

建筑机电从设计到制造的飞跃

Autodesk Fabrication 与 Revit的协同应用

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简介

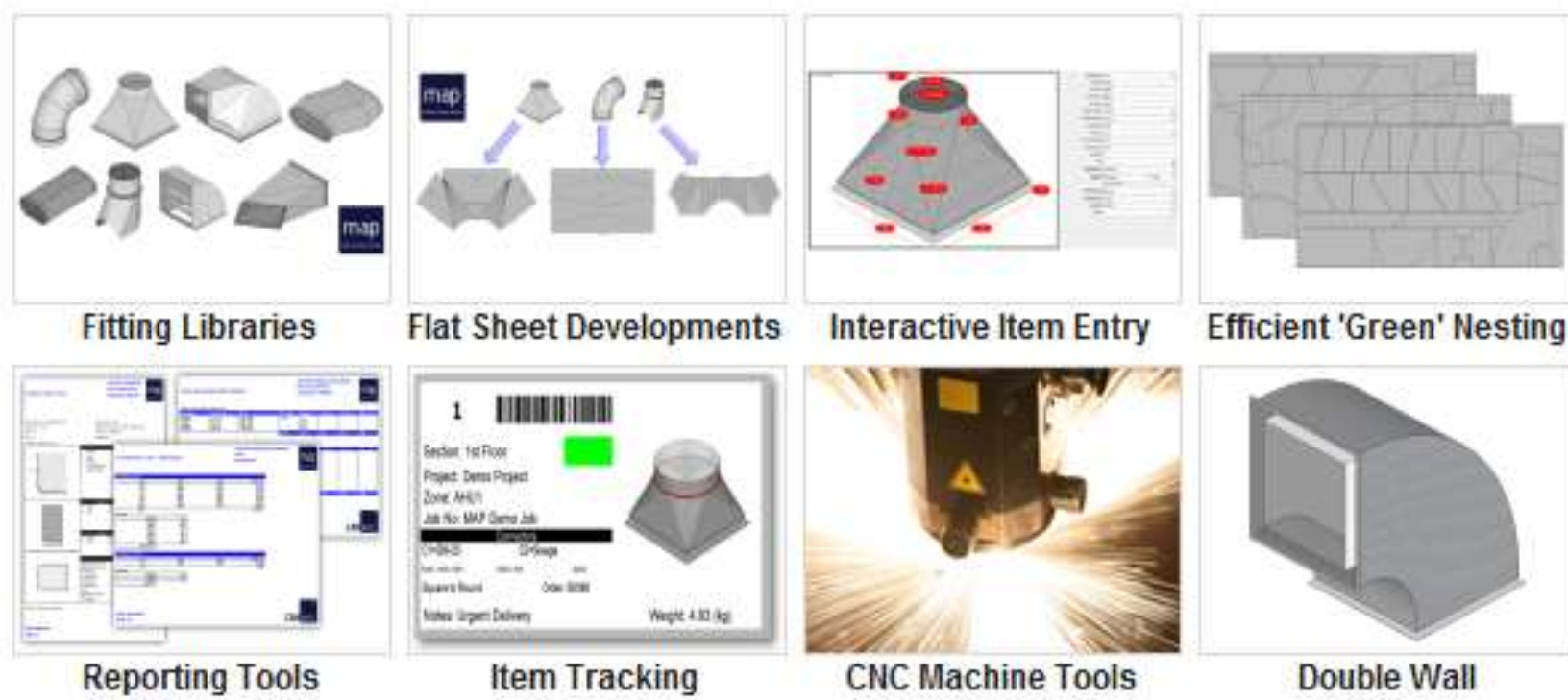
随着对于BIM模型越来越高的精细化要求，Autodesk推出了以Autodesk Fabrication和Revit为主的机电精益化设计和制造的解决方案，来满足机电设计、建模、制造及安装的整个流程的BIM应用。

本讲座将介绍如何将Autodesk Fabrication系列软件与Revit软件有效的结合使用，利用来自Fabrication系列产品的丰富而真实的构件，创建LOD400级别的机电预制加工模型。使用Autodesk Fabrication ESTmep对建筑项目进行准确的估算和成本分析，以及使用Fabrication CAMduct生成钣金件展开图，发送数控机床直接加工。从而提高模型的准确度以及与机电安装过程的匹配度，实现风管的精益化制造，提高效率降低成本，完成机电专业从设计、深化、预制加工图、以及安装的整个流程的BIM应用。

内容摘要

通过此课程，您将了解到：

- 使用Fabrication CADmep预制建筑机电管线
- 使用Fabrication ESTmep精确统计机电制造和安装成本
- 使用Revit与Fabrication CAMduct实现风管的数控制造
- 使用Revit 2016中最新发布的机电预制详图功能



BIM在建筑机电领域的应用趋势

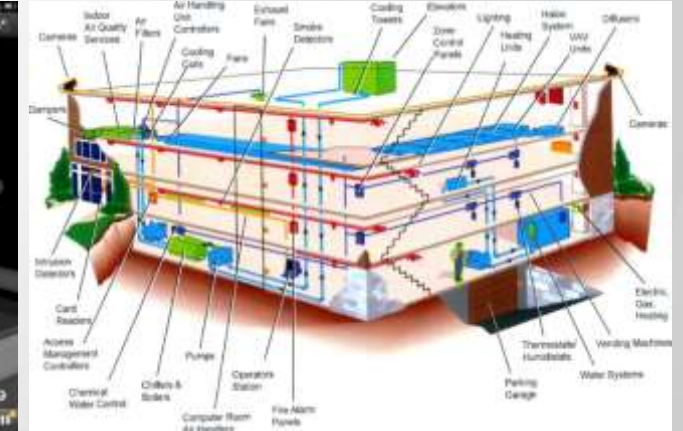
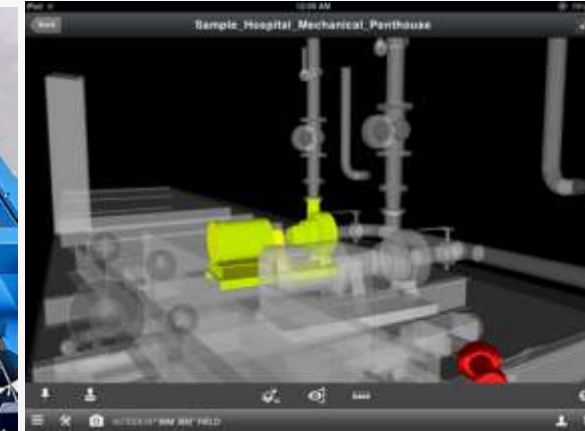
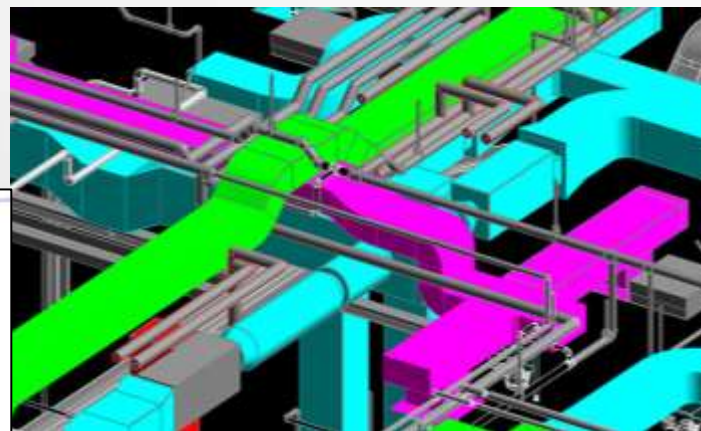
设计、可视化
与模拟

空间协同

数字化制造

运维管理

真实系统与虚拟
运维模型的
全面集成



Source: Global Industry Trends With BIM by McGraw Hill Construction

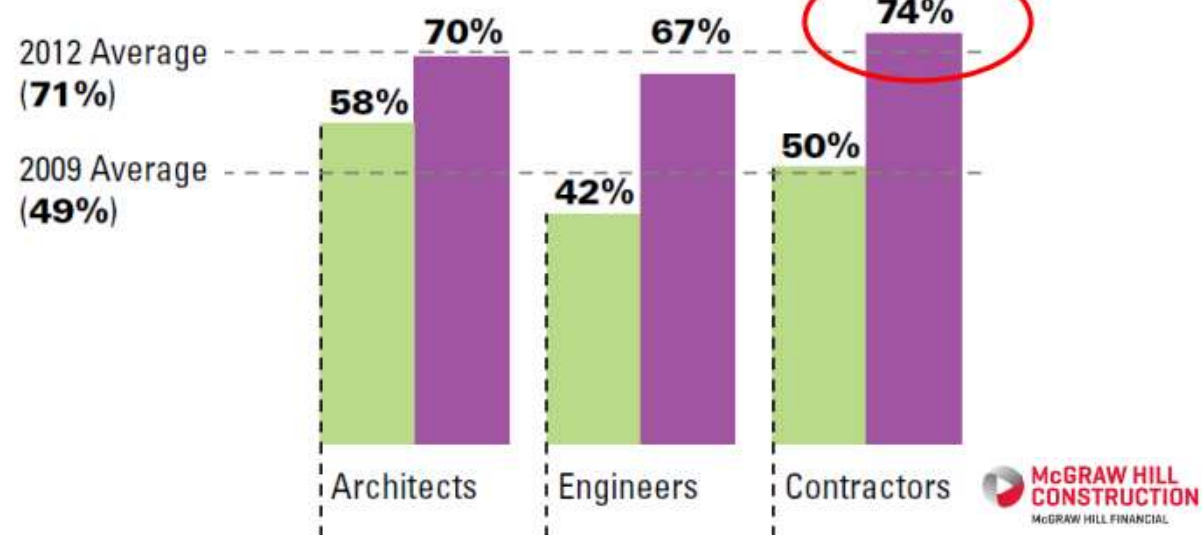
利用BIM实现LEAN(精益化)建造

越来越多的建筑承包商使用BIM技术

Adoption (USA): Contractors have surpassed Architects/Engineers

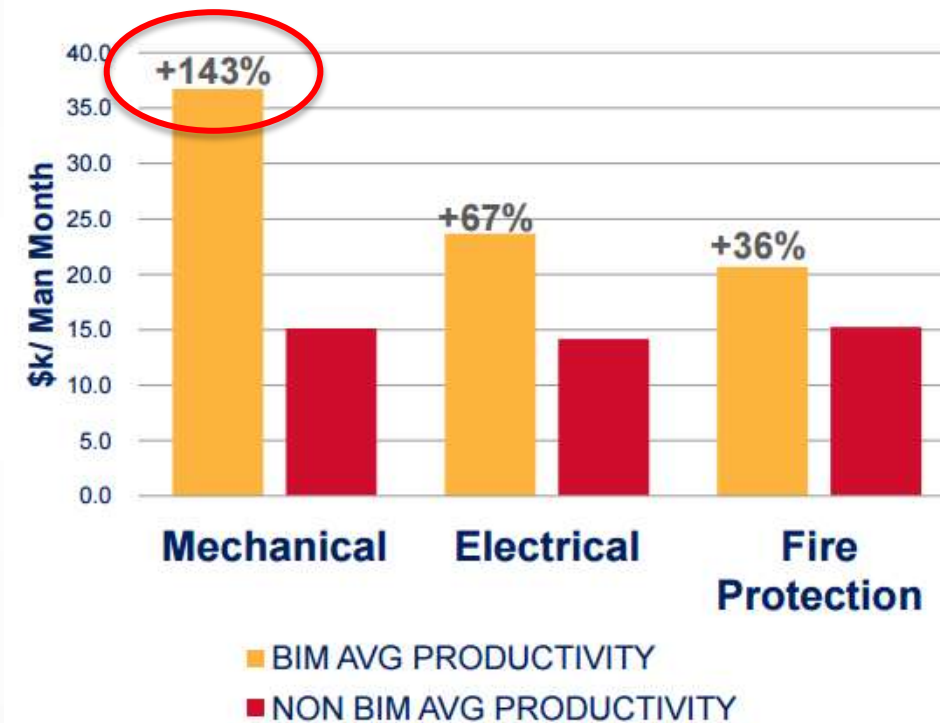
Source: McGraw-Hill Construction, 2012

2009 2012



BIM技术与精益化建造大幅提高生产效率

Increased Productivity (work-in-place / man-hour)



BIM+LEAN Results
(Average Trade Productivity Metrics)

143% Increase in Mechanical
67% Increase in Electrical
36% Increase in Fire Protection

