Autodesk University 2012

Hybrid Autodesk® Revit® Modeling: MEP Modelers Encountering Complex Architectural Geometry

Speaker: Mark Green – CASE Design, Inc. www.case-inc.com
Co-Speaker: Alan Jackson – CASE Design, Inc. www.case-inc.com

MP5745 This class covers advanced techniques for MEP modelers to automate the placement, modification, and customization of mechanical elements when confronted with complex architectural geometry. Techniques demonstrated will involve custom workflows between Revit MEP and Revit Architecture. You will learn how Adaptive Components, Pattern Based Systems, and the Conceptual Massing Environment can be appropriated from the architectural tools to MEP users.

Learning Objectives

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

- Explain how Revit modelers can automate and manage issues when encountering complex architectural geometry
- Describe alternatives for creating custom MEP families through appropriating Revit Architecture tools
- List and describe custom workflows using Adaptive Components, Pattern-based families, and the Conceptual Massing Environment
- Explain how parametric relationships can be used to enhance productivity

About the Speaker

As Director of Learning at CASE, Mark Green focuses on integrating emerging technology with current design practices in the professional, academic, and internal capacity. He leads efforts on experience as an educator in developing intelligent and strategic methodology for global learning initiatives. He is an Adjunct Professor at Columbia University's GSAPP and an Associate Instructor at the University of Utah College of Architecture + Planning. He has led design technology workshops for both faculty and students on topics related to BIM and parametric design at Syracuse University and Taubman College School of Architecture and Urban Planning at the University of Michigan.

Mark received his Bachelor of Science in Architecture from the University of Utah, graduating summa cum laude, and his Master of Architecture from Columbia University receiving the Honor Award for Excellence in Design.

m.green@case-inc.com
@marktgreen

www.rethinkingbim.wordpress.com
www.case-inc.com
www.designreform.net

Alan Jackson is a Senior Design Technology Specialist at CASE and specializes in MEP engineering and consulting. Alan's passion for sustainability, master-planning, and energy/performance analysis has translated to an interest in utilizing energy modeling platforms and related analysis tools to address and improve building performance. He joins CASE from KlingStubbins where he held the position of HVAC Project Engineer/BIM Team Leader. Alan received his Bachelor of Science in Mechanical Engineering Technology from Northeastern University and is LEED AP.

Not to be mistaken for the country music artist, Alan is an avid traveler and world history buff currently favoring Japanese culture and Samurai films. He is also the founder of openRevit.com, a blog that concentrates on Revit MEP and energy modeling for the BIM community.

a.jackson@case-inc.com
@alnjxn
www.openRevit.com

<u>This class will cover the following topics:</u>

Problem: Adaptation of MEP Families to Complex Geometric Form

Topics:

- **Parent – Child Relationship**
    - Understanding they key settings for originating geometry at the child level
- **Hosting**
    - Face based vs Surface-specific based
- **Nesting**
    - Proper categorization and constraints
- **Adaptive Components**
    - Augmenting existing adaptability with additional point-based control
- **Pattern-based Families**
    - Normal-based control through divided surface manipulation
- **Divided Surfaces, Placement, and Updating**
    - Adjusting controls to allow for directional modifications and updating

Problem:

Complex curvature in architectural geometry impacts MEP design in various ways. Often, it is the task of the engineer to avoid clashing with those elements. However, where the trades intersect into public space, MEP elements often need to locate themselves perpendicular to any given surface. Depending on how the architect has generated this surface, different methods in Revit can be employed to ensure MEP elements have properly been located and still maintain their functionality. It should be noted that much of these workflows have been generated to provide accurate data for clash detection.

