Revit MEP Programming: All Systems Go

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About the Presenter

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Jeremy is a member of the AEC workgroup of the Autodesk Developer Network ADN team, providing developer support, training, conference presentations, and blogging on the Revit API.

He joined Autodesk in 1988 as the technology evangelist responsible for European developer support to lecture, consult, and support AutoCAD application developers in Europe, the U.S., Australia, and Africa. He was a co-founder of ADGE, the AutoCAD Developer Group Europe, and a prolific author on AutoCAD application development. He left Autodesk in 1994 to work as an HVAC application developer, and then rejoined the company in 2005.

Jeremy graduated in mathematics and physics in Germany, worked as a teacher and translator, then as a C++ programmer on early GUI and multitasking projects. He is fluent in six European languages, vegetarian, has four kids, plays the flute, likes reading, travelling, theatre improvisation, yoga, carpentry, loves mountains, oceans, sports, dancing, and especially climbing.

Class Summary

- Overview of the Revit MEP API
- MEP API enhancements in Revit 2013
- Working programmatically with Revit MEP models
- Overview of available Revit MEP API samples
- Prerequisites: we assume prior knowledge of
  - How to program in .NET
  - The basics of the generic Revit API
  - Revit MEP product usage

Learning Objectives

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

- Understand and use the Revit MEP 2013 API enhancements
- Analyze, create, manage and modify electrical, HVAC and plumbing models, systems, and components programmatically
- Understand and reuse Revit SDK and ADN sample functionality

Agenda

- Introduction
- Analysis
- Hierarchical systems and connectors
- Electrical
- HVAC and plumbing
- The Revit MEP 2013 API
- Sample applications
- Learning more

Introduction

Autodesk Developer Network

- Access to almost all Autodesk software and SDK's
  - Includes early access to beta software
- Members-only website with thousands of technical articles
- Product direction through conferences
- Unlimited technical support
- API training classes
  - One to three free for professional members
- Marketing benefits
  - Exposure on autodesk.com
  - Promotional opportunities

www.autodesk.com/joinadn

Acronyms

- ADN Autodesk Developer Network
- AEC Architecture, Engineering, Construction
- API Application Programming Interface
- BIM Building Information Model
- GUI Graphical User Interface
- HVAC Heating, Ventilation, and Air Conditioning
- MEP Mechanical, Electrical, and Plumbing
- RAC Revit Architecture
- RME Revit MEP
- RST Revit Structure
- SDK Software Development Kit
- UI User Interface

MEP Application Requirements

- Mechanical, electrical and plumbing domains
- M is for HVAC, i.e. heating, ventilation and air conditioning
- Model analysis tools
  - Physical, thermal, environmental etc.
  - Building codes and regulations
  - Geometrical relationships
  - MEP project information
  - Green Building XML, gbXML
  - Spaces and zones
- BIM component and data access
  - Systems, components, properties and parameters
  - Creation and modification
  - Traversal and analysis

The Generic Revit API

- Basic Revit API is generic
- All flavours use the same Revit API .NET assemblies
- Specific additional features exist for each flavour, e.g.
  - Room-related functionality in Revit Architecture
  - Access to the analytical model in Revit Structure
  - Access to the MEP model in Revit MEP
  - Onebox supports all in one box
- Runtime discipline switching
  - ProductType Architecture, Structure, MEP, Revit

Revit MEP API Evolution

- Generic element and parameter access can always be used
- Revit 2008 provided no MEP-specific API
- Revit 2009 introduced MEP-specific API support
  - MEP model property, space and zone, electrical and mechanical equipment, lighting device and fixture, connector, electrical system
- Revit MEP 2010 – mechanical
  - MEP namespace, support for HVAC and piping systems
- Revit MEP 2011 – electrical
  - Conduit, cable tray, panel schedule
- Revit MEP 2012 – mechanical
  - Pipe settings and sizes, placeholder elements, insulation and lining
- Revit MEP 2013 – mechanical and analysis
  - Routing preferences, analysis and calculation enhancements, new and updated APIs

Analysis

MEP Project Info and EnergyDataSettings

- EnergyDataSettings object represents gbXML project info
  - Manage > Project Settings > Project Information > Energy Data
  - Access via EnergyDataSettings.GetFromDocument method
  - Define settings for gbXML export, heating and cooling load calculations, conceptual energy analysis
- For project location use Document.ActiveProjectLocation
- Green Building XML export

```
Document.Export(
  string folder,
  string name,
  GBXMLExportOptions );
```

Spaces and Zones

- Architectural rooms are unsuitable for MEP analysis
  - Wrong height, often too large for analysed region
- MEP uses space instead of room, and zone to manage spaces
- Rooms can be subdivided into exterior and interior subspaces
- AddSpaceAndZone SDK sample
  - Programmatic creation and management of spaces and zones
- FamilyInstance class has Room and Space properties

```
FamilyInstance fi; // get a family instance
Space space = fi.Space; // query space containing it
Space space2 = fi.get_Space( phase ); // space in a specific
phase
```

Model Inspection Utilities

- Determine component location, space adjacency analysis, etc.
- Volumes, rooms and spaces
  - FamilyInstance.Space determines space containing family instance
  - Room.IsPointInRoom determines if a point is in a room volume
  - Space.IsPointInSpace determines if a point is in a space volume
  - GetRoomAtPoint and GetSpaceAtPoint return room or space containing point
- Element filters by intersection, Boolean operations, etc.
  - BoundingBoxIntersectsFilter, BoundingBoxIsInsideFilter, BoundingBoxContainsPointFilter, ElementIntersectsElementFilter, ElementIntersectsSolidFilter
- Ray intersection
  - ReferenceIntersector class, ex FindReferencesWithContextByDirection method
  - Shoot a ray through the model, given a starting point and direction vector
  - Return an array of references of intersected elements and faces
  - AvoidObstruction, FindColumns, MeasureHeight, RayTraceBounce SDK samples

Revit 2013 ReferenceIntersector Class

- Constructor specifies target elements, target type and 3D view
- Elements specified by ElementId, ElementIdSet , ElementFilter
- Target type can be elements, meshes, edges, curves, faces

```
ReferenceIntersector( <elements>, FindReferenceTarget, View3d )
```

- Call Find or FindNearest to cast a ray given origin and direction
- Returns references intersecting ray, or closest to origin

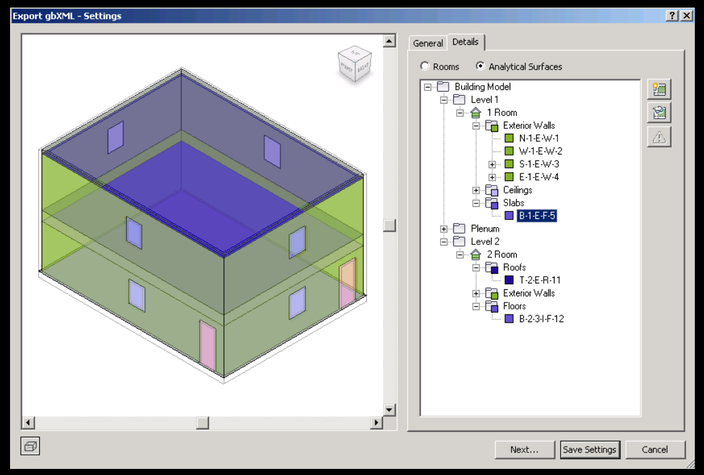
```
Find( XYZ origin, XYZ direction )
FindNearest( XYZ origin, XYZ direction )
```

