Carnegie Mellon University

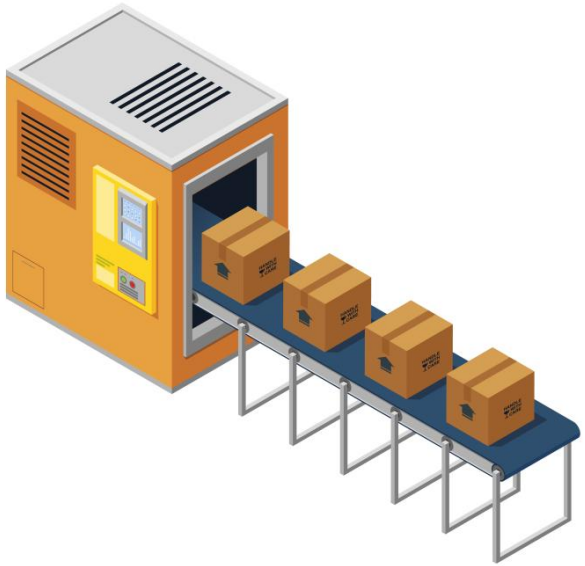
Week 5 – Lecture
Design Automation

Old Ideas

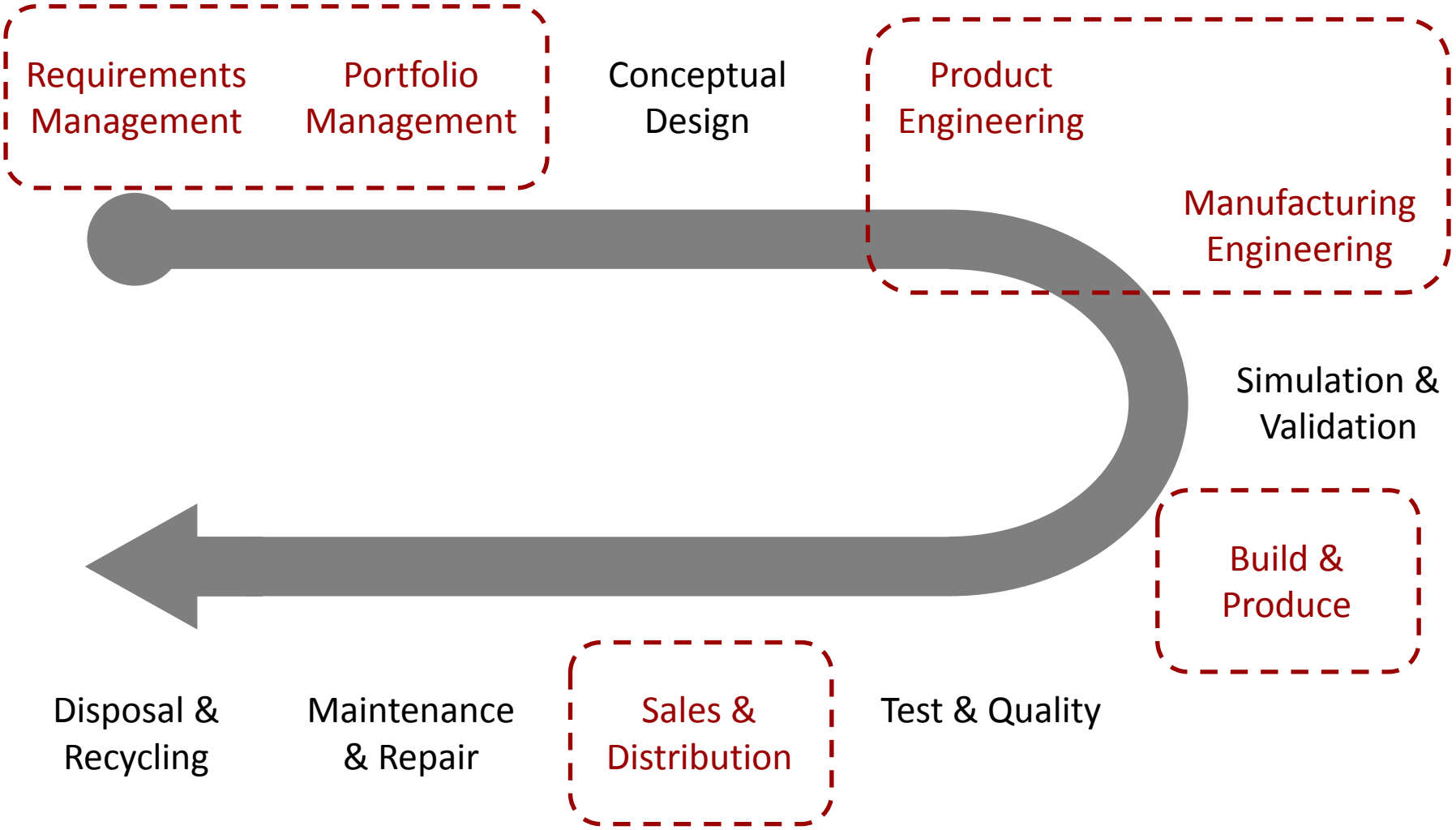
"You can have any color you want, as long as it is black"
– Henry Ford

Design Automation Overview

- Design automation is the process of automating the engineering requirements of product design reducing the need for human tasks.