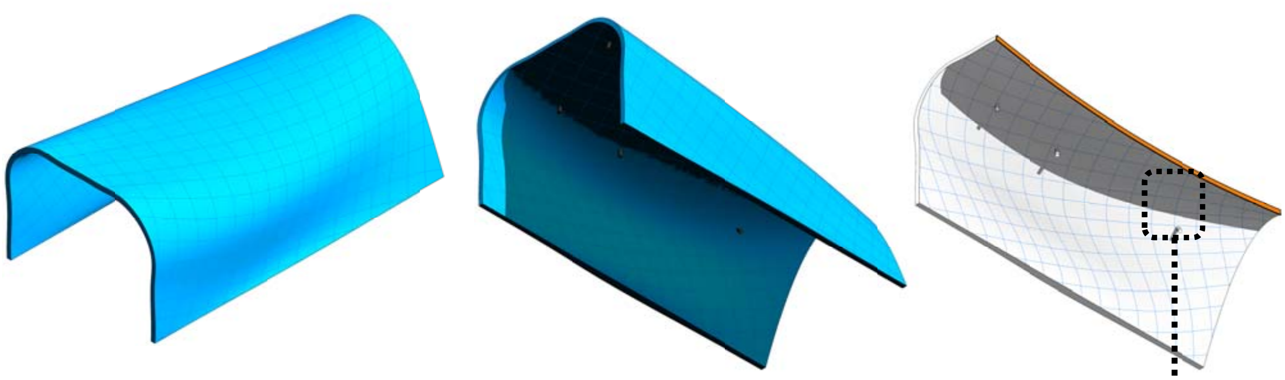
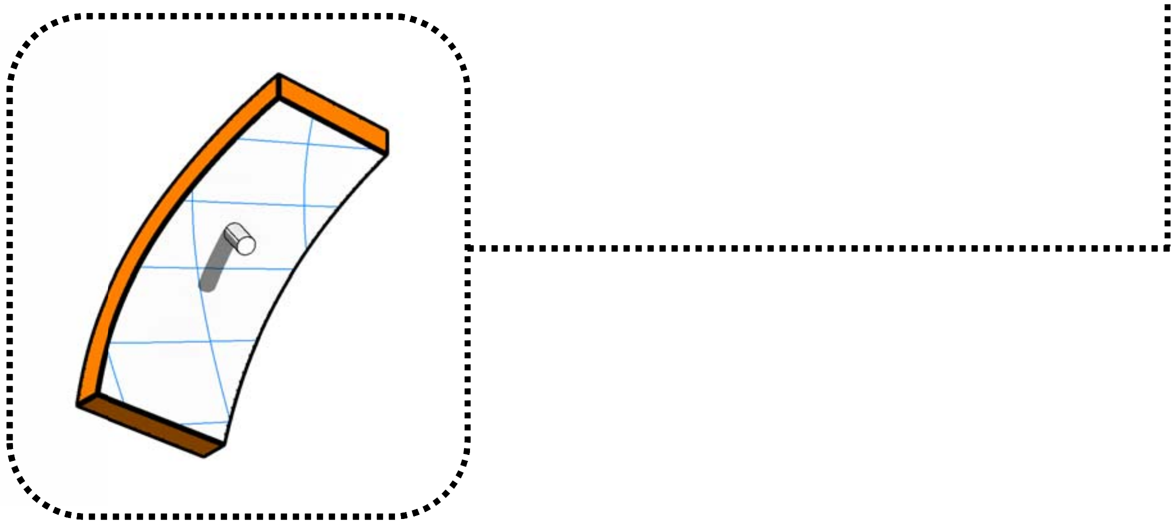


Figure 1: **Complex Curvature with MEP**



Solution:

Nested Families

Nested Family Structure:

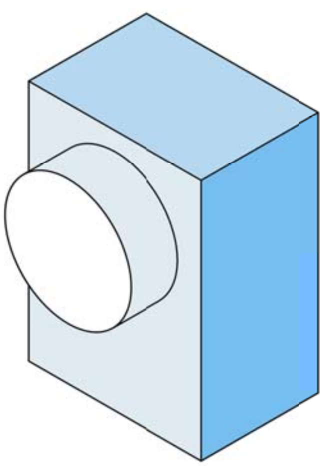
CHILD PARENT

Generic Model > **Face-based Family** > **Adaptive Component** > **Pattern-based Family**

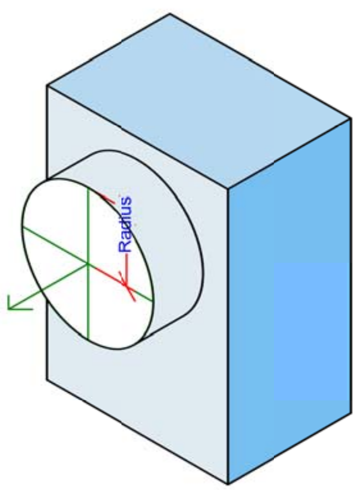
(Example: Air terminal)

