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Custom Homes in Revit: The Tools to Succeed

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Learning Objectives

- Make a finite decision as to whether or not it is beneficial to use Revit

- Gain a basic understanding of Revit software and its merits

- Learn how to identify how to increase efficiency with your current Revit workflow

- Learn how complex components can speed up your drafting experience

Description

This class is designed to shed some light on how Revit software can turn your 2D workflow into a 3D workflow that is 5 to 8 times more efficient. The class will focus on setting yourself up to be faster, smarter, and more organized when using Revit software as your primary drafting tool. The main focuses of the demonstration will be on how to set up your template, families, keynotes, and typical details in order to gain the most optimal time savings. At the end of the presentation the group will have a breakdown of the labor savings gained when using a Building Information Modeling (BIM) solution such as Revit software.

Your AU Experts

Dennis Dixon is the current owner of BluPrint Design + Build, a company that specializes in the design and construction of custom homes in Richmond Hill, Ontario, Canada. Dennis is also a Senior Application Expert with RAND IMAGINiT Technologies in Mississauga, ON, Canada. Dennis has an extensive background using software that includes, but is not limited to, SoftPlan software, AutoCAD software, and Revit software. He started his career building custom homes in the heart of cottage country and eventually worked his way into the design sector. After working for many years with a custom home developer in Kitchener, Ontario (Eastforest Homes) and a custom home design firm in Port Carling, Ontario (t-squared design studio inc.), he decided to make a shift to a business of his own. Dennis has since been actively involved with Revit and AutoCAD on a large scale, both through RAND IMAGINiT Technologies and with BluPrint Design + Build. Through doing so, he has acquired the knowledge to produce exceptionally efficient digital construction methods

Why Revit? "I have been doing 2d Drafting for years and I am really proficient!"

Hmmm…What are we doing right now? (May Vary)

Before getting into the why's and how's of the superior capabilities of BIM, it is best to understand a typical Custom Home workflow for 2D Drafting:

Design Development Stage (-16 Hours)

Client comes in to the designer's office and says "I have a sad plot of land that needs an uplifting friend (Custom Home) to fill the void." The designer agrees on the contract, "You bet! I will design you a castle with a hockey rink in the basement!" The designing begins!

If Available, the Designer acquires a copy of the Site Survey from the Client or Land Registry Office. If the client does not have access to a registered survey, they will have the land surveyed by a Licensed Surveyor. The Designer will then begin hand sketching the concept drawings with pens, pencils and maybe even crayons (User preference). This concept is then translated into AutoCAD Line drawings for layout and rough Elevation review. The floorplans are used in conjunction with the registered Site Plan to determine By-law restrictions. In some cases this Site Plan is re-drawn by the designer due to lack of information or having no access to .dwg files.

After By-law requirements are sorted out, the designer will work out grading using a calculator or Abacus (Preference) and determine if the building will be a Fully Enclosed, Look-out or Walk-out basement. This requires the designer to determine the top of foundation, decipher the relationship to top of grade, adjust the grade lines on Elevations, change exterior stairs, garage door heights, etc. All changes are submitted back to the Surveyor for alterations to the Site Plan in order to finalize Grading requirements in regards to Swales, Utility inverts, etc.

The design is sent to marketing for Rendering and Materials are selected for the Site Plan Approval process

Zoning/Site Plan Approval/Building Permit Stage (-31 Hours)

Once the Design and Site Requirements have been hashed out, the Designer (in some cases) will be required to submit for Site Plan Approval. The Elevations and zoning requirements may cause the building design intent to change. If there are any changes, these changes will have to be adjusted on each Elevation, Floor Plan, Marketing Plan, Demolition Plan (If required) and Site Plan.

Once Site Plan Approval is complete, the Building goes forward with Construction/Permit drawings. Copies of the Floor plans, Elevations, Sections, etc are sent to all parties involved in Construction Documentation: HVAC, Plumbing, Electrical (In most cases the Designer), Structural Engineer, Truss/Lumber Manufacturer and Septic Installer (If Required).