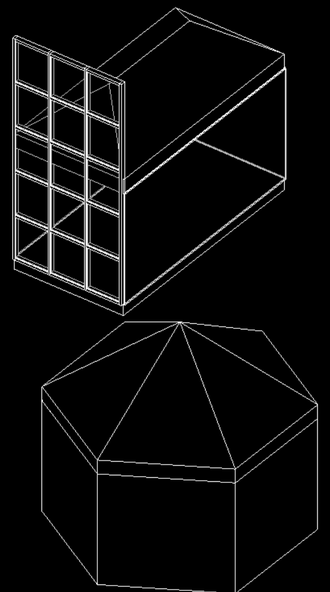
Conceptual Energy Analysis API

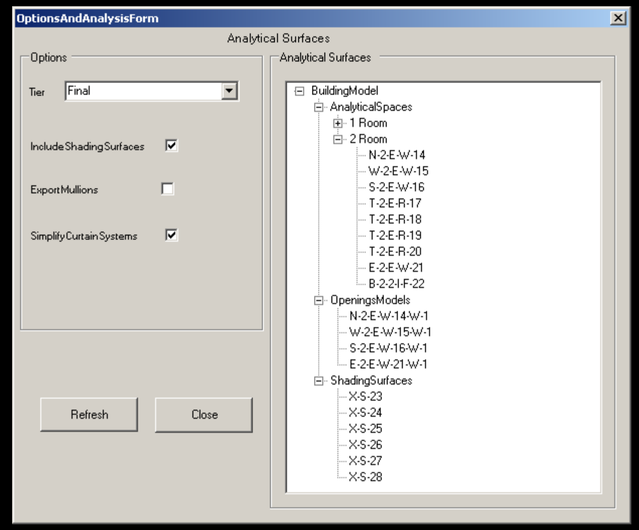
- Energy analysis on conceptual design models
- New overload of Document.Export method taking MassGBXMLExportOptions argument
- Create a gbXML file containing energy analysis elements generated from conceptual mass family instances

Detailed Energy Analysis Model API

- Produce analytical thermal model from physical building model
- Retrieve energy analysis detail model and present as tree view
- Access Export to gbXML, Heating and Cooling Loads data
- Analytical thermal model
  - Composed of volumetric elements: spaces, zones, planar surfaces
  - Created and initialised by calling EnergyAnalysisDetailModel.Create()
  - Methods GetAnalyticalSpaces, Surfaces, Openings, ShadingSurfaces
- SDK sample Analysis > EnergyAnalysisModel







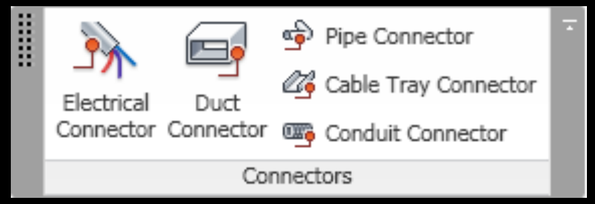
Hierarchical Systems and Connectors

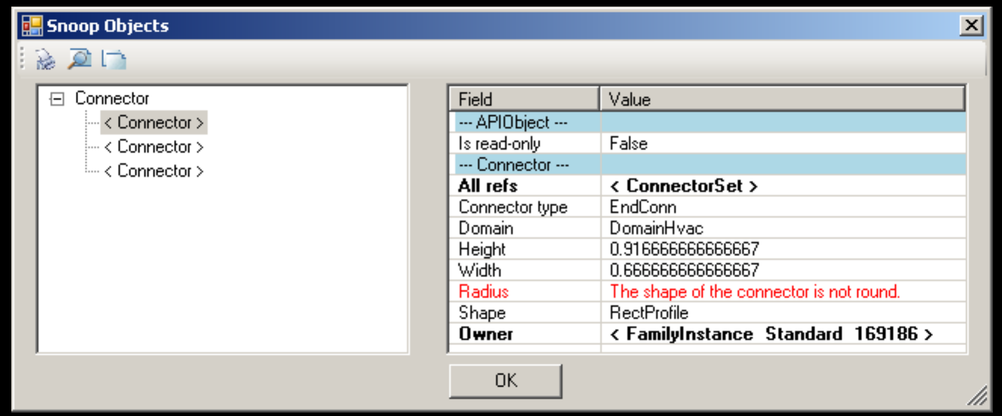
Hierarchical System Structure and MEP Model

- MEP systems consist of hierarchically connected components
- Many components are represented using family instances
- Connectors can link neighbouring components and transfer info
- Top level node is MEP system
  - Represented by MEPSystem class, with derived classes ElectricalSystem, MechanicalSystem, PipingSystem
- Family instance provides MEPModel property
  - MEPModel has ConnectorManager and ElectricalSystems properties
  - Derived classes include ElectricalEquipment, LightingDevice, LightingFixture, MechanicalEquipment, MechanicalFitting

Connectors

- Family editor connection elements
  - Independent elements for defining connectors
  - Used to model library parts in **family context**
  - Specialised derived classes for duct, pipe and electrical connectors
- Connector class
  - Used to represent connections in the Revit BIM **project context**
  - Part of MEP component, not independent Revit database element
- Logical connectors
  - Used in electrical domain
  - Cables and wires are possibly not specified
  - Enables traversal of connected electrical system hierarchies
- Physical connectors
  - Connect neighbouring components physically
  - Transmit sizing dimensions and flow information





Electrical

Electrical System Hierarchy

- Three-tier recursive hierarchy, cf. electrical system browser
- Panel > systems or circuits > circuit elements, may be panels
- Logical connections between components
- Wires are annotation elements
- System can be traversed through connectors
- Connectivity information also available in element parameters
- Electrical samples
  - PowerCircuit SDK sample shows creation and editing power circuits
  - PanelSchedule SDK demonstrates use of the electrical panel schedule API
  - AdnRme electrical sample demonstrates traversal using both MEP connectors and generic parameters (much harder)

HVAC and Plumbing

HVAC and Piping Hierarchy

- Systems manage the top level system properties
- Ducts and pipes define the main flow elements
- Fittings implement bends and branches in the system
- Connectors hook up the ducts, pipes and fittings

Systems

- MechanicalSystem and PipingSystem classes
- Access to equipment, connectors and system type
- Access to system properties such as flow and static pressure
- DuctNetwork and PipeNetwork properties access system contents
  - Ducts and fitting elements in no particular order
  - Does not include terminals or equipments
- Query connector managers for traversal in flow direction
- TraverseSystem SDK sample

Duct and Pipes

- Represented by Duct, FlexDuct, Pipe and FlexPipe classes
  - Derived from MEPCurve
- Provide read access to duct properties, types, and geometry
- Change duct or pipe type
- Move duct or pipe
  - Use Move method rather than Location
- Layout duct or pipe
  - Driven by two points, point and connector, or two connectors

Fittings

- Represented by standard RFA family instances
- Created using dedicated creation doc New*Fitting methods
- Elbow, Tee, Cross, Takeoff, Transition, and Union
- Access fitting properties, shape and dimensions through the FamilyInstance.MEPModel property

Connectors

- Read duct, pipe, and fitting connector properties
  - Flow, Coefficient, Demand
- Access physical connector properties
  - Origin, Angle, Height, Width, Radius
- Read and write assigned connector properties
- The fitting connectors define the properties
  - Flow, Flow Configuration, Coefficients, Loss Method
- Change connector size and location
- Connect and disconnect

Element Creation

- Methods on Autodesk.Revit.Creation.Document
- Create New Systems
  - NewMechanicalSystem, NewPipingSystem
- Create New Elements
  - NewDuct, NewFlexDuct, NewPipe, NewFlexPipe
- Create New Fittings
  - New...Fitting for Cross, Elbow, TakeOff, TeeFitting, Transition, Union
- New classes Conduit, CableTray provide static Create methods
- Connector elements
  - Created in the family context using methods on FamilyItemFactory
  - Accessed through the Document.FamilyCreate property
  - NewDuctConnector, NewPipeConnector, NewElectricalConnector

The Revit MEP 2013 API

and the past few releases as well...

