Tech. 10

3D CAD Module

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G.M.C.S.

In this module, you will learn some aspects of designing a house using simple 3D CAD software.

Concept: Computer Aided Design
Time: 10 hours plus homework
Teams: 2 people

Objectives: Students should be able to…

- Use CAD software to create and design building plans.
- Understand the terms relating to house design
- Be able to read blueprints
- Explain the application and efficiencies of CAD software.
- Generate drawings that conform to the standards of drafting.
- Find information about professions in this field of work.

Material:

√ Any catalogue of Home Designs
√ Software: Home Design Suite 2012

Activity 1: House Plans

Take a look at the book of home designs located in your drawer or use Google > Images Tab and type in “house plans”. Pick out 2 house that you like. Fill in the Assignment 1 Worksheet that looks like this: (You may find it easiest to fill it in electronically)

Assignment #1:
House Plan Worksheet

Insert the house plan layout here	
House #1	House #2

Evaluate the house by filling in the following formation:

Kitchen:	House #1	House #2
• Size (small/Compact, Large/Family Size		
• Little or Lots of Cupboards/storage		
• Is it designed to be a “Gathering Place” (island with stools and lots of room)		

Occupants: This house was designed:	House #1	House #2
• Single person, Family with small kids, Retired Couple, Regular family, Large Family		
• Number of Bedrooms (These days, 4 Bedrooms is normal)		
• Is there a Basement (you will		

Activity 2: Housing Types

Take a look at each of the housing types shown below. These designs are in addition to the basic family bungalow. Fill in the worksheet with an example of each type that you find on the internet (Google > Images (copy & paste).

HOUSING TYPES (info. you should know)

Single Family Detached: A free-standing home which sits on its own lot and is occupied by only one family.

Semi-detached: A single family home that is joined to another one by a common wall.

Duplex: Two units, one above the other, (in British Columbia can be next to each other) The owner may live in one unit and rent the other.

Row or Townhouse: One of several single family homes joined by common walls. These can be condominium or freehold units.

Link or carriage Houses: (freehold or condominium) These are joined by garages or carports which provide access between the front and rear yards. Builders sometimes join basement walls so that link houses appear to be single family homes on small lots.

Highrise Condominium: Multi-storey residential building containing condominium units. A condominium is not a type of house but a form of ownership.

Mobile or Manufactured: A factory-built, single family dwelling that is transported to your chosen location and placed on a foundation.

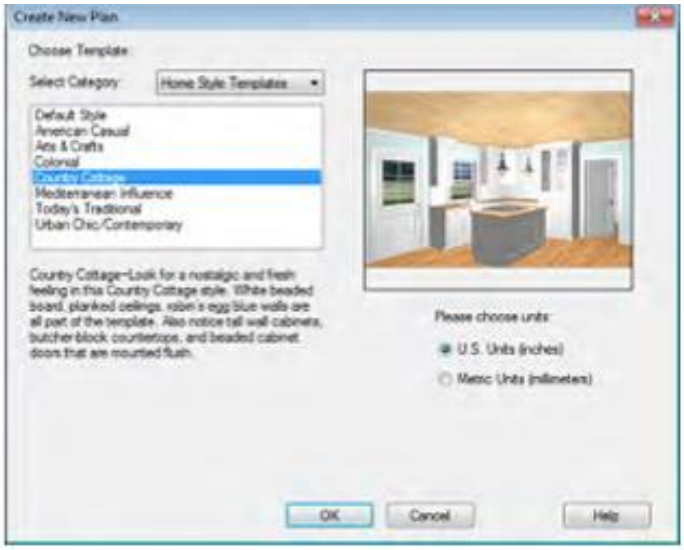
Activity 3: Home Design Suite Software

We've purchased the finest design software on the market for you to design your projects, **Home Design Site 2012**. We have two links to training videos and a link to the software manuel to assist you (see our BBT website).

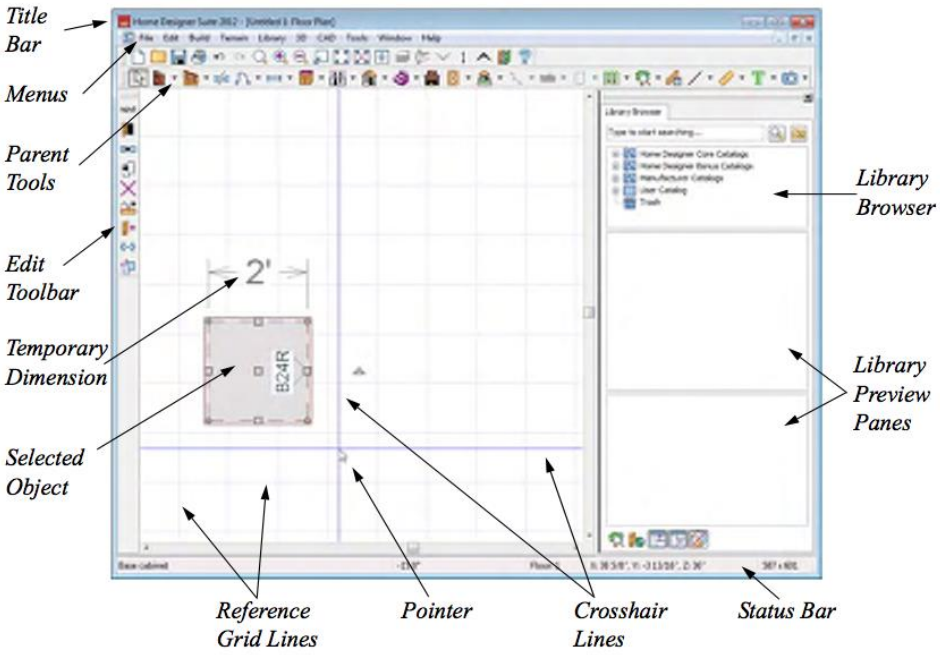
1. Go to the video link on our BBT page and watch the first two "Question" videos about this software (**Introduction** and **Wall & Floor Layouts**). (You will need headphones or a speaker)

2. Answer the first two questions on you're your Video Question Worksheet after watching the videos.

3. Find the Home Designer Suite 2012 software on your computer. The first screen asks you to select a category of building and to choose the units of measure. Choose Country Cottage and U.S. Units (inches).



4. Here is a diagram of the interface with the names of each part/tool. Refer to this when you don't understand where to find tools later on.



5. Let's start by building a cottage so you can get familiar with the program and the tools available. To get you started… select the exterior wall parent tool icon.

