

Modelovanie dynamiky sústav telies v 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**

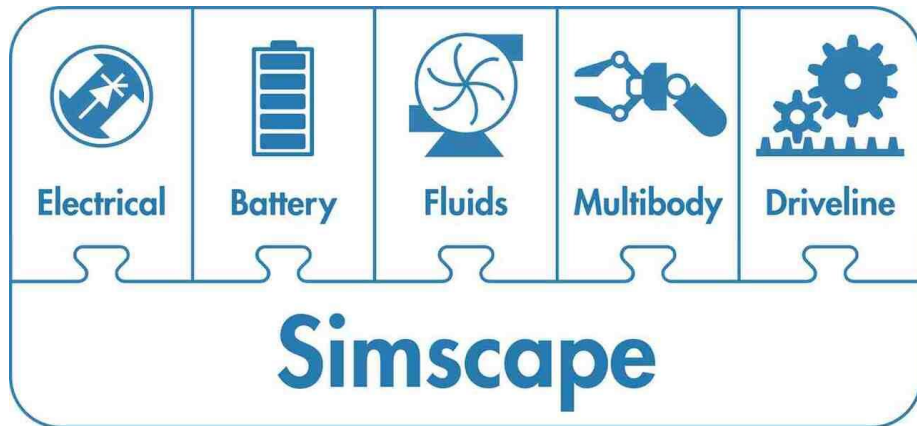


Žilinská univerzita
v Žiline

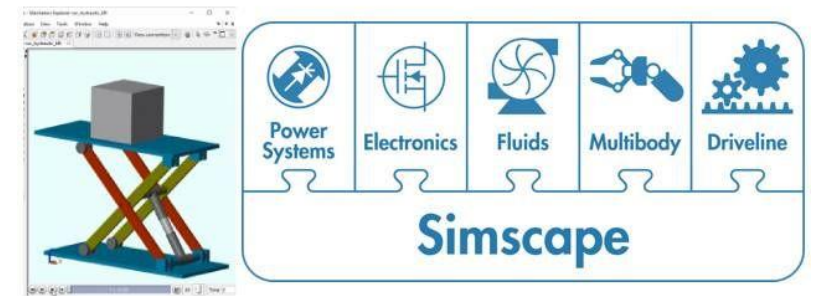
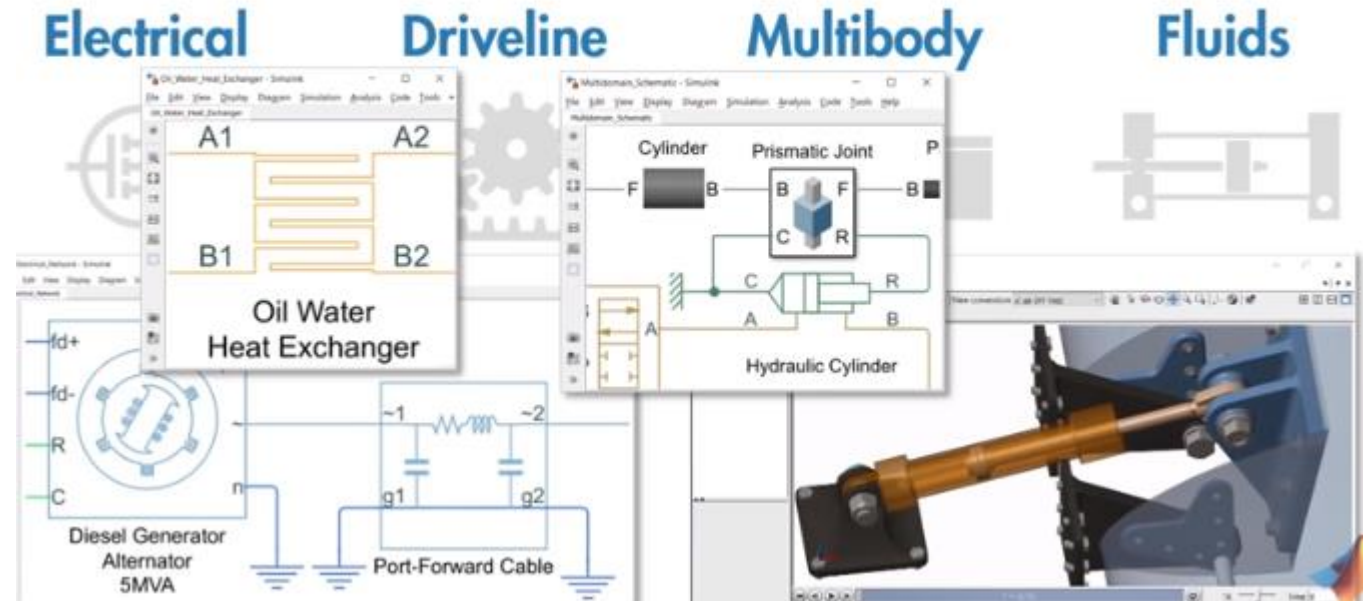


Simscape

- Modelovanie bez rovníc.
- Fyzikálne prepojenia.
- Okamžitá 3D vizualizácia.
- Riešenie multifyzikálnych úloh.
- Digitálne dvojča.

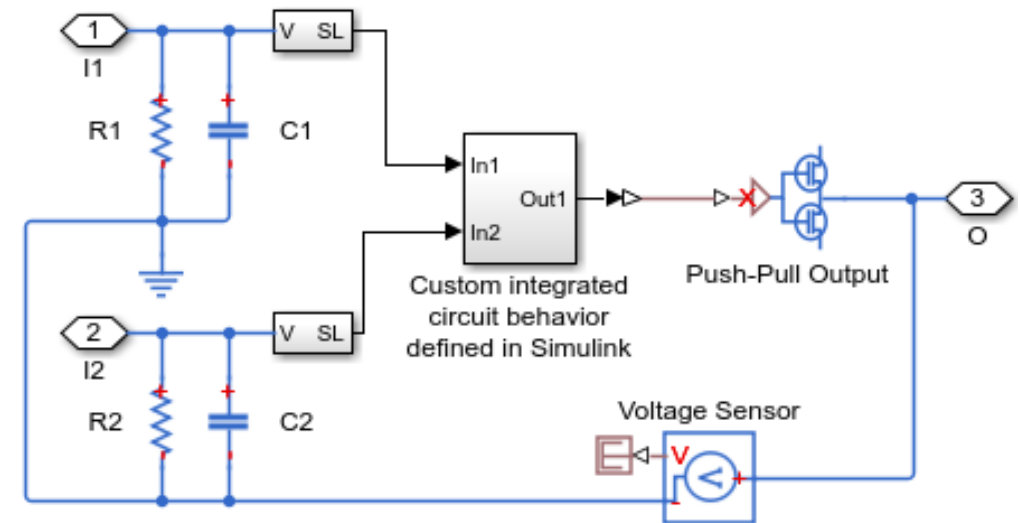
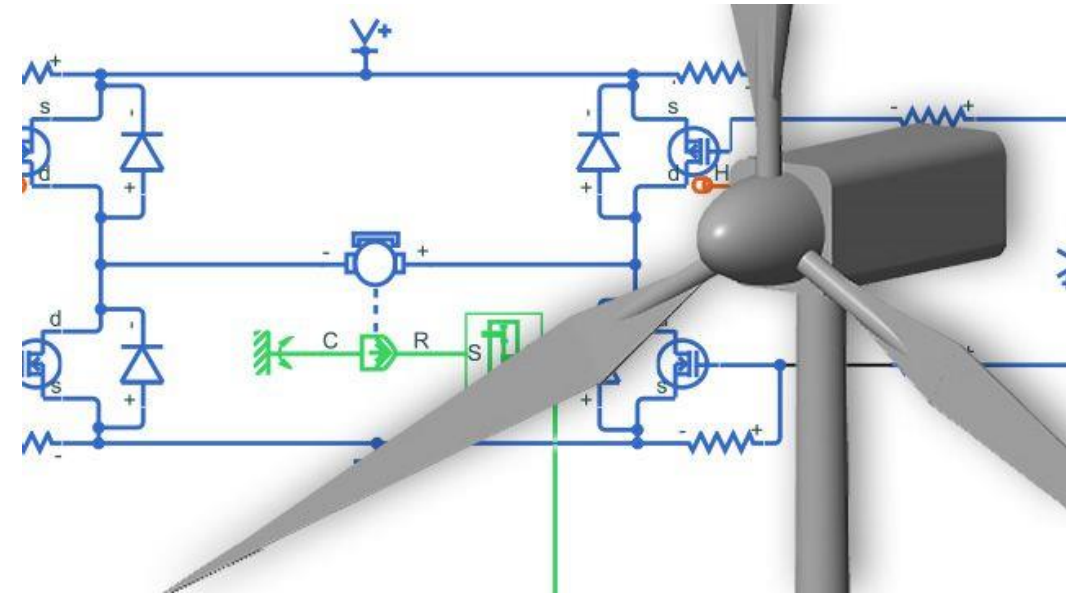
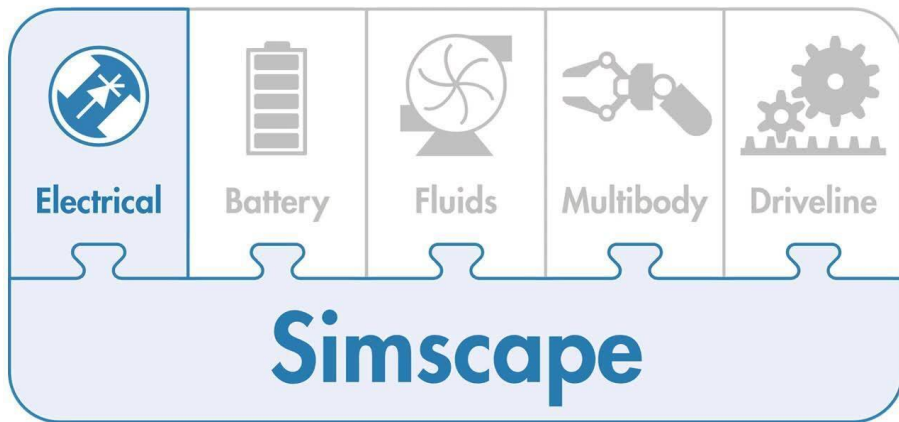