Revit MEP 2011 Product Enhancements

- Panel Schedules
- Cable Tray and Conduit
- Other Enhancements
  - Placing Valves and Fittings in Section or Elevation Views
  - Tagging of MEP Elements during placement
  - Demand Factors and Load Categories
  - Piping Companion Flanges
  - New Electrical Content
  - Oval Duct

Revit MEP 2011 API Enhancements

- New classes for cable tray and conduit
  - Pipe to conduit converter sample
- Panel schedules
  - API access and PanelSchedule SDK sample
- Other Enhancements
  - EnergyDataSettings
  - Validation in ElectricalSystem Properties
  - WireMaterialType, InsulationType, TemperatureRatingType
  - DuctConnector, PipeConnector, ElectricalConnector
  - Demand Factor and Load Classifications

Revit MEP 2012 Product Features

- Placeholder elements
- Insulation and lining
- Parallel pipe and conduit runs
- Sloped piping enhancements: settings, tooltips, connection
- System browser filtering, hovering and selection
- System: graphic overrides and warnings, disconnect markers, materials, calculation control, connector labels

Revit MEP 2012 API Enhancements

- Pipe settings and sizes
- Placeholder ducts and pipes
- Duct and pipe insulation and lining
- Small Enhancements and Changes
- MEP related APIs
  - Detailed Energy Analysis
  - Conceptual Energy Analysis

Placeholder Ducts and Pipes

- Placeholder elements indicate a planned layout
- System layout can be defined with minimal info and maximum flexibility
- Convert into true duct and pipe elements later on
- Size, slope and other properties can be assigned
- MepPlaceholder sample
  - Two commands: CreatePlaceholders and ConvertPlaceholders

Insulation and Lining

- Before, family defined insulation and lining, triplicating geometry
- Now insulation and lining can be added programmatically
- New classes DuctInsulation, PipeInsulation, DuctLining
- Applicable to duct, pipe, and fitting
- Support read, write and create access
- Accessible as standalone element related to parent
- Sample command: InsulateDuctwork

Pipe Settings and Sizes

- MEP pipe settings and pipe size settings are now accessible programmatically
- Read and write access
- Static methods PipeSettings.GetPipeSettings and PipeSizeSettings.GetPipeSizeSettings return singleton objects
- Sample command: GetPipeSettings

Small Enhancements and Changes

- Spare and space circuits
  - ElectricalSystem.CircuitType property identifies type: circuit, spare or space
  - ElectricalSystem.AddToCircuit throws exception on spare or space systems
- Cable tray and conduit domain
  - Autodesk.Revit.DB.Domain enumeration cable tray and conduit values
- Connector
  - New read-only properties added for JointType, GenderType and EngagementLength
- MEPSystem
  - New property MEPSystem.IsEmpty
- Graphical warnings for disconnects
  - New ‘show graphical warning’ properties and setters on the Application class
- Space properties
  - BaseHeatLoadOn indicates if heat gain per person properties have default or user defined value
- Fitting methods
  - New fitting methods no longer remove unused or dangling curve connectors

Revit MEP 2013 Product Features

- Routing preferences
- Calculation enhancements
- MEP centrelines
- New MEP properties
- Enhanced analysis and simulation functionality

MEP 2013 API Enhancements

- Routing preferences
- MEP pressure loss calculation sections
- Fluid viscosity and density friction properties
- Thermal properties
- External services
- And more...

Routing Preferences API Access

- Select preferred fitting types for various sizes and materials
  - Set routing preference policies for end users
  - Query fittings and segments used for given size criteria
- RoutingPreferenceManager class
  - Manages routing preference rules for segments and fittings
  - Query fitting or segment chosen by Revit for a given size condition
- MEPCurveType RoutingPreferenceManager property
  - Access main routing preferences object for a given MEPCurve type
  - Currently only PipeType and DuctType support routing preferences
- Use demonstrated by RoutingPreferenceTools SDK sample

Routing Preference Helper Classes

- RoutingCriterionBase and PrimarySizeCriterion
  - Criteria for fitting and segment selection based on min max size constraints
- RoutingPreferenceRule
  - Manage one segment or fitting preference
- RoutingCondition and RoutingConditions
  - RoutingPreferenceManager.GetMEPPartId input to select fittings and segments
- Segment and PipeSegment
  - Represent a length of MEPCurve of specific material and set available sizes
  - Subclass representing a length of pipe
- RoutingPreferenceRuleGroupType enumeration
  - Types of routing items managed by routing preference rules
  - Elbows, Junctions, Crosses, Transitions, Unions, MechanicalJoints, Segments, TransitionsRectangularToRound, TransitionsRectangularToOval, TransitionsOvalToRound

Routing Preference Usage

- Routing preferences choose first symbol in rule list matching criteria
- Set size criteria to ensure a later symbol is chosen for a given scenario
- Temporarily re-order rules using RemoveRule and AddRule methods

Flow Analysis Sections

- MEPSection base class for duct and pipe sections
  - Support for pressure loss calculation
  - Represent a series of connected elements
  - Ducts or pipes, fittings, terminals and accessories
- All section members have same flow analysis properties
  - Flow, Size, Velocity, Friction and Roughness
- An element can belong to multiple sections
  - A tee fitting with three connectors usually belongs to three sections
  - A tap will divide a duct or pipe segment into two separate sections

Fluid Viscosity and Density

- More precise temperature dependant friction calculation
- New FluidTemperature class
  - Represent viscosity and density properties at a given temperature
- Extended FluidType class
  - Provide read-write access to a collection of FluidTemperature objects
  - Represent fluid properties at various different temperatures
  - AddTemperature, GetTemperature, RemoveTemperature
  - GetFluidTemperatureSetIterator

Thermal Properties

- New properties on ThermalProperties class
  - Absorptance, heat transfer, roughness, thermal mass and resistance
  - Available on BIM elements, e.g. wall, floor, ceiling, roof, door, window, etc.
- ThermalAsset class
  - Thermal properties on materials
  - Specify using PropertySetElement and SetMaterialAspectByPropertySet
- Thermal property control in gbXML export
  - EnergyDataSettings.IncludeThermalProperties determines whther to include thermal information from model assemblies and components in gbXML export
  - Use calculated values or pre-defined values from Constructions.xml: MEPBuildingConstruction GetBuildingConstructionOverride, SetBuildingConstructionOverride

More Revit MEP API News

- ConnectorProfileType and PartType enumeration changes
- ConnectorElement changes and new static creation methods
- More LabelUtils access to localized user-visible display strings
- Access to panel schedule spare circuit values
- Light and Light Group API
- ReferenceIntersector class
- External services framework
  - Wrap external service functionality, enable encapsulation, replacement
  - Basis for future MEP calculations and structural code checking
  - In place and fully functional, but not yet used, so no examples