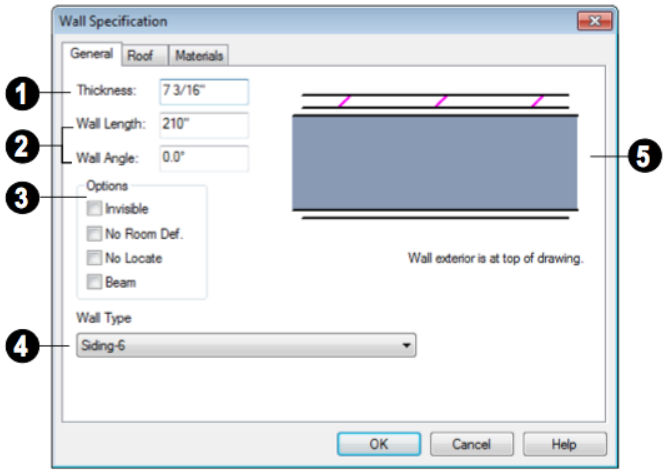
Exterior  **and Interior Wall**  **tools**

Create the outside cottage walls that measure exactly 40 feet by 30 feet. The design should include:

- The front wall should be Brick (Brick – 6)
- Put dimentions on all surfaces (choose "Auto Exterior Dimensions" tool)

Note: Immediately save your project in your Network drive as "Design Project 1".

6. We can change the wall thickness, materials, and other attributes by selecting a wall and click the Open Object edit button. (The same can be done for other objects too). Check the thickness of the walls that you created so far.



Some items on the General tab are available only when they apply to the selected wall or railing.

1 The **Thickness** of the selected wall displays and can be changed here. If the wall is a Post to Overhead Beam railing, this setting also affects the width of the beam. See "Wall Thickness" on page 107.

2 Specify the **Wall Angle** and **Wall Length** of a straight wall. These options are not available for curved walls.

- **Wall Angle** - The current absolute angle of the wall in a floor plan view is shown. Type in a new angle to rotate the wall about its locked point.
- **Wall Length** - The current length is shown. Type in a new length. The part of the wall that extends or contracts is determined by where it is locked.

3 Check any of the **Options** to modify the selected wall accordingly. In most cases, multiple options can be selected. Not available for fencing.

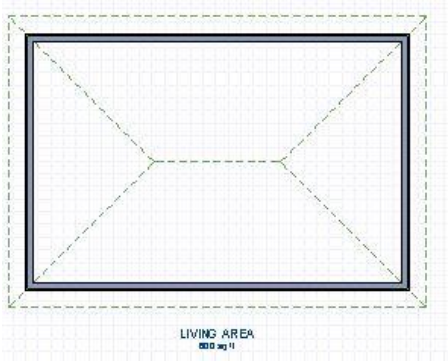
- Select **No Room Def.** to display the wall in floor plan and/or 3D views but not create room definition. See "Room Definition" on page 120.
- Select **No Locate** to prevent Auto Exterior Dimensions from locating a wall. Railings have No Locate selected by default. See "Auto Exterior Dimensions" on page 371.
- Select **Beam** to have the wall display as two lines in floor plan view and a beam in 3D views.

4 The **Wall Type** drop-down allows you to change the type of the wall currently selected to any of the available options. Its graphic representation in the upper right corner will update to reflect the wall type that is currently selected. Not available for fencing.

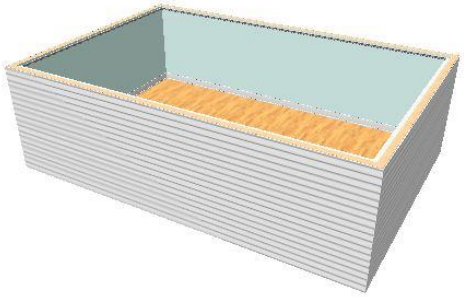
5 A preview diagram of the selected wall type displays here.

7. Let's see how it looks so far. We can look at our work in several differnet ways. Chose the "camera view Tools" icon on the Parent Tools Toolbar and select the different views.

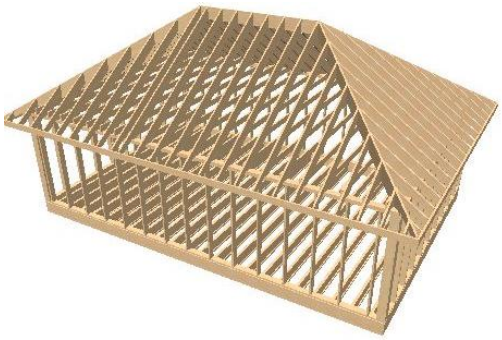
Floor Plan View



Doll House View



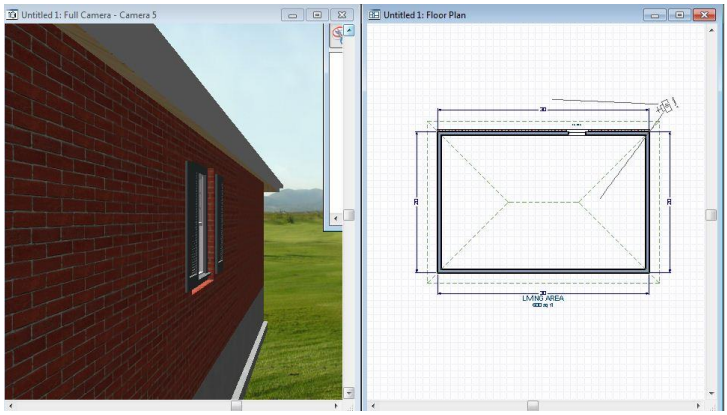
Framing View



Full Overview

You can tile the views so they sit side by sie. This is helpful to see how your changes in your floor plan create an effect in the actual look of the design. To tile choose the Windows **Menu > Tile Vertically.**

Here is an example:



Activity 4: Home

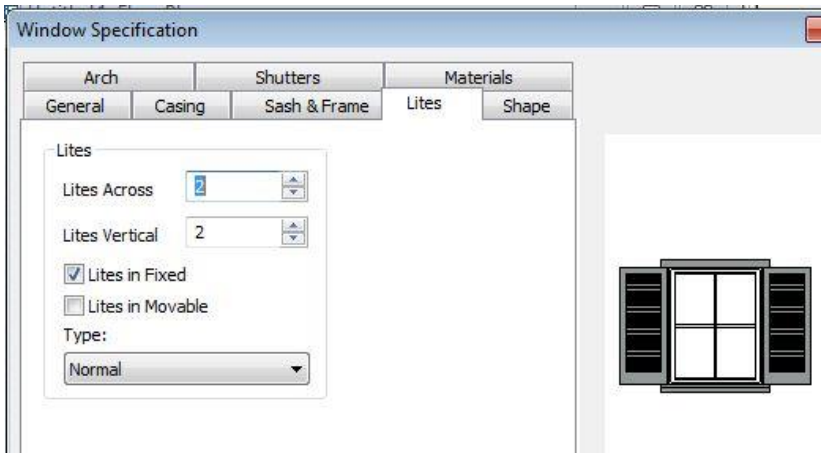
1. Watch the Videos **Doors & Windows** and **Kitchens & Baths.** These will help you when you continue to build. Answer the questions #3-8 on the 3D **Design Video Questions Worksheet**.