Parent – Child Relationship

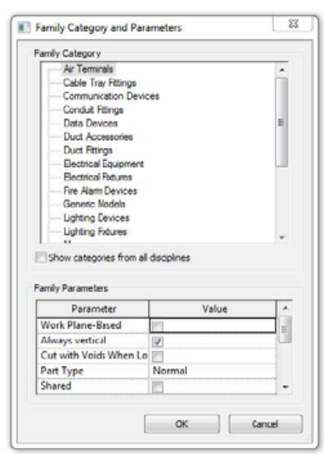
Identifying the type of hosting necessary will prevent excess remodeling, but in most cases, one begins family generation with a generic model. After properly setting directionality, it is key to ensure the categorization of the parent-child relationship is understood. The child-family should be categorized appropriately to the object type, and only the child. This is to ensure connections properly function when instantiated into the project scene. However, it is also critical to leave the nested families on the default setting or errors will occur (we will discuss this more in detail in subsequent sections).



Family Template:
Generic Model



Directionality:
Set Direction



Categorization:
Air Terminal

Hosting:

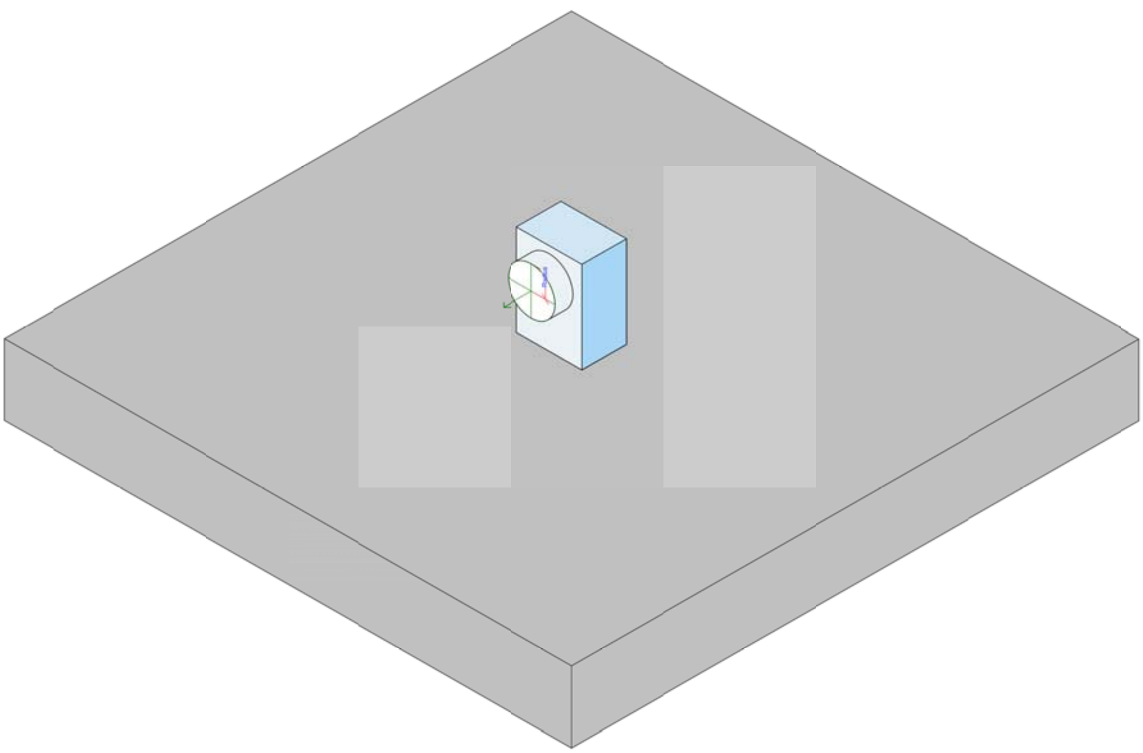
Determining the host and how easily a family can be updated is a primary objective. Manually locating any particular MEP element for each instance in a project might initially seem effective but the task rarely results in a one-time action. Architectural surfaces change often and having adaptability built into MEP families becomes crucial.

Q: Face based or Surface-specific based?

