

# Modelowanie dynamiki układów ciał w programie SIMSCAPE MULTIBODY

**Interreg**



Spolufinancovaný  
EURÓPSKOU ÚNIOU

**Poľsko – Slovensko**

**SPÁJAME REGIÓN BESKYDY PROSTREDNÍCTVOM TECHNICKÉHO VZDELÁVANIA  
ŁĄCZYMY REGION BESKIDÓW POPRZEZ EDUKACJĘ TECHNICZNĄ**

Miesto konania/ Miejsce wydarzenia: **Žilinská Univerzita v Žiline (SK)**

<https://www.uniza.sk/> | <http://kame.uniza.sk/inter/inter.php>

Termín/Termin: **22.–24. 04. 2026**



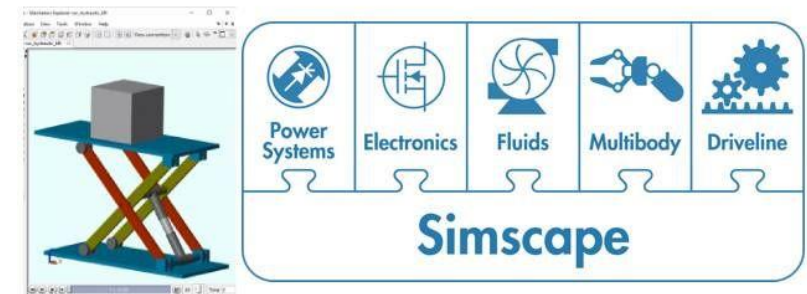
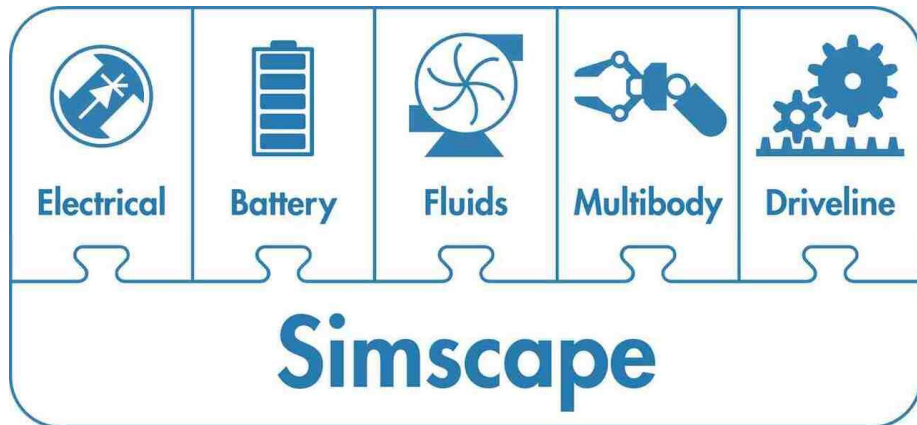
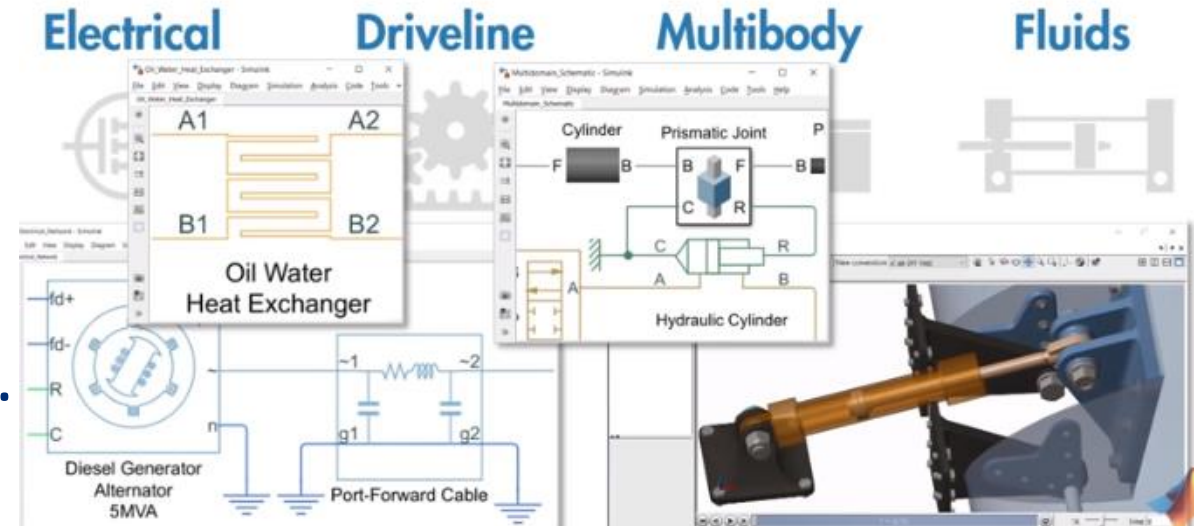
Žilinská univerzita  
v Žiline



# Simscape

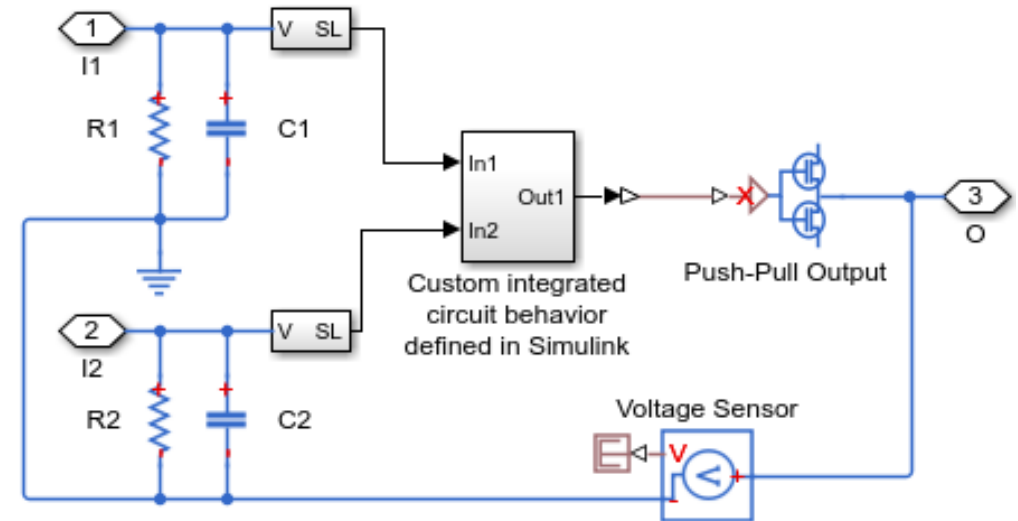
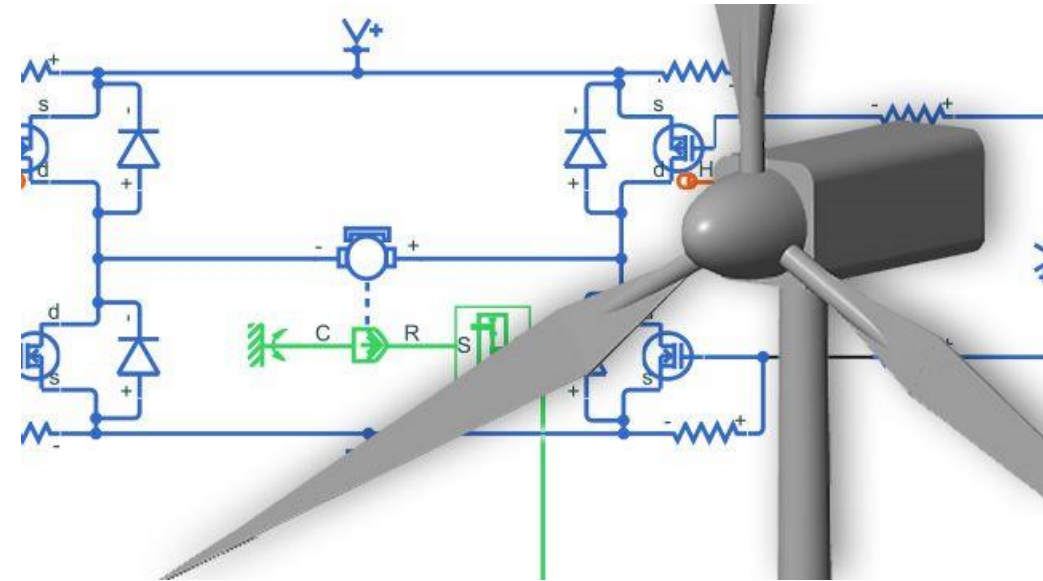
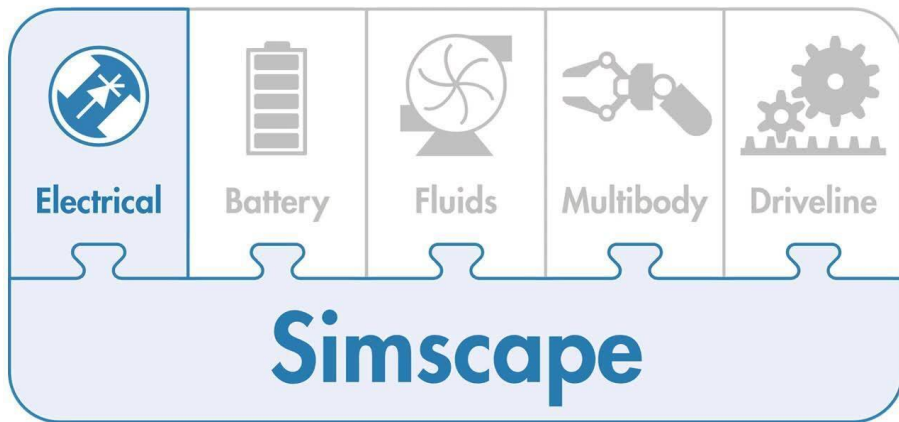
- Modelowanie bez równań.
- Powiązania fizyczne.
- Natychmiastowa wizualizacja 3D.
- Rozwiązywanie zadań wielofizycznych.
- Cyfrowy bliźniak.

# Simscape



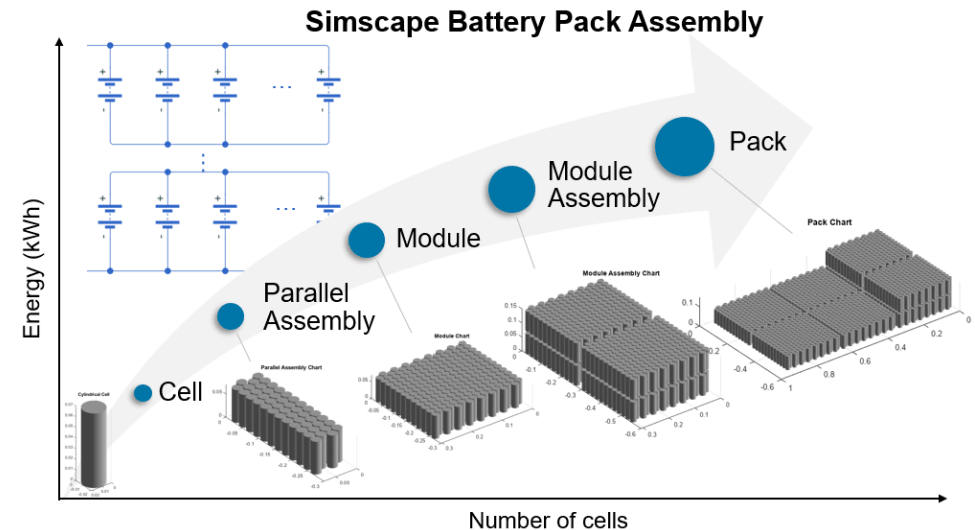
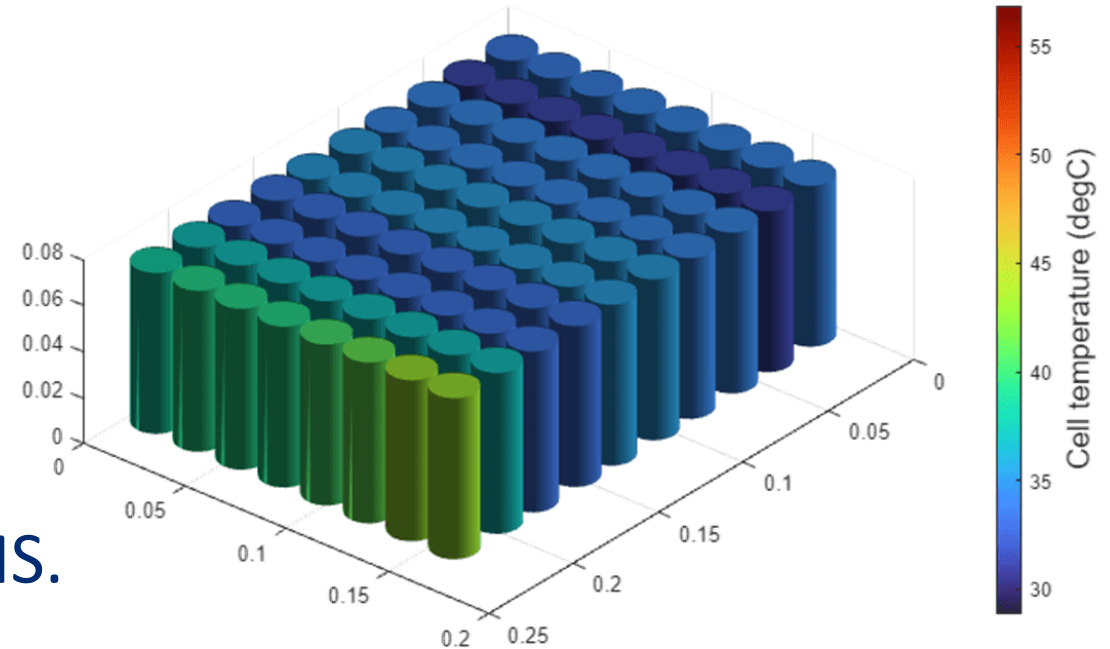
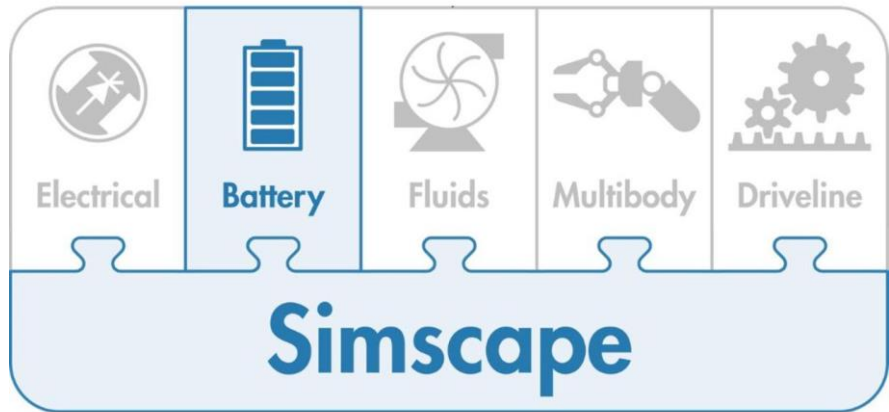
# Simscape Electrical

- Integracja wielodomenowa (mechatronika).
- Szeroka gama modeli maszyn elektrycznych.
- Elektronika mocy i półprzewodniki.
- Kompleksowe sieci energetyczne.
- Szybkie prototypowanie i HIL.



