Photorealistic Rendering Techniques in Autodesk® AutoCAD ®

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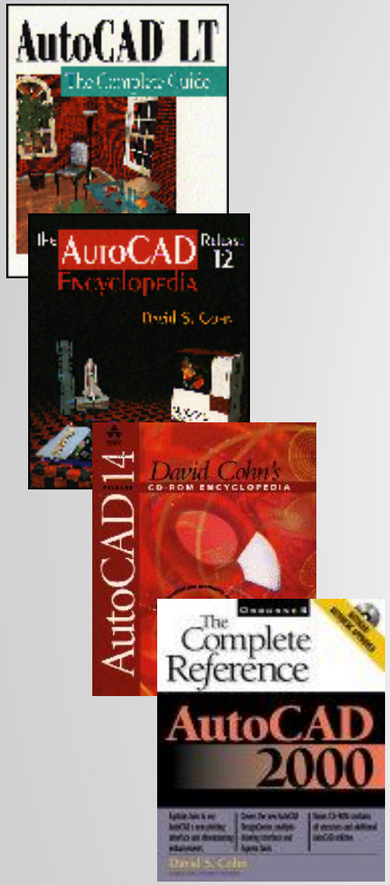
David S. Cohn



- Technical Publishing Manager
  4D Technologies/CADLearning
- Contributing editor *Desktop Engineering*
- Former editor of *CADalyst*, *Engineering Automation Report* and *CADCAMNet*
- Frequent contributor to *Computer Graphics* World, *PC* Magazine, and others
- Registered architect—30+ years experience
- AutoCAD experience—25+ years
- Author of numerous books & articles

COMPUTER GRAPHICS WORLD

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PC MAGAZINE

Class summary

Do you want to create professional-looking renderings? Learn how to convert your 3D Autodesk AutoCAD models into finished, photorealistic renderings using tools already built into AutoCAD software. In this class, you learn how to use lighting, material, and rendering tools in AutoCAD to place and control lights, add and adjust materials and textures, and control the surrounding model environment to produce eye-catching images. You see how to take real-world objects and quickly create custom materials, and produce reusable models of light fixtures that behave like real-world lights. You also see how to take full advantage of the Autodesk 360 cloud-based rendering service to create beautiful renderings quickly and easily, and even produce rendered animations entirely inside AutoCAD.

Key learning objectives

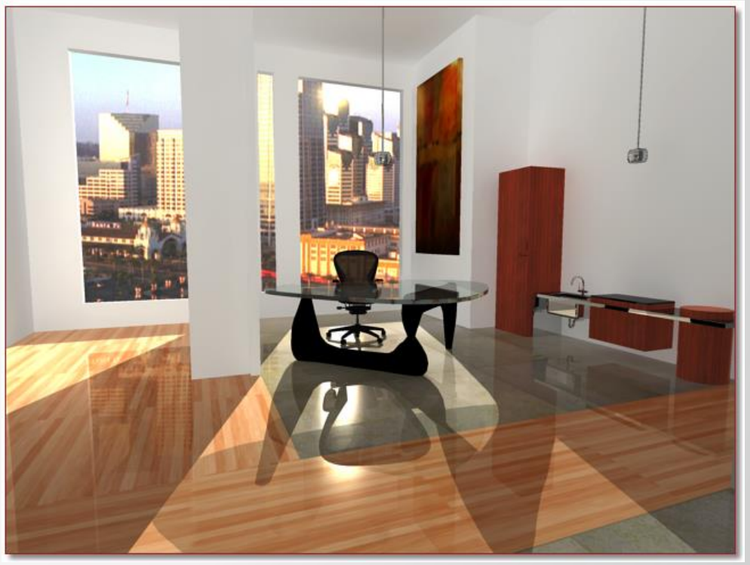
At the end of this class, you will be able to:

- Add lights and model actual light fixtures
- Attach and modify materials and create custom materials
- Control the rendering environment to simulate natural lighting and atmospheric effects
- Render on your computer or in the cloud

Rendering Basics

Rendering in AutoCAD

- Tools have existed for many years but were completely revised in AutoCAD 2007
  - Based on the **mental ray**® rendering engine
  - Use the same material library as other Autodesk products
  - Use render presets to quickly create renderings
  - Can also create walkthroughs and flythroughs



Rendering caveats

If you used rendering tools in earlier versions of AutoCAD

- Lights and materials are different since ACAD2007
  - If working with older drawings
    - **CONVERTOLDLIGHTS** – converts older lights to new format
    - **CONVERTOLDMATERIALS** – converts older materials to new format
  - Procedural materials and material mapping settings do not migrate
  - Material by ACI no longer supported
  - Obsolete landscape commands (LSNEW, LSLIB, LSEDIT)

While working in AutoCAD

Display models with realistic materials, lighting, and shadows.

- Depends on the current active visual style

  Visual style – *a collection of settings that control the display of edges and shading in a viewport*

- AutoCAD comes with 10 predefined visual styles
  - 2D wireframe
  - 3D wireframe
  - 3D hidden
  - Conceptual
  - Realistic
  - Shaded with Edges
  - Shades of Gray
  - Sketchy
  - Wireframe
  - X-Ray

- You can create and save your own

Rendering Basics

Preparing drawings for rendering can be a very time consuming process

- You may spend more time adjusting camera positions, lighting, and materials than actually building the model
- Multiple light sources and shadows require fast computers

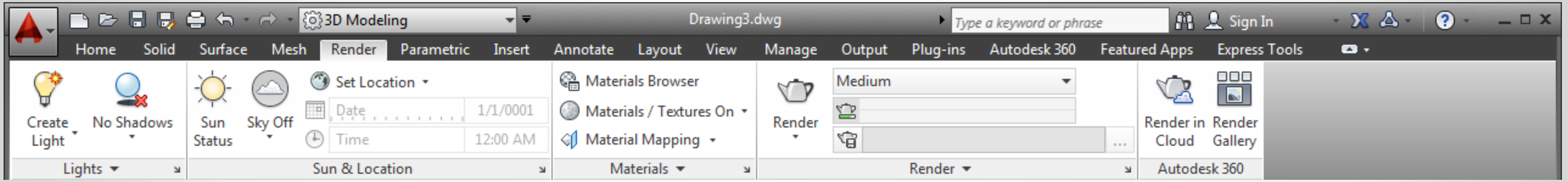
4 conceptual steps of rendering

- Create the model
- Place lights
- Attach materials to objects
- Render the image

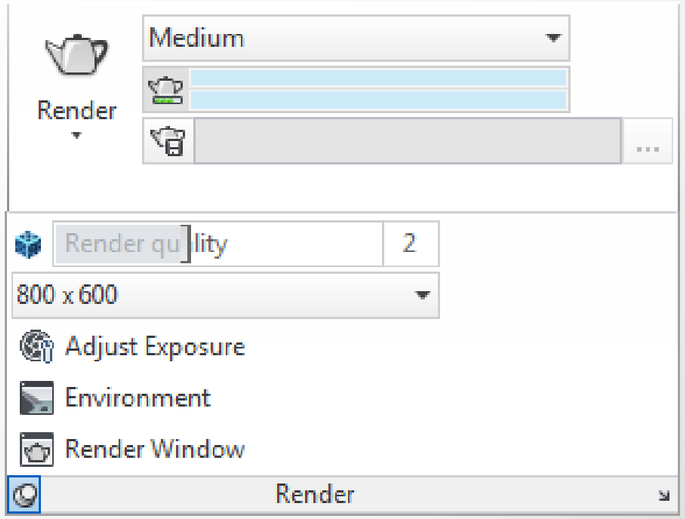
- 5th step: adjust camera positions

The Rendering Tools

All tools are located on the **Render** ribbon



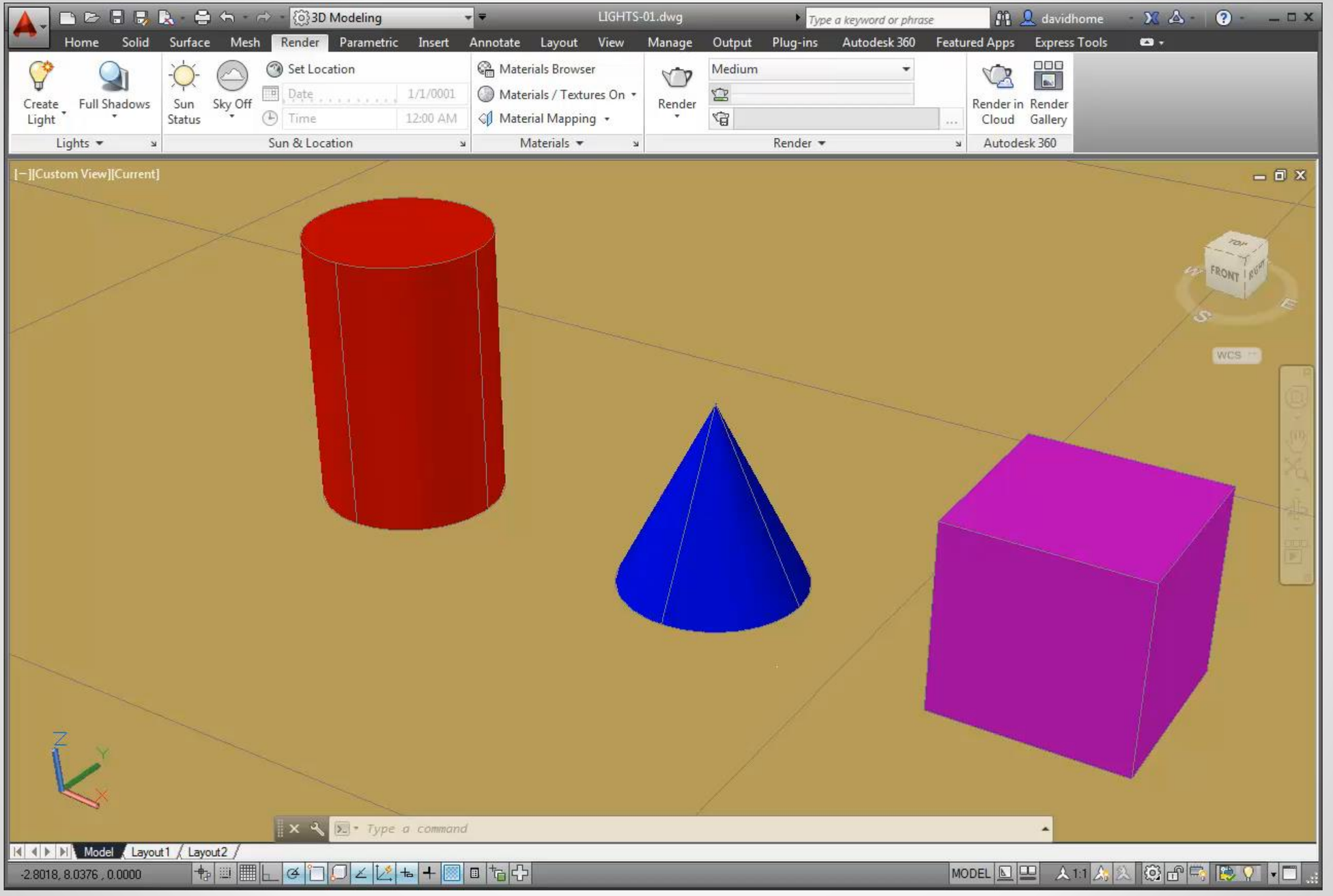
Use tools in the **Render** panel to quickly create a rendering



Working with Lights

Default lighting

- Comes from two distant sources that follow the viewpoint as you move.
  - All faces are illuminated
  - You can control brightness and contrast
  - Default lighting must be turned off to see the effect of user-created lights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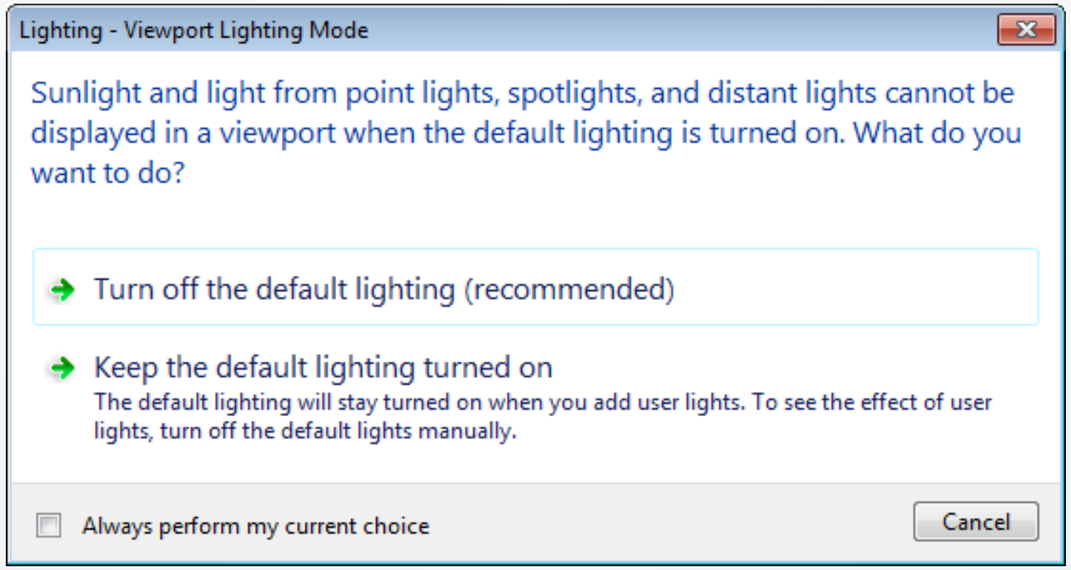
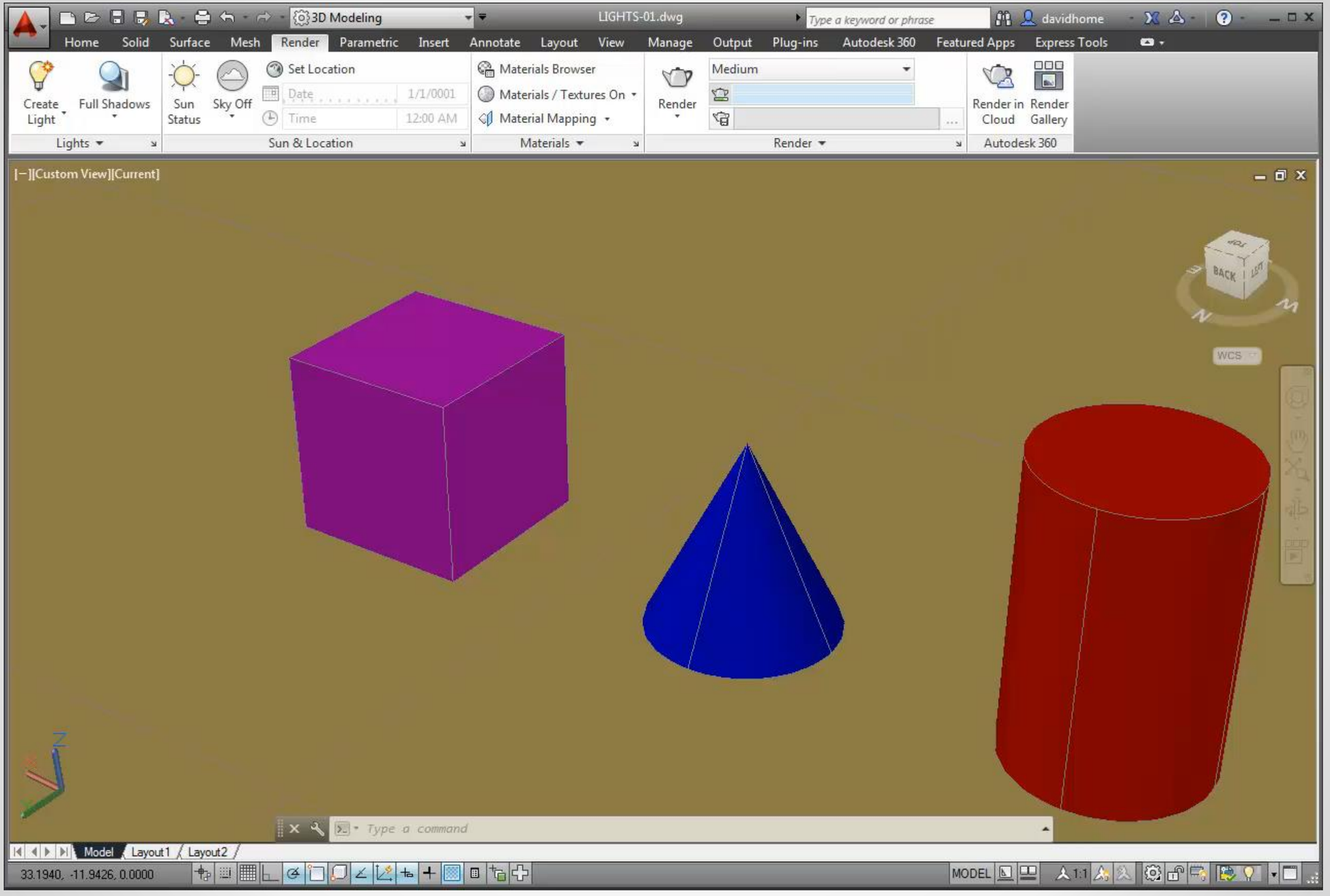
User-Created Lights

- Provide control over lighting
- When you place the first user light, AutoCAD displays an alert.
  - You must turn off default lighting in order to see their effect

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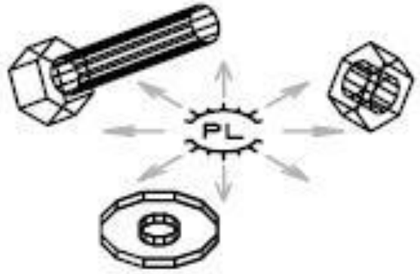
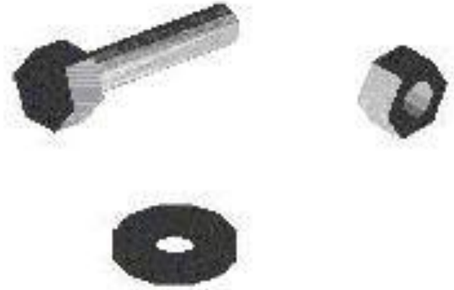
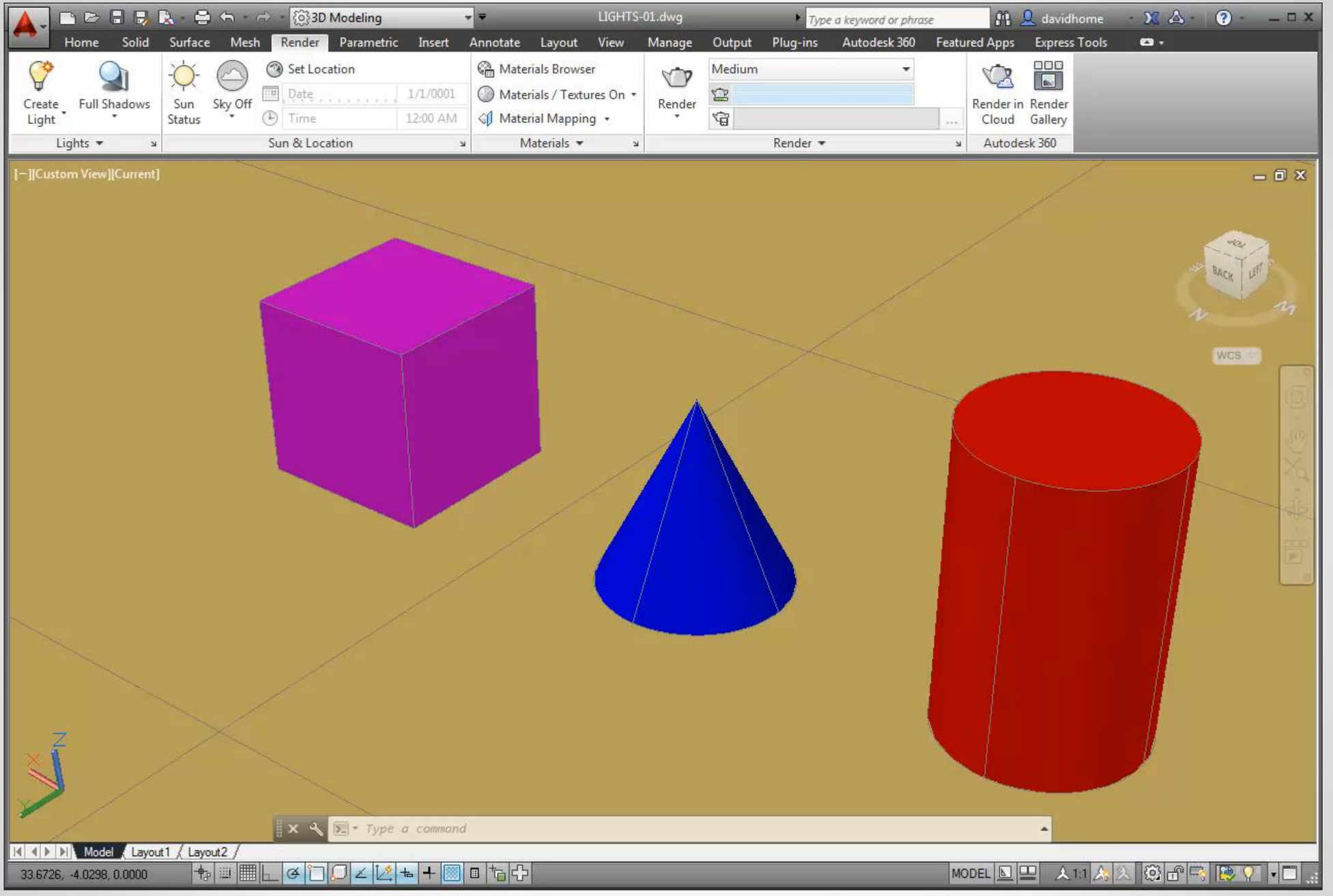
Point Lights

- Radiates light in all directions
  - Useful for general lighting effects
  - Intensity diminishes over distance
  - Specify the **Location** of the light



point light


rendering with point light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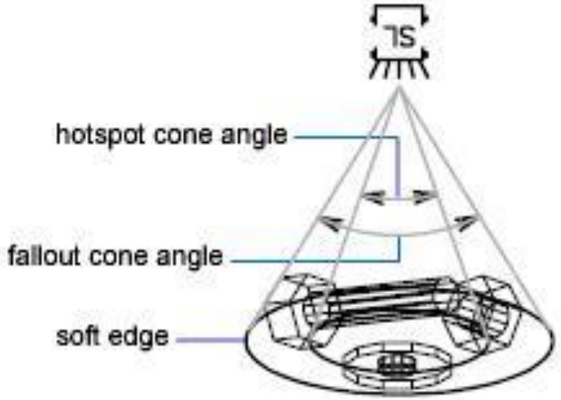
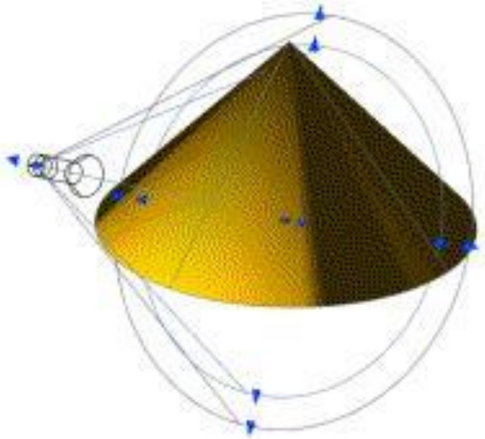
Spot Lights

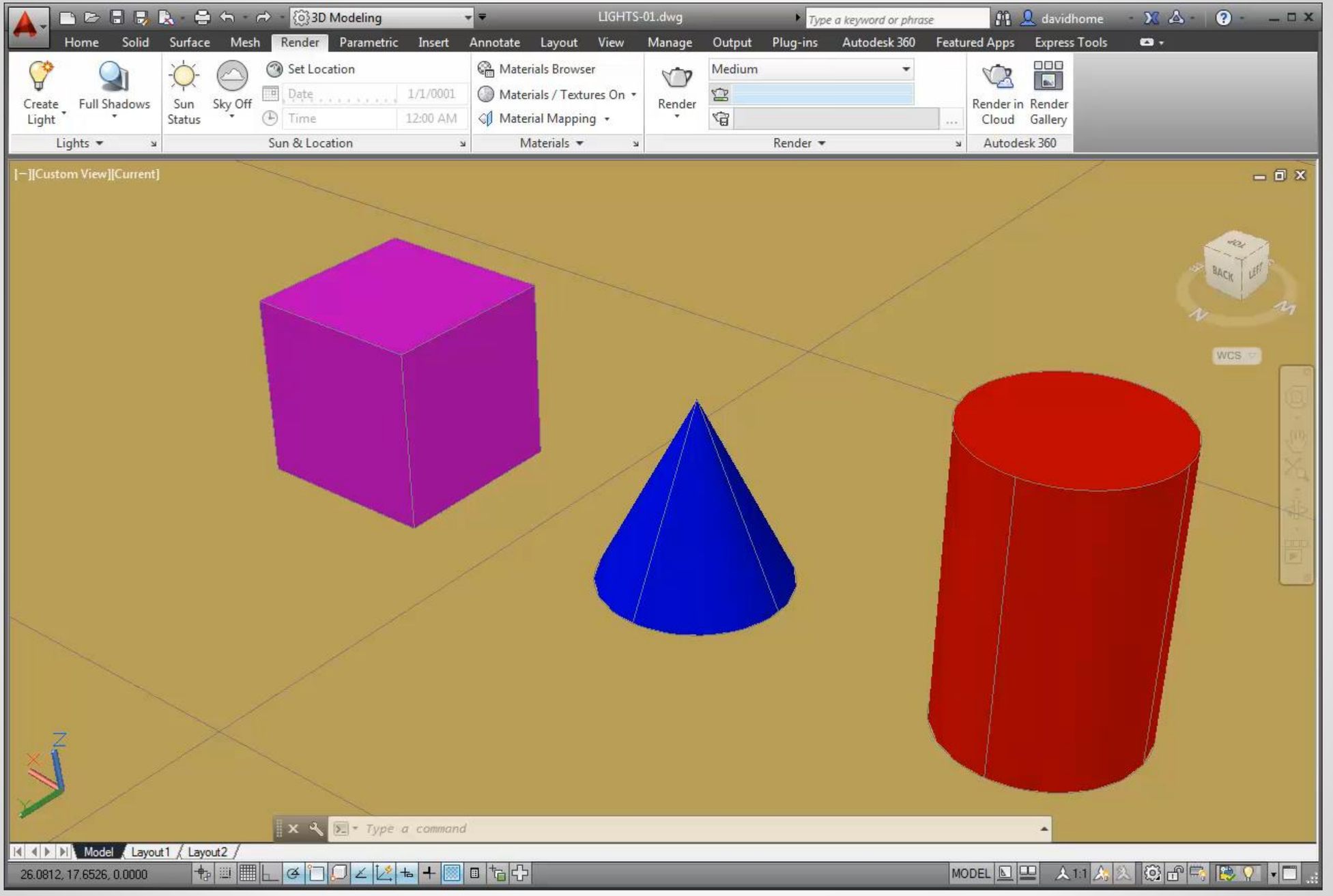
- Emits a directional, focused cone of light
  - Useful for highlighting features
  - Intensity diminishes over distance
  - You control the hotspot and falloff
  - Specify **Location** and **Target**



spotlight




rendering with spotlight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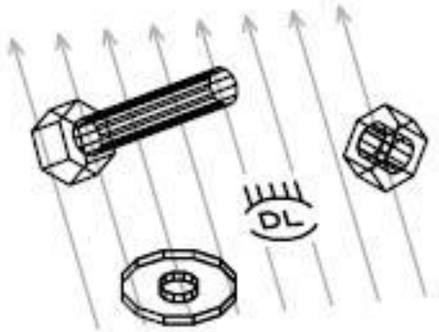
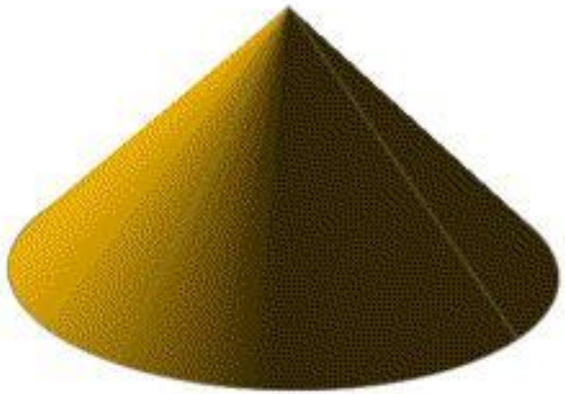
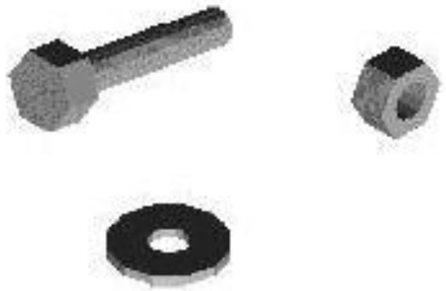
Distant Light

