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# Week 5 – Lecture Design Automation

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### **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



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**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:

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### 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

Compression Spring Component Generator							
Esign SG Calculation				<b>₽</b> f <sub>9</sub>			
	Spring Start Closed End Coils	n <sub>z1</sub>	1.500 ul	* *			
	Transition Coils	n <sub>t1</sub>	1.000 ul	P.			
	Ground Coils	z <sub>o1</sub>	0.750 ul	•			
Placement	Spring End						
Axis	Closed End Coils	n <sub>z2</sub>	1.000 ul	P.			
Start Plane	Transition Coils	n <sub>t2</sub>	0.750 ul	P.			
	Ground Coils	z <sub>o2</sub>	0.500 ul	F			
Installed Lengur	Spring Length						
→ WWWWW ← Min. Load +	Length Inputs		L <sub>0</sub> , n> t	-			
	Loose Spring Length	Lo	83.571 mm	•			
Min. Load Length 80.000 mm	Pitch	t	9.902 mm	- F			
Coil Direction right -	Active Coils	n	5.000 ul	P.			
Spring Wire	Spring Diameter						
Wire Diameter d 7.100 mm	Diameter		Outer	•			
		D1	40.003 mm	F			
v     v       Image: State of the s							



# **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**



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# **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

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# **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.



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## **Autodesk Inventor ETO Overview**

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



## **Autodesk Inventor ETO Demo**

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



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## **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



# Results Double



Doubled sales and tripled the company's opportunity list within 12 months.

process of its design automation programs.

- 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

To achieve double-digit growth and stay ahead of the competition, Evans Consoles needed to accelerate and simplify the concept-to-manufacture

### **Evans Consoles Video**



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## Computer-Cluster Projects (CP5)

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 Guided instructions for automated gear creation using design accelerators.



• Guided instructions for introduction to iLogic.



Guided instructions for iLogic conditional statements.



 Guided instructions for iLogic Microsoft Excel Snippet.



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 Guided instructions for iLogic assembly configurations.



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## **Project Set Assignment**

• Creation of configurable robot assembly.



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# Design Automation Demo Topics

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## **Bevel Gear Design Accelerator**

Bevel gear

Ribbon: Design tab | Power Transmission panel

vel Gears Component Generator	X	Bevel Gears Component Generator	
Design 🚱 Calculation	2 Ref 2	Sesign fg- Calculation Method of Strength Calculation	Results
Common       Gear Ratio       Facewidth         2.4783 ul       ▼       1.000 in       ▶         Diametral Pitch       Shaft Angle       10.000 ul /n       ♥         Gear 1       ✓       Ø0.0000 deg       ▶         Gear 1       ✓       ✓       Cylindrical Face         Number of Teeth       ✓       ✓       Plane         Unit Correction       ✓       ✓       Plane         Unit Correction       ✓       ✓       ✓         0.0000 ul       ▶       ✓       ✓	Pressure Angle Helix Angle   20.0000 deg 0.0000 deg   Unit Corrections Guide   User Preview   Gear2   Component   Number of Teeth   57 ul   S7 ul   Displacement   -0.0000 ul   Plane   Tangential Displacement   -0.0000 ul	ISO 6336:1996           Loads         Gear 1         Gear 2           Power         P         1.000 hp         0.380 hp           Speed         n         1000.00 rpm         403.51 rpm           Torque         T         5.252 biforce ft         1.2.756 biforce ft           Efficiency         η         0.980 ul         >           Material Values         Gear 1         User material         Gear 2           Gear 1         User material         Gear 3         51100.0 psi         51100.0 psi           Modula of Elebatty         E         2990000 psi         \$2990000 psi         2990000 psi           Poisson's Rato         μ         0.300 ul         >         0.300 ul         >           Required Life         Lh         10000 hr         E         200000 psi         2 ul         2 ul	Fr.         65.453 bforce           Fn         69.654 bforce           V         8.403 fps           net         22889.469 rpm           Gear 1         1           Fr.1         22.092 bforce           Fa2         8.914 bforce           SH         2.4092 bforce           Fa2         8.914 bforce           SH         2.400 ul           SFH         2.2001 Sforce           Fr1         8.914 bforce           Fr2         8.914 bforce           Fr4         2.200 ul           SFH         2.200 ul           SFH         12.056 ul           Gear 2         12.056 ul           Fr4         8.914 bforce           Fa2         22.092 bforce           Fa2         22.092 bforce           Fa2         22.092 bforce           SFH         2.618 ul           SFH         2.618 ul           SFH         2.33 ul           SFH         2.33 ul           SFH         2.33 ul           SFH         2.303 ul           SFH         2.509 ul           SH         2.509 ul
nput Type Size Type Gear Ratio Module Number of Teeth Diametral Pitc Jnit Tooth Sizes Gear 1	Calculate OK Cancel <<	4:04:51 PM Design: Gear 1: The Unit Correction (x) is less than the Unit Correction without Tapering I         4:04:51 PM Design: Calculation indicates design compliance!         (c)         (c) <t< td=""><td>Cancel K</td></t<>	Cancel K
Addendum         a*         1.0000 ul           Clearance         c*         0.2000 ul           Root Fillet         rf*         0.3000 ul		Power, Speed> Torque     Orque, Speed> Power     Orque, Speed> Power     Unit Values     Contact Bending	

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Bearing

Key Key

Spur Gear

Shaft

Worm

Gear

V-Belts

nsmi

# **iLogic Panel**

### • iLogic - Ribbon: Manage tab | iLogic panel





**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.



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**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



Add Numeric 💌	Update
Add Numeric	
Add Text	
Add True/False	



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### **If-Then-Else Statement**



The working of an if-then conditional statement

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

The working of an if-then-else conditional statement

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

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### **Select Case Statement**



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## **Excel Data Links Snippets**



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## **CAD** Project

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## **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