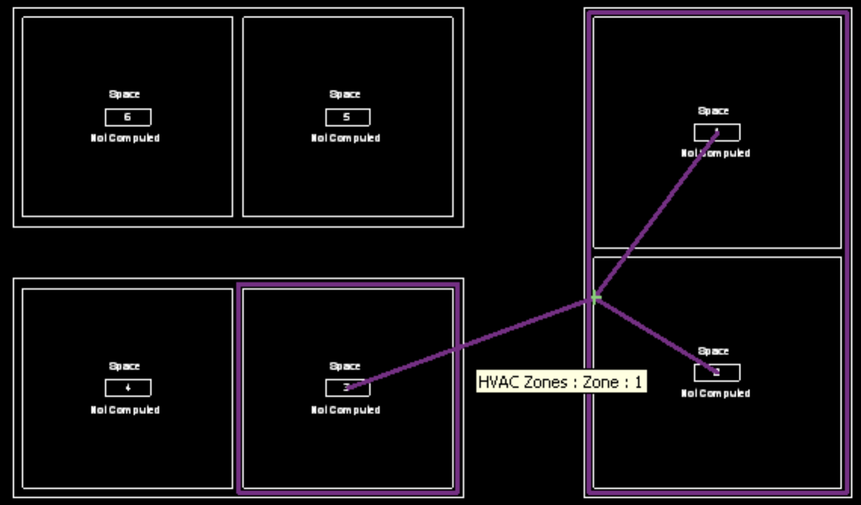
Sample Applications

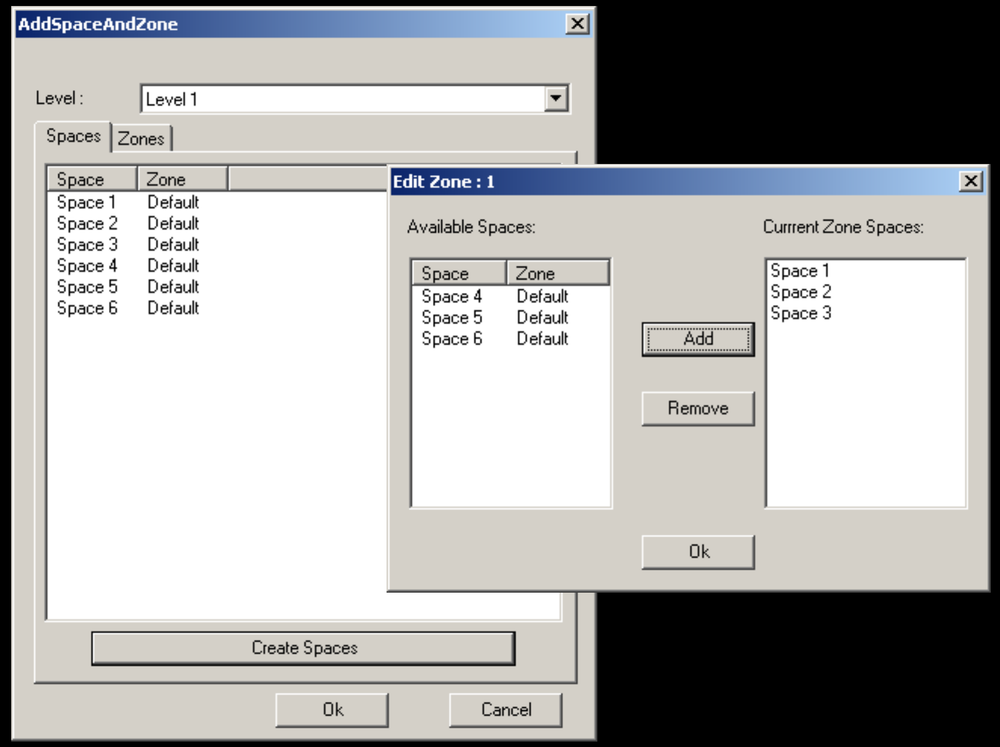
Sample Overview

- Revit SDK Samples
  - AddSpaceAndZone
  - AutoRoute
  - AvoidObstruction
  - CreateAirHandler
  - EnergyAnalysisModel
  - PanelSchedule
  - PowerCircuit
  - RoutingPreferenceTools
  - TraverseSystem
- AdnRme
  - Electrical System Hierarchy
  - HVAC Air Terminal Sizing
- Blog
  - Pipe to Conduit Converter
  - Cable Tray Creation and Layout
  - Loose Connector Navigator
  - MEP Placeholders

AddSpaceAndZone

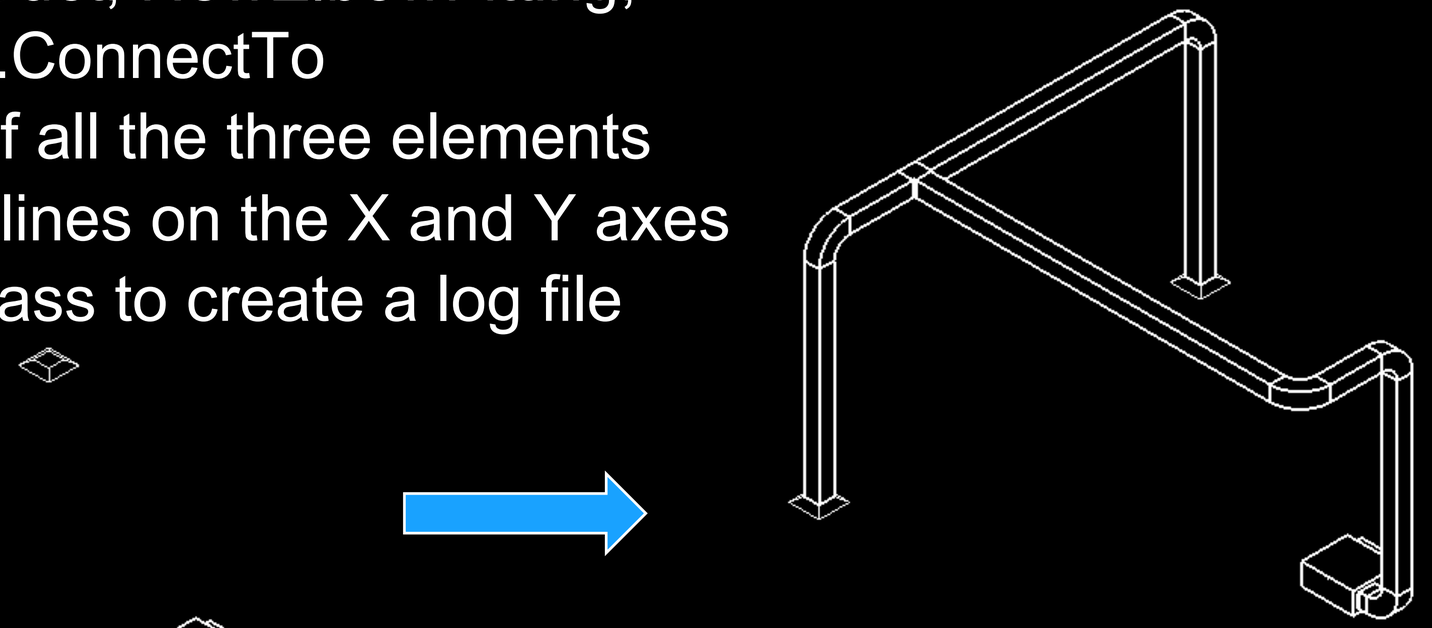
- Retrieve and list existing spaces and zones
  - Demonstrates use of an element filter
- Create new spaces
  - For each closed wall loop or space separation
  - Demonstrates use of the NewSpaces method
- Create a new zone element
  - Specified level and phase
- Add and remove spaces in a zone
  - Use the AddSpaces and Remove methods





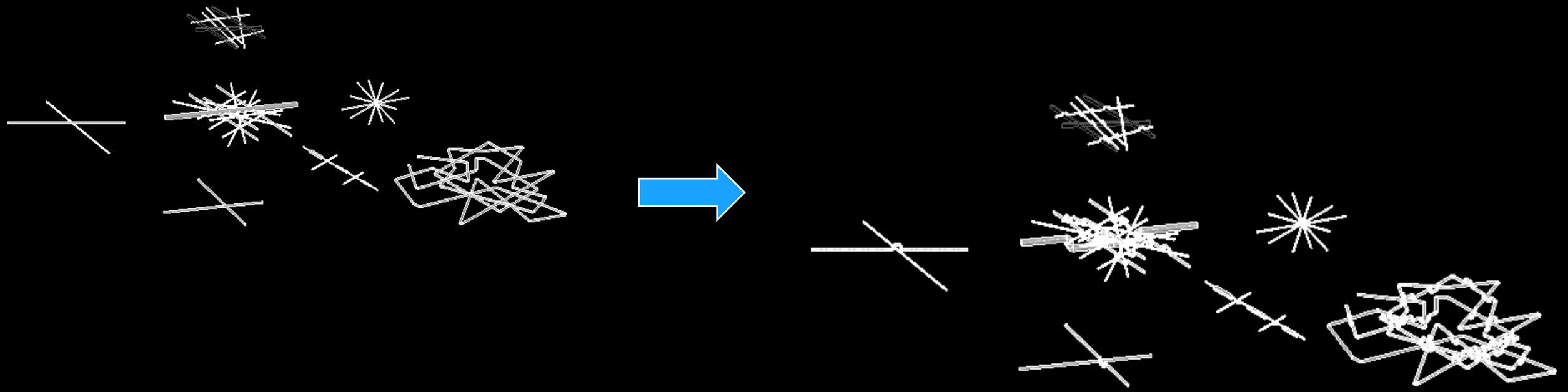
AutoRoute

- Automatically create and route a set of ducts and fittings
  - Source is the air supply equipment
  - Sink is two air outlet terminals
  - Positions can be freely moved
- Create a new mechanical system, ducts, fittings and connections
  - NewMechanicalSystem, NewDuct, NewElbowFitting, NewTeeFitting and Connector.ConnectTo
  - Determine the bounding box of all the three elements
  - Use the middle line or quarter lines on the X and Y axes
  - Uses.NET framework Trace class to create a log file