Product Lifecycle – Week 5



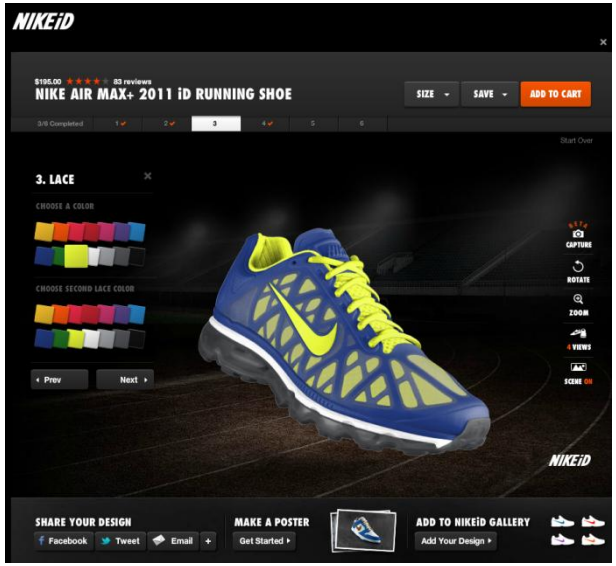
Market Opportunities

Customer Personalization

Niche Markets

Market Examples

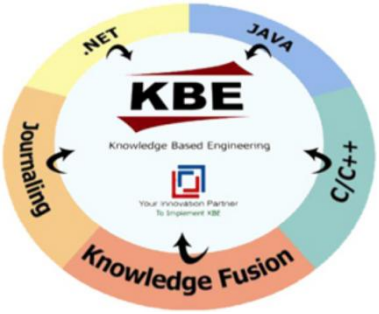
Personalization

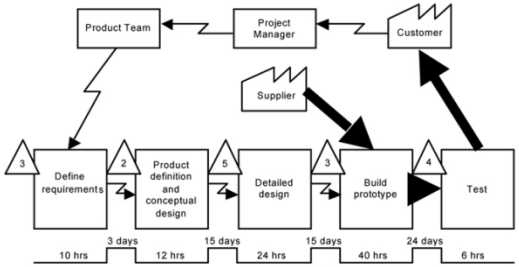


Niche Markets

Common Terms

- Knowledge Based Engineering (KBE)
  - Embedding knowledge elements into CAD models for standardization and automation.
- Engineer-to-Order (ETO)
  - Method of automating product that is engineered and manufactured differently per each order derived from a set of rules.
- Configure-to-Order (CTO)
  - Method of manufacturing to allow create variable products from base product.
- Design Automation
  - Methods and tools to automate and streamline design tasks





Design Automation Benefits

- Improve Profits (Time and Money)
- Address Niche and Personal Markets
- Decrease Time to Market
- Provide Accurate Product Cost Estimates
- Improved Sales Tools and Proposals
- Perfect Product Quality

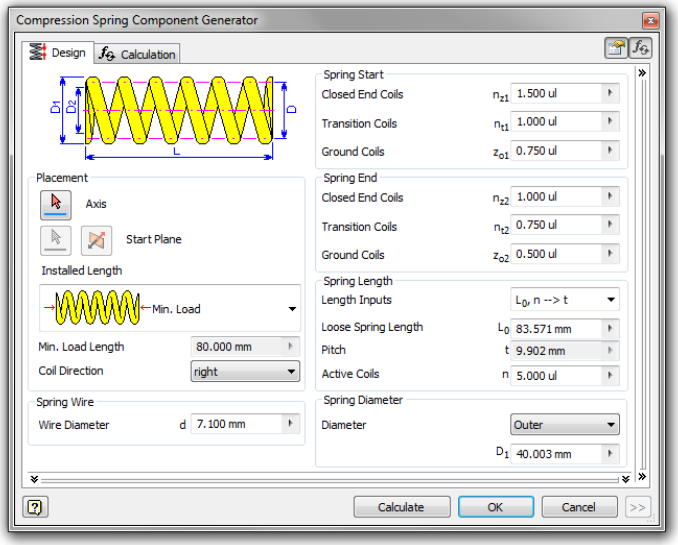
KBE Overview

Knowledge Based Engineering (KBE) is the embedding of rules in designs for:

- Capturing
  - Capture within your design models critical knowledge and logic
- Sharing
  - Once design logic is captured you can easily share and reuse.
- Reapplying
  - Leverage the logic downstream for automating tasks