- Emits parallel rays of light in one direction
  - Useful for uniformly lighting objects or background
  - Intensity does not diminish over distance
  - Specify **From** and **To** points
  - Not physically accurate

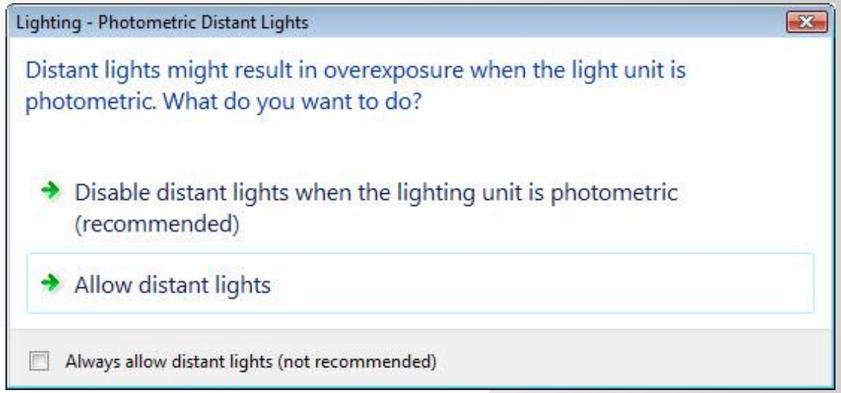


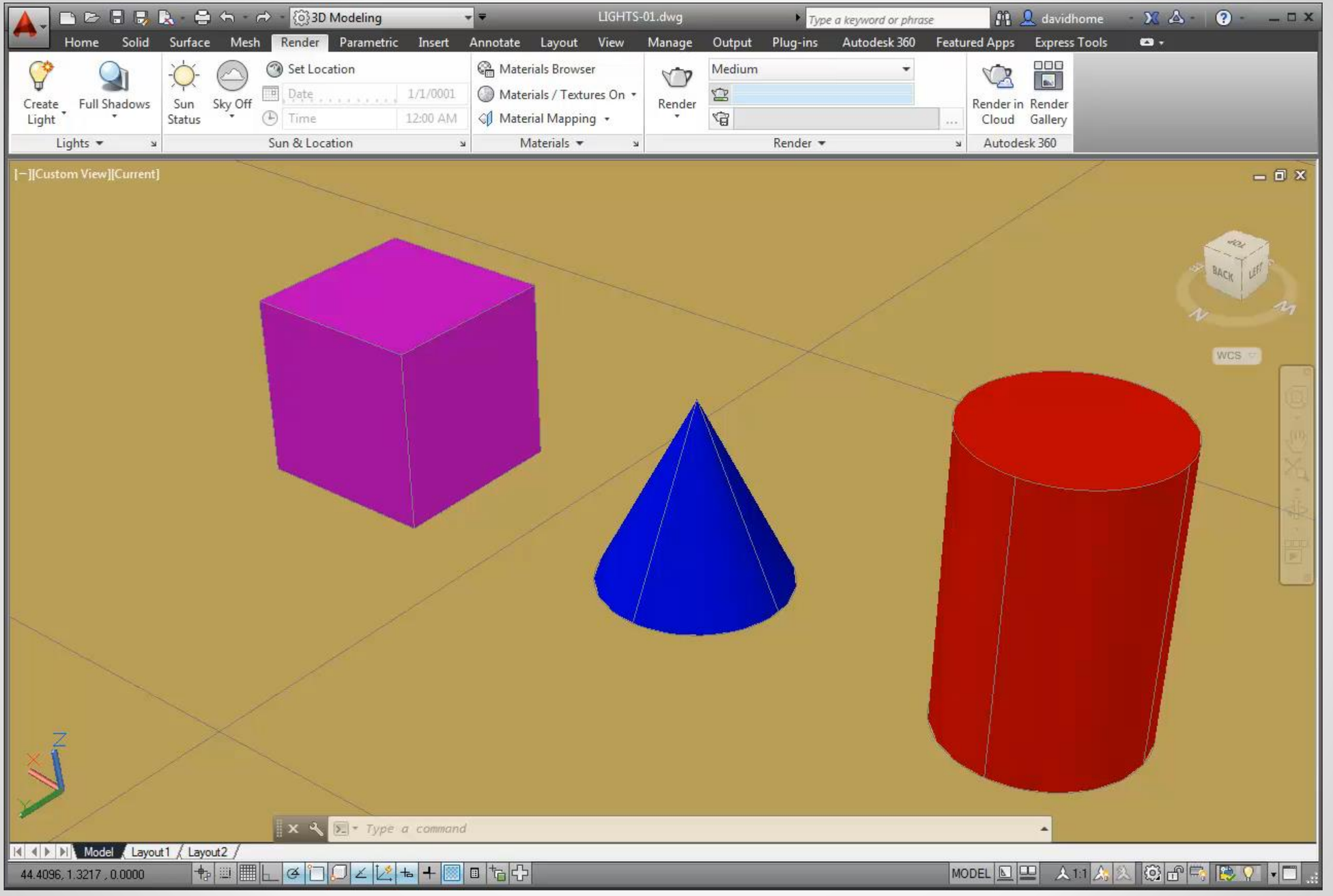
distant light





rendering with distant light

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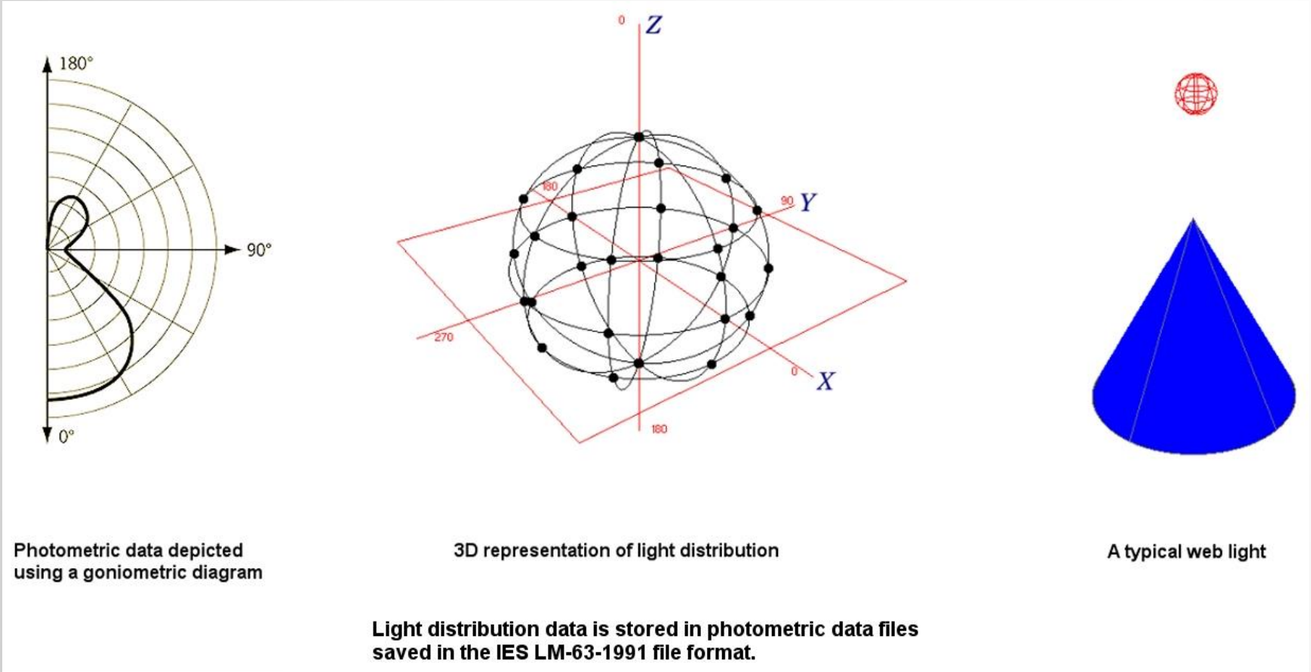
Weblight

- 3D representation of light intensity distribution
  - Derived from data provided by manufacturers (in IES format)
  - Several provided with AutoCAD (in Tool Palette)

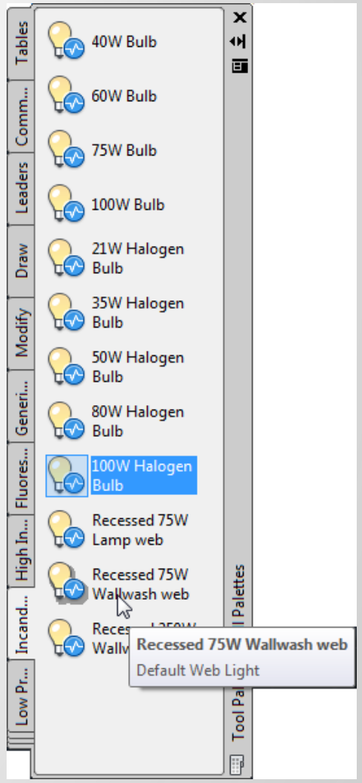


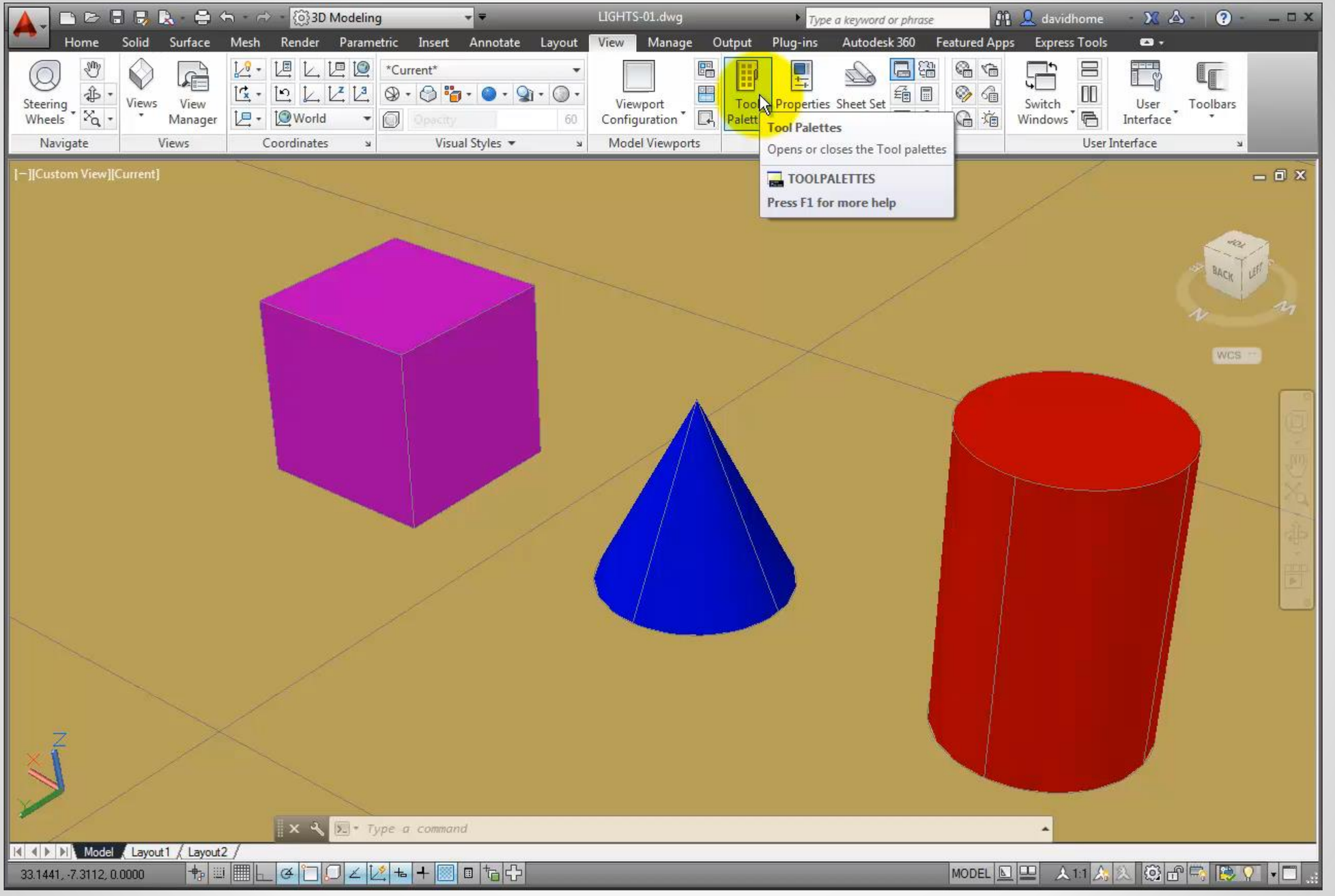
Photometric data depicted using a goniometric diagram

3D representation of light distribution

A typical web light

Light distribution data is stored in photometric data files saved in the IES LM-63-1991 file format.

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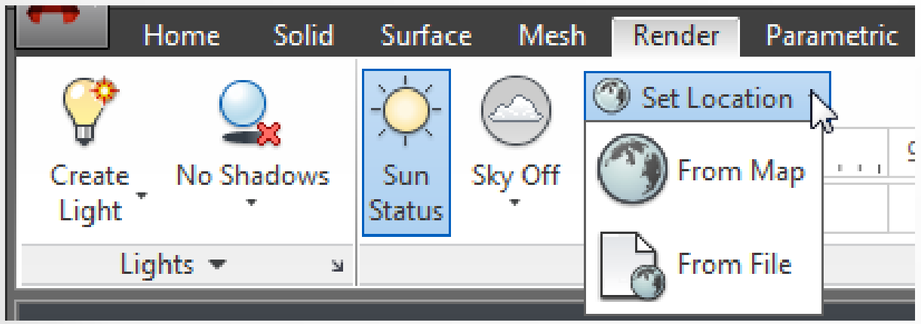
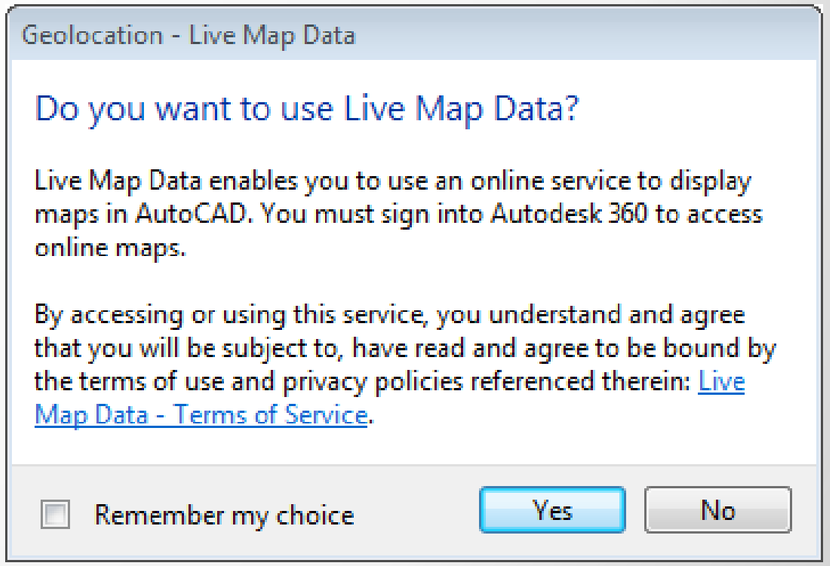
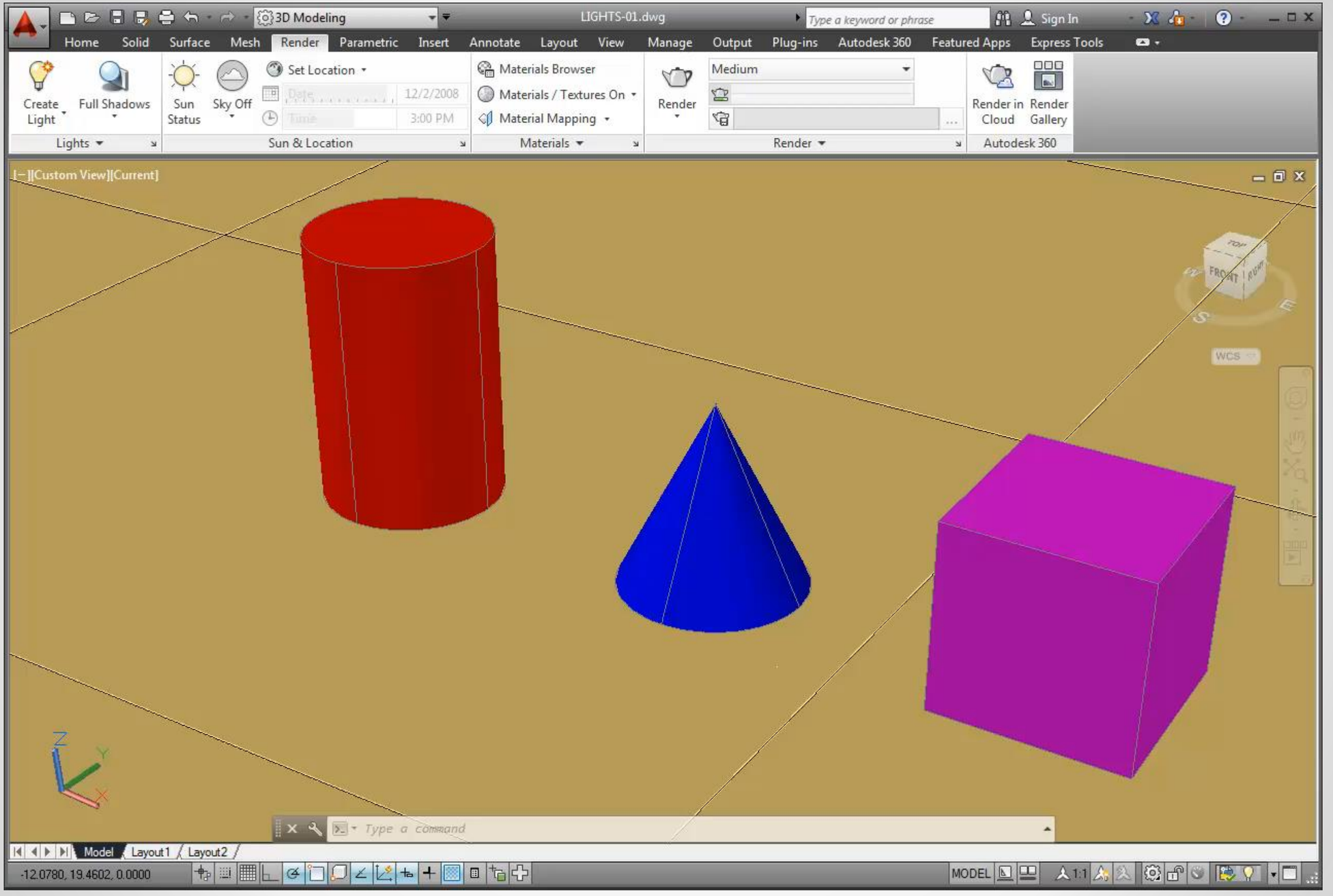
Working with Sunlight

- Simulates the sun
  - Parallel rays with same intensity over any distance
  - Tools in the **Sun & Location** panel
  - Import a file or use **Live Map Data** (requires Autodesk 360 login)



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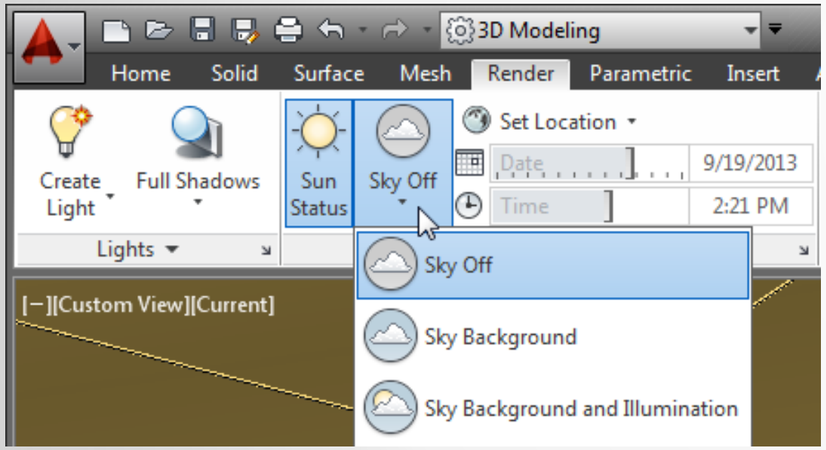
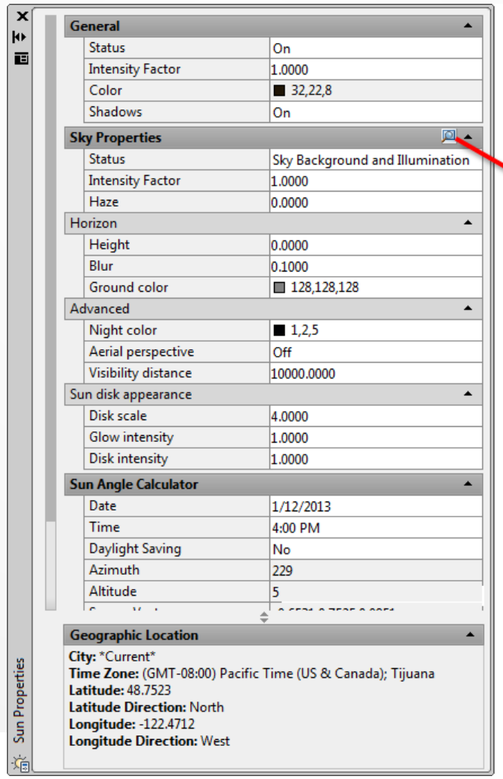
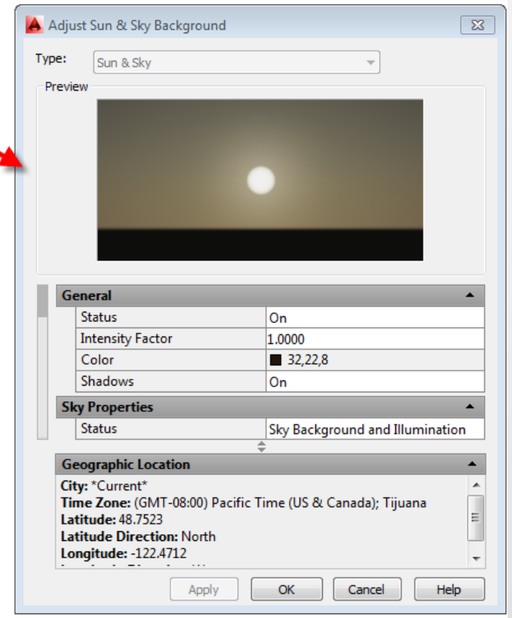
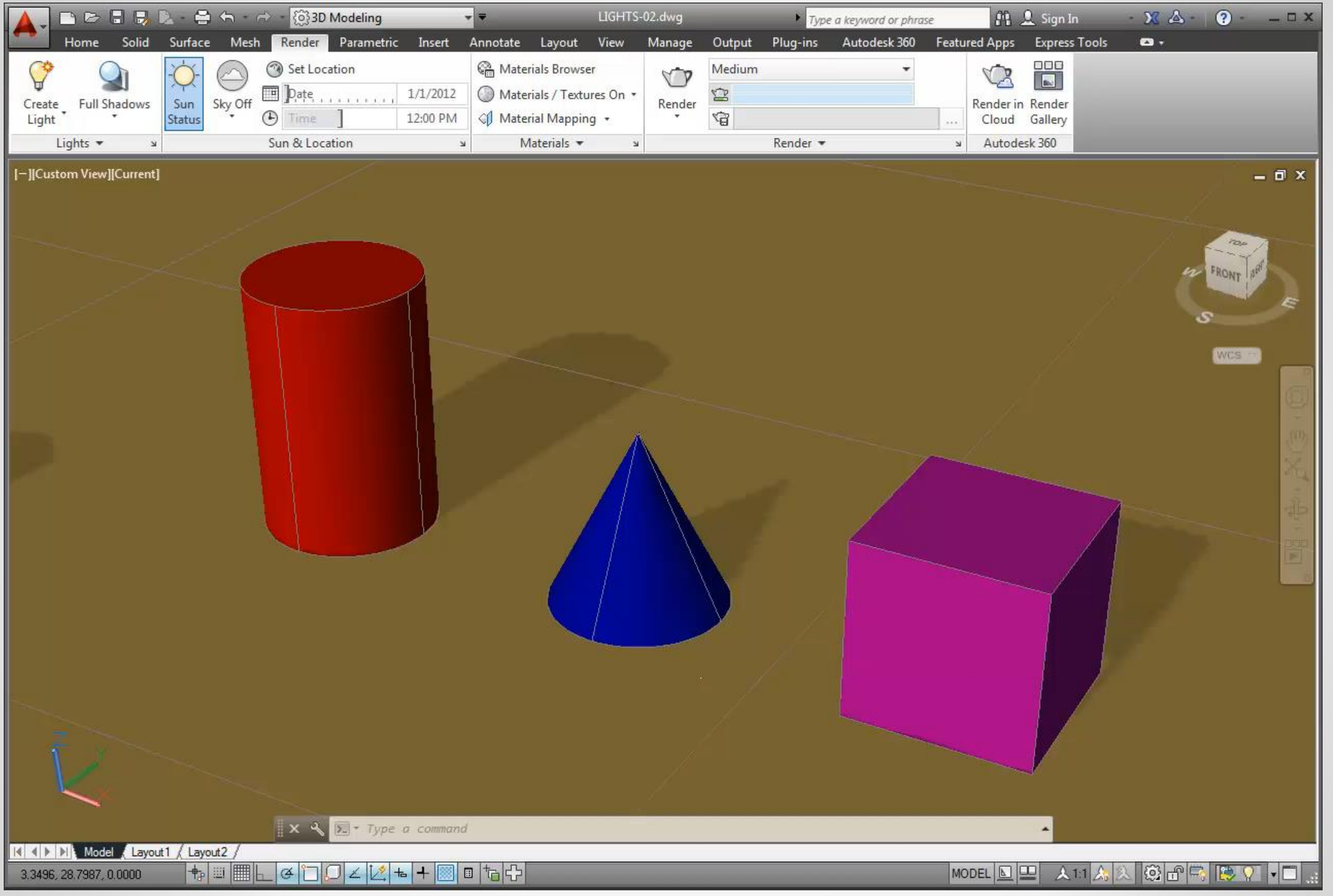
Controlling the Sky and Background Illumination