Simscape



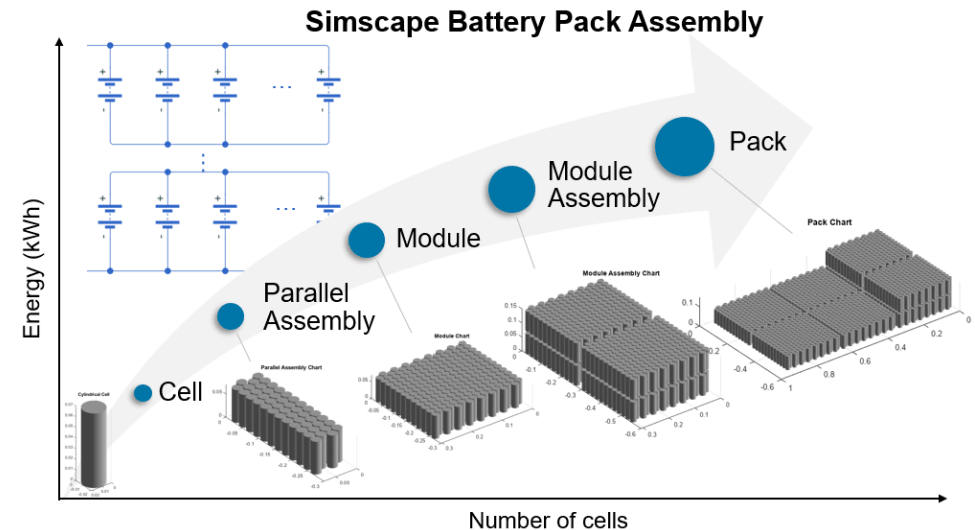
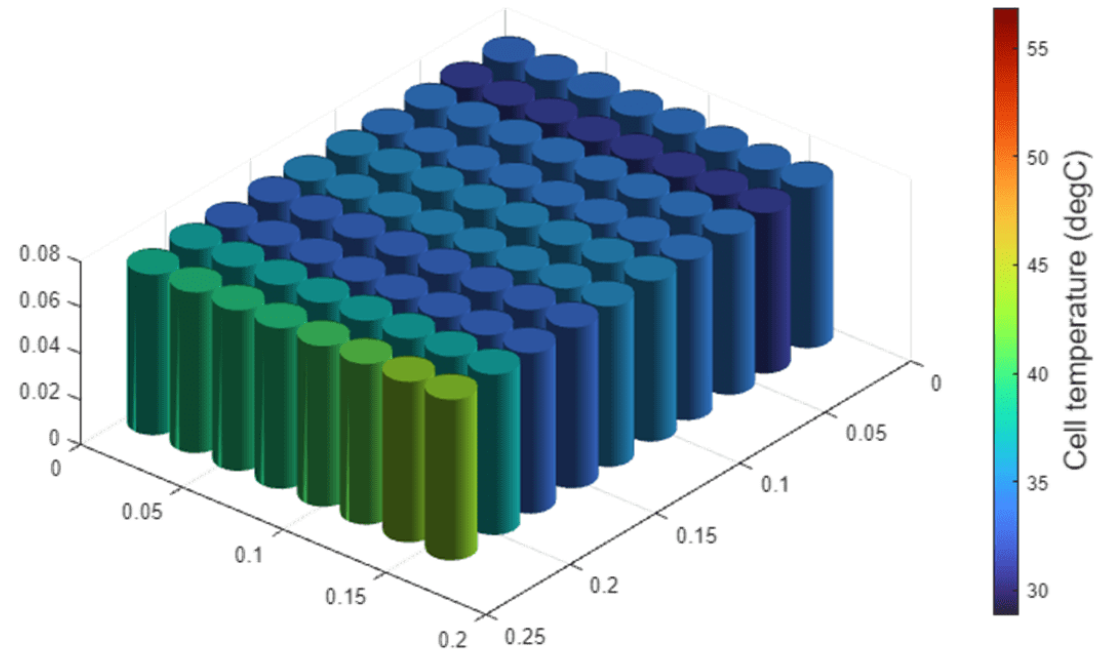
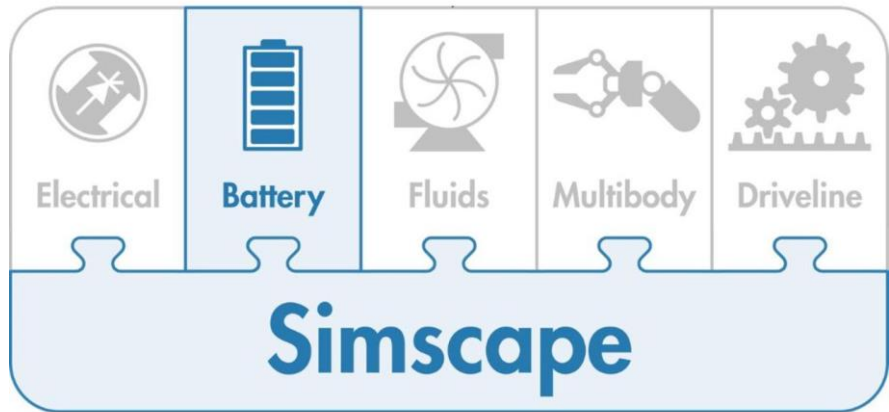
Simscape Electrical

- Multidoménová integrácia (Mechatronika).
- Široká škála modelov elektrických strojov.
- Výkonová elektronika a polovodiče.
- Komplexné energetické siete.
- Rýchle prototypovanie a HIL.



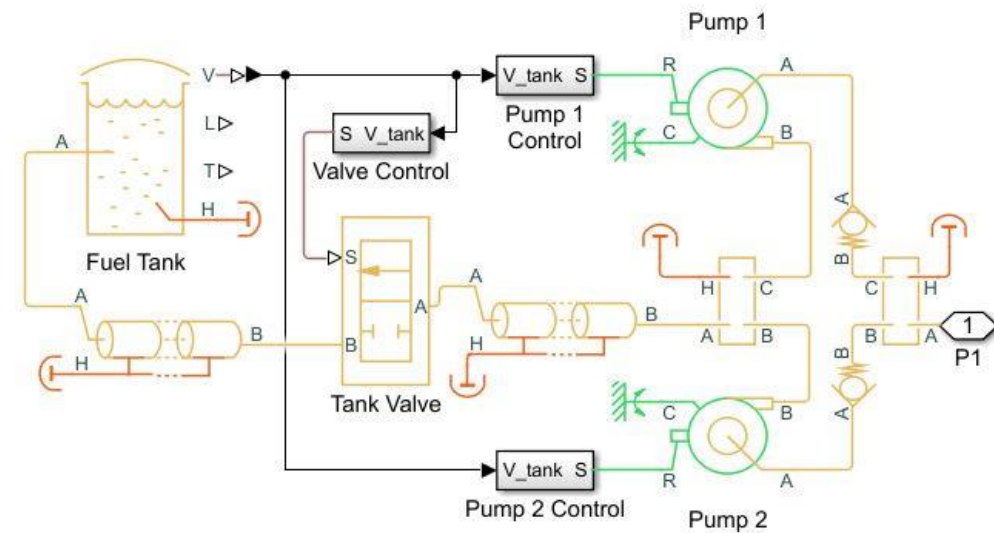
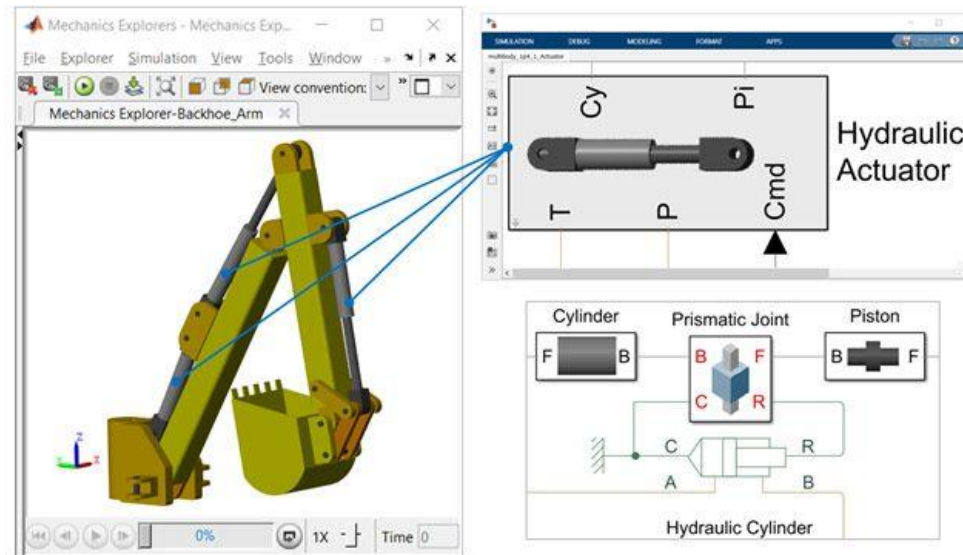
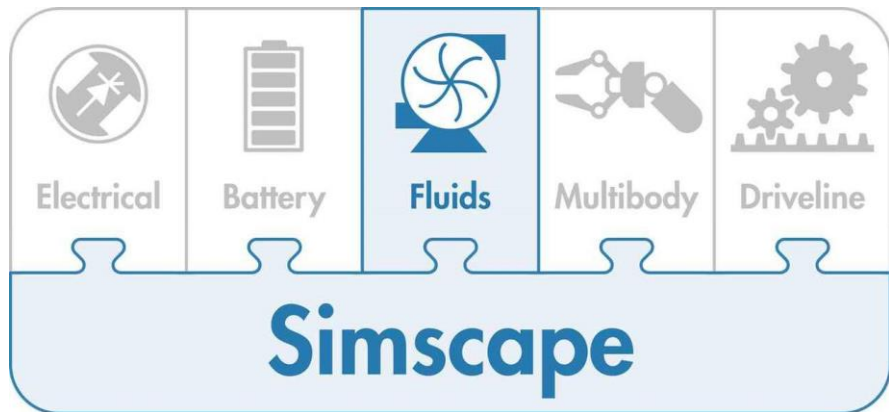
Simscape Battery

- Škálovateľná hierarchia.
- Elektro – termálna vernosť.
- Digitálne dvojča stárnutia.
- Vývoj a validácia BMS.
- Systémová integrácia a dojazd