Turner

Turner: 美国最大的“绿色”承包商，第4大建筑承包商

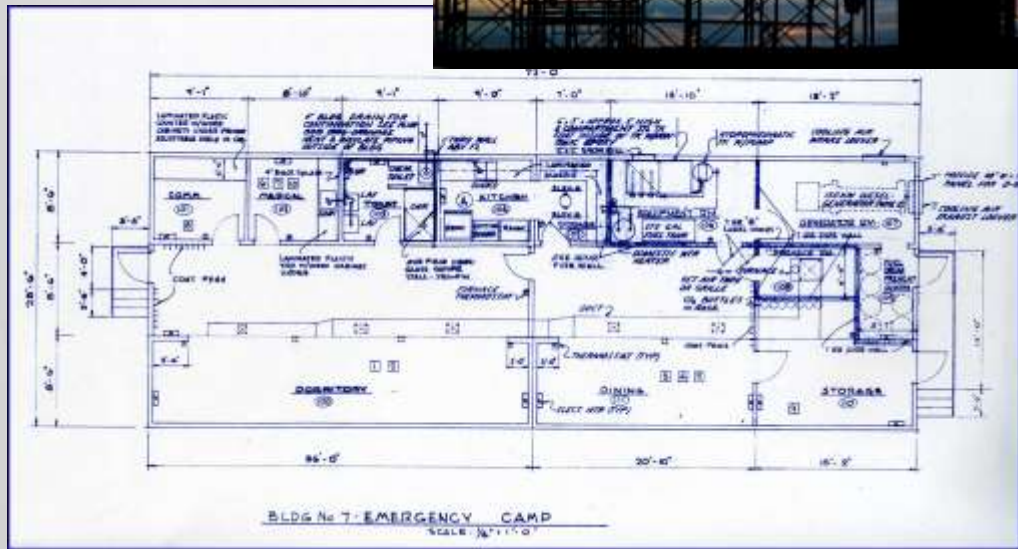


Image: Turner

BIM + LEAN =



提升建筑工程建设的效率和质量



传统建筑体系

预制装配式建筑体系



将建筑的所有构件进行工厂化预制，然后在现场完成快速装配。

工厂化生产 + 装配化施工 = 高效优质

建筑机电数字化制造与安装



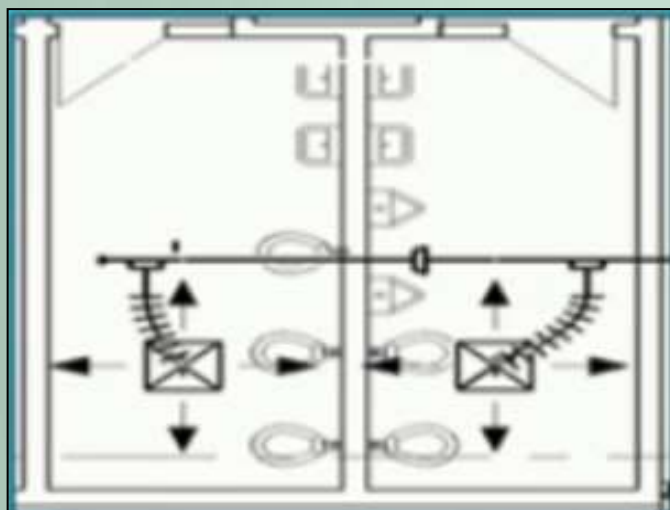
现场制作安装



工厂预制 + 现场安装

建筑机电模型交付阶段

LOD 100~300
设计模型



LOD 350
预制模型



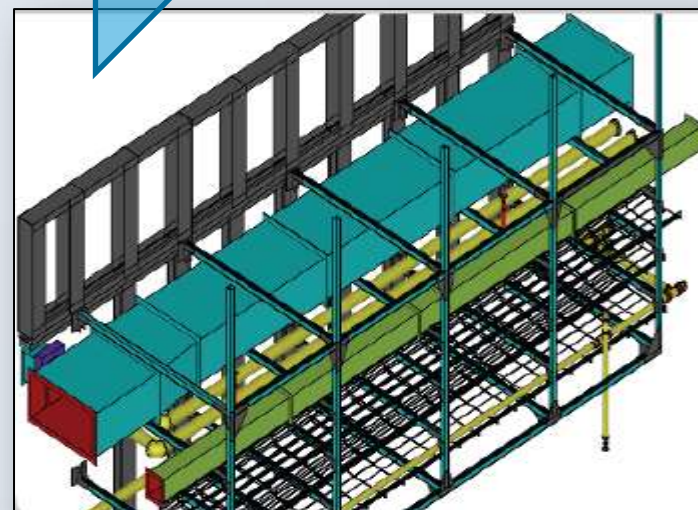
Revit



Fabrication



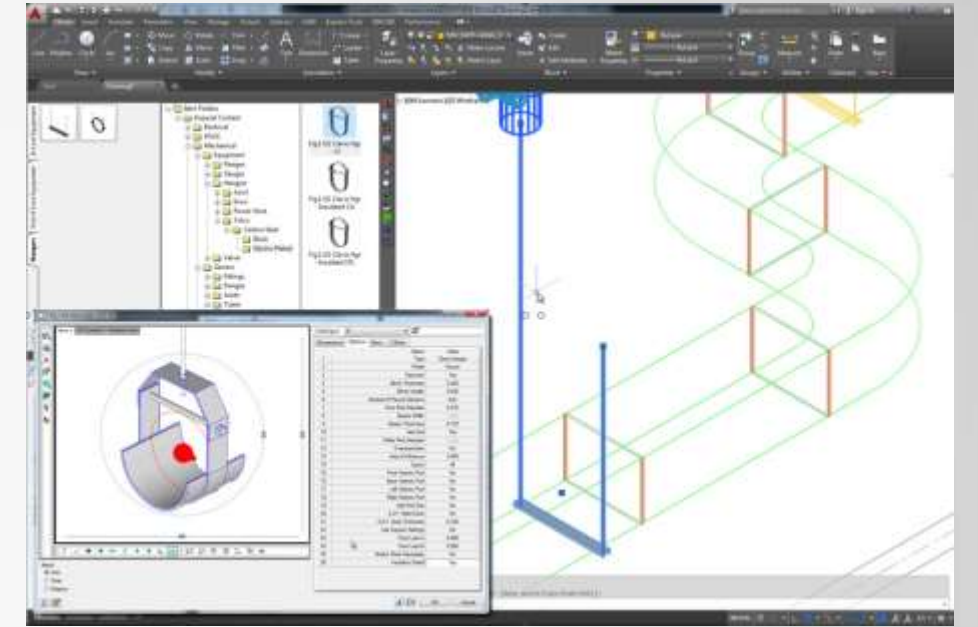
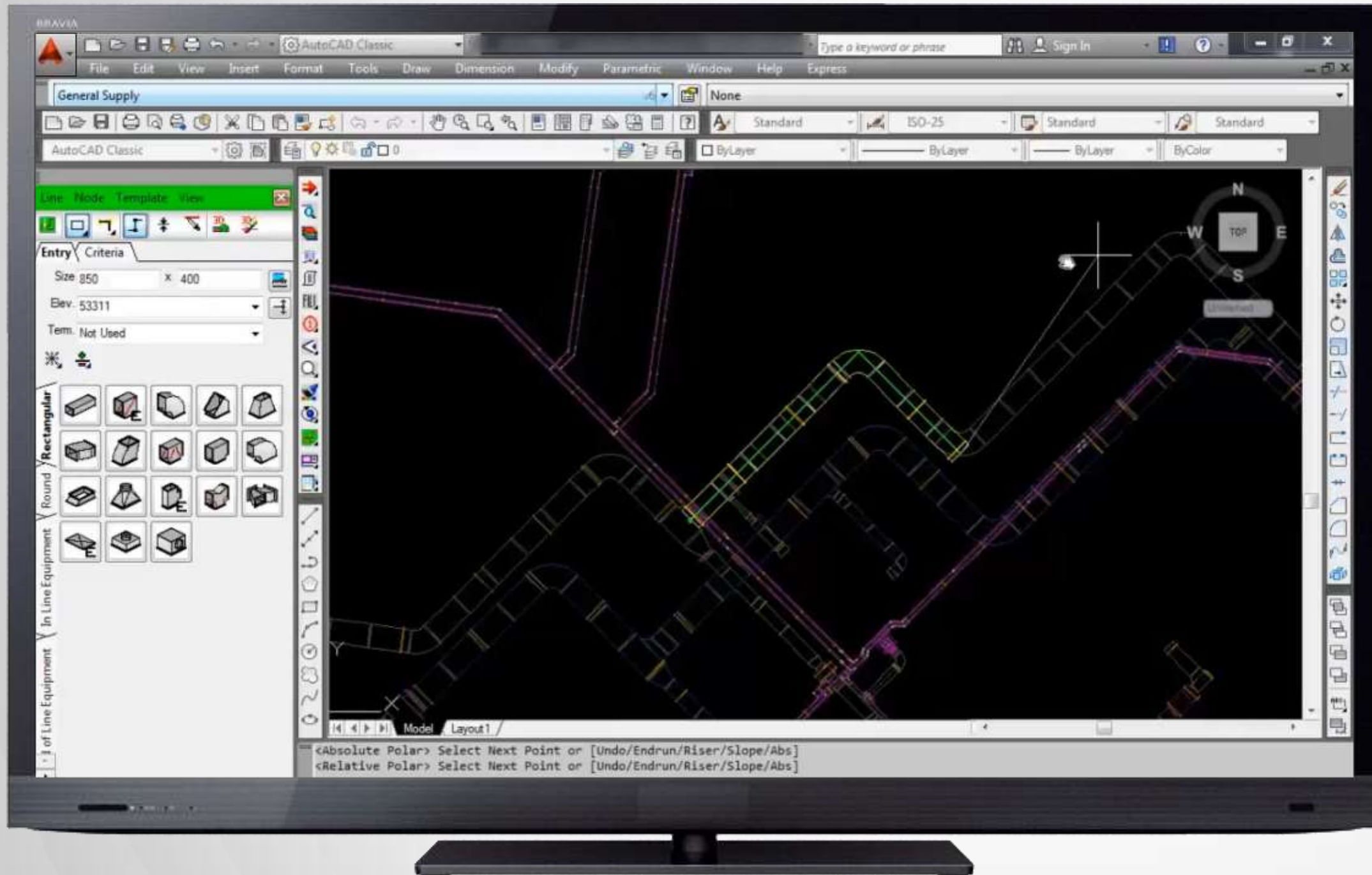
LOD 400
建造模型



LOD 500
竣工模型



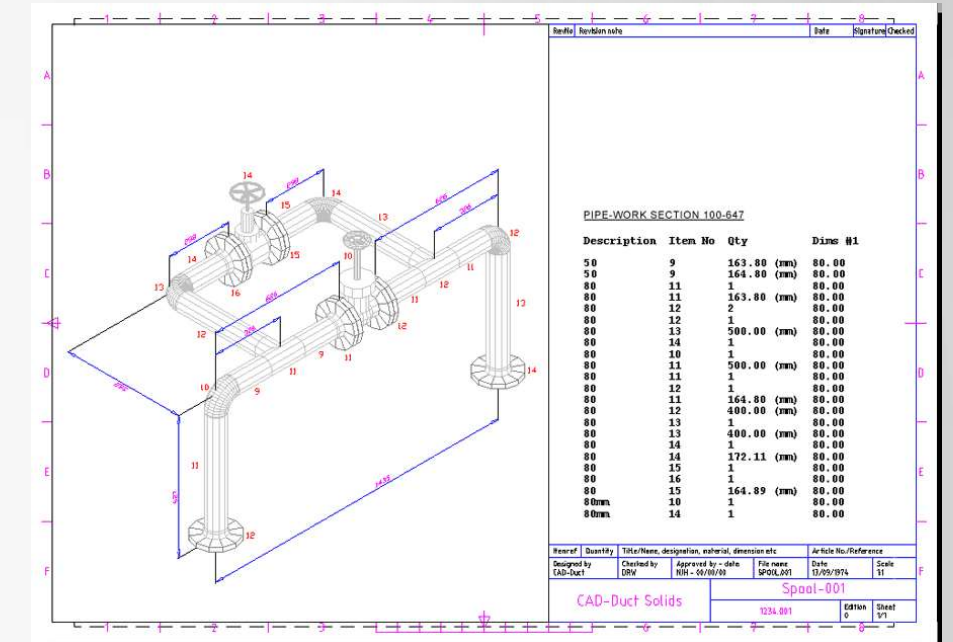
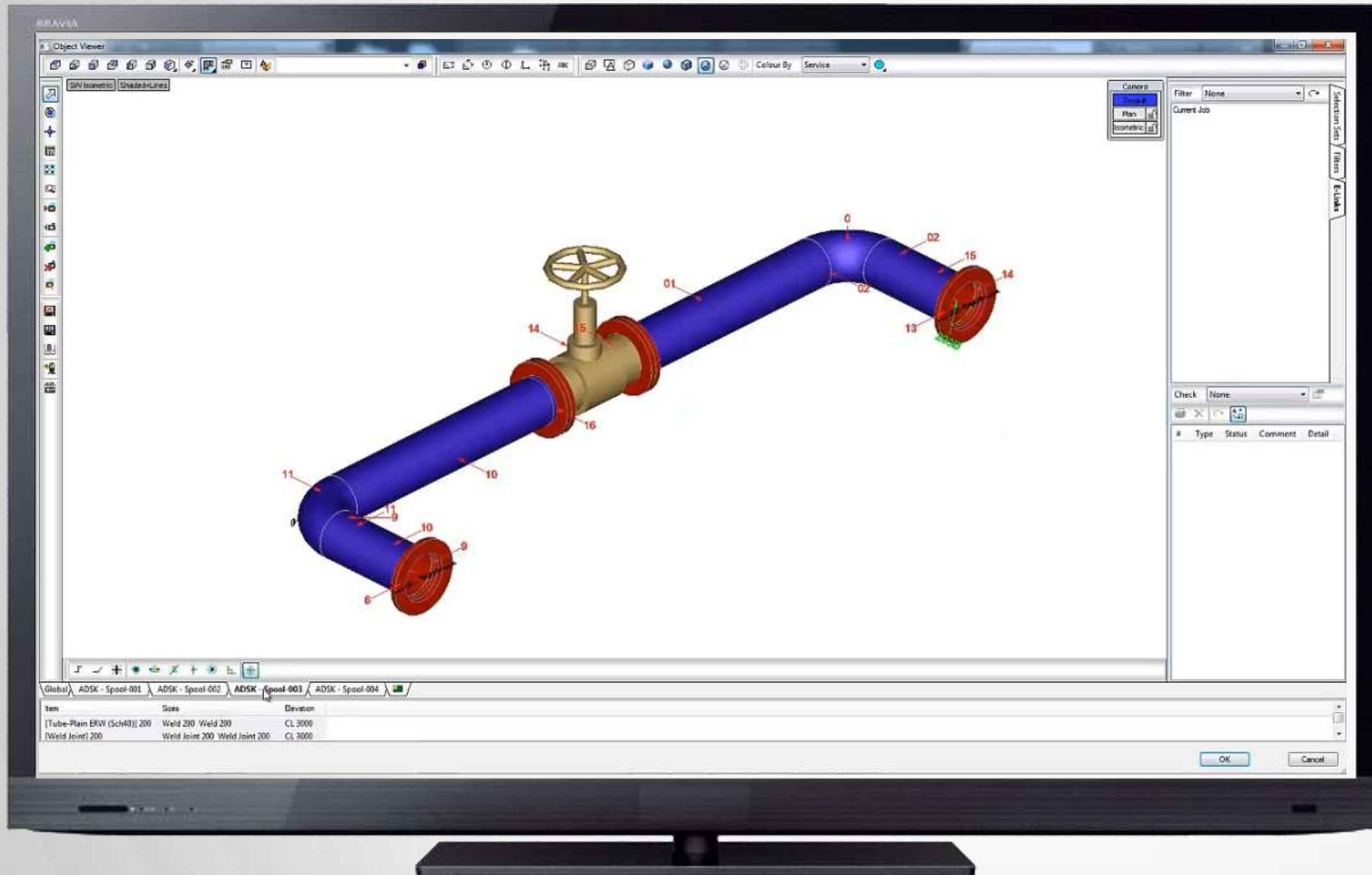
Fabrication CADmep与机电施工模型 | 设计线功能



使用设计线 (Design Line) 功能，
可以按照预定规则快速绘制管道。设置
包括：

- 按照管道的材质与制造方式拆分管段。
- 按照管道尺寸确定连接方式
- 按照管道尺寸确定保温层材质与厚度
- 按照管道规格自动放置支吊架

Fabrication CADmep与机电施工模型 | 预制管段图功能



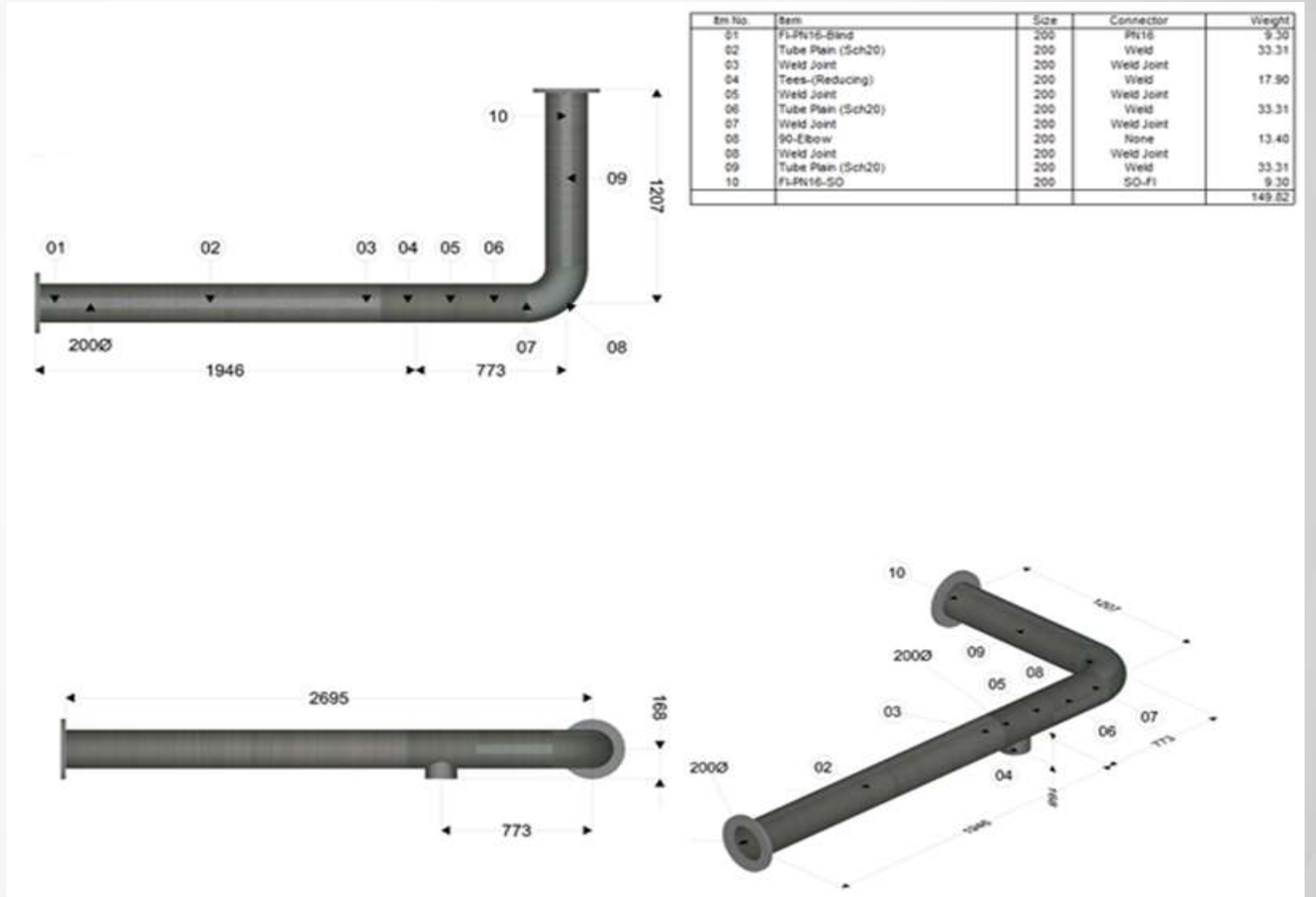
使用CADmep可以创建预制管段图 (Spool drawings), 设计管道预制:

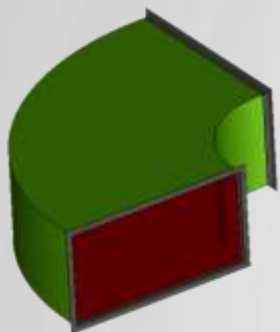
- 定义管段划分方式
- 创建管段三视图
- 为构件依次编号
- 标注构件之间的距离
- 生成管段的BOM表