- Adds realistic atmospheric light scattering:
  - Sky background only or background AND illumination
  - Enables control of background, horizon, and solar disk





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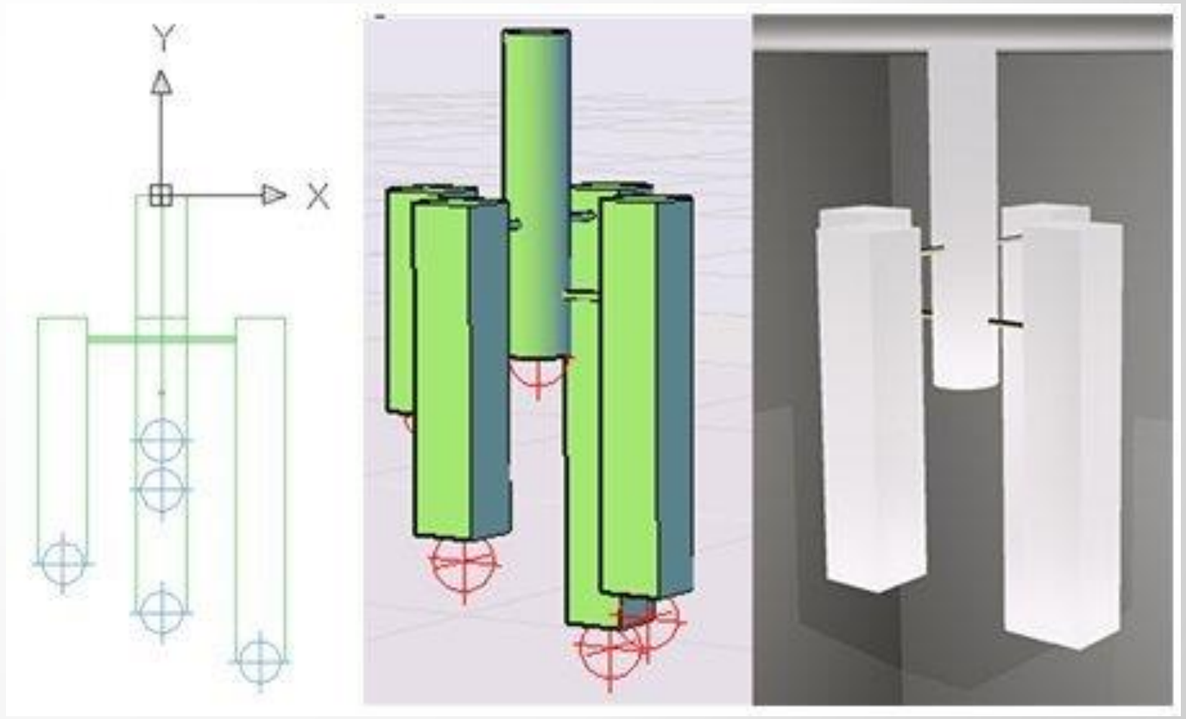
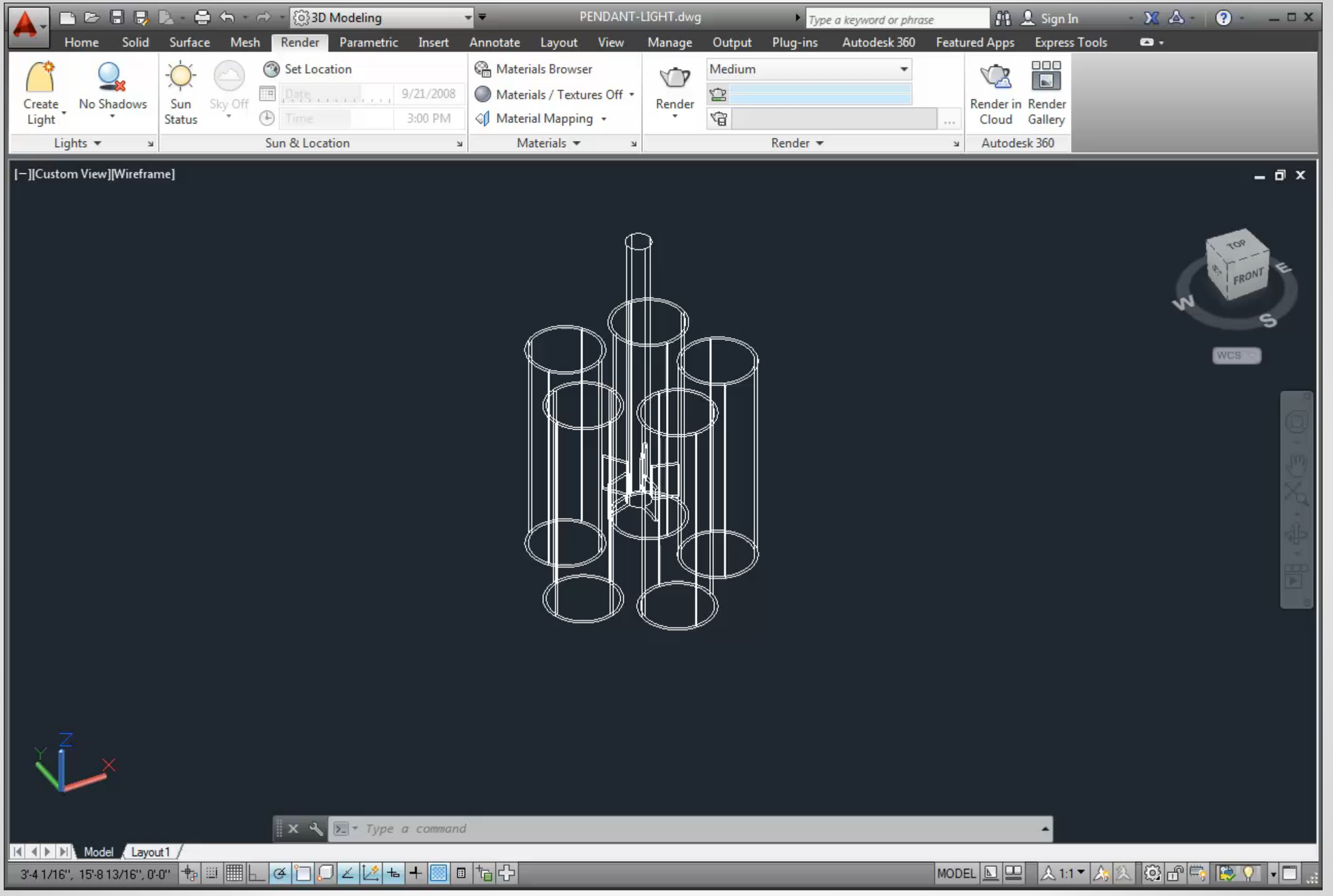
Using Luminaire Objects

- Embed lights inside blocks
  - Create light fixture that models both physical and light properties of a lighting fixture

1. Model 3D light
2. Add light within model
3. Save as a block
4. Use in other models

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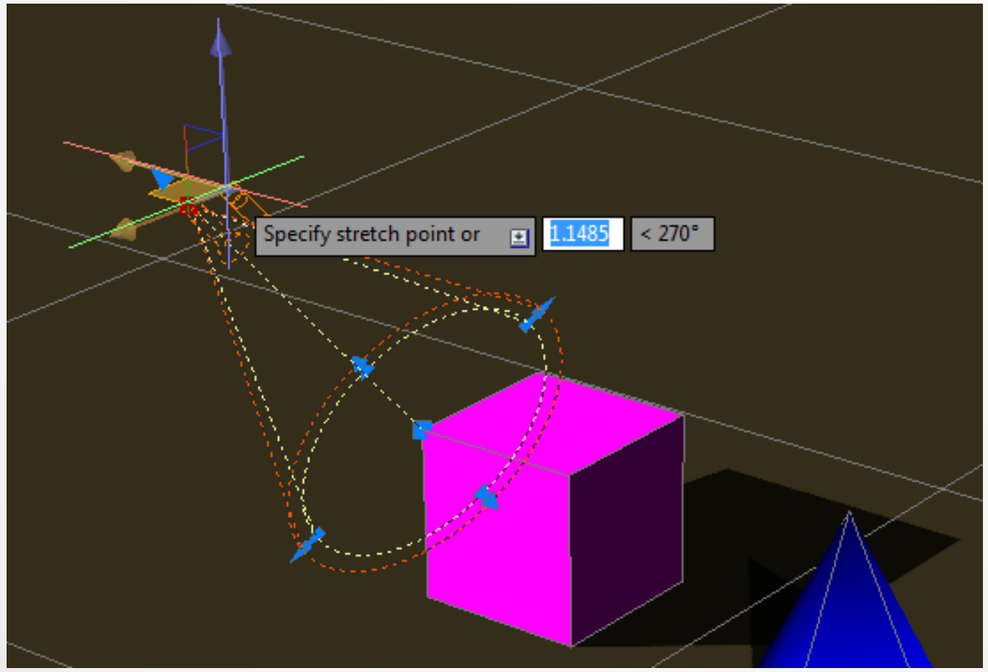
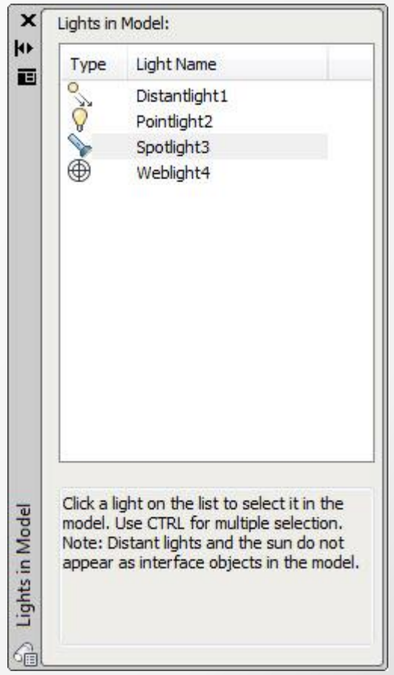
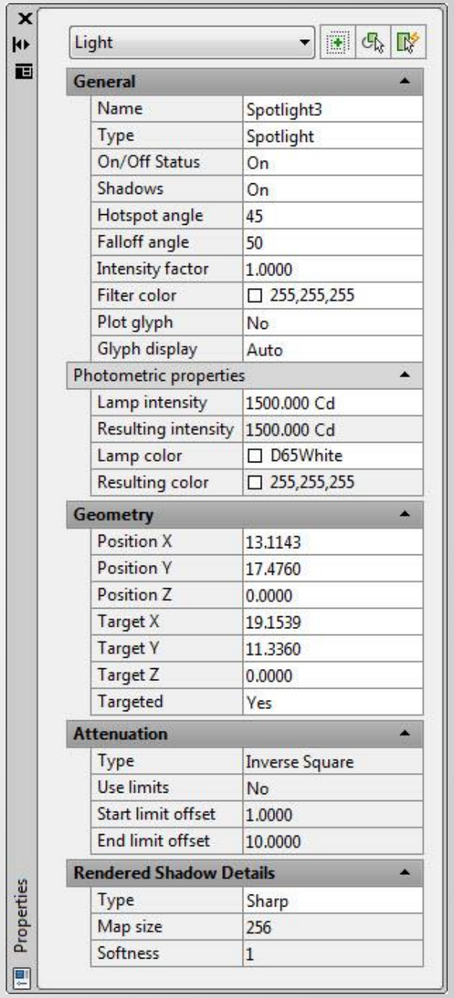
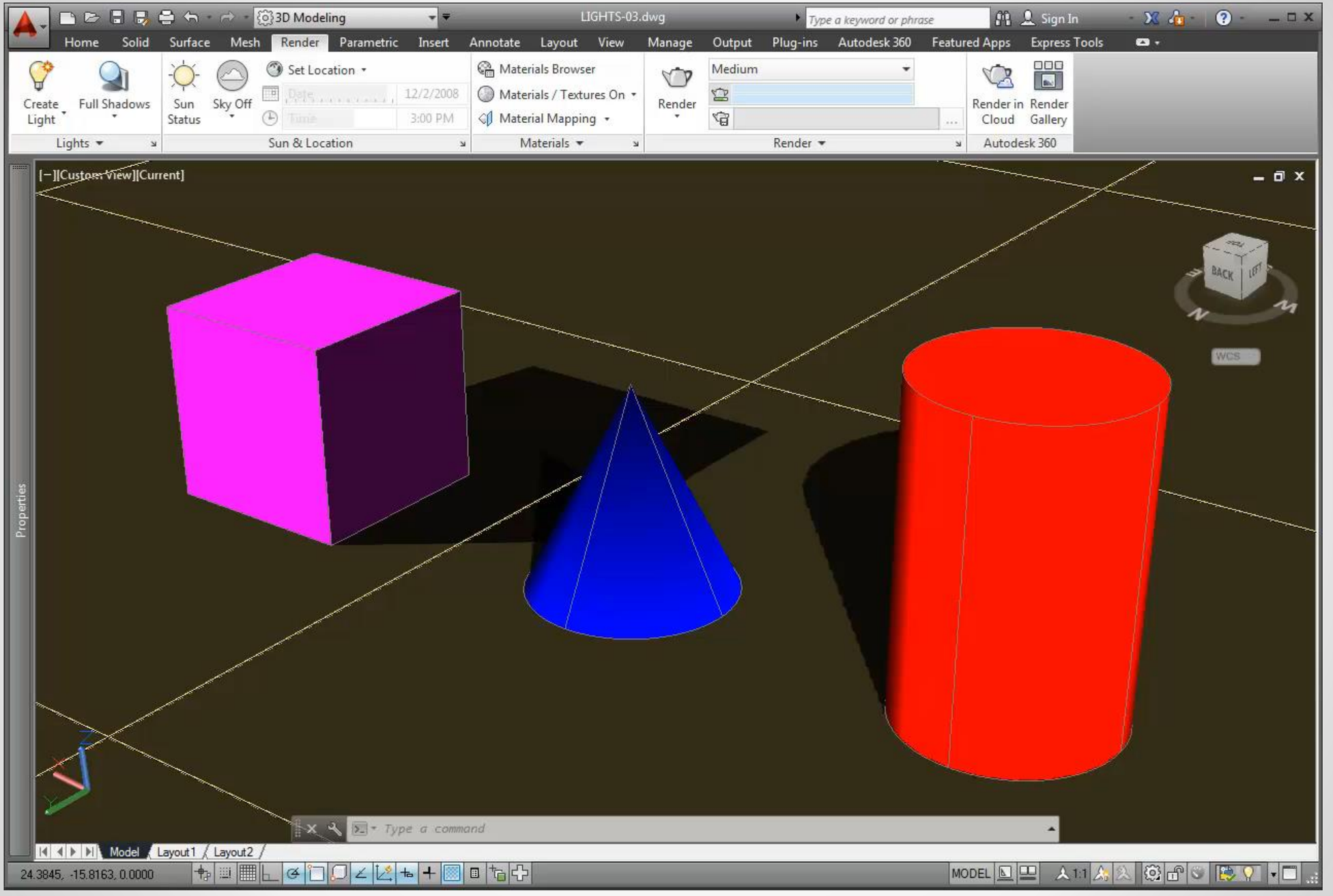
Controlling the Location and Properties of Lights

- Select any light in the **Lights in Model** palette
- Adjust properties in the **Properties** palette
- Use grips and gizmos





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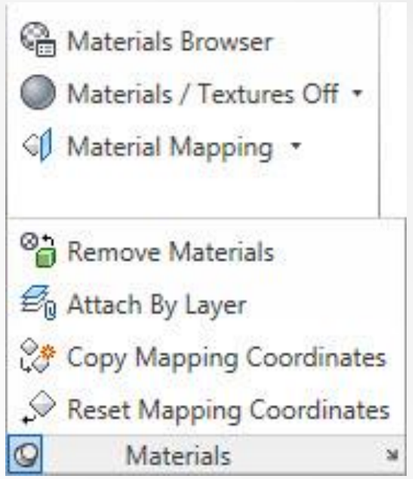
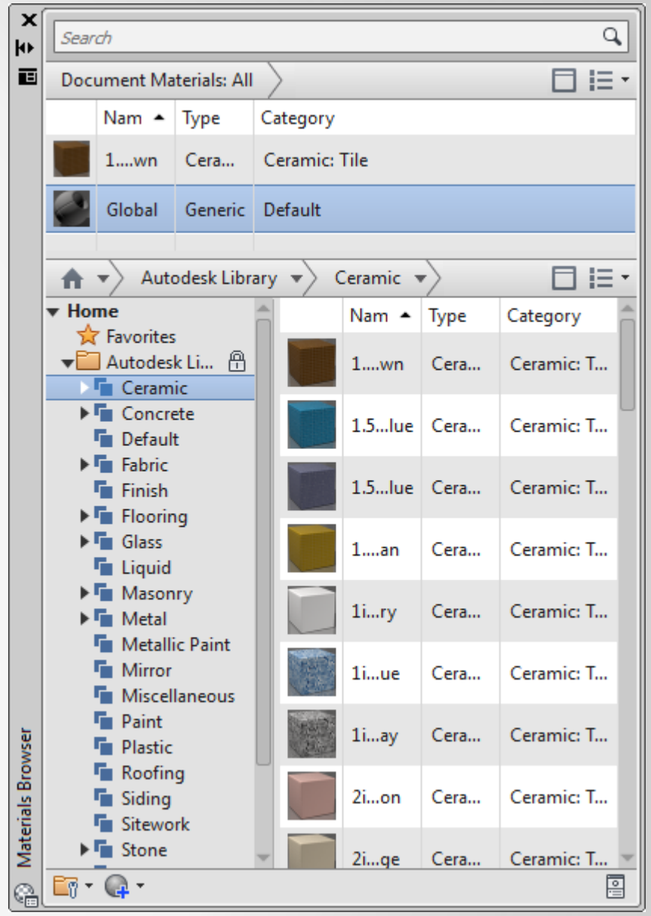
Create Light
Full Shadows
Sun Status
Sky Off
Set Location
Date
12/2/2008
Time
3:00 PM
Lights
Sun & Location
Materials Browser
Materials / Textures On
Material Mapping
Materials
Render
Medium
Render
Render in Cloud
Render Gallery
Autodesk 360
[−][Custom View][Current]
BACK
LEFT
WCS
Properties
Type a command
Model
Layout1
Layout2
24.3845, -15.8163, 0.0000
MODEL
1:1

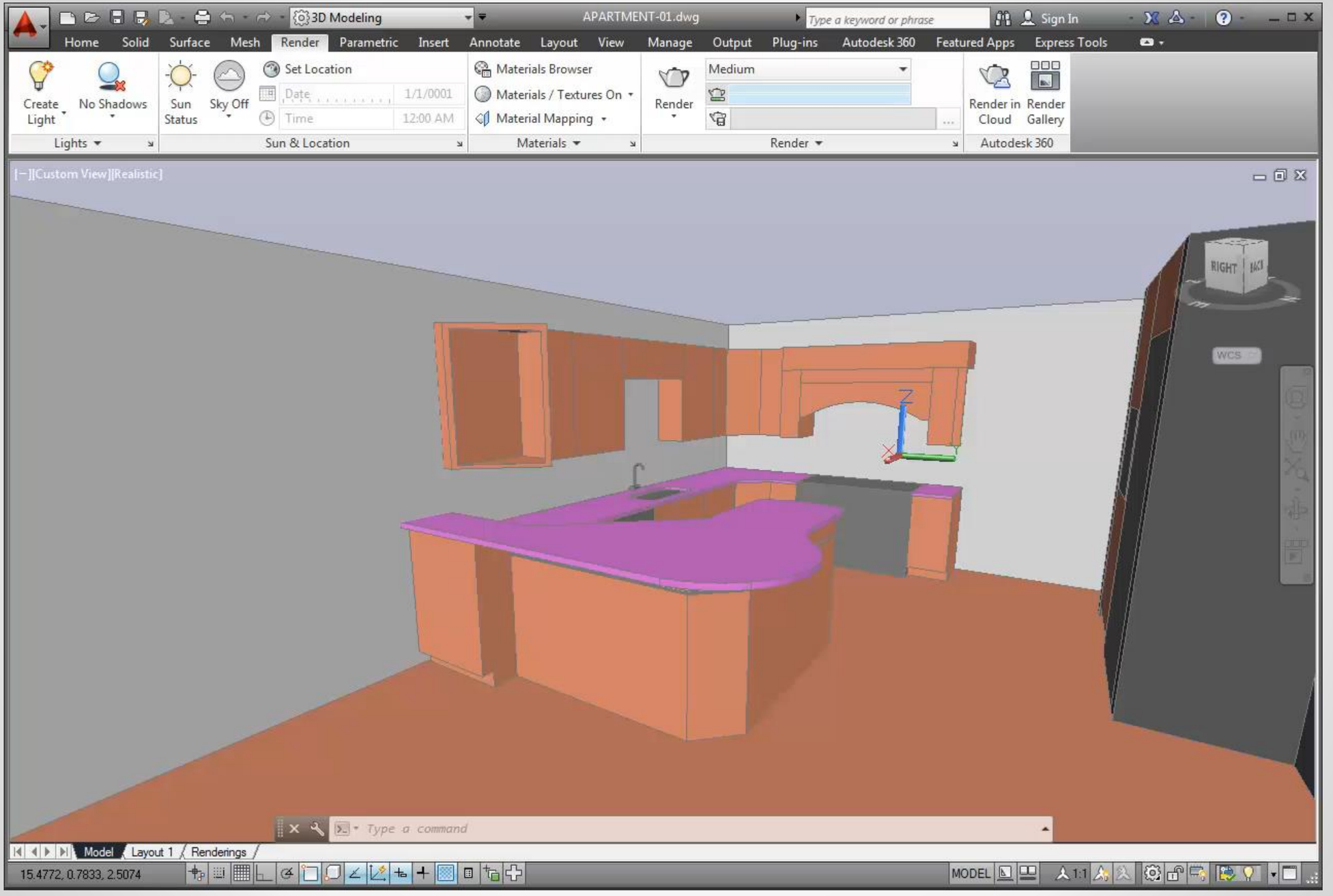
Working with Materials

Working with Materials



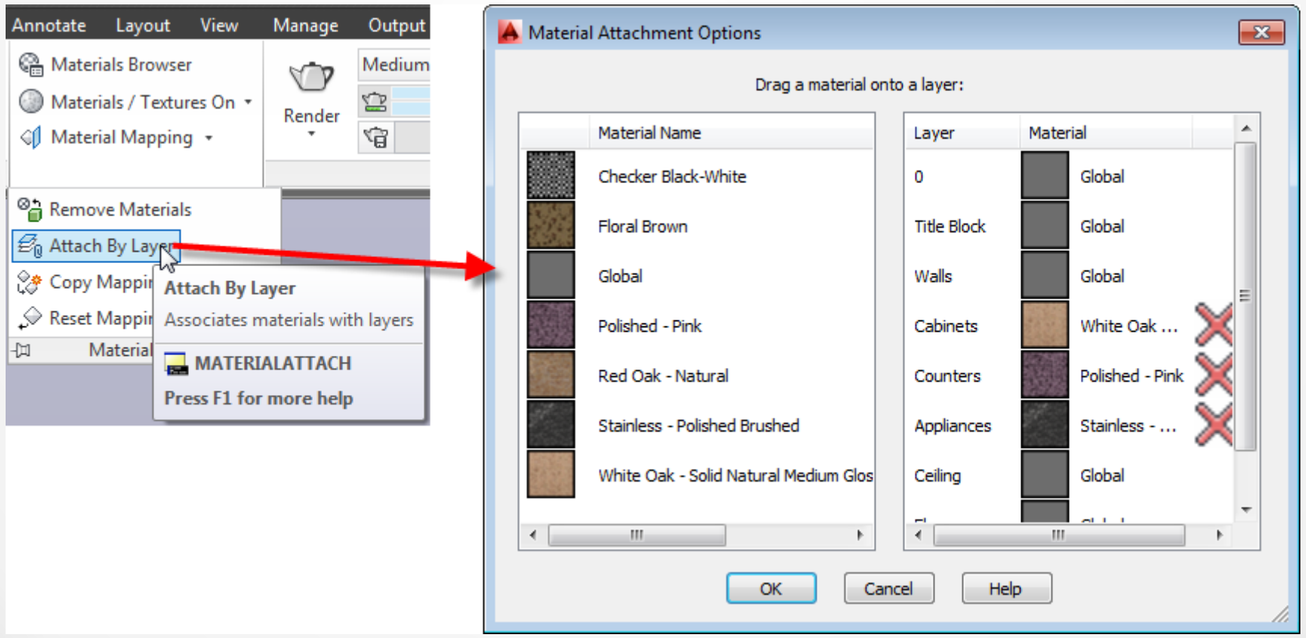


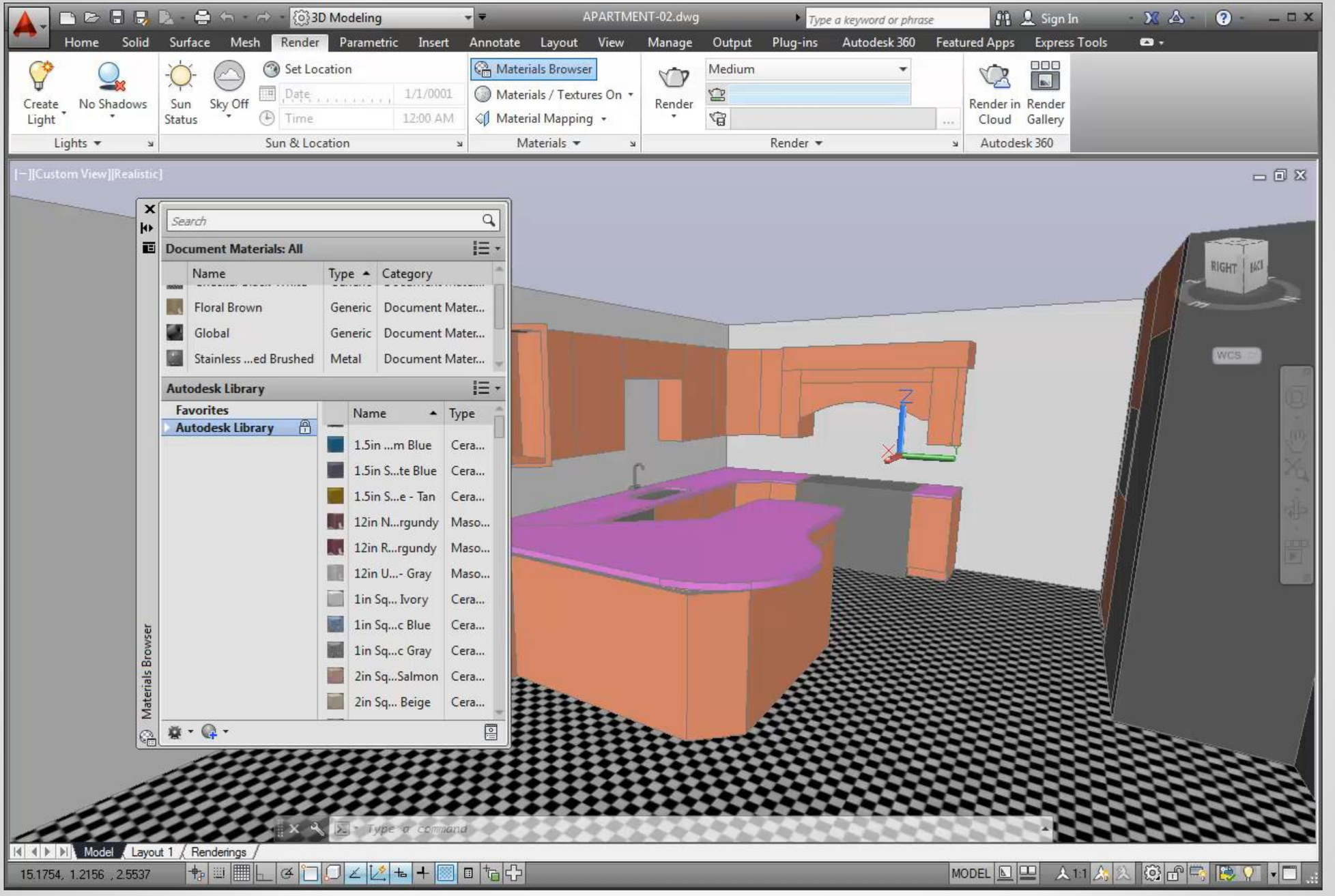
- Brings models to life
- Tools in the **Materials** panel and **Materials Browser**
  - Autodesk Materials Library (shared by Autodesk programs)
  - All materials appear in Library area
  - Materials in drawing appear in Document area