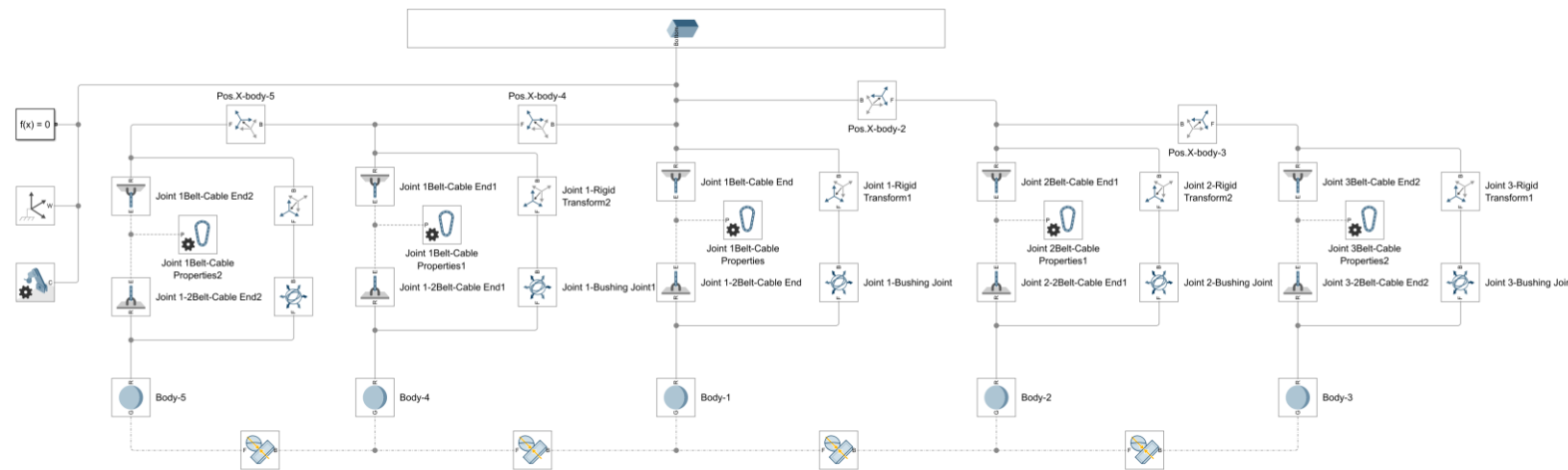
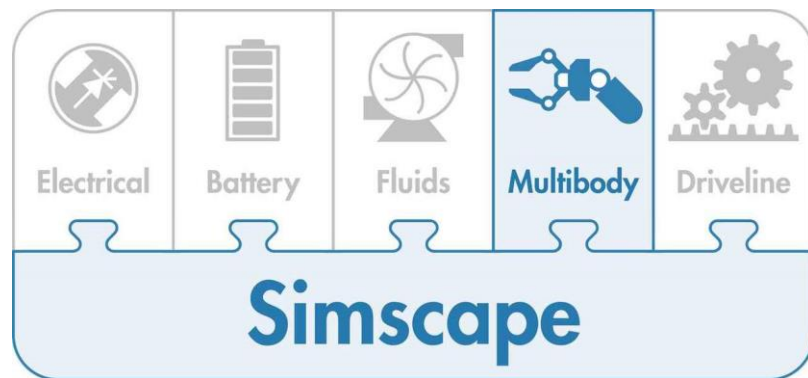
Simscape Fluids

- Modelovanie prúdenia.
- Dynamika plynov.
- Simulácia kavitácie a vzduchu.
- Vlastné vlastnosti médií.
- HIL simulácie.



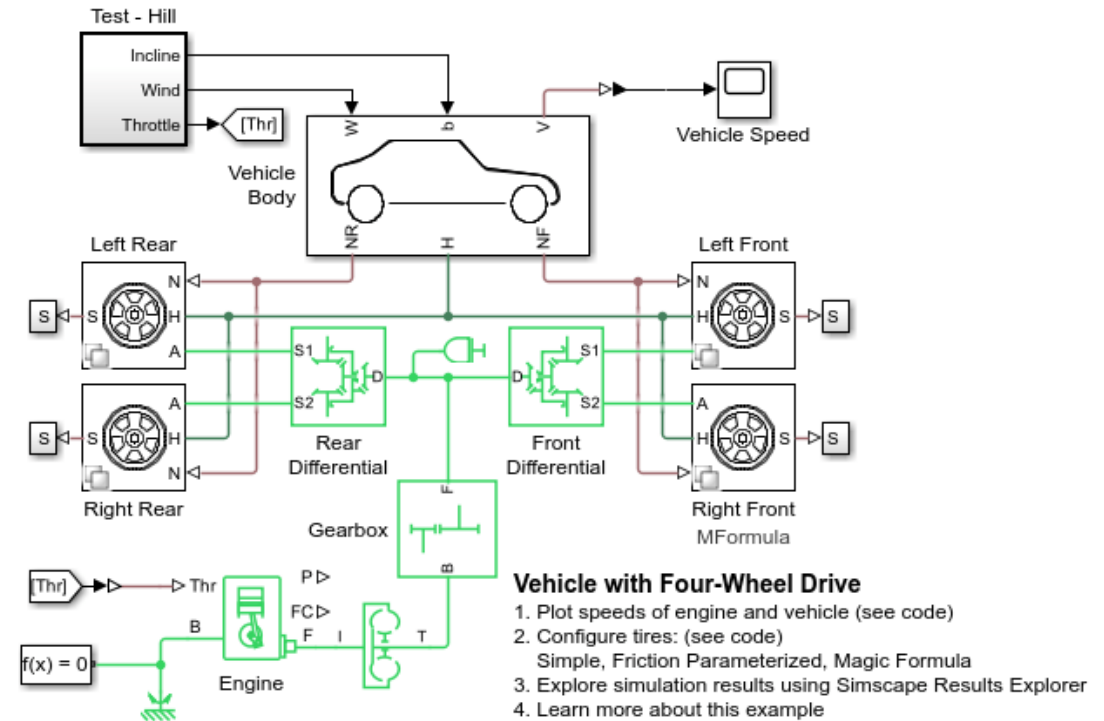
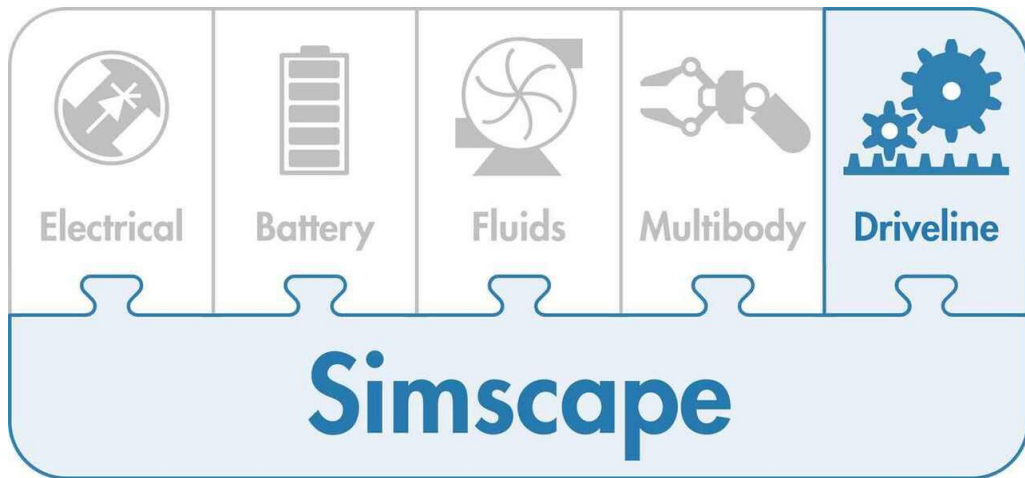
Simscape Multibody

- Fyzikálne modelovanie založené na väzbách a automatickom generovaní rovníc.
- Možnosť integrácie s CAD a parametrizácie.
- Analýza nelineárnych interakcií.
- Multifyzikálna ko – simulácia a syntéza riadenia.
- Virtual prototyping, HIL.



Simscape Driveline

- Knižnica strojárskych komponentov.
- Modelovanie trenia a strát.
- Riadenie a prechodové javy.
- Pneumatiky a dynamika vozidla.
- Kombinácia s Multibody pre vizualizáciu.