为预制管段创建ISO图



PCF格式

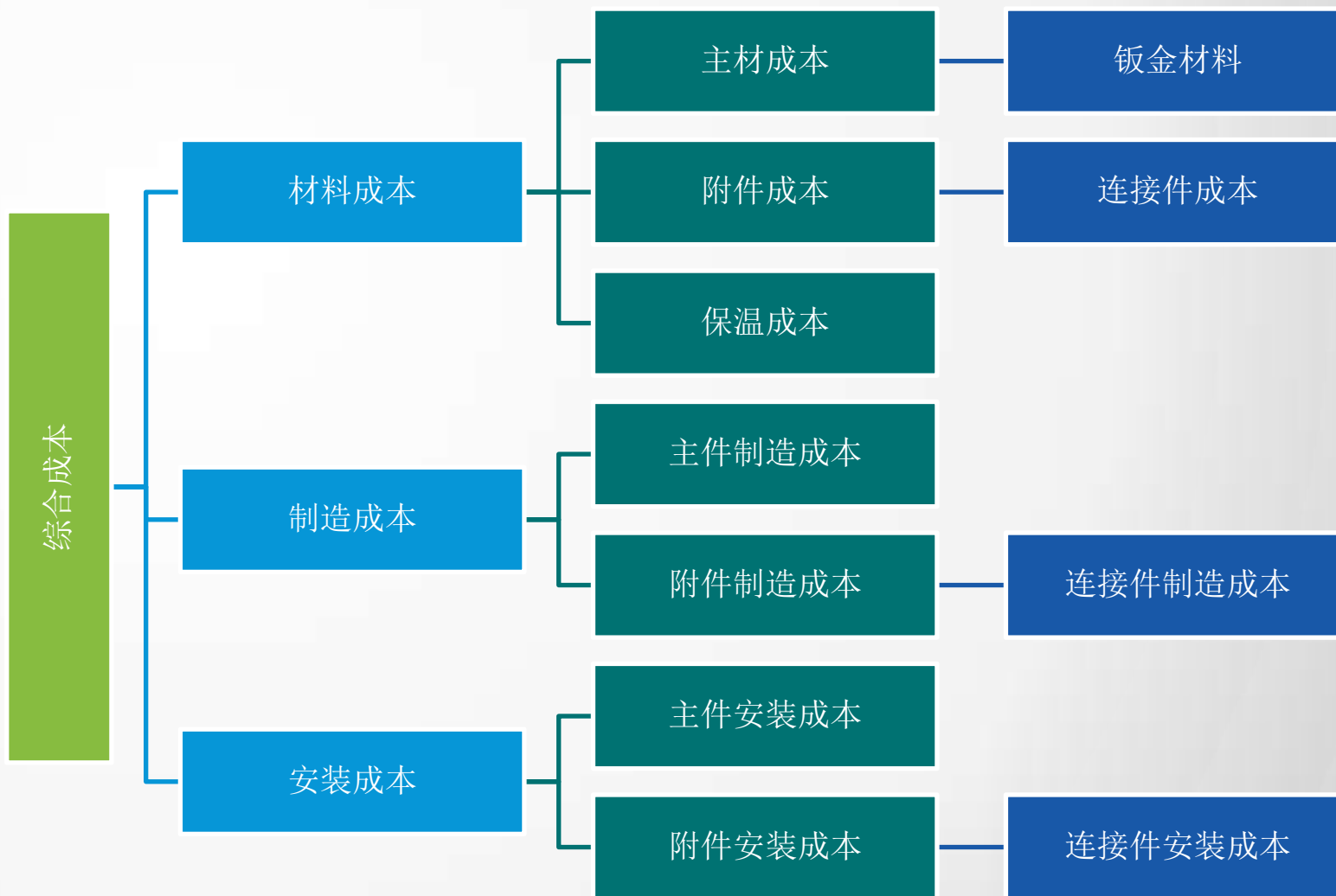




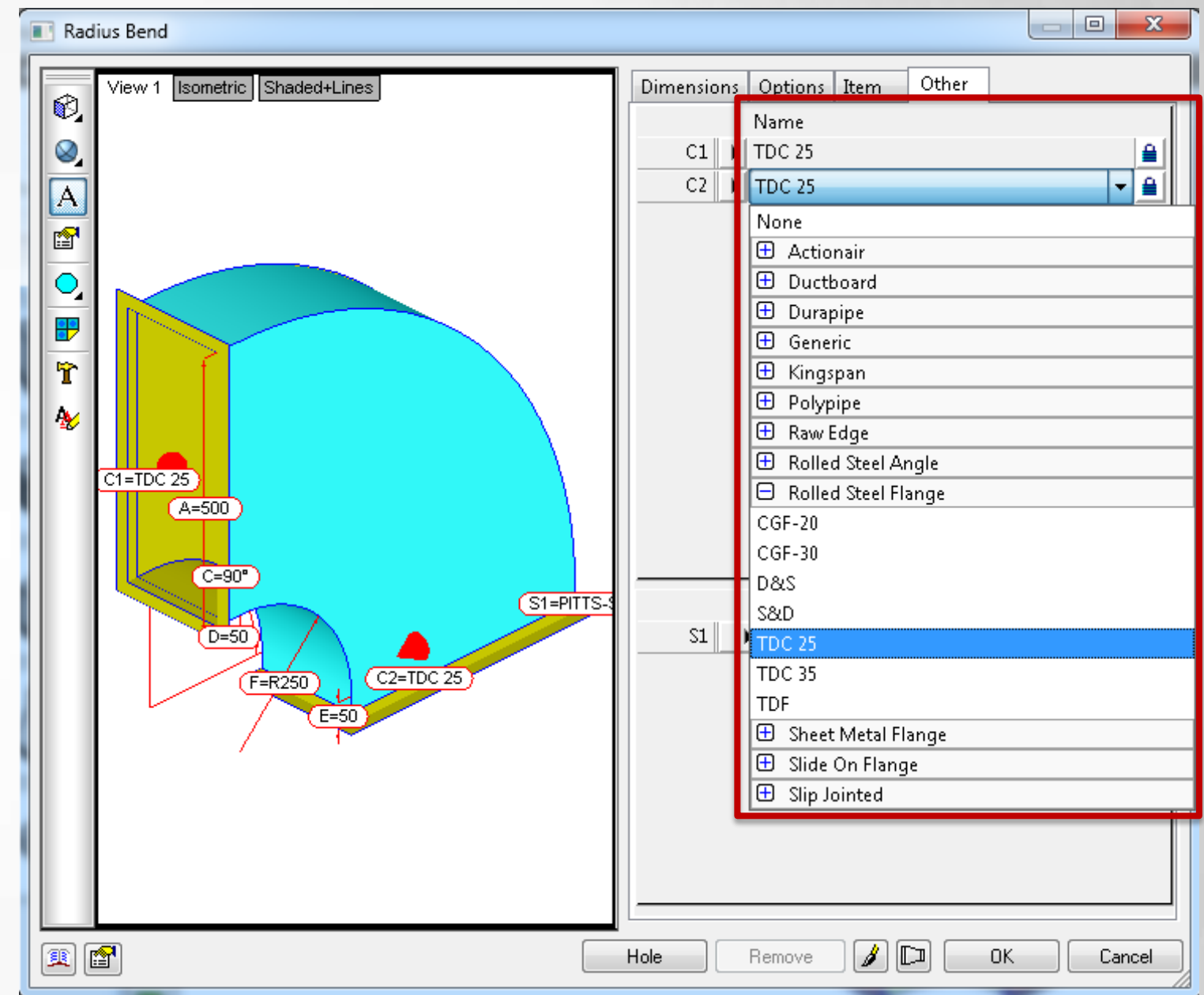
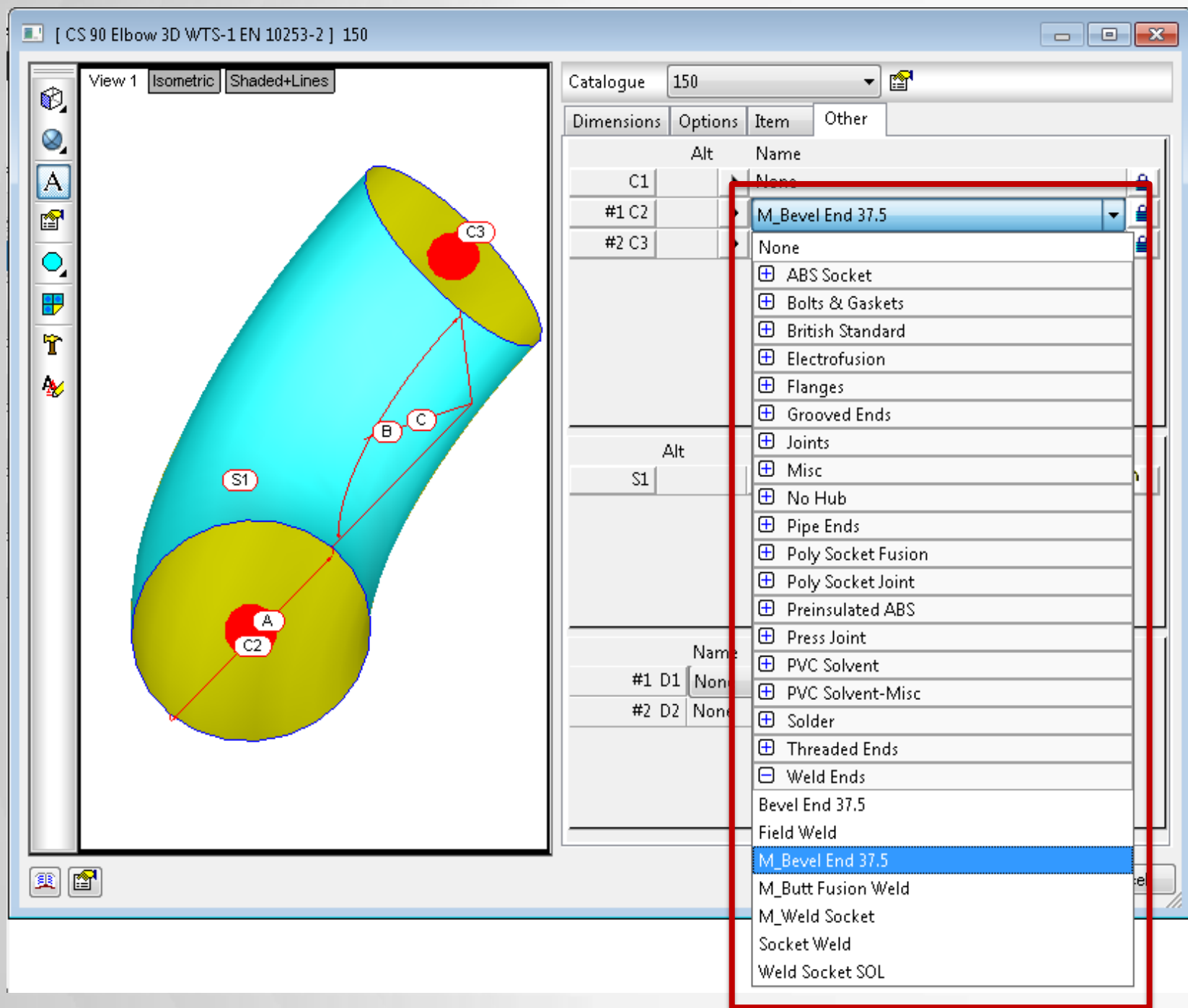
风管弯头
Radius Bend.ITM

Item 6 (Radius Bend) [x 1]

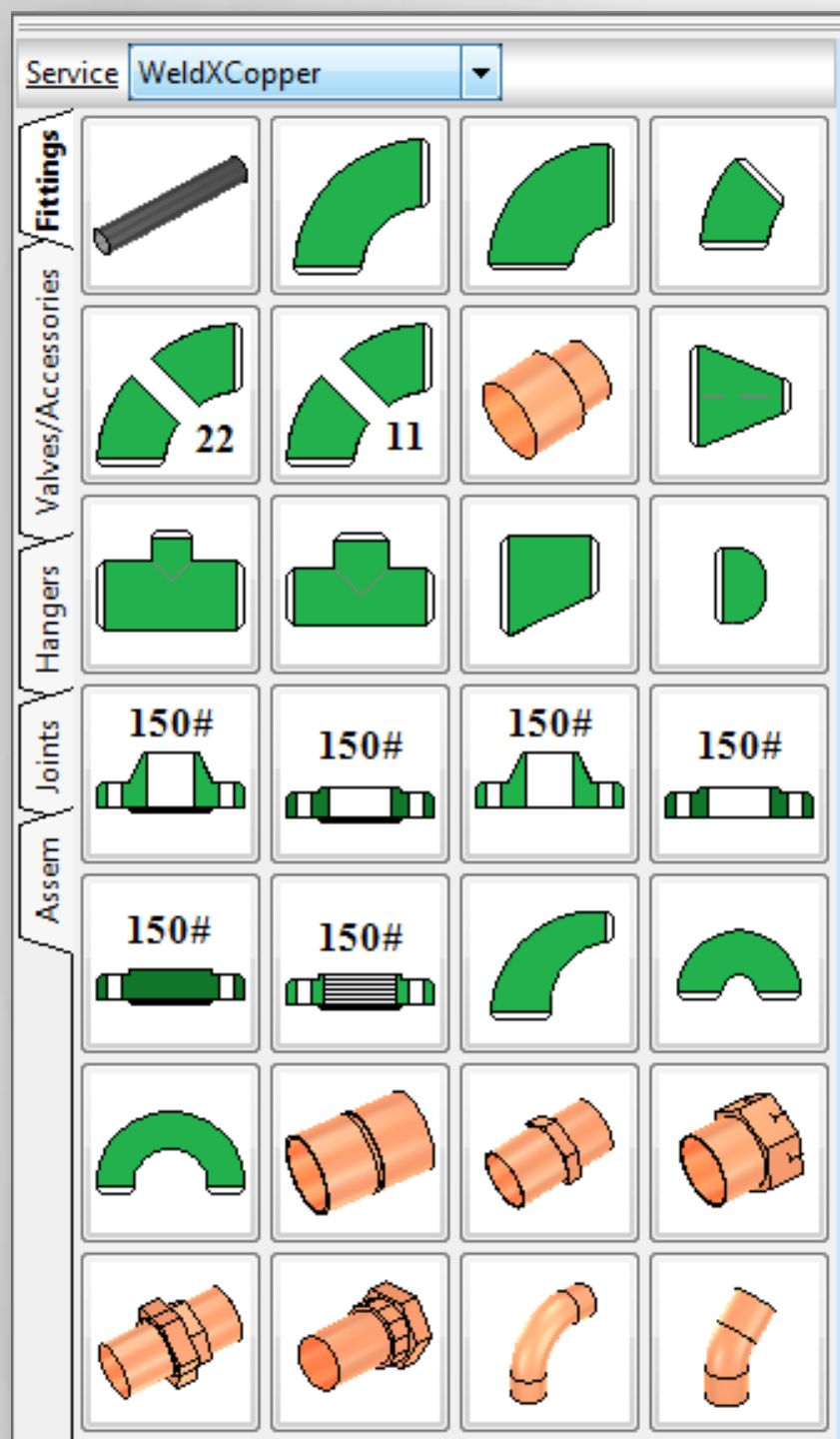
- Material Costs = £12.14 per Qty
 - Material Cost = £7.55 per Qty
 - Part 1/4 = £2.54 per Qty (3.62349 (kg) Galvanised x 0.80)
 - Part 2/4 = £2.54 per Qty (3.62349 (kg) Galvanised x 0.80)
 - Part 3/4 = £0.76 per Qty (1.0917 (kg) Galvanised x 0.80)
 - Part 4/4 = £1.71 per Qty (2.44687 (kg) Galvanised x 0.80)
 - Ancillary Cost = £4.59 per Qty
 - Connector Cost = £4.59 per Qty
 - TDC 25 @ 500.00x200.00 = £2.29 per Qty
 - Corners: TDC 35 [ADSK_80001740] x 4 = £1.20 per Qty
 - Fixings: M8x20 Set Screws [ADSK_80001780] x 2 = £0.18 per Qty
 - Clips: Universal 'G' clamp [ADSK_80001733] x 2 = £0.78 per Qty
 - Gasket: GASKET TAPE 5mm [ADSK_80001836] x 0.70 (m) = £0.13 per Qty
 - TDC 25 @ 500.00x200.00 = £2.29 per Qty
 - Insulation Cost = £0.00 per Qty
- Total = £12.14 per Qty

- Fabrication Cost = £8.03 per Qty
- Fabrication Table Cost = £6.53 per Qty (90 Radius Bend)
 - Value Set 1 = £6.53 per Qty (0.44 (hrs) @ 15.00 £/(hrs))
- Ancillary Fabrication Cost = £1.50 per Qty
 - Connector Fabrication Cost = £1.50 per Qty
 - TDC 25 @ 500.00x200.00 = £0.75 per Qty (0.05 (hrs) @ 15.00 £/(hrs))
 - TDC 25 @ 500.00x200.00 = £0.75 per Qty (0.05 (hrs) @ 15.00 £/(hrs))
- Total = £8.03 per Qty
- Installation Cost = £4.22 per Qty
- Installation Table Cost = £3.70 per Qty (90 Radius Bend)
 - Value Set 1 = £3.70 per Qty (0.25 (hrs) @ 15.00 £/(hrs))
- Ancillary Installation Cost = £0.53 per Qty
 - Connector Installation Cost = £0.53 per Qty
 - TDC 25 @ 500.00x200.00 = £0.26 per Qty (0.02 (hrs) @ 15.00 £/(hrs))
 - TDC 25 @ 500.00x200.00 = £0.26 per Qty (0.02 (hrs) @ 15.00 £/(hrs))
- Total = £4.22 per Qty
- Total Unit Cost = £24.38 per Qty
- Gross Unit Cost = £24.38 per Qty (@ 0% Total)
- Gross Item Extn = £24.38 Total