Construction Stage (XX Hours)

While approvals are being worked out in the permit office, the drawing package is distributed to the estimators for detailed Quantity Take-off for the builders and suppliers. Building goes out for Construction and the design is put to the test…..

This is where the 2-Dimensional work-flow falls apart and causes a large list of late change orders due to unforeseen collisions and head-room issues.

What's wrong with this process?
The Short answer is: Nothing at all. The core Design-Cost-Build process has been proven as a decent way to organize the stages of Custom Home Design & Construction. The problem isn't with the process itself. The problem stems from the tools used and the increased probability for human error.

The success rate for 2-dimensional drafting is completely reliant on the user. The user has to have the ability to visualize mistakes in their head and predict the potential methods to rectify the error. These changes then have to be reflected in multiple "Static" plans or details. This further compounds the possibility of forgetting to alter design items in similar layouts. For example, a parapet height was adjusted on the East Elevation, but was not reflected on the Permit Drawing for the North Elevation. The same parapet was updated on the North Elevation of the Marketing drawing but they forgot the update on the South Elevation…In this way, 2-Dimensional drafting is no different than drafting on sheets of paper. There are too many variables and too much time is spent dealing with drawing management.

How do we fix it?
The hardest thing for business owners to do is admit that they have inefficient workflow. It is not easy giving up a methodology that has worked for so many years, to shift into something new. Due to stringent timelines and fee structures presented by clients, it is very difficult to stack yourself up to the competition if you do not have a competitive edge.

The world is moving towards a BIM solution for building design and those whom are neglecting this initiative are going to be left in the dark. Building Information Modelling (BIM) provides designers and engineers the ability to work in a collaborative environment that promotes Data enriched coordination. With Revit, the users are able to predict on-site errors before the drawings go out on site. In turn, the software allows the user to become more conscientious of Building Codes, Design restrictions, clearances, etc.

So, how do we fix our problem? The solution is simple: shy away from that 2-D workflow and start thinking of a smarter methodology for design. Adopt BIM and take notice of the results.

What does Revit do that AutoCAD can't?
AutoCAD is a tool used to draw 2-Dimensional line data for the purposes of a 2-Dimensional product such as a paper set of Permit Drawings. Revit produces the same as the aforementioned, and adds so much more. Revit has the capabilities of 3-Dimensional modeling/massing, Collaboration (Allowing multiple users to work on the same file), Live Scheduling of any item in the project (Doors, Windows, Light Fixtures, etc), Revision Management, Clash detection, Energy Analysis, Structural Analysis, Heat Loss/Heat Gain Calculations, Sun/Shadow Studies, and much more! Revit was designed as a tool for the full design-construction workflow. This is not just a tool that draws pretty pictures. It's a tool that draws pretty pictures with lots of other great stuff!

We Fear Change!
One of the major concerns in switching from a 2D drafting tool to BIM is the fact that so much data has been built up in their 2D tool. It will take too much time to redraw all of that information again! Well Revit accepts DWG, SKP, SAT, DXF, OBJ, etc. So typical details, floor plans or any other drafting data can be linked directly into the Revit File. This allows for a much smoother transition from 2d to 3d.

We Have Revit Now! How Do We Organize Our Template?

The #1 item that needs to be set-up is a solid Revit Template. This template is the backbone of efficiency. A well-organized project template is the largest contributor towards profit gains.

