AB2485 Asking an architect to create systems inside of Revit is like asking him or her to speak a foreign language. BIM encompasses the whole building into the design process, so why do we still think about and process our designs one element at a time? Design intent, code constraints, functional requirements, and aesthetic proportions are some of the factors contributing to the building systems hierarchy integration and performance. Creating systems is an everyday task for MEP engineers when modeling inside of Revit MEP. Just like MEP systems, architectural and structural systems are now more interconnected than ever before. Curtain systems, beam systems, and furniture systems are few examples of building systems that capture design intent and streamline productivity. This class is an in-depth quest for order, systems hierarchy integration, and efficiency in a design environment. As BIM continues to evolve, we need to evolve our thinking process and begin designing with systems as opposed to single elements.

Learning Objectives
At the end of this class, you will be able to:

- Identifying architectural systems and understand how to use them in the design process.
- Learn how to develop systems for different categories and sub-categories within your model.
- Learn how the system design approach can automate repetitive tasks.
- Discuss how creating systems could assist in Clash Detection, Quantity Take Off, Timeline Simulations, and in Facility Management.

About the Speaker
Mike has more than 15 years of experience as an architect working on various types of projects. He is currently Senior AEC Building Application Specialist at Applied Software, where he helps firms assess, plan, and implement new technology. His knowledge and enthusiasm for AutoCAD® products runs deep; he has been a user of AutoCAD since Release 9 and of AutoCAD Architecture since its debut. He has also developed a deep appreciation for Autodesk® Revit®. Mike is a contributing author of Autodesk Official Training Courseware and a repeated speaker at Autodesk University.

Rabi Sidawi, AIA education includes a B.ARCH (1985), M.ARCH (1986) and MA (1988). Since 1988 he practiced architecture in Los Angeles, Honolulu and Atlanta. Rabi is a registered Architect and a senior application consultant at Applied Software. In his current role, he provides AEC project planning/implementation, trains AEC professionals on (BIM) applications including Revit Architecture, Revit Structure, Navisworks and Ecotect Analysis. Other activities include web seminars and marketing presentations, project management, GSA BIM template creation, model error checking & validation, simulation of project phases, quantity & material take-offs and building performance analysis. Autodesk recognized Rabi as having received the highest ratings from students for instructor performance. He was named (ATC) Instructor of the Year for 2007. In 2009 he received the North America award for distinguished performance in Revit Architecture.
Introduction
Welcome aboard. Please take your seat and fasten your seat belt. We are about to blast off to 21st century architecture. All Systems are GO… 3…2…1… Blast off!

The emerging trends in architecture today have changed how we approach design and practice architecture. As designers and architects, we are expected to design more efficient buildings, quicker, with smaller fees, that have less impact on the environment. The economic state of our country is at a point where we have to be as efficient as possible on each and every job. Technology has equipped us with tools to assist us in tackling these issues head on. We have to know when, where, and how to use technology so that it is assisting us and not hindering us.

This session focuses on using a system approach to architecture using Autodesk Revit Architecture 2012. Revit Architecture is the authoring tool for Building Information Modeling (BIM) as we head into the 21st century. As the demand for BIM in our industry continues to increase, developing a Systems Approach will ensure that we are more efficient and that we are preparing our designs to be used in a true BIM environment.

System Approach to Design
What does it mean to Architects?

Using systems in our approach to design is not a new concept. This approach has been around for many decades. The concept takes us back to our college design courses where we had to define our designs and incorporate our designs into a program that was not only aesthetically pleasing, but functional too. In The Building Systems Integration Handbook, Richard D. Rush defines a system as "a coherent set of physical entities organized for a particular purpose." If we take this definition and apply it to design, then we can begin breaking down the parts of a building or project and group them into systems that will give us some order in our design as opposed to haphazardly putting building parts together.
So what’s New about a System approach?

Today’s BIM methodology & parametric technology enables us to have a systems approach to building design, which has the potential to revolutionize the AEC industry and project delivery. BIM is and will continue to be the catalyst and the tool to make that happen. Projects are no longer being designed just for 2D documents that are issued for Construction Documents. BIM is enabling us to create 3D intelligent models that are being used during the construction phase, and then being brought into the operation phase for facility management. It is more important now than ever before that we understand not only how buildings are constructed, but also how buildings are operated, because our models can be used for operations if we have the fore knowledge to build and populate our models correctly with the appropriate information.