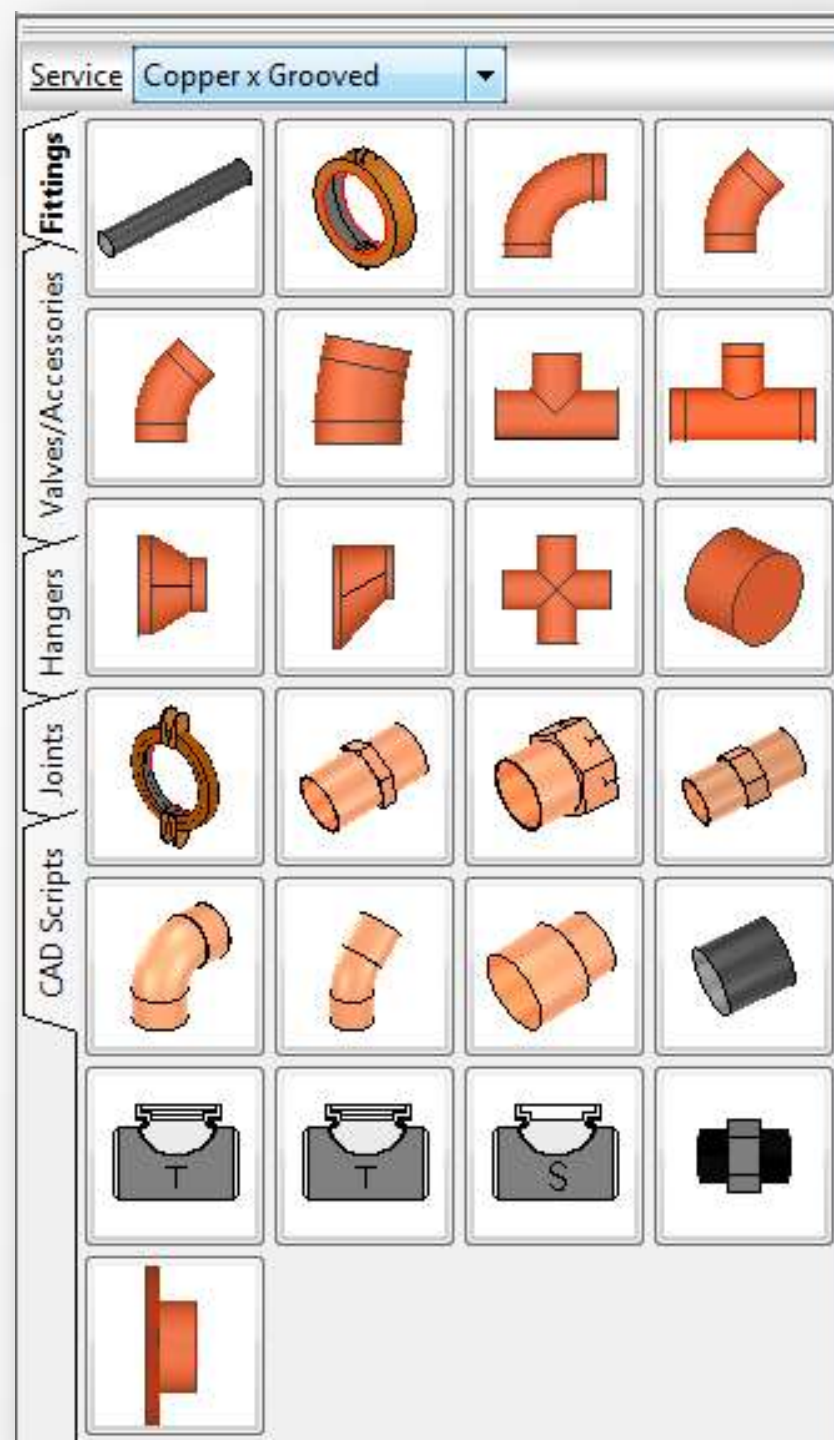
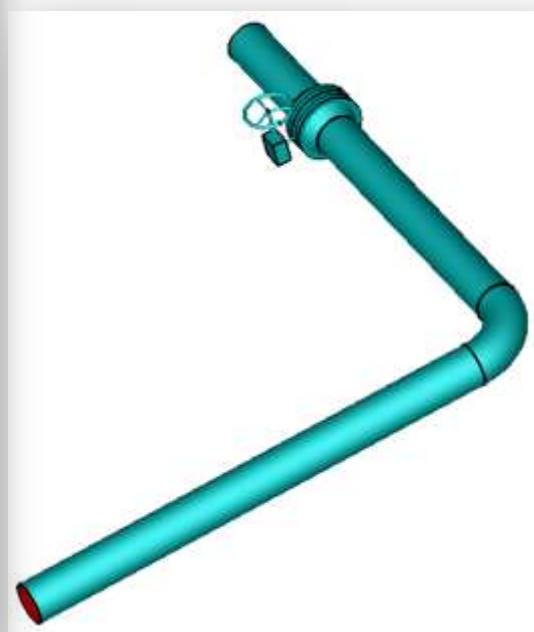
Fabrication ESTmep | 构件连接方式与成本



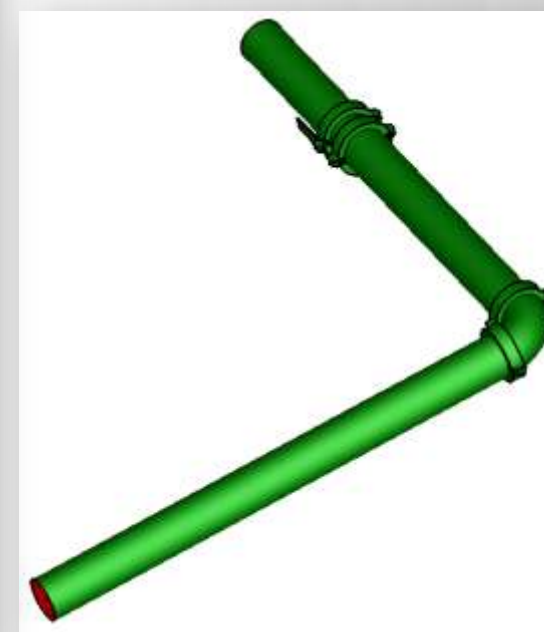
Fabrication ESTmep | 构件连接方式与成本

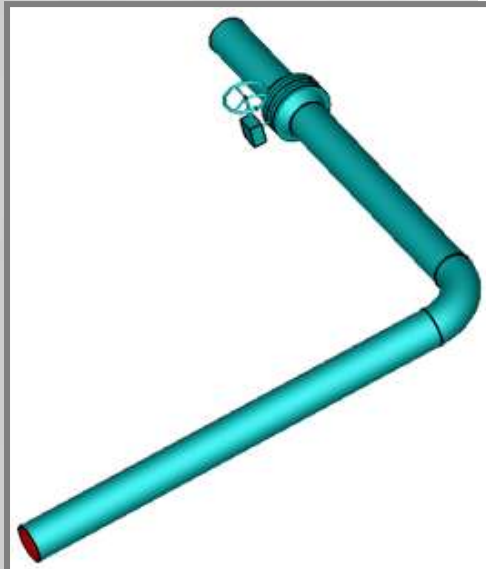


焊接



沟槽连接





Project:

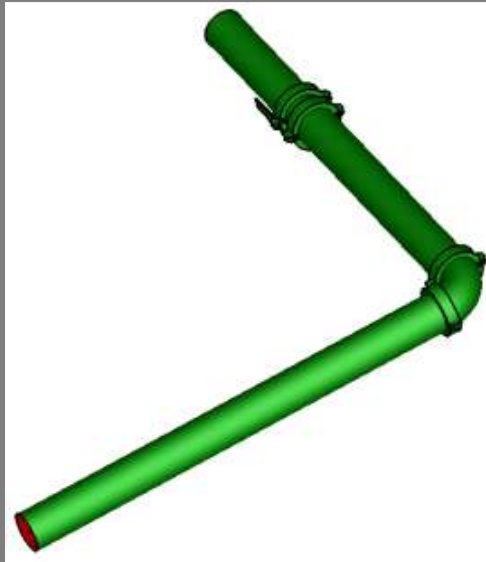
Page: 1/1

From:

Weld System (焊接系统)

Drawing:

Service	Length of Pipe	Quantity of Fittings/Valves	System Capacity (Gallons)	E times(hrs)	Install Time(MD)	\$ Material Cost
Chilled Water: CHW 0-2 CuxWeld	42' - 10 1/4"	12	24.4	35.26	4.4	480.50
	42' - 10 1/4"	12	24.4	35.26	4.4	480.50



Project:

Page: 1/1

From:

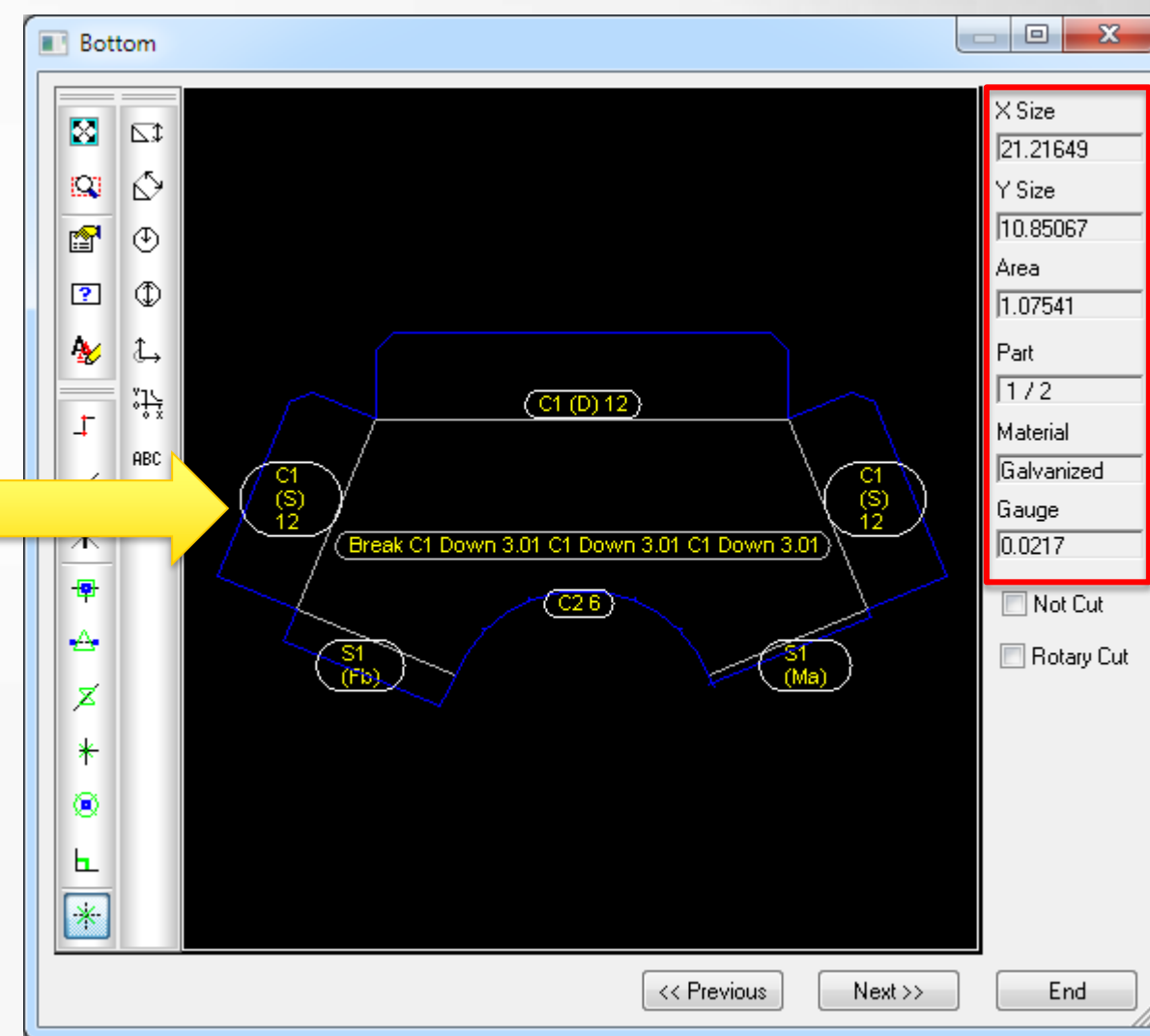
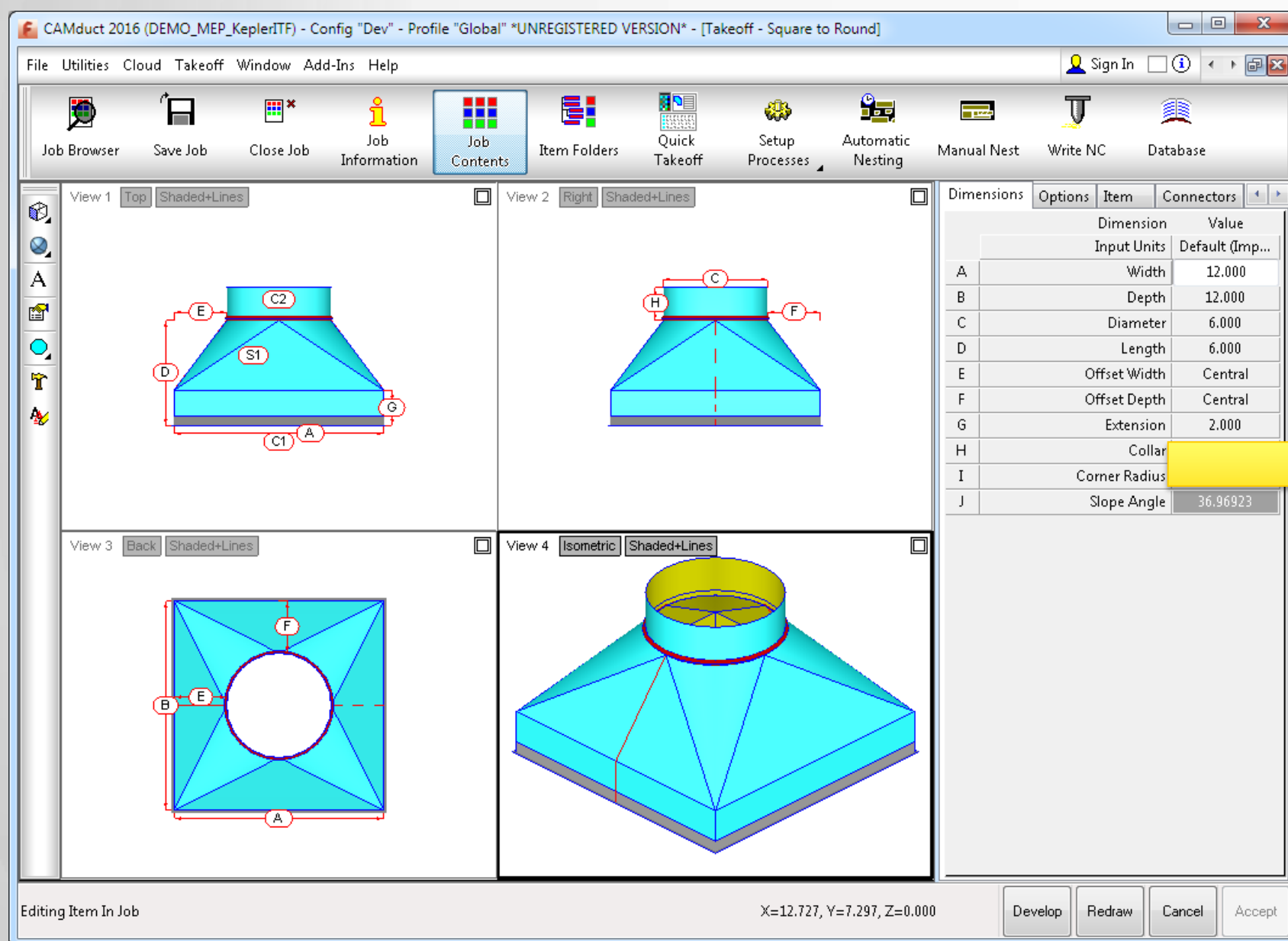
Groove System (沟槽连接系统)

Drawing:

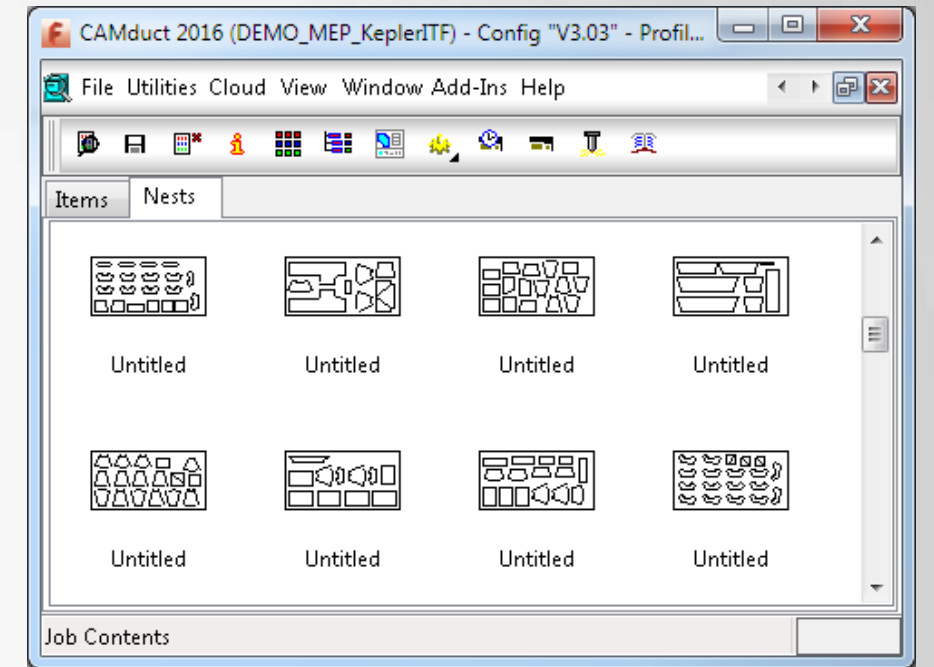
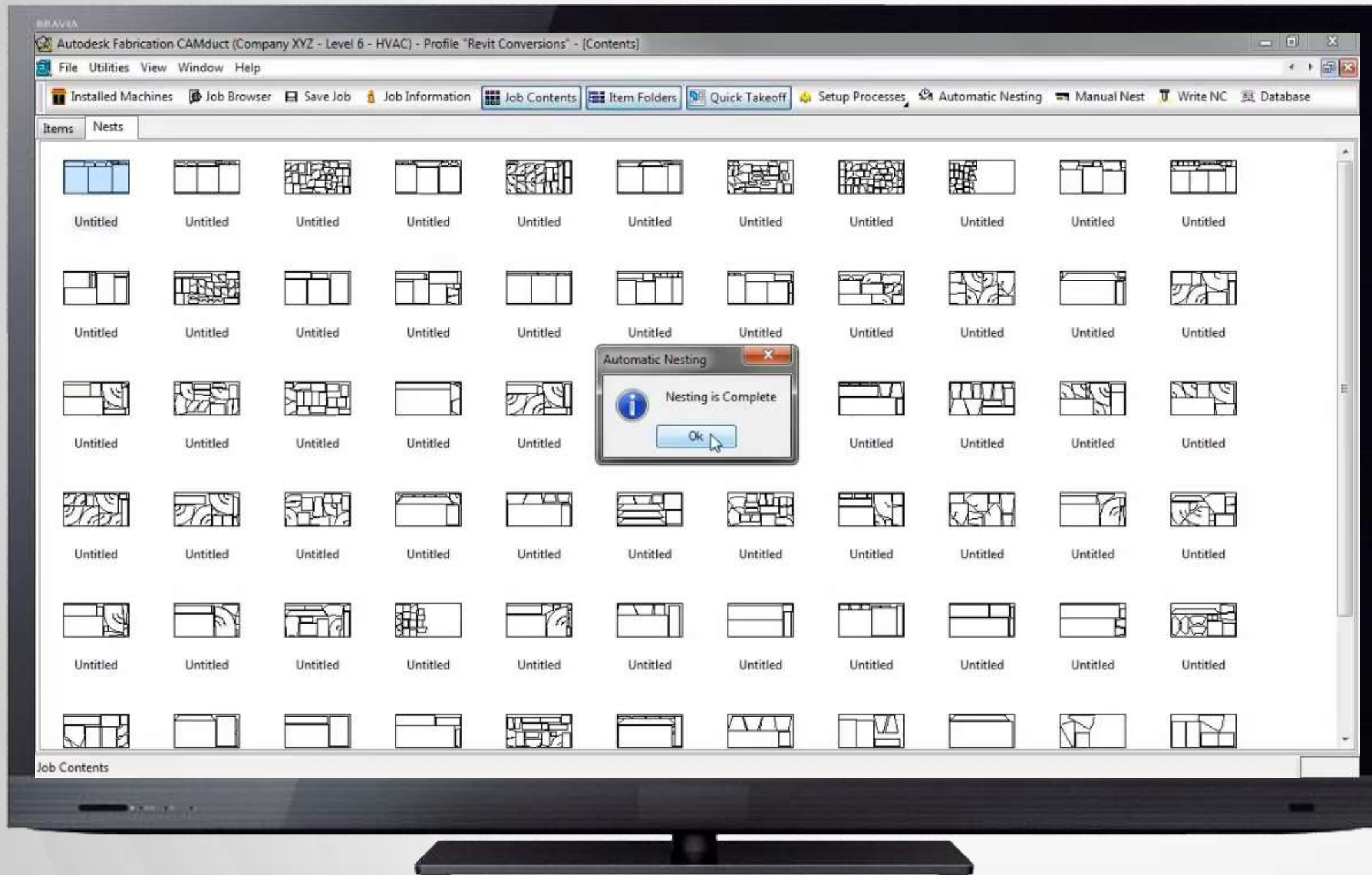
Service	Length of Pipe	Quantity of Fittings/Valves	System Capacity (Gallons)	E times(hrs)	Install Time(MD)	\$ Material Cost
Chilled Water: CHW 0-2 CuxVic	42' - 5 3/4"	16	25.6	17.88	2.2	1410.20
	42' - 5 3/4"	16	25.6	17.88	2.2	1410.20

Fabrication CAMduct | 风管构件展开图

- 将风管构件展开为钣金加工图

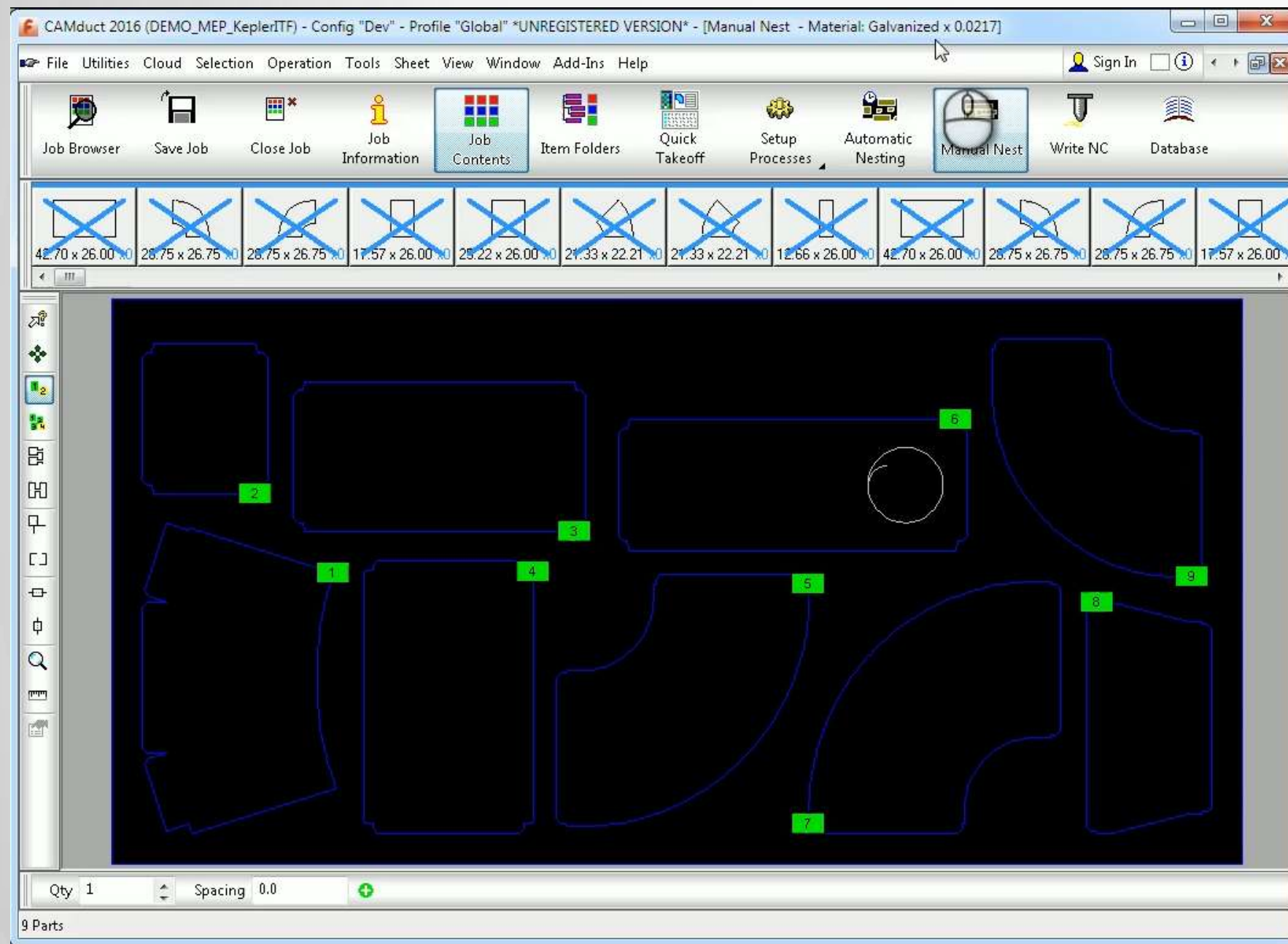


Fabrication CAMduct | 风管自动展开下料图



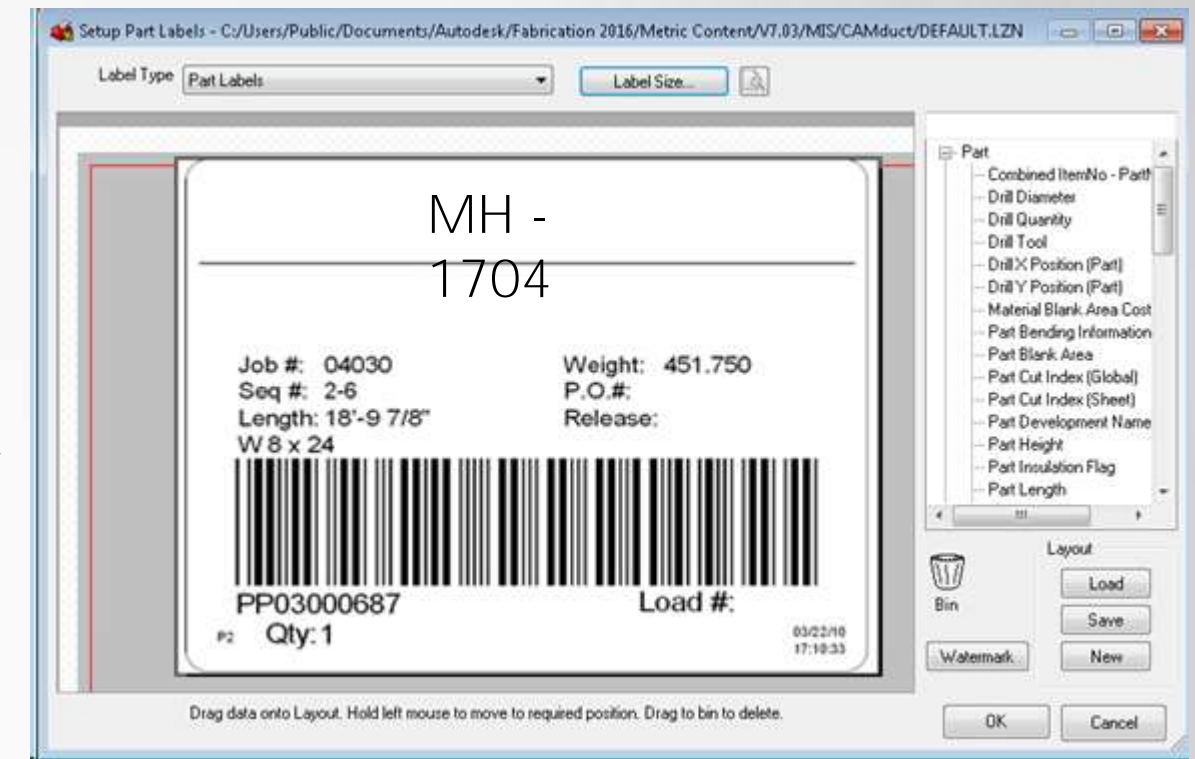
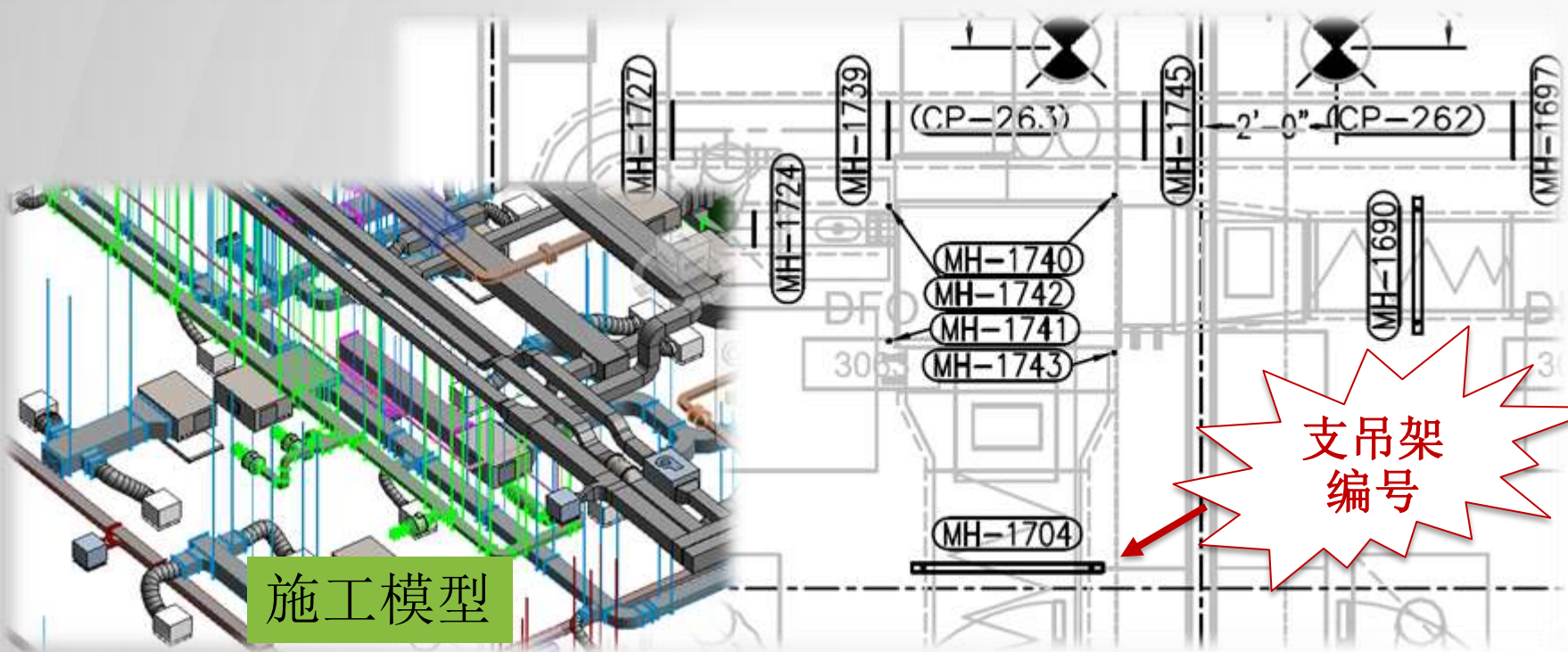
根据用户选择的钣金材料，自动将项目中的风管构件展开，优化布置在每一张钢板中，最大化材料使用率。

Fabrication CAMduct | 输出到机床数控制造



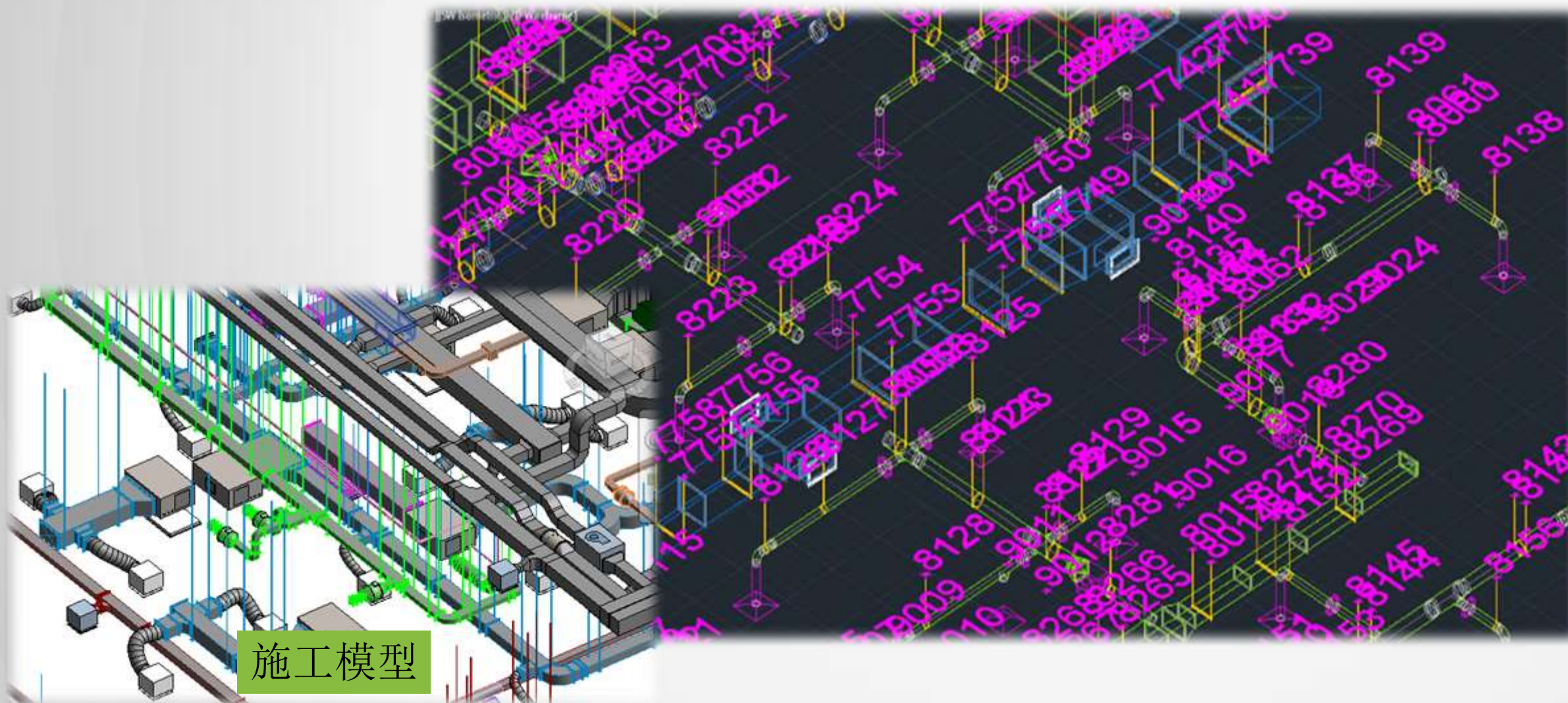
支持生成多种机器代码，方便数控等离子切割机、数控激光切割机、数控雕刻机、数控水砂切割机 etc 机器读取操作。

Fabrication CAMduct | 构件管理



施工模型与现场放样

- 使用Autodesk Point Layout, 将BIM模型中创建的点坐标, 导出到现场的测量设备, 提高现场放样速度与精度, 提高施工质量与效率。



图片来源: Wertenham Construction, Inc.