   Let's keep building! We will add:
   - Interior Walls
   - The Doors & Windows
   - Cabinets
   - The Plumbing
   - The Room specifications and Room Type

2. Create interior walls for 3 Rooms (2 Bedrooms and 1 main Kitchen/Living Room)

3. Place two external Windows in each bedroom. I want a certain type of window:
   - Fixe Glass Window Type
   - 38" wide
   - 48" high
   - 2 Lites Vertically and 2 Lites horizontally

Use the Door and Window Icons on the Parent Tools bar. 



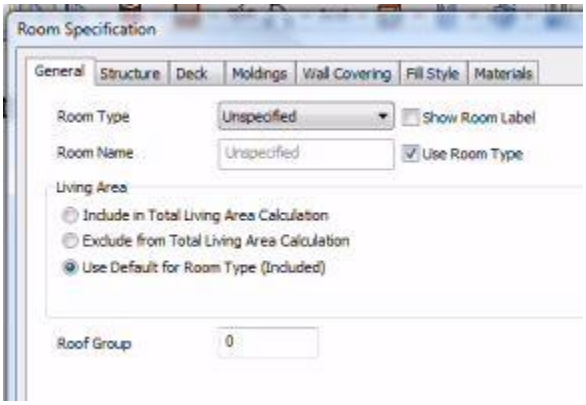
4. Place a front door, a big picture window in the living room, and a large window in the kitchen (just like in the video – see picture below).

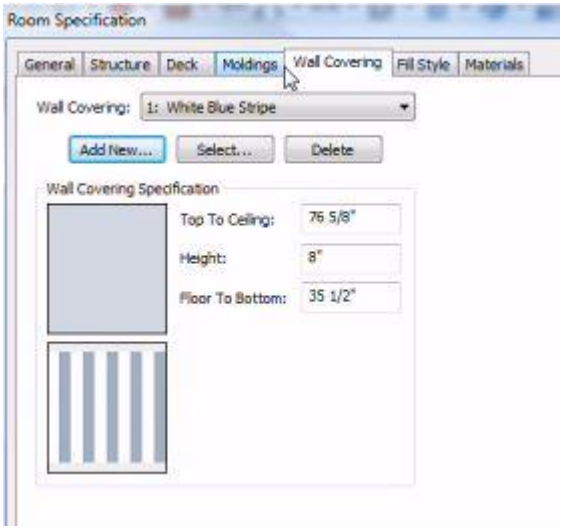
5. Next, build some nice cabinets in the kitchen. I like cabinet in the video so I'd like you to design the same cabinets in our kitchen.

5. Now, add the same appliances and plumbing fixtures as in the video (see the picture) including:

    - A sink
    - Dishwasher
    - Fridge
    - Range with Range hood

6. Finally, specify the name of the rooms (see the video, or page 123 – 126 of the userguide). Make the kitchen walls a nice green to match the picture. Also, add hardwood floors to make it look classy. You choose the other room colors. Be creative. Here are some shots of the Kitchen attributes:





Assignment: Using your 3D view, check over your work. Use your "Snip It" tool to take a picture of the finished kitchen that you can put in your presentation PowerPoint at the end.

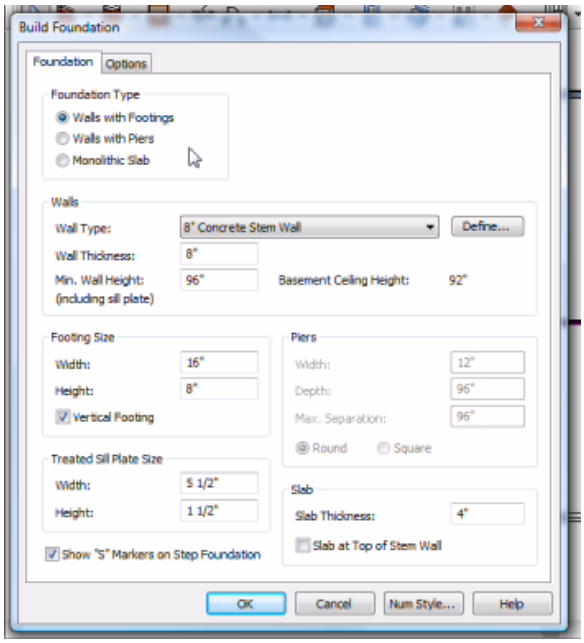
Activity 5:

Foundations, Roof, Stairs & Dimensions

Open the Cottage/House that you have been working on. We need a basement and then stairs that go down to basement..

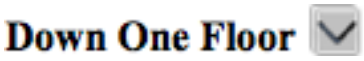
1. First, watch the Questions Video: **Building Tools**. Answer questions #10 - 13 on your worksheet.

2. We are ready to build the foundation.
   - Select **Build > Floor > Build Foundation**.
     - Change the Minmum Stem Wall Height to 100 inches (or 250 cm).
     - Choose "Walls with Footing" as the type of foundation.
     - Click OK. (see diagram below)



   - Select **"Derive New Foundation Plan from the First Floor Plan"** and click OK.

   - Find the Down One Floor Icon on your toolbar. This should take you to the basement layout view.



Assignment: Using your 3D view, check to make sure that you have a foundation (look inside and outside). Use your "Snip It" tool to take a picture that you can put in your presentation PowerPoint at the end.

In 3D views, all objects on Floor 0 will only display when the "Foundation" layer is turned on.