So at this point, you can sum it up by saying that the System approach is the same as it has always been, but the methods, tools, and what we do with the end results have changed drastically over the last few years. Technology is changing more quickly every day. With the release of Revit 2012, new tools such as Parts and Assemblies allow contractors to break apart the systems that architects are creating to be used for scheduling, quantifying, or development of shop drawings. As we move into the future, this technology will continue be developed and we will have to continue to evolve how we work with systems on our projects.

What is a System?

Wikipedia defines a system as the following:

- A whole compounded of several parts or members
- a set of interdependent components forming an integrated whole
- a set of elements and relationships

Most systems share common characteristics, including:

- Systems have structure, defined by components and their composition;
- Systems have behavior, which involves inputs, processing and outputs of material, energy, information, or data;
- Systems have interconnectivity: the various parts of a system have functional as well as structural relationships to each other.
- Systems may have some functions or groups of functions

Above all Systems promote *Strategic Thinking* about the project!
Engineers approach projects using a system approach. Everything engineers include in their designs is typically part of systems. It would be crazy for them to include a Supply Diffuser on an Exhaust System or a Sanitary Pipe on a Cold Water System. Systems are critical to their designs and to the process of what they are designing. We as architects should be as critical in our thinking when it comes to building parts and how they are going to operate and function. A wall is not just a wall. A door is not just a door. Walls can be part of the substructure, shell, or the interior of the building. Knowing the system or category of a building element can eliminate confusion and errors downstream during construction and operation.

**MasterFormat (CSI) vs. UniFormat**

MasterFormat is the standard for organizing specifications for building projects in the U.S. and Canada. MasterFormat is a product of the Construction Specifications Institute (CSI). In November 2004, MasterFormat expanded from 16 Divisions to 50 Divisions, reflecting innovations in the construction industry. It provides a master list of divisions, section numbers and titles within each division, to follow in organizing information about a facility’s construction requirements and associated activities.

![Keynotes in Revit use MasterFormat Classification](image)
UniFormat is a method of arranging construction information based on functional elements, or parts of a facility characterized by their functions, without regards to the materials and methods used to accomplish them. These elements are often referred to as systems or assemblies. UniFormat is often seen in performance specifications. Its most notable use is as a format for estimators to present cost estimates during the schematic design phase. UniFormat breaks a facility into systems and assemblies that perform a predominating function such as substructure, shell, interiors, and services, without defining the technical solutions to provide these functions.

Assembly Codes in Revit use UniFormat Classification

To summarize, MasterFormat is product or material specific whereas UniFormat groups products together to form assemblies or systems. As we move deeper into this session, it is not a debate as to which one we should use. Both MasterFormat and UniFormat have their purpose. Understanding what information can be retrieved from each is important to remember.
Good BIM Standards for Systems Approach to Design

Create Good Templates

To begin using MasterFormat or UniFormat on Revit projects, the Keynote parameter and the Assembly Code parameter need to be selected. A good start would be to modify your Revit project template to include these parameters. Inside the project template the Keynote values can be added to materials in the Material Library, and Assembly Codes can be added to System Families.

Material Library

New to Revit 2012 is the ability to export/import material libraries which allow the possibility of companywide, client specific, or project specific libraries. The Keynote value can be found under the Identity tab for the material.

Material Library with Keynote values assigned to materials
**System Families**

System families contain family types that are used to create basic building elements such as walls, floors, ceilings, and stairs in building models. System families are predefined in Revit, and saved in templates and projects, not loaded into templates and projects from external files. System families are usually created from multiple components. Each of the components is assigned a material that has hopefully already been assigned a Keynote value in the Material Library. Users can now assign an Assembly Code to the System family that can be used for the assembly of components. The Assembly Code will use the UniFormat classification system.

Occasionally, we use System families to represent elements other than what they were intended to be used for. We may use walls, for example, to represent ductwork. It is even more critical that we verify the Assembly Codes for these System families so that later there is no confusion on what walls are and what ductwork is.

System Families can be created in Revit template files, or another good practice is to create a System family project file that users can open to copy system families to bring into their current project. This workflow will allow the Revit template to be a smaller file size by not having the entire library of System families loaded. Regardless of where they are stored, make sure that the Assembly Codes are correct for the system that they are trying to represent.