3D Modeling
APARTMENT-01.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Lights
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Sun & Location
Materials Browser
Materials / Textures On
Material Mapping
Materials
Render
Medium
Render
Render in Cloud
Render Gallery
Autodesk 360
[−][Custom View][Realistic]
RIGHT
BACK
WCS
Type a command
Model
Layout 1
Renderings
15.4772, 0.7833, 2.5074
MODEL
1:1

Applying Materials to Objects and Faces

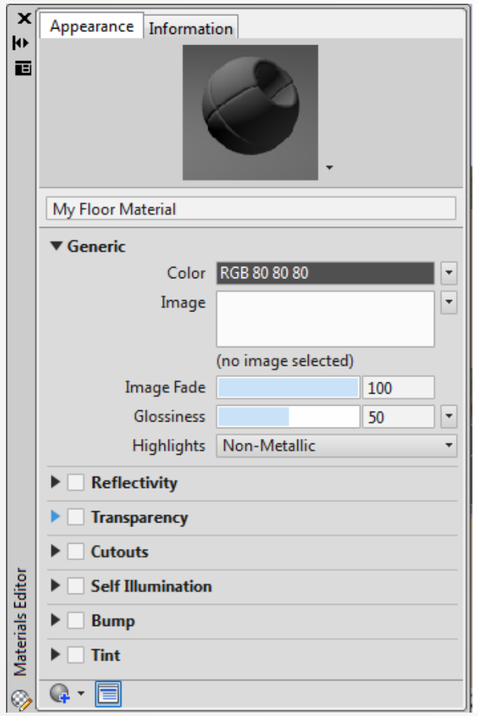
- To an object – drag and drop onto object
- To a face – press CTRL and drag onto face of object
- By layer – use Attach by Layer tool to display dialog

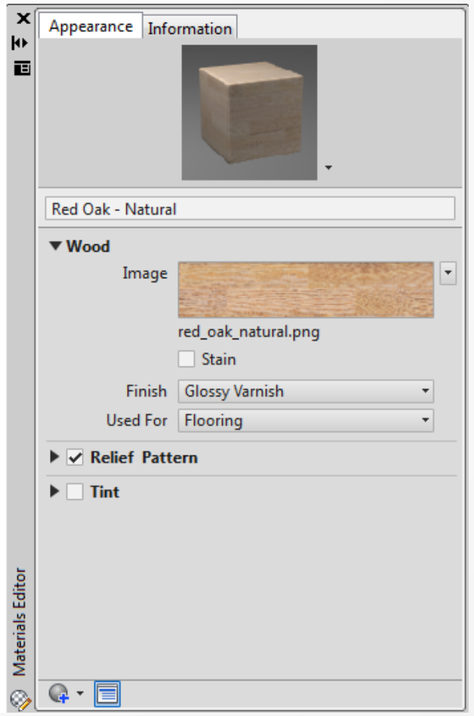


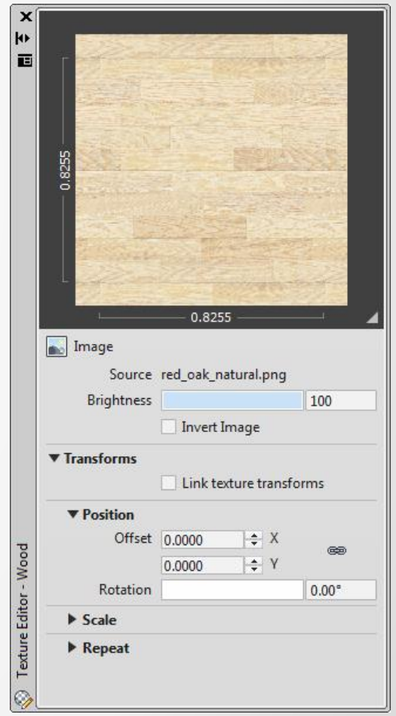

3D Modeling
APARTMENT-02.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Materials Browser
Materials / Textures On
Material Mapping
Render
Medium
Render in Cloud
Render Gallery
Lights
Sun & Location
Materials
Render
Autodesk 360
[−][Custom View][Realistic]
Search
Document Materials: All
Name
Type
Category
Floral Brown
Generic
Document Mater...
Global
Generic
Document Mater...
Stainless ...ed Brushed
Metal
Document Mater...
Autodesk Library
Favorites
Autodesk Library
Name
Type
1.5in ...m Blue
Cera...
1.5in S...te Blue
Cera...
1.5in S...e - Tan
Cera...
12in N...rgundy
Maso...
12in R...rgundy
Maso...
12in U...- Gray
Maso...
1in Sq... Ivory
Cera...
1in Sq...c Blue
Cera...
1in Sq...c Gray
Cera...
2in Sq...Salmon
Cera...
2in Sq... Beige
Cera...
Materials Browser
RIGHT
BACK
WCS
Type a command
Model
Layout 1
Renderings
15.1754, 1.2156 , 2.5537
MODEL
1:1

Creating and Modifying Materials

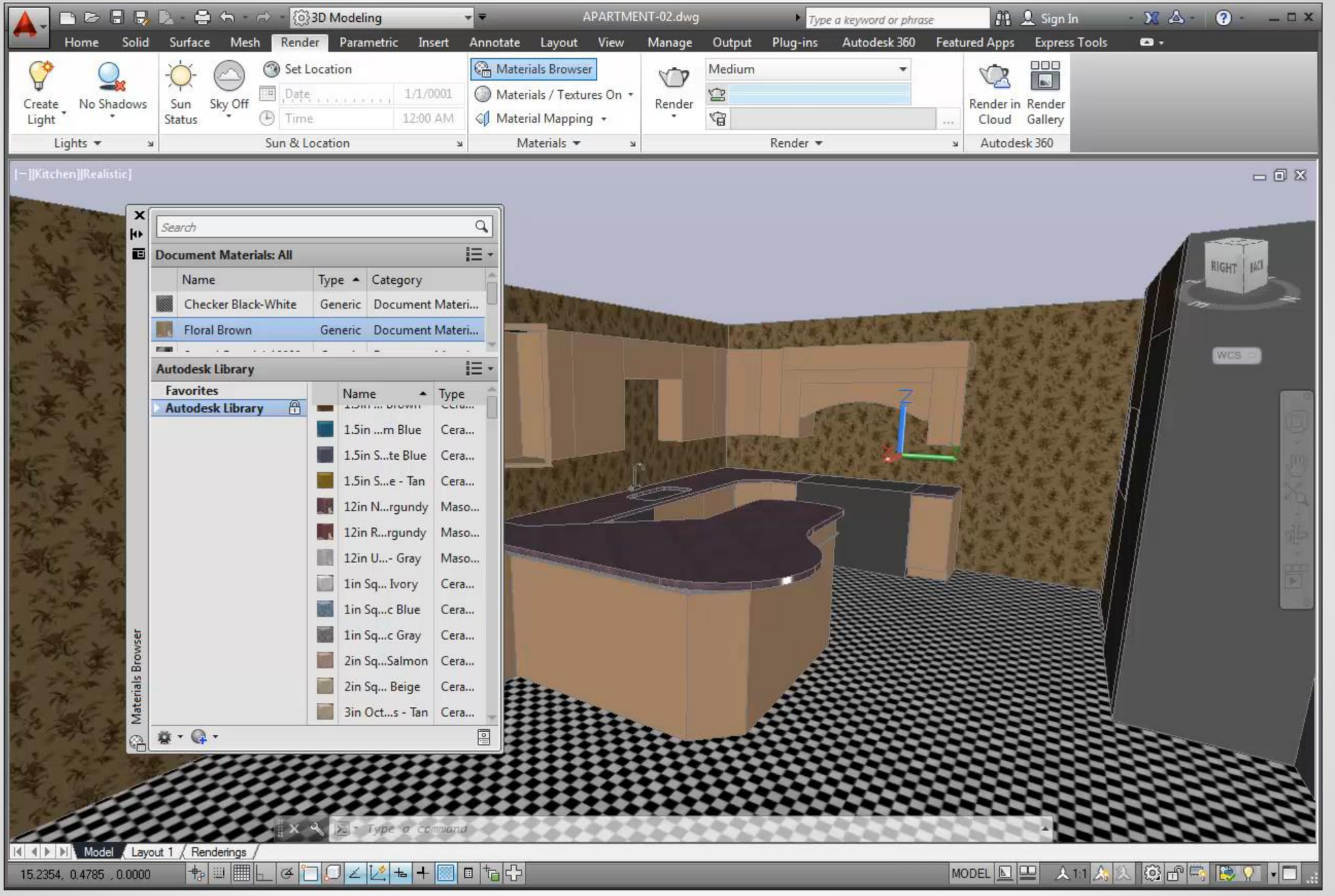
- Use tools in **Materials Browser** to create new material
  - Only adjust materials in current drawing or user library
- Use tools in **Materials Editor** to adjust its properties
  - Color
  - Image
  - Image Fade
  - Glossiness
  - Highlights
  - Reflectivity
  - Transparency
  - Cutouts
  - Self-illumination
  - Bump





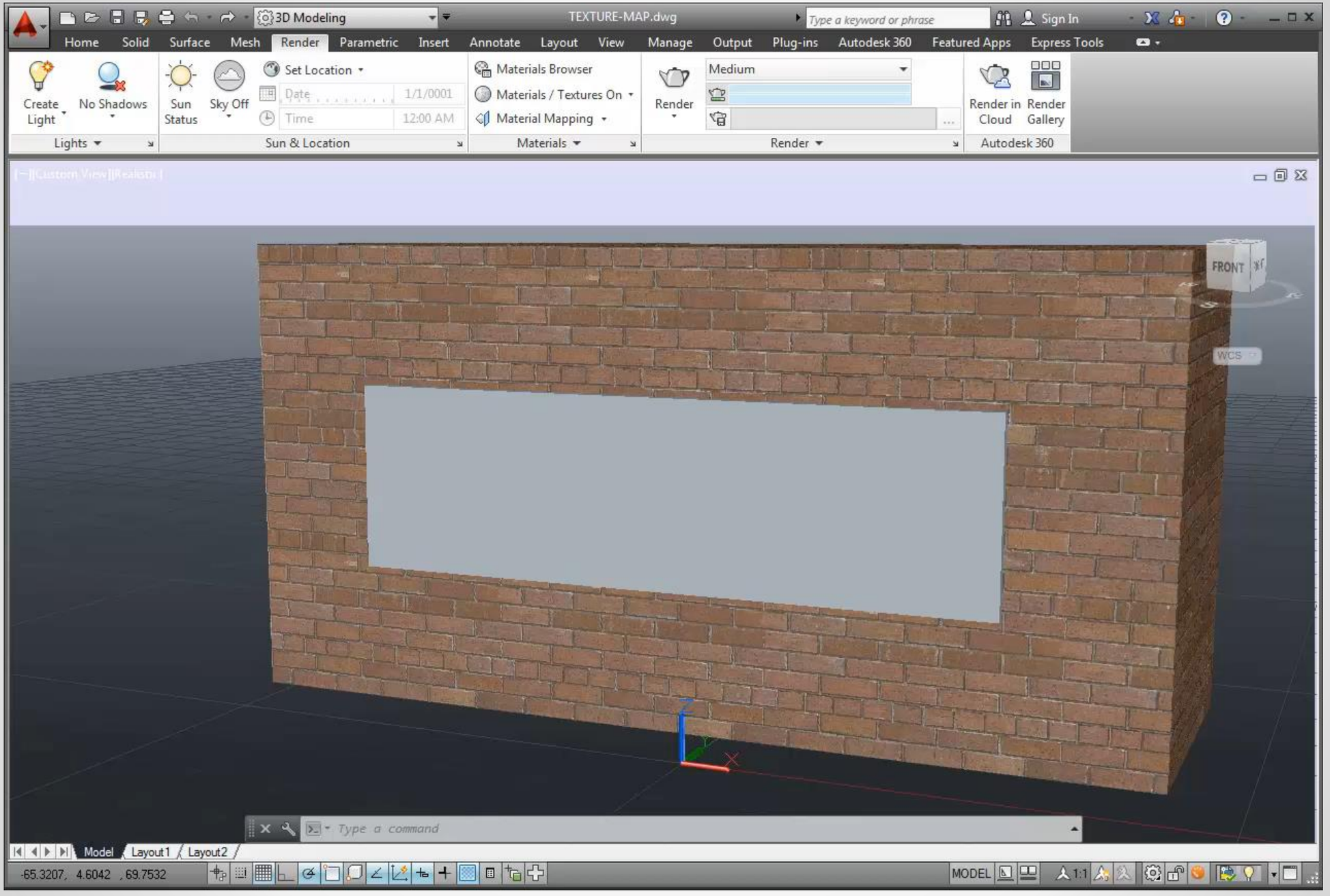


- Adjust image-based maps using **Texture Editor**


3D Modeling
APARTMENT-02.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Materials Browser
Materials / Textures On
Material Mapping
Render
Medium
Render in Cloud
Render Gallery
Lights
Sun & Location
Materials
Render
Autodesk 360
[−][Kitchen][Realistic]
Search
Document Materials: All
Name
Type
Category
Checker Black-White
Generic
Document Materi...
Floral Brown
Generic
Document Materi...
Autodesk Library
Favorites
Autodesk Library
Name
Type
1.5in ...m Blue
Cera...
1.5in S...te Blue
Cera...
1.5in S...e - Tan
Cera...
12in N...rgundy
Maso...
12in R...rgundy
Maso...
12in U...- Gray
Maso...
1in Sq... Ivory
Cera...
1in Sq...c Blue
Cera...
1in Sq...c Gray
Cera...
2in Sq...Salmon
Cera...
2in Sq... Beige
Cera...
3in Oct...s - Tan
Cera...
Materials Browser
RIGHT
WCS
Type a command
Model
Layout 1
Renderings
15.2354, 0.4785 , 0.0000
MODEL
1:1

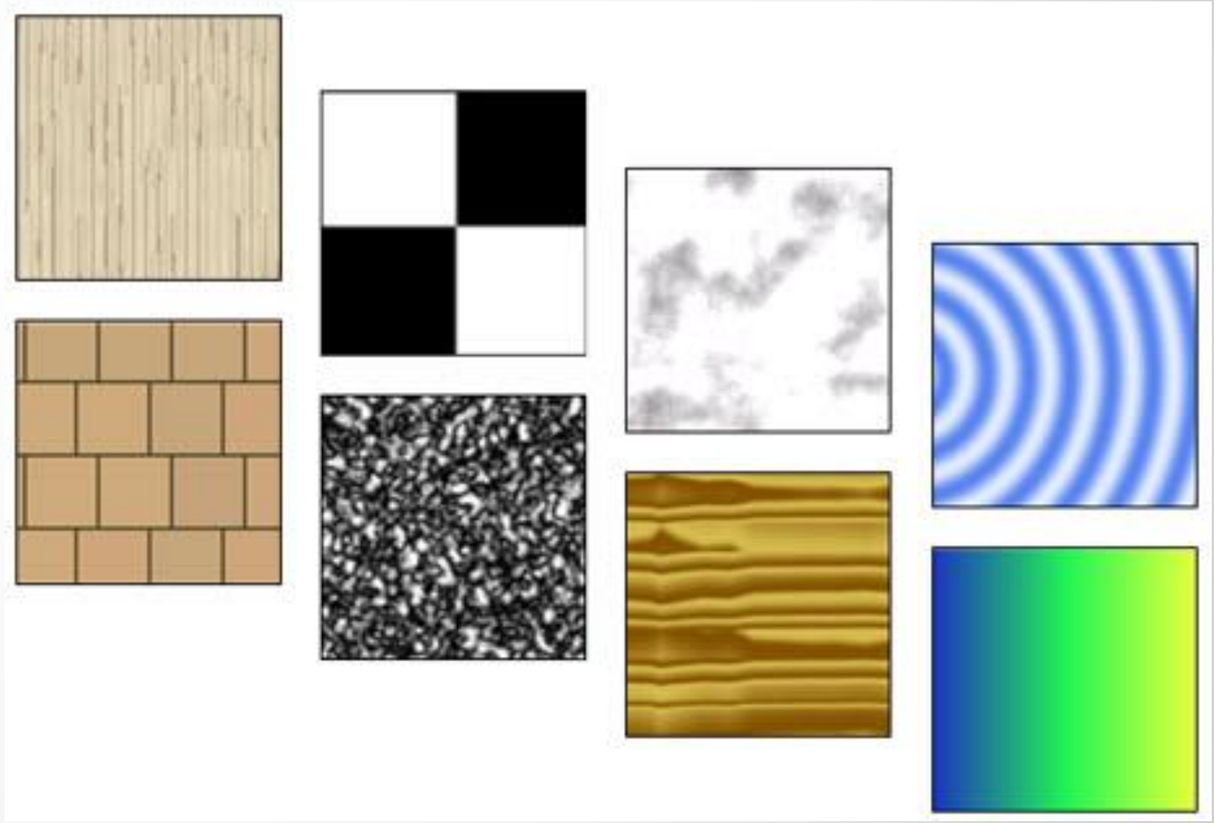
Using Texture Maps

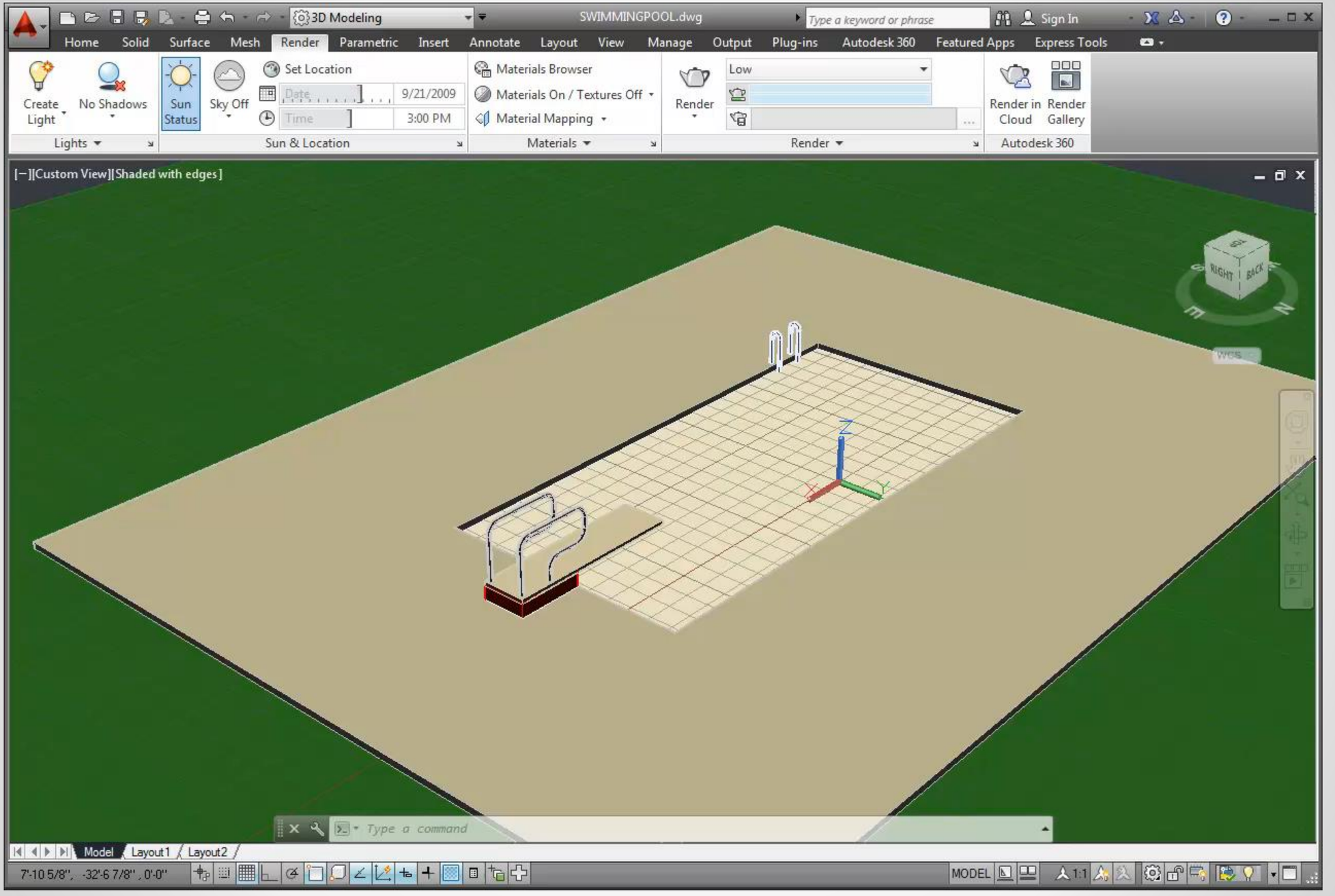
- Images assigned to materials are called *maps*
- Materials containing images are *mapped materials*
  - BMP, GIF, JPG, PCX, PNG, TGA, TIF
  - Apply multiple maps to create effects (such as cutouts)
  - In **Texture Editor**, link transforms (change to one map applies to all)


3D Modeling
TEXTURE-MAP.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Materials Browser
Materials / Textures On
Material Mapping
Render
Medium
Render in Cloud
Render Gallery
Lights
Sun & Location
Materials
Render
Autodesk 360
[-][Custom View][Realistic]
FRONT
WCS
Type a command
Model
Layout1
Layout2
-65.3207, 4.6042, 69.7532
MODEL
1:1