A: **Face based**

> It can be argued that 90% of the time, for trades linking their project files into the architect's models, face-based families would most often be recommended. This principle prevents your families from being deleted due to hosts being deleted. Face based families will simply inform the user that they no longer have a host and need to be reassigned. This is much easier to manage then re-instantiating each object.

(Note: Consider which face of the will be hosted, as it may have to be re-modeled to adjust later)



Family Template:	Parameters:	Categorization:
Generic Model Face-based	**Yes/No**	**Default**

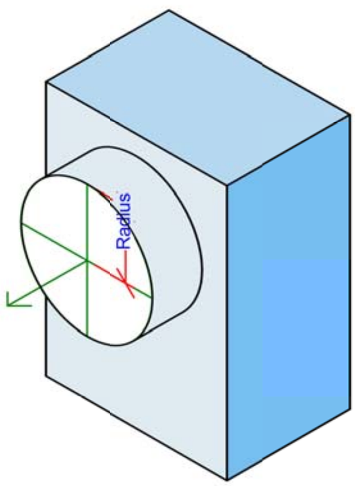
Nesting:

This particular workflow involves nesting four family types together. This may seem excessive at first but each family serves a specific function to enable a more complex adaptability in the project environment. At the child level, we originate the geometry and set parameters. At the face based level, we ensure which face of the original family connects with its host. The adaptive component stage enables flexibility in conforming to irregular surfaces. Finally, the pattern based family optimizes the workflow and allows for one-click placement, rather than four-point adaptive placement.

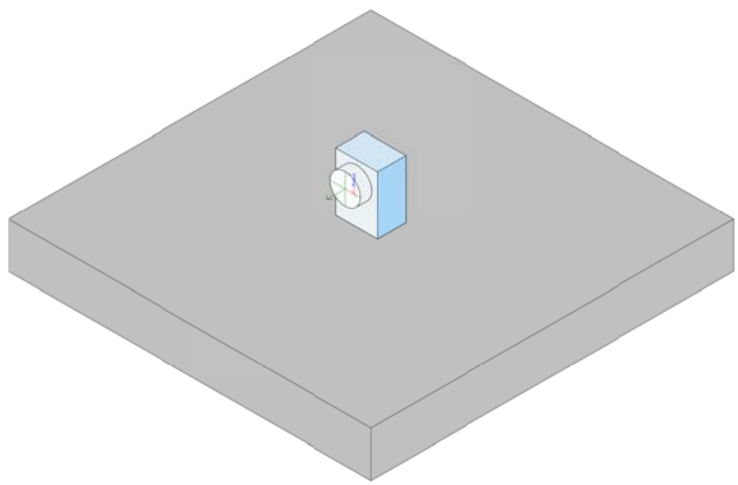
Nested Family Structure:

CHILD PARENT

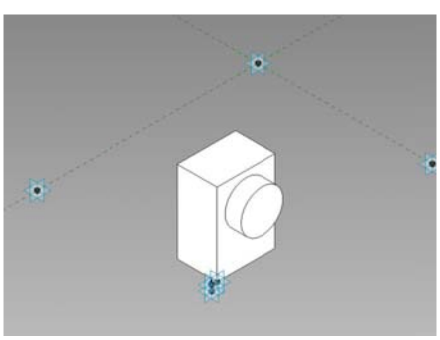
Generic Model > **Face-based Family** > **Adaptive Component** > **Pattern-based Family**