KBE Examples

Spring Generator

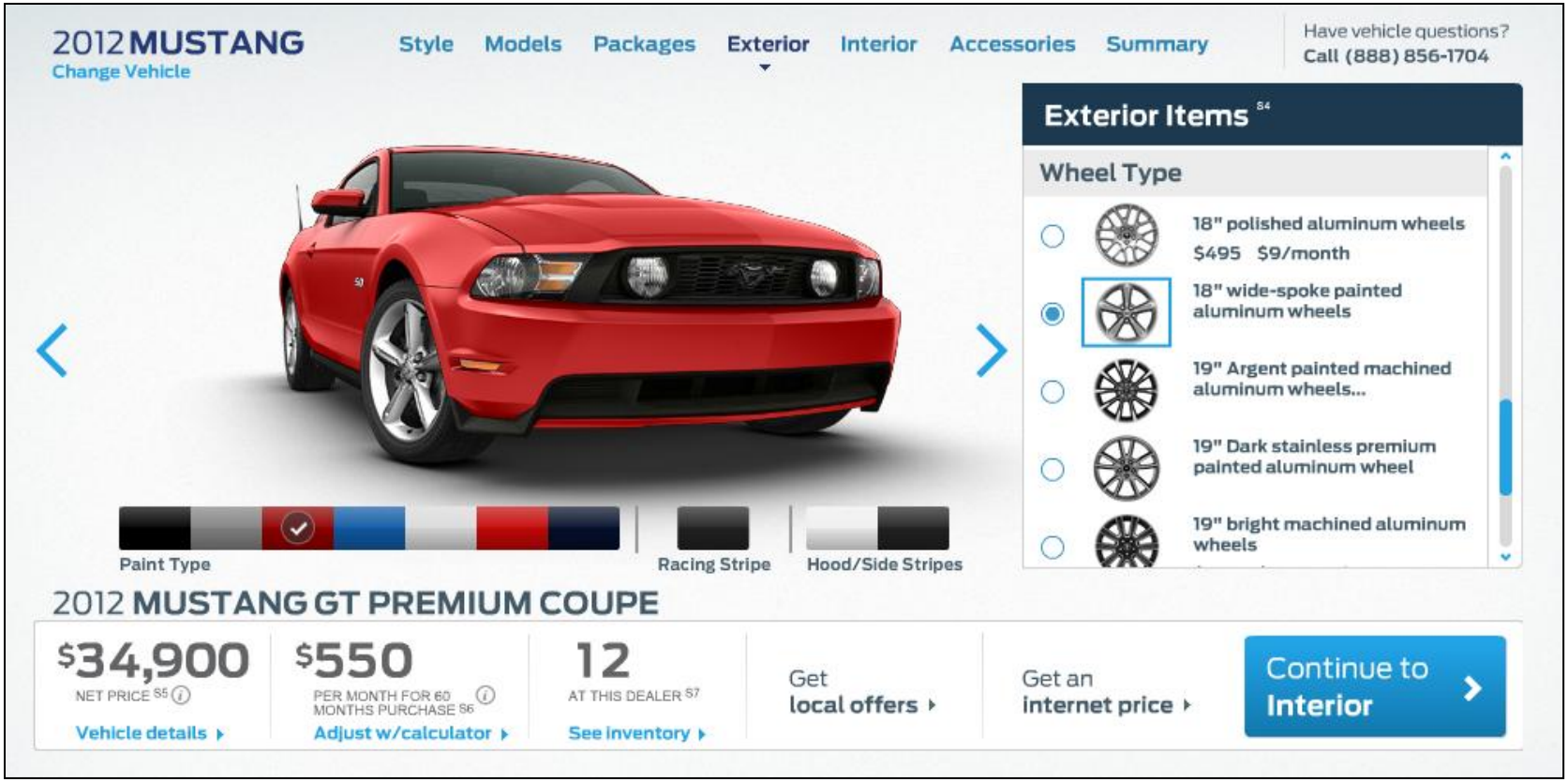


Clamp Cylinder

Configure-to-Order (CTO) Products

- The product has been designed with a fixed set of variations.
- All components generally already have been assigned a part number.
- In most cases there is no engineering time required to fulfill the specific product order.
- Products may have some automated one off personalization elements.

CTO Product Example



Engineer-to-Order (ETO) Products

- Products have established rules that require inputs to create infinite product variations.
- There are often components that specific to the one single product order.
- There is often engineering required per each order and is often automated.
- Product order often result in one off product designs.

ETO Product Example

Source: XXXXX

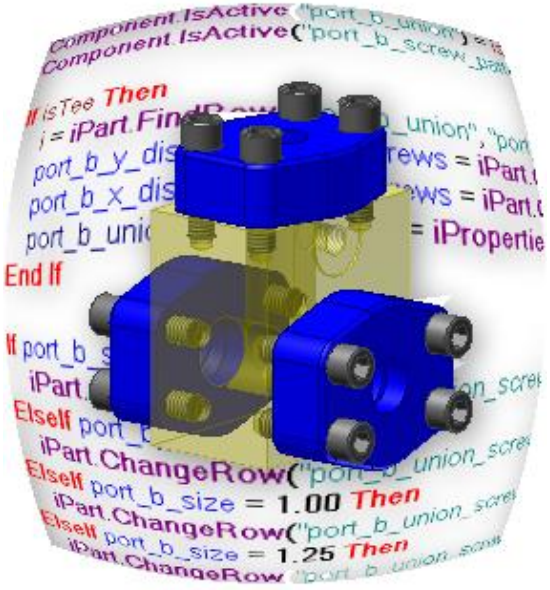
Supporting Applications

- Enterprise Resource Planning (ERP) System
  - CTO products can be fully configured and processed just from managing the BOM within the ERP system in some cases.

- Autodesk Inventor
  - **iLogic**
    - Embedded KBE rules (code) within model files
  - **Autodesk Inventor Engineer-to-Order**
    - Development platform for ETO solutions
  - **Custom Programming**
    - Writing custom code using API of application

iLogic Overview

- iLogic is an integrated, rules-based development environment within Autodesk Inventor for Knowledge Base Engineering.

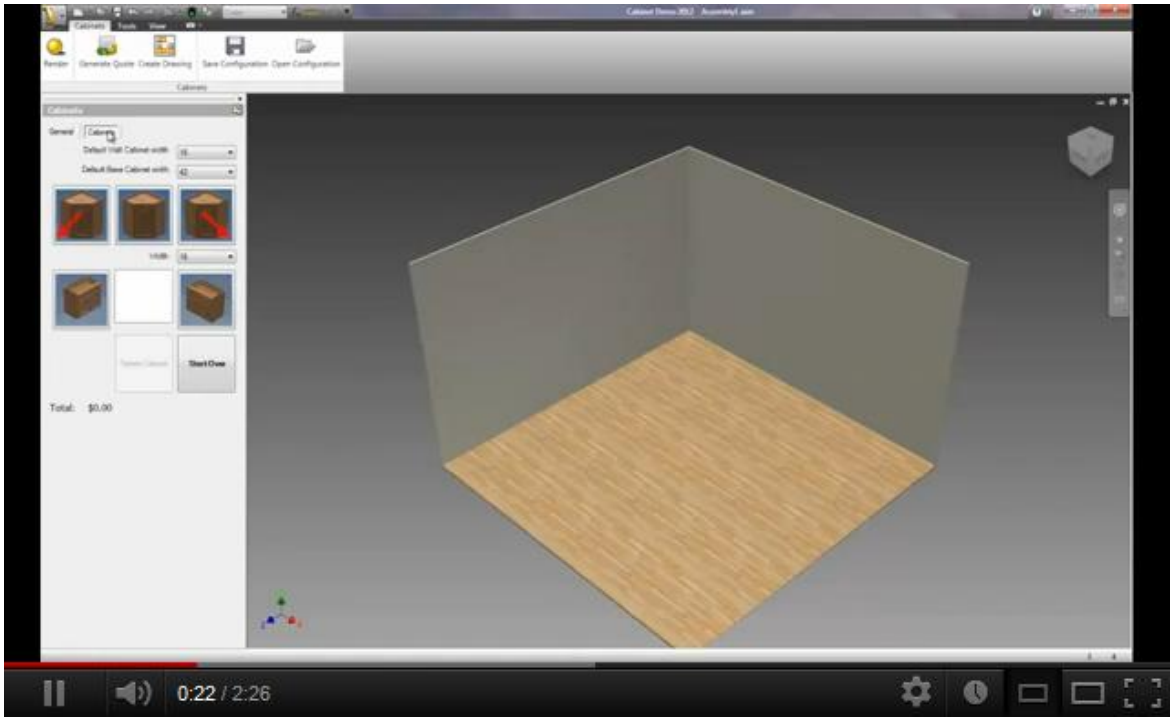


Autodesk Inventor ETO Overview

- Autodesk® Inventor™ Engineer-to-Order software serves as a flexible development platform for building specialized applications for configurable systems.