图片来源: PCL Construction

建筑机电设计 + 预制的整合策略

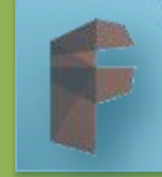
HVAC + Piping
Design



Ductwork +
Pipework Detailing



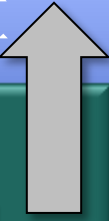
Spool Diagramming
Traditional +
Modular



Estimating +
Manufacturing

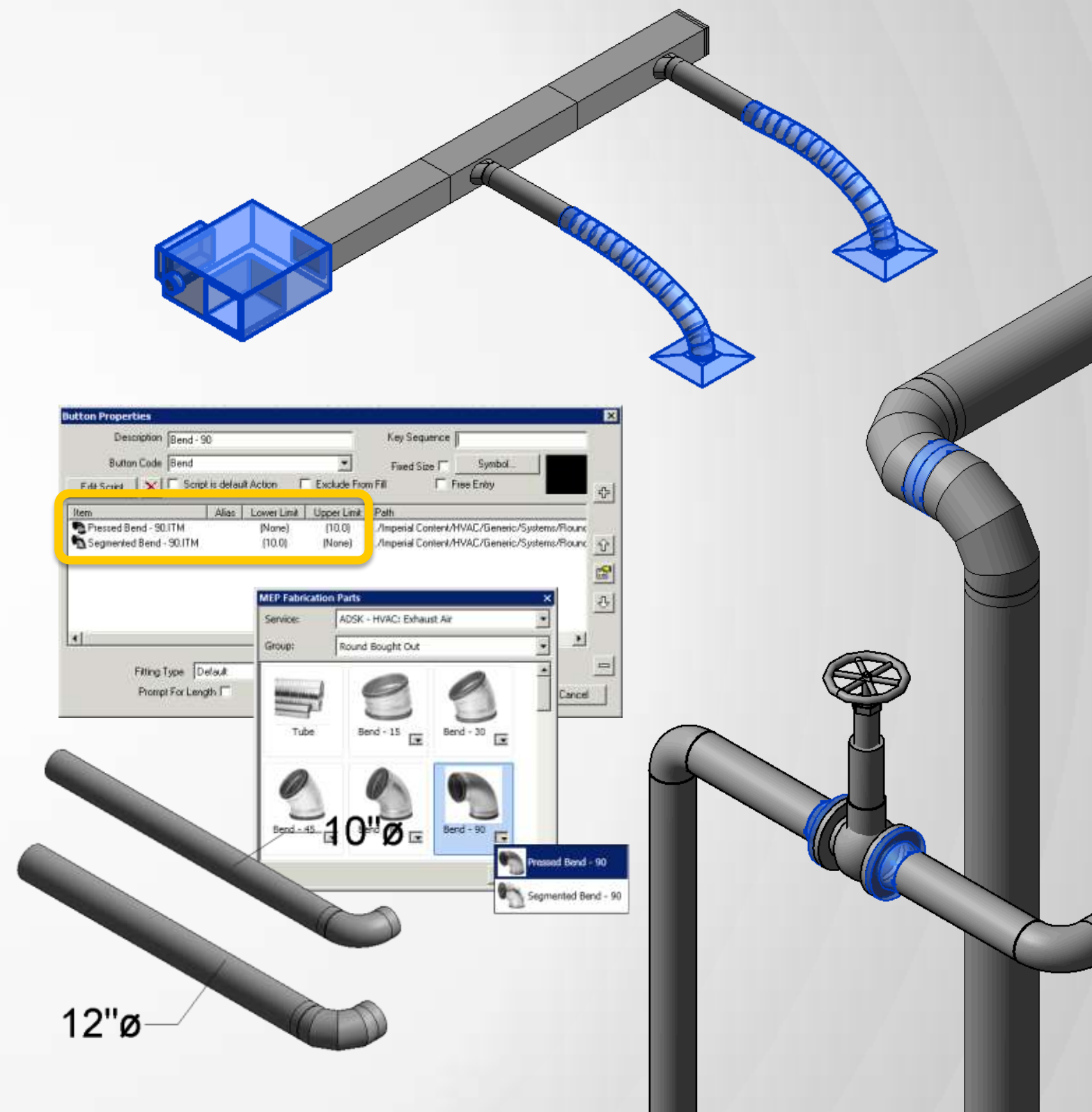
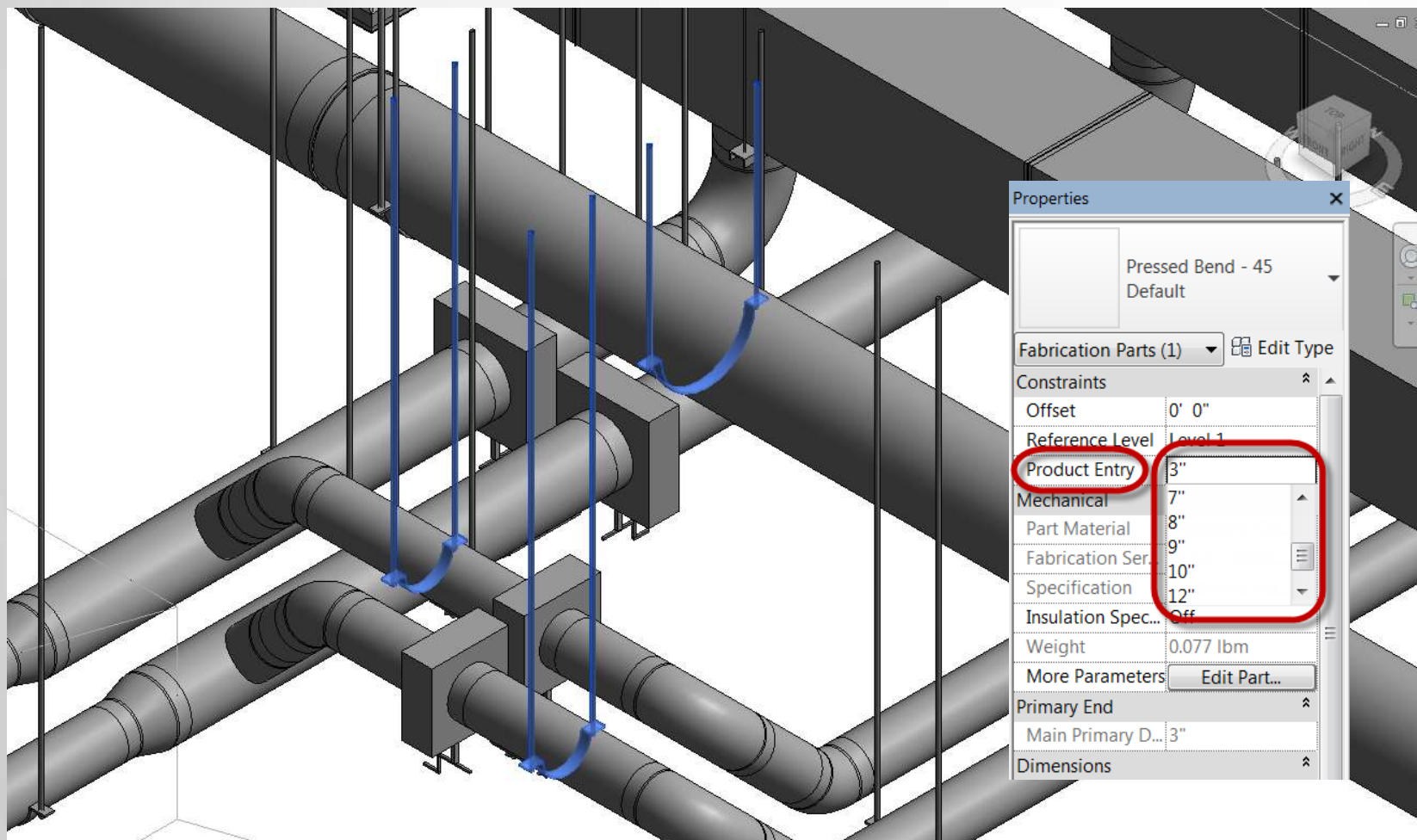