Template Organization – Site
- Set-up two Site Plans. One for True North and another for Project North. The Project North Site Plan will be used for any plotted Site Plan Layouts.
- On the Site Plan, using the property lines tool, draw a 60ft x 150ft deep lot and ensure that any elevations sit outside of the property boundary.
- Insert a property line setback that mimics your current town by-law requirements
- Create a view template for that view that incorporates the following:
    - o Scope Box to encompass just outside of the property lines
    - o View Range adjusted to be unlimited view depth and cut plane set at 1000' above grade
    - o Ensure that only Walls, Roofs, Lines, and Site information are visible
    - o Visual Graphics are set according to Company Preference
- Create a Dependent View for an additional Site plan if Site Plan Approval is required on your project

Template Organization – Floor Plans
- Set-up floor plans and area plans for Site Plan Approval, Demolition, Marketing and Building Permit. Create Sheets to correspond with each plan and place plans on those sheets.
- Set up Scope Boxes for each set of floor plan templates. This will ensure consistency if grids or levels are used.
- Create a view template for that view that incorporates the following:
    - o Scope Box to encompass just outside of the property setbacks
    - o View Range to be at 4ft above the finished floor, base to be 0ft and top is 8ft
    - o Marketing plans and Demolition plans are to be set to course detail level. All other plans must be set to medium or fine
    - o Visual Graphics are set according to Company Preference
    - o Set view specific scales for each view template

Template Organization – Sections
- Set-up two Sections. One section going north-south and another going east-west. These sections are placed for working purposes.
- Create View templates for Building Sections, Wall Sections, Section Details and Plan Details
- All Section Views are to be set to Fine Detail

Template Organization – Elevations

- Set-up 4 Elevations. Each Elevation is to be placed on Level 1 and is to sit outside of the Property Line
- Create duplicate views for Site Plan Approval, Demolition, Marketing and Building Permit. Create sheets to correspond with each elevation and place elevations on those sheets.
- Create levels for the following:
    - T/O BASEMENT SLAB
    - U/S 1ST FLOOR (OR T/O FOUNDATION)
    - T/O 1ST FLOOR
    - U/S 2ND FLOOR
    - T/O 2ND FLOOR
    - T/O TOP PLATE
    - ROOF
- Create a view template for that view that incorporates the following:
    - Scope Box to encompass just outside the property setbacks
    - Far Clipping set to none
    - Ensure that all interior items are turned off (Furniture, Specialty equipment..etc)
    - Visual Graphics are set according to Company Preference

Template Organization – Schedules

- Set up a Door Schedule and create shared parameters for R-Value (RSI), Door Swing, Number of Panels, Operable, Panel Material, Panel Finish, Frame Material, Frame Finish and Weather-stripping
    - Door Schedule to have additional headings for Manufacturer, Count, Cost, Type, Size, R.O., Comments and Fire Rating
- Window Schedule to have similar set-up as Door Schedule. Add additional Shared parameter for Grilles and Glass Type
- Create a Schedule for Levels, Rooms and Views for use in rapid changes for design