Autodesk Inventor ETO Demo

- Live Demo
  - http://etosamples.autodesk.com/Conveyor
- Video demo of Autodesk Inventor ETO



ASC - Case Study

Challenge

To handle the complexity of designing and building autoclaves quickly and efficiently, ASC needed to automate its engineering and design process with Autodesk Intent.

Results

- Enabled users to validate design and engineering decisions as they worked, minimizing the need for physical prototypes.
- Reduced autoclave design time from 16 weeks to only hours.
- Enabled engineers to spend their time improving the product as opposed to modeling.

"A typical autoclave can take even an experienced engineer up to 16 weeks to design and model. With the help Autodesk Intent, we can reduce that timeline to just a few hours."

Dave Mason
President
ASC Process Systems
United States

Evans Consoles - Case Study

Challenge

To achieve double-digit growth and stay ahead of the competition, Evans Consoles needed to accelerate and simplify the concept-to-manufacture process of its design automation programs.

Results

- Doubled sales and tripled the company's opportunity list within 12 months.
- Slashed design time from weeks to only minutes.
- Vastly improved communication between design engineers and the shop floor.

"Autodesk Inventor Automation helped us improve our bottom line by allowing us to provide real-time quotations to customers and get products out to the marketplace without adding new designers. In fact, our business has literally doubled in the last 12 months and our headcount has remained relatively the same."

Greg Smith
CEO
Evans Consoles
Canada

Evans Consoles Video

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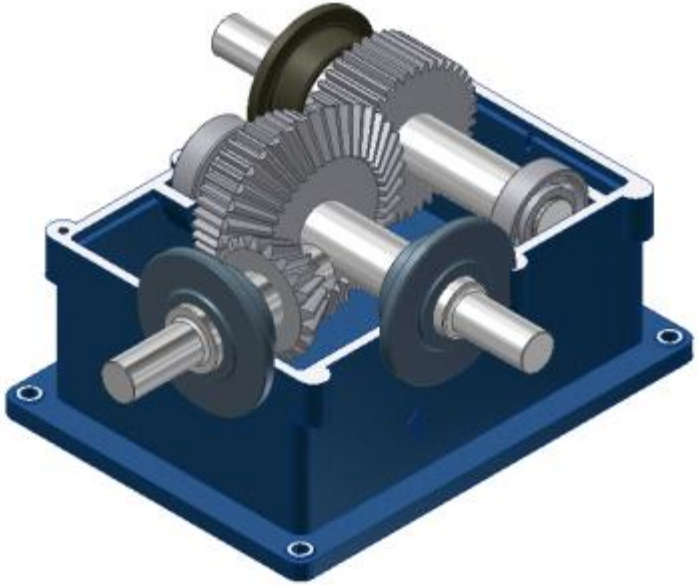
Computer-Cluster Projects (CP5)

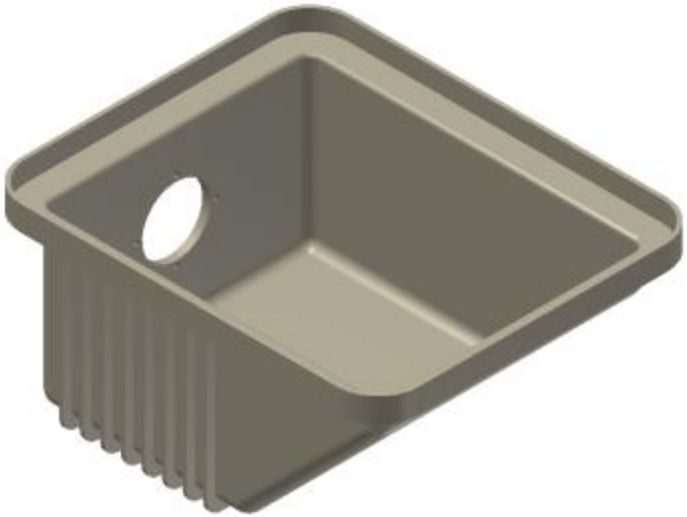
Guided Lab Project 1

- Guided instructions for automated gear creation using design accelerators.



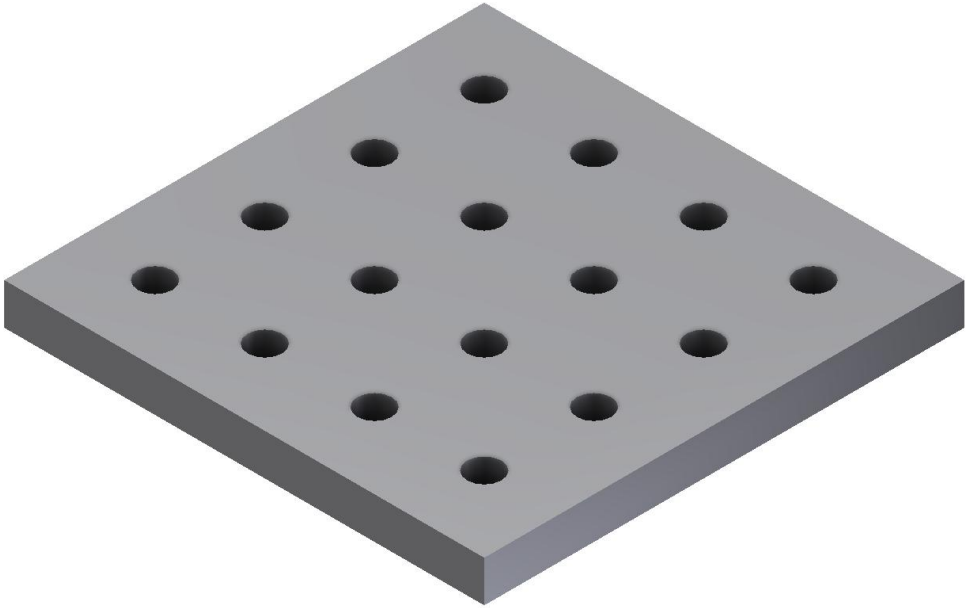
Guided Lab Project 2

- Guided instructions for introduction to iLogic.