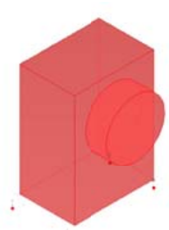
Generic Model

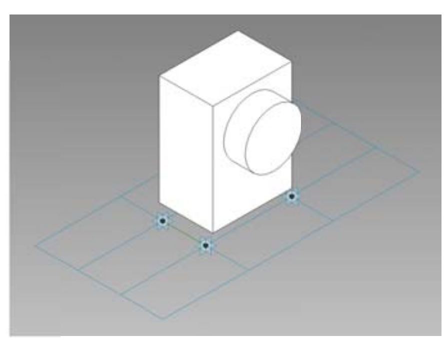


Generic Model Face-based



Generic Model Adaptive



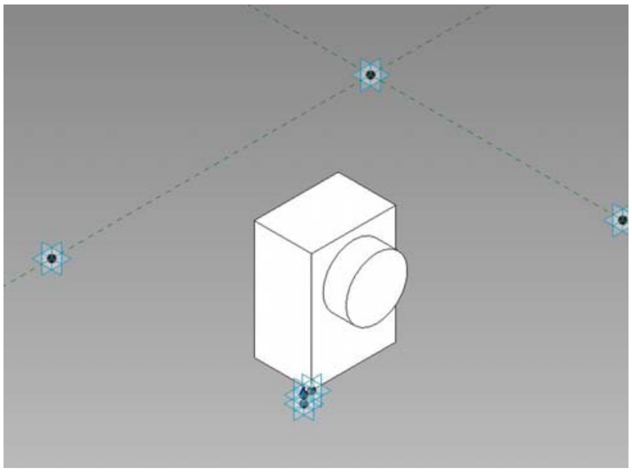


Curtain Panel Pattern Based

Adaptive Component:

Understanding Point vs Line Based Hosting

1.



2.

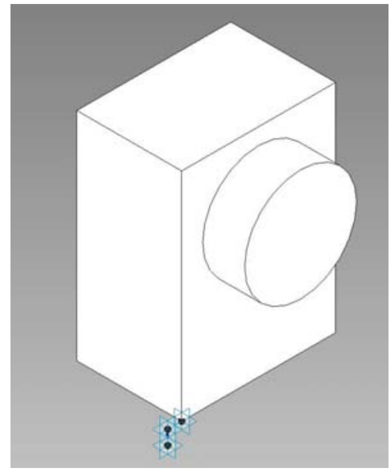


Figure 1: Face based family nested into an adaptive component.
Figure 2: Enlarged nested family hosted manipulated by 2 additional adaptive points.

The primary reason for utilizing adaptive components in this process is to control the normals. In this example, the air terminal must remain perpendicular (or normal) to double-curved surface. Even though each air terminal is positioned uniquely with respect to each other, each fixture is identical but must be precisely placed for clash detection. These surfaces changed often and locations are also modified. This calls for an adaptable family.

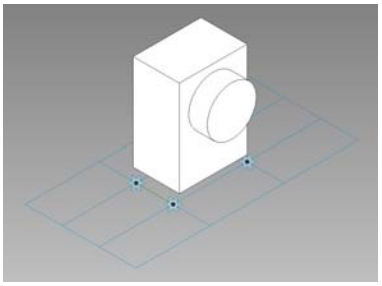
It should also be noted that this specific family was not sufficient to be placed directly on a host surface as work-plane based issues will arise. Nesting becomes necessary.

Note: SAT and DWG imports, serving as the base surface, are not sufficiently snap-able by point. A divided surface system or projected surface by intersection becomes necessary.

Curtain Panel Pattern Based:

Nesting to pattern based systems and adding additional parameters

1.



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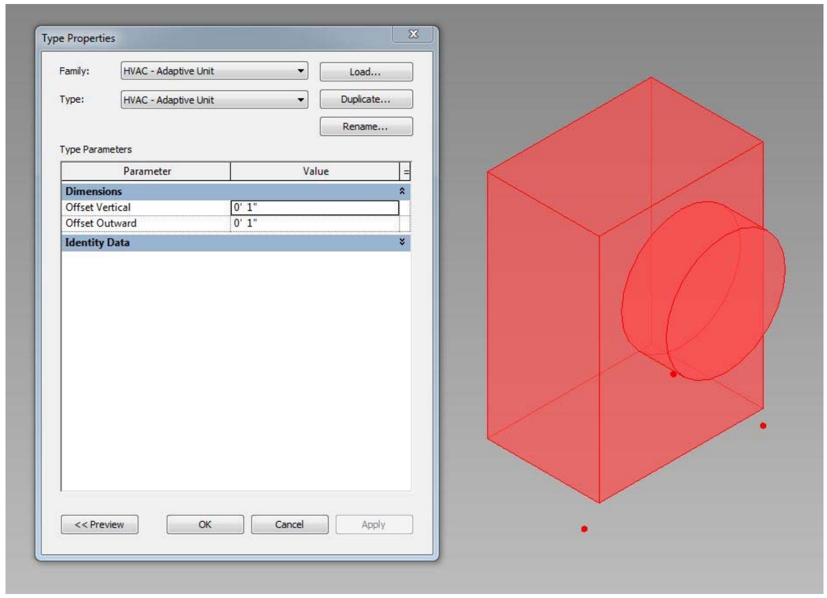