Template Organization – Libraries

- When creating a library of families for Revit, leave them out of the template. All component families can brought in on an "As Need" basis. Too many families in the template will decrease file performance
- System Families such as Walls, Floors, Ceilings and Stairs can exist in the template. These System families can be populated on a dedicated floor plan view and placed on a Phase called "Family Library" that precedes the 'Existing' Phase. The elements placed on this view will need to be demolished in a "Family Library – Demolished" Phase.
- Create a dedicated Revit Project for the storage of typical details. These details should be drawn on Drafting Views and Grouped.
- Variations of Kitchen layouts should be created as families. U-Shaped, Galley, L-Shaped, Islands, etc.
- Each of the aforementioned kitchen layouts should be parametric in nature. They should only be composed of a Counter Top, Sink, Fridge, Dishwasher and a Range. Detail lines can be incorporated to represent wall cabinets above and hidden lines for breakfast bars.
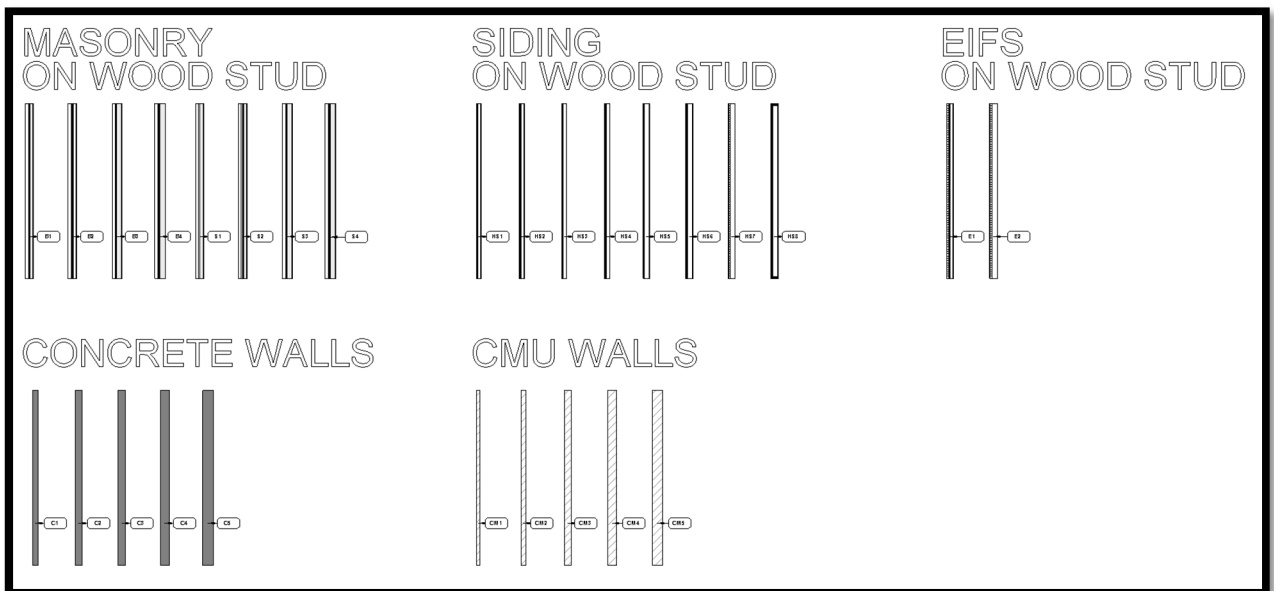
Template Organization –Windows & Doors
- When creating doors and windows, keep the families simple. Over-complicated families can cause issues. If extra detail is needed, use detail components.
- If the manufacturer of windows or doors is known for your project, contact them for availability of Revit Families.
- When using openings from manufacturers, you may need to incorporate shared parameters from your company templates
- Information is more important than modelling. When scheduling doors, the data for Finishes, Materials, Panel Types, etc can all be categorized using text-based shared parameters
- Instance or Type parameters? Dimension, Panel Type and Manufacturer data should be Type Parameters. All other information should be instance parameters.

Template Organization – Walls, Floors, Ceilings and Roofs
- INFORMATION!! Do your due diligence. System family data is very important, especially if the model is going to be used in determining Heat Loss/ Heat Gain calculations.
- Walls should include the data for Fire Ratings, R-values (RSI), STC Rating, ULC designations
- Typical wall sweep profiles such as concrete sills, Metal cap flashing, etc should be created and saved in the family library. Wall sweeps can include detail components to enhance the detail shown at smaller scales.
- Wall thicknesses should always be accurate. NEVER round the material thicknesses within a wall. For example, a 7/16" plywood sheathing should never be rounded to ½". Use dimensions for the purposes of rounding. The wall data should always be accurate especially if this data is utilized for estimation purposes
- As mentioned in *Template Organization – Families*, Place all wall, floor, ceiling and roof types on a dedicated view for ease of coordination

- Materials must be named accordingly. These material names will be used when using material tags on elevations and floor plans
- If using CSI Masterformat or ULC, ensure to use Keynotes for tagging and scheduling purposes

Most Efficient Modelling Practices

Establishing a routine for design can really help in driving efficient modelling practices. Revit has many tools for conceptual design which include Conceptual Massing & Computational Design in Dynamo. Each of these options are great, however due to the size and scale of Residential Home projects, it is not beneficial to the design routine to utilize many of these tools. Revit walls, floors, roofs and components are plenty enough to establish design intent. With that being said, there is an order to the madness of design development.