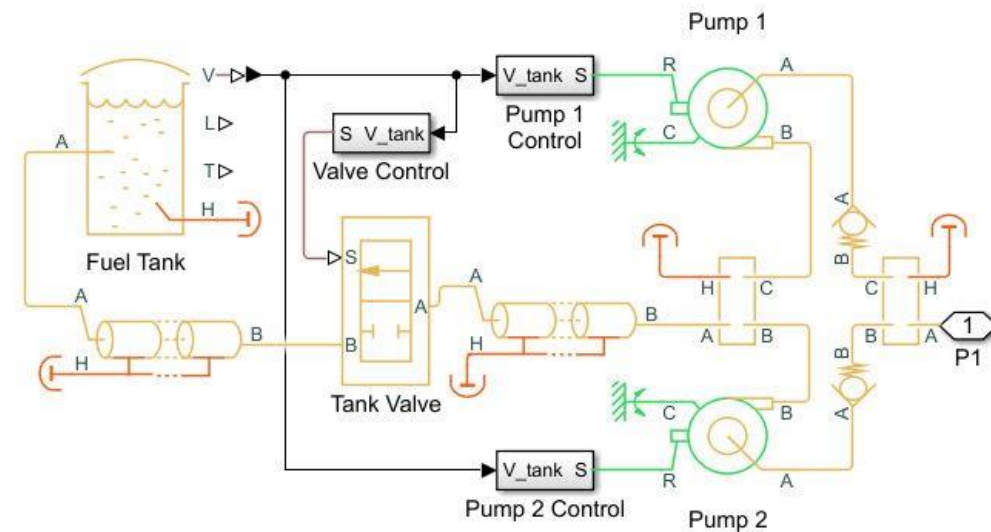
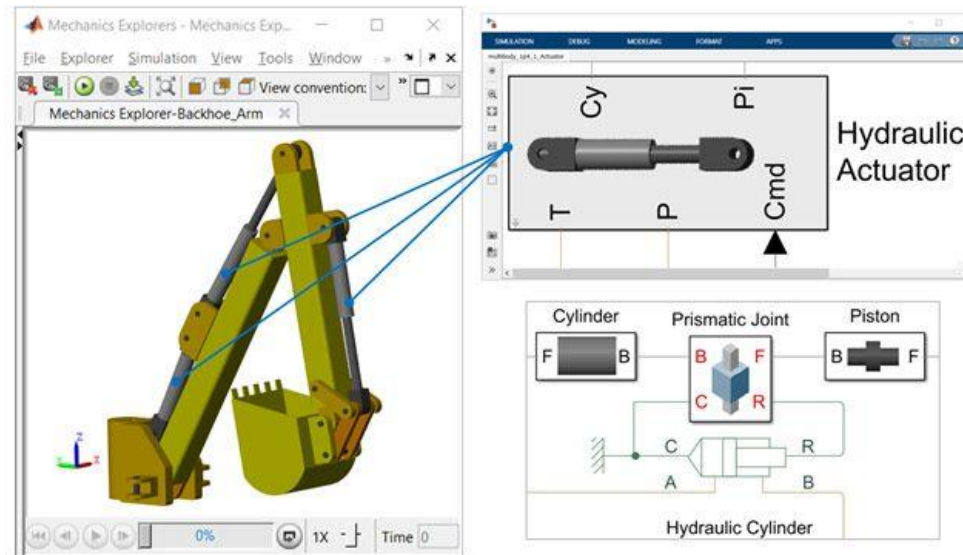
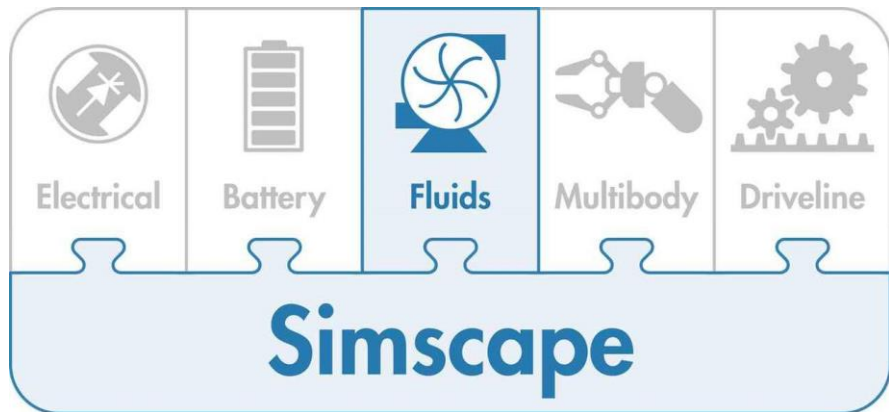
# Simscape Battery

- Skalowalna hierarchia.
- Wierność elektrotermiczna.
- Cyfrowy bliźniak procesu starzenia.
- Opracowanie i walidacja systemu BMS.
- Integracja systemowa i zasięg.



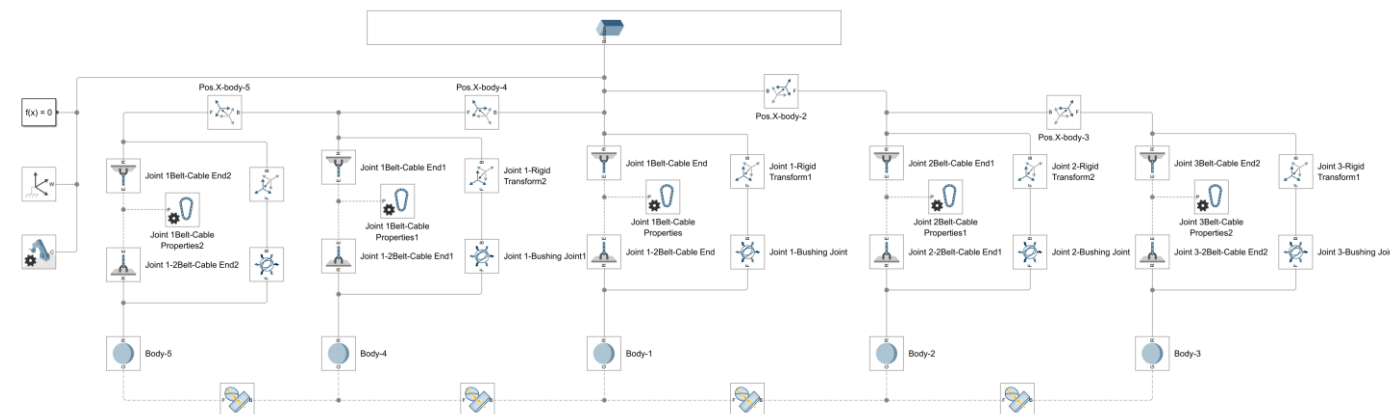
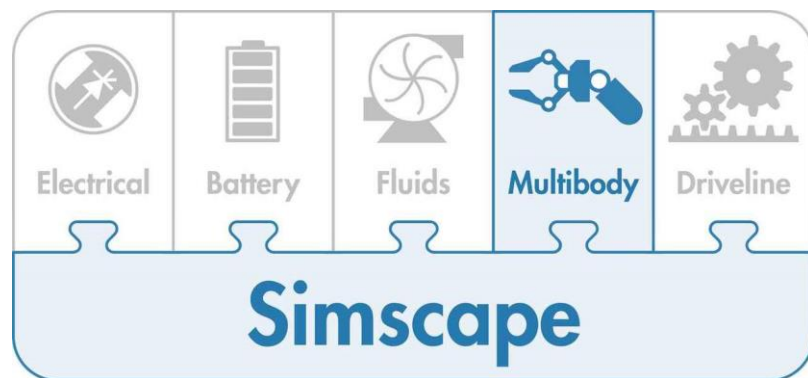
# Simscape Fluids

- Modelowanie przepływów.
- Dynamika gazów.
- Symulacja kawitacji i powietrza.
- Właściwości mediów.
- Symulacje HIL.



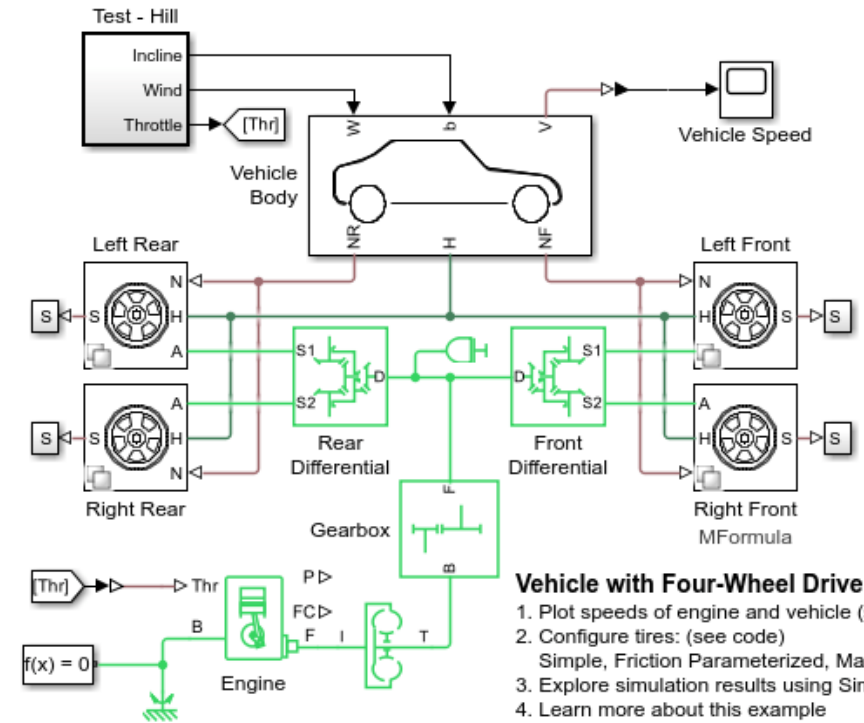
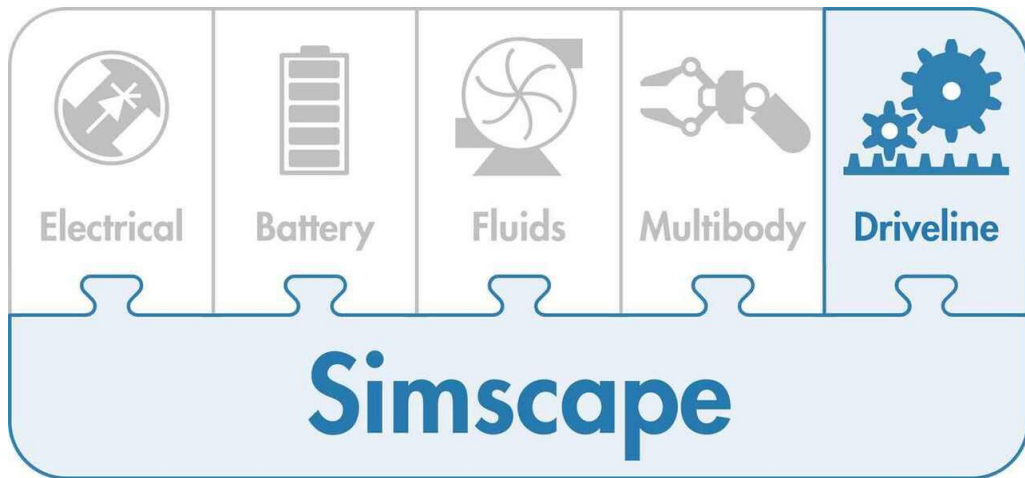
# Simscape Multibody

- Modelowanie fizyczne oparte na powiązaniach i automatycznym generowaniu równań.
- Możliwość integracji z systemami CAD oraz parametryzacji.
- Analiza interakcji nieliniowych.
- Wielofizyczna ko-symulacja i synteza sterowania.
- Wirtualne prototypowanie, HIL.



# Simscape Driveline

- Biblioteka komponentów mechanicznych.
- Modelowanie tarcia i strat.
- Sterowanie i zjawiska przejściowe.
- Opony i dynamika pojazdu.
- Połączenie z Multibody w celu wizualizacji.

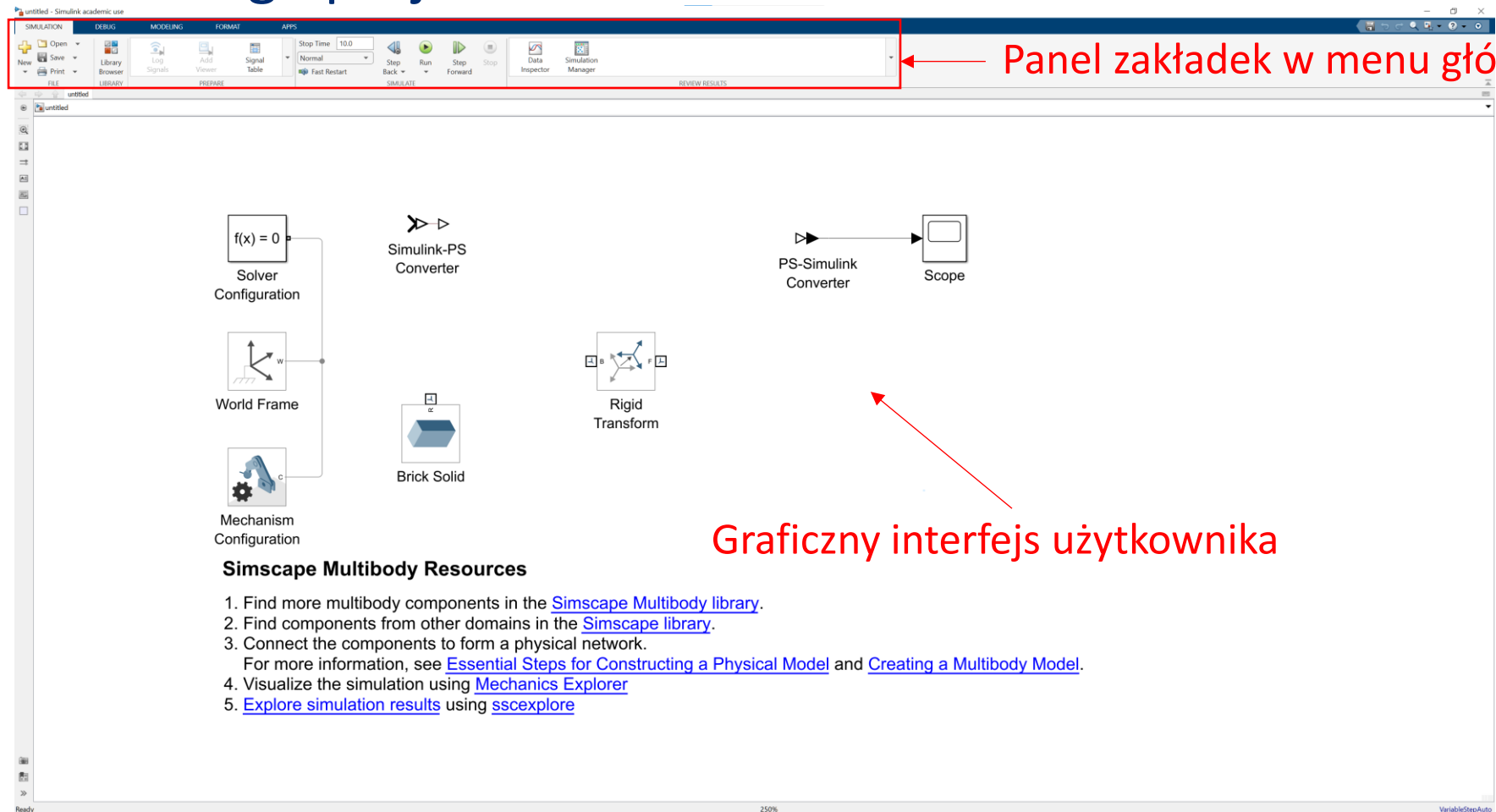


Copyright 2004-2022 The MathWorks, Inc.



# Tworzenie modelu

- Utworzenie nowego projektu: *smnew*



The screenshot displays the Simulink software interface. The top menu bar includes SIMULATION, DEBUG, MODELING, FORMAT, and APPS. The main workspace contains a block diagram with the following components: Solver Configuration (f(x) = 0), Simulink-PS Converter, PS-Simulink Converter, Scope, World Frame, Brick Solid, and Rigid Transform. A red box highlights the top menu bar, and a red arrow points to it with the text "Panel zakładek w menu głównym". Another red arrow points to the block diagram with the text "Graficzny interfejs użytkownika".