云计算



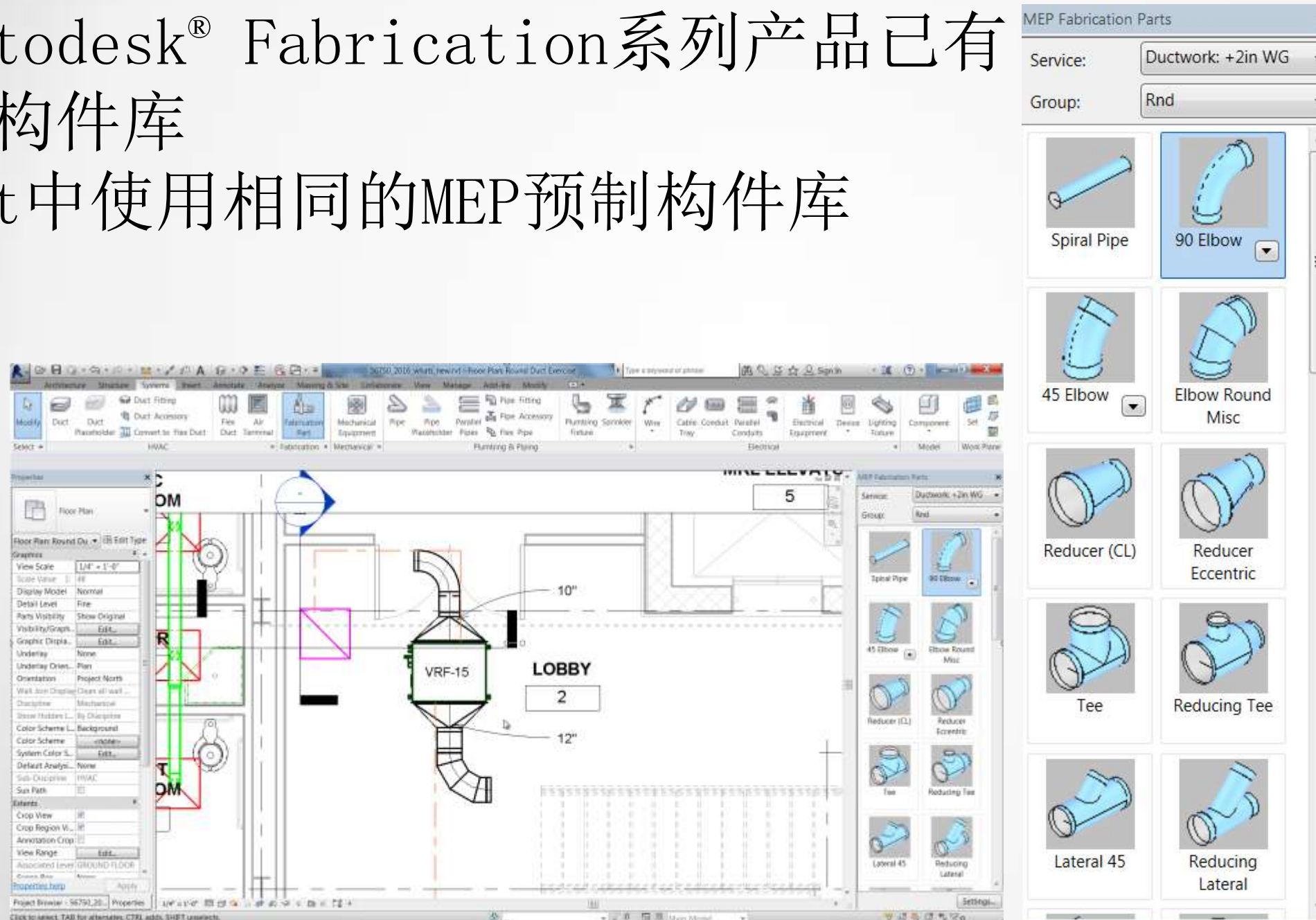
Revit 2016 | 预制详图功能

- 在Revit中提供 LOD400 的机电建模能力



Revit 2016 | 使用MEP预制构件库

- 沿用Autodesk® Fabrication系列产品已有的通用构件库
- 在Revit中使用相同的MEP预制构件库



Revit 2016 | 符合制造标准的风管建模

- 在管道等级说明中定义可用的材料
- 设置管道标准长度
- 设置管道和管件的连接方式

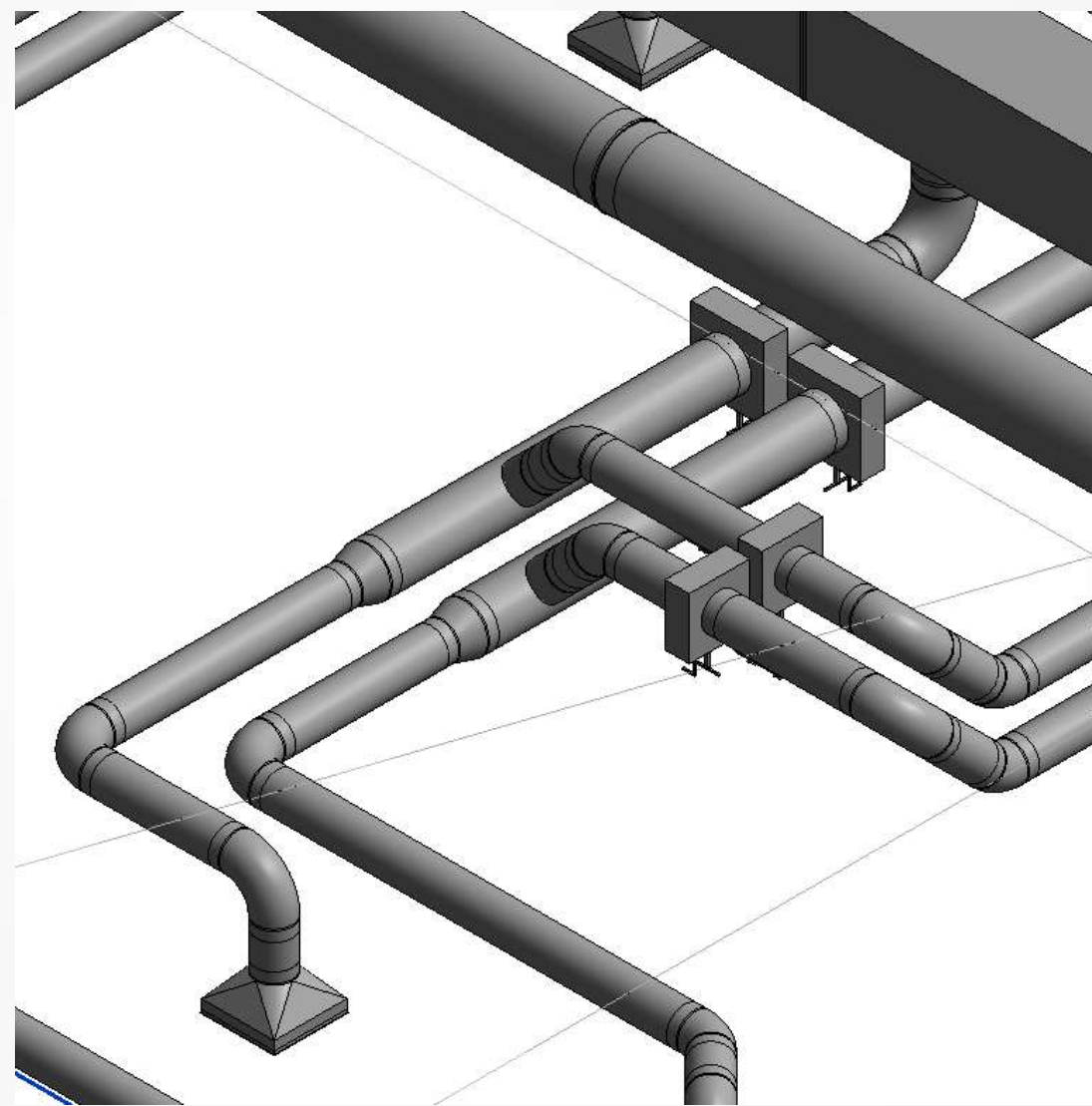
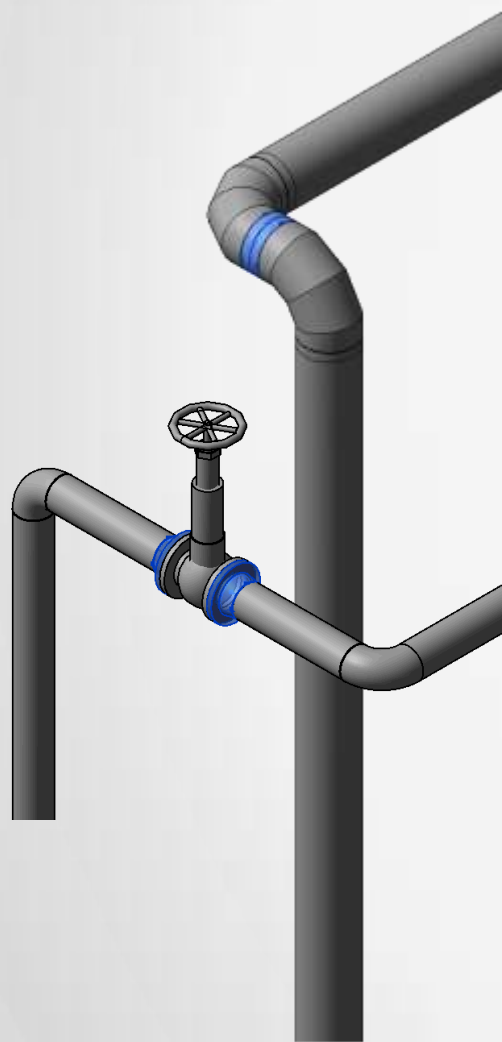
<= LS	<= SS	Gauge	STD Straight	Connector (In)	Connector (Out)	Connector (Sqr-Rnd)	Seam	Stiffener
12.000	12.000	26	60.000	S&D	Not Used	Not Used	Snaplock	None
26.000	18.000	26	60.000	Standing S&D	Not Used	Not Used	Snaplock	None
26.000	26.000	24	60.000	TDC	Not Used	Not Used	Snaplock	None
30.000	30.000	22	60.000	TDC	Not Used	Not Used	Snaplock	None
42.000	42.000	22	60.000	TDC	Not Used	Not Used	Snaplock	TR +2WG(5)
72.000	72.000	22	60.000	TDC	Not Used	Not Used	Snaplock	TR +2WG(5)
96.000	48.000	20	60.000	TDC	Not Used	Not Used	Snaplock	TR +2WG(5) + H...
108.000	108.0...	20	60.000	TDC	Not Used	Not Used	Snaplock	TR +2WG(5) + H...
999.000	999.0...	20	60.000	TDC	Not Used	Not Used	Snaplock	TR +2WG(5) + H...

Value	Lock
C1 Duct - Flg Connector: TDC	
C2 Duct - Flg Connector: TDC	
C3 Duct - Flg Connector: TDC	
Duct - Flanged: 1in Flg In	
Duct - Flanged: 1in Flg Out	
Duct - Flanged: 3/4in Flg Out	
Duct - Flg Connector: TDC	
Duct - Flg Connector: TDC EC	

Value
C1 Slide On Flange: DM-25
C2 Rolled Steel Flange: S&D
Rolled Steel Flange: TDC 25
Rolled Steel Flange: TDC 35
Rolled Steel Flange: TDF
Sheet Metal Flange: 25 TURN IN
Sheet Metal Flange: SMF 15
Sheet Metal Flange: SMF 20

Revit 2016 | 基于厂商的标准构件库

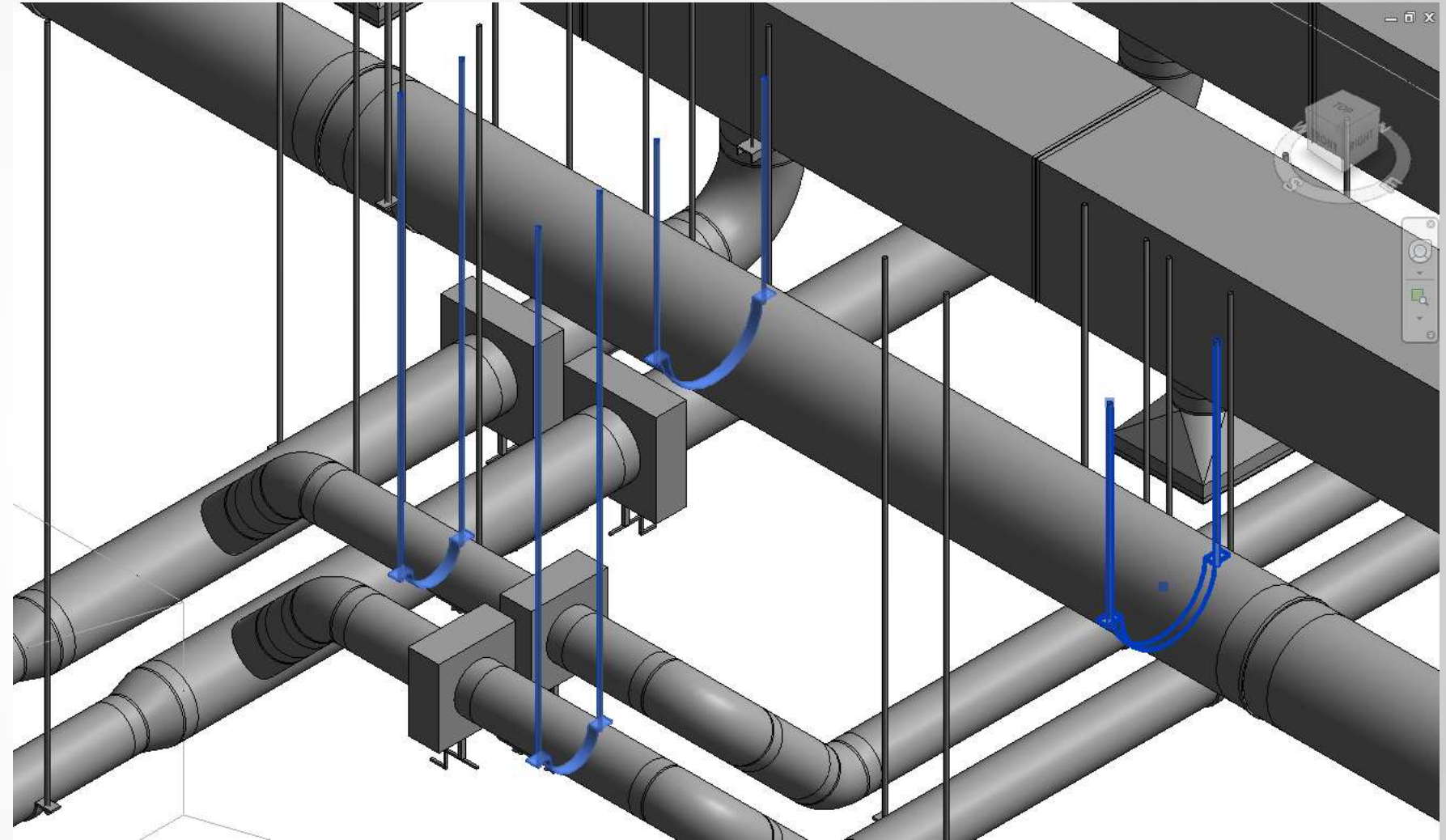
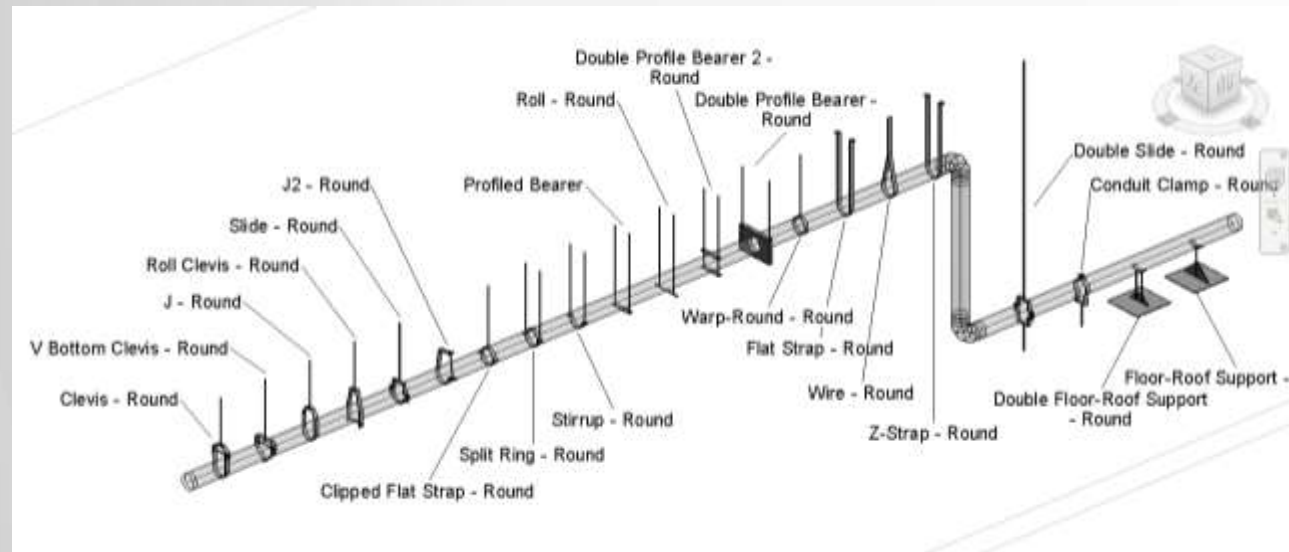
- 管件尺寸列表与厂商产品目录相符

A screenshot of the Revit Properties panel for a pipe bend. The panel is titled "Properties" and shows the following information:

- Pressed Bend - 45 Default
- Fabrication Parts (1) Edit Type
- Constraints
 - Offset: 0' 0"
 - Reference Level: Level 1
 - Product Entry: 3" (highlighted with a red circle)
 - Mechanical: 7" (highlighted with a red circle)
 - Part Material: 8"
 - Fabrication Ser.: 9"
 - Specification: 10"
 - Insulation Spec...: 12"
 - Insulation: Off
- Weight: 0.077 lbm
- More Parameters: Edit Part..
- Primary End
 - Main Primary D...: 3"
- Dimensions

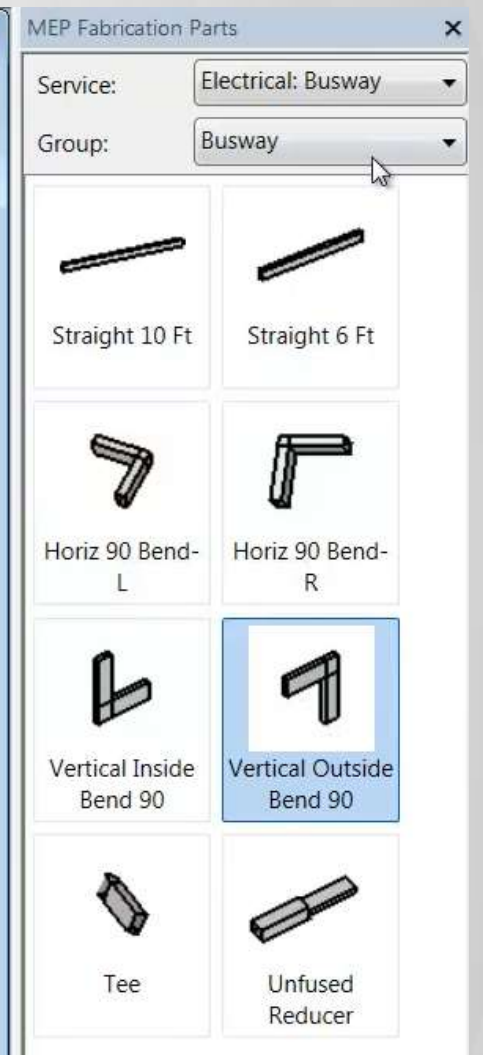
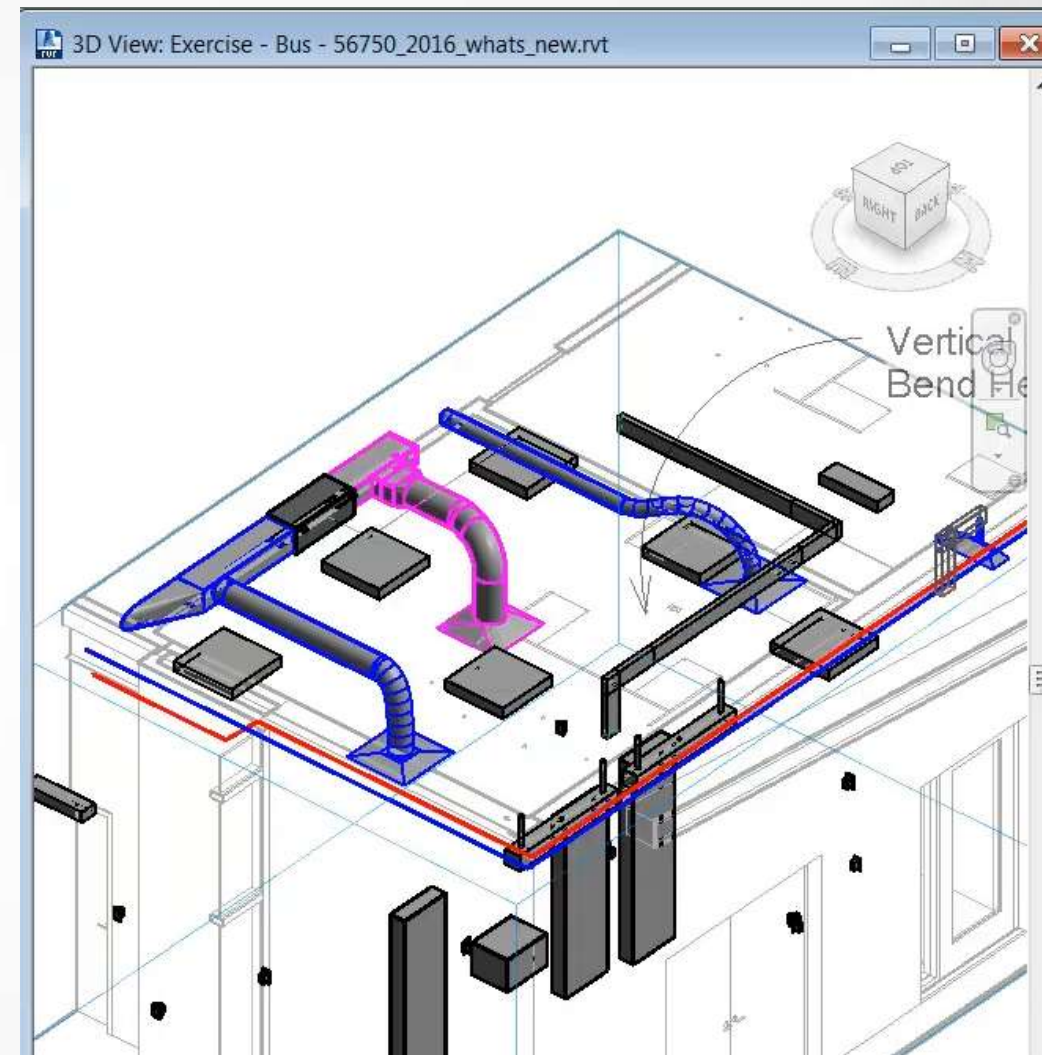
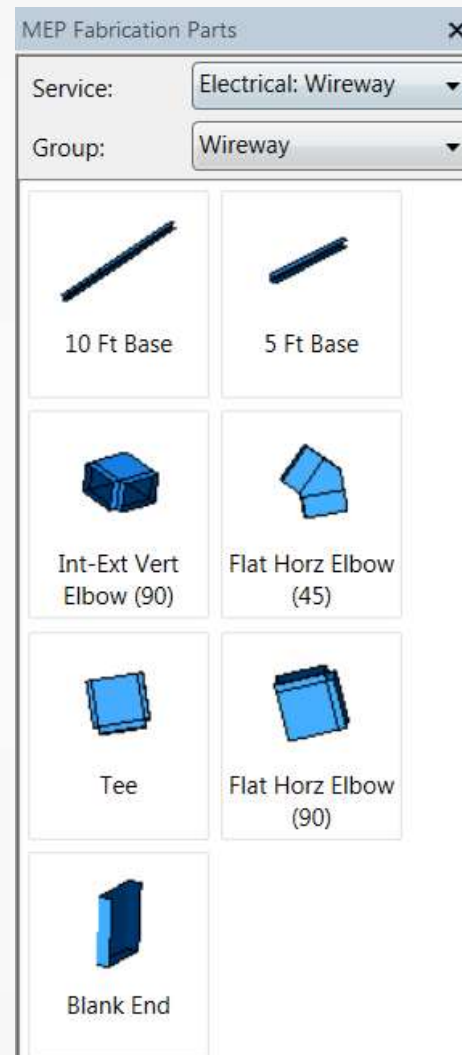
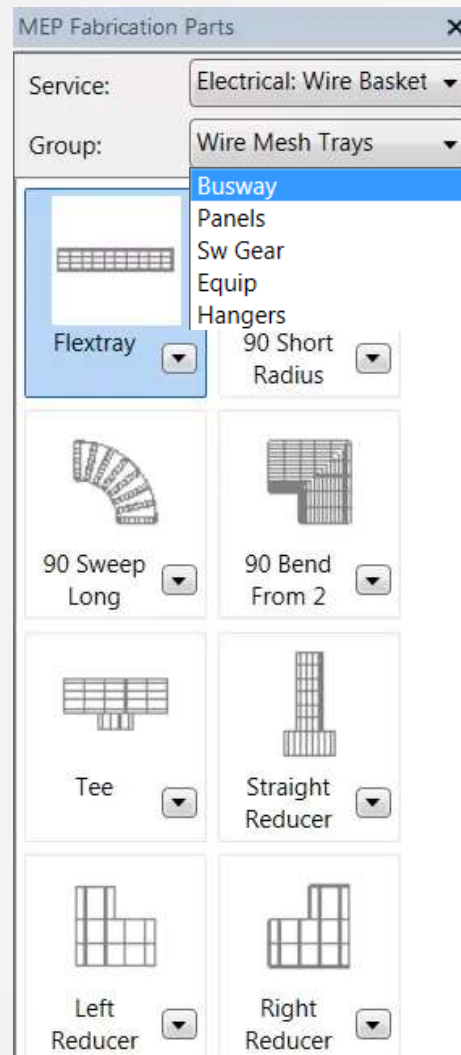
Revit 2016 | 支吊架建模