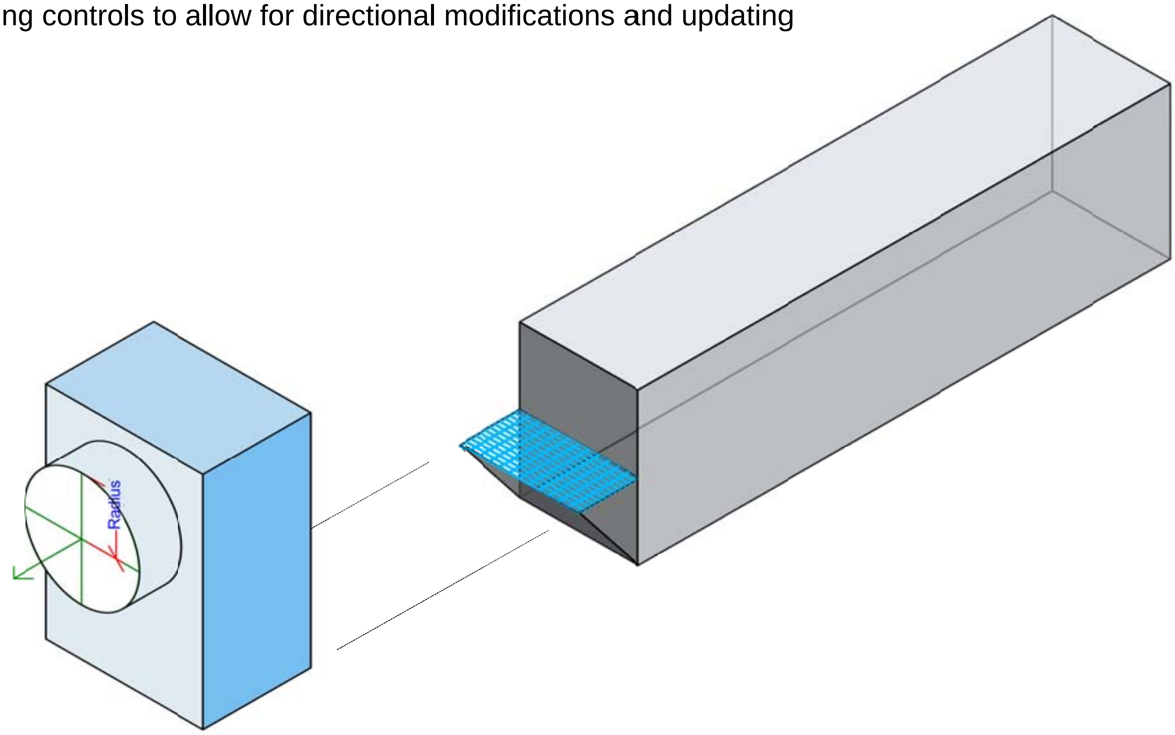
Figure 1: Nested Adaptive Component in a Curtain Panel Pattern Based Family
Figure 2: Type Properties of Adaptive Component while nested in Pattern Based Family

MEP systems may not regularly employ the use of "curtain panel pattern based" systems. The strength of these systems is in arraying while conforming to a complex geometric surface. The pattern based family offers control with arraying and offsetting. The ease of updating will save time while the architect continually manipulates the surface.

At this point we will isolate the primary adaptive points, native to the pattern based family, to ensure the adaptive component is not accidentally constrained to a nearby host. We will then place the component in the same sequential order to which we specified in the adaptive component family. You will notice a varying orientation if this is done out of sequence.

Divided Surfaces, Placement, and Updating:

Adjusting controls to allow for directional modifications and updating



Here we will define the surface to act as the host for the pattern based family. Once we have designated it as a divided surface, we will specify how many divisions are needed using the UV settings. This will control how many air terminals should be located on that surface. It is important to note that we will be setting the values to (1). We do not want an array, just a single adaptable family. This also must be done while in the Edit In-Place Mass environment.

As long as the air terminal family has properly been categorized at the child level, it will read as an air terminal at the project level. To modify the object, such as changing its orientation, one must edit the mass again by selecting, Edit In-Place, and make the changes.