Panel zakładek w menu głównym

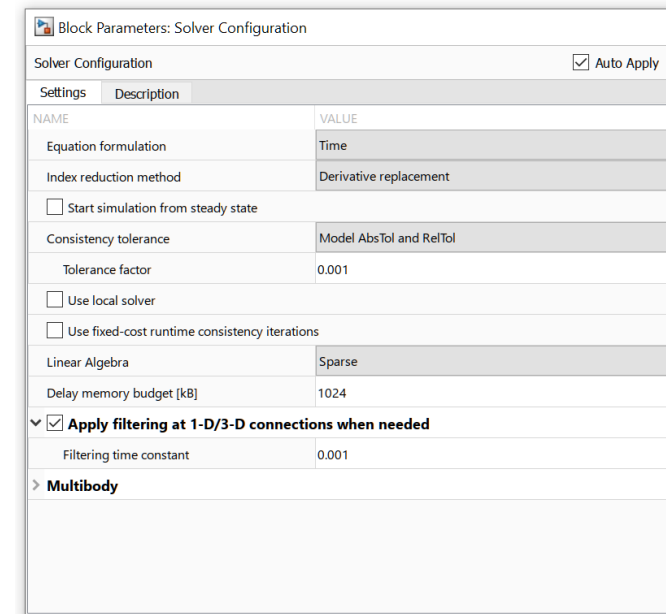
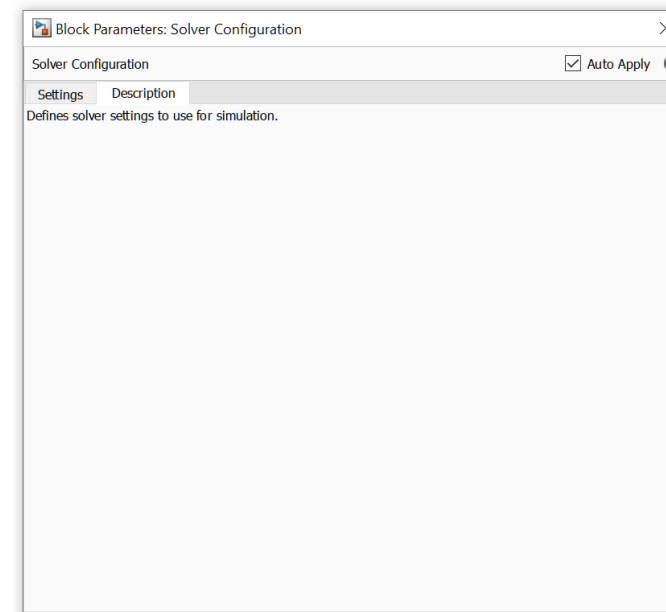
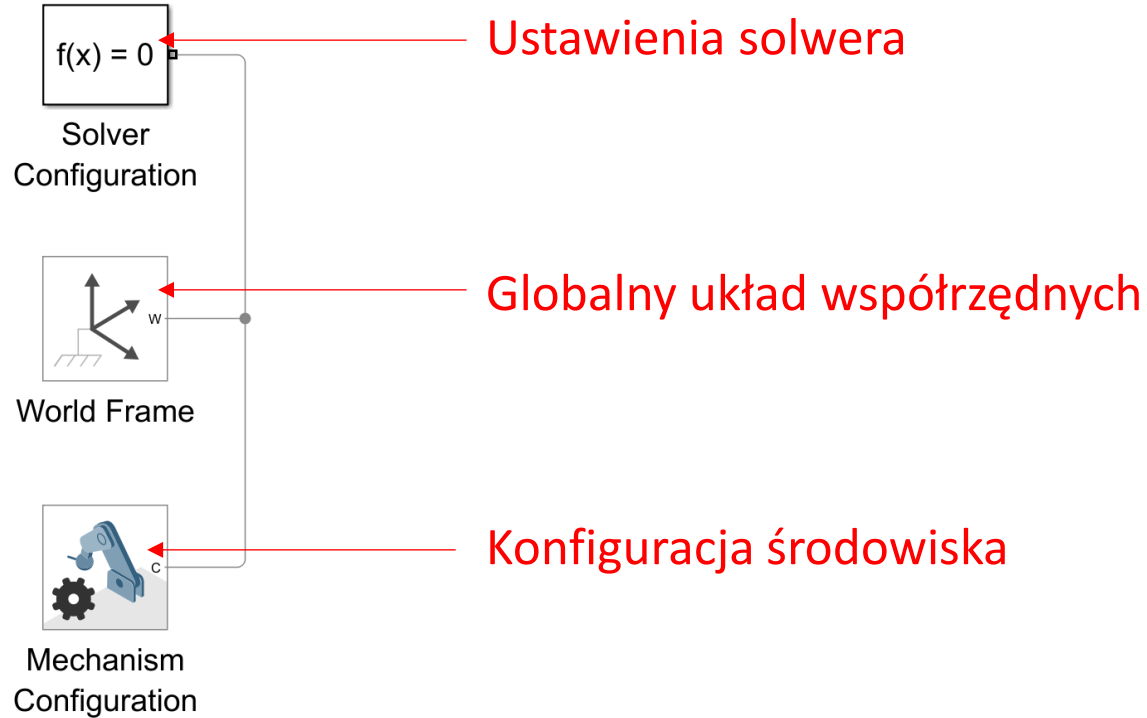
Graficzny interfejs użytkownika

**Simscape Multibody Resources**

1. Find more multibody components in the [Simscape Multibody library](#).
2. Find components from other domains in the [Simscape library](#).
3. Connect the components to form a physical network.  
For more information, see [Essential Steps for Constructing a Physical Model](#) and [Creating a Multibody Model](#).
4. Visualize the simulation using [Mechanics Explorer](#)
5. [Explore simulation results](#) using [sscexplore](#)

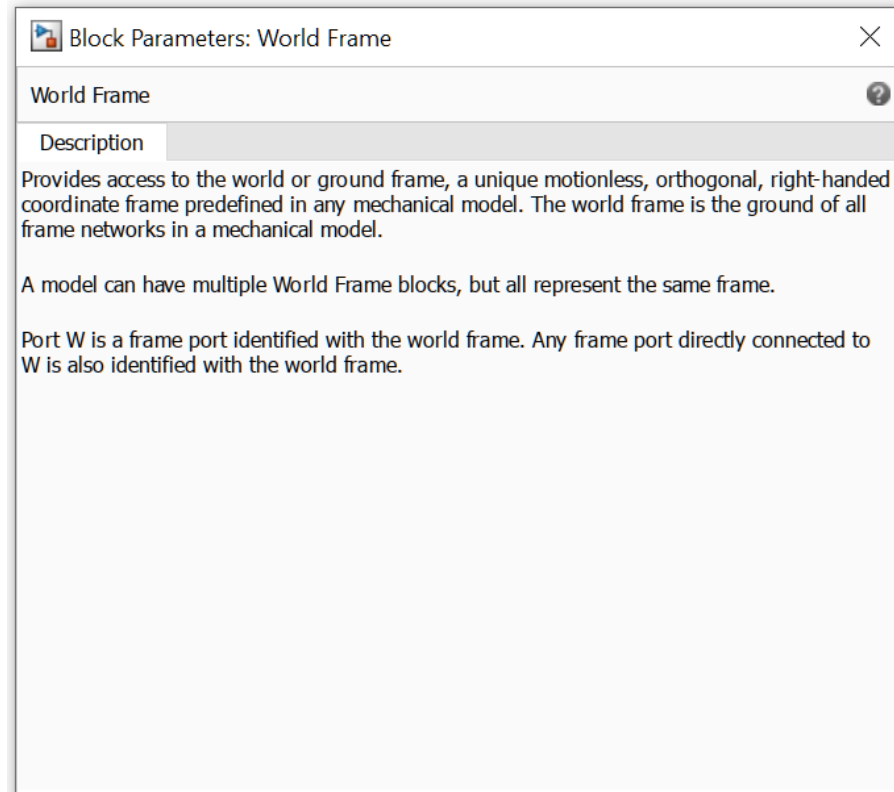
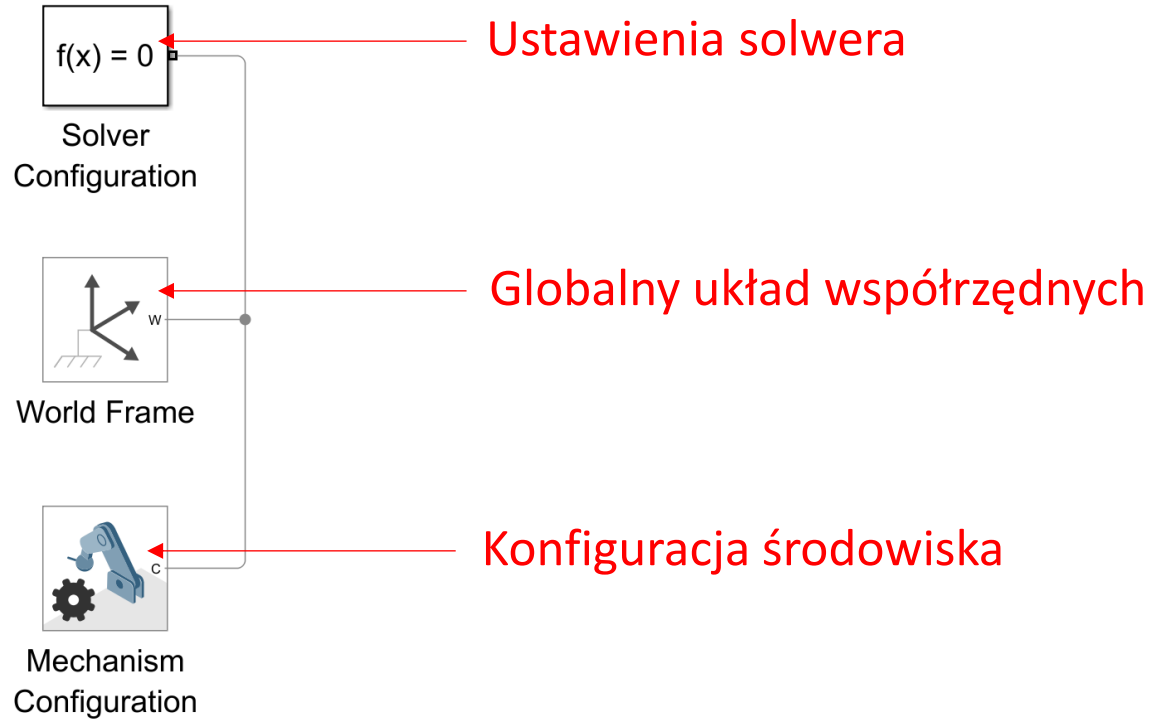
# Tworzenie modelu

- Podstawowe elementy każdego modelu:



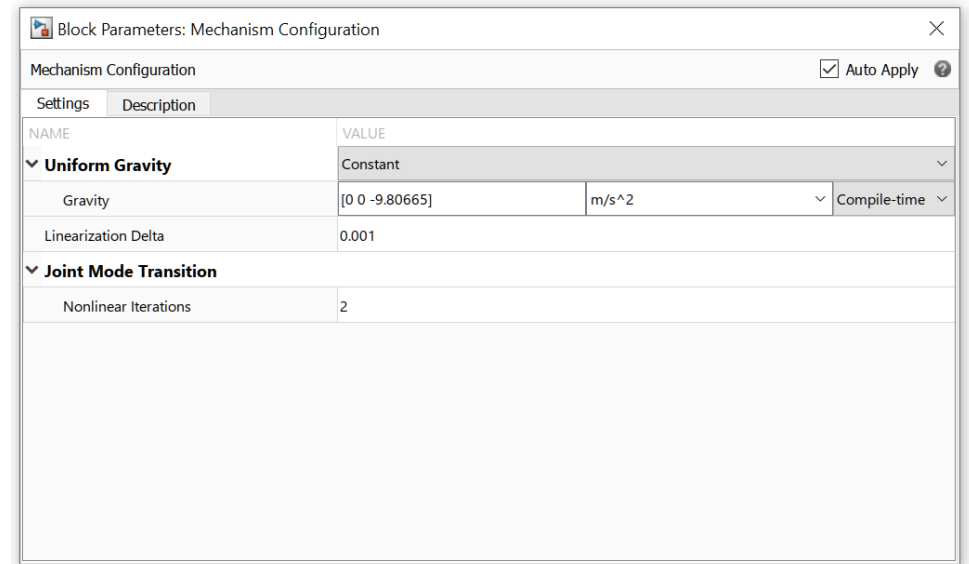
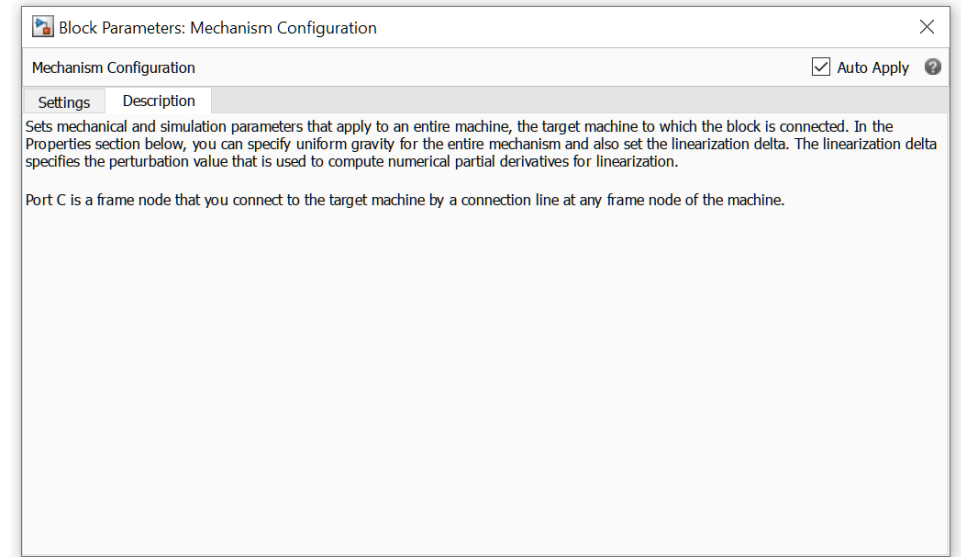
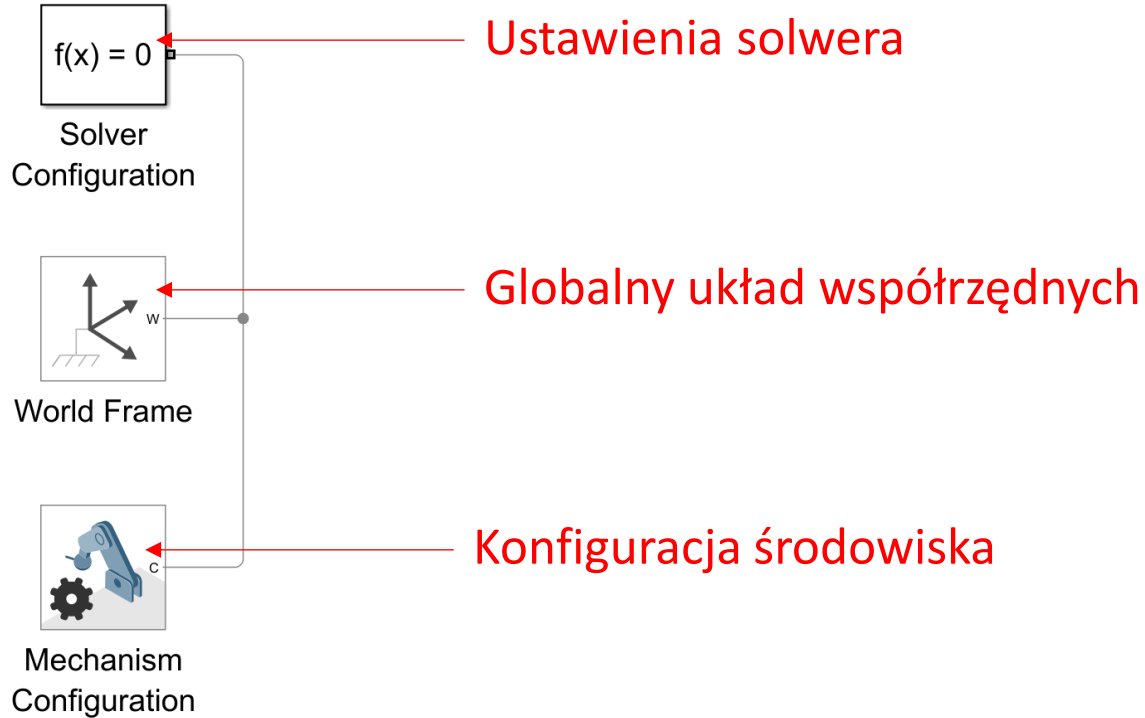
# Tworzenie modelu

- Podstawowe elementy każdego modelu:



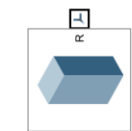
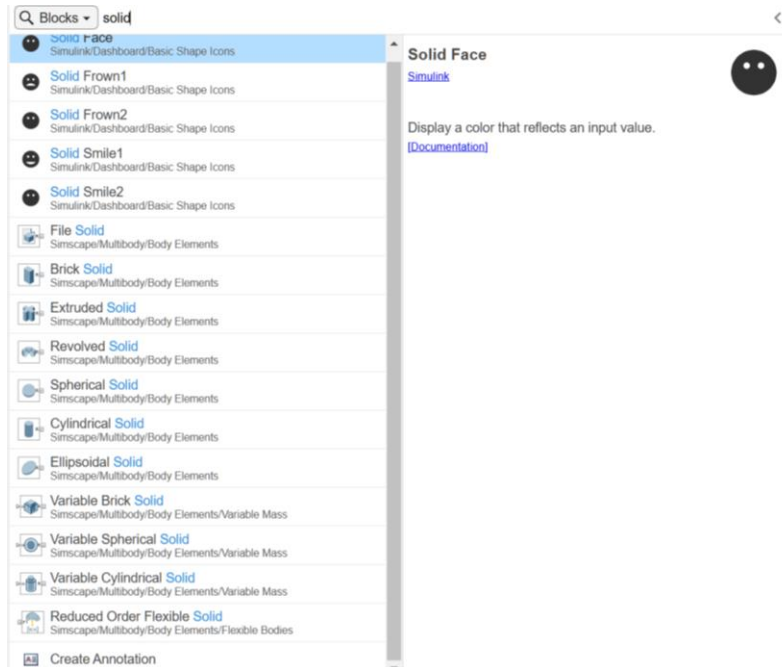
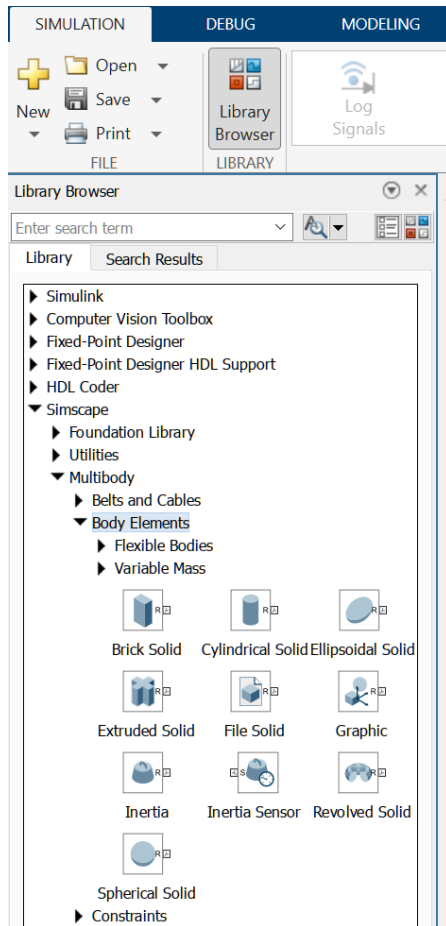
# Tworzenie modelu

- Podstawowe elementy każdego modelu:

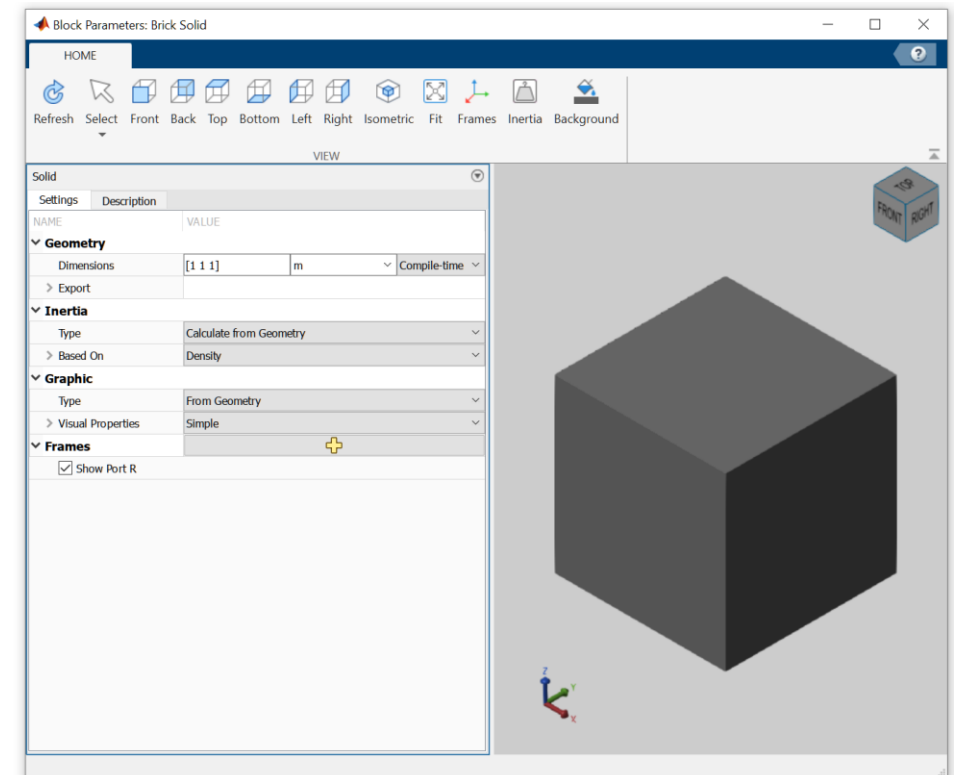


# Tworzenie modelu

- Bloki brył.



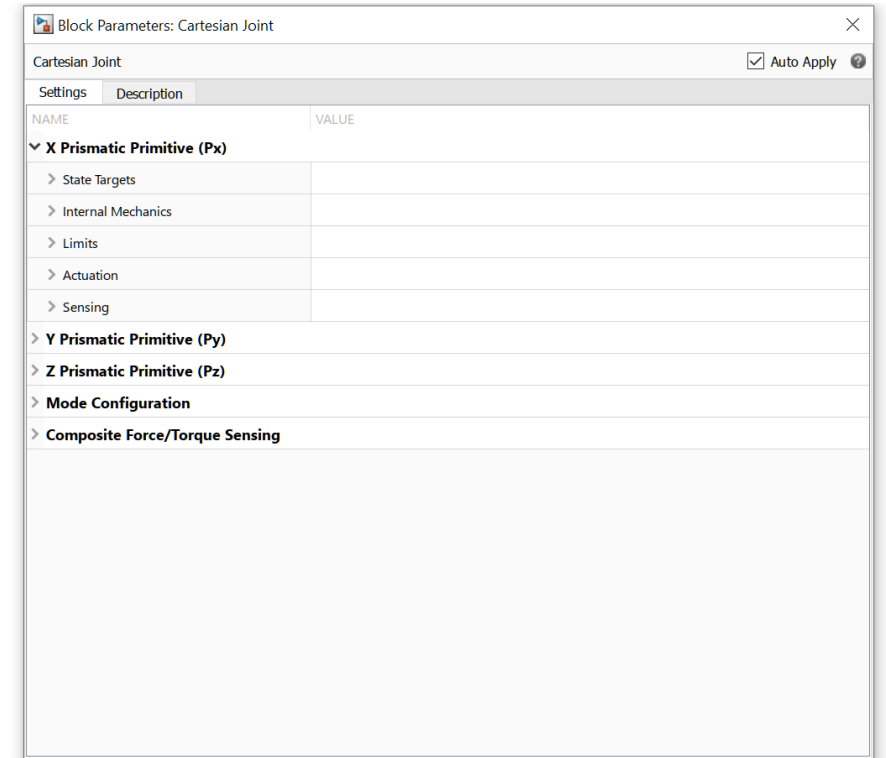
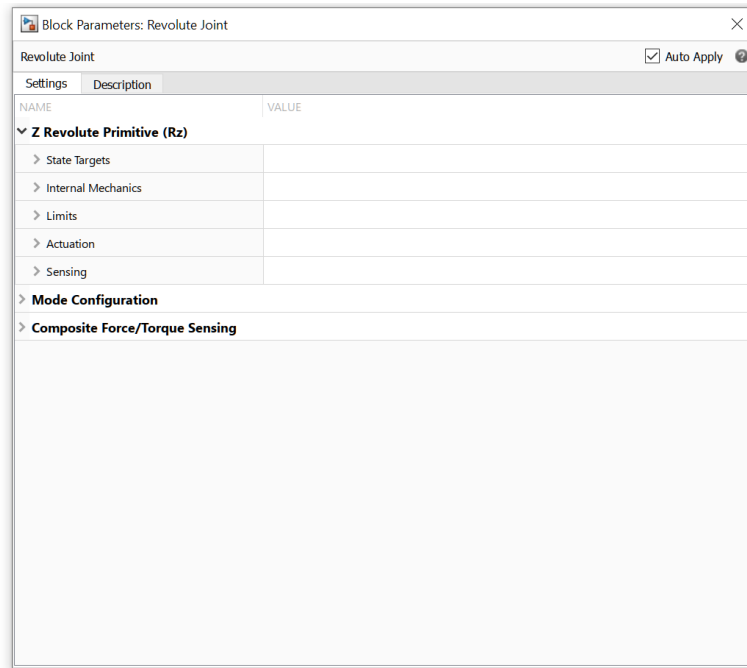
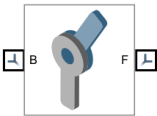
Brick Solid



# Tworzenie modelu

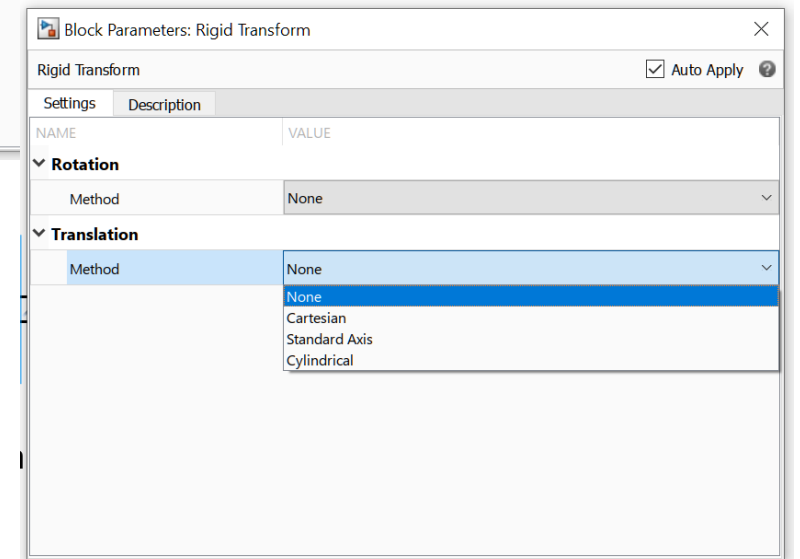
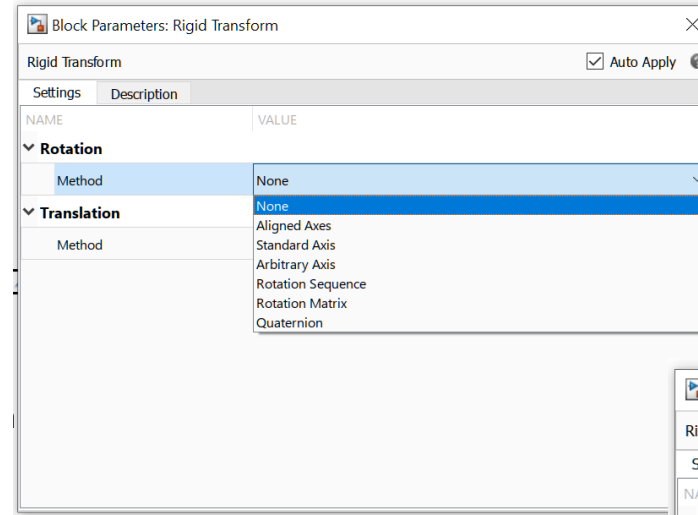
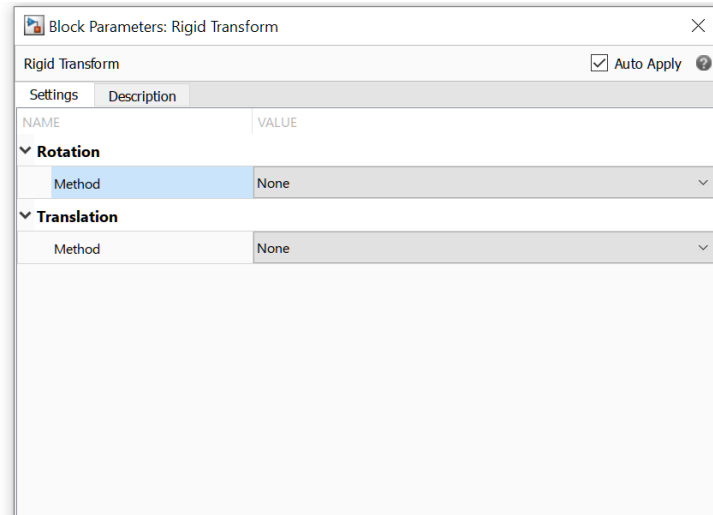
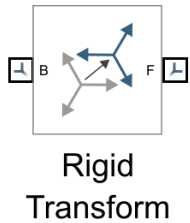
## • Bloki połączeń (Joints).

- 6-DOF Joint
- Bearing Joint
- Bushing Joint
- Cartesian Joint
- Constant Velocity Joint
- Cylindrical Joint
- Gimbal Joint
- Lead Screw Joint
- Pin Slot Joint
- Planar Joint
- Prismatic Joint
- Rectangular Joint
- Revolute Joint
- Spherical Joint
- Telescoping Joint
- Universal Joint
- Weld Joint



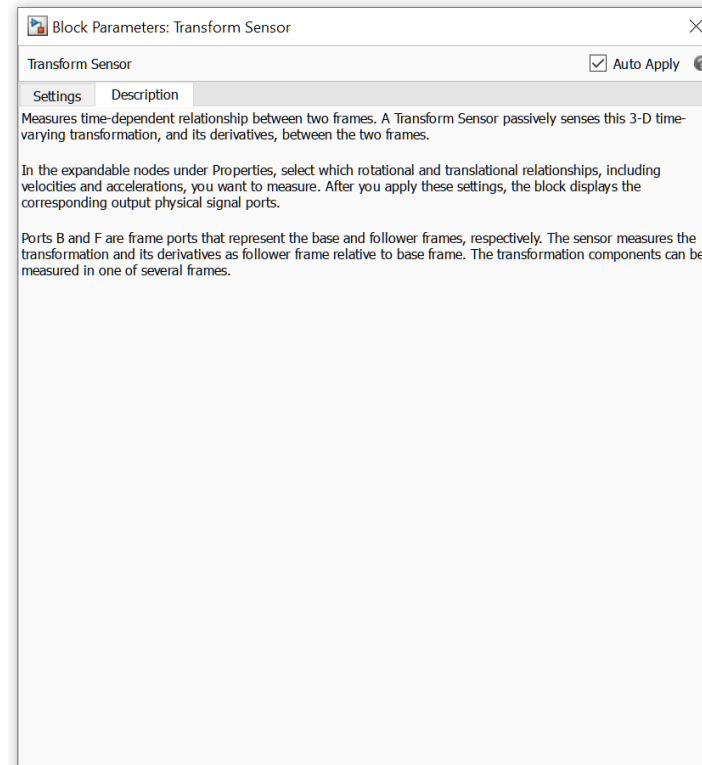
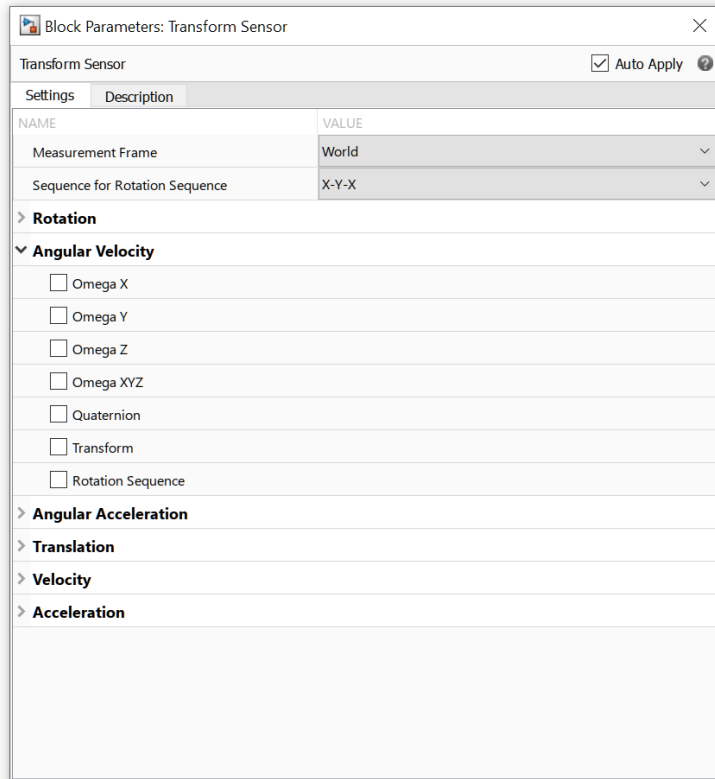
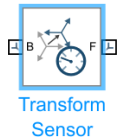
# Tworzenie modelu

- Transformacja lokalnego układu współrzędnych.



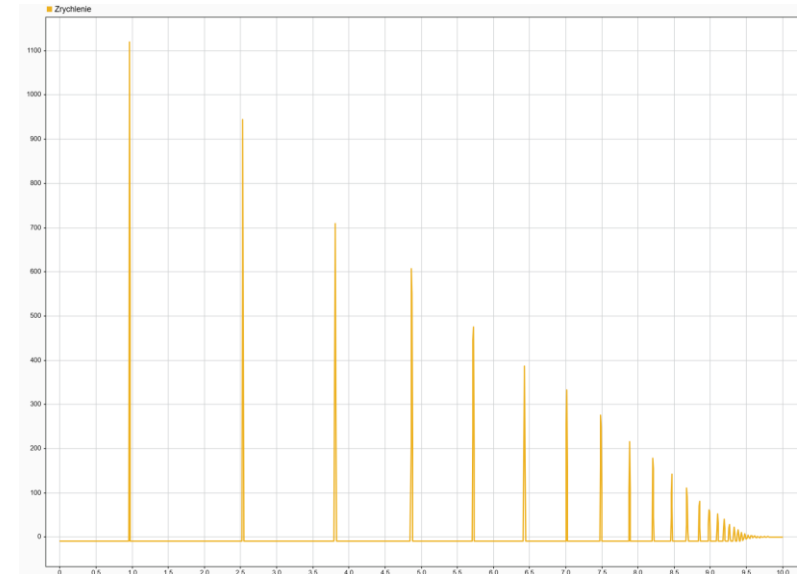
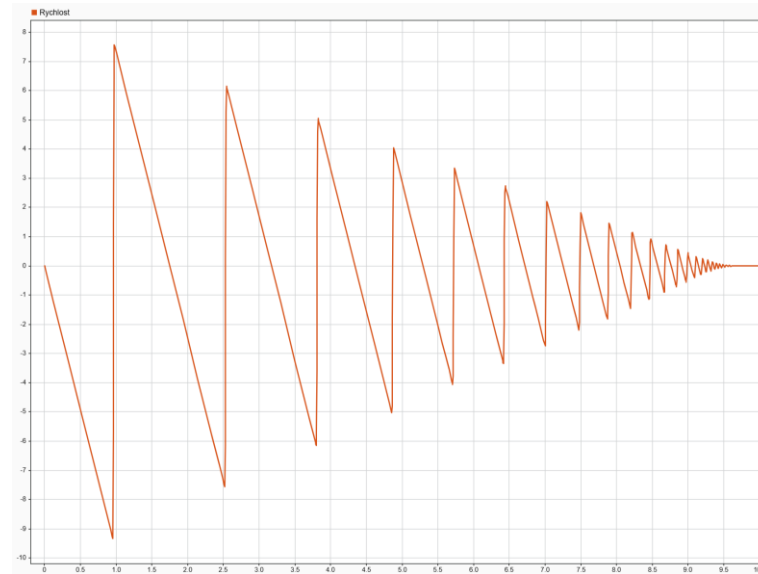
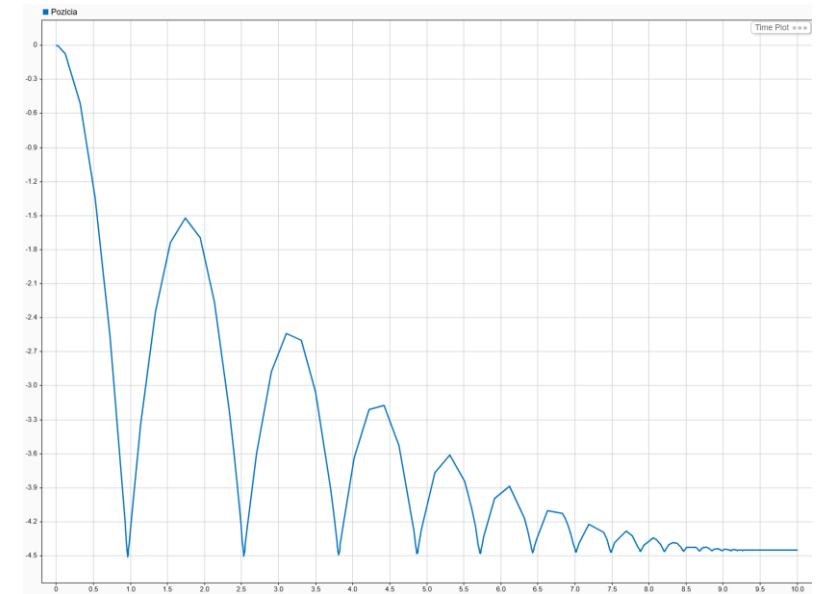
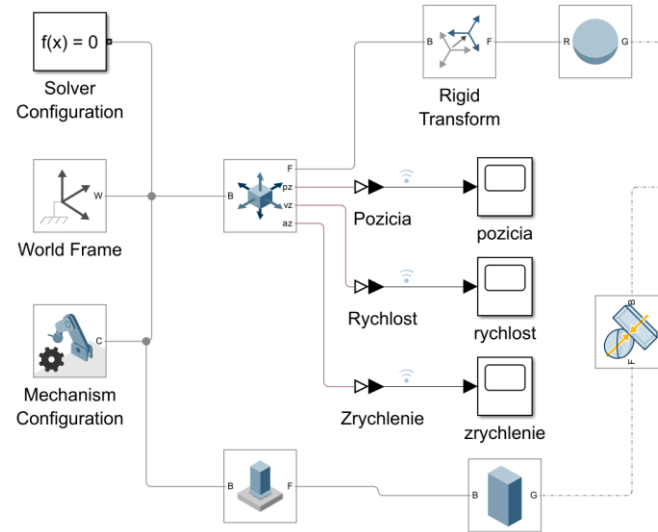
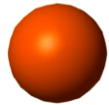
# Tworzenie modelu

- Przekształcenie prędkości względnej.



# Tworzenie modelu

- Swobodny spadek ciała.





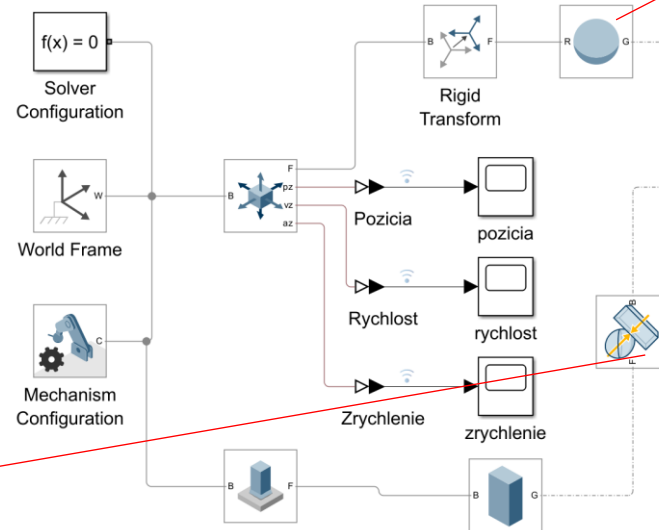
# Tworzenie modelu

- Swobodny spadek ciała.

Block Parameters: Spatial Contact Force

Auto Apply

NAME	VALUE
<b>Normal Force</b>	
Method	Smooth Spring-Damper
Stiffness	1e7 N/m
Damping	1e4 N/(m/s)
Transition Region Width	1e-4 m
<b>Frictional Force</b>	
<b>Sensing</b>	
<b>Zero-Crossings</b>	



Block Parameters: Spherical Solid

HOME

Refresh Select Front Back Top Bottom Left Right Isometric Fit Frames Inertia Background

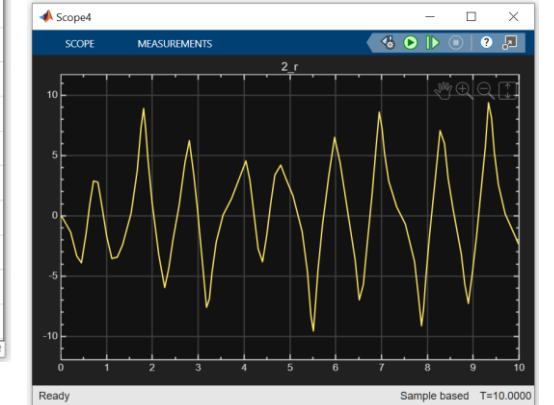
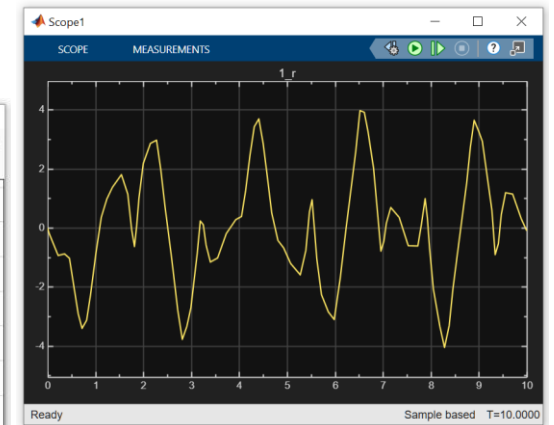
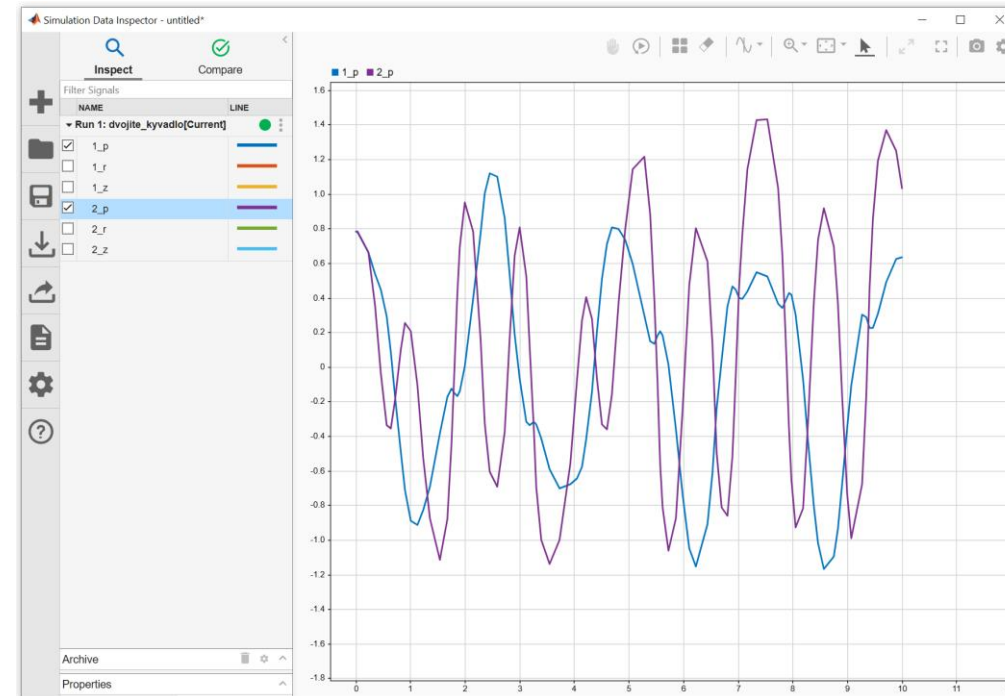
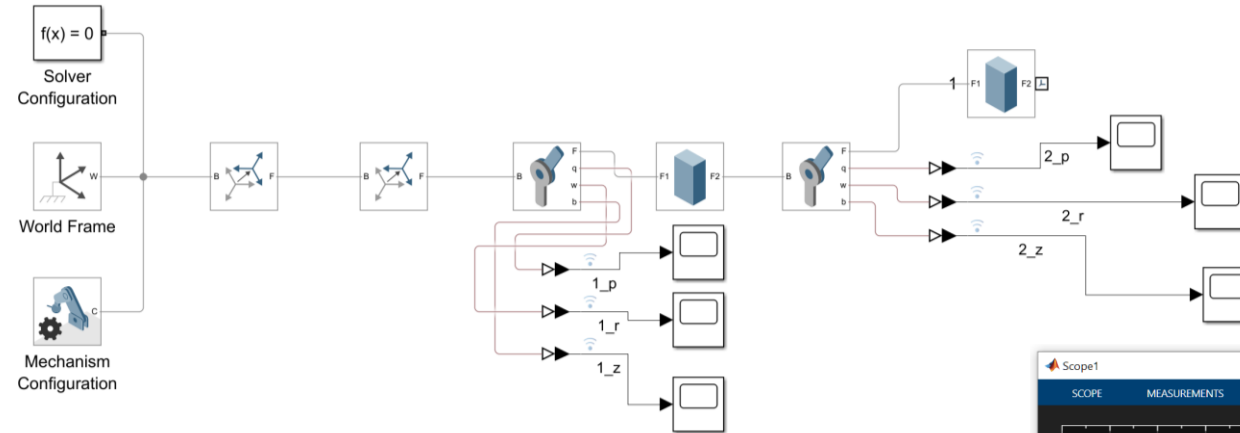
VIEW

Settings	Description	VALUE
<b>Geometry</b>		
Radius	0,5	m
<b>Inertia</b>		
<b>Graphic</b>		
Type	From Geometry	
<b>Visual Properties</b>		
Diffuse Color	[1 0.3333 0]	
Opacity	1	
<b>Frames</b>		

The image shows a 3D rendering of a red sphere in a software interface. The sphere is centered in the view. The interface includes a toolbar with various view options and a settings panel on the left.

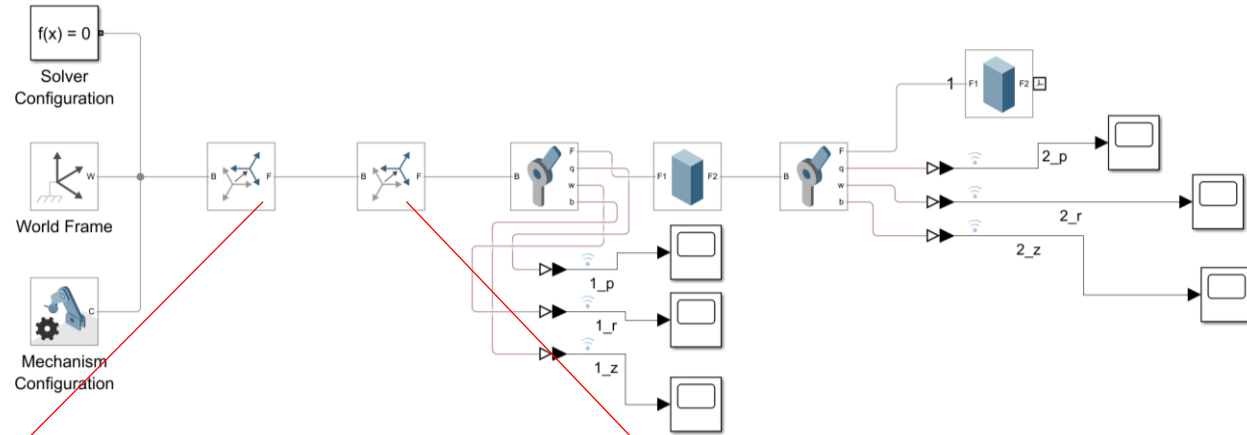
# Tworzenie modelu

- Podwójne wahadło.



# Tworzenie modelu

- Podwójne wahadło.



Block Parameters: Rigid Transform

Rigid Transform  Auto Apply

Settings Description

NAME	VALUE
<b>Rotation</b>	
Method	Standard Axis
Angle	90 deg Compile-time
Axis	+Z
<b>Translation</b>	

Block Parameters: Rigid Transform1

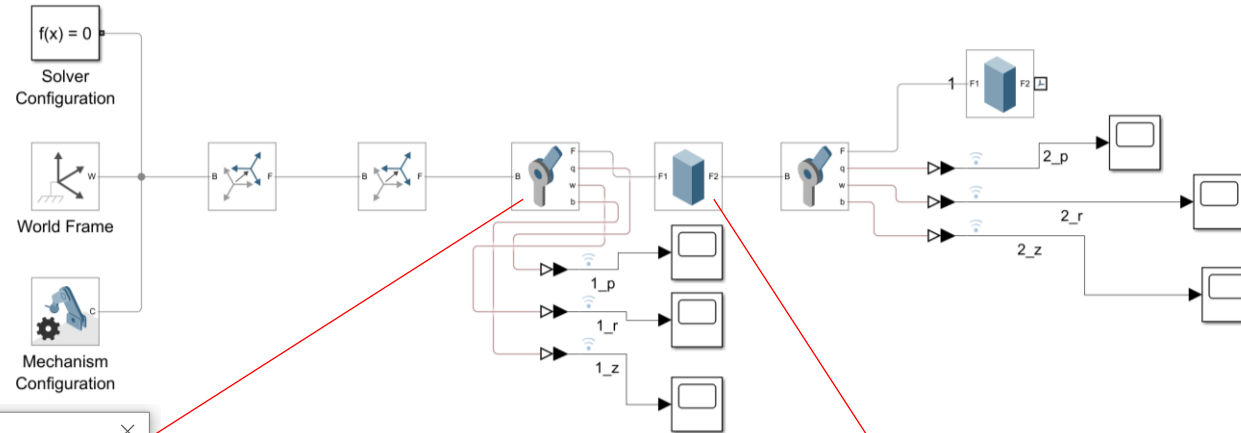
Rigid Transform  Auto Apply

Settings Description

NAME	VALUE
<b>Rotation</b>	
Method	Standard Axis
Angle	90 deg Compile-time
Axis	+Y
<b>Translation</b>	

# Tworzenie modelu

- Podwójne wahadło.



Block Parameters: Revolute Joint

Revolute Joint  Auto Apply

Settings Description

NAME	VALUE
<b>▼ Z Revolute Primitive (Rz)</b>	
▼ State Targets	
<input checked="" type="checkbox"/> Specify Position Target	
Priority	High (desired)
Value	45 deg Compile-time
<input type="checkbox"/> Specify Velocity Target	
> Internal Mechanics	
> Limits	
> Actuation	
▼ Sensing	
<input checked="" type="checkbox"/> Position	
<input checked="" type="checkbox"/> Velocity	
<input checked="" type="checkbox"/> Acceleration	
<input type="checkbox"/> Actuator Torque	
<input type="checkbox"/> Lower-Limit Torque	
<input type="checkbox"/> Upper-Limit Torque	
> Mode Configuration	
> Composite Force/Torque Sensing	

Block Parameters:

HOME

Refresh Select Front Back Top Bottom Left Right Isometric Fit Frames Inertia Background

VIEW

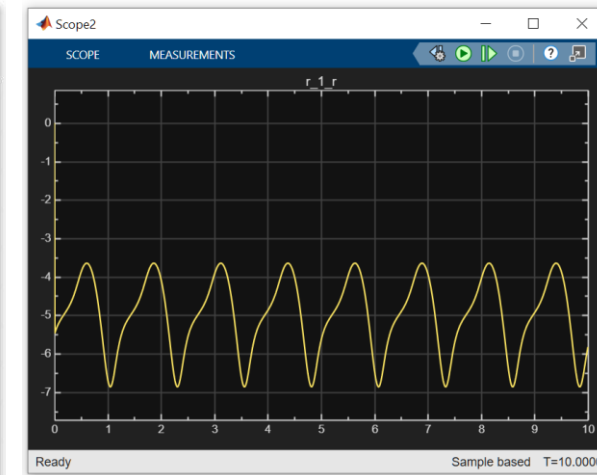
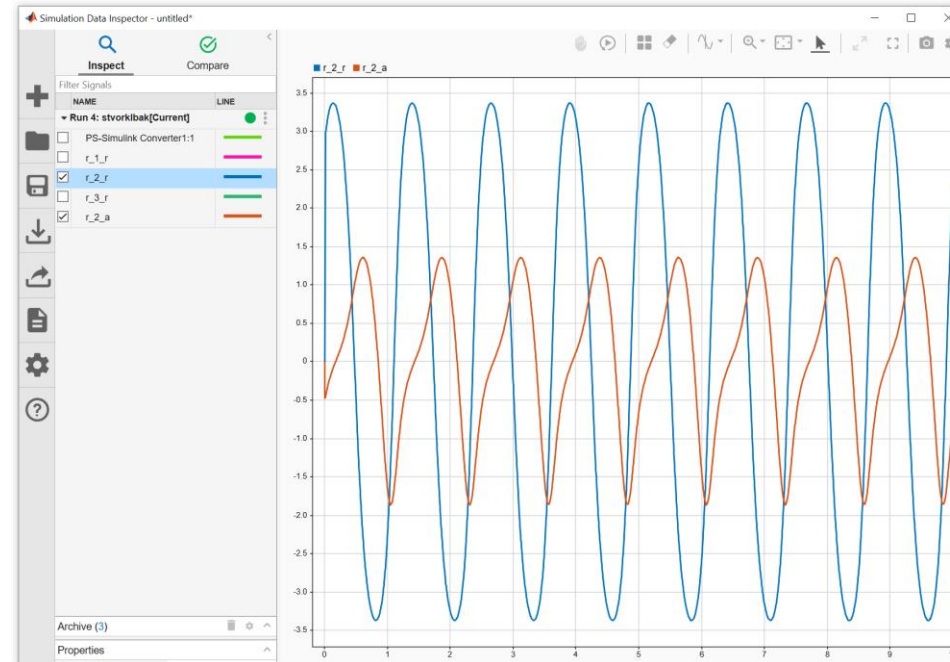
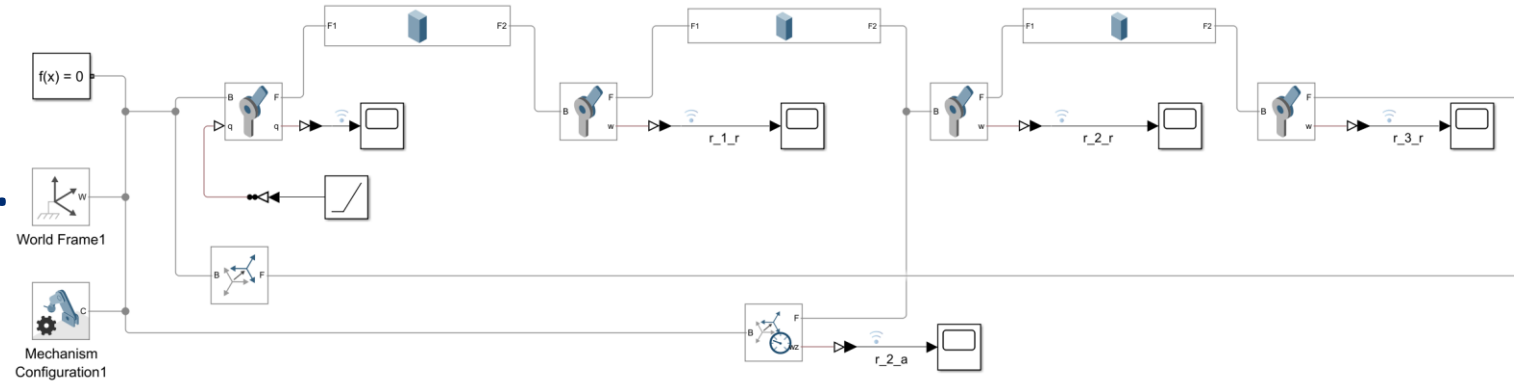
Solid

Settings Description

NAME	VALUE
<b>▼ Geometry</b>	
Dimensions	[1 0.1 0.1] m Compile-time
> Export	
> Inertia	
> Graphic	
> Frames	

# Tworzenie modelu

- Mechanizm czteropunktowy.



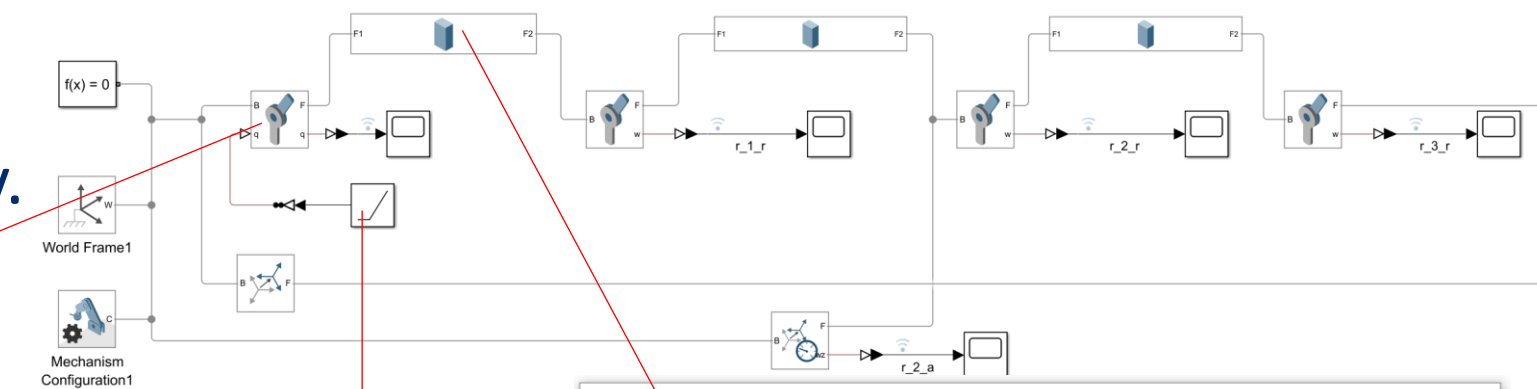
# Tworzenie modelu

- Mechanizm czteropunktowy.

Block Parameters: Revolute Joint

Revolute Joint  Auto Apply

Settings	Description
NAME	VALUE
<b>▼ Z Revolute Primitive (Rz)</b>	
▼ State Targets	
<input checked="" type="checkbox"/> Specify Position Target	
Priority	High (desired)
Value	45 deg
<input type="checkbox"/> Specify Velocity Target	
▼ Internal Mechanics	
Equilibrium Position	45 deg
Spring Stiffness	0 N*m/deg
Damping Coefficient	0 N*m/(deg/s)
► Limits	
▼ Actuation	
Torque	Automatically Computed
Motion	Provided by Input
▼ Sensing	
<input checked="" type="checkbox"/> Position	
<input type="checkbox"/> Velocity	
<input type="checkbox"/> Acceleration	
<input type="checkbox"/> Actuator Torque	
<input type="checkbox"/> Lower-Limit Torque	
<input type="checkbox"/> Upper-Limit Torque	
► Mode Configuration	
► Composite Force/Torque Sensing	



Block Parameters: Ramp

Ramp (mask) (link)  
Output a ramp signal starting at the specified time.

Parameters

Slope:  
5

Start time:  
0

Initial output:  
pi/4 0.7854

Interpret vector parameters as 1-D

OK Cancel Help Apply

Block Parameters: Brick Solid1

HOME

Refresh Select Front Back Top Bottom Left Right Isometric Fit Frames Inertia Background

VIEW

Settings	Description
NAME	VALUE
<b>▼ Geometry</b>	
Dimensions	[20 1 1] cm
► Export	
<b>▼ Inertia</b>	
<b>▼ Graphic</b>	
Type	From Geometry
<b>▼ Visual Properties</b>	
Diffuse Color	[0.2 0.2 1.0]
Opacity	1.0
<b>► Frames</b>	

The image shows a 3D model of a blue brick solid. The brick is oriented diagonally. The background is a light gray with a coordinate system and a 'FRONT RIGHT' label.

# Tworzenie modelu

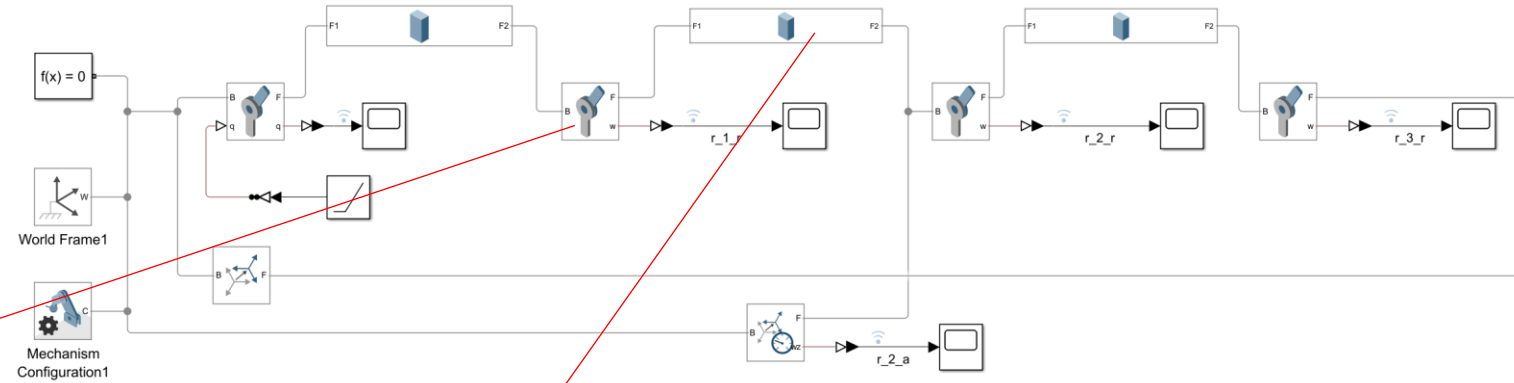
- Mechanizm czteropunktowy.

Block Parameters: Revolute Joint1

Revolute Joint  Auto Apply

Settings Description

NAME	VALUE
<b>Z Revolute Primitive (Rz)</b>	
State Targets	
<input type="checkbox"/> Specify Position Target	
<input type="checkbox"/> Specify Velocity Target	
Internal Mechanics	
Equilibrium Position	0 deg Compile-time
Spring Stiffness	0 N*m/deg Compile-time
Damping Coefficient	0 N*m/(deg/s) Compile-time
Limits	
Actuation	
Torque	None
Motion	Automatically Computed
Sensing	
<input type="checkbox"/> Position	
<input checked="" type="checkbox"/> Velocity	
<input type="checkbox"/> Acceleration	
<input type="checkbox"/> Actuator Torque	
<input type="checkbox"/> Lower-Limit Torque	
<input type="checkbox"/> Upper-Limit Torque	
Mode Configuration	
Composite Force/Torque Sensing	



Block Parameters: Brick Solid2

HOME

Refresh Select Front Back Top Bottom Left Right Isometric Fit Frames Inertia Background

VIEW

Solid

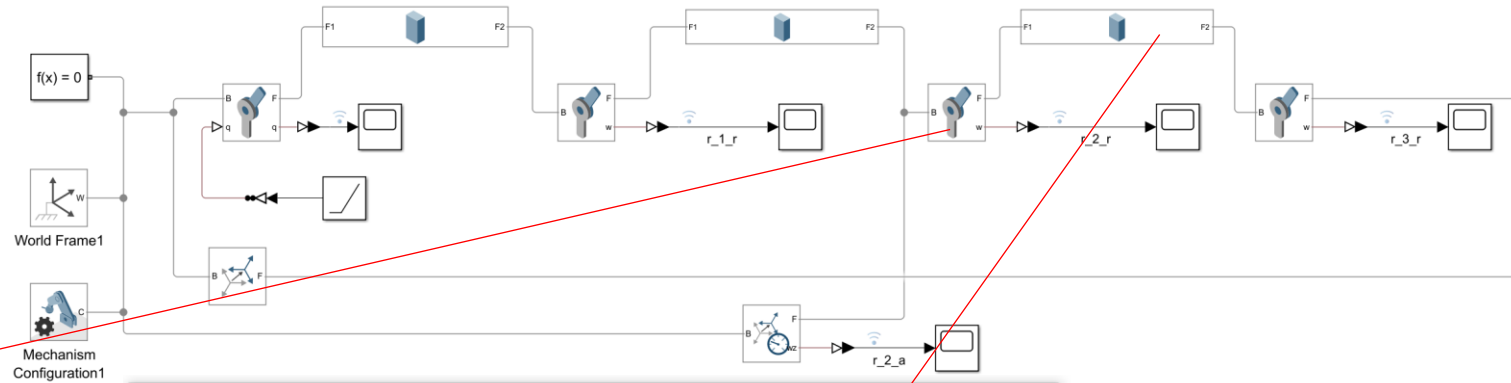
Settings Description

NAME	VALUE
<b>Geometry</b>	
Dimensions	[80 1 1] cm Compile-time
Inertia	
<b>Graphic</b>	
Type	From Geometry
Visual Properties	
Diffuse Color	[0.0 0.8 0.4]
Opacity	1.0 Compile-time
Frames	

The image shows a 3D view of a brick solid in a software environment. The brick is a rectangular prism with dimensions [80 1 1] cm. It is colored with a diffuse color of [0.0 0.8 0.4] and has an opacity of 1.0. A green line is drawn across the front face of the brick. The view is labeled 'VIEW' and includes a toolbar with options like Refresh, Select, Front, Back, Top, Bottom, Left, Right, Isometric, Fit, Frames, Inertia, and Background. A small 3D coordinate system is visible in the bottom left corner of the view area.

# Tworzenie modelu

- Mechanizm czteropunktowy.



Block Parameters: Revolute Joint2

Revolute Joint  Auto Apply

Settings Description

NAME	VALUE
<b>Z Revolute Primitive (Rz)</b>	
▼ State Targets	
<input type="checkbox"/> Specify Position Target	
<input type="checkbox"/> Specify Velocity Target	
▼ Internal Mechanics	
Equilibrium Position	0 deg Compile-time
Spring Stiffness	0 N*m/deg Compile-time
Damping Coefficient	0 N*m/(deg/s) Compile-time
Limits	
▼ Actuation	
Torque	None
Motion	Automatically Computed
▼ Sensing	
<input type="checkbox"/> Position	
<input checked="" type="checkbox"/> Velocity	
<input type="checkbox"/> Acceleration	
<input type="checkbox"/> Actuator Torque	
<input type="checkbox"/> Lower-Limit Torque	
<input type="checkbox"/> Upper-Limit Torque	

Mode Configuration

Block Parameters: Brick Solid3

HOME

Refresh Select Front Back Top Bottom Left Right Isometric Fit Frames Inertia Background

VIEW

NAME	VALUE
<b>Geometry</b>	
Dimensions	[30 1 1] cm Compile-time
Export	
<b>Inertia</b>	
<b>Graphic</b>	
Type	From Geometry
▼ Visual Properties	
Diffuse Color	[1.0 0.0 0.0]
Opacity	1.0 Compile-time
Frames	

# Tworzenie modelu

- Mechanizm czteropunktowy.

Block Parameters: Rigid Transform1

Rigid Transform  Auto Apply

Settings	Description	VALUE
<b>Rotation</b>		
Method		None
<b>Translation</b>		
Method		Cartesian
Offset		[0.8 0 0] m Compile-time

Block Parameters: Transform Sensor1

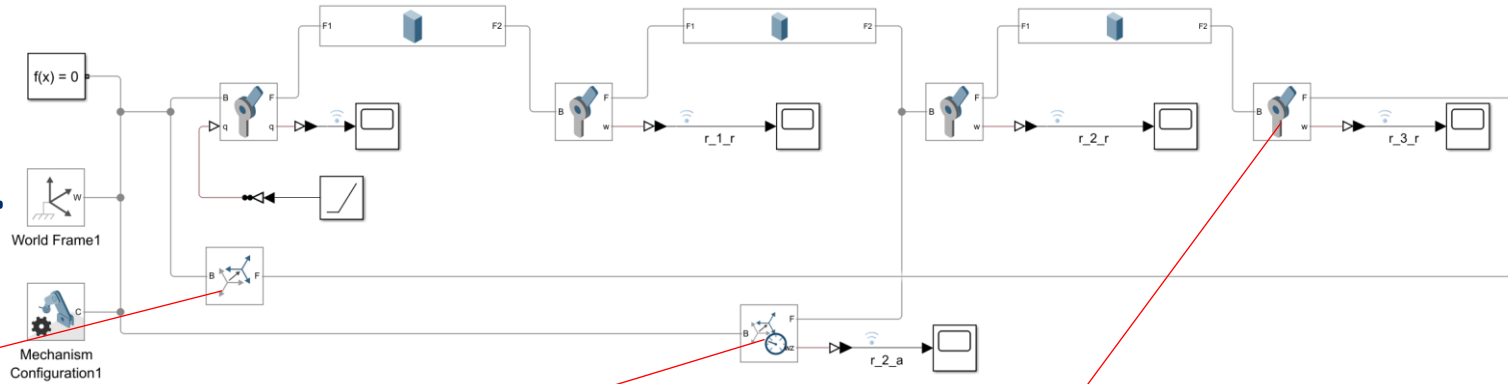
Transform Sensor  Auto Apply

Settings	Description	VALUE
<b>Rotation</b>		
Measurement Frame		World
Sequence for Rotation Sequence		X-Y-X
<b>Angular Velocity</b>		
<input type="checkbox"/> Omega X		
<input type="checkbox"/> Omega Y		
<input checked="" type="checkbox"/> Omega Z		
<input type="checkbox"/> Omega XYZ		
<input type="checkbox"/> Quaternion		
<input type="checkbox"/> Transform		
<input type="checkbox"/> Rotation Sequence		
<b>Angular Acceleration</b>		
<b>Translation</b>		
<b>Velocity</b>		
<b>Acceleration</b>		

Block Parameters: Revolute Joint3

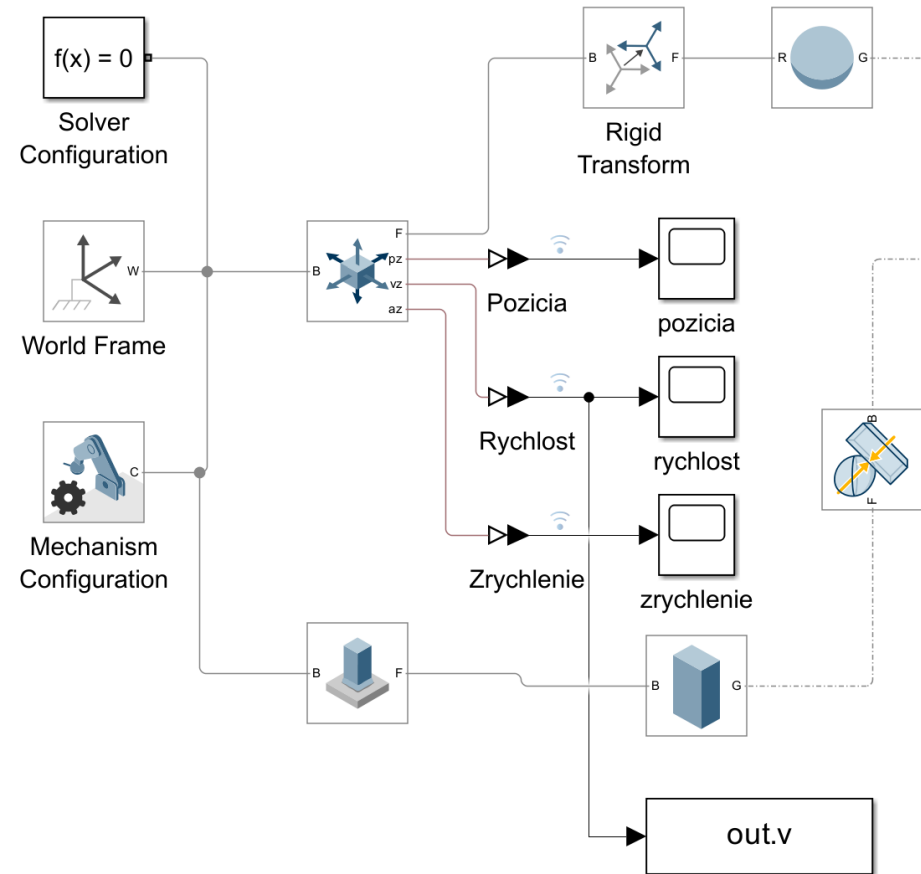
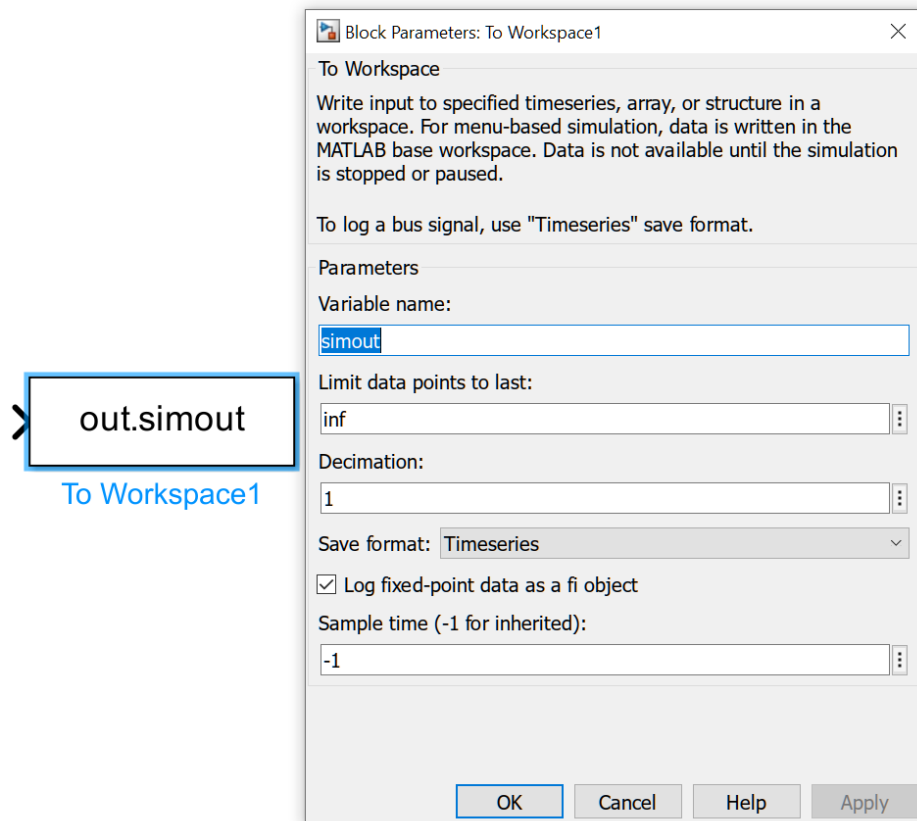
Revolute Joint  Auto Apply

Settings	Description	VALUE
<b>Z Revolute Primitive (Rz)</b>		
<b>State Targets</b>		
<input type="checkbox"/> Specify Position Target		
<input type="checkbox"/> Specify Velocity Target		
<b>Internal Mechanics</b>		
Equilibrium Position		0 deg Compile-time
Spring Stiffness		0 N*m/deg Compile-time
Damping Coefficient		0 N*m/(deg/s) Compile-time
<b>Limits</b>		
<b>Actuation</b>		
Torque		None
Motion		Automatically Computed
<b>Sensing</b>		
<input type="checkbox"/> Position		
<input checked="" type="checkbox"/> Velocity		
<input type="checkbox"/> Acceleration		
<input type="checkbox"/> Actuator Torque		
<input type="checkbox"/> Lower-Limit Torque		
<input type="checkbox"/> Upper-Limit Torque		
<b>Mode Configuration</b>		



# Tworzenie modelu

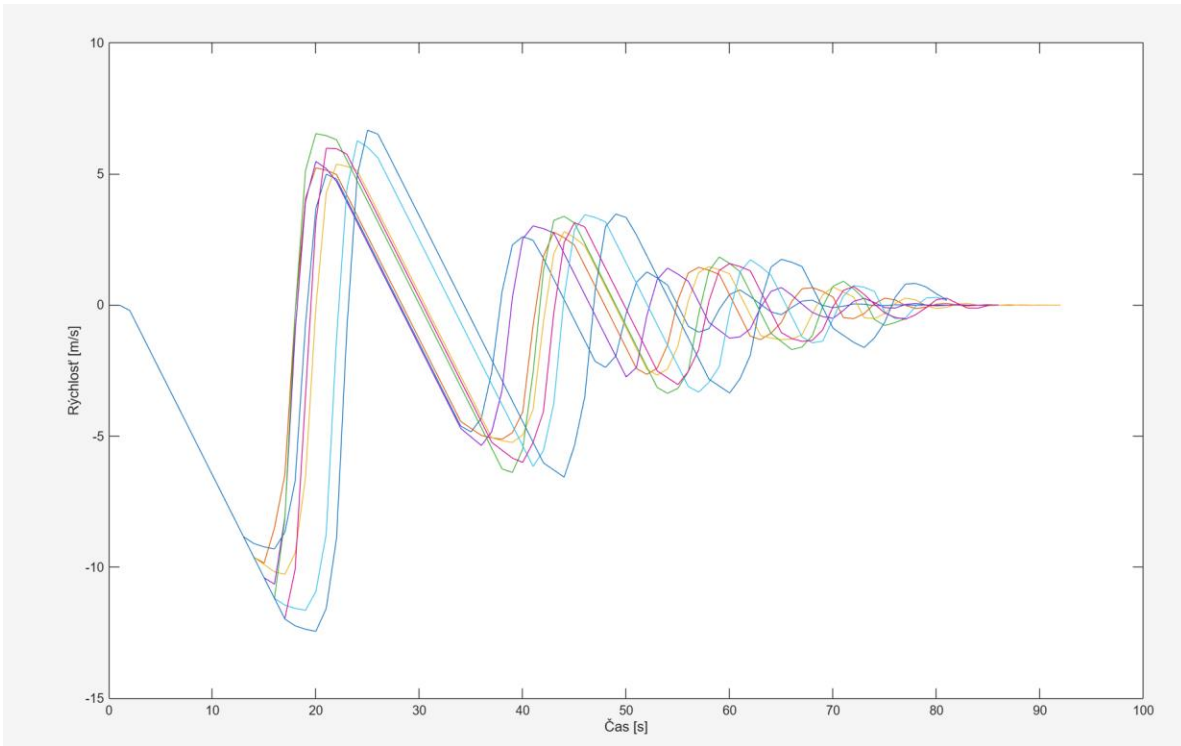
- Integracja MATLAB-a i Simscape Multibody.





# Tworzenie modelu

- Optymalizacja wysokości piłki.



```
% skript na prepojenie Simscape Multibody a MATLAB
clc;
clear;
close all;

v = 5; % výška z akej je guľička spustená

% zbehnutie simulácie
simIn = Simulink.SimulationInput("volny_pad_prepojenie");

% načítanie výstupu simulácie
out = sim(simIn);
% priradenie do premennej
rychlost = out.v.Data;

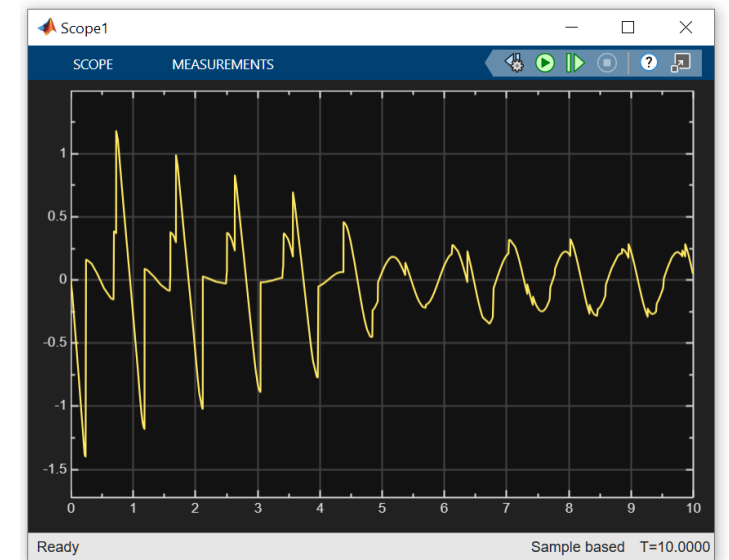
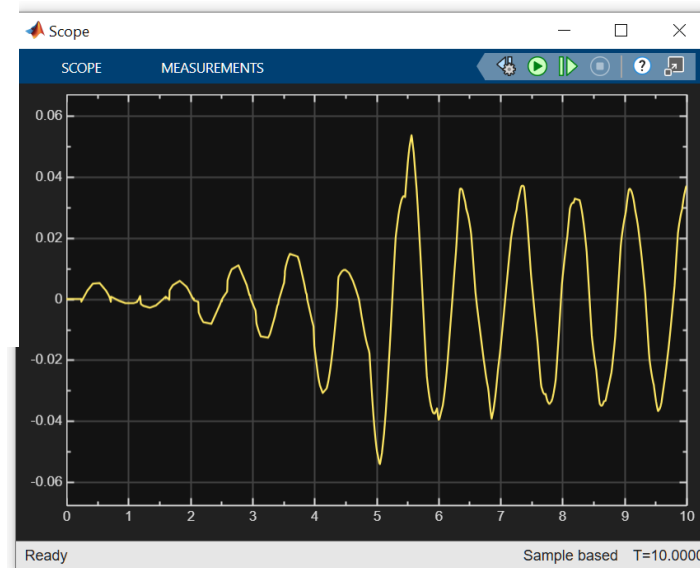
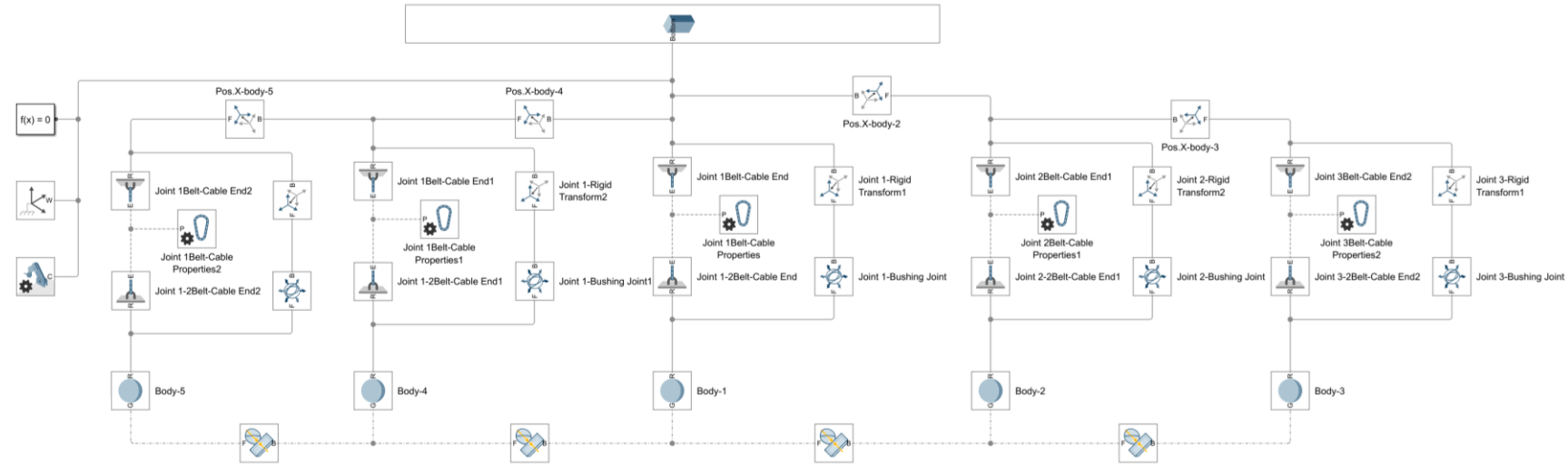
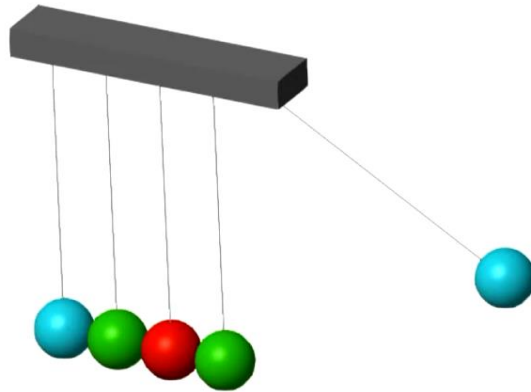
% vykreslenie priebehu rýchlosti
figure
plot(rychlost)
xlabel("Čas [s]")
ylabel("Rýchlosť [m/s]")
drawnow

hold on
pocet_simulacii = 1;
while true
    if max(abs(round(rychlost,2))) >= 12
        rychlost_vysl = rychlost;
        break
    else
        v = v+0.5;
        try
            out = sim(simIn);
        catch
            v = v+0.5;
        end
    end
    rychlost = out.v.Data;
    hold on
    plot(rychlost)
    xlabel("Čas [s]")
    ylabel("Rýchlosť [m/s]")
    drawnow
    pocet_simulacii = pocet_simulacii+1;
end

fprintf("Potrebná výška je h = %d m\n",...
        round(rychlost_vysl,2))
fprintf("Počet simulácií bol %d\n",pocet_simulacii)
```

# Tworzenie modelu

- Wahadło Newtona.



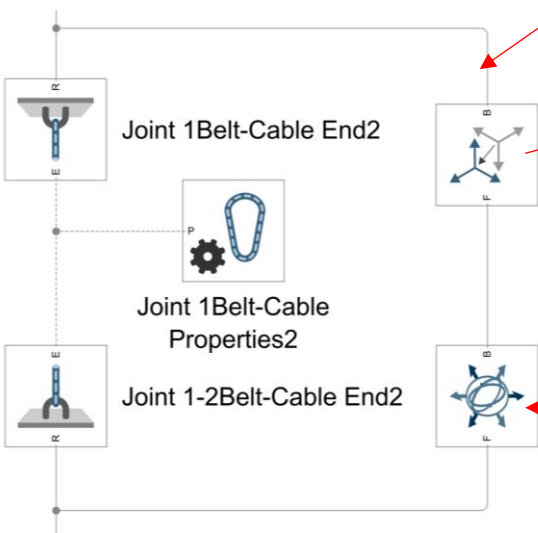
# Tworzenie modelu

- Wahadło Newtona.

Block Parameters: Mechanism Configuration

Mechanism Configuration  Auto Apply

NAME	VALUE
<b>Uniform Gravity</b>	
Gravity	Constant [0 -9.80665 0] m/s^2 Compile-time
Linearization Delta	0.001
<b>Joint Mode Transition</b>	



Block Parameters: Joint 1-Rigid Transform3

Rigid Transform  Auto Apply

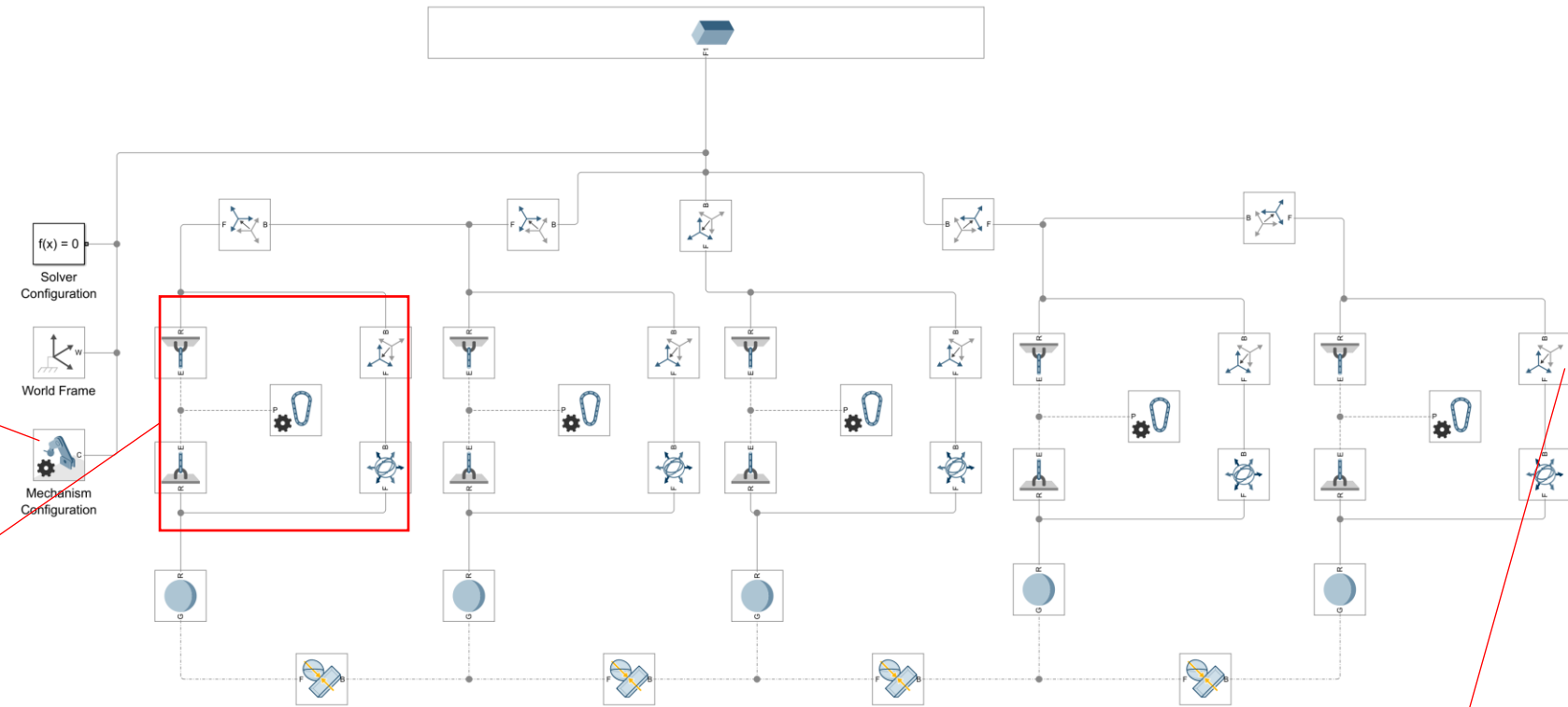
NAME	VALUE
<b>Rotation</b>	
Method	None
<b>Translation</b>	
Method	Cartesian
Offset	[0 -0.2 0] m Compile-time

**Bushing joint**

Block Parameters: Rigid Transform8

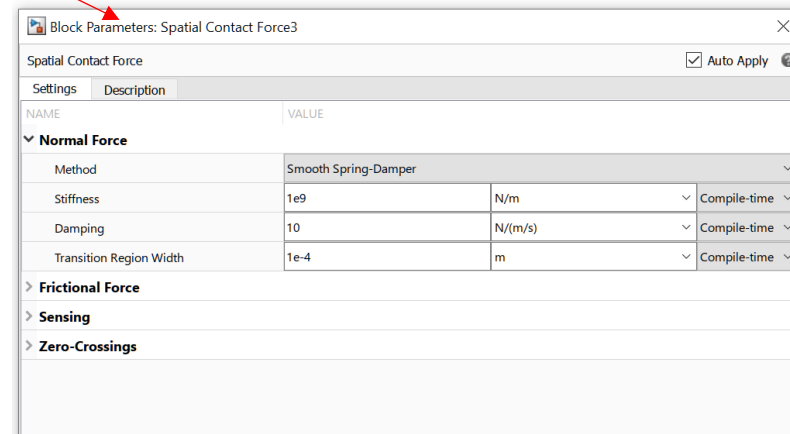
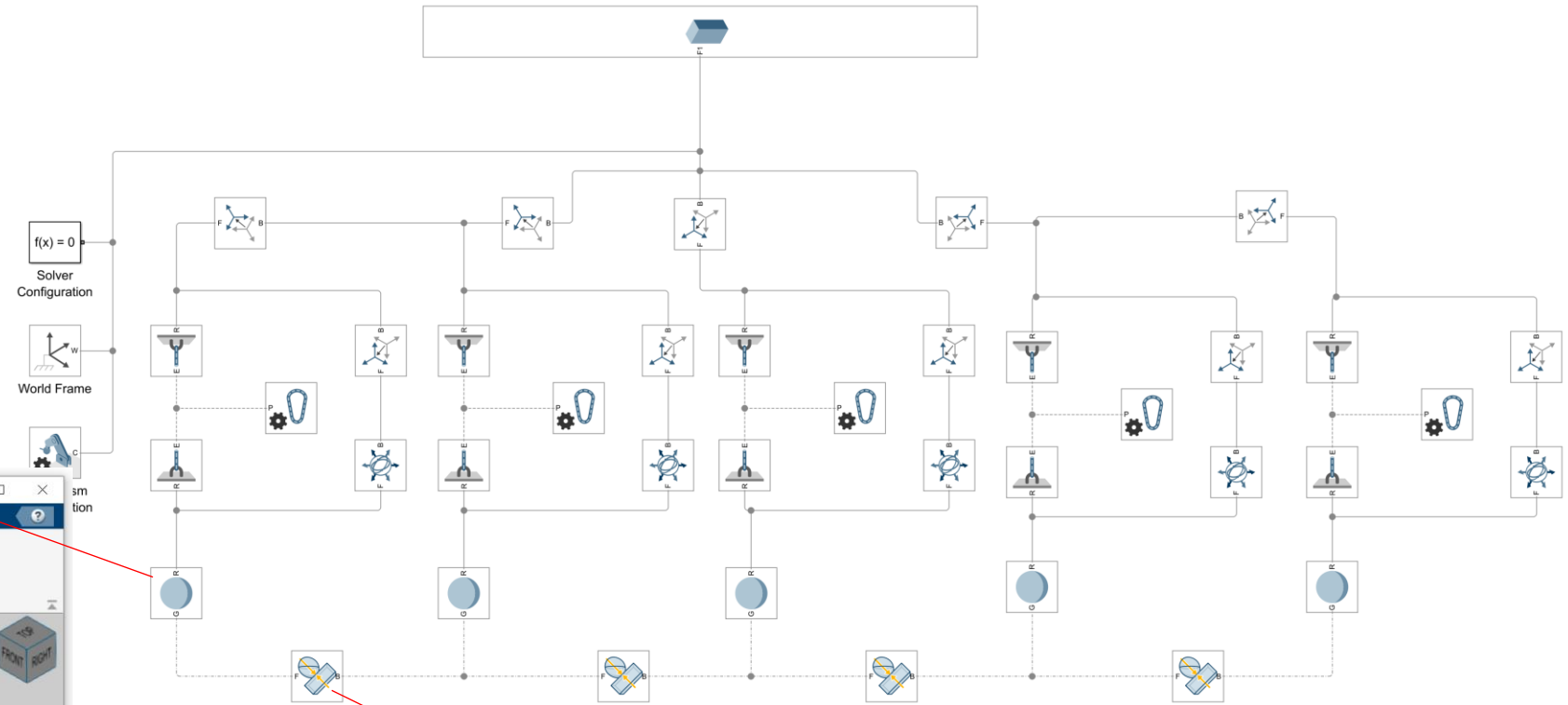
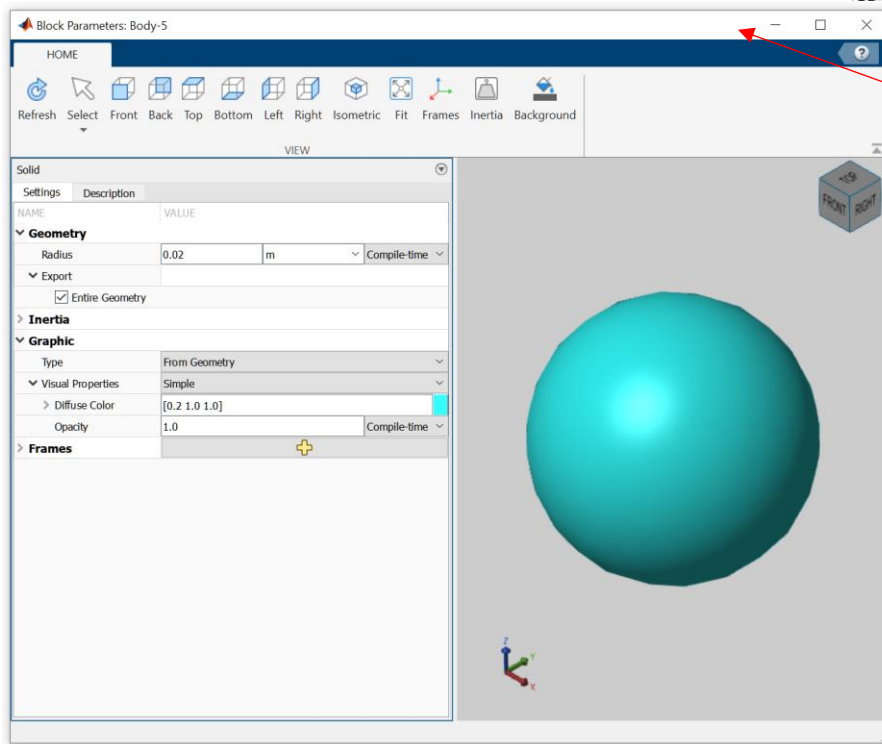
Rigid Transform  Auto Apply

NAME	VALUE
<b>Rotation</b>	
Method	None
<b>Translation</b>	
Method	Cartesian
Offset	[0.2*sind(60) -0.2*cosd(60) 0] [0.1... m Compile-time



# Tworzenie modelu

- Wahadło Newtona.



# Tworzenie modelu

- Wahadło Newtona.