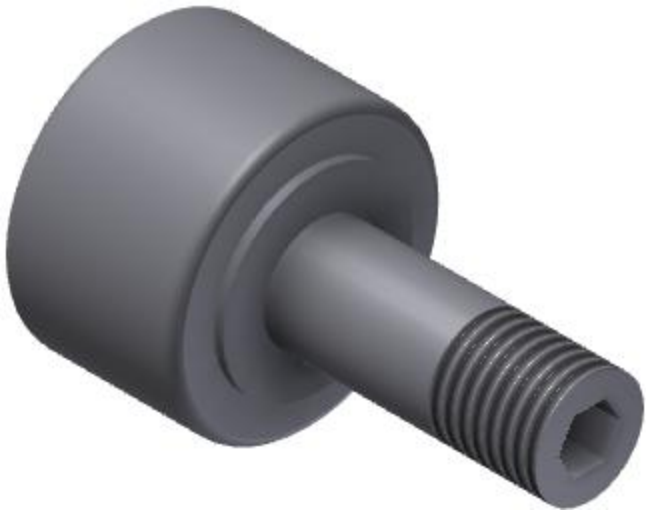
Guided Lab Project 3

- Guided instructions for iLogic conditional statements.



Guided Lab Project 4

- Guided instructions for iLogic Microsoft Excel Snippet.

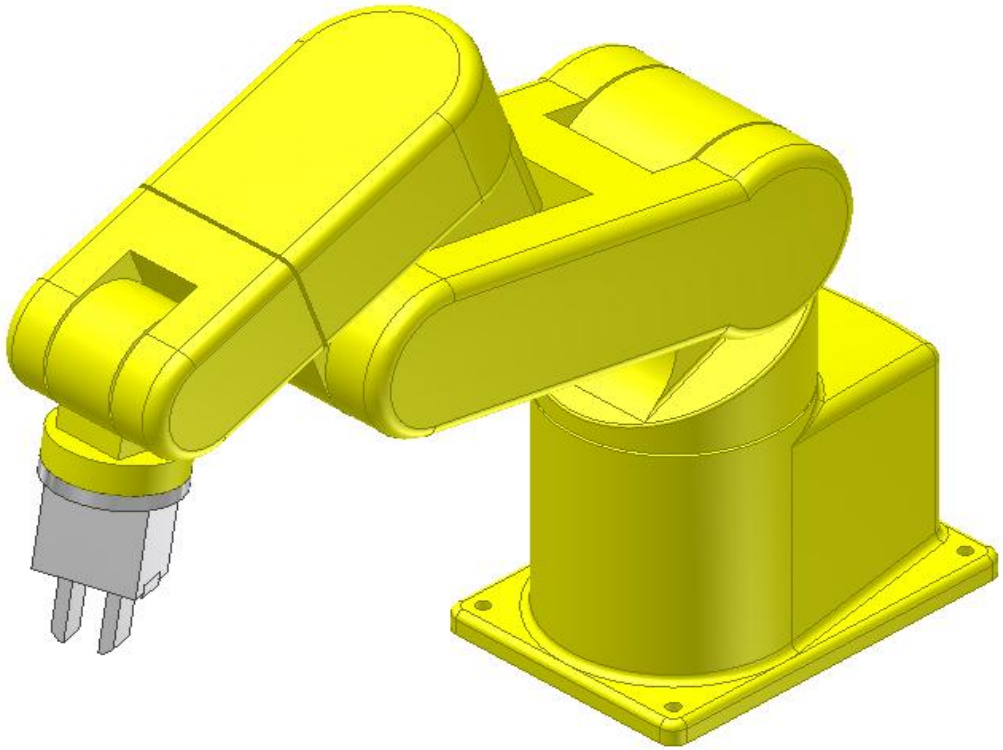


Guided Lab Project 5

- Guided instructions for iLogic assembly configurations.

Project Set Assignment

- Creation of configurable robot assembly.



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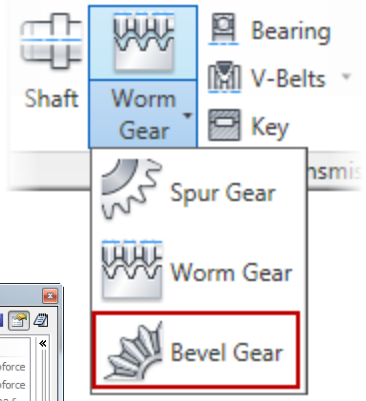
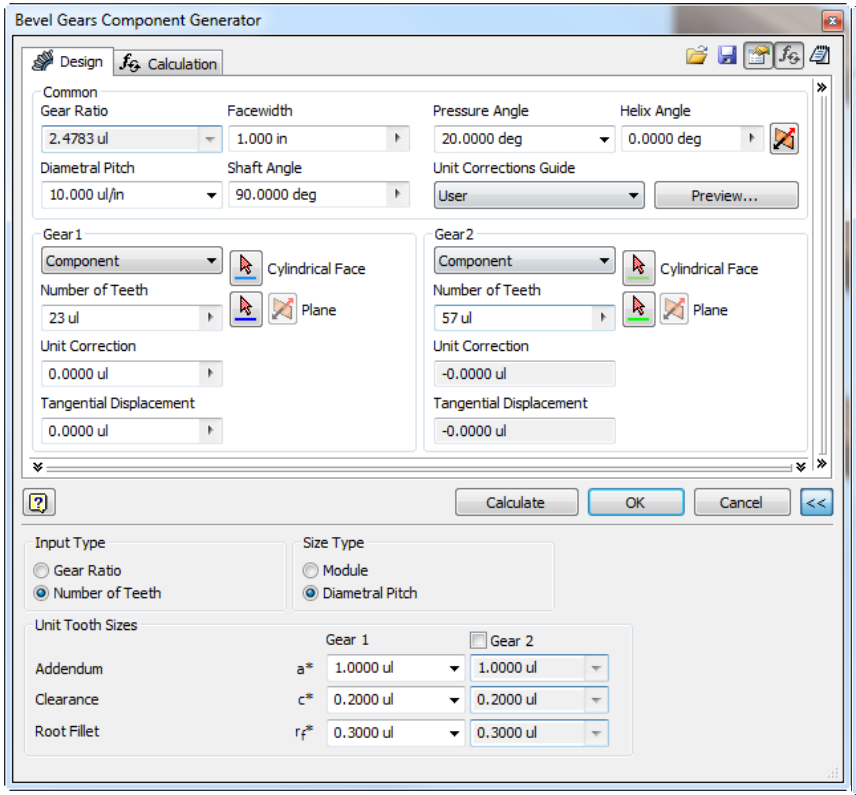
Design Automation Demo Topics