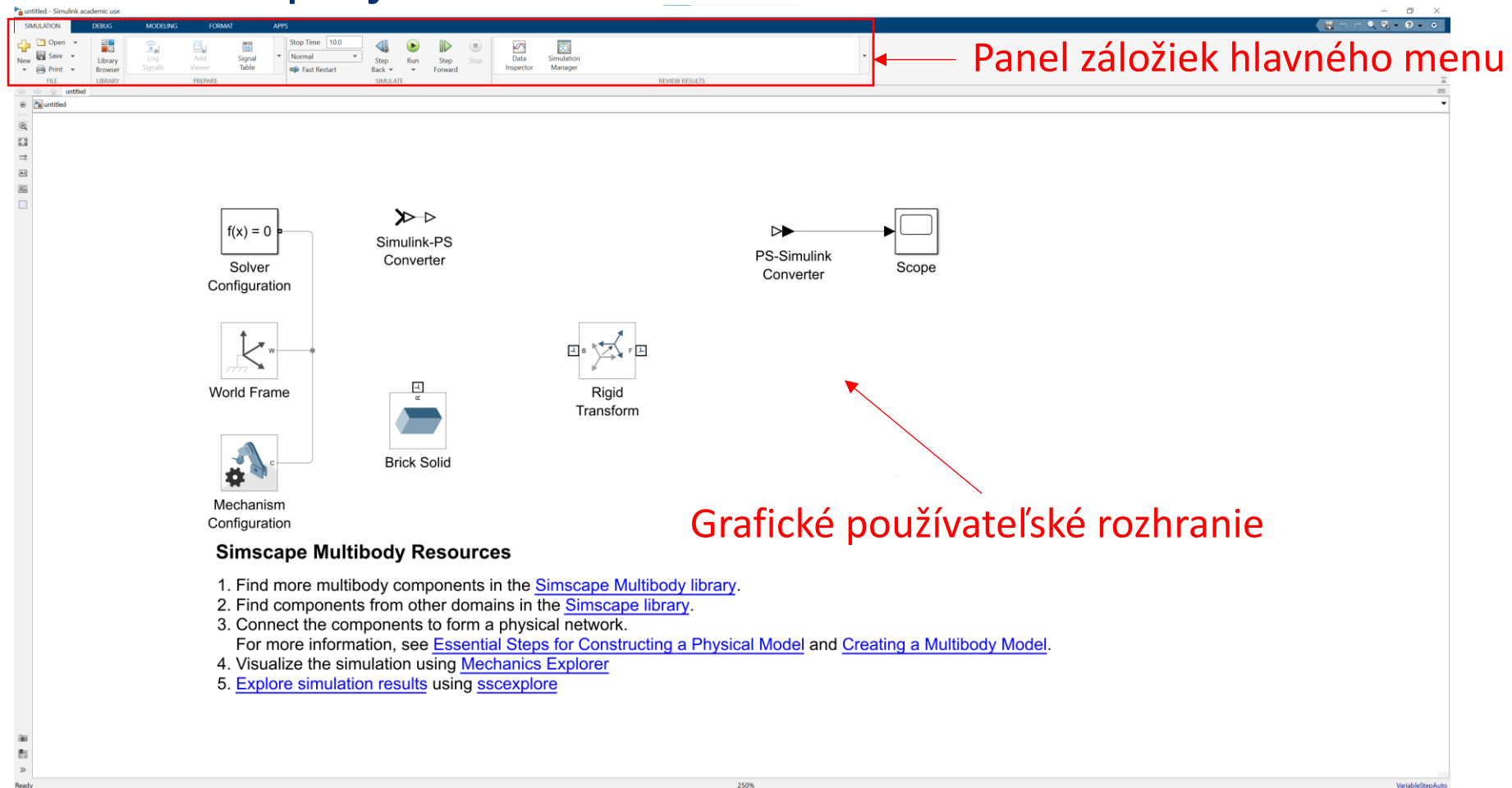


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Tvorba modelu

- Vytvorenie nového projektu: *smnew*



Panel záložiek hlavného menu

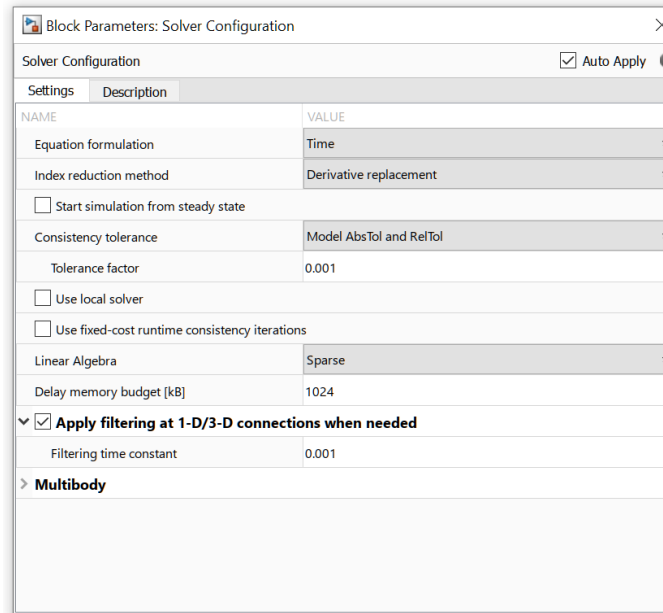
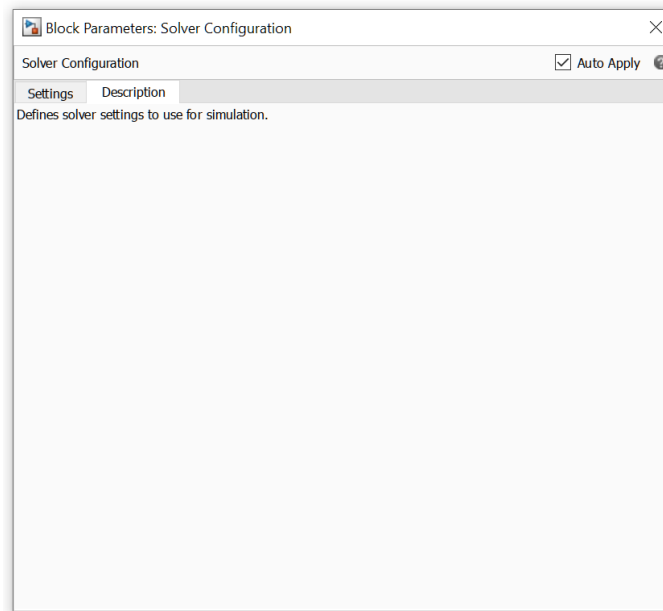
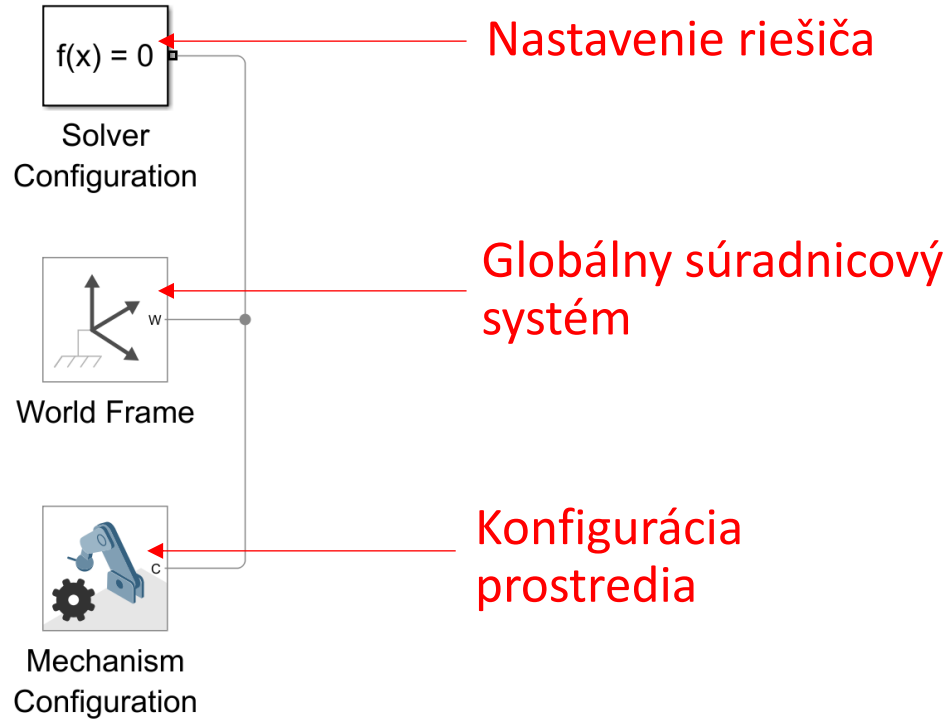
Grafické používateľské rozhranie

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](#)

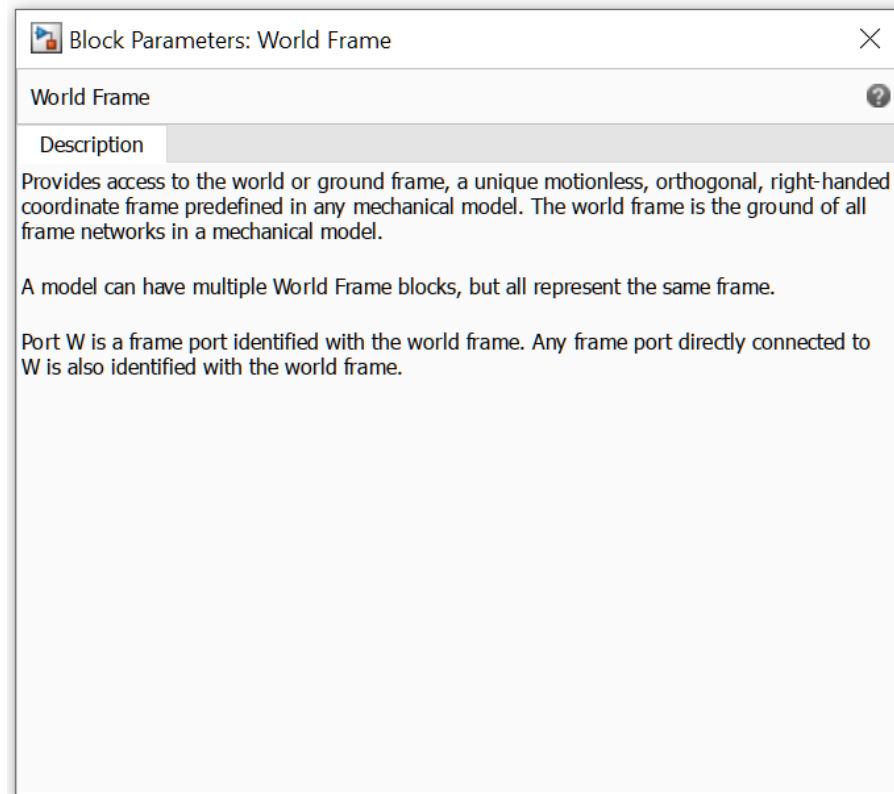
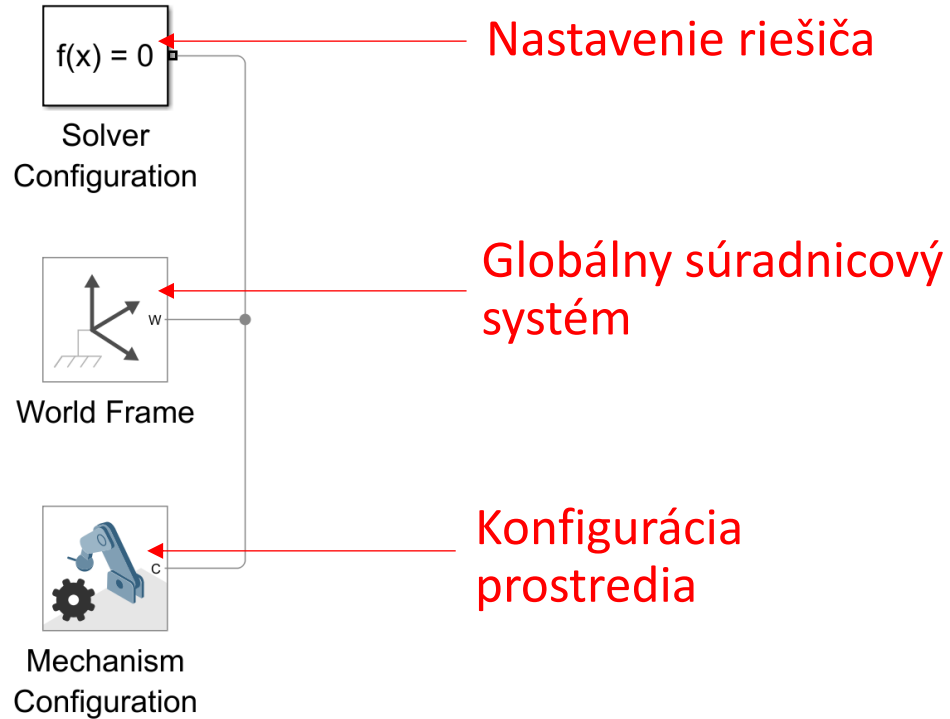
Tvorba modelu

- Základné bloky každého modelu:



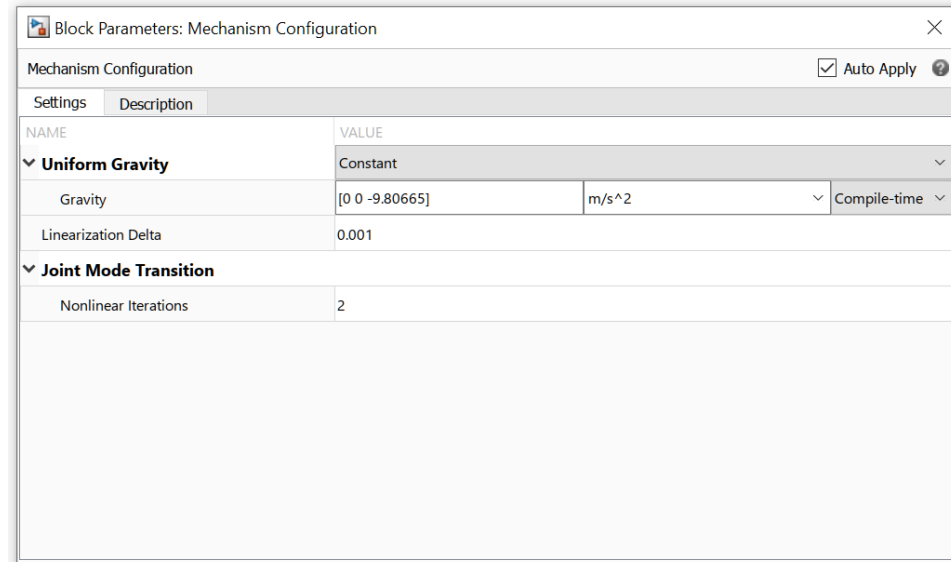
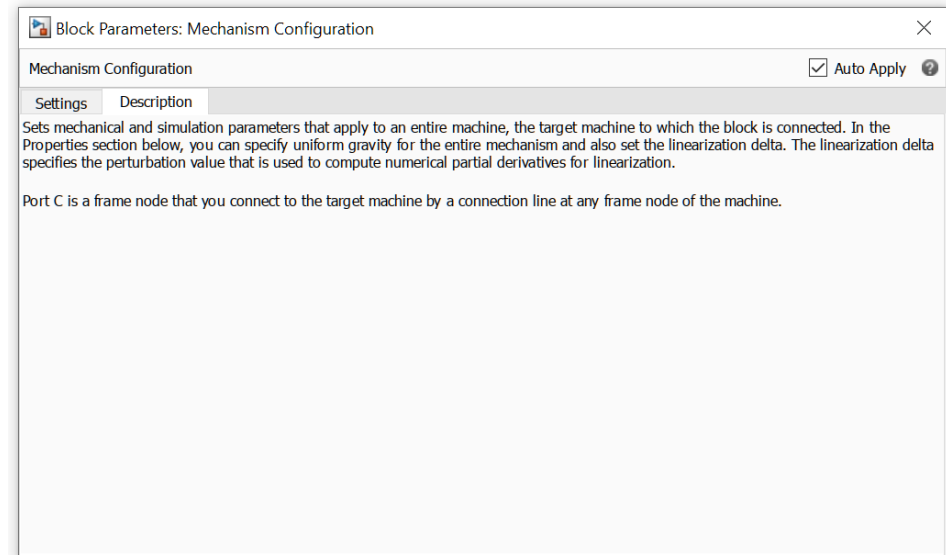
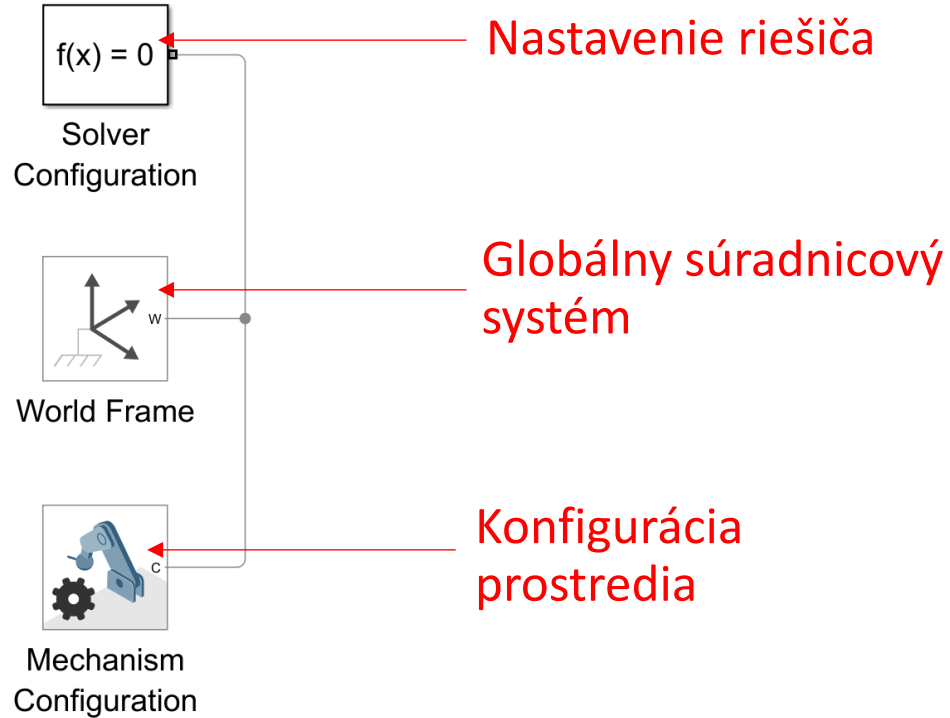
Tvorba modelu

- Základné bloky každého modelu:



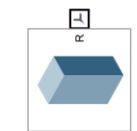
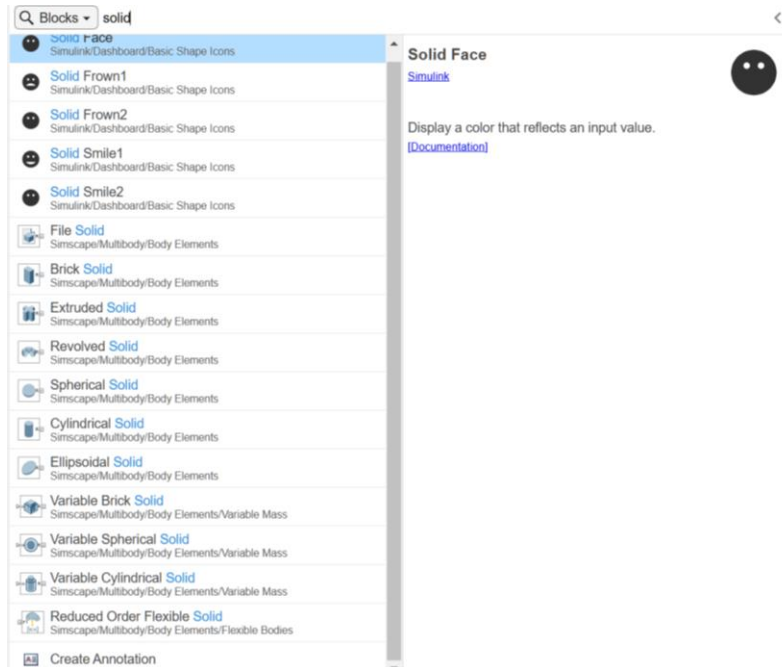
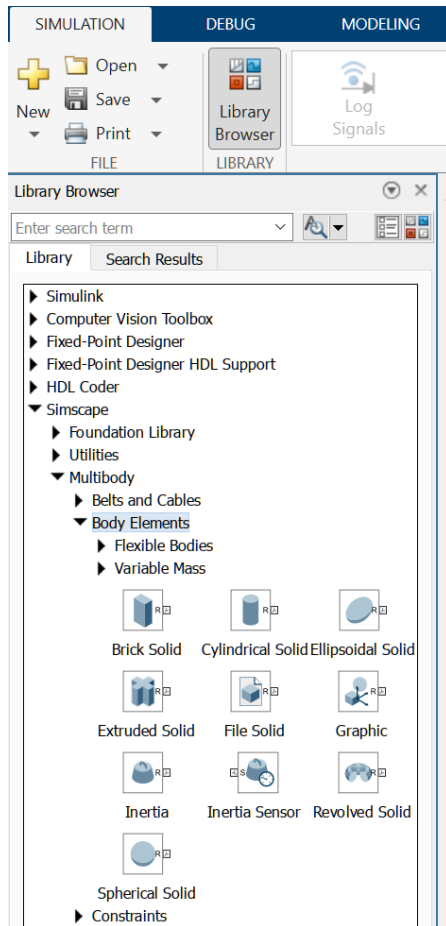
Tvorba modelu

- Základné bloky každého modelu:

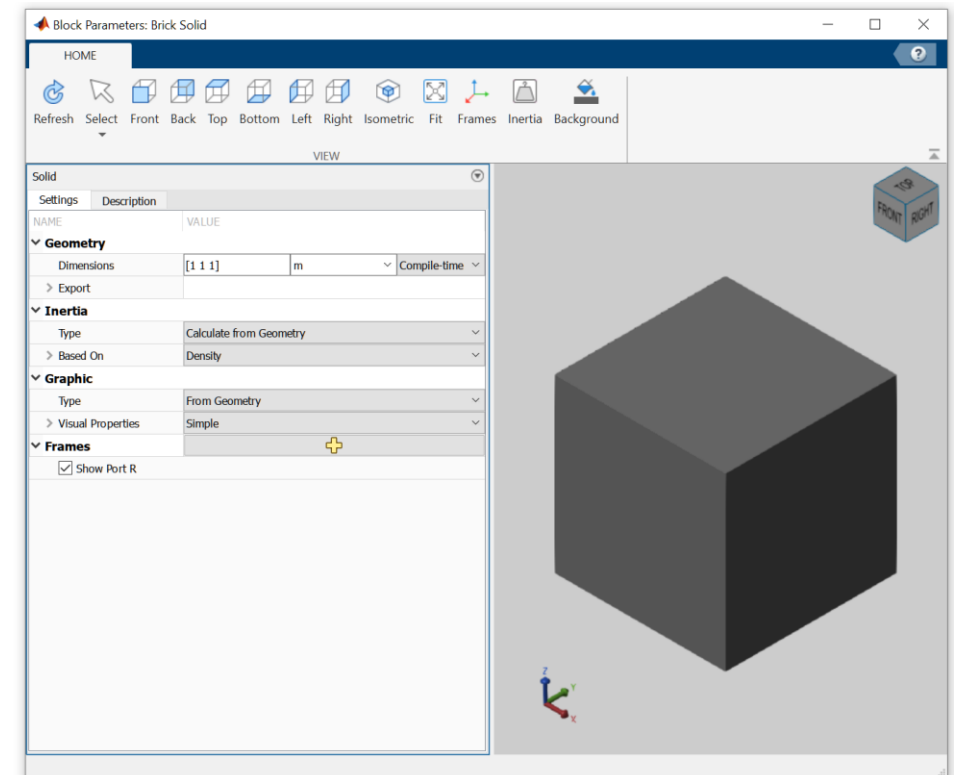


Tvorba modelu

• Bloky telies



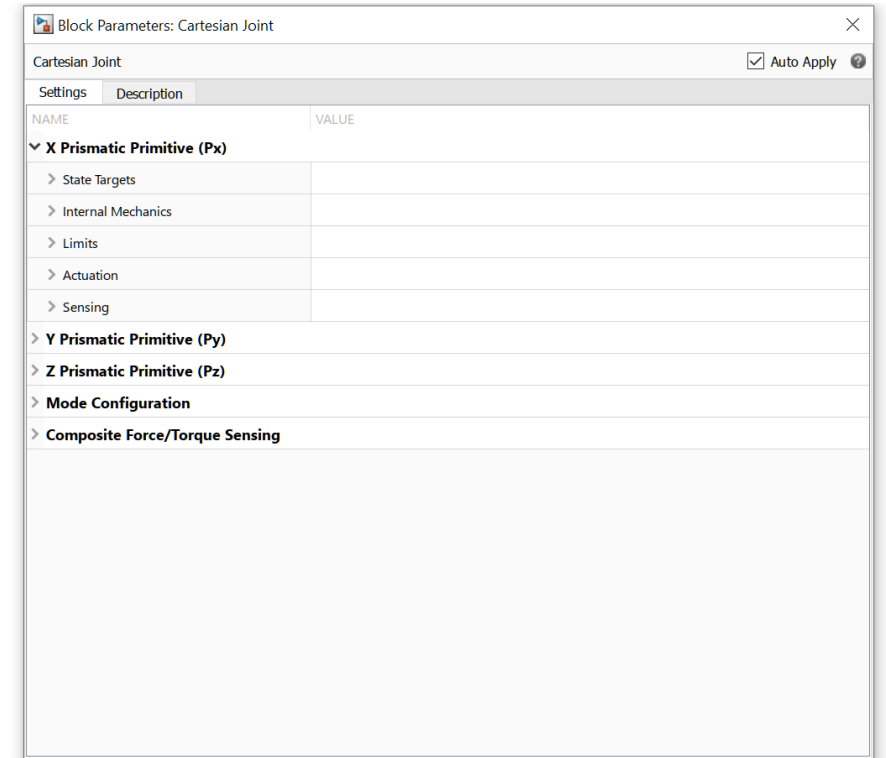
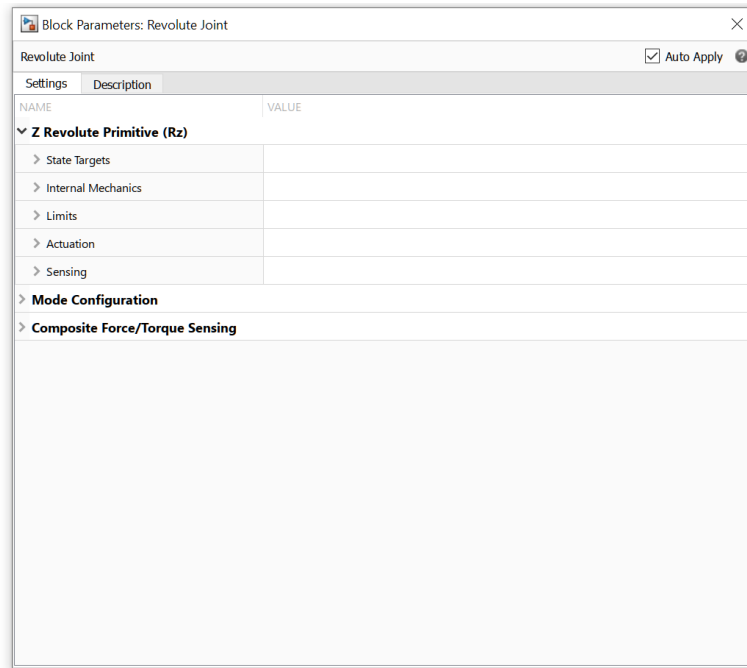
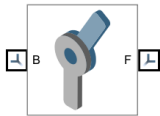
Brick Solid



Tvorba modelu

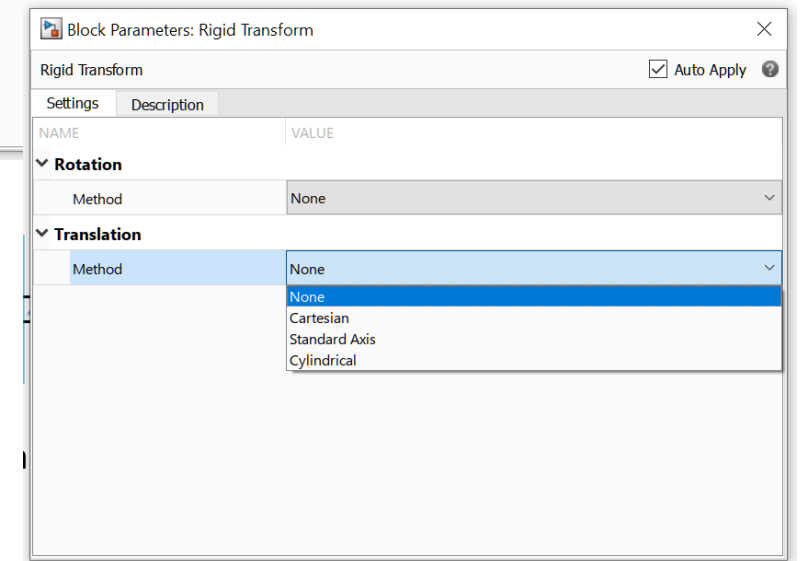
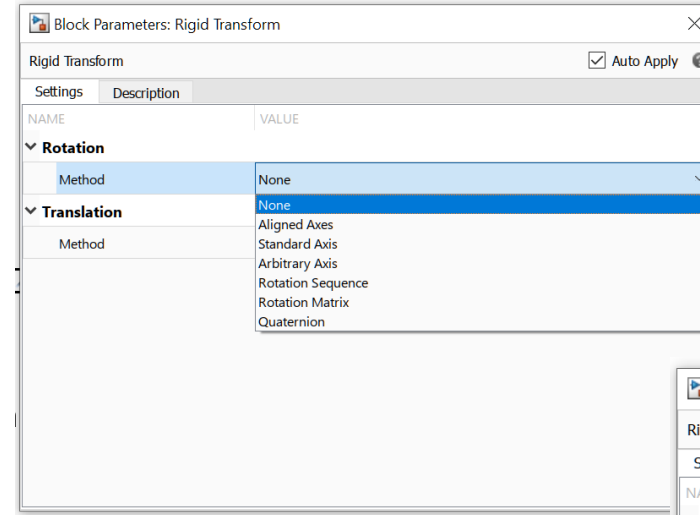
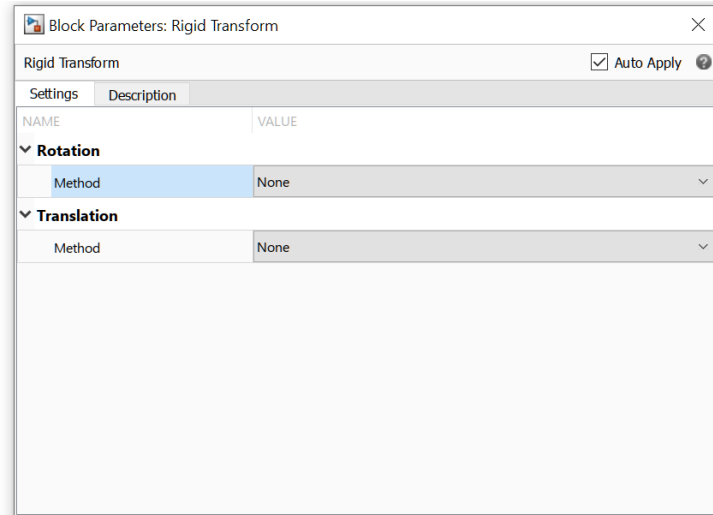
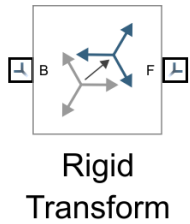
• Bloky väzieb (Joints)

- 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



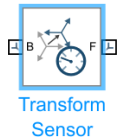
Tvorba modelu

- Transformácia lokálneho súradnicového systému



Tvorba modelu

- Transformácia relatívnej rýchlosti



Block Parameters: Transform Sensor

Transform Sensor Auto Apply

Settings Description

NAME	VALUE
Measurement Frame	World
Sequence for Rotation Sequence	X-Y-X

Rotation

Angular Velocity

- Omega X
- Omega Y
- Omega Z
- Omega XYZ
- Quaternion
- Transform
- Rotation Sequence

Angular Acceleration

Translation

Velocity

Acceleration

Block Parameters: Transform Sensor

Transform Sensor Auto Apply

Settings Description

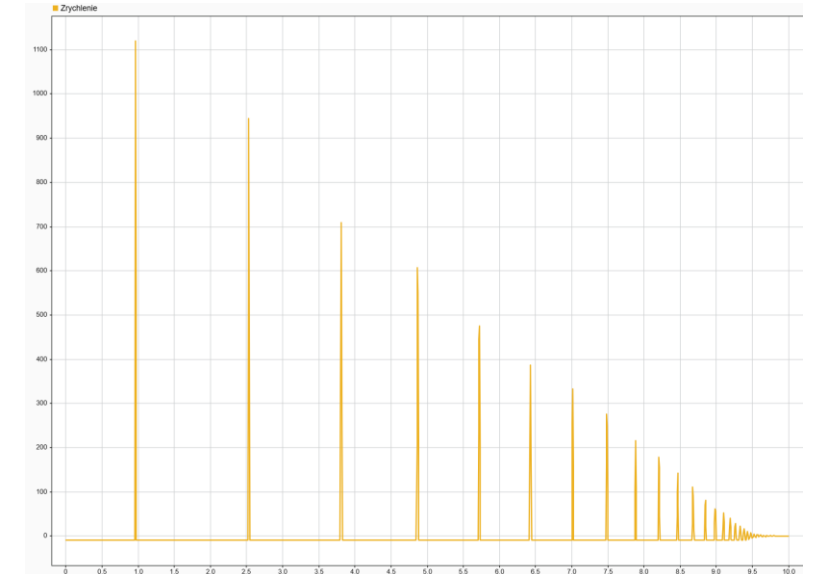
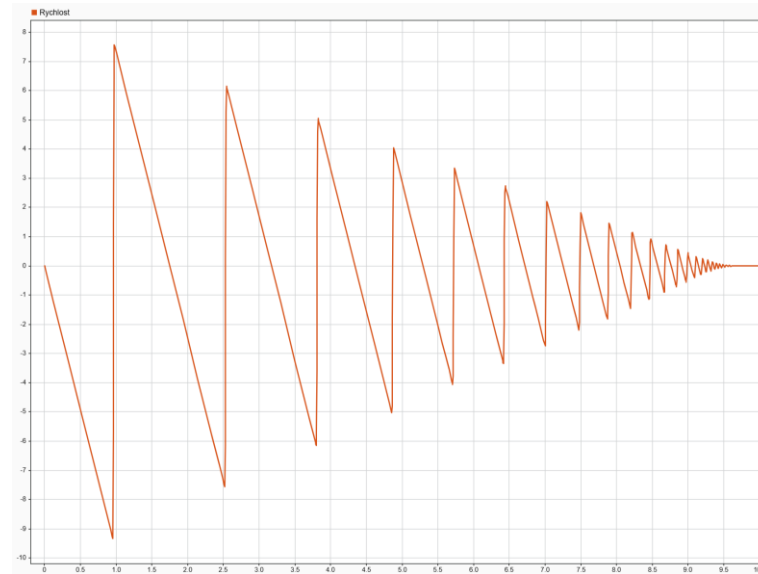
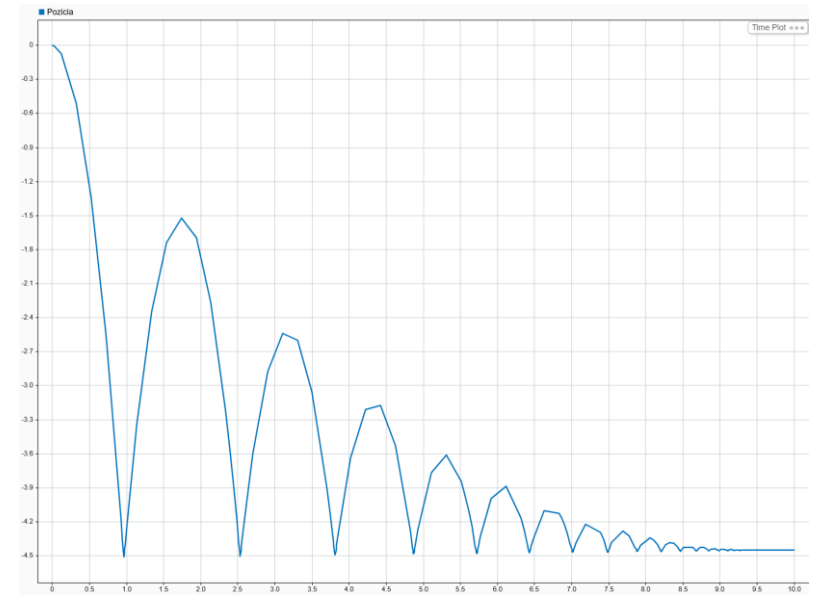
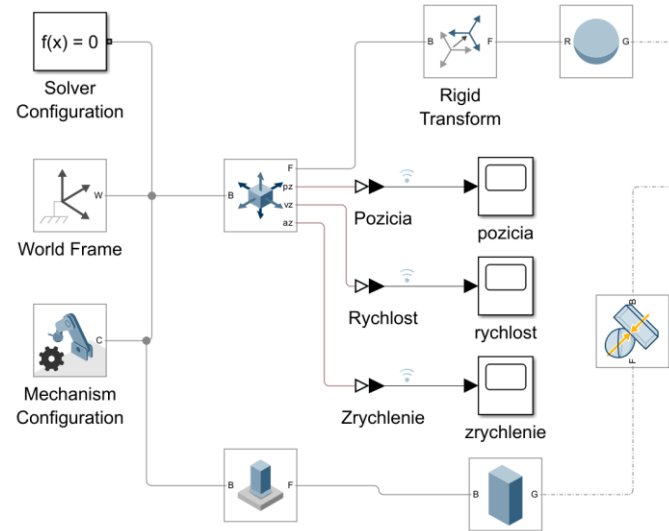
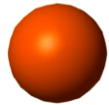
Measures time-dependent relationship between two frames. A Transform Sensor passively senses this 3-D time-varying transformation, and its derivatives, between the two frames.