2. Constructing a Roof…

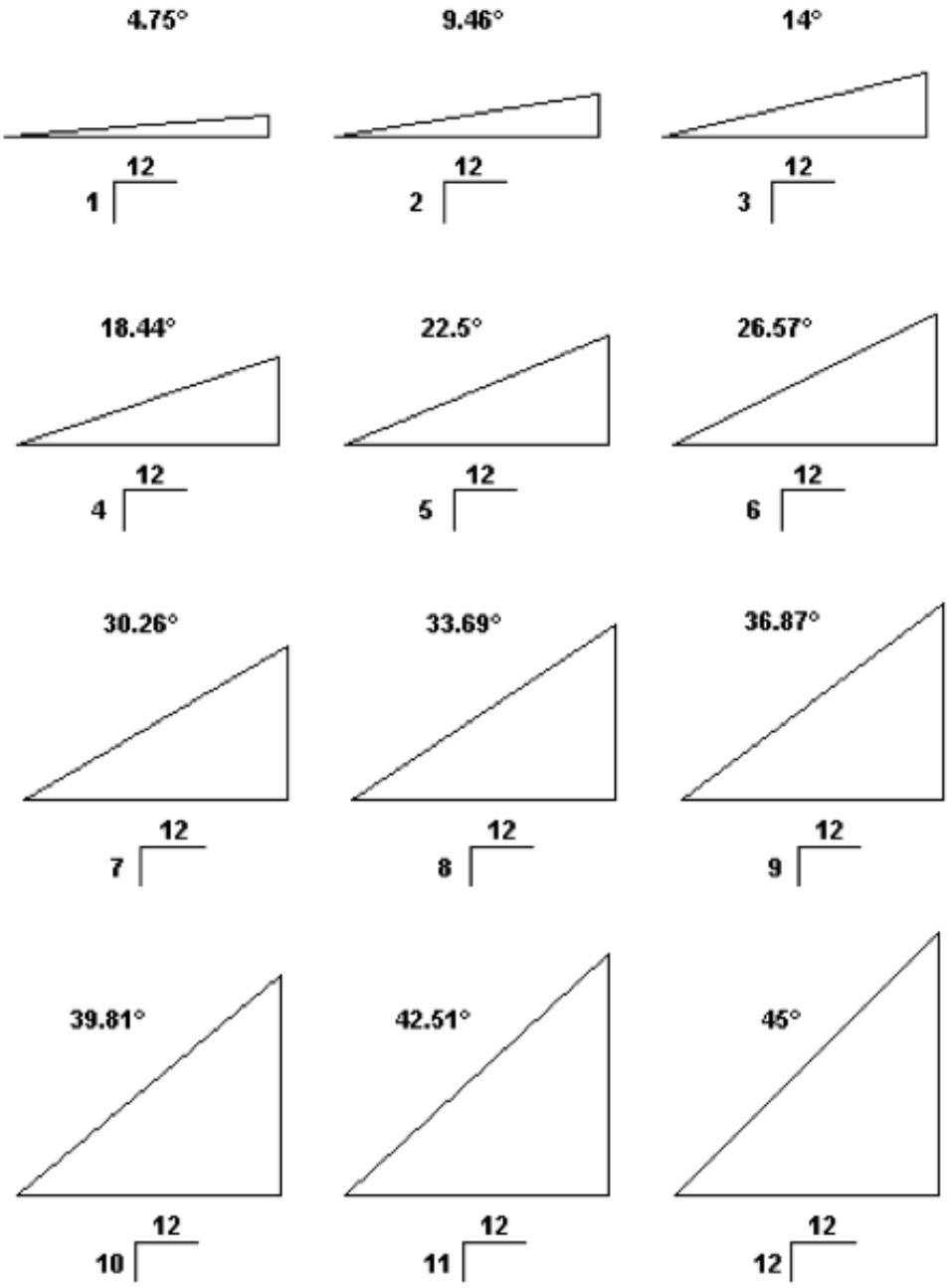
- Select **Build > Roof > Build Roof** (or click the Roof icon)

- Choose the **Styles** Tab and choose the "**Gambrel Roof**". When you click on one, it give you the instructions how to build it. (Print the instructions if that is easiest to work with)

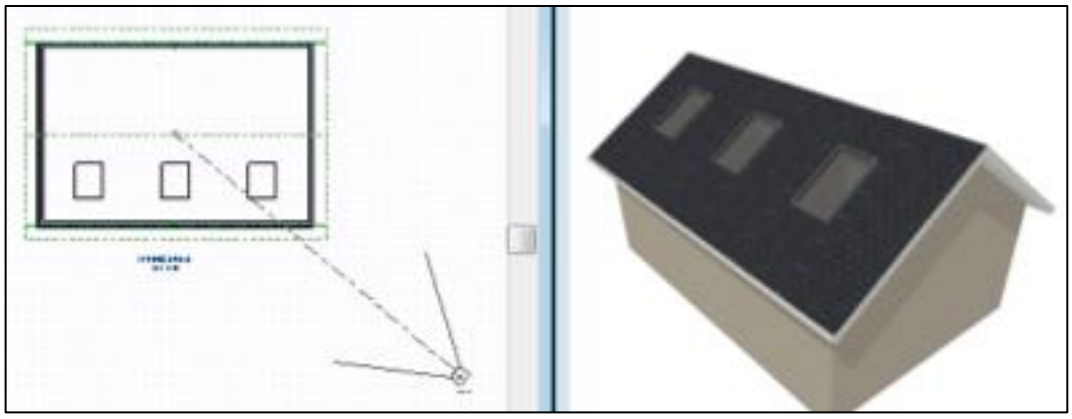
- Rather than using the standard black ashfalt shingles, click the materials tab and choose and Earth Roof Tile material.

- The "**Pitch**" of a roof refers to the slant. A slant is required so snow will not accumulate and cause the weight of the snow to collapse the roof. A minimum slope is 4" in 12" and steep slope is 12" in 12". (See the examples of pitch on the next page)

Examples of Roof Pitch:



- On your own, look at page 192-3 of the manual, and **install a skylight measuring 18 inches by 24 inches.**

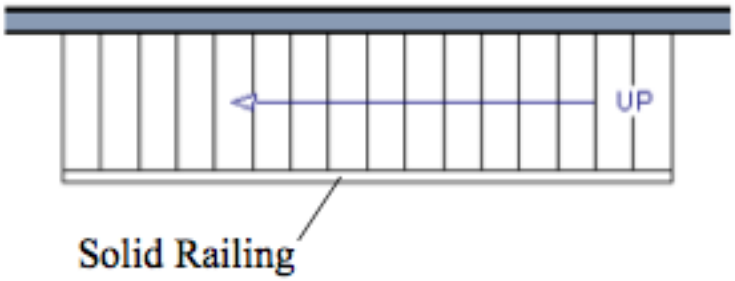


Assignment: Using your 3D view, check to make sure that your roof looks correct. Use your "Snip It" tool to take a picture that you can put in your presentation PowerPoint at the end.