*An Assembly Code in the Type Properties of a Wall System Family*
Filters

Once Keynote parameters and Assembly Code parameters have been assigned, Revit can begin using those parameters to create filters. Filters provide a way to override the graphic display and control the visibility of elements that share common properties in a view.

For example, if you need to change the line style and color for Exterior - Brick on Mtl. Stud walls that have the Assembly Code of B2010158, you can create a filter that selects all walls in the view that have B2010158 value for the Assembly Code parameter. You can then select the filter, define the visibility and graphic display settings (such as line style and color), and apply the filter to the view. This will update all walls that meet the criteria defined in the filter update with the appropriate visibility and graphics settings.

Filter settings for an Assembly Code filter

Schedules

Schedules can also be created based on Keynote or Assembly Code parameters. This will create unique schedules that can either be filtered or sorted by Keynote or Assembly Code parameters. For example, a schedule can be created that will sort all the walls in the project by their Assembly Code. This will group the sub-structure walls together, the shell walls together, and the interior walls together. Looking downstream at how a contractor might use this information, he will probably have different trades doing the sub-structure vs. the shell vs. the interior. Breaking the information up like he is going to use it makes more sense.
Create good Content

In addition to assigning the Keynote and Assembly Code parameters in the Revit Template file, it is important to assign these parameters when creating loadable families. Loadable families are families used to create both building components and some annotation elements. Loadable families create the building components that would usually be purchased, delivered, and installed in and around a building, such as windows, doors, casework, fixtures, furniture, and planting. Making sure that the correct Assembly Code and Keynote parameters are assigned during the creation of these loadable families can ensure proper usage of them downstream.

Remember that the Keynote parameter is referring to the material, and materials in families are not always defined. Materials are typically left as a parameter so they can be modified by the user once inserted into the project, in which case the project’s Material Library’s Keynote parameters will define the material to be used.

Properties of a Revit Family with Keynote and Assembly Code Parameters
Using Keynote Tags / Assembly Tags / Schedules with Systems

Keynote Tags

Revit has the ability to place tags to call out the values of the Keynote parameters. Revit comes with three different types of Keynote tags.

- **Element.** A keynote can be applied to an entire element, such as a wall, detail component, or door.

- **Material.** A keynote can be assigned to a material that has been painted on a surface, and to materials assigned to the component layers of an element. Material keynotes are not supported for the insulation drafting tool, the detail components line and filled region, or wireframe views.

- **User.** This option provides a way to use commonly used notes or phrases to address documentation issues. These additional user notes must be added to the provided keynote text files or included in one that you create.

If the Keynote parameter has been selected and applied to the materials in the Material Library, then when a Keynote tag is applied it will display its value automatically. Users can choose the keynote style from the type selector when placing the keynote tag. Users can choose from a tag that shows the numerical value, boxed numerical value or the description text of the keynote. If the keynote parameter has not been assigned for the element that is being tagged, users can select it directly from the keynote database.

Either numerical or text values can be used in Keynote tags
Using keynote tags will create consistency in annotation throughout documents at a project level and at a firm level. The database is a text file that can be maintained on the server. All projects can be linked to a single database, or you can have project specific databases. If the databases are updated or revised, all projects linked to that database will update the next time that project is opened.

Keynotes can also be used in conjunction with a Keynote Legend. This will allow users to have reference to numbered notes that refer to a common legend. The legend can be either sheet based or project based. This type of annotating is also known as note-by-numbers.

Assembly Code Tags

Another tag that could be useful is an Assembly Code tag, but oddly enough Revit does not come with one out of the box. Creating an Assembly Code tag would be beneficial in the conceptual / schematic design phases of a project, or before all of the materials are completely determined but the general make-up of the assembly is known. Once the materials are determined and the project moves into the Design Development or Construction Documents Phases, the Keynote Tag may be preferred over the Assembly Tag.

Multi-Category Tag calling out the Assembly Code and the Assembly Description

To create an Assembly Tag, you will need to create an annotation family using the Multi-Category Tag template. Inside of the family, simply insert a Label using the Assembly Code and/or the Assembly Description. Once loaded into your project you can use the Multi-Category Tag tool and select the desired elements to tags. If you want to see a leader on the tag, that can be set in the Edit Type properties of the tag.

