

# EN1740 Computer Aided Visualization and Design

# Spring 2012

4/17/2012 - Lecture B

Brian C. P. Burke

# Brown University

#### Last Time:

- Intro to GD&T
- Motion analysis with Pro/E

#### Tonight:

• Motion analysis with Pro/E

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## **EXERCISE** - Motion Analysis

#### How system rotates the assembly

- Click Define Servo Motor
  - Name it crank
  - Select Motion Axis
  - Click axis on crank shaft (should come up as Connection\_1.axis\_1)

Servo Motor Definition		
Crank	╸┉╦┉╬╗╡╡┇┇╗╝╝	
Type Profile Briven Entity		
Motion Axis     Geometry     Connection_1.axis_1	Connection 7	
Flip		
OK Apply Cancel		
Sprt SmcCHANISM Bug BODIES CONNECTION		
MOTORS     STRINGS     AMPERS     FORCES/TOR     MALYSES		
PLAYBACKS		×× • ***
Connection_7	Mechanism	<b>.</b>

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### **EXERCISE** - Motion Analysis

#### How system rotate the assembly

- Click Define Servo Motor
  - Click Profile tab
  - Select Velocity as Specification
  - Un-check Current and enter 0 as Initial Position
  - Select Constant as Magnitude
  - Enter 36 as a value
  - Click OK



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## EXERCISE - Motion Analysis

#### How system rotate the assembly

- Define a Mechanism Analysis
  - Click Mechanism Analysis icon
  - Make sure Type is set to Kinematic
  - Switch to Motor tab and make sure the crank motor is selected
  - Click Run
    - Stuff moves
  - Click OK



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### **EXERCISE** - Motion Analysis

How system rotate the assembly

- Click Playbacks icon
- Note our results are present
- Click Playback button
  - Animation dialog appears
  - Click Capture button to export

E PIST-CRANK (Active) - Pro/ENGINEER Education Edition		
Eile Edit View Insert Analysis Info Applications Tools Manikin Window Help		
[ 🛄 Playbacks	X X < Q 4 C 2 A C 2 A C 7	
		<b></b>
Result Set		
AnalysisDefinition1		
Collision Detection Settings		
Movie Schedule Display Arrows		X
🖻 🔽 Display Time		
		₩X
🖺 🗹 Default Schedule		g
	Animate X	2
Close	Frame	1
		×
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X MECHANISM		
GRAVITY		
SPRINGS → ☆ DAMPERS	Speed	
E ANALYSES		$\sim$
	Capture	× .
		×× ·
	Close	<i>z</i> <sup>(</sup> \
	i selected Mechanism	<b>)</b>

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## **EXERCISE** - Motion Analysis

#### How system rotate the assembly

• Click Save Current Set to Disk so analysis will be there when we get back

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B → PLAYBACKS	×
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	and here
1 selected Mechanism	2

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## **Motion Analysis**

#### Extended mechanism functionality

- Quantified motion analysis
- Mechanism components
  - Springs
  - Friction Forces
- Assumptions
  - All parts are steel
  - Rotation is 1000rpm



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# **EXERCISE** - Motion Analysis

#### Change the assembly units

- The parts are currently in mm-N-sec and the assembly is in in-lb-sec
- Change the assembly units to match the part
  - Back to Standard Application
  - Edit > Setup > Units
     > mm-N-sec
  - Set
  - Check Convert
     dimensions
  - OK







Assign density to each part

- Save the assembly
- Switch the application to Mechanism
- Select the Mass Properties icon

🖾 Mass Properties 🛛 🔀	
Reference Type	
Part	
Part	
Define Properties by	
Default	9) 
Coordinate System	
Basic Properties Center of Gravity	Is
Density X	
Volume Y	×
At Coordinate System Drigin	
At Center of Gravity	
lyy lxz	
Izz Iyz Iyz	×* ¥*
OK Apply Cancel	
	1 selected Mechanism 🖌 👌



Assign density to each part

- Keep Reference Type as Part
- Select the PISTON part
- Change *Define Properties by* dialog to Density
- Enter