To delete a roof, select Build > Roof > Delete Roof Planes

3. Let's build the stairs down to the basement…

- Select **Build > Stairs > Straight Stairs** (or click the stairs icon) 
- Stairs are always drawn going up (from the lower floor). Click and drag to draw a short stair section as shown below. Start in the basement. Did you leave enough room for the stairs or do you need to move them?
- We need to create the stairwell now, so **Right-click** on the stairs and click the **Auto Stairwell.** This creates the whole for the stairs in the floor above. Use your camear to make sure the stairs are done properly.

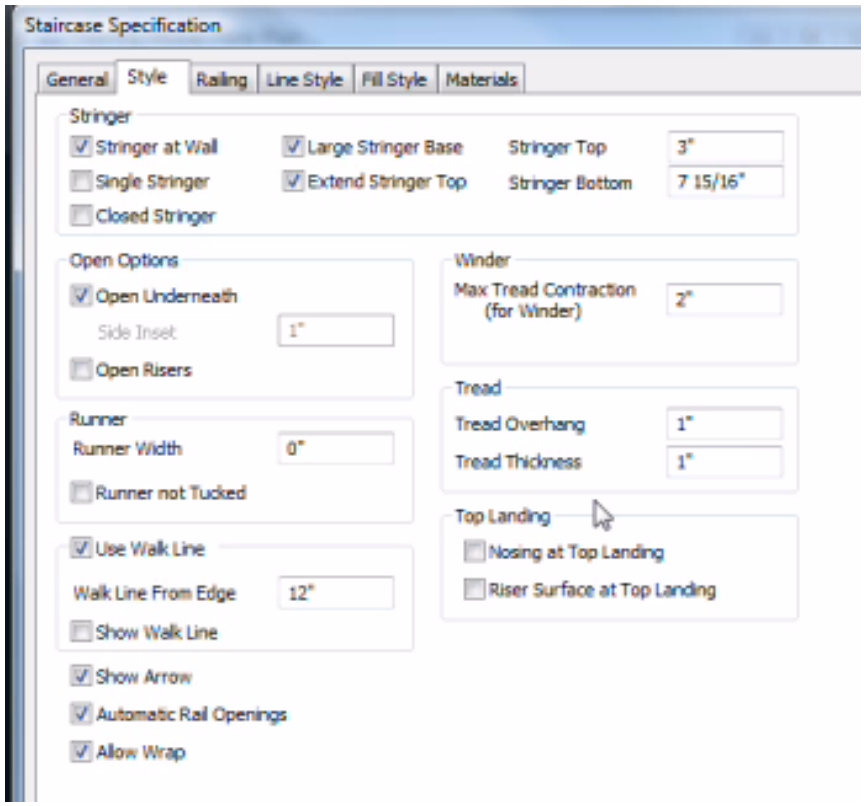


Creating a Stairwell Automatically

To create a stairwell that matches the perimeter of a selected staircase, click the **Auto Stairwell** edit button. This button is only available when a living space exists above the staircase. It will not be available if the space above is Open Below or on the Attic Floor.

Auto Stairwell  automatically creates a room on the floor above enclosed by railings, defined as **Open Below** in the **Room Specification** dialog, and given a **Stairwell** room label. This room can be selected and edited like any other room.

- Choose the properties that you need to complete the railing and other material.



(Read page 208-9 of the user guide to build stairs that have a landing.)

Assignment: Take a picture of the 3d View that shows your stairs go to the bottom and fit properly. Use your “Snip It” tool to take a picture that you can put in your presentation PowerPoint at the end.

4. Finally, use the Automatic Dimension tool:

Interior Dimensions

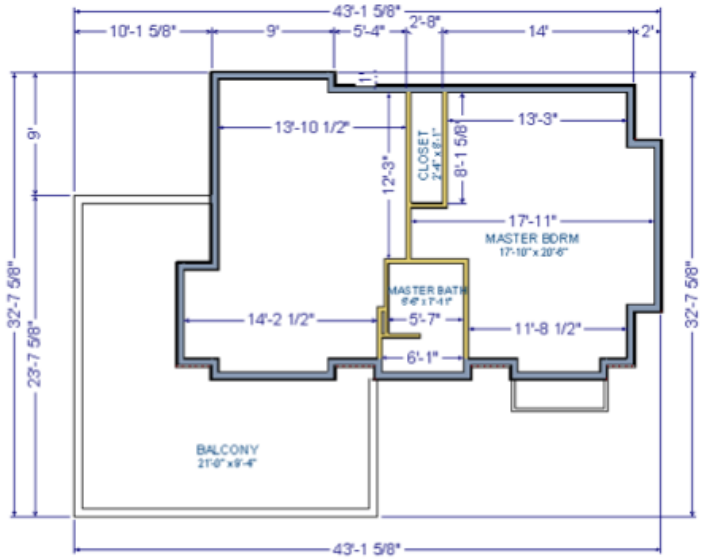
Draw **Interior Dimension** lines parallel to walls in floor plan view to create interior dimensions.

The **Interior Dimension** tool locates interior wall surfaces only. It does not dimension between layer surfaces in the same wall, and it does not locate walls unless it actually intersects them.

Auto Exterior Dimensions

The **Auto Exterior Dimension** tool generates dimensions around a plan's exterior in floor plan view.

Here is an example:

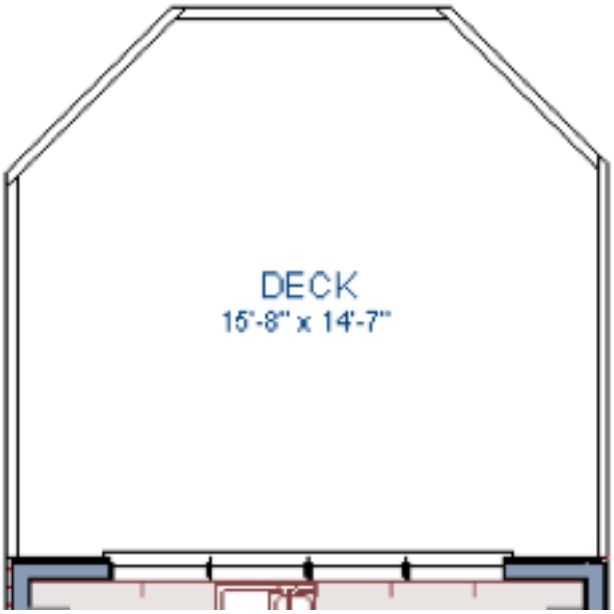


Assignment: Take a picture of the floor plan that shows the dimensions. Use your "Snip It" tool to take a picture that you can put in your presentation PowerPoint at the end.