Procedural Maps

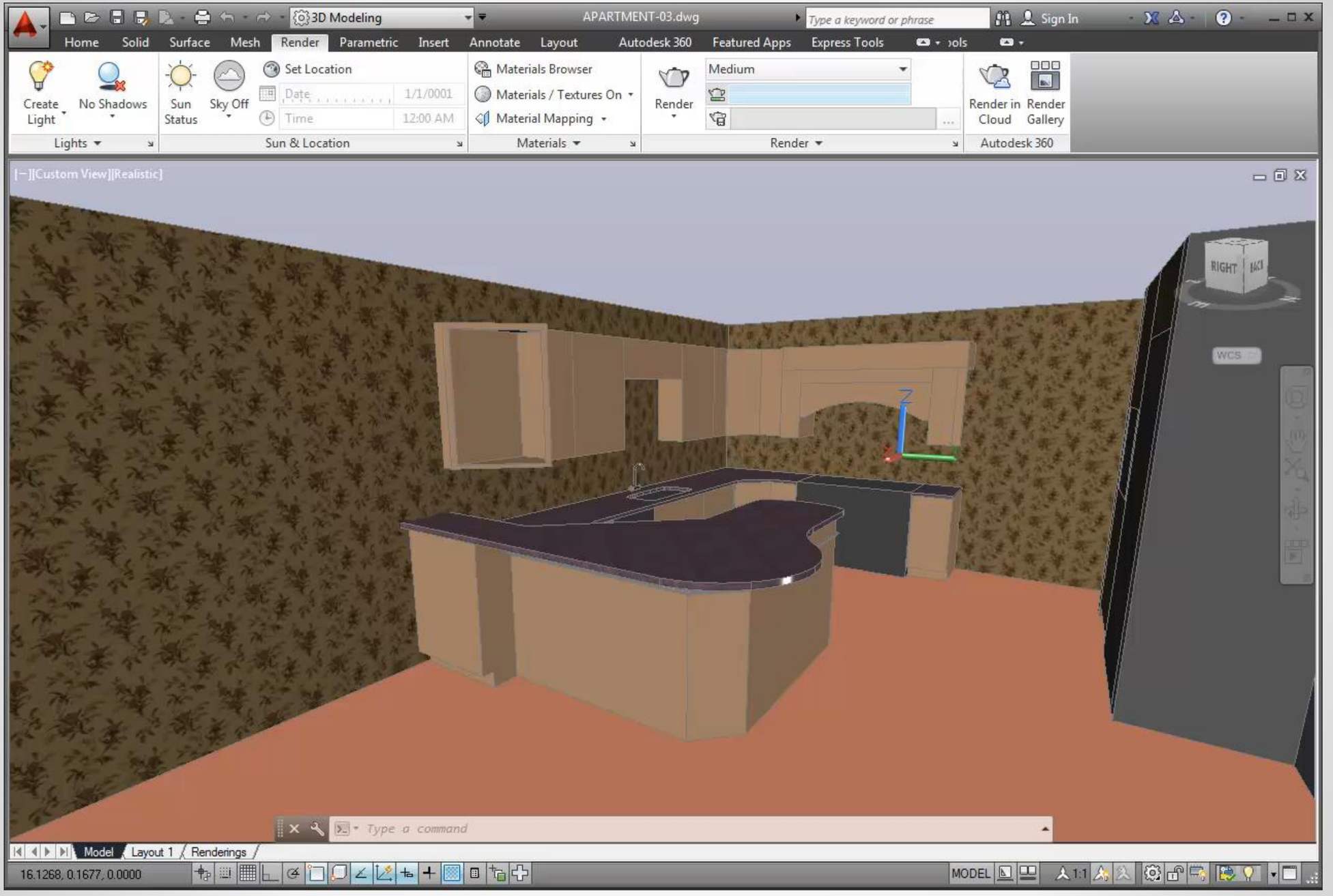
- Generated using mathematical algorithm (not images)
  - Can be generated in 2 or 3 dimensions
    - Checker
    - Gradient
    - Marble
    - Noise
    - Speckle
    - Tiles
    - Waves
    - Wood




3D Modeling
SWIMMINGPOOL.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
9/21/2009
Time
3:00 PM
Materials Browser
Materials On / Textures Off
Material Mapping
Render
Low
Render in Cloud
Render Gallery
Lights
Sun & Location
Materials
Render
Autodesk 360
[−][Custom View][Shaded with edges]
Type a command
Model
Layout1
Layout2
7'-10 5/8", -32'-6 7/8", 0'-0"
MODEL
1:1

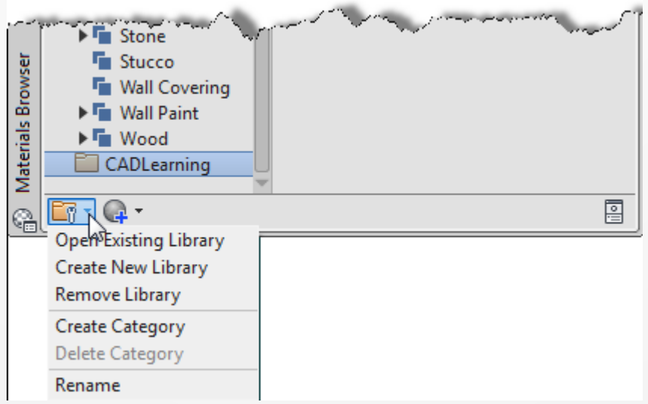
Preparing Your Own Bitmaps

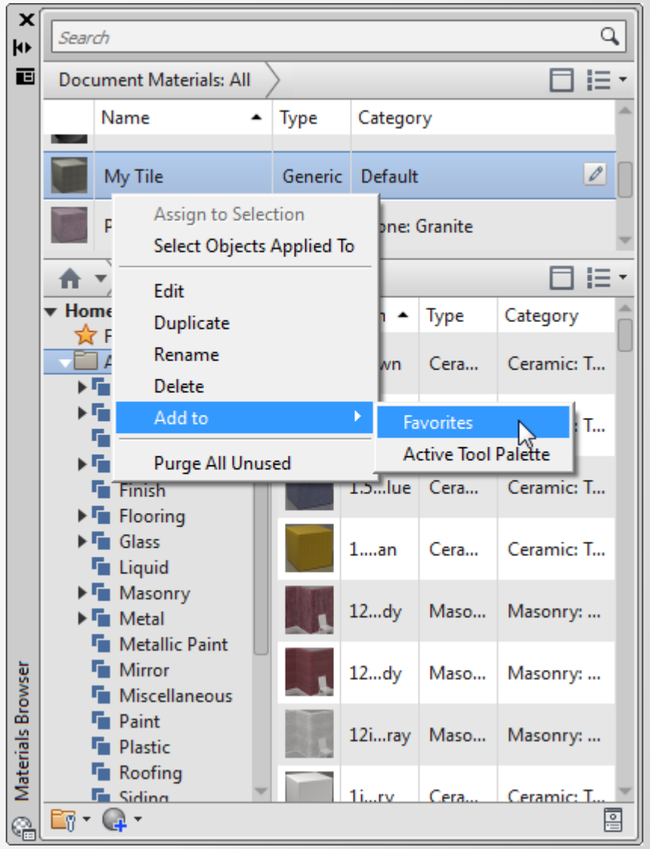
- Create your own custom materials from digital photos or scanned images
  - BMP, GIF, JPG, PCX, PNG, TGA, TIF
  - Make sure images tile seamlessly

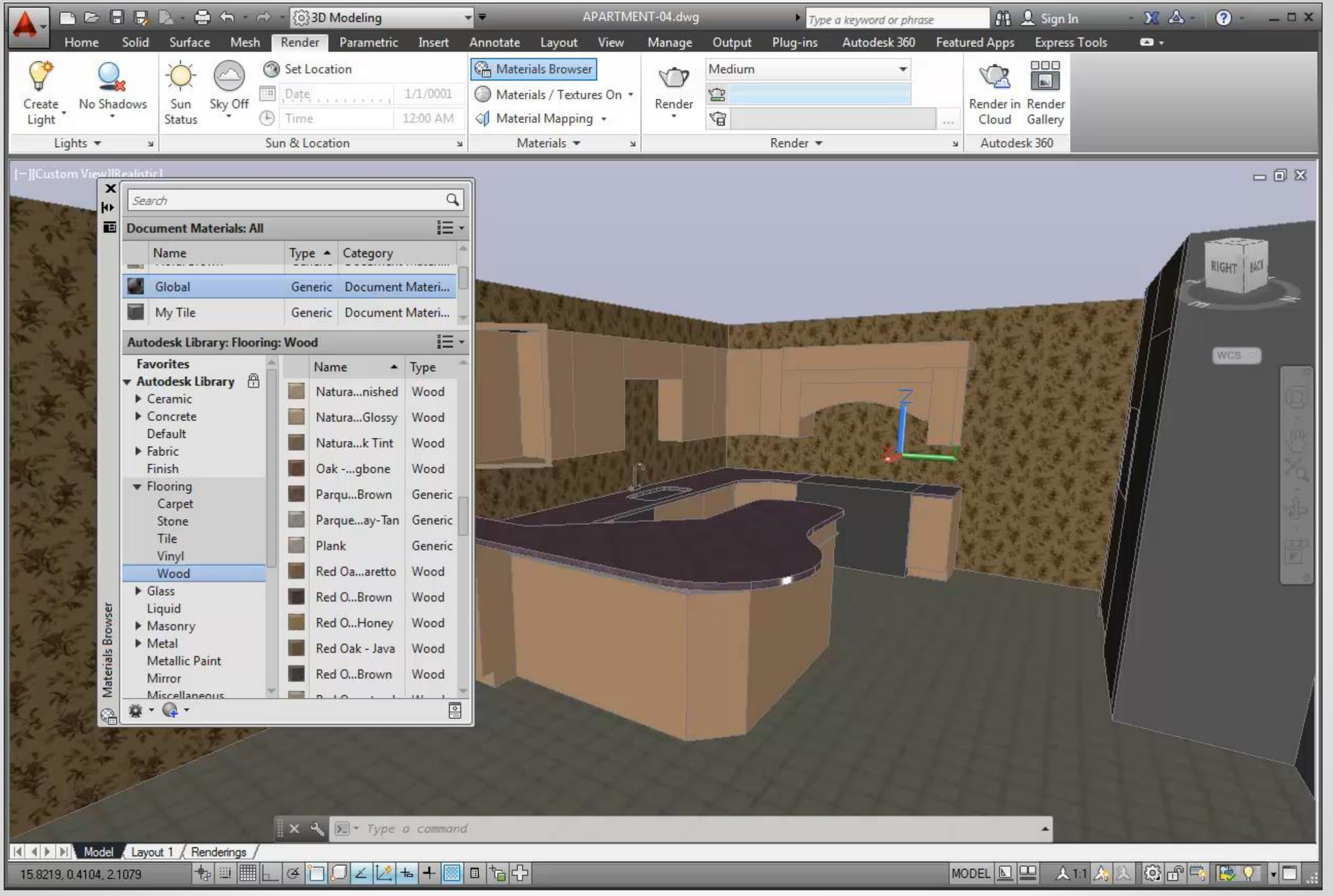

3D Modeling
APARTMENT-03.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Lights
Sun & Location
Materials Browser
Materials / Textures On
Material Mapping
Materials
Render
Medium
Render in Cloud
Render Gallery
Autodesk 360
[−][Custom View][Realistic]
RIGHT
WCS
Type a command
Model
Layout 1
Renderings
16.1268, 0.1677, 0.0000
MODEL
1:1

Saving Materials to a User Library

- New/modified materials only exist in the drawing
  - You cannot make any changes to the Autodesk Material Library
  - You can save new/modified materials to
    - Favorites library
    - Custom user libraries

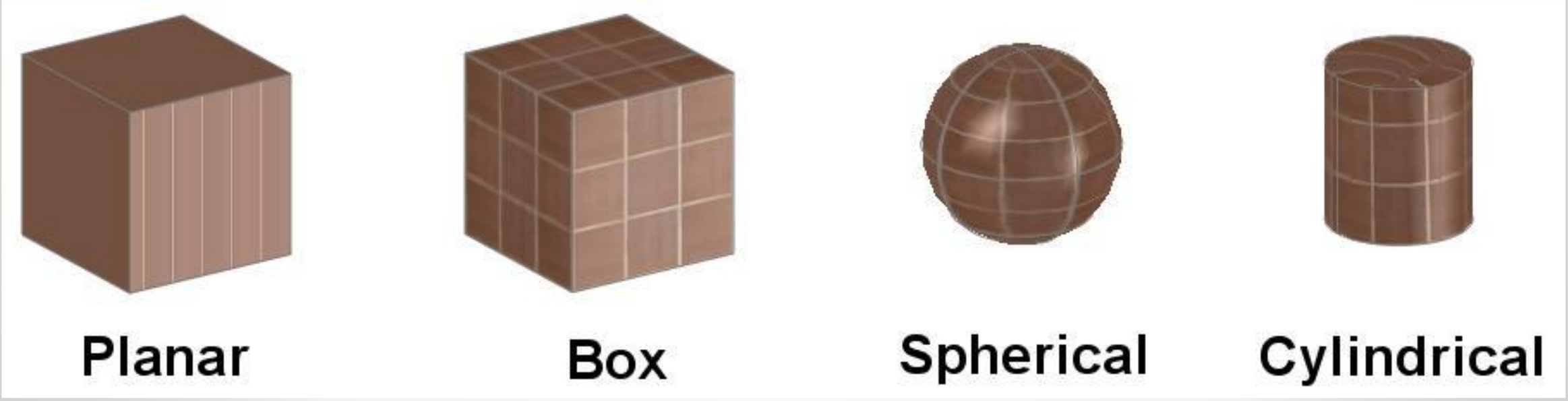





3D Modeling
APARTMENT-04.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Lights
Sun & Location
Materials Browser
Materials / Textures On
Material Mapping
Materials
Render
Medium
Render
Render in Cloud
Render Gallery
Autodesk 360
[−][Custom View][Realistic]
Search
Document Materials: All
Name
Type
Category
Global
Generic
Document Materi...
My Tile
Generic
Document Materi...
Autodesk Library: Flooring: Wood
Favorites
Autodesk Library
Ceramic
Concrete
Default
Fabric
Finish
Flooring
Carpet
Stone
Tile
Vinyl
Wood
Glass
Liquid
Masonry
Metal
Metallic Paint
Mirror
Miscellaneous
Name
Type
Natura...nished
Wood
Natura...Glossy
Wood
Natura...k Tint
Wood
Oak -...gbone
Wood
Parqu...Brown
Generic
Parque...ay-Tan
Generic
Plank
Generic
Red Oa...aretto
Wood
Red O...Brown
Wood
Red O...Honey
Wood
Red Oak - Java
Wood
Red O...Brown
Wood
Materials Browser
RIGHT
BACK
WCS
Type a command
Model
Layout 1
Renderings
15.8219, 0.4104, 2.1079
MODEL
1:1

Adjusting Material Mapping

After attaching a material, you can adjust the orientation of the texture map if it was not applied properly

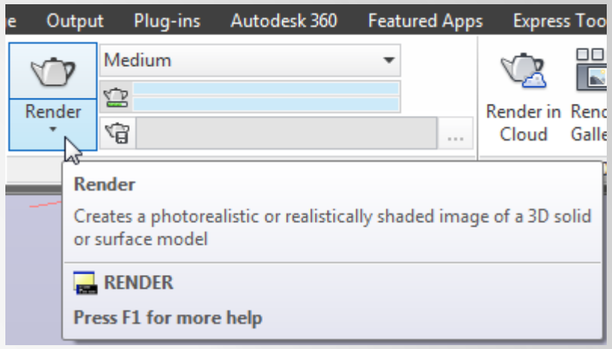


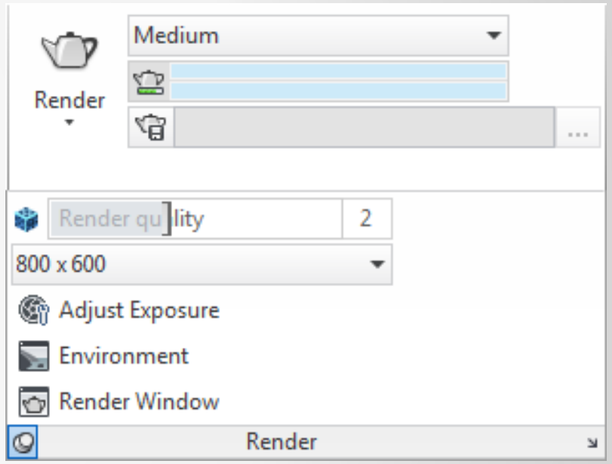

TRADER JOE'S
LIGHT
COCONUT
MILK
50% LESS FAT THAN
REGULAR COCONUT
MILK
SEE SIDE PANEL FOR
NUTRITION FACTS
NET 14 FL OZ (400ml)

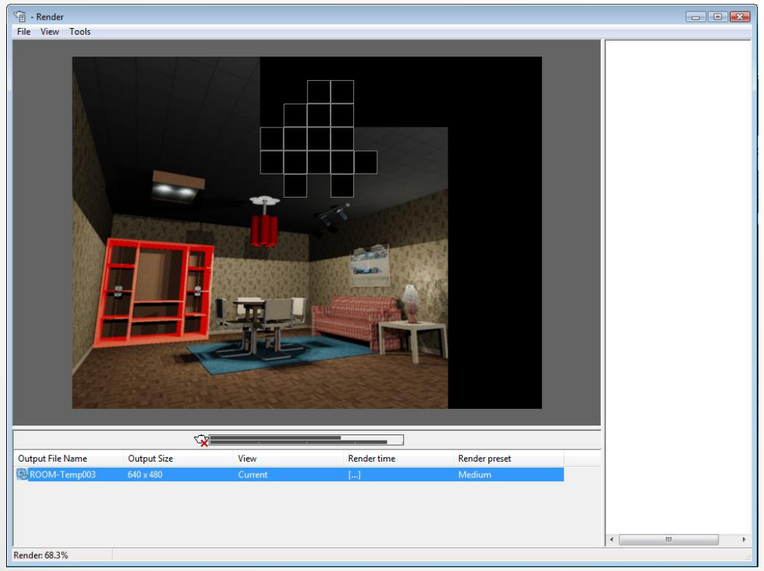
Creating a Rendering

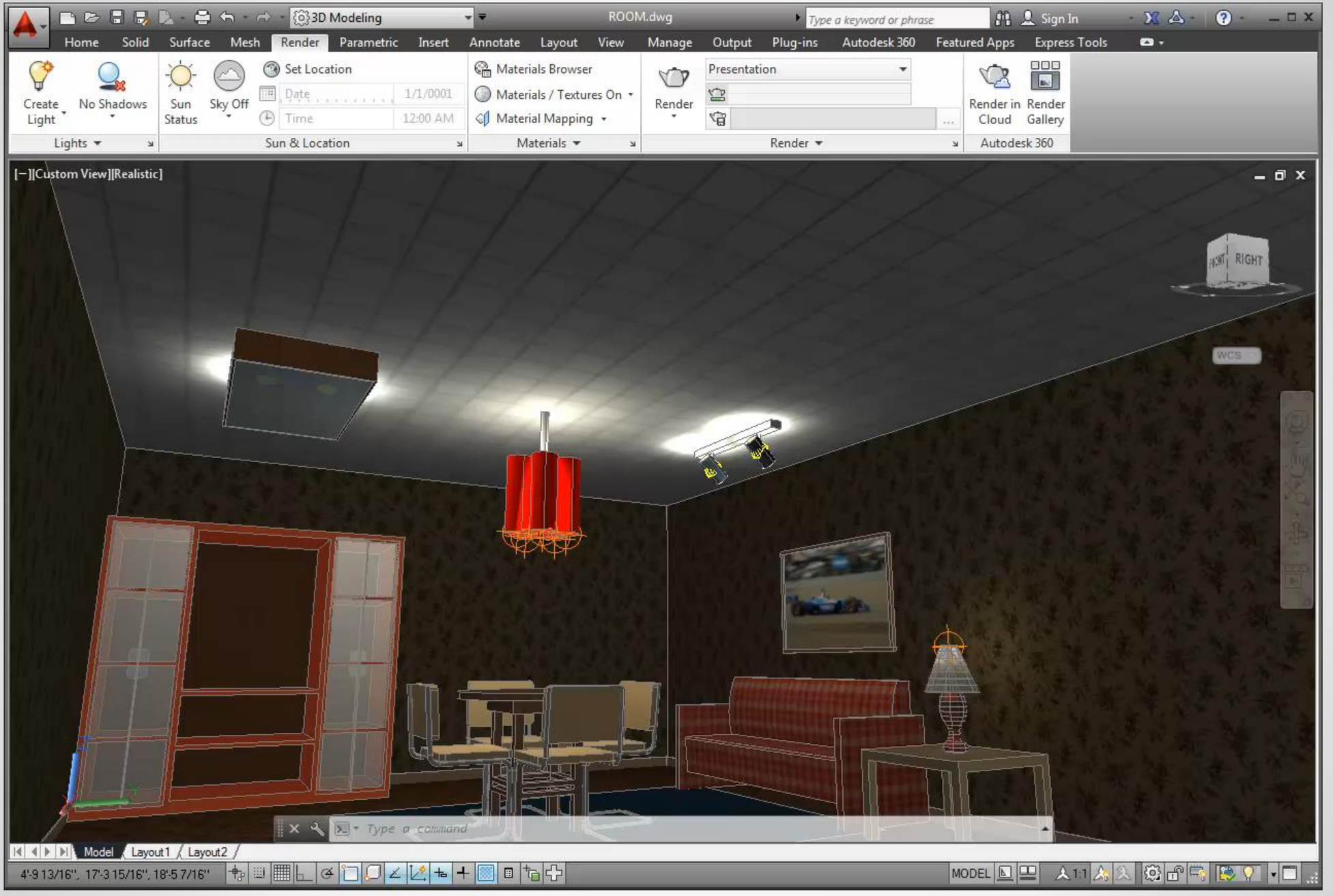
Creating a Rendering

- Use tools on the **Render** panel
  - 5 predefined render presets
  - Expand the panel to see additional tools
  - Renderings appear in Render Window (default)



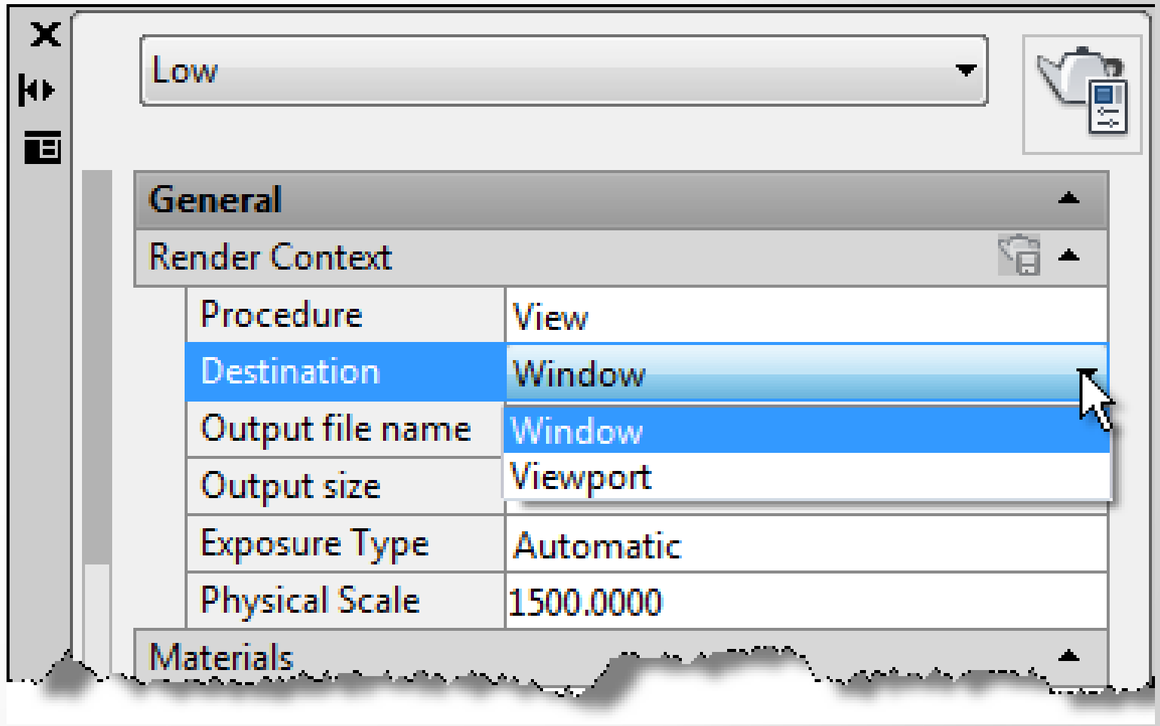




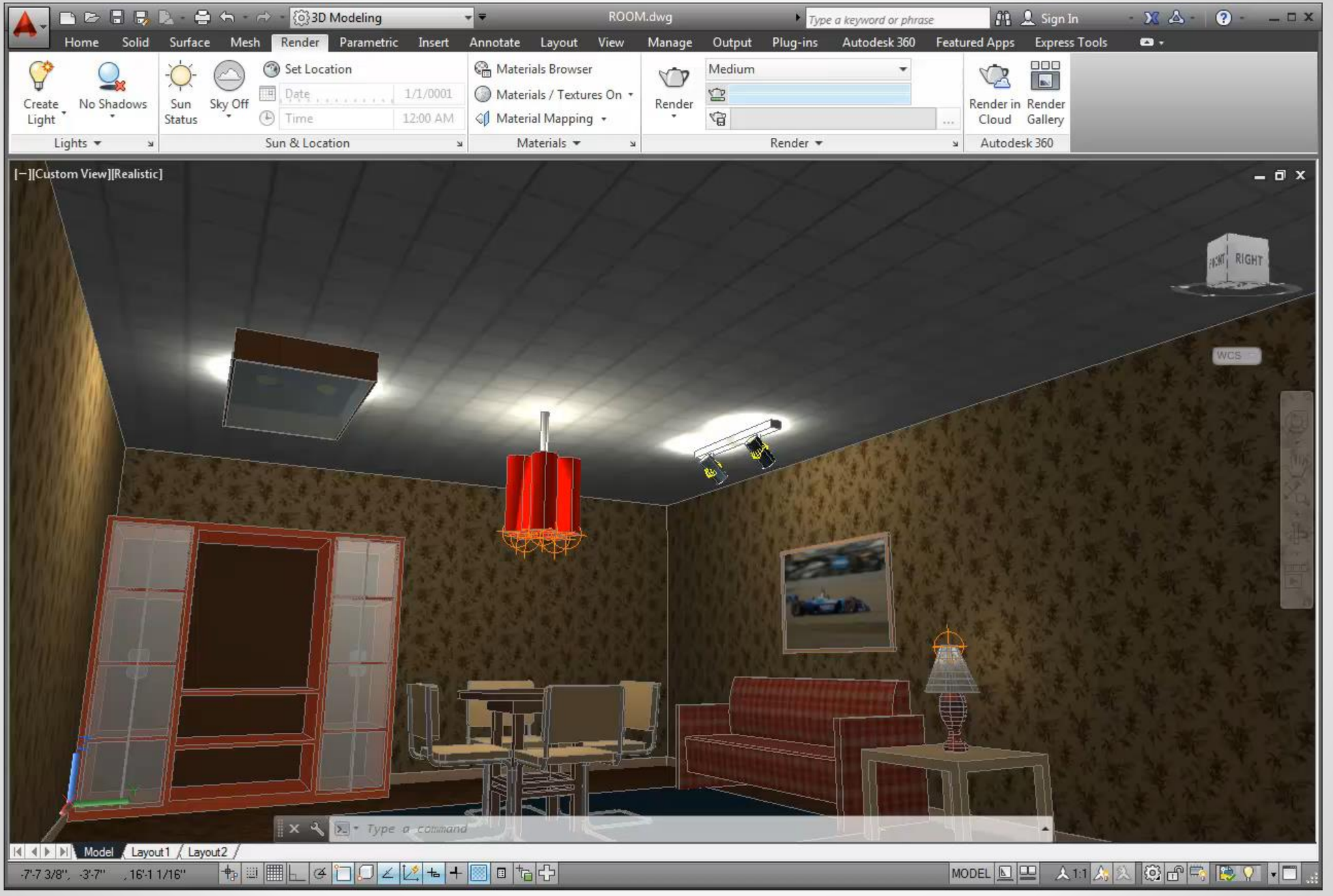

3D Modeling
ROOM.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Materials Browser
Materials / Textures On
Material Mapping
Render
Presentation
Render in Cloud
Render Gallery
Lights
Sun & Location
Materials
Render
Autodesk 360
[−][Custom View][Realistic]
RIGHT
WCS
Type a command
Model
Layout1
Layout2
4'-9 13/16", 17'-3 15/16", 18'-5 7/16"
MODEL
1:1