Modelling Practices – Site

When starting a design for a specific site, ensure that the Surveyor provides .dwg point data for all contours and elevation points. These points and contours allow a Revit user to "Drape" a 3D topography over the site, therefore eliminating the need for manual elevation calculations. Revit then has the ability to read out exact spot elevations upon placement of a Spot Elevation Tag. This eliminates the need to type in geodetic elevation data.

Project North should be established in the .dwg file previous to inserting it into a Revit file. True North can then be rotated in the Revit file after insertion of the survey. To some, this may seem a little odd. The reason for using this methodology is largely due to the Revit Template. Everything in the Revit Template is preset to Project North. If the Project North is rotated in any way or fashion, every view will be angled inappropriately and the user will be forced to rotate or reconfigure individual views.

Modelling Practices – Floor Plans

When initiating the floor plan layouts, ensure that you start on the 1st floor and set your walls to an unconnected height of 6ft. This will allow the walls to move independent of walls on other floors. If the walls are constrained to a floor above, any walls in the same plane will move with them. When the exterior walls of the 1st floor plan are decided upon, they can be copied to clipboard and pasted to the basement level. If there is a 2nd level, the walls that were copied to clipboard, can be pasted there as well. From this point, underlays can be used to maintain a visual connection to floors above and below. The Top and Bottom constraints of these walls can be adjusted when the final perimeter is decided.

When drawing walls for floor plans, do not waste time plugging in exact dimensions. Revit is designed to be parametric in nature. This means that items are much easier to edit after placement. Walls should be drawn roughly, then after placement, use dimension strings to lock in the final size requirements. Too much time is spent in attempting to decipher dimensional properties during the design stages.

Modelling Practices – Stairs & Railings

This is very straight forward: Stairs and Railings in Revit are extreme in terms of time consumption. It is very easy for a Revit user to waste countless hours attempting to make the perfect staircase. Every Revit user should have a stair that is solely composed of treads. This staircase should be extremely basic and meet the requirements of their local building code. This stair is perfect for establishing spatial requirements during layout design.

When designing a stair with winders, it is best practice to use Stair by Sketch. The "Winder" stair provided in the Revit software is not conducive to actual winder stair design.

Railings should use the same methodology listed above. Every Revit user should have a basic railing that is solely composed of a 38mm (1-1/2") handrail. This railing is merely used to identify connection and visibility issues in elevation as well as show the basic outline on the floor plan.

Modelling Practices – Detailing
The number one mistake in 3-D workflows is over-modelling. A user has to be able to weigh options when modelling. If it seems like it is taking too long, it might be best practice to fill in the gaps with 2-D detail components. A rule of thumb to follow is: If it is only visible in one view and is more complex than usual, it may be beneficial to use a combination of linework and detail components.

Detail Components should be designed to accomplish as much as possible for as many possible applications. For instance, the cross section of nominal lumber can be used for studs, joists ceiling joists, anchor plates, etc. So why not create a detail component that uses those nominal lumber components to build a parametric header detail. What about a floor transition detail from top plate of first floor to bottom of second floor? What about repeating details for Floor Joists @ 16"o.c.? Let's take this a step further…What about a fully parametric wall section detail for a wood frame house that is adjustable according to floor height. This detail can then use visibility parameters to turn on or off header and sill details. Taking it a step further…How about adding Foundation anchor plates and a repeating detail for brick? Once a steeper knowledge of detail components is acquired, there becomes a massive increase in productivity.