Activity 6: Decks & Landscapes

1. Watch the Videos **3D Models** and **Decks & Landscaping.** These will help you when you continue to build. Answer the questions #14-17 on the 3D **Design Video Questions Worksheet**.
2. Let's build a deck on the design that you have been creating!

Create the deck shown:



Follow these instructions:

To draw a deck

1. To begin, while in floor plan view, let's select **Tools> Display Settings> Display Options** and uncheck the Disp for both the "Terrain, Elevation Data" and "Plants" layers and click **OK**.
2. In floor plan view, go to the first floor (you may be there already).
3. Make sure **Angle Snaps** and **Object Snaps** are turned on.
4. **Zoom** in on the back portion of the house.
5. Next select **Build> Deck> Straight Deck Railing**.
6. Draw five deck railings as shown in the following image. The angled railings are drawn at a 45 degree angle to the others. Note that when the mouse is released, the room is assigned the Room Type of Deck and given a room label.

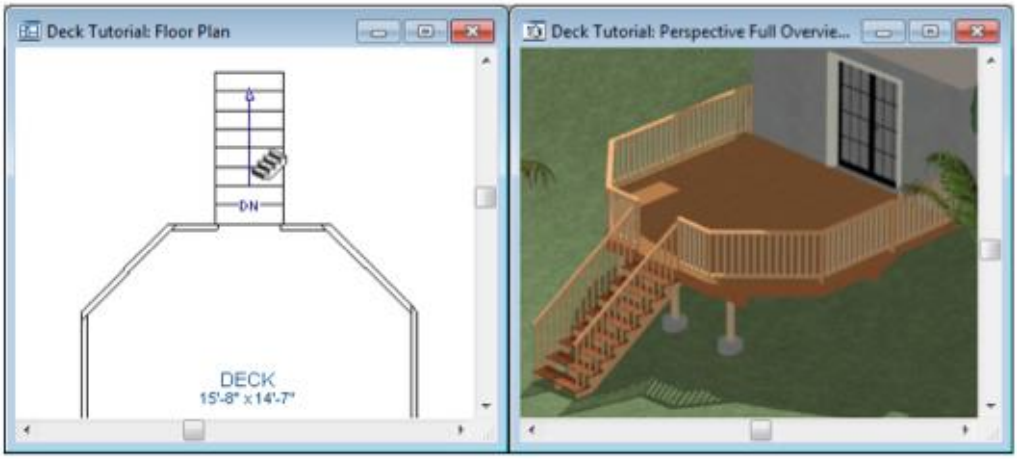
7. When the deck area is enclosed, click the **Select Objects** button, then click in this room to select it.
8. Click the **Open Object** edit button to display the Room Specification dialog.
9. On the Structure tab we will set the Floor (C) value to -108" so that it will generate at the door for our walkout basement then click **OK**.
    - Note that Deck rooms by default will not automatically generate a Roof or Ceiling over the room, however, you can still select these options. We will leave the checkboxes alone for the purposes of this tutorial.

Drawing Stairs

Now we'll draw stairs between the deck to the terrain below. For more information, see "Stairs, Ramps & Landings" on page 377 of the Reference Manual

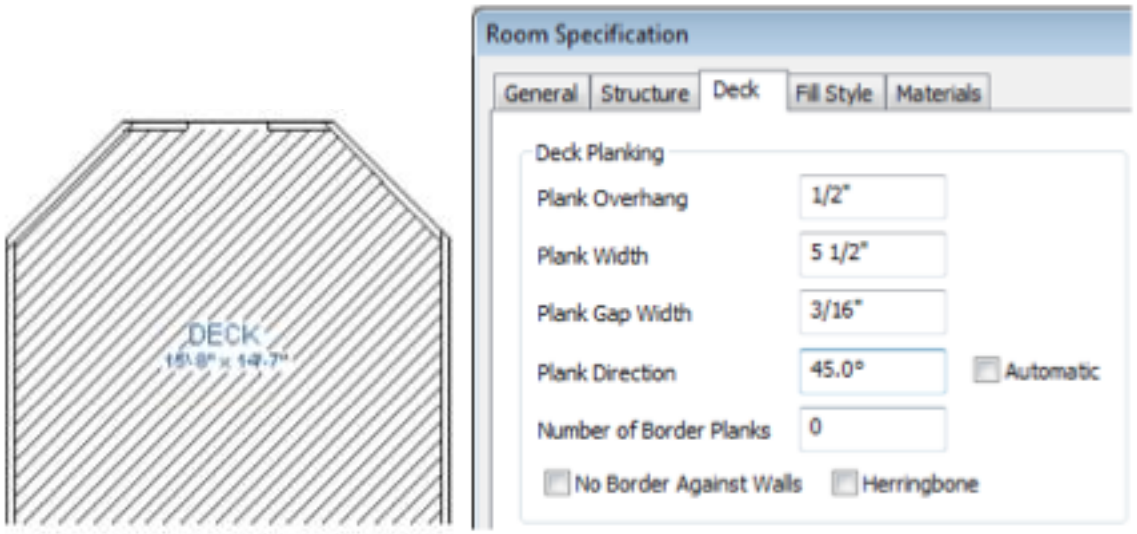
To connect the upper and lower decks with stairs

1. In the floor plan view window, make sure that you are on the first floor.
2. The deck planking is making it difficult to see the area where we'll be working. In the **Layer Display Options** dialog, turn off the display of the layer "Framing, Deck Planking".
3. Make sure **Angle Snaps** and **Object Snaps** are turned on.
4. Select **Build> Stairs> Click Stairs** .
5. Click just to the outside of the deck platform, as shown in the following image.



6. In most cases when using the Click Stairs tool, an opening will be added automatically to the deck railing at the top of a staircase.
7. If an opening is not created, select **Build> Door> Doorway** in either floor plan or a 3D view, then click on the deck railing to create an opening in front of the staircase.