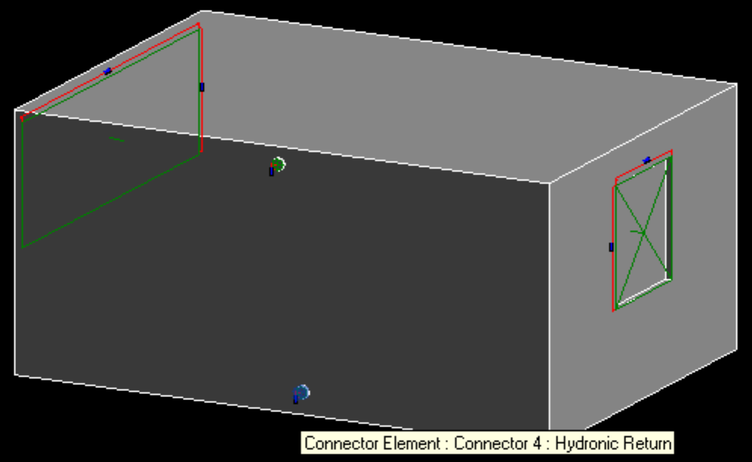
AvoidObstruction

- Detect and resolve collisions between ducts, pipes, and beams
- FindReferencesWithContextByDirection ray cast intersection analysis
- Split pipe into segments and insert elbows to reroute detour



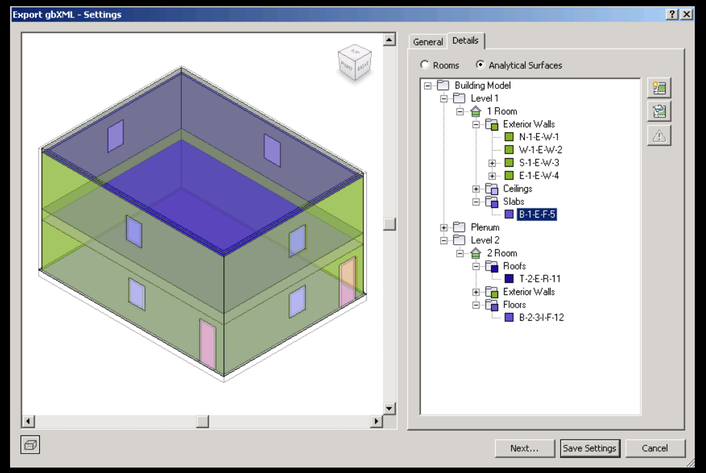
CreateAirHandler

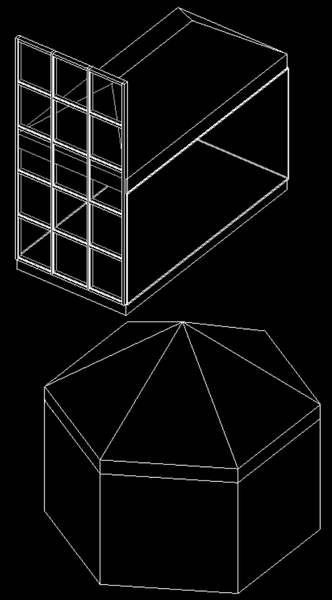
- Create an air handler with pipe and duct connectors
- Check family category to verify mechanical equipment starting point
- Use FamilyItemFactory class methods
  - NewExtrusion, NewPipeConnector, NewDuctConnector
- Set proper connector parameters
- Use Document.CombineElements to join extrusions
- Geometric shape creation is generic
- Addition of the connectors is MEP specific
- Runs in all flavours of Revit anyway

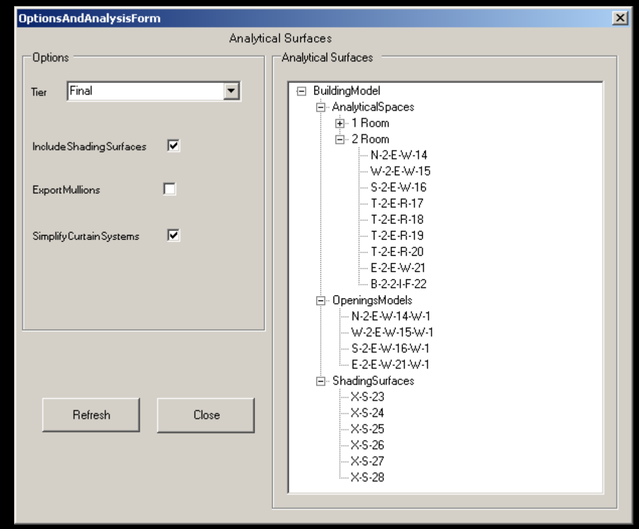


EnergyAnalysisModel

- Retrieve energy analysis detail model and present as tree view
- Analytical thermal model generated from physical building model
- Similar to Export to gbXML and Heating and Cooling Loads
- Analytical thermal model is composed of spaces, zones, planar surfaces
  - Volumetric elements
  - Created and initialised by calling EnergyAnalysisDetailModel.Create()
  - Methods GetAnalyticalSpaces, Surfaces, Openings, ShadingSurfaces

