Machinery Cable Tutorial

This is a model of a rudder system for a light aircraft. You will first perform an analysis with the initial model which uses ideal couplers to transmit motion through the pulley system. Then you will replace the couplers with a cable system modeled via Adams/Machinery Cable.

This chapter includes the following sections:

- What You Will Create
- Creating Rudder Module
- Adams/PostProcessor Results

What You Will Create

During this tutorial, you will model a rudder system for a light aircraft. You will first perform an analysis with the initial model which uses ideal couplers to transmit motion through the pulley system. Then you will replace the couplers with a cable system modeled via Adams/Machinery Cable.



Figure 1 Rudder Model

Creating Rudder Module

In this section, you will create a rudder system for a light aircraft.

- 1. Copy **rudder.cmd** and *rudder.xmt_txt* from **<topdir>\amachinery\examples\cable** to your working directory
- 2. Open A/View and import existing model rudder.cmd.





3. Run a scripted simulation using the simulation script test.



4. Save the analysis as **with_coupler**.



5. Go to Adams/PostProcessor and plot the angular rotation of the driver rudder and follower rudder:

6. Return to Adams/View and deactivate the coupler named **cable** by right clicking the coupler either from the model browser or from the graphics window, selecting (**De**)Activate and, from the ensuing dialog, un-checking both options.





7. From the **Machinery** tab in the Adams/View ribbon click on the Create Cable System icon within the **Cable** container to launch the Cable System Creation wizard.