Rough Labour Savings – Case Study (BluPrint Design + Build)

The CAD Design Package
A standard Building Permit package for BluPrint is $3.00/Sq.ft. CAD. This package consists of the following: (Based on a 3,600sq.ft. Custom Home @ $10,800.00 plus tax)

Structural Engineer (17%) –	$1,820.00	
Mechanical – 'In-house' (5%) –	$560.00	(8 Hours)
Electrical - 'In-house' (4%) –	$450.00	(6 Hours)
Architectural - 'In-house' (69%) –	$7,452.00	(156 hours)
Profit (2.5%) –	$270.00	
Overhead (2.5%) -	$270.00	

The Revit Design Package – Initial Productivity Gains
Using the same package above, let's take a look at how Revit began to help BluPrints workflow.

- 2 Hours were saved due to not drawing outline sketches for concept layout in CAD
- 14 Hours were saved due to Coordinating Site Plan details via point elevation topography from the surveyor.
- 21 Hours were saved due to not having to make the same redundant changes for multiple elevations or plans.
- 12 Hours were saved from making redundant alterations to SPA or Building Permit plans on multiple elevations or plans

- A Total of 49 hours were turned into profitable earnings from utilizing Revit vs CAD "Out-of-the-Box"

Structural Engineer (17%) –	$1,820.00	
Mechanical – 'In-house' (5%) –	$560.00	(8 Hours)
Electrical - 'In-house' (4%) –	$450.00	(6 Hours)
Architectural - 'In-house' (47.5%) –	$5,111.00	(156 hours - 49 hours = 107 Hours)
Profit (24%) –	$2,611.00	(+21.5% Profit, +$2,341.00)
Overhead (2.5%) -	$270.00	

The Revit Design Package – Enhanced Productivity Gains

Taking this a step further, we begin to look at additional enhancements to the Revit workflow for BluPrint:

- 6 Hours saved from automated door & window schedules
- 10 Hours saved from smart detail components/keynoting and tagging
- 2 Hours saved from Heat Loss/ Heat Gain Calcs
- 2 Hours saved from the creation of parametric kitchen families
- 3 Hours saved from milestone specific view templates and corresponding views placed on sheets within the template
- A Total of 23 Hours were turned into profitable earnings due to a few small alterations within the template

Structural Engineer (17%) –	$1,820.00	
Mechanical – 'In-house' (5%) –	$560.00	(8 Hours)
Electrical - 'In-house' (4%) –	$450.00	(6 Hours)
Architectural - 'In-house' (69%) –	$3,265.00	(107 hours - 23 hours = 84 Hours)
Profit (39%) –	$4,187.00	(+36.5% Profit, +$3,917.00)
Overhead (2.5%) -	$270.00	

The Revit Design Package – <u>Enhanced</u> Enhanced Productivity Gains

Now that we have a profit increase of approximately 36.5%, let's get even more greedy! Let's say you are a production home builder and have an estimating division. Revit compiles a database of information that is updated live as items are being populated in the model. These Items are being tracked and can be scheduled in multiple ways. Because of Revit, Quantity Take-off has now been shortened down from 38 Hours to approximately 7 Hours. That is a time savings of over 80%!! Estimators do not have to count light fixtures, doors, windows, etc. The cost and manufacturer data can be compiled right within the software.

Above and beyond the call of duty, Revit has also provided the designer with the tools to predict issues that may have cost extreme amounts of money on site. Headroom issues, HVAC Cross-overs/bulkheads, miscellaneous clearances etc.

With everything in perspective, a company can see almost 50% worth of profitable productivity gains. This allows the firm to take on 2 projects in the same time that 1 project was originally completed in CAD.

The Conclusion

The above calculation was done in 2013 for a one-man company that worked a part-time pace of 2 hours a day. That same company still works 2 hours a day, 5 days a week and has completed 23 homes in 2015 ranging from 2,000 sq.ft single family dwellings to 9,000 sq.ft. mansions. That is an average of 22.5 hours per custom home. Let's do a little extrapolation:

If this same person was to work a full 8 hour workweek, this person would personally be capable of tackling approximately 89 Custom Homes from scratch.

If this was a production home environment that number would almost quadruple! It almost makes too much sense to make the switch to BIM. What do you think?