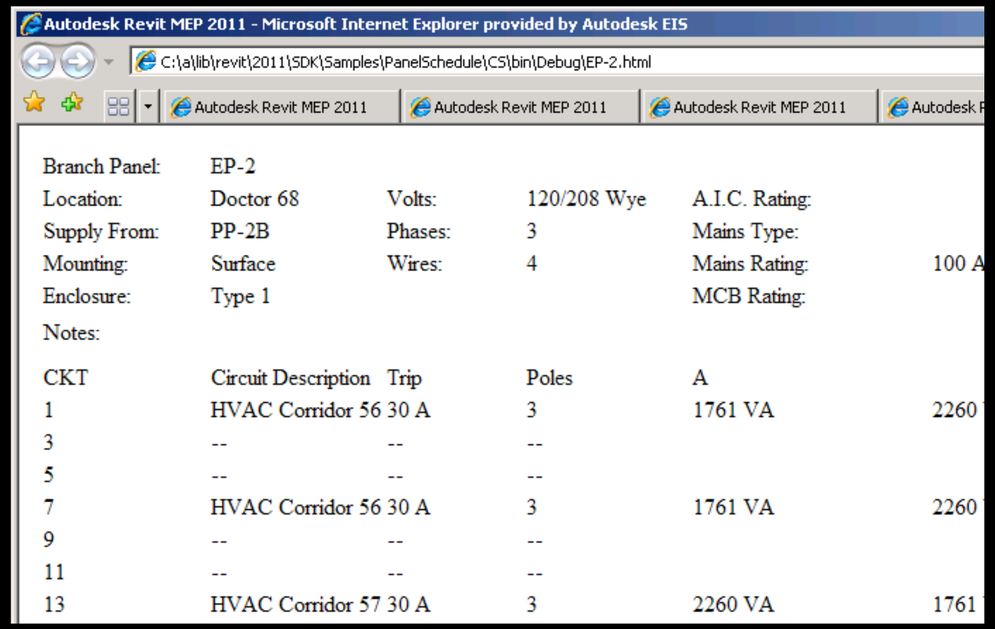


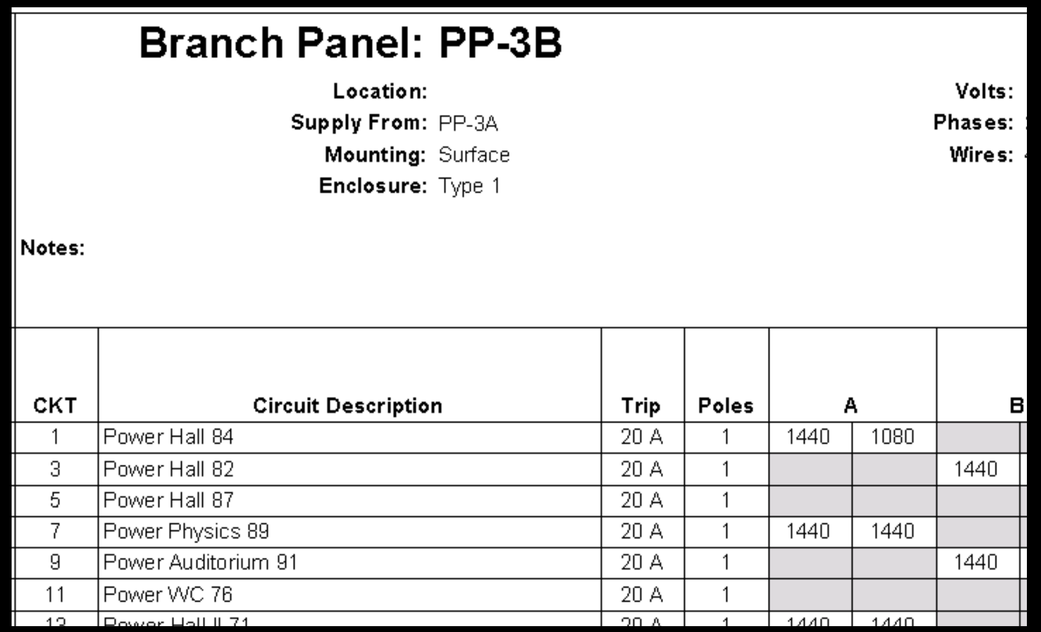




PanelSchedule

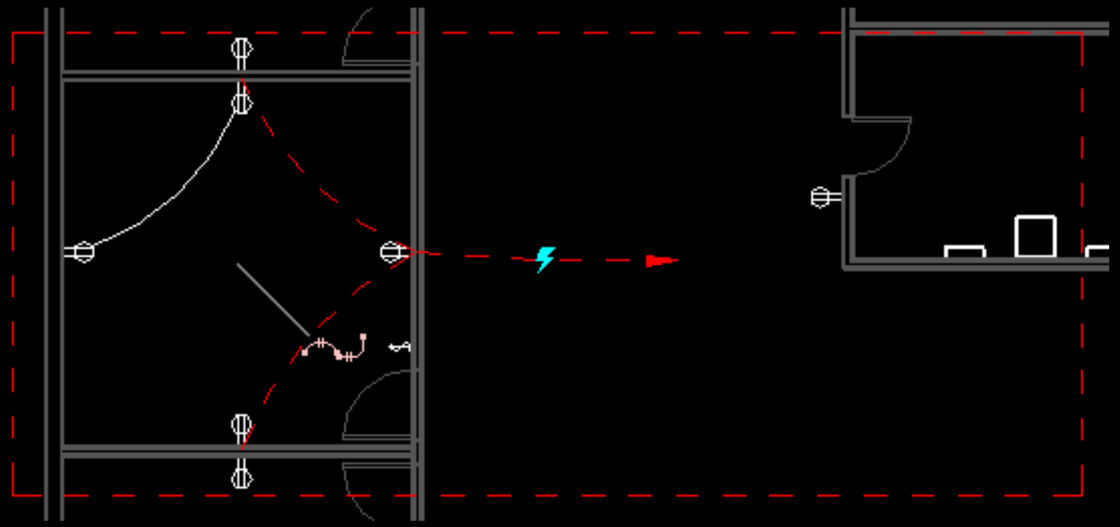
- Data exchange sample showing use of the Panel Schedule API
- PanelScheduleExport read + export panel schedule CSV or HTML
- InstanceViewCreation create panel schedule view instance
- SheetImport place all panel schedule views on a sheet



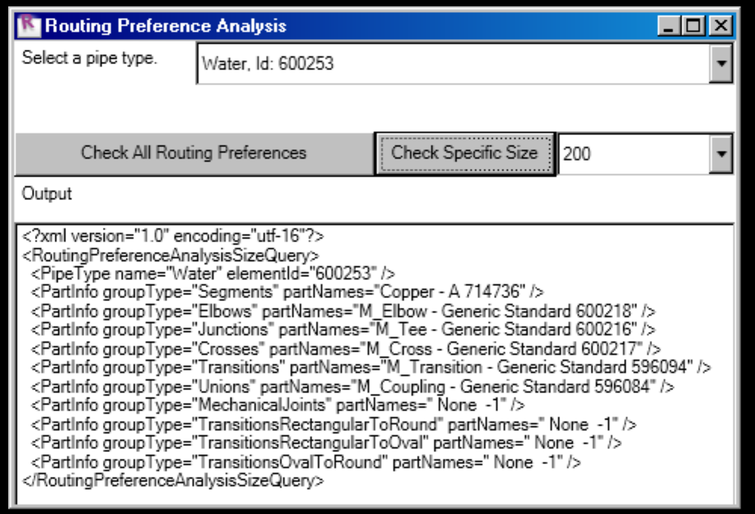


PowerCircuit

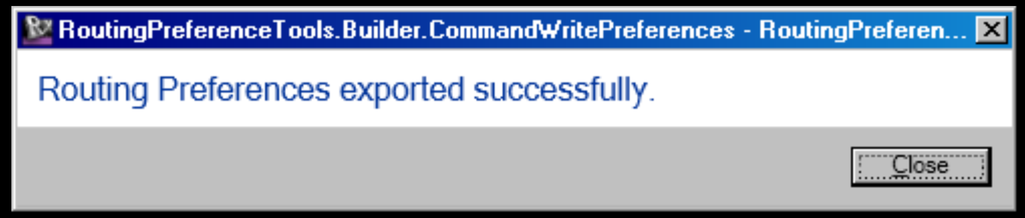
- Operate power circuits, similar to legacy RME Circuit Editor toolbar
  - Show use of MEPModel and ElectricalSystem classes
  - Demonstrate handling interactive element selection
  - Implement toolbar user interface for external command
  - Use .NET ResourceManager class for image and string resources
- Create a new power circuit with selected elements
- Edit circuit and add and remove circuit elements
- Select or disconnect a circuit panel



RoutingPreferenceTools



- Routing preference analysis and reporting
  - Analyse routing preferences of a given pipe type
  - Look at all rules and criteria for a given pipe type
  - Check for common problems
- Routing preference builder XML import and export
  - CommandReadPreferences and CommandWritePreferences
  - Set project pipe type, fitting, and routing preferences
  - Export for archival, documentation, and collaboration purposes
  - Enable users to work with RP data in a shareable XML format
  - Suitable for reuse in a wide variety of BIM management environments

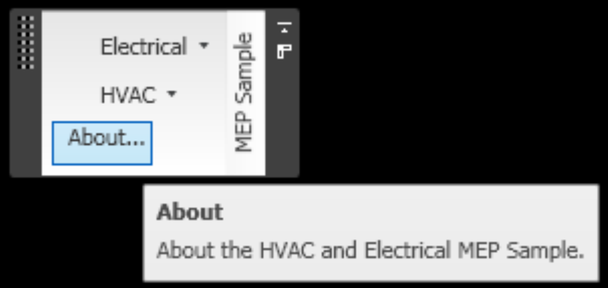


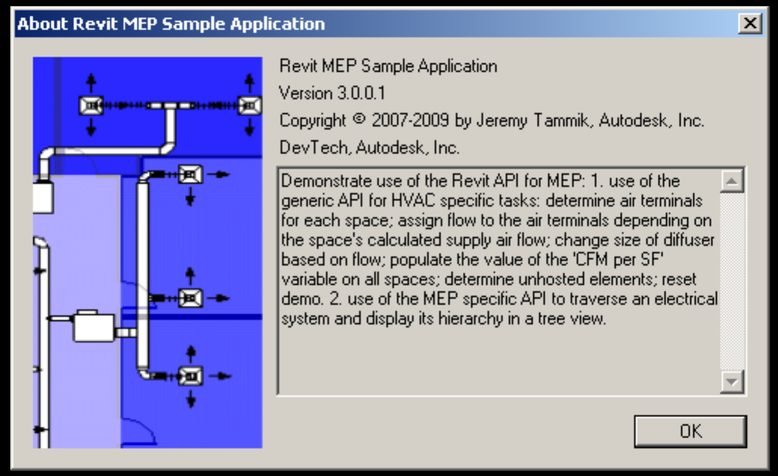
TraverseSystem

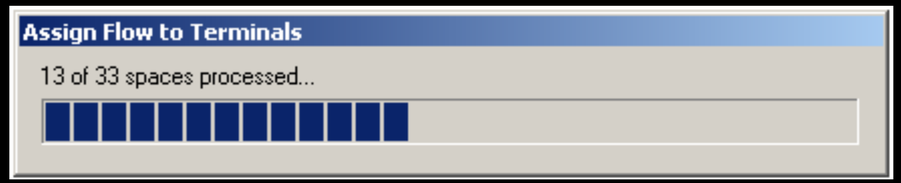
- Traverse a mechanical or piping system in the direction of flow
  - Check MechanicalSystem IsWellConnected property
- Dump the traversal results into an XML file
- Determine system
- Query base equipment as starting point
- Query connector manager for connected neighbour elements
- Similar approach works for electrical as well, cf. AdnRme sample