In the expandable nodes under Properties, select which rotational and translational relationships, including velocities and accelerations, you want to measure. After you apply these settings, the block displays the corresponding output physical signal ports.

Ports B and F are frame ports that represent the base and follower frames, respectively. The sensor measures the transformation and its derivatives as follower frame relative to base frame. The transformation components can be measured in one of several frames.

Tvorba modelu

- Voľný pád telesa



Tvorba modelu

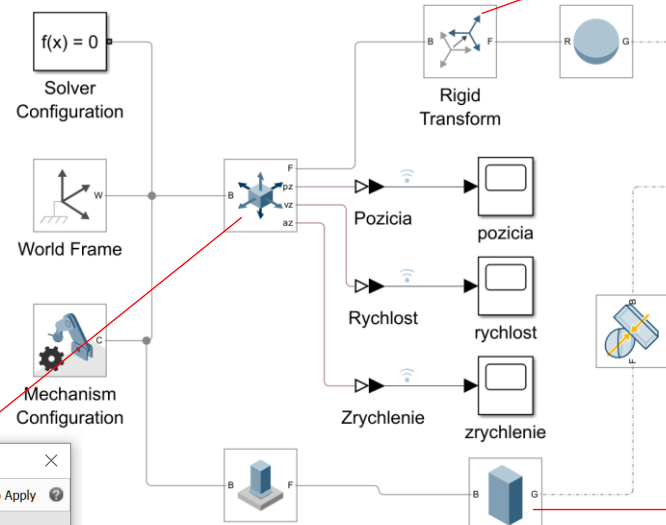
- Voľný pád telesa

Block Parameters: Cartesian Joint

Cartesian Joint Auto Apply

Settings Description

NAME	VALUE
> X Prismatic Primitive (Px)	
> Y Prismatic Primitive (Py)	
> Z Prismatic Primitive (Pz)	
> State Targets	
> Internal Mechanics	
> Limits	
> Actuation	
> Sensing	
<input checked="" type="checkbox"/> Position	
<input checked="" type="checkbox"/> Velocity	
<input checked="" type="checkbox"/> Acceleration	
<input type="checkbox"/> Actuator Force	
<input type="checkbox"/> Lower-Limit Force	
<input type="checkbox"/> Upper-Limit Force	
> Mode Configuration	
> Composite Force/Torque Sensing	



Block Parameters: Rigid Transform

Rigid Transform Auto Apply

Settings Description

NAME	VALUE
> Rotation	
Method	None
> Translation	
Method	Cartesian
Offset	[2.5 0 5] m

Block Parameters: Brick Solid

HOME

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

VIEW

Solid

Settings Description

NAME	VALUE
> Geometry	
Dimensions	[5 3 0.1] m
> Export	
> Inertia	
> Graphic	
> Frames	

One or more frames cannot be resolved. The frame origin or axis definitions may be invalid. Unresolved frame origins are assumed coincident with the

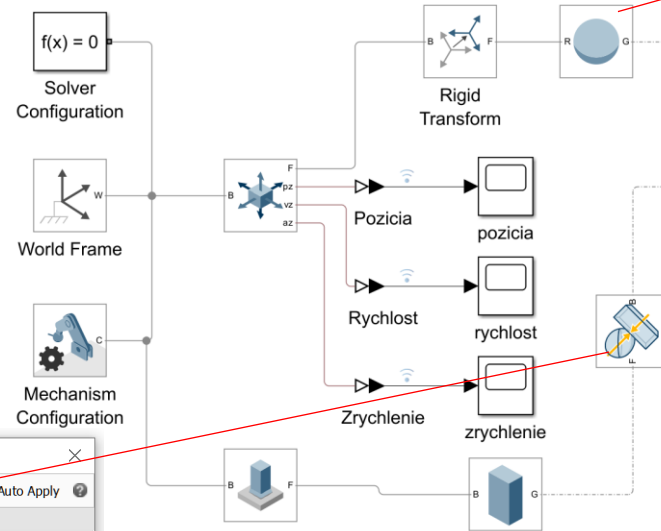
Tvorba modelu

- Voľný pád telesa

Block Parameters: Spatial Contact Force

Spatial Contact Force Auto Apply

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



Block Parameters: Spherical Solid

HOME

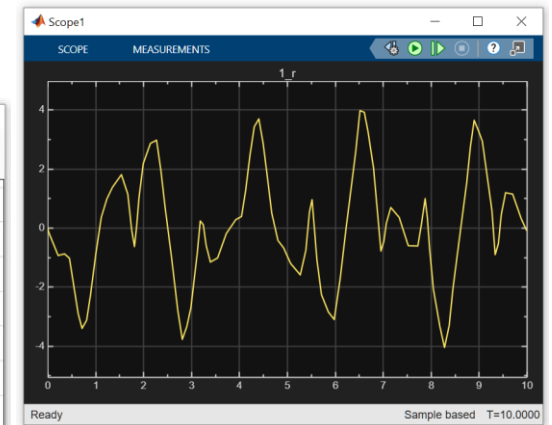
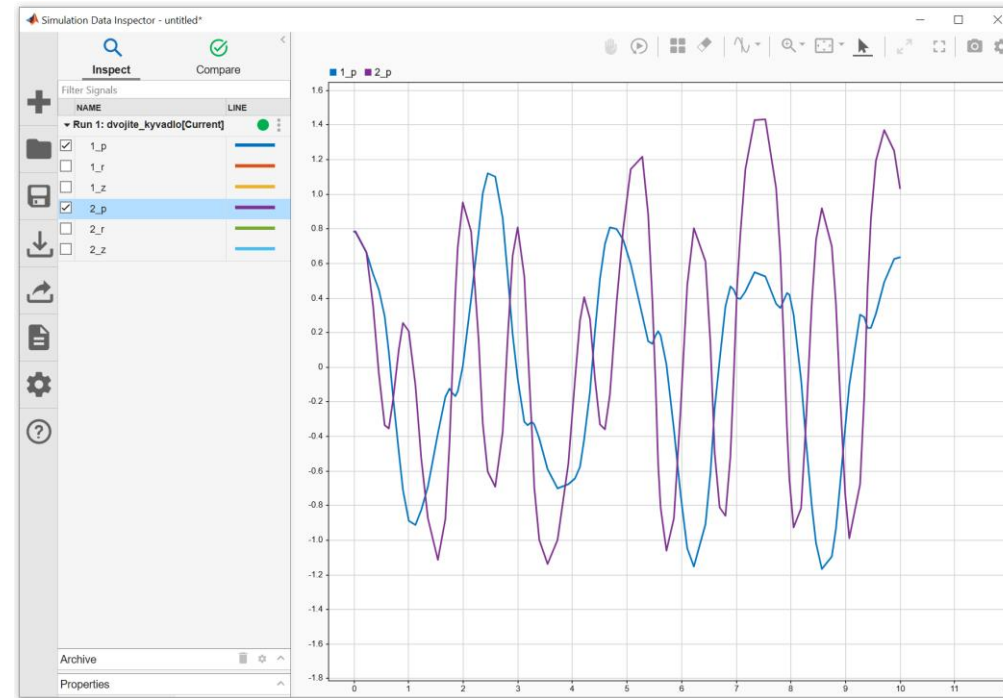
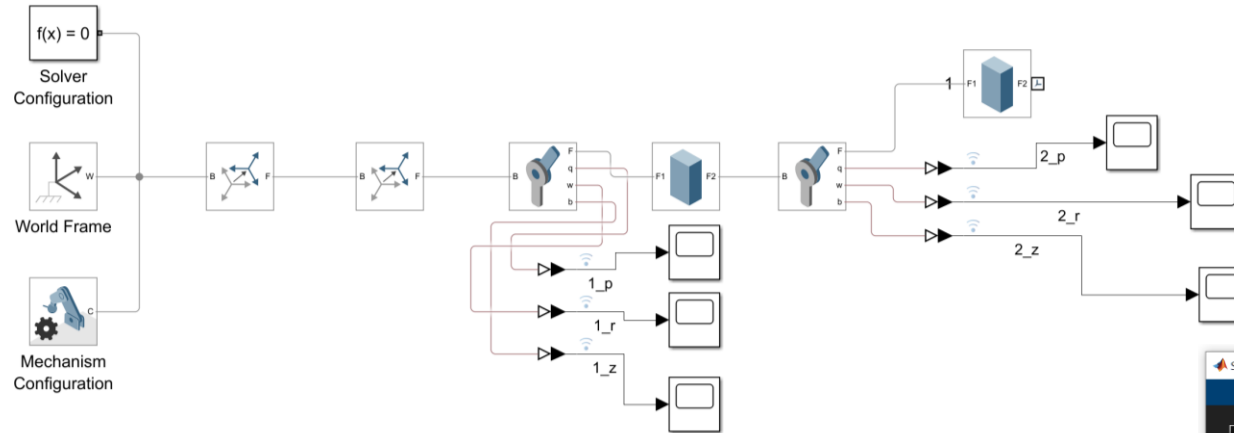
Refresh Select Front Back Top Bottom Left Right Isometric Fit Frames Inertia Background