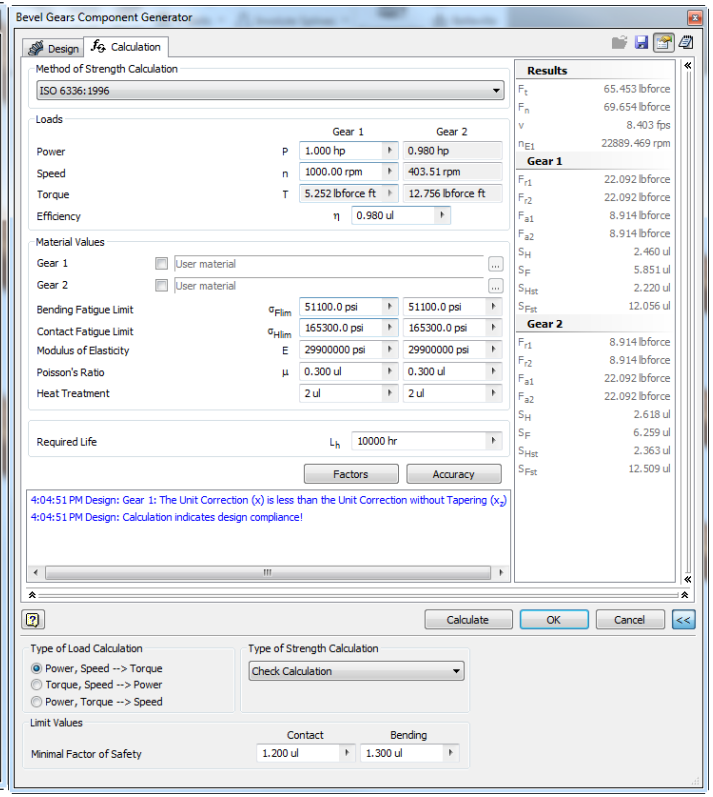
Bevel Gear Design Accelerator

- **Bevel gear**

  Ribbon: **Design** tab | **Power Transmission** panel







iLogic Panel

- **iLogic -** Ribbon: **Manage** tab | **iLogic** panel

Add rule: The Add Rule command enables you to add a rule to your model in inventor

Rule Browser: The Rule Browser command shows all rules applied in the current document

Event Triggers: The Event Triggers command helps you enable or disable the rules applicable for events.

iTrigger: iTrigger is a user parameter you can use to activate rules manually. It can execute one or more rules

Regenerate All Rules: This command helps you synchronize the parameters in the rules with your model.

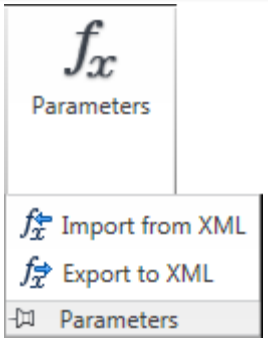
Delete All Rules: This command deletes all the rules associated with your model. This is ideally used after configuring the model to export a sample configuration.

About iLogic: This command gives you the details of the iLogic Extension

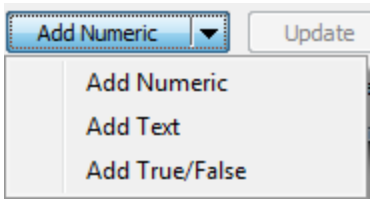
Parameters Panel

- **Parameters**

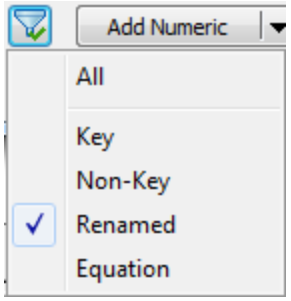
  Ribbon: **Manage** tab | **Parameters** panel