AdnRme Sample

- Non-SDK sample, included in presentation material
- HVAC air terminal analysis and sizing
- Hierarchical display of an electrical system
- Implements a ribbon panel, about box, and progress bar

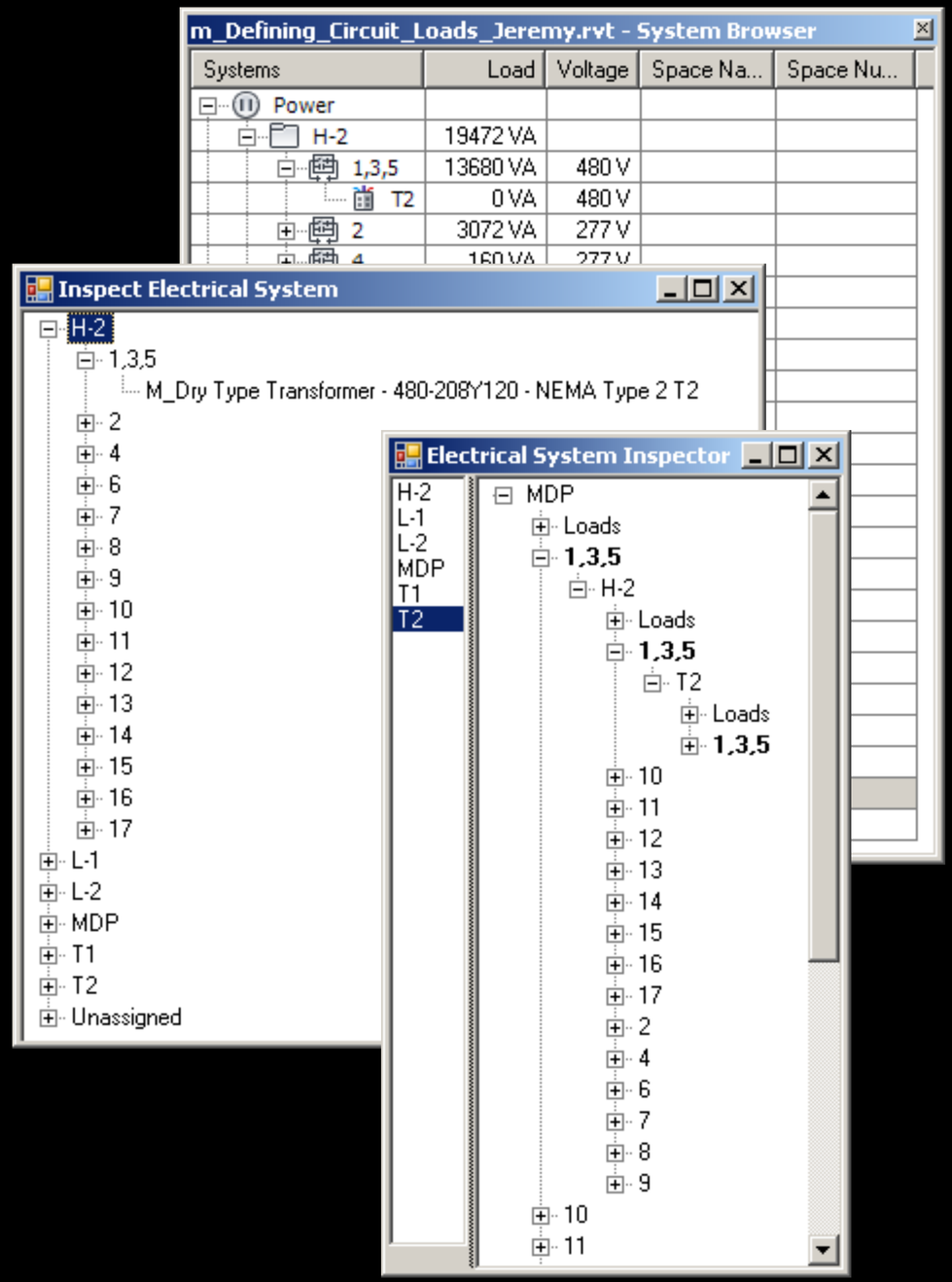






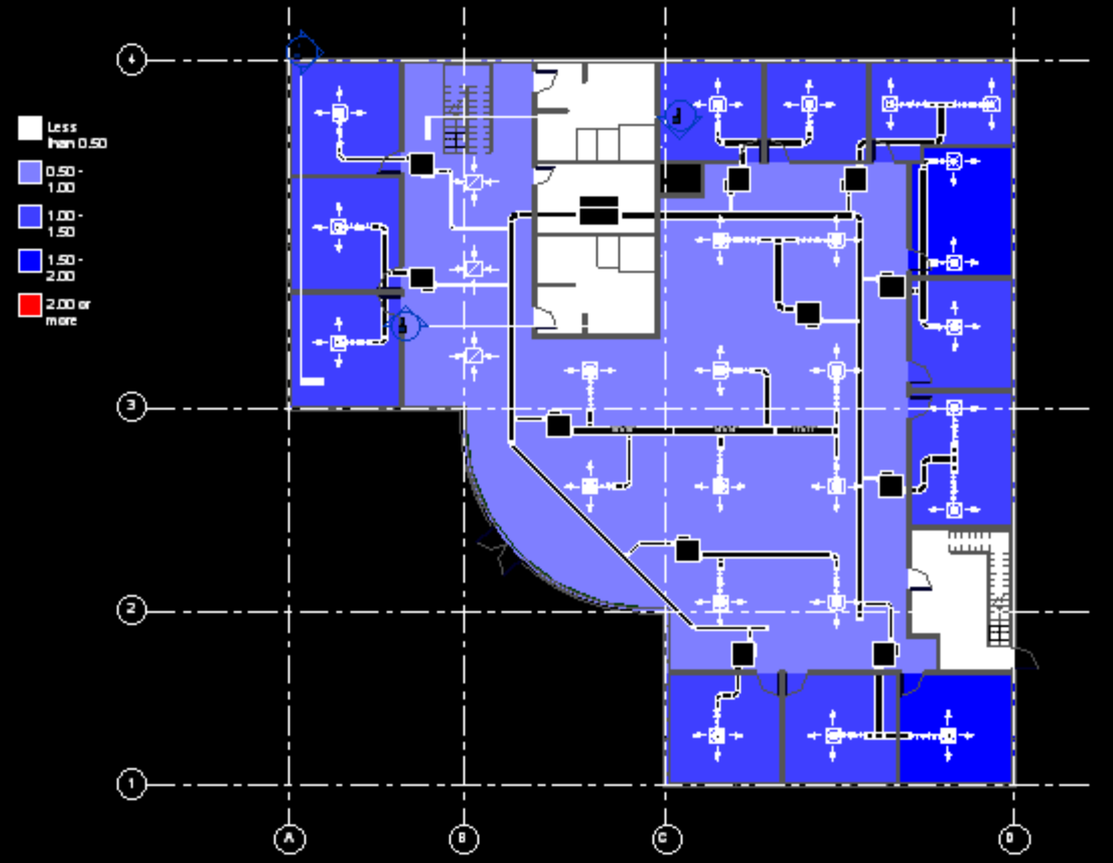
AdnRme Electrical Sample

- Traverse the electrical system
- Reproduce the system browser data structure in a tree view
- Display the complete connection hierarchy in a tree view
- CmdElectricalConnectors is similar to TraverseSystem SDK sample for ducts
- Traversal is also possible using parameter data instead of connector manager, but harder



AdnRme HVAC Sample

- HVAC Task
  - Place and size air ducts and terminals
  - Analysis and verification of results
- Commands aligned with HVAC engineering workflow
  - Assign flow to terminals
  - Change air terminal size
  - Verify design by air flow per surface area
  - Reset demo
- All modification uses generic parameter and type access
- Changes are reflected by schedules and colour fill