Setting the Render Destination

- Use **Advanced Render Settings** palette to choose **Destination**:
  - **Window** = Render Window
    - Save images from Window
  - **Viewport** = Current viewport
    - Use SAVEIMG command

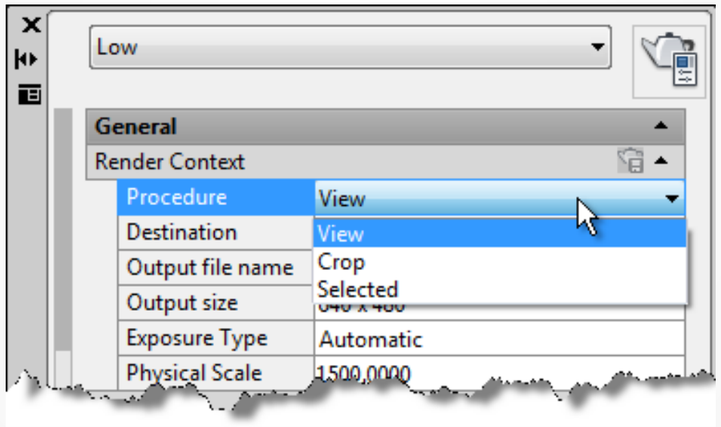


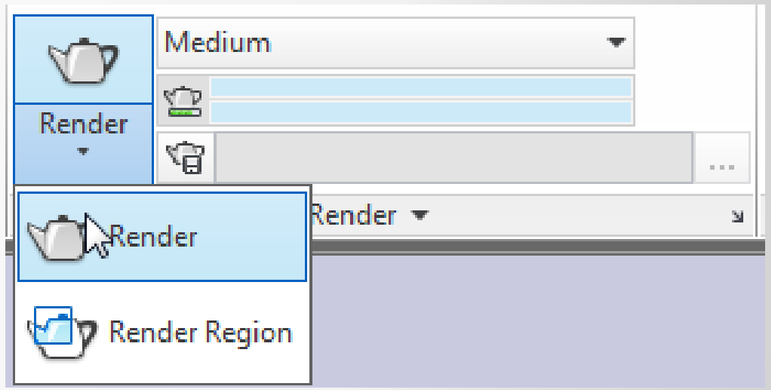
  - Setting remains in effect until changed


3D Modeling
ROOM.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Lights
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Sun & Location
Materials Browser
Materials / Textures On
Material Mapping
Materials
Render
Medium
Render
Render in Cloud
Render Gallery
Autodesk 360
[−][Custom View][Realistic]
RIGHT
WCS
Type a command
Model
Layout1
Layout2
-7'-7 3/8", -3'-7", 16'-1 1/16"
MODEL
1:1

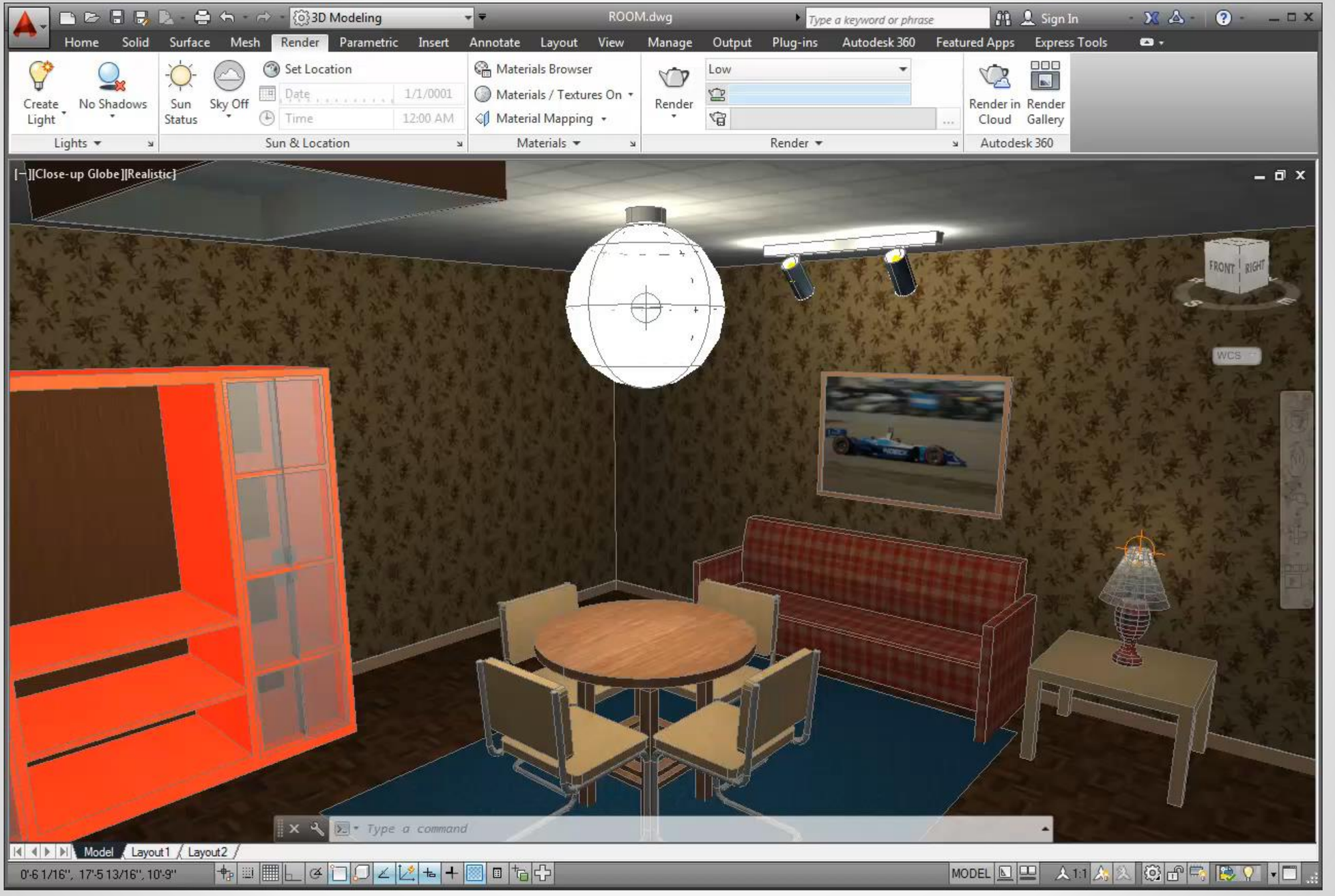
Rendering Portions of What You See

- Render selected objects or a region
  - Use Render button to render all or region
  - Use Advanced Render Settings palette:
    - View
    - Cropped
    - Selected



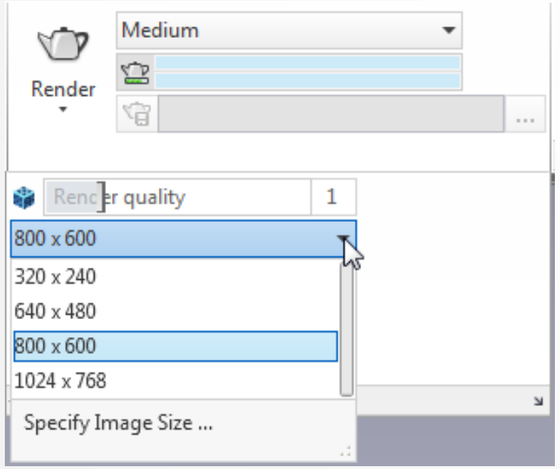


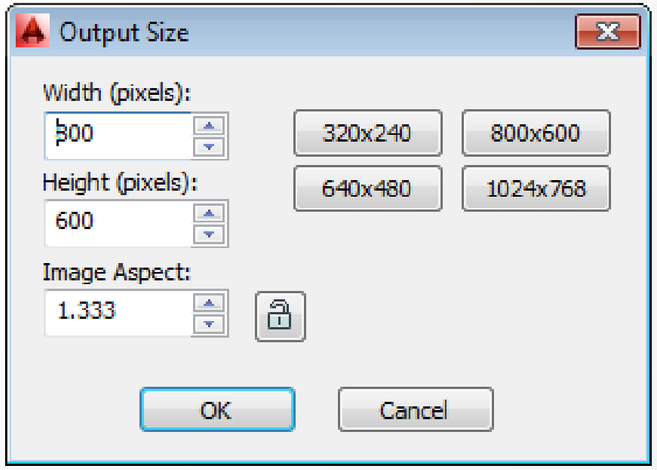
  - Changes in Advanced Render Settings remain in effect until changed


3D Modeling
ROOM.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Materials Browser
Materials / Textures On
Material Mapping
Render
Low
Render in Cloud
Render Gallery
Lights
Sun & Location
Materials
Render
Autodesk 360
[−][Close-up Globe][Realistic]
FRONT
RIGHT
WCS
Type a command
Model
Layout1
Layout2
0'-6 1/16", 17'-5 13/16", 10'-9"
MODEL
1:1

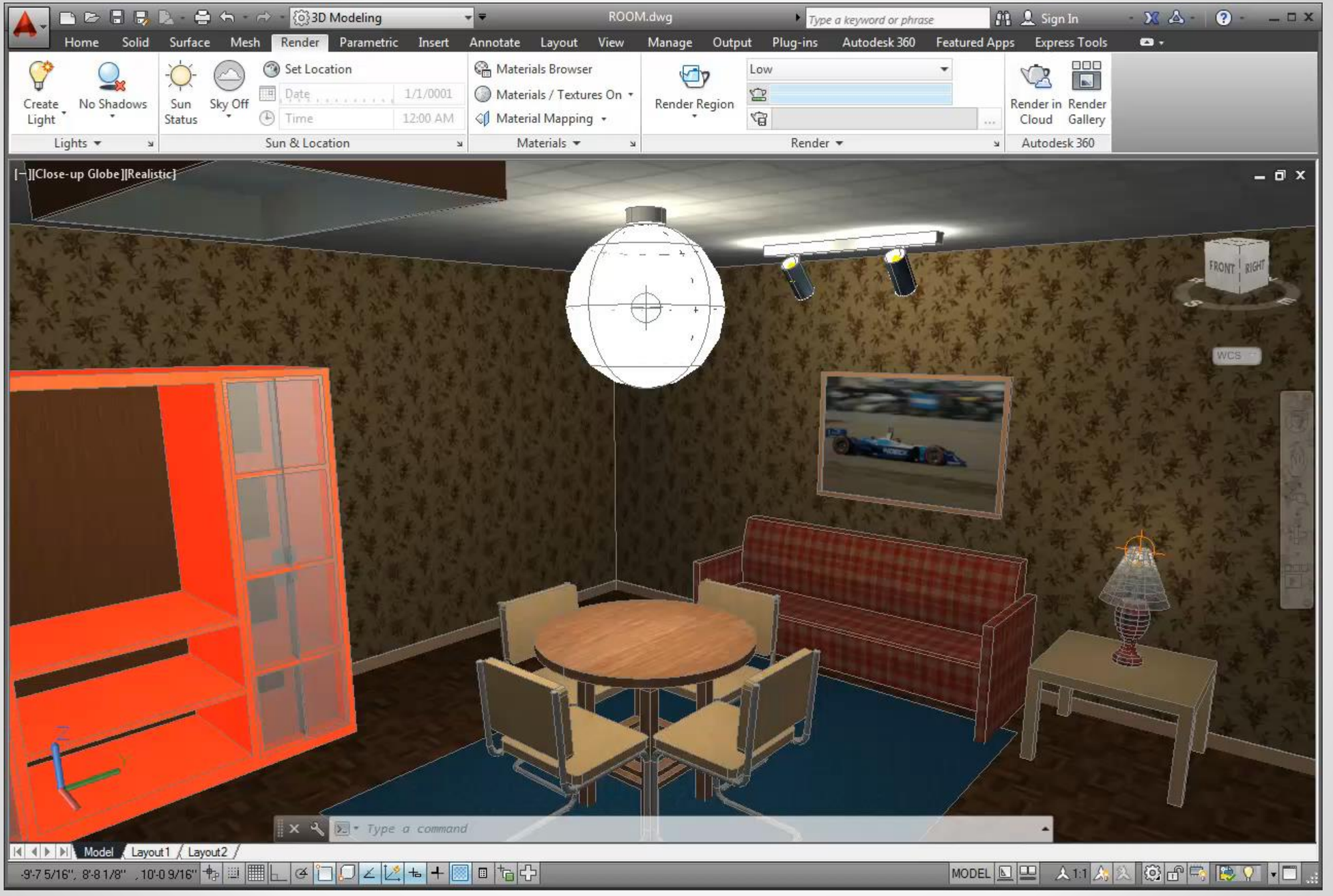
Setting the Render Output Resolution

- 4 predefined sizes in **Render Output Size** drop-down
- Click **Specify Image Size**
  - **Output Size** dialog to set custom sizes



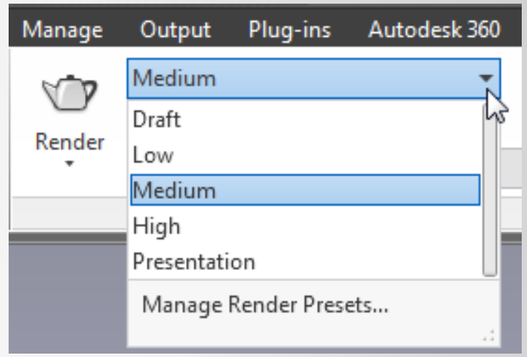


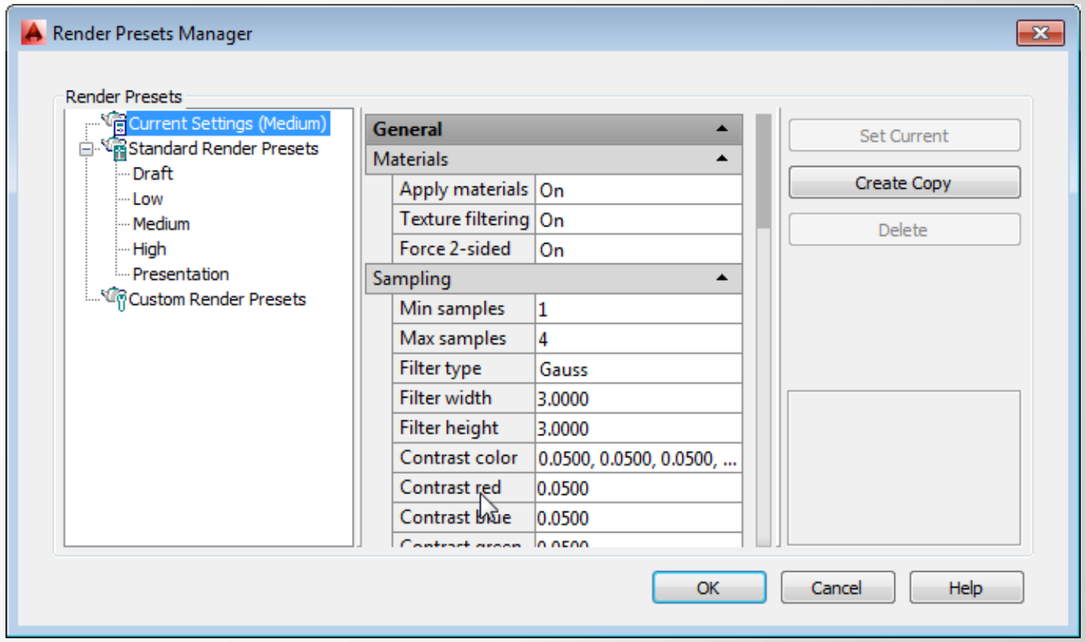
  - Higher resolution = longer rendering
    - Need faster CPU with more cores (or use Autodesk 360 Rendering)

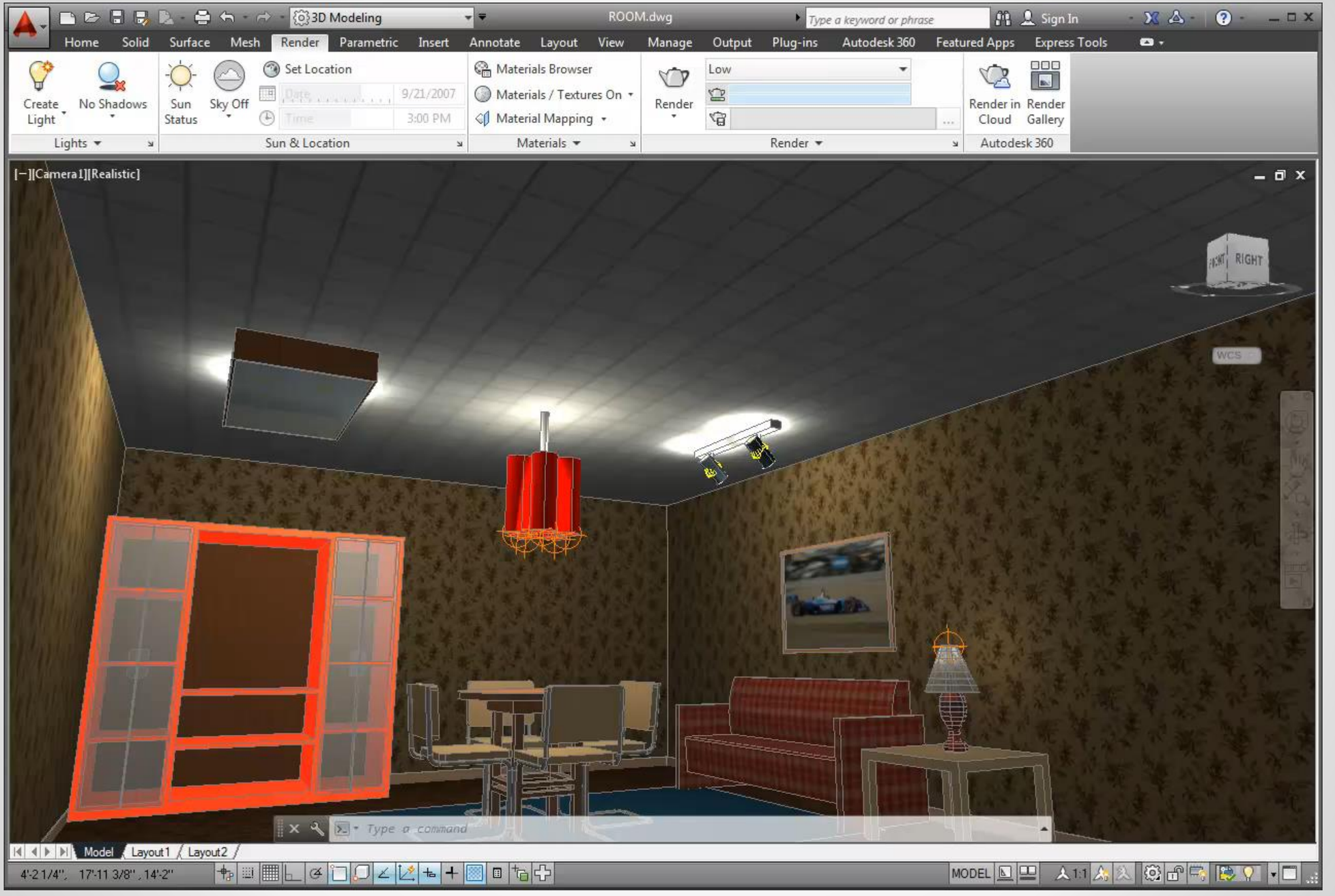

3D Modeling
ROOM.dwg
Type a keyword or phrase
Sign In
Home
Solid
Surface
Mesh
Render
Parametric
Insert
Annotate
Layout
View
Manage
Output
Plug-ins
Autodesk 360
Featured Apps
Express Tools
Create Light
No Shadows
Sun Status
Sky Off
Set Location
Date
1/1/0001
Time
12:00 AM
Lights
Sun & Location
Materials Browser
Materials / Textures On
Material Mapping
Materials
Render Region
Low
Render
Render in Cloud
Render Gallery
Autodesk 360
[−][Close-up Globe][Realistic]
FRONT
RIGHT
WCS
Type a command
Model
Layout1
Layout2
MODEL
1:1

Understanding Rendering Settings

- 5 render presets
  - Changes made in **Advanced Render Settings** dialog are not saved to presets
  - Use **Render Presets Manager** to create custom presets



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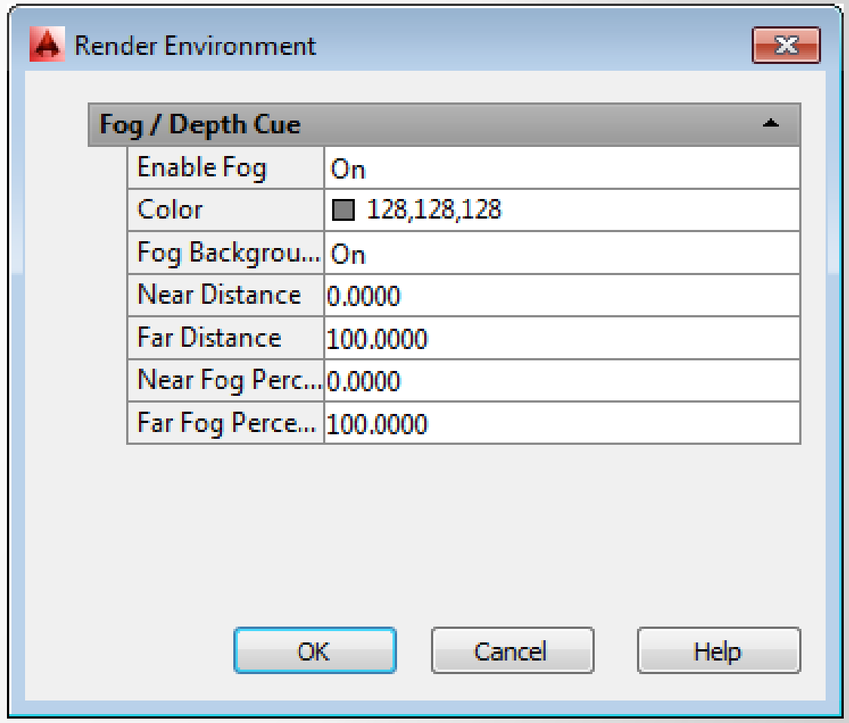
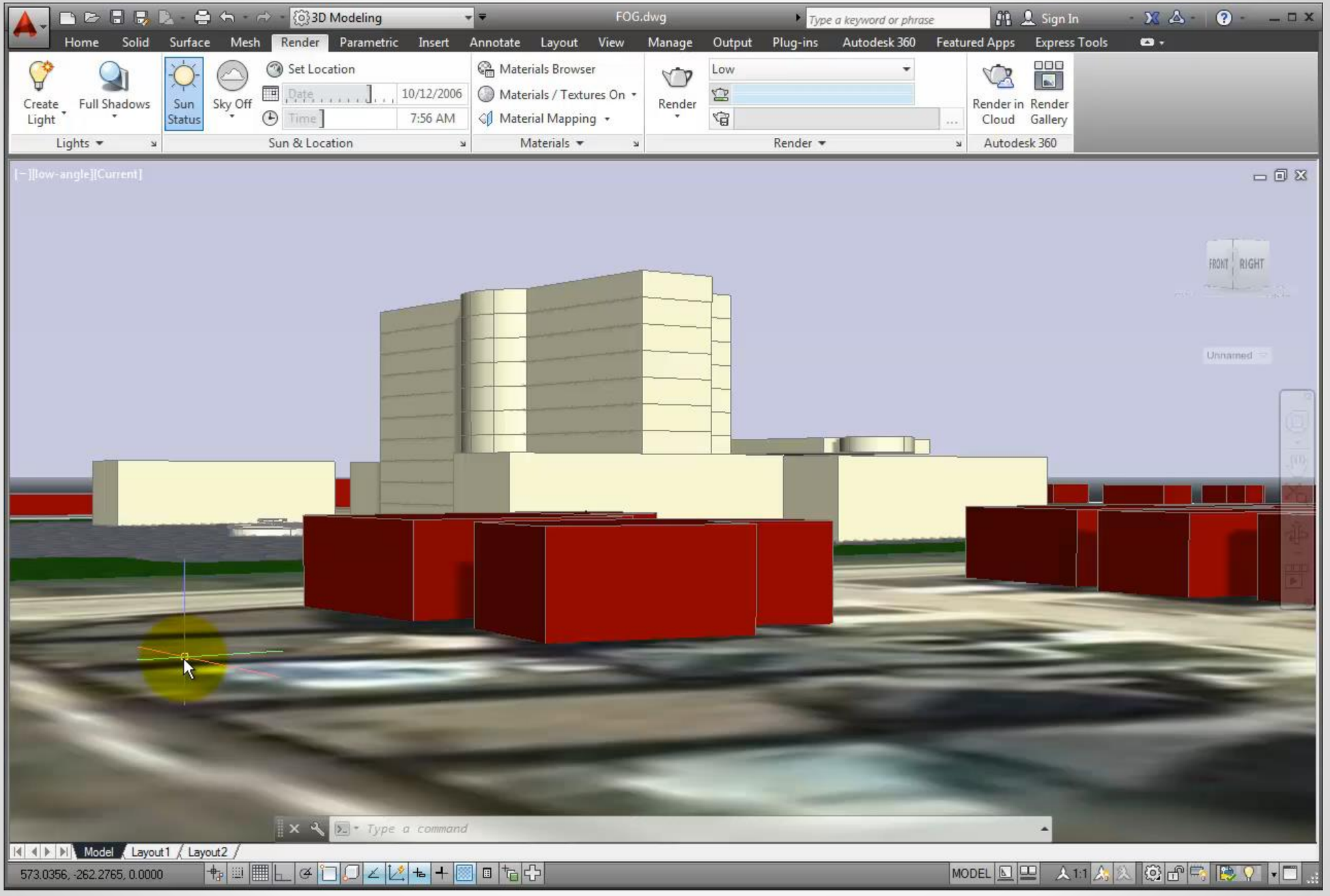
RIGHT
WCS
Type a command
Model
Layout1
Layout2
4'-2 1/4", 17'-11 3/8", 14'-2"
MODEL
1:1

Controlling the Rendering Environment

- Add fog and depth cueing
  - Makes objects appear to fade into the distance
    - **Enable Fog** – toggle on/off
    - **Color** – Set color of fog effect
    - **Fog Background** – Toggle fog effect on background
    - **Near Distance** – % distance from camera
    - **Far Distance** – % distance from camera
    - **Near Fog Percentage** – % of opacity at near distance
    - **Far Fog Percentage** - % of opacity at far distance