I want you to change the decking so that it's 4 inches thick and so that it runs at 45 degrees. See diagram.



Add some furniture and a BBQ to the deck!

Also, add some features to your yard, like shown in the image.

Assignment: Take a picture of the deck in 3D view. Use your "Snip It" tool to take a picture that you can put in your presentation PowerPoint at the end.

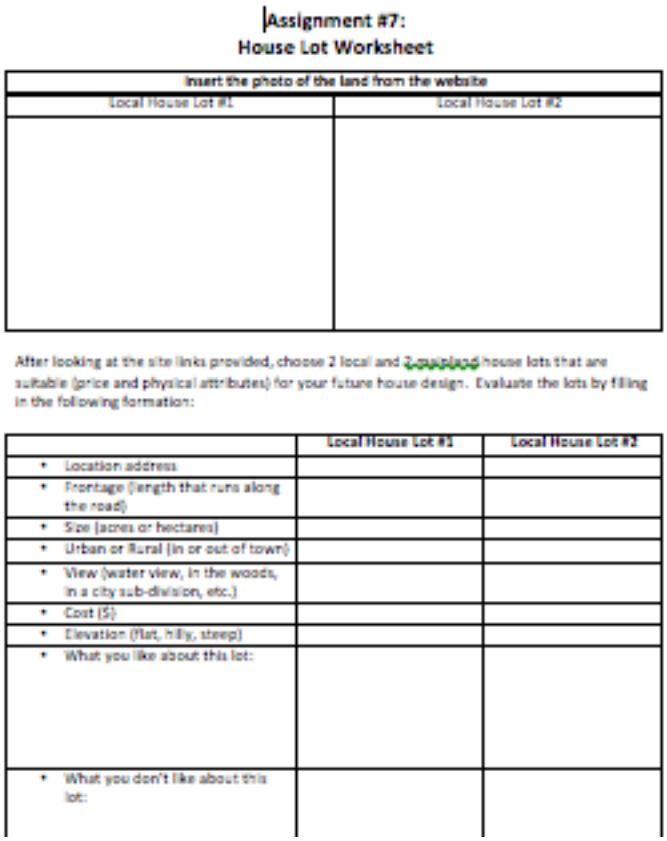
Activity 7: Purchasing Land

Let's take a break from the program for a minute and find some suitable land to build on. That might be a little harder than you think. Often land is valued for the view and an ocean view is quite expensive. A 1 acre lot is required in a rural area (to make room for a septic field), whereas a much smaller lot is the minimum in a city.

1 acre = 43,560 square feet or 4046 square meters
(remember, a = l x w) Not a lots are perfect rectangles.
i.e. A lot with 100 ft along the road would extend back 435 ft.

Let's take a look at a couple of local real estate sites and see if we can find some appropriate land for your budget. **Fill in the House Lot Worksheet** for 2 local and 2 mainland house lots (see the links on our BBT site or Google Real Estate sites).

Worksheet:



Assignment #7:
House Lot Worksheet

Insert the photo of the land from the website	
Local House Lot #1	Local House Lot #2

After looking at the site links provided, choose 2 local and ~~2 mainland~~ house lots that are suitable (price and physical attributes) for your future house design. Evaluate the lots by filling in the following formation:

	Local House Lot #1	Local House Lot #2
• Location address		
• Frontage (length that runs along the road)		
• Size (acres or hectares)		
• Urban or Rural (in or out of town)		
• View (water view, in the woods, in a city sub-division, etc.)		
• Cost ($)		
• Elevation (Flat, hilly, steep)		
• What you like about this lot:		
• What you don't like about this lot:		

Activity 8: Design A House For Your Customer

I'm going to pay you to design a house for me. I'm quite picky so make sure you build it just the way I want it. I'm going to Hawaii for 2 months. When I return, I want the house ready to build.

Here's what I want:

- 2 stories and a basement - Dimensions: 30' X 40'
- 4 bedrooms and a large bath on the top floor
- A large living room that is open to the kitchen and dining room on the main floor. There should be a decent size bathroom on that floor.
- Can you make my bedroom look like this?

- Do you think you could create a landing part way up and then continue with the stairs in another direction?
- I like lots of big windows so the sun shines in.
- My wife wants lots (yes, lots!) of cupboards and closets. I want to make her happy so we should have a walk in closet in the master bedroom and some linen closets on each floor.
- A nice deck
- In the design include:
    - Dimensions
    - Room Labels
    - Plumbing
    - Furniture
    - Electrical outlets and lights (incl. Switches)
    - Roof Design
    - Outside landscaping and yard features

Activity 9: Scale

Yes, there is some math in nearly every job… Any drawing that depicts physical objects that are too small or too large to be drawn easily, or are larger than the paper size, must be scaled to fit on the page.

The building industry still uses the Imperial System of measure so it's important to know that 1 foot = 12 inches. (2.5 cm = 1 inch).

Scale is written as 1 unit on paper = a certain number of units in real life. The first number is **ALWAYS 1** in a scale.

For example: 1: 500.

That could mean that 1 cm of your drawing represents 500 cm in real life, or, 1 inch on paper = 500 inches in real life.

What is the scale for each of these?

1. One foot = 35 feet in real life? _____
2. One meter = 10 meters in real life? _____
3. 25 cm = 1000 cm in real life? _____
4. ¼ inch = 1 foot (think about this)? _____
5. 1/8 inch = 1 foot? _____

Lets find the actual size of these objects: (show your work)

6. A swimming pool is 6 cm by 2 cm on a 1:500 scale diagram

7. My car is 13 feet long. How large would it be on a drawing if the scale was 1:96

Activity 10: Environmentally Friendly Designs

Designing environmentally friendly homes is one way that we can save energy costs and help to protect our environment. Some designers have come up with some very environmentally friendly ideas.

√ **Read**, "Designing Houses With the Environment in Mind" by Wendy Priesnitz.

√ **Answer the following questions** related to her article: (Answer on the worksheet)

1. Name 10 recycled materials that can be used in the construction of a house? (Name the material and what it is used for)
2. How can rain water be used to help cool the house?
3. Name 5 ideas that were used to make the plumbing system more environmentally friendly.
4. What type of tree would be planted to keep the house shaded in the summer and open to the sun in the winter?
5. Describe two ways the kitchen can be designed to make it easier for the family to employ the three R's (Reduce, Re-use, and Recycle).
6. How much more efficient was this type of home compared to standard homes relating to energy and water usage?