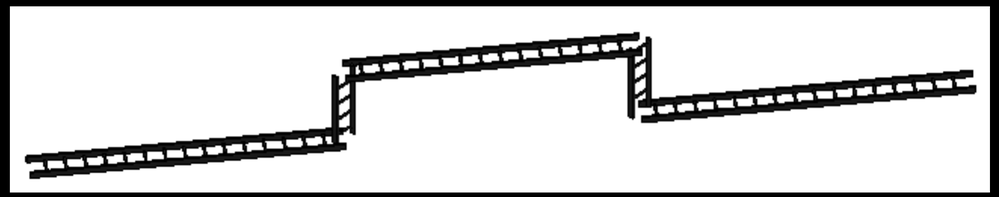


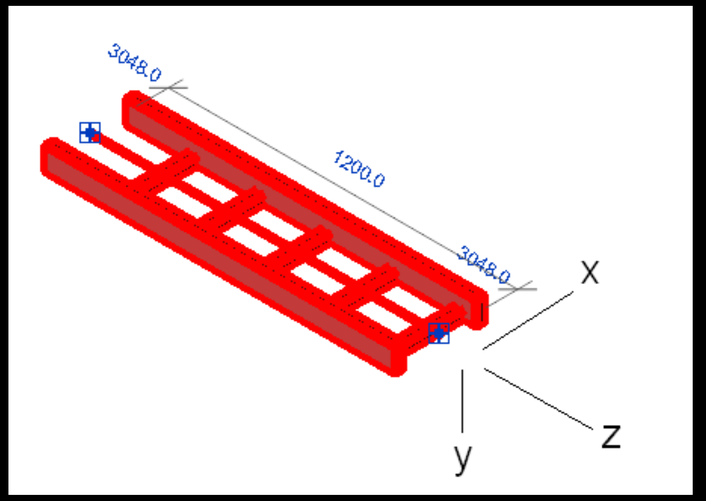
Pipe to Conduit Converter

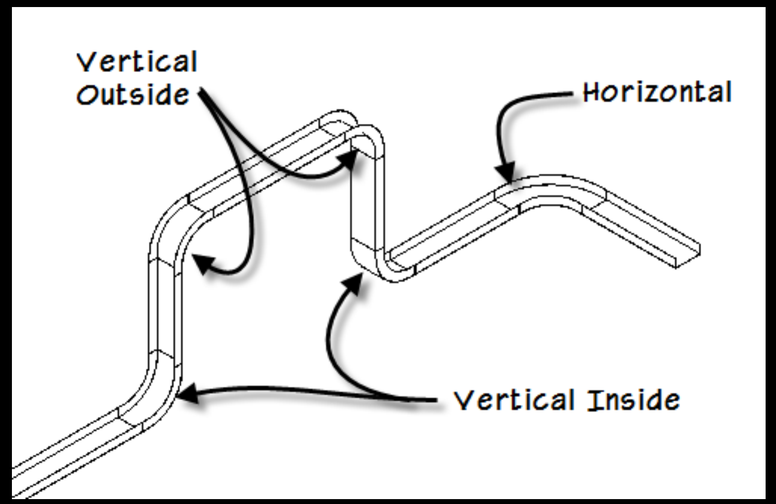
- Two hundred lines of code
- My First Revit 2011 Add-in
- Illustrates all major Revit 2011 API renovations
  - Revit API assembly split
  - Namespace reorganisation
  - Command registration manifest
  - External command Execute method and attributes
  - Transaction mode
  - Regeneration option
  - Task dialogues for user messages
  - Interactive filtered element selection
  - Redesigned element filtering
  - New element creation paradigm
  - Access to pipe and conduit sizes

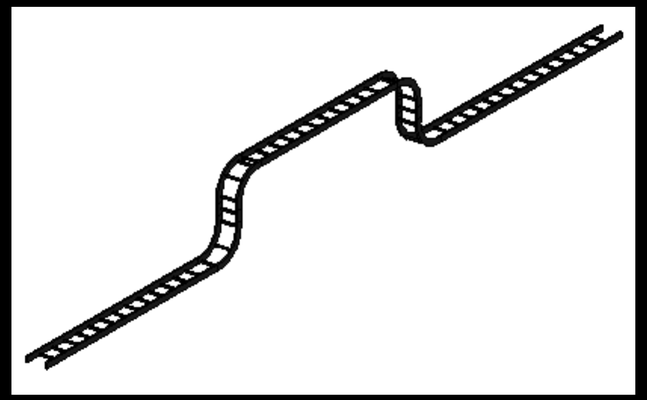
Cable Tray Fitting Creation and Layout

- Inserting a cable tray is as easy as a conduit, cf. p2c
- Inserting fittings requires exact alignment, i.e. proper orientation



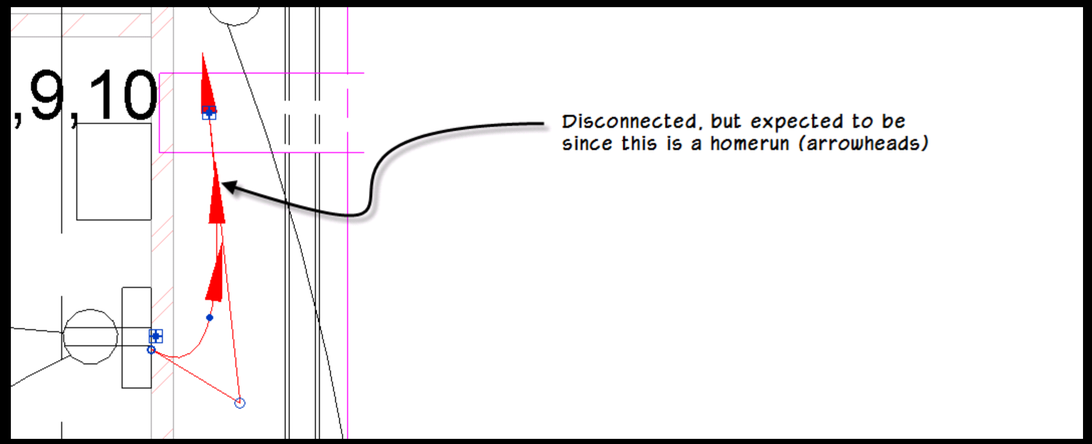






Modeless Loose Connector Navigator

- Modeless navigation interacting with Idling event
- Ensure that modeless dialogue remains on top of Revit
- Filter for all MEP connectors in project
  - Combine all relevant classes and family instance categories
- Check IsConnected property on each connector
- Log results to file and display to user
- Interact with Revit and navigate through results in modeless dialogue



MEP Placeholder Sample

- Placeholder ducts and pipes
  - CreatePlaceholders and ConvertPlaceholders commands
- Duct and pipe insulation and lining
  - InsulateDuctwork command
- Read and write access to MEP pipe settings and sizes
  - GetPipeSettings command

Summary and Further Reading

Materials

- Blog posts
  - http://thebuildingcoder.typepad.com/mep
- Handout and sample code
  - CP4108_tammik_rme_api.pdf
  - CP4108_tammik_rme_api.zip
    - HVAC and electrical MEP sample code

Learning More

- Revit Developer Center: DevTV and my first plugin introductions, SDK, samples, and API help
  - http://www.autodesk.com/developrevit
- Product Online Help and Developer Guide
  - http://www.autodesk.com/revitapi-wikihelp
- ADN Revit and Revit MEP API Webcasts, Trainings and Archives
  - http://www.autodesk.com/apitraining
  - http://www.adskconsulting.com/adn/cs/api_course_sched.php > Revit API
  - http://www.adskconsulting.com/adn/cs/api_course_webcast_archive.php > Revit API
- Discussion Group
  - http://discussion.autodesk.com > Revit Architecture > Revit API
- ADN AEC DevBlog and The Building Coder Revit API Blog
  - http://adndevblog.typepad.com/AEC
  - http://thebuildingcoder.typepad.com
- ADN, The Autodesk Developer Network, and DevHelp Online for ADN members
  - http://www.autodesk.com/joinadn
  - http://adn.autodesk.com
- Learning Autodesk Revit MEP 2012 video training
  - http://cad-notes.com/2011/12/learning-autodesk-revit-mep-2012-training-video-is-available

Class Summary

- Overview of the Revit MEP API
- MEP API enhancements in Revit 2013
- Working programmatically with Revit MEP models
- Overview of available Revit MEP API samples

Learning Objectives

So... are you now able to:

- Use the Revit MEP 2013 API enhancements?
- Analyze, create, manage and modify electrical, HVAC and plumbing models, systems, and components programmatically?
- Understand and reuse Revit SDK and ADN sample functionality?

Good luck and much success!