



BEACON Newsletter – January 2025

Calculating Centre of Pressure in 3DEXPERIENCE Platform - FMK

In aerodynamics, understanding the forces acting on a body as it moves through a fluid is crucial for designing efficient and stable structures. One key metric in this analysis is the center of pressure (CoP), the point where the total sum of aerodynamic pressure forces acts on a body. This point is essential in determining the stability and control of vehicles such as aircraft, rockets, and even automobiles.



As an object moves through a fluid, the fluid's velocity changes along the object's surface, leading to variations in pressure at different points. These pressure differences generate an aerodynamic force on the object when integrated over the surface area. This force can be considered to act through the average location of these pressure variations, known as the Center of Pressure, like how the center of gravity represents the average location of an object's weight. The aerodynamic force can then be divided into lift and drag components, both of which act through the center of pressure during flight.

Determining the center of pressure is crucial for any flying object. To trim an airplane or ensure the stability of a model rocket or kite, it's essential to know the exact location of the center of pressure for the entire aircraft. But how do engineers identify the center of pressure when designing an aircraft?

In general, finding the center of pressure (cp) is a complex task because the pressure varies across the object. This process involves calculus and an understanding of the pressure distribution along the object's surface. The pressure variation can be

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represented as a function p(x), where pressure depends on the distance x from a reference line, typically the leading edge of the object. Once the form of this function is known, engineers can use calculus integration methods to calculate the center of pressure.

$$C_p = \frac{\int x \, p(x) \, dx}{\int p(x) \, dx}$$

In this blog, we will guide you through the steps to calculate the center of pressure using the powerful simulation tools available on the 3DEXPERIENCE platform using Fluid Dynamics Engineer (FMK) role. Open Physics Results Explorer

Field Expressions

Define each of the coordinates of Centre of Pressure in Field Expressions.

- 1. Load results
- 2. Go to Calculations from below task bar

	Standard Setup Plots Sens	rs Calculations Display Explore View AR-VR Tools Touch	
Command Search.	Undo Model Scenario Result	Play Results Feature Envelope	Field Combined Stress Results Vertual Combined Load Case Linearization Query Bolt Checker

3. Select Field Expressions and define the following parameters

Held Expression Manager			×			
Name 🔺	Expression Magnitude					
\$ COP_Y	<pre>= surface_integral(\$PRESSUREGAU*\$\$CENTROID[2])/surface_integral(\$PRESSUREGAU)</pre>	Length 🗸	x ^			
\$ COP_X	<pre>= surface_integral(\$PRESSUREGAU*\$\$CENTROID[1])/surface_integral(\$PRESSUREGAU)</pre>	Length	×			
\$ CoP_Z	= <pre>surface_integral(\$PRESSUREGAU*\$\$CENTROID[3])/surface_integral(\$PRESSUREGAU)</pre>	Length 🗸	×			

- surface_integral(\$PRESSUREGAU*\$\$CENTROID[1])/surface_integral(\$PRESSUREGAU)
- surface_integral(\$PRESSUREGAU*\$\$CENTROID[2])/surface_integral(\$PRESSUREGAU)
- surface_integral(\$PRESSUREGAU*\$\$CENTROID[3])/surface_integral(\$PRESSUREGAU)

Display group

Create a display group containing the Race Car Surface.

1. Go to **Display** in the action task bar below





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2. Click on **Display group**



Sensor

Create a sensor for each of the coordinates of Centre of Pressure

1. Click on Sensors from action bar and select Sensor



2. Define all the highlighted parameters and click apply

-							
§ Sensor	×						
Type ၊ Field 🚺 H	listory 🔿 XY Curves 🧿						
Name CoP_X							
Value							
Template <none></none>	Template <none></none>						
Definition	▼ Definition						
3 Variable CoP_X	·						
4 Processing O Sc	alars Quantity at Centroids 🔻						
Scope 5							
Frames Last frame of	of each step 🔹 🖉 🛞						
Location 6							
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0.1.1.1	-						
Output	7						
Value per support	Average 🖉						
🔽 Create paramete	Create parameters						
Create paramete	rs for each selected step						
Create paramete	rs for each selected loadcase/frame						
Output Summary							
Name	Expression						
Average	Average (CoP)						
Characterian							
Current servant version	is incompatible for creating sum and average						
parameters.							
	OK Close Apply						
	Apply						



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3. Click on **Feature Manager**, select **Sensors** to get plotted values

Feature	e Manager	ase.1											
ß	2	1	3										
Fie	ld Plots	Sensor	s Display Groups	Field Expressio	ons								
	Name	Туре	Parameters		Frame information								
8	CoP_X	Field	Average: 0.221 mm		Last frame of each st	ep							
8	CoP_Y	Field	Average: 15.6 mm		All frames								
8	CoP_Z	Field	Average: 86.8 mm		Last frame of each ste	ер							
					Standard Setup P	lots	Sensors	Calculation	ns Display	Explore View	AR-VR	Tools	Touch
	Command Search	Сору	Paste Undo	* Model	Scenario R	Ses ults	A	Play	Results Visualization	Feature Mapager	¥	9 Sensor	Result

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