Tagging elements with Keynote tags or Assembly Code tags will eliminate time and errors. Why enter the information twice? If the information is already known by either the material or the assembly, then let Revit do the work and call it out for you. This is one area where a company can really gain efficiency in their production if they simply take the time to create a database of keynotes and learn how to properly apply the parameters and tags.
Systems for Repetitive Uses

In addition to adding information to model elements to define systems, systems can be created and saved when they are needed for repetitive uses. There are many parts of buildings that are repetitive and can be modeled once and simply repeated or referenced as opposed to remodeling. There are also similar systems that can be carried over from project to project as opposed to starting from scratch each and every time.

We all do this in a formal or an informal manner. We are all guilty of stealing something or copying something from another project as opposed to modeling it over. There is nothing wrong with that except that there should be some order to it, and some way of knowing where to get what you are looking for. There are many ways to organize content, families, details, or libraries for your company. This course is not about teaching you how to organize your BIM library. Where this ties into Systems is that we can take parts or pieces and put them together and assemble systems. There are many examples to choose from inside of Revit:

- Curtain Systems that are made up of a series of mullions and panels
- Railing Systems that are made up of a series of balusters, posts, and rails
- Stair Systems are made up of tread, risers, and railings
- Toilet Partitions are made up of partitions and doors
- Furniture Systems are made up of panels, work surfaces, drawers, cabinets
- Ceiling Systems made up of ceilings, lights, diffusers, speakers

A Furniture System Family Created From Separate Parts

A Door Family with a nested Light Fixture Family
As a modeler, you should be looking at these systems to see which ones could possibly be used repeatedly. If you have some that are repeated, then it would benefit you and the project and possibly the entire office to spend the time to create a family with those individual parts assembled into a system.

One area of caution is that you will probably have to create a Shared Parameter file and begin linking parameters together when you begin creating these 'nested' families. A Shared Parameter file will enable you to tag and schedule parameters from the original family.

Grouping is another option to use as opposed to creating nested families. Grouping inside of a project setting can enable quick copying and editing. You can also save the groups out to a file and then link groups into your project. This will allow you to have groups that are driven by an office wide standard and can be updated. Groups can also allow you to have ‘one-off’ instances where you can hide an element inside of a group if one instance is different from the rest of the group. This enables the group to be slightly different without having to make an entirely new one.

Excluding an element from a Group by Tab Selecting the Element and Right Clicking
Taking System Designs into the Contractor Arena

At the beginning of this course, one of the important reasons for designing with the Systems approach was how it affects the contractors downstream. With the release of Revit Architecture 2012, the transition from the design model to the construction model has gotten smoother thanks to two new tools. The new Parts tool and the new Assembly tool will help bridge the gap between the design model and the construction model without having to start the process over or without having to redo what the architect has already done.

Making Parts out of System Families

The new Create Parts/Divide Model tool provides a method for dividing Revit Architecture geometry into smaller parts for the purpose of creating more accurate schedules, quantity takeoffs, visualizations, and exports. It provides visibility controls and helps to maintain a persistent design intent model.

So you may be asking why would being able to take a System family back to its components be such a big deal? It all comes into play when the contractor tries to simulate construction sequencing of a system family. Imagine a wall that has CMU block, brick façade, and Gypsum Board. In previous releases, the contractor could not schedule that wall being built any other way except the total wall being built at one time. Now with Parts he can simulate the CMU being built first, then the Brick being built, and the Gypsum Board being installed last. It can also come into to play when the contractor plugs the wall into his estimating program. Previously, he was not getting actual values of the components. Now he can.

If the contractor chooses to use the Parts Divide tool, he can divide or split System families. For example, if the model contains one continuous floor, the contractor may choose to sub-divide the floor into multiple sections to match the number of pours it will take to pour the floor.
Creating Assembly Views

The new Assemblies tool helps support the creation of shop drawings for pre-fabricated building assemblies such as precast walls, columns, beams and floors. An assembly can be selected, scheduled, isolated, tagged, and tracked in the project. All annotations or views created inside the assembly views will not interfere with regular views of the main model. Again, this process is bridging the gap between the design model and the construction model by taking what the architect has created and moving it to a construction shop drawing level.

Conclusion

A Systems Approach to architecture using BIM is a natural flow. There are many built in tools to assist you in the workflow. The components and materials are the basis for our models and all have the primary parameters for both the MasterFormat and the UniFormat Classification systems. These systems are and have been recognized in our industry for years. We, as designers and architects, just have to begin thinking about how to use them and think about how to take advantage of them in our design process. This will lead to better designs, and better projects, as BIM becomes more of a standard in our industry.