- 丰富的支吊架类型
- 自动匹配管径
- 自动附着到链接模型中的结构



Revit 2016 | 电缆桥架与电气总线

- 电缆桥架
- 网格桥架
- 电气总线



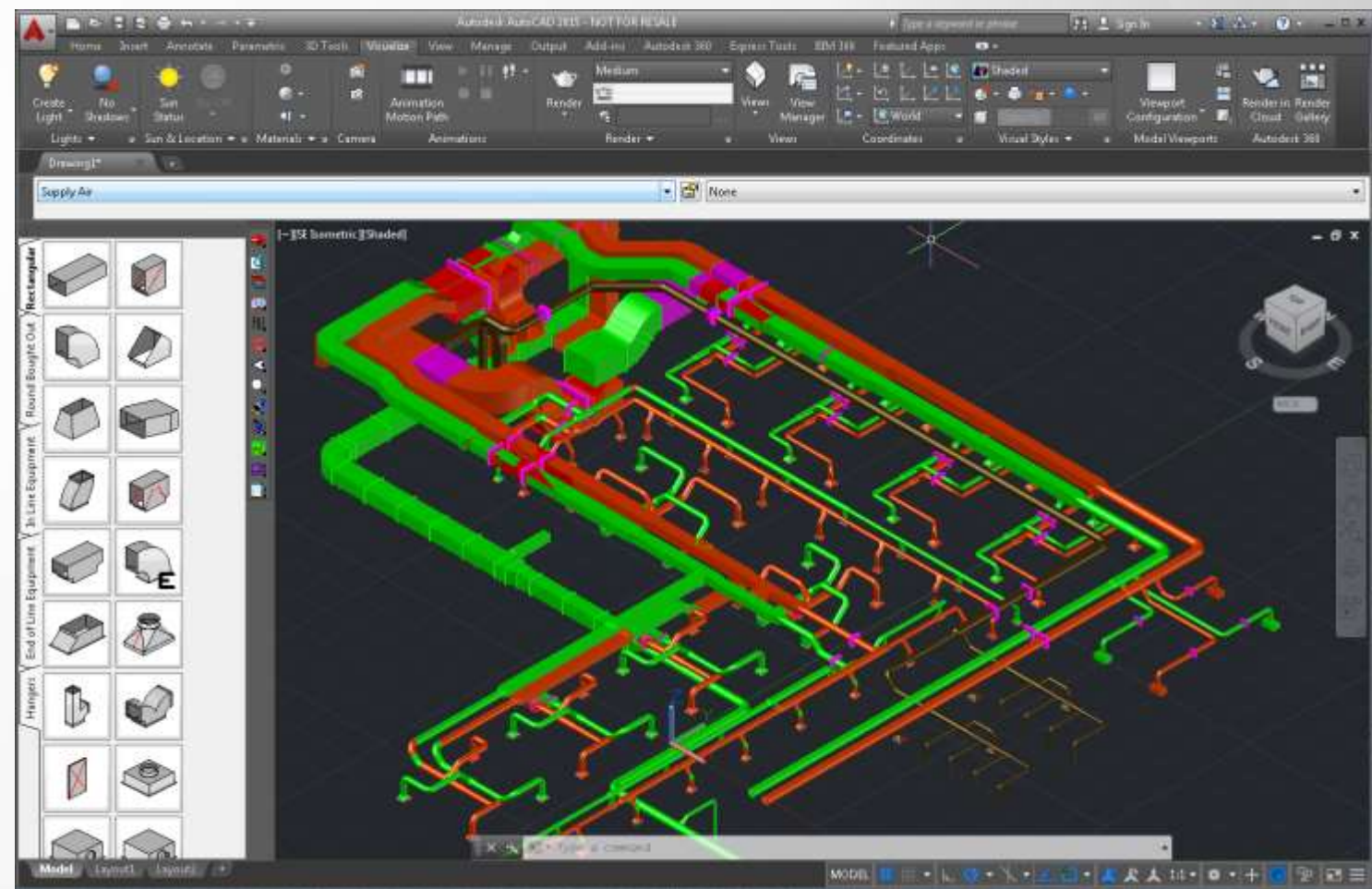
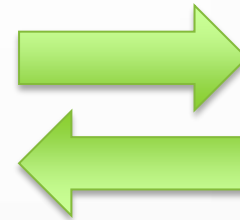
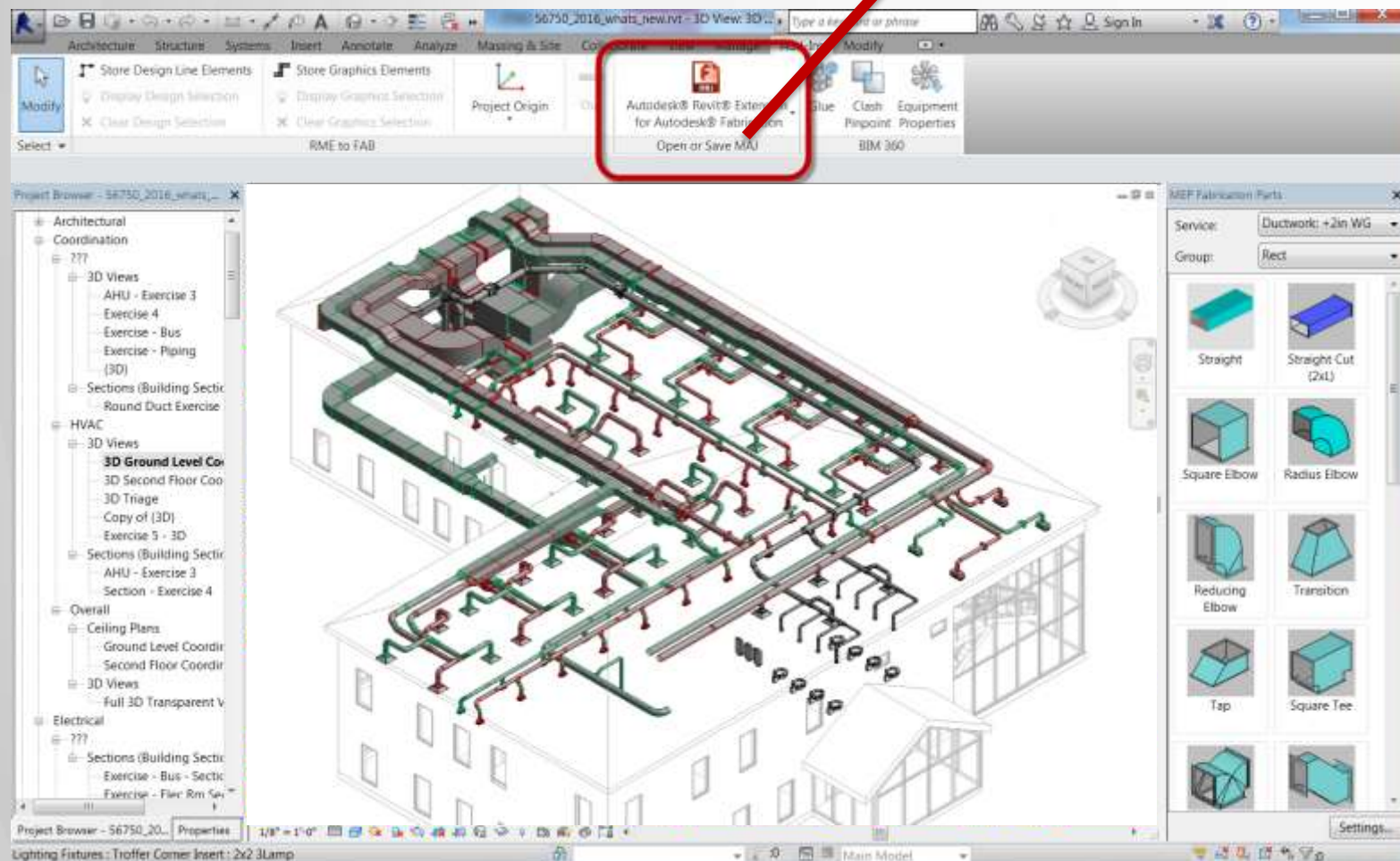
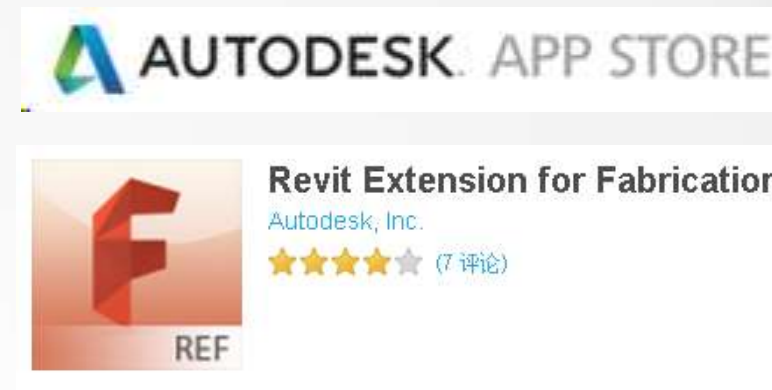
Revit 2016 | Revit与Fabrication产品的交互



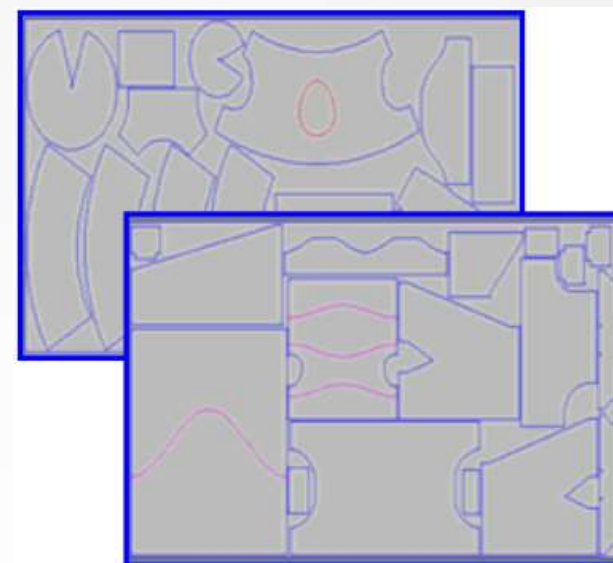
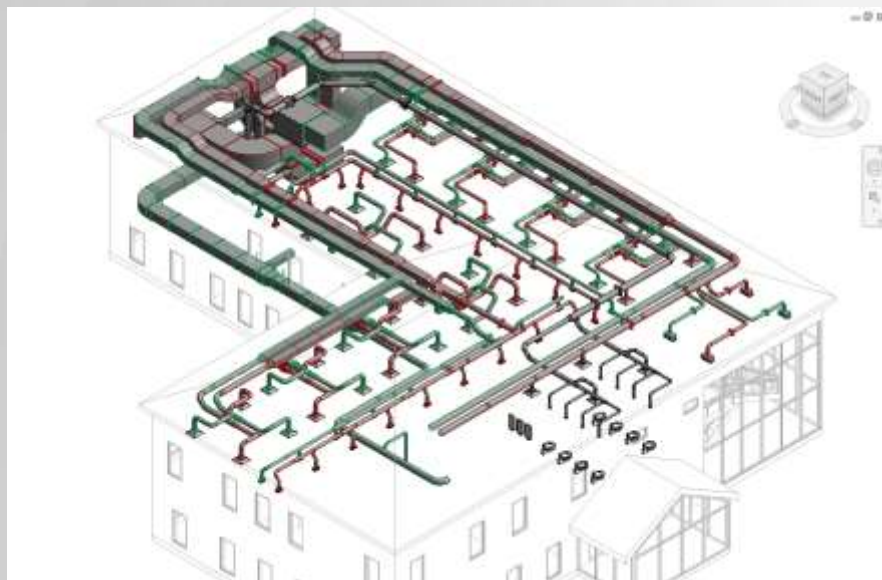
功能概要:

- 在Revit中使用真实构件的机电建模;
- 将Revit中的预制详图模型导出为Fabrication的工程文件;
- 在Fabrication软件中编辑后的工程文件可以导入到Revit中。

Revit Extension for Fabrication 工具



提高风管制造质量与效率



Revit预制详图模型



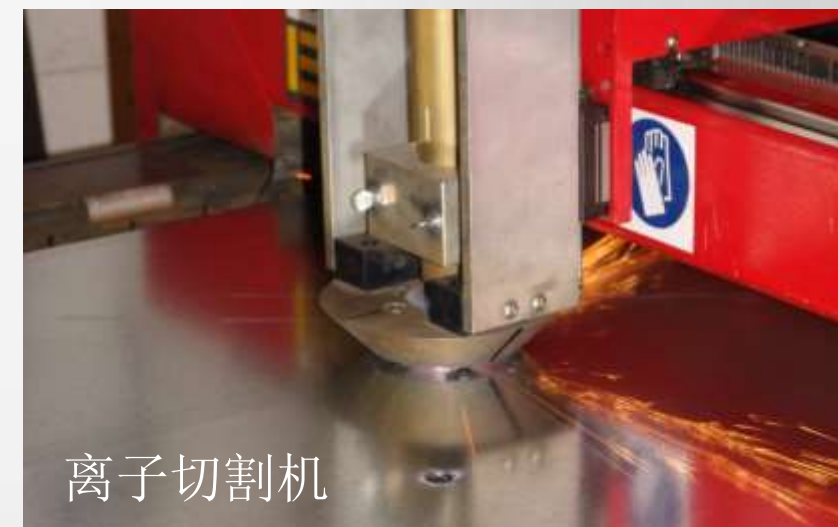
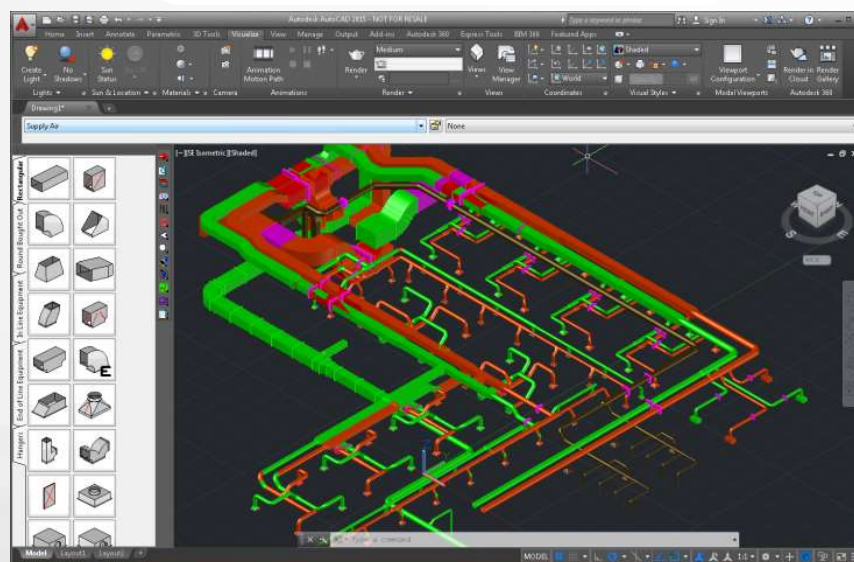
Fabrication Job



CAMduct风管展开下料图



导出到数控机床



离子切割机

总结 | 建筑机电 BIM 应用