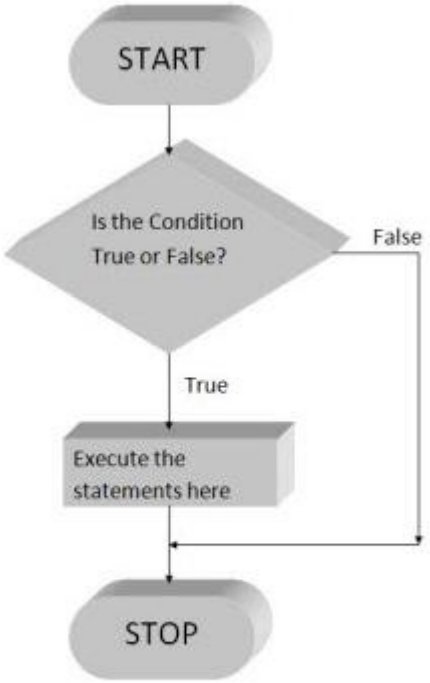
- Add Text
- Add True/False



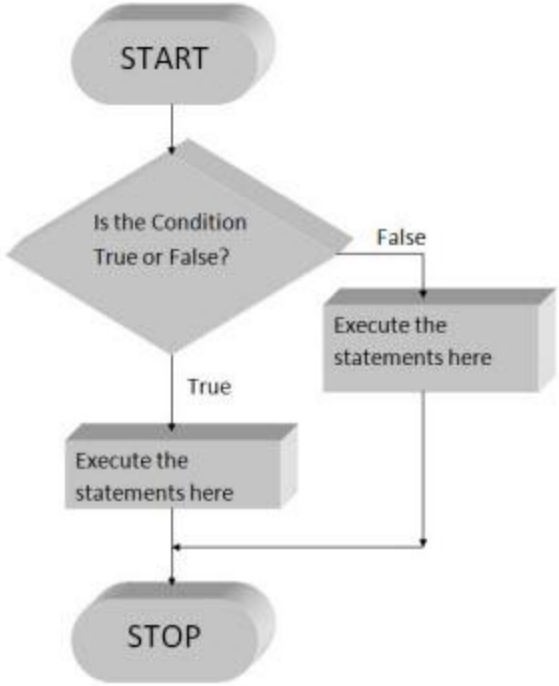
- Filter



If-Then-Else Statement



The working of an **if-then** conditional statement

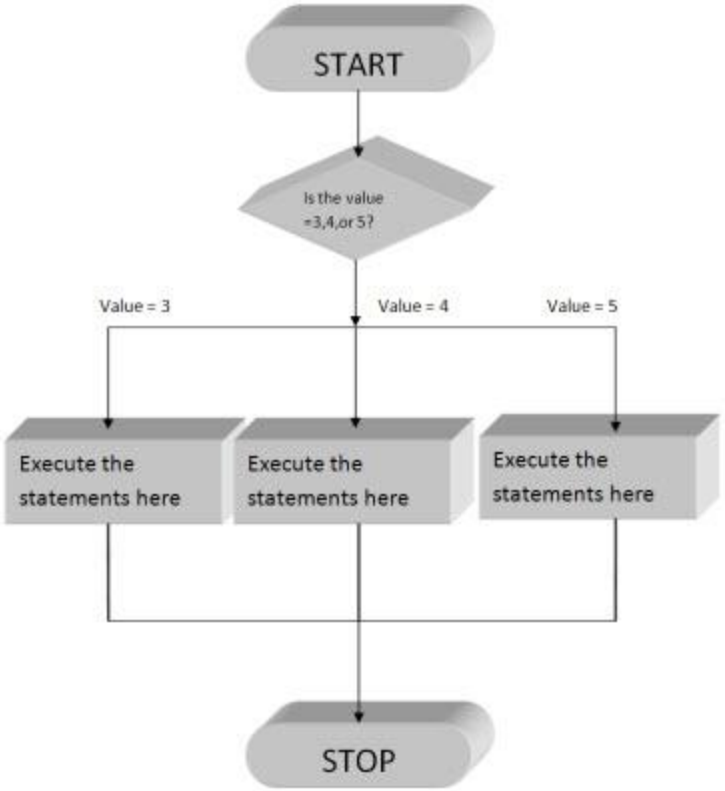


The working of an **if-then-else** conditional statement

```
If Length = "long" Then
   Boxsize = 10.0
End If
```

```
If Length = "long" Then
   Boxsize = 10.0
Else
   Boxsize = 6.0
End If
```

Select Case Statement

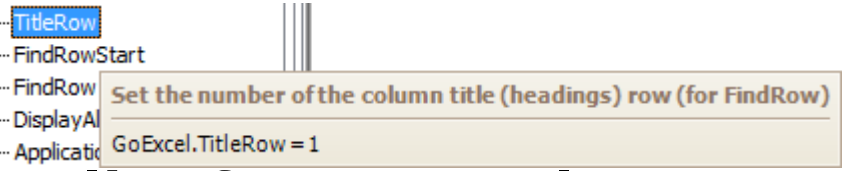



```
Select Case Liquid

      Case "Water"
            Density = 1000
      Case "Turpentine"
            Density = 868.20
      Case "Kerosene"
            Density = 817.15

Case Else

      Density = 0
      MessageBox.Show("Not a valid material", "Warning")

End Select
```

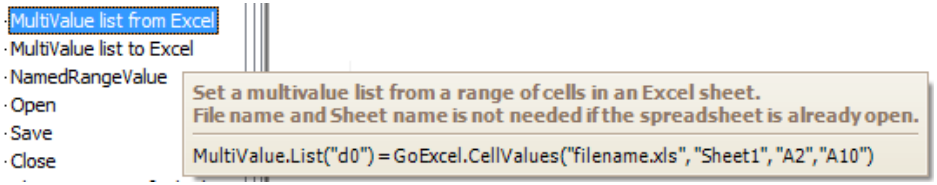
```
Select Case True

      Case Viscosity >= 5
            Density = Viscosity + 10
            Volume = 100/Density
      Case Viscosity < 5
            Density = Viscosity + 5
            Volume = 50/Density
End Select
```

