants, the skins prevent the walls from melting and refreezing into an icy crust. If that crust forms, the snow loses all its insulating capacity and the cold from outside gets into the igloo.

Heavy snow

Snow is a big deal in building design in Canada. In most places, roofs have to be constructed so they can hold up A LOT of snow. Different regions of the country get different amounts of snow, and so roofs have to be designed to hold more snow in Glacier, BC (which has one of the highest snow loads), than in Iqaluit, NU.

To design safe roofs, engineers reference baseline snow loads which tell them how much a 10m x 10m roof can hold before collapsing. How much snow does a 10mx10m roof have to hold where you live? Here are a few examples. You can look up other cities and towns on the *Canadian Geographic* web site. http://www.canadiangeographic.ca/alacarte/JF03

Snowloads for flat 10mx10m roofs

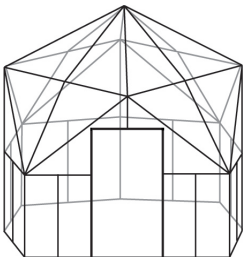
Glacier, BC	88,776 kg
Kuujuarapik, QC	44,898 kg
Iqaluit, NU	29,529 kg
Inuvik, NT	22,449 kg
Fort McMurray, AB	14,286 kg
Toronto, ON	12,245 kg

Smoke alarms

Building engineers work on developing building materials that don't burn quickly or smoke too much when on fire. They hope these materials will help more people survive house fires.

In 2000, there were 21,206 residential fires in Canada. They resulted in 243 deaths and 1676 injuries. While the over all rate of residential fires has been going down, the rate in Aboriginal communities is higher than the average.

One of the best ways to survive a house fire is to make sure you have working smoke alarms installed in your home. You should have at least one smoke alarm on each storey of your house. At least one should be near the bedroom doors. Alarms inside each bed room are also a good idea. Remember, smoke alarms only work when they have batteries. You should change the batteries in your alarms at least twice a year.



Engineering is a great profession. There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realisation in stone or metal or energy. Then it brings homes to men or women. Then it elevates the standard of living and adds to the comforts of life. This is the engineer's high privilege.

-Herbert Hoover

Wind Tunnel Models

One of the things building engineers do is study how a building or group of buildings react to strong winds. By making scale models of buildings, and placing them in wind tunnels, they study many wind effects. They may be interested in:

- how buildings in areas which have hurricanes or tornadoes might react to the extreme storms;
- how groups of buildings might act together to funnel wind down a street of around a corner;
- how very tall buildings move and sway in the wind;
- how oddly shaped building extensions can affect air flow.

An architect in your town has designed a building that looks like Figure A. On snowy, windy days the air flow around the building is so turbulent that people can't see to cross the street safely. To conduct your wind tunnel tests you need to give scale sketches to a colleague who will create a model of the building for you. Which of the sketches in Figure B is the front view of the building?

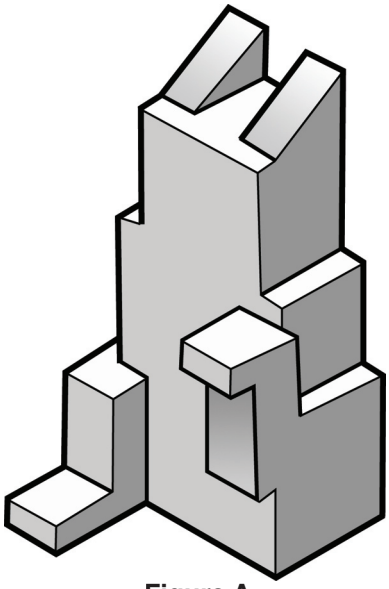


Figure A

Based on a puzzle found at Puzzles in Education, http://puzzles.com/powPrev4.htm

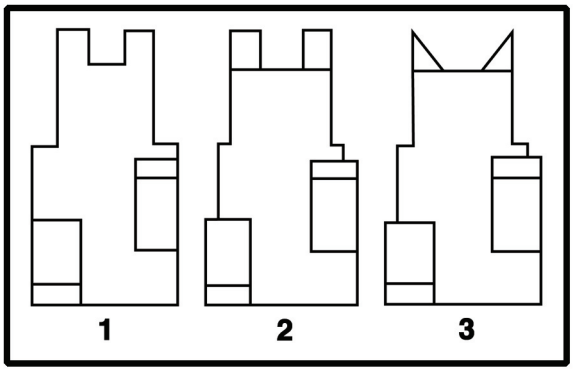


Figure B

Ans. 2

All about us

Native Access provides culturally relevant learning opportunities in science, math, engineering and technology to Aboriginal students and their teachers across Canada.

Established in 1993, the project's ultimate goal was to increase the representation of Aboriginal peoples among the the ranks of practicing engineers and scientists in Canada.

ISSN 1492-6075

You can reach us at:

Aboriginal Access to Engineering Program
Faculty of Applied Science & Engineering
Queen's University
Kingston Ontario K7L 3N6

Tel: 613-533-6000 ext. 78563
Email: director@aboriginalaccess.ca
URL: www.aboriginalaccess.ca