7.827e-9 tonne/mm<sup>3</sup>

- OK
- Repeat the process for the other 2 components





- Go to mechanism model tree in the lower left
- Expand
  - Motors
  - Servo
- Open the *crank* motor we defined previously





• Click the Profile tab

📕 Servo Motor Definiti	ion 🛛 🔀
Name crank	
Type Profile Specification	]
Velocity 💊	deg/sec
Initial Angle Current	
60 0	deg
Magnitude Ramp	•
A 0 B 360	
Graph	<ul> <li>✓ Position</li> <li>✓ Velocity</li> <li>Acceleration</li> </ul>
	Apply Cancel

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- There are a number of ways to define the motion of the servo motor
- Input variable x is time
- Output variable is q, selected by user in Specification box
- Coefficients are defined by user to specify motion according to the definitions shown right



Magnitude Description Required Settings Type Constant Use for constant motion. q = Awhere A = Constant Use for a constant motion or a  $q = A + B^*x$ Ramp profile that changes linearly over where time. A = Constant B = Slope Cosine Use to assign a cosine wave value  $q = A^* \cos(360^* x/T + B) + C$ to the motor profile. where A = Amplitude B = Phase C = Offset T = Period SCCA Use to simulate a cam profile output. SCCA can only be used when Acceleration is chosen as the motion type. Cycloidal Use to simulate a cam profile  $q = L^* x/T - L^* sin (2^* Pi^* x/T)/2^* Pi$ output. where L = Total rise T = Period Parabolic Use to simulate a trajectory for a  $q = A^* x + 1/2 B(x^2)$ motor. where A = Linear coefficient B = Ouadratic coefficient Polynomial Use for generic motor profiles.  $q = A + B^*x + C^*x^2 + D^*x^3$ where A = Constant term coefficient

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- Redefine the crank motor to be
- Specify Position
- Use a Ramp Magnitude
  - A=0 (initial angular pos.)
  - B=6000
- Select Position and Velocity to graph
- Click graph icon



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- Back to the mechanism model tree in the lower left
- Expand Analyses
- RMB on the Analysis we had defined last time





- Drop down Analysis Type
- Note Type differences
  - Kinematic No mass or force
  - Dynamic Includes mass and force, nonzero acceleration
  - Static zero acceleration
- Set type to Kinematic
- Note duration definitions
  - Length and Rate Set speed
  - Length and Frame Count Set number
  - Rate and Frame Count Calculate rate

Analysis Definition	×
Name	
AnalysisDefinition1	
Kinematic	~
Preferences Motors Ext Loads	
Graphical Display	
Start Time U	
Length and Rate	~
Length and Rate	
Bate and Frame Count	
Fighte Hane Count	
Minimum Interval 0.0006	
	<b></b>
	<u> </u>
	I â
	X
	•
- Initial Configuration -	
Current	80
Snapshot:	
OK Run	Cancel



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- Set the Length and Frame Count
  - Set End Time to .06
  - Frame Count 101
- Click Run
- Go over to Playbacks and Save Analysis 🔲 Play

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	AnalysisDefinition1	
Count	Type Kinematic	
Journ	Preferences Motors Graphical Display	Ext Loads
	Start Time 0	
	Length and Frame D End Time 0 Frame Count 1	.06 01
	Frame Rate 1	666.67
ave	Locked Entities	.0006
🔲 Playback		믝
아 🕼 🕒 X 🖧 💣		
AnalysisDefinition1	✓	
Collision Detection Settings		
Movie Schedule Display Arrows		
✓ Display Time		
Default Schedule		OK Run Cancel
Close		

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- Click the Measures tool
- Click Create New
  Measure tool
- From Measure Definition
- Select Position as Type
- Click on the Servo motor icon on the crankshaft
- Click OK





- Double Click on the Results Set
- Click the Graph icon



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#### **Reset position**

- In Mechanism Tree expand Motors to find Rotation Axis
- RMB > Edit Definition
- Set Current Position to 0.0
- Done