Excel Data Links Snippets

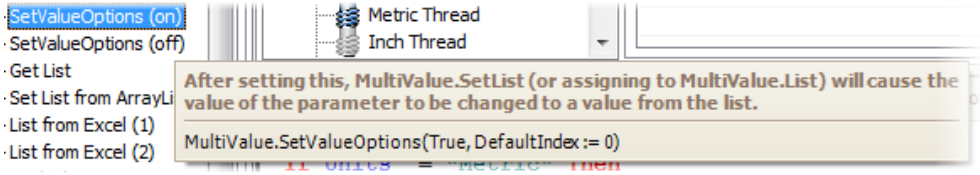
- **TitleRow**



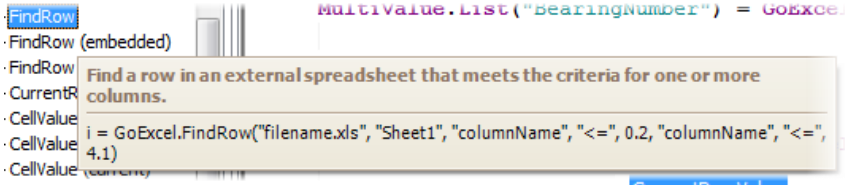
- **MultiValue list from Excel**



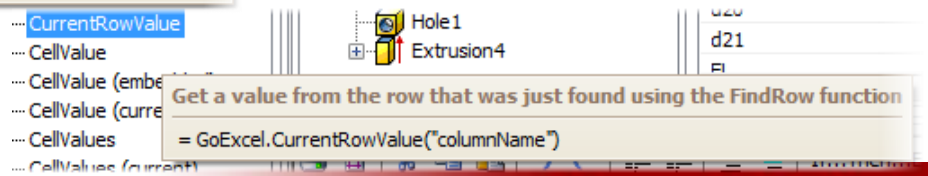
- **SetValueOptions (on)**



- **FindRow**



- **CurrentRowValue**



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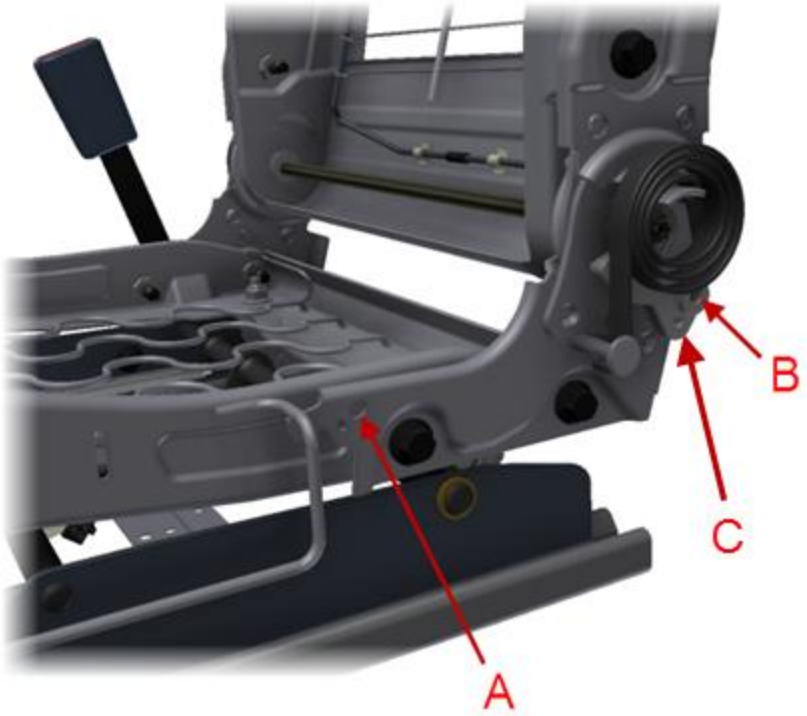
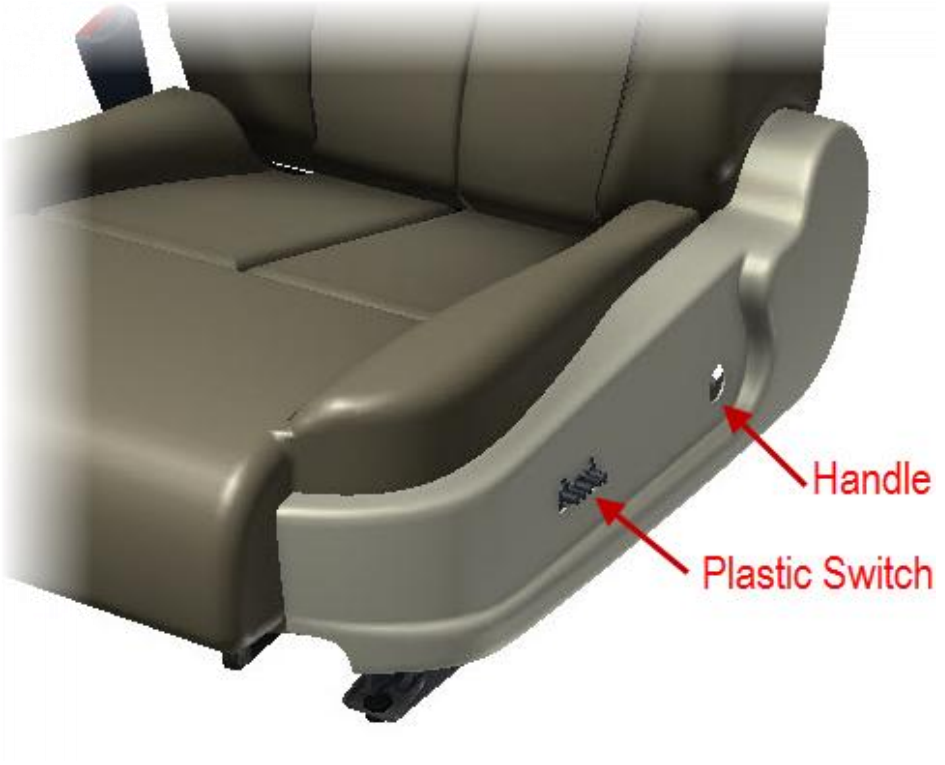
CAD Project

CAD Project Overview

- Design seat handle release mechanism and assemble of side controls.





CAD Project Provided Items

- Project Assignment Document
- Seat Assembly Model
- Side Plastic Shield Cover and Electrical Switch Parts
- Design Requirements
- Project Schedule

CAD Project Deliverables

- Interim Report – Due 8am October 10, 2012
  - Submit conceptual design sketch images of handle and seat switch pad.
  - Submit project task list with resource assignments
- Final Report – Due 8am October 17, 2012
  - Submit Autodesk Inventor model files and DWG files
  - Submit PowerPoint report file
  - Submit 5 min design presentation video (with audio explanation)
- Presentation
  – 8:30-10:20am October 18, 2012