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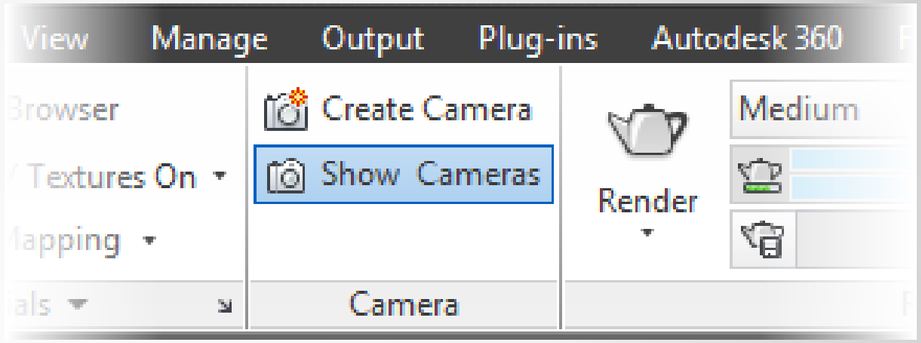
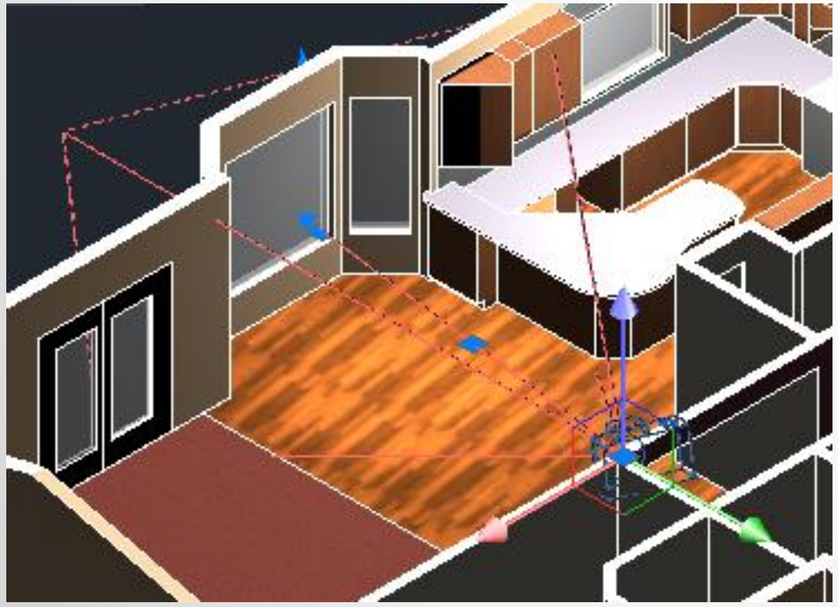
MODEL
1:1

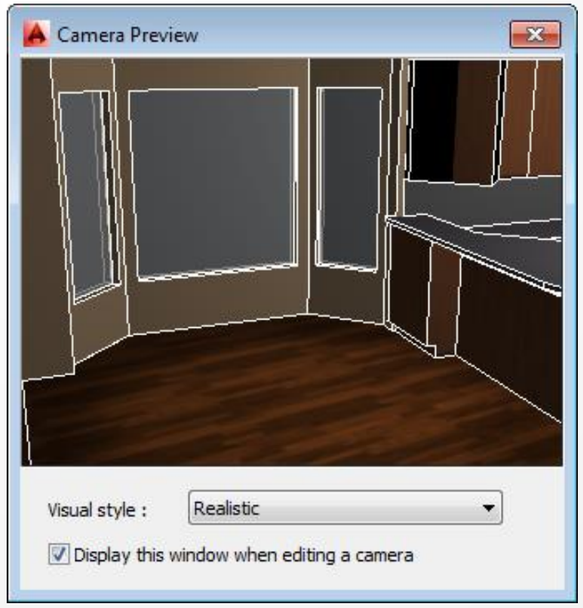
Working with Views

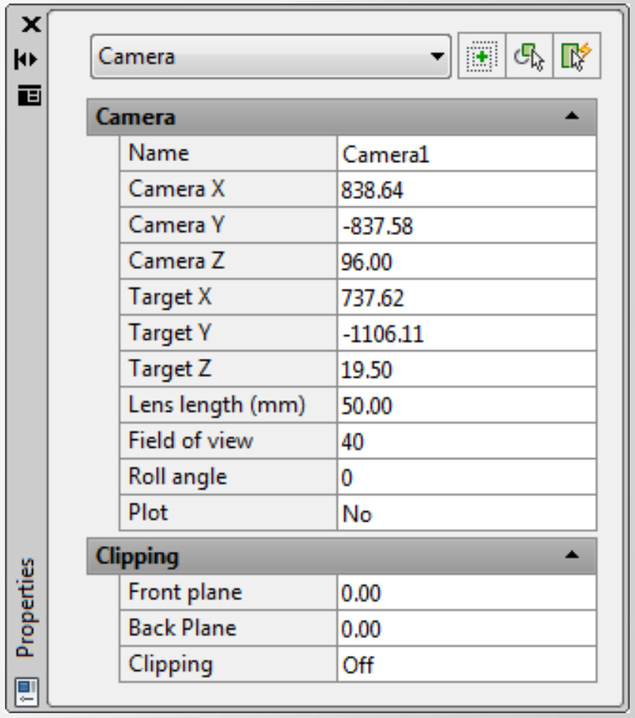
Placing Cameras and Creating Views

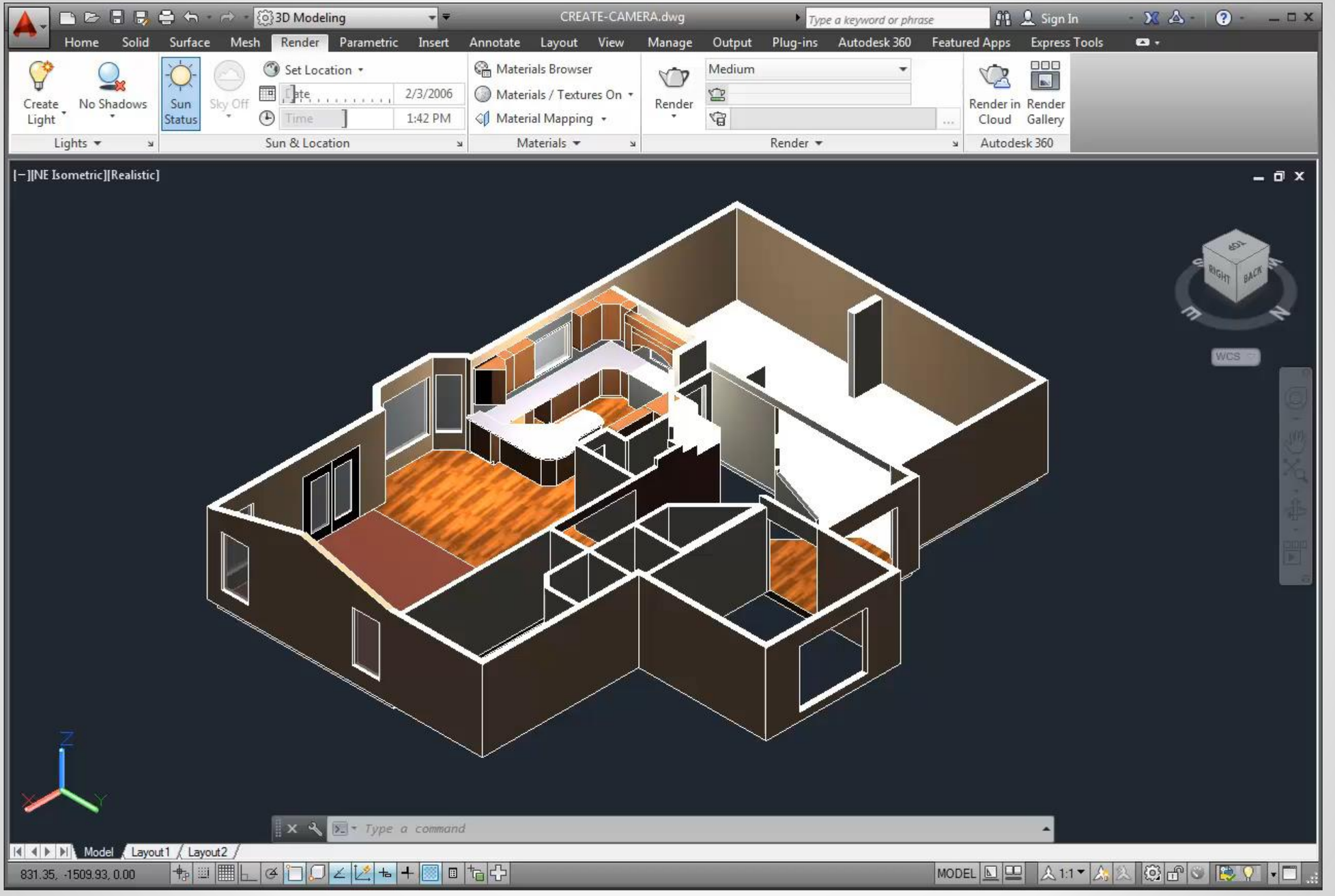
- **Camera** tool: places a camera, which creates a named view
  - See what the camera sees
  - Adjust the camera properties







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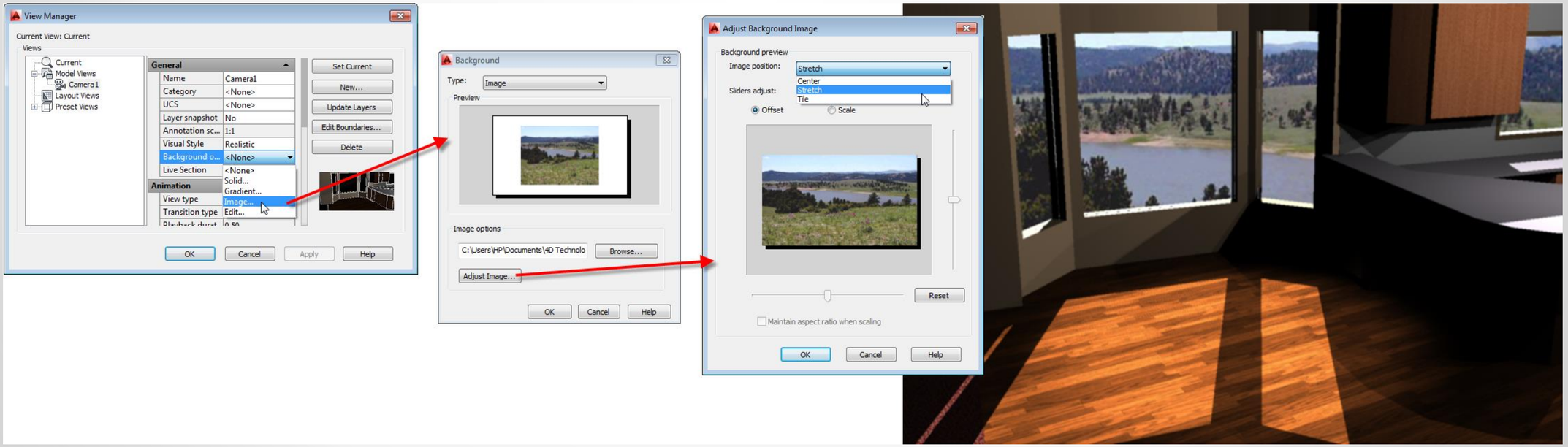
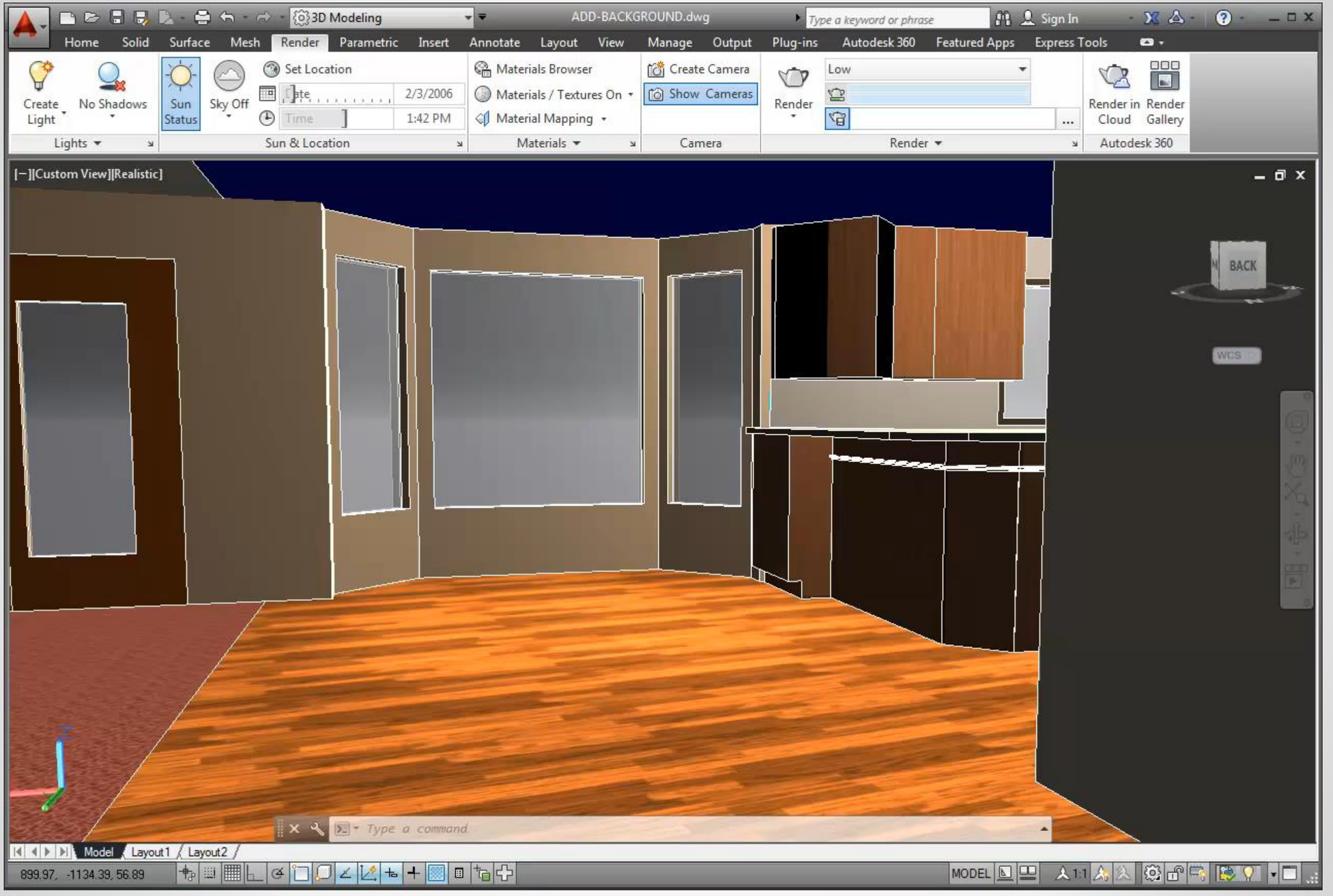
831.35, -1509.93, 0.00
MODEL
1:1

Adding a Background to a View

- Add a background image to a named view
  - Included whenever you render the view
  - Works best for still images
  - Use **View Manager**

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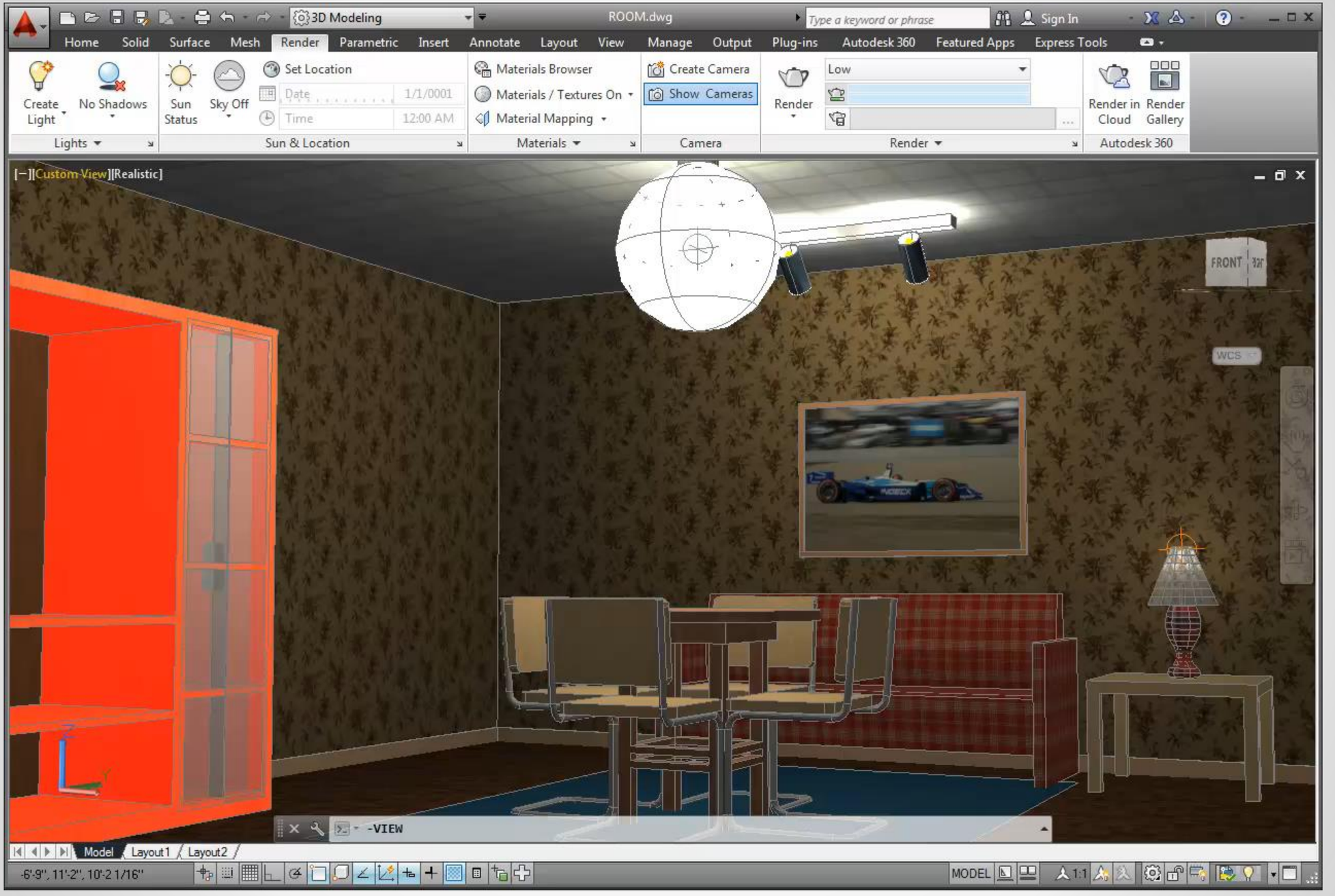
Layout2
899.97, -1134.39, 56.89
MODEL
1:1

Saving and Redisplaying Rendered Images

- Save image from Render Window
- Use SAVEIMG command from viewport
- Render directly to a file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Layout1
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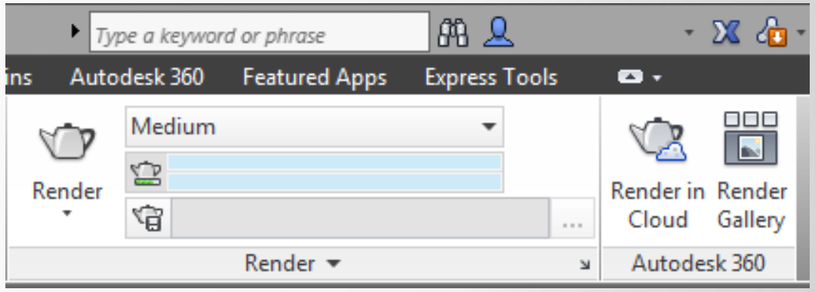
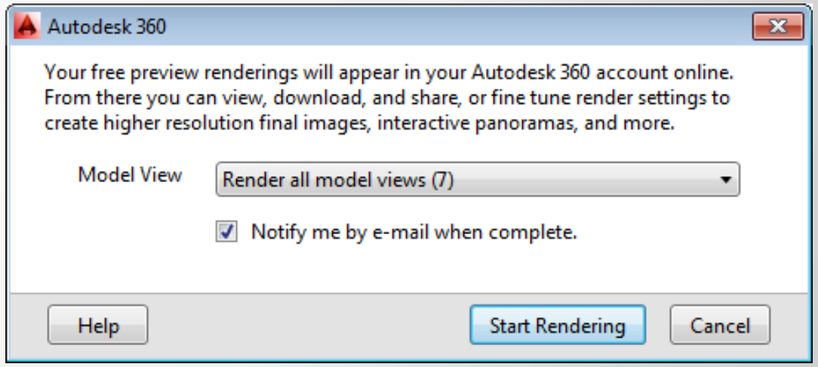
-6'-9", 11'-2", 10'-2 1/16"
MODEL
1:1

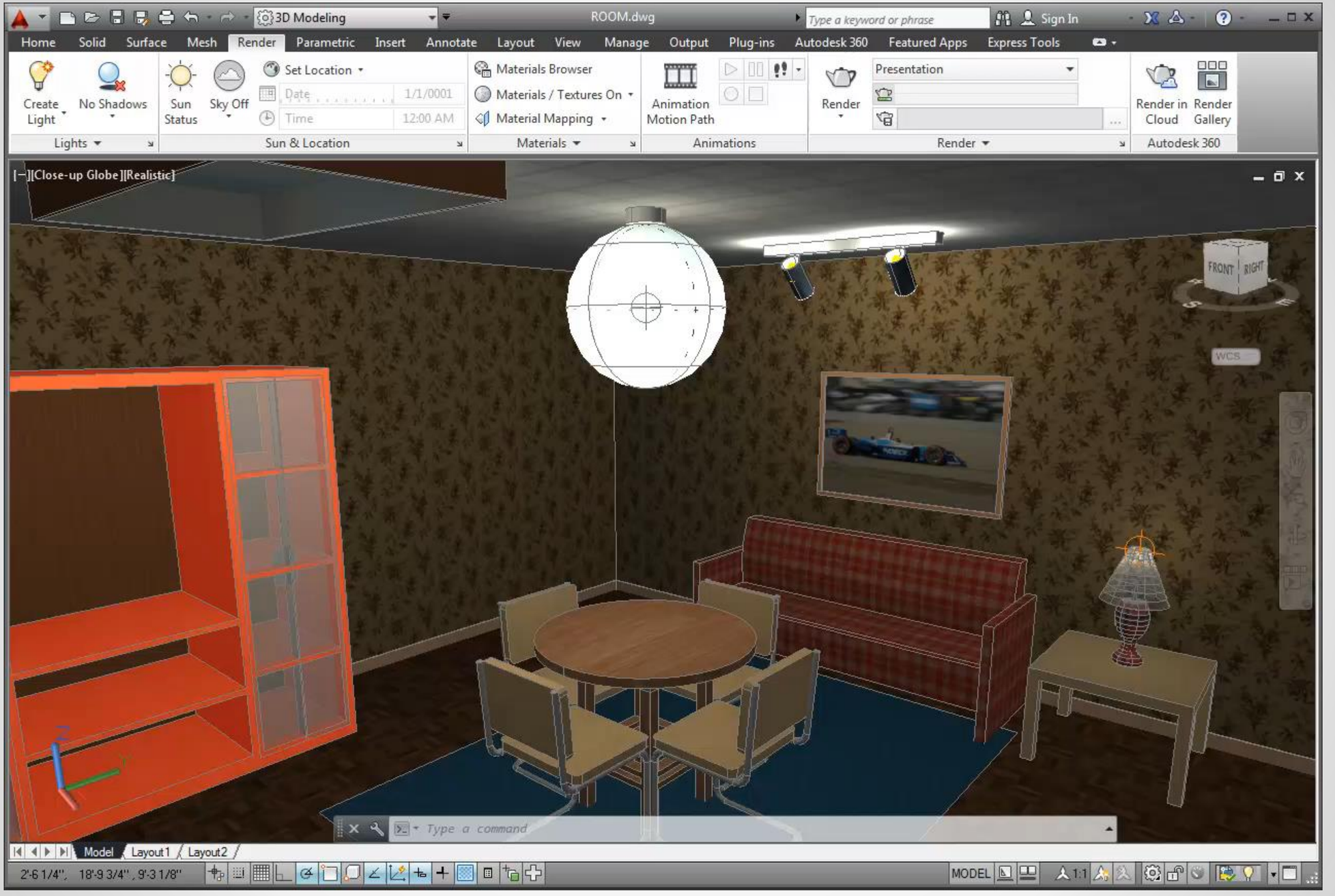
Rendering in the Cloud

Rendering in the Cloud

- When you Render on your computer
  - AutoCAD is busy until the rendering is complete
  - Complex renderings require fast CPU with lots of cores
- Render online instead
  - Using your free Autodesk 360 account
  - Cloud credits
  - Notified by email when complete