Designing Houses With the Environment in Mind

by Wendy Priesnitz

In 1991, CANMET, the main research and technology development arm of Energy, Mines and Resources Canada, challenged the building industry to design and build houses that promoted energy efficiency and environmental responsibility. Ten builders responded to the challenge, and green homes began to sprout up all over the country.

In Ontario, the Kitchener-Waterloo Home Builders Association and Enermodal Engineering Limited, with the assistance of over 200 other companies, created a raised bungalow in a subdivision on the outskirts of Waterloo.

Although the house looks conventional from the outside, many innovative concepts were incorporated into its design to improve energy efficiency and reduce the amount of construction materials. The design philosophy was to have the minimum exposed surface area with the maximum use of interior space. Exposed surface area is kept to a minimum and a dormer on the south side of the home allows natural light to penetrate to the interior.

Enermodal Engineering loaded the home with as many secondary materials as was practical, creating what might well be the single most recycled house ever built in Canada using conventional construction methods and new materials.

Here are just some of the recycled features that went into the design and construction of the Waterloo Region Green Home.

- Recycled crushed glass and recycled aggregate were used underneath the concrete basement floor.
- There is a laminated wood structural beam in the basement made from thousands of small wood chips.
- The wall cavities are filled with over nine inches of wet-blown cellulose insulation manufactured from recycled newspapers.
- The exterior is covered with siding made from pressed scrap wood.

- Interior drywall is made from gypsum and old newsprint.
- Ceramic tiles in the bathroom and front foyer are 70 percent recycled glass.
- Structural wood trusses are made from rapid-growth trees and designed to use 35 percent less wood than a conventional building.
- The roof is covered in tile-shaped steel made from recycled car bodies, instead of asphalt shingles which are highly polluting and can't be recycled.
- The walkway to the front door is paved with rubber.
- The basement carpeting is made from recycled plastic pop bottles, and the underpad was once automobile tires.

The interior finishes were carefully selected to address environmental issues as well. In keeping with the reuse and recycle theme, all of the furniture is antiques or yard sale finds. Some finishing materials were also salvaged, where possible. The main floor hardwood flooring was recovered from a demolished building. A refurbished claw-foot bathtub and sink are used in the lower floor washroom.

Indoor air quality is improved by using materials that don't release toxic chemicals such as urea formaldehyde and volatile organic compounds (VOCs). Particle board was avoided, and the pine-faced kitchen cabinets were sealed with acrylic latex to reduce off-gassing. VOC-free paints and rubber-based adhesive tapes and silicone caulking were used. Draperies were made from chemically untreated cotton.

Heating & Cooling

Space heating and ventilation is handled by a prototype combined furnace/heat recovery ventilator (HRV). This Canadian-developed system uses a conventional mid-efficiency natural gas furnace connected to a small container of rocks with two compartments. Stale air from the bathrooms and kitchen mix with the furnace flue gases and pass through the first compartment of rocks. The large surface area of the rocks ensures that almost all of the heat in the exhaust air is removed and stored in the rocks.

Outdoor air is heated by the rocks as it passes through the second compartment. Approximately every five minutes, a reversing valve switches the air stream to the two rock compartments, and thus, the heated rocks are cooled and cooled rocks are heated. The outdoor air is distributed throughout the house via furnace ductwork.

Products of combustion are prevented from reentering the house by pressurizing the fresh air stream.

The house and landscaping were designed to reduce the need for mechanical cooling. Ground and rain water are collected in a cistern and used for cooling. The cistern water is circulated through plastic tubing buried below the basement floor and through a coil in the air handling system.

Plumbing Systems

The plumbing system was designed to reduce hot and cold water consumption and to use natural water sources. The two toilets require only two and three litres per flush instead of the standard 20 litres. One of the toilets liquefies waste to aid in flushing.

The shower has a low-flow showerhead and manual shut-off to conserve water while lathering. Aerators restrict faucet flow. The 3,000 gallon cistern buried under the front lawn collects rainwater for watering the garden, flushing the toilets and supplying cold water for clothes and car washing. All piping contains recycled copper.

A solar water heating system supplies hot water. A high-efficiency, low-power pump is controlled and powered by photovoltaic cells that convert sunlight directly into electricity.

Landscaping

Environmental responsibility is also applied to the building lot. Native plant species were selected for hardiness, drought resistance and the provision of habitat for butterflies, birds and other wildlife. Trees and shrubs include white oak, downy serviceberry, red osier dogwood and bearberry. Deciduous trees are located so as to reduce summer cooling and maximize winter solar gains. Woodland plants such as lady ferns and Solomon's seal, and flowers such as sedum and lobelia are also used.

Ground covers of perennial rye and fescue grasses and white Dutch clover were selected because of their drought resistance and tolerance to foot traffic.
On-site water retention is maximized by terracing steep slopes and using hollow-core paving units in the driveway. Plantings are heavily mulched. The soil is supplemented with decomposed horse manure (a by-product from a nearby mushroom farm) to boost organic content, and with gypsum from waste drywall to improve drainage. An organic vegetable garden is another key component of the landscape plan.

No matter how environmentally sound a building might be, the people constructing and

living in it must behave in an environmentally responsible manner. So a comprehensive waste management program was undertaken during construction to reduce the impact of the house construction and operation on the environment. To encourage the residents of the house to practice the three Rs, a number of features have been designed. The kitchen contains a recycling centre which allows separation of materials for recycled and composting. Storage space is designed to accommodate bulk buying in refillable containers.

Performance

The Green Home's performance is impressive. It has a peak space heating requirement of four kilowatts, the equivalent of three hair dryers. Space heating costs average only $8 a month. Annual electricity usage is under 4,000 kWh; the average Ontario home uses 12,700 kWh for lights and appliances. In total, the Green Home uses only 28 percent of the energy of a similar-sized new home. Water use is only 26 percent of the standard home in Waterloo region.

Accurately determining the cost of the home is difficult because several components are prototype units and not yet commercially available. Nevertheless, each product in the house was carefully chosen to represent a cost-effective, environmentally appropriate alternative to conventional building practice. In some cases, the systems used were less expensive than conventional practice. Recycled glass for drainage and cellulose insulation are examples of capital cost saving products.

Stephen Carpenter, president of Enermodal Engineering, says that many conventional materials don't take into account the cost to society of cutting trees and using cheap oil to make plastic materials. “What is the value of a 200-year-old tree?” he asks. “The lumber company has one price, society has another.”

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