- 8. On the Anchor Layout page, name the cable system and specify that you want four anchors.
- 9. Specify the name, location and connection part for each of the four anchors as follows:
 - a. 1

```
i. Name = anchor_a1
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ii. Location: pick location of marker .rudder.driver.a1 (the position coordinates of the marker will be read into the field)

iii. Connection Part = pick "driver"

b. 2

i. Name = anchor_a5

ii. Location: pick location of marker .rudder.driver.a5

iii. Connection Part = pick "follower"

c. 3

i. Name = anchor_b1

ii. Location: pick location of marker .rudder.follower.b1

iii. Connection Part = pick "driver"

d. 4

i. Name = anchor_b6

ii. Location: pick location of marker .rudder.driver.b6

iii. Connection Part = pick "follower"

1 01 5							
	Anchor Layout	٠	Pulley P	roperties	•	Pulley Layout	
able Syst	tem Name Rudder_Cab	les	Number Of	Anchors 4			
1							×
		Name		anchor_a1			
		Locati	on	0.0, -400.0, -	20.		
		Conne	ction Part	driver			
		Winch	1	NONE			

10. Click **Next** and proceed to create a pulley property set as shown below. The pulley property set is convenient way to store pulley cross-sectional dimensions and contact parameters which you'd like to use for multiple pulleys in the cable system.

Create Cable							X
Step 2 of 5							
•	Anchor Lay	rout o	Pulley Pr	operties	•	Pulley Layout	
Number Of 1 Pulley Pro	Pulley_Propertie perty Name Dim	es 1 all_pulleys ensions			Contact Pa	rameters	×
	Width Depth Radius Angle	20 5 2 4			Hertz K Hertz E Hertz Cm Friction Mu Friction Vt	1.0E+004 1.0 0.1 0.6 100.0	
•					< <u>B</u> ack	Next >	Close

- 11. Click **Next** and proceed to create 7 pulleys at the location of the markers a2, a3, a4, b2, b3, b4, and b5, respectively.
 - a. Accept the defaults on the Material and Connection tabs for each pulley
 - b. See the image below for the specification of the first pulley's layout tab:

4	Pulley Properties	•	Pulley Layout	٠	Cable	•
umber Of	Pulleys 7					
2 3	4 5 6 7					-
ayout 1	Material Connection	đ				×
	1					
		Name	nulley a2			
		Location	-200.0, -450.0, -20.0			
		Axis Of Rotation	Global Z 👻	0.0,0.0,0.0	-	
		Flip Direction				
		Diameter	100			
		Pulley Property	all_pulleys			
						-

- c. The others will differ in name and location. For example, the next pulley will be located at marker "a3" so name the pulley "pulley_a3" and for the Location entry right-click the Location field, select Pick and pick the marker "a3" from the graphics window.
- d. They will also differ in "Flip Direction" which determines the direction in which we intend the pulley to rotate Set "Flip Direction" as follows:
 - i. 1, pulley_a2; Flip Direction = Off (default)
 - ii. 2, pulley_a3; Flip Direction = Off (default)
 - iii. 3, pulley_a4; Flip Direction = On
 - iv. 4, pully_b2; Flip Direction = On
 - v. 5, pully_b3; Flip Direction = On
 - vi. 6, pully_b4; Flip Direction = On
 - vii. 7, pully_b5; Flip Direction = Off (default)

e. **Note:** Once the pulleys are created initially this direction of rotation is shown visually on the screen at each pulley by a green arrow icon:



12. Pulley geometry will now be visible in your model:



- 13. Click **Next** and proceed to create 2 cables:
 - a. First Cable:

i. Layout: Start Anchor = anchor_a1; Wrapping Order = pulley_a2, pulley_a3, pulley_a4; End Anchor = anchor_a5 (these can be graphically selected or selected via right-mouse Browse or Guesses)

ii. Layout: Diameter = 3mm

iii. Parameters: Damping = 1.0E-2 N*s/mm, Preload = 100N, Formulation = simplified

iv. Output: Pulley Results = 1,2,3,4,5; Span Results =1,2,3,4 (this will generate requests on each of the 5 anchors and pulleys and at the midpoint of each of the 4 spans)

v. Rest of the entries can be kept as default values

< Pul	ley Layout	Cable	•	Completion	•
umber of Cables	2				
1 2					
	and the second				×
Setup Paran	neters Output				1
	Cable Name Beain Ancho	cable	a at		
	Wrapping O	rder Dulley	a2. pulley a:		
	End Anchor	anch	or_a5		
	Diameter	3.0			

eate Cab	le					
4 of 5						
•	Pulley Layout	٠	Cable	•	Completion	•
Number o	f Cables 2					23
Setu	p Parameters 0	utput				
	Density	1.0E-006	Meth	od	simplified •	
	Young's Modulus	1.0E+005	Solve	r	auto 👻	
	Rix	1.0	Gravit	tational Effect	on 💌	
	Rkb	1.0E-004	Inertia		on 💌	
	Rid	1.0E-003	Diser	gagement	on 💌	
	Damping	1.0E-002	Mesh	()	0.15	
	Velocity	0.0	Zone		forward 👻	
	Preload	0.0	Delta		1000.0	
_						
ы				< <u>B</u> ac	k <u>N</u> ext >	Close

4 of 5 Pulley Layout Cable Completion Immber of Cables 2 1 2 Setup Parameters Output Pulley Results 1.2.3.4.5 Span Results [1.2.3.4 [1.2.3.4 Immodel Immodel<					
Vumber of Cables 2 1 2 Setup Parameters Output Pulley Results 1.2.3.4.5 Span Results [1.2.3.4	4 of 5	a •	Cable	Completion	•
Pulley Results 1.2,3,4,5 Span Results (1.2,3,4	umber of Cables 2 1 2 Setup Parameters	Output			5
open resours [1,2,0,4	Pulley Results	1.2.3.4.5			
	opan Results	[[1,2,3,4		 	

b. Second Cable:

i. Layout: Start Anchor = anchor_b1; Wrapping Order = pulley_b2, pulley_b3, pulley_b4, pulley_b5; End Anchor = anchor_b6

ii. Layout: Diameter = 3mm

- iii. Parameters: Damping = 1.0E-2 N*s/mm, Preload = 100N, Formulation = simplified
- iv. Output: Pulley Results = 1,2,3,4,5,6; Span Results = 1,2,3,4,5
- v. Rest of the entries can be kept as default values

Pi	ulley Layout	•	Cable	•	Completion	•
umber of Cables	2					
1 2						
						×
Setup Para	ameters Output					T.
			(A) (A) (A)	_		
	Cable	lame	cable_b			
	Begin	Anchor	anchor_b1	_		
	Wrapp	ng Order	pulley_b2, pulley_	b:		
	End Ar	chor	anchor_b6	- 2		
	Diamet	er	3			
10- 10-						

4	Pulley Layout	•	Cable	•	Completion	•
umber	of Cables 2					
1 2	ľ.					
	12					
Set	tup Parameters 0	lutput				
					-	_
	Density	1.0E-006	Metho	d	simplified	-
	Young's Modulus	1.0E+005	Solver		auto	-
	Riox	1.0	Gravita	ational Effect	on	×
	Rkb	1.0E-004	Inertia		on	-
	Rkt	1.0E-003	Disen	gagement	on	•
	Damping	1.0E-002	Mesh		0,15	
	Velocity	0.0	Zone		forward	Ŧ
	Preload	100.0	Delta		1000.0	
			-			

•	Pulley Layout	•	Cable	•	Completion	•
lumber of	Cables 2					
1 2						
						×
Setup	Parameters Outp	ut				
	Pullay Results	123456				
	Span Results	1,2,3,4,5				
-						_

14. Click **Next** and the cables are created.



15. Click **Finish** to exit the wizard.

- 16. Now that a cable system is in place (replacing the simple coupler used initially), re-run the simulation using the simulation script **test**.
- 17. Save the analysis as **with_cables**.

Adams/PostProcessor Results

Go to Adams/PostProcessor and plot the angular rotation of the driver rudder and follower rudder again on top of the original curves and zoom in see differences in the rudder travel.