3D Modeling
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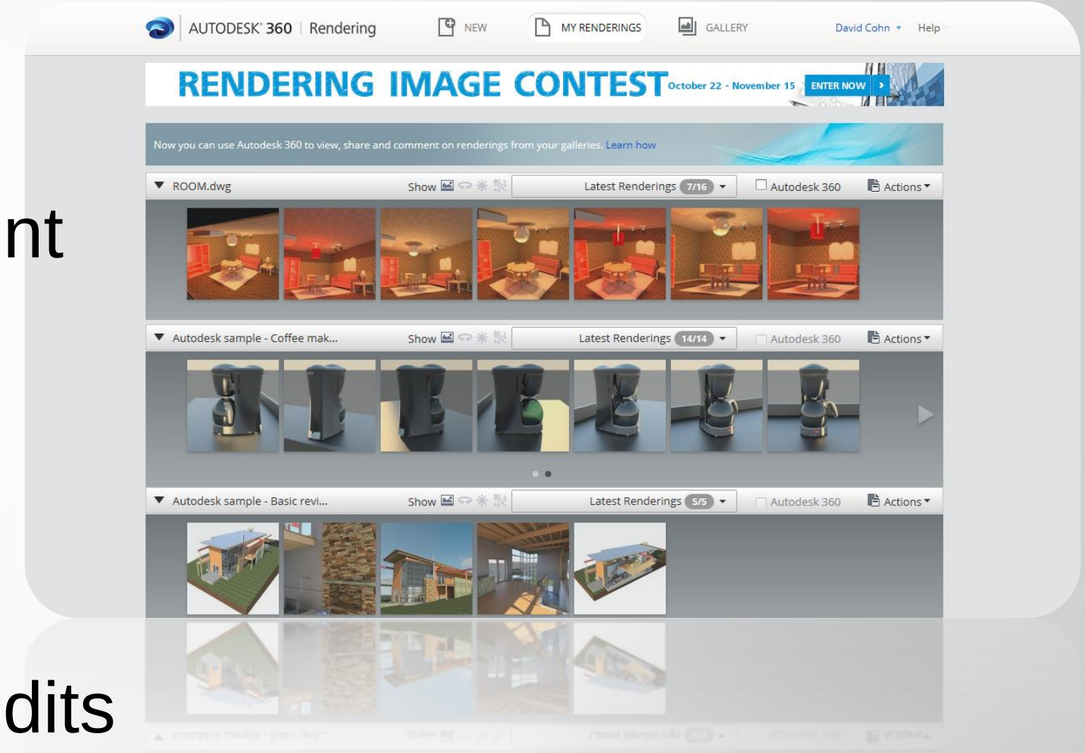
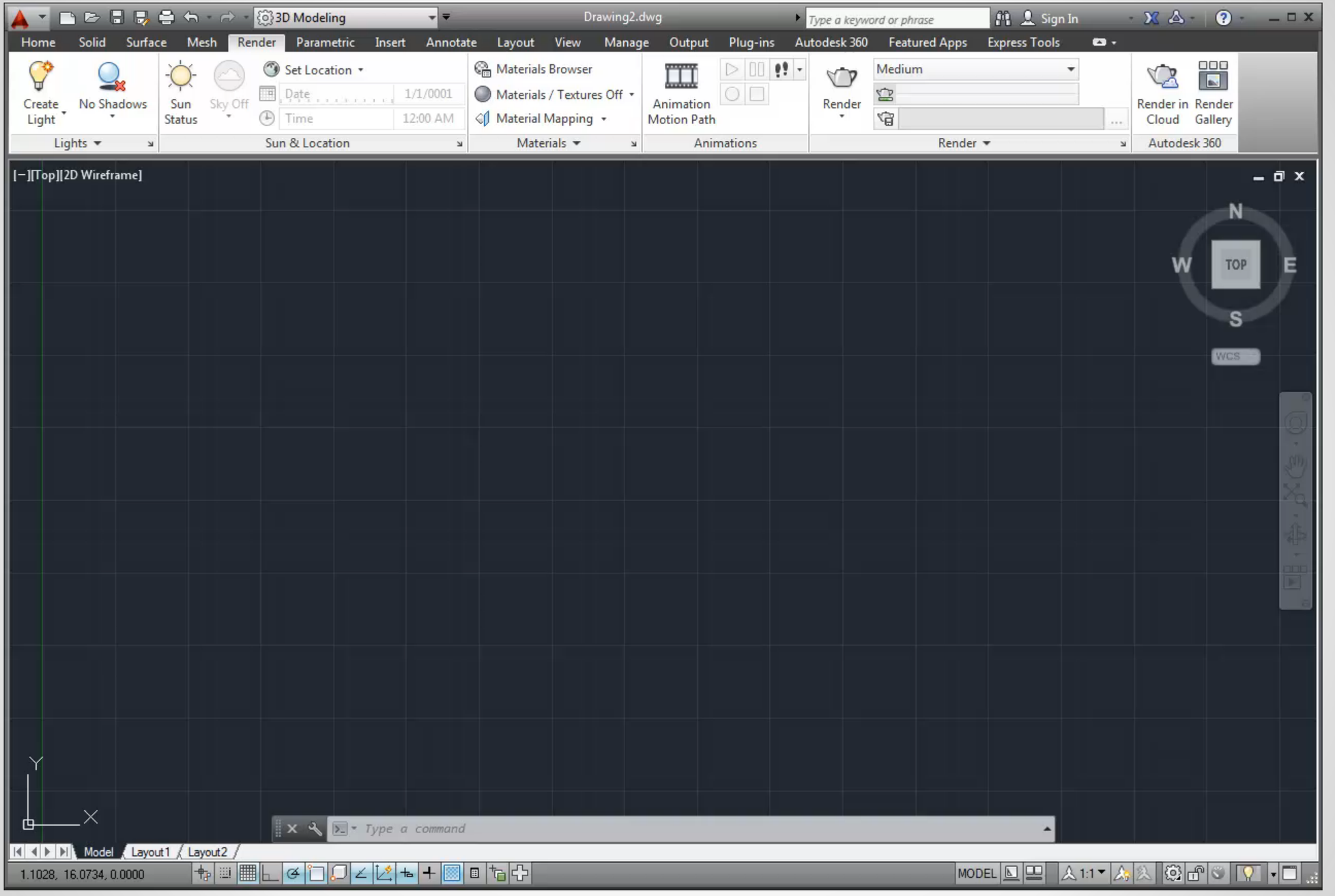
Layout2
2'-6 1/4", 18'-9 3/4", 9'-3 1/8"
MODEL
1:1

Understanding the Render Gallery

- The interface for accessing online renderings
  - Click the Render Gallery tool
  - Opens a browser window
  - Sign into your Autodesk 360 account
    - See your renderings
    - Re-render images
    - Download/delete/adjust images
    - Upload a DWG eTransmit ZIP
  - 3GB of online storage/75 cloud credits

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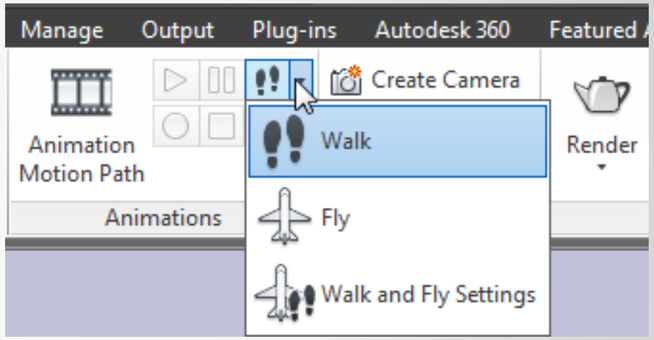
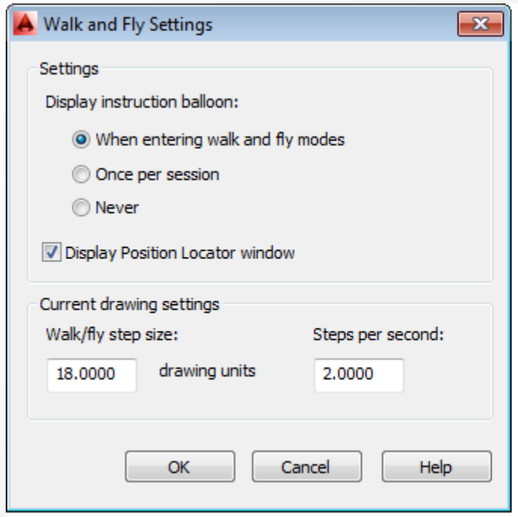
MODEL
1:1

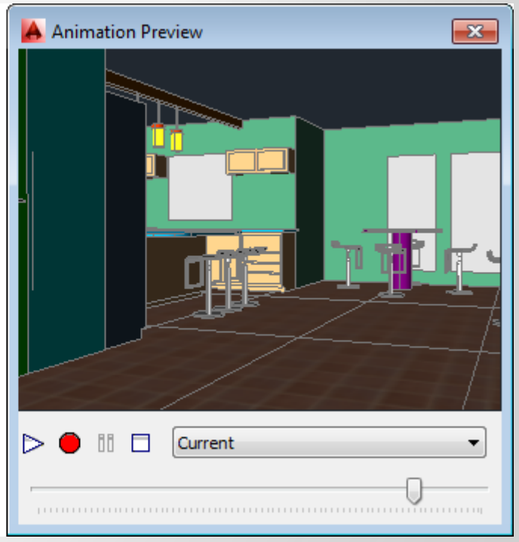
Walkthroughs and Flythroughs

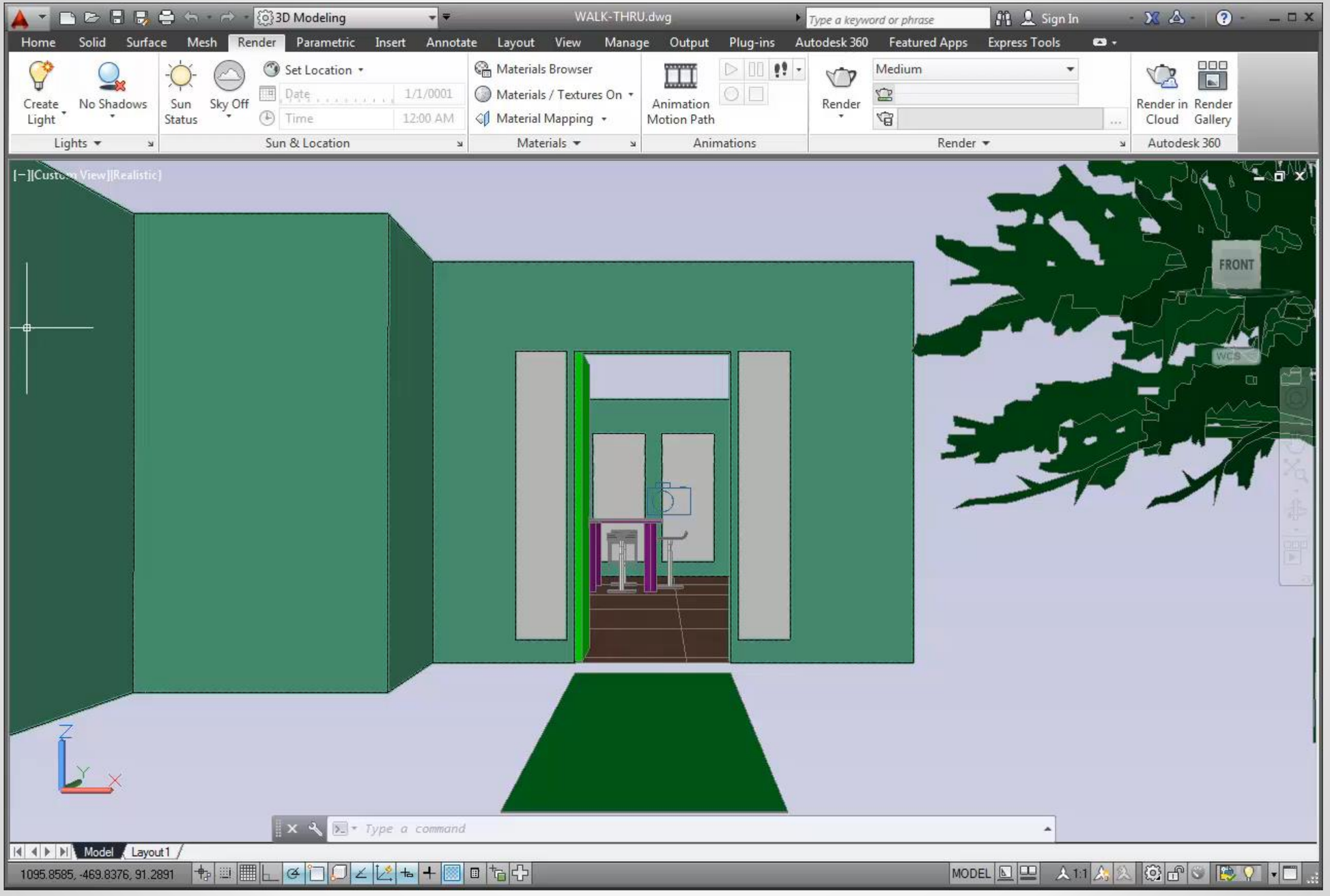
Creating Walkthroughs and Flythroughs

- Create animated walkthroughs and flythroughs
  - Tools in the **Animations** panel
    - **Walk** – stays on XY-plane
    - **Fly** – not constrained to XY-plane
  - Use keyboard and mouse to move
  - Adjust settings
  - Save as an animation





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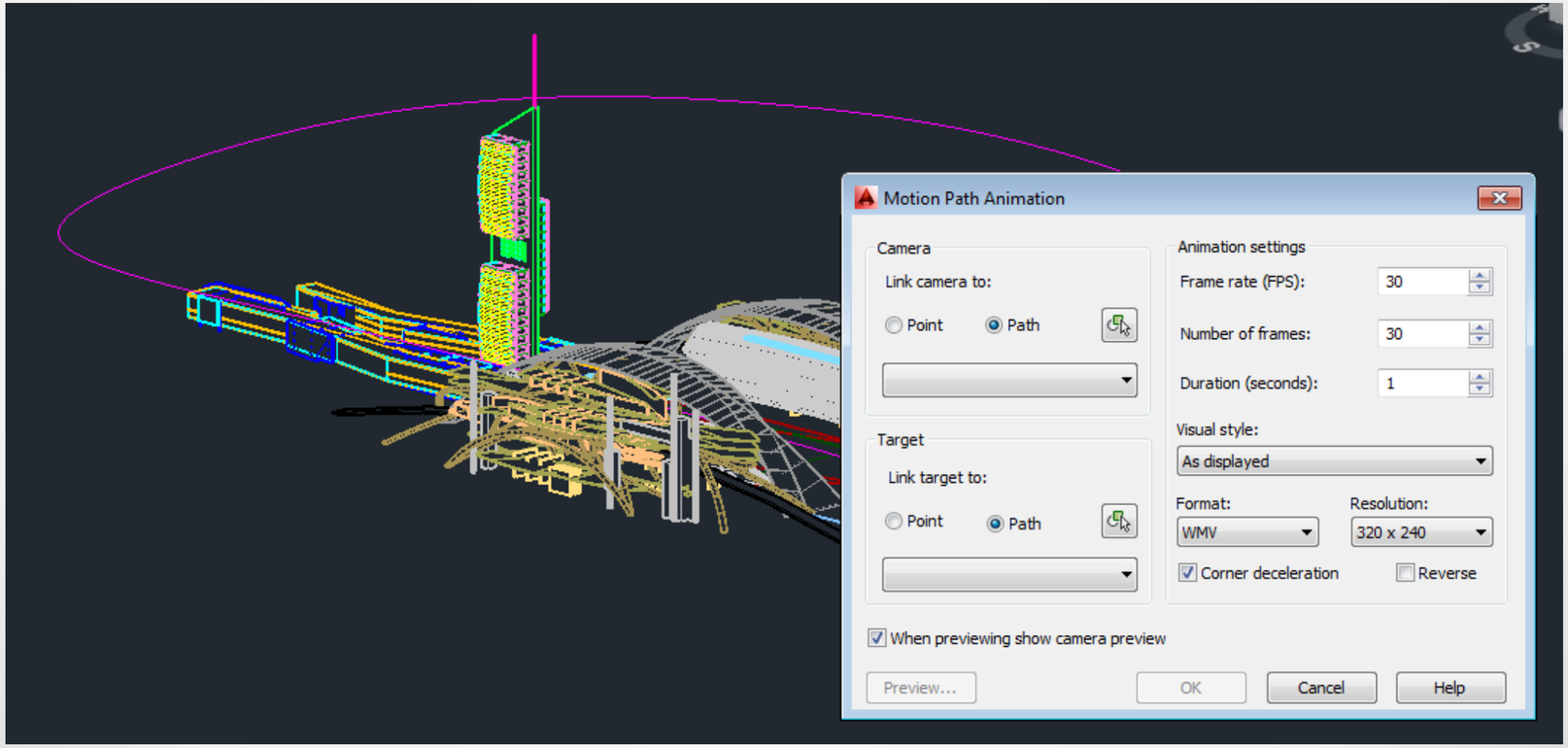
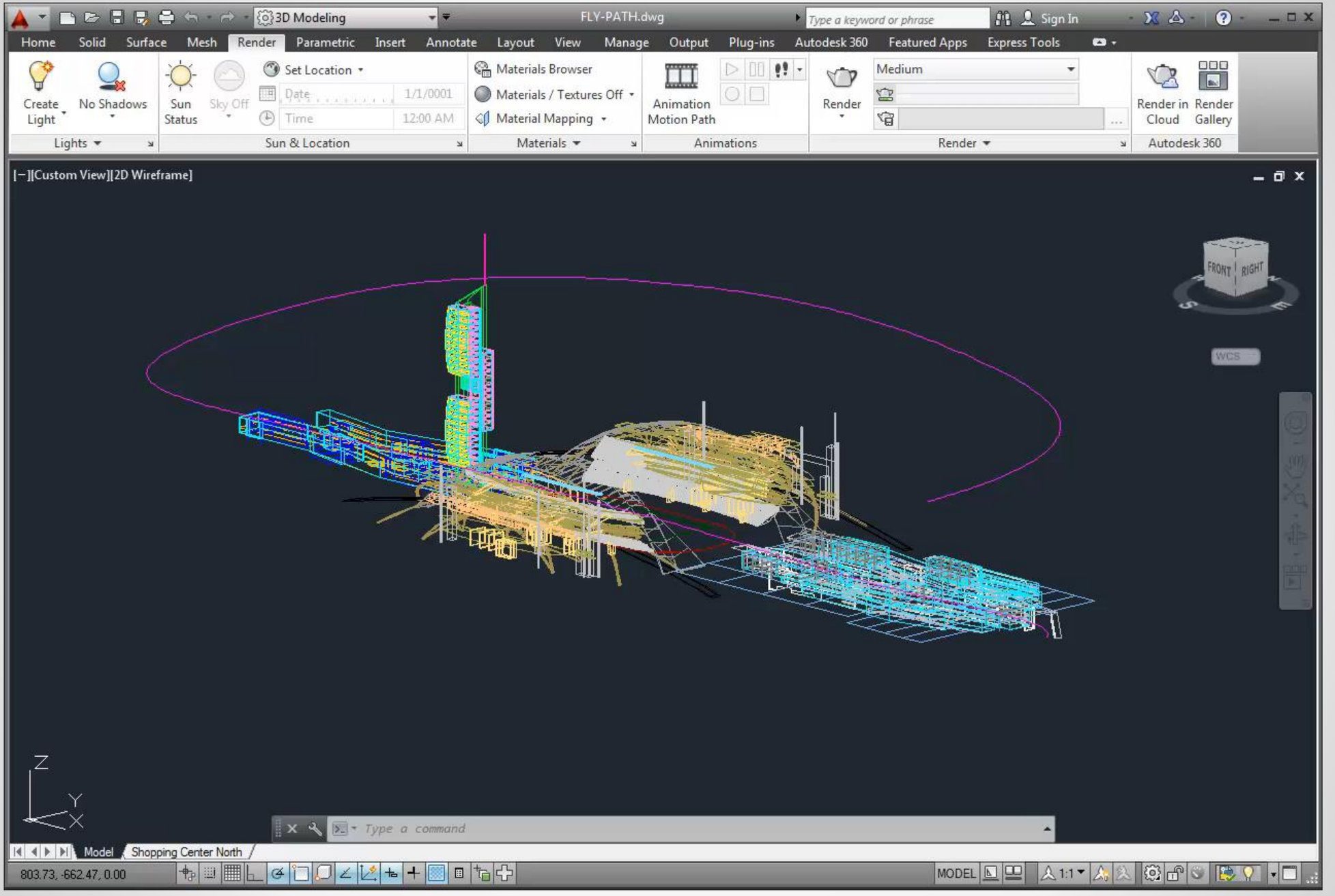
1:1

Animating Along a Path

- Use the **Animation Motion Path** tool to move the camera/target along a predefined path

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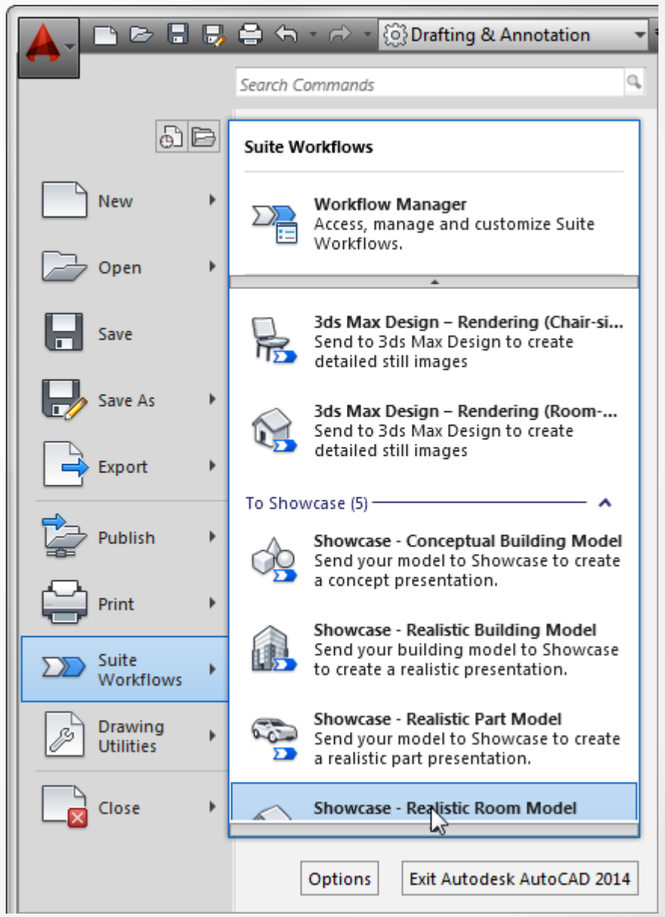
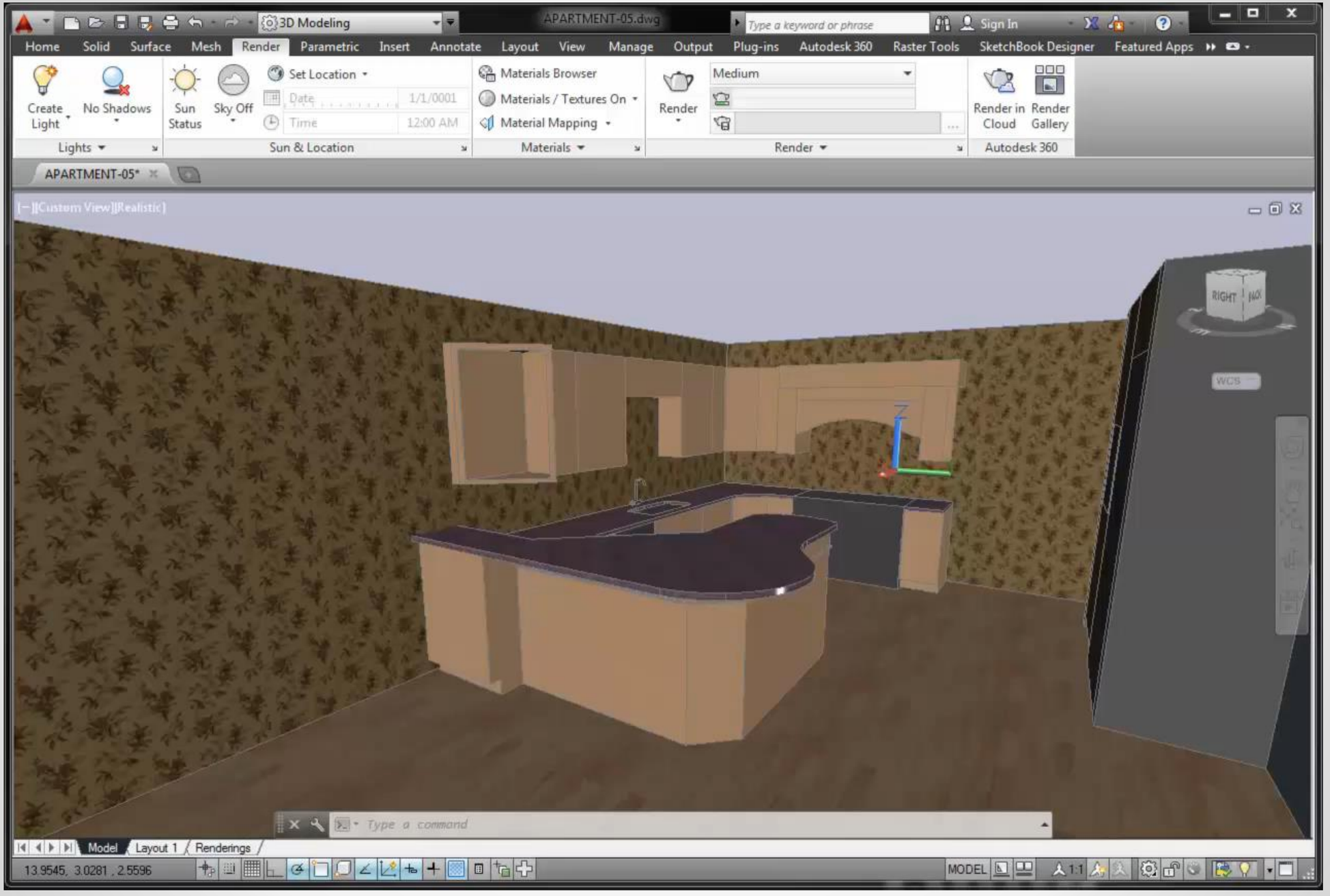
Using Other Tools

Autodesk Design Suite Workflows

- Render and animate using other software in the AutoCAD Design Suite
  - 3ds Max Design
  - Autodesk Showcase
- Suite Workflows

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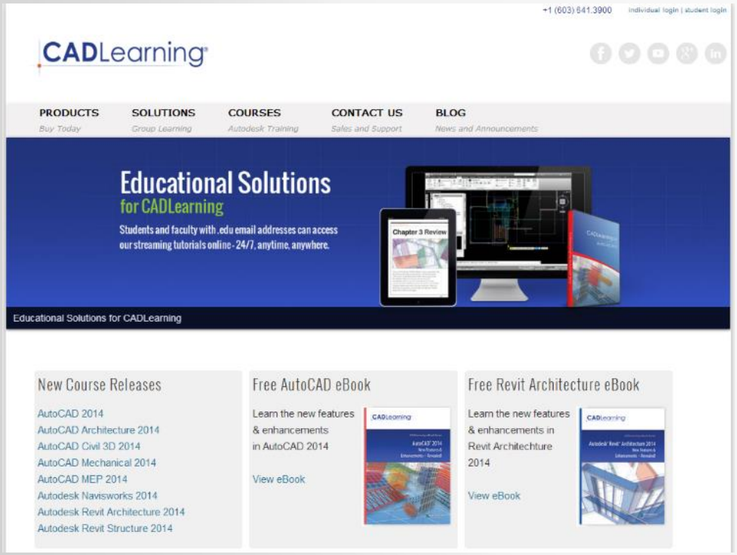
MODEL
1:1

Conclusion

- Other resources
  - CADLearning eBooks
  - CADLearning courses at Udemy.com
  - Full CADLearning courses

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TV Remote
OverDrive
Newsstand
USA TODAY
USA TODAY
BhamHerald
iBooks
IMDb
IMDb
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Safari
Mail
Photos
Reminders
Music

Questions & Answers

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Personal thoughts and opinions on just about anything