VIEW

NAME	VALUE
Geometry	
Radius	0,5 m
Inertia	
Type	From Geometry
Visual Properties	
Diffuse Color	[1 0.3333 0]
Opacity	1
Frames	

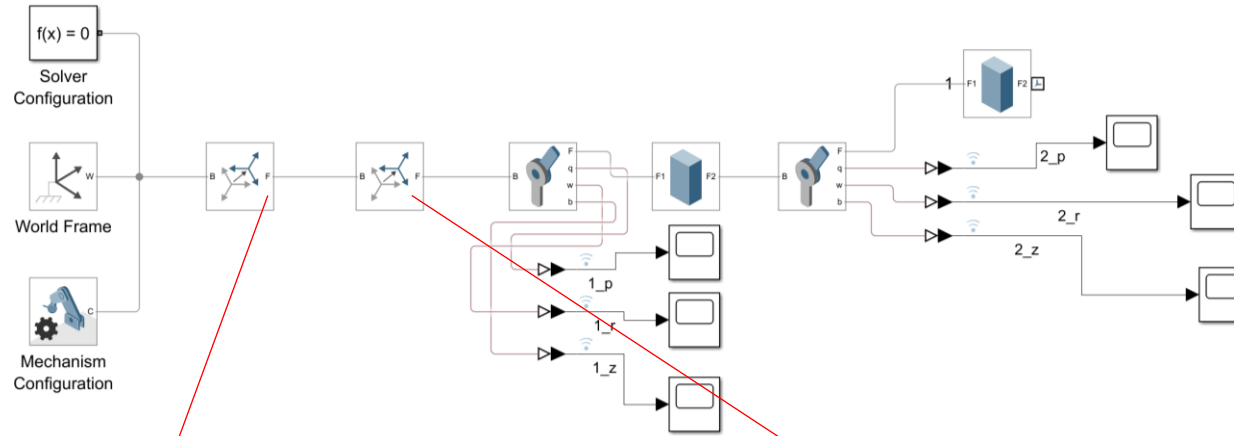
Tvorba modelu

- Dvojité kyvadlo



Tvorba modelu

- Dvojité kyvadlo



Block Parameters: Rigid Transform

Rigid Transform Auto Apply

Settings Description

NAME	VALUE
Rotation	
Method	Standard Axis
Angle	90 deg Compile-time
Axis	+Z
Translation	

Block Parameters: Rigid Transform1

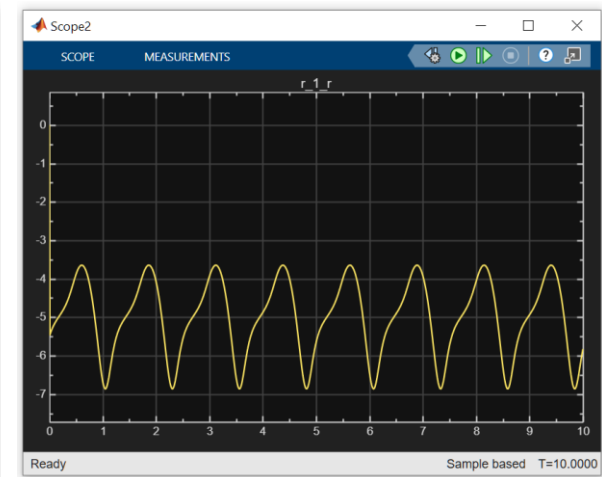
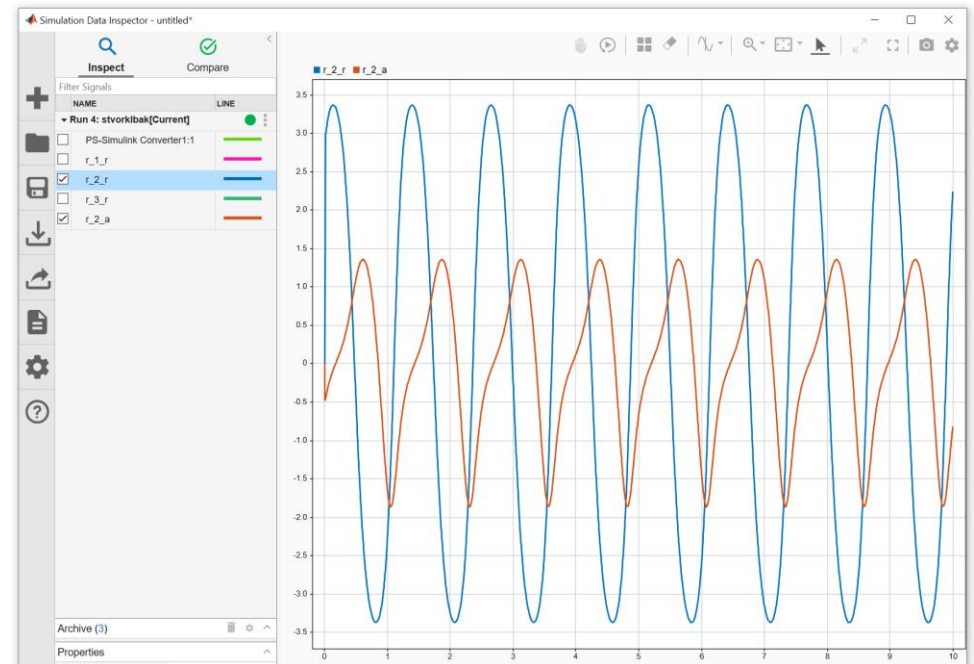
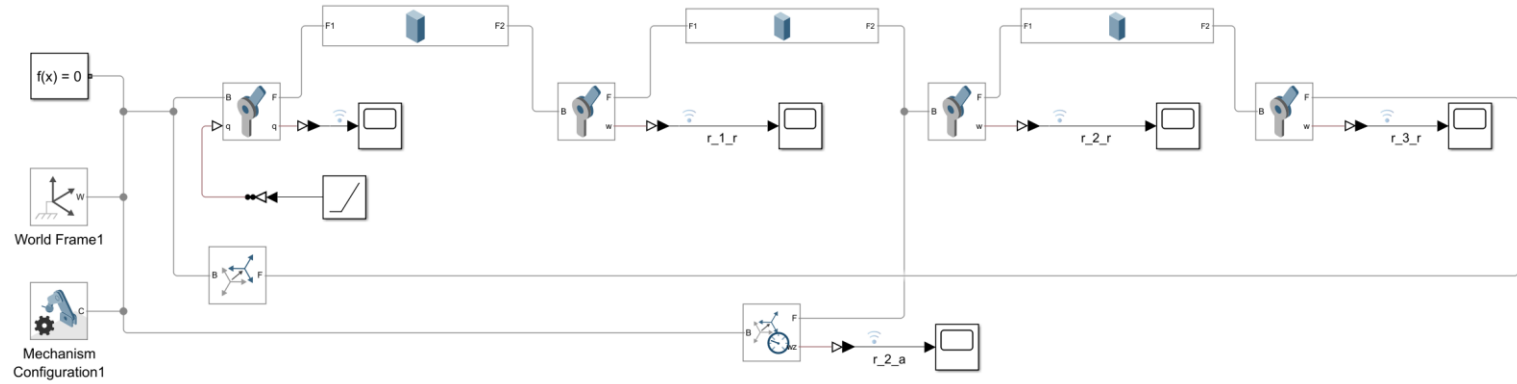
Rigid Transform Auto Apply

Settings Description

NAME	VALUE
Rotation	
Method	Standard Axis
Angle	90 deg Compile-time
Axis	+Y
Translation	

Tvorba modelu

- Štvorkíbový mechanizmus



Tvorba modelu

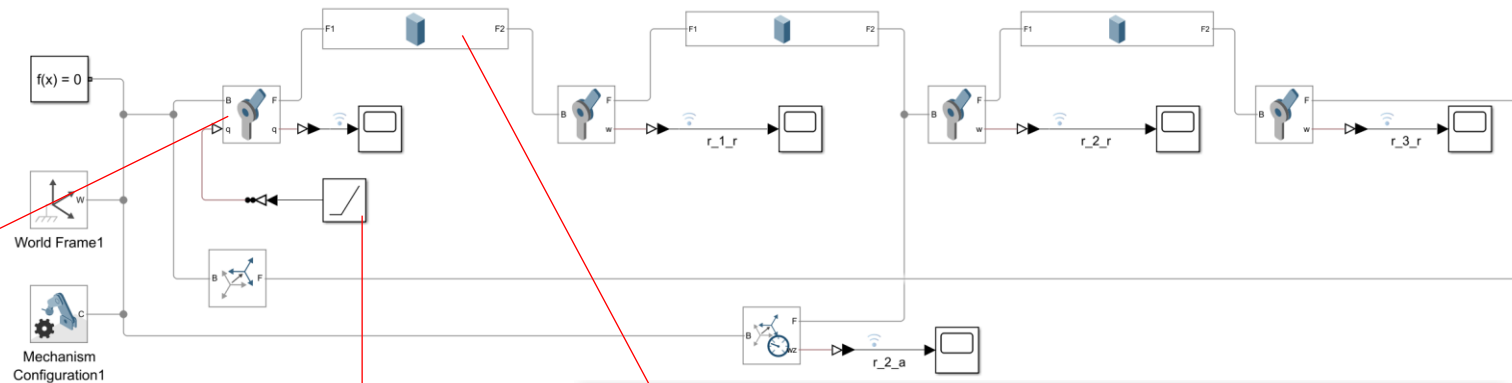
• Štvorkĺbový mechanizmus

Block Parameters: Revolute Joint

Revolute Joint Auto Apply

Settings Description

NAME	VALUE
Z Revolute Primitive (Rz)	
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	
Equilibrium Position	45 deg Compile-time
Spring Stiffness	0 N*m/deg Compile-time
Damping Coefficient	0 N*m/(deg/s) Compile-time
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:

Start time:

Initial output:

 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

Solid

Settings Description

NAME	VALUE
Geometry	
Dimensions	[20 1 1] cm Compile-time
Export	
Inertia	
Graphic	
Type	From Geometry
Visual Properties	
Diffuse Color	[0.2 0.2 1.0]
Opacity	1.0 Compile-time
Frames	

The image shows a 3D model of a blue brick solid. The brick is oriented diagonally in the 3D view. The 'Block Parameters: Brick Solid1' dialog box is open, showing the settings for the brick's geometry, inertia, graphic, and frames. The 'Diffuse Color' is set to [0.2 0.2 1.0] and the 'Opacity' is 1.0. The 'Frames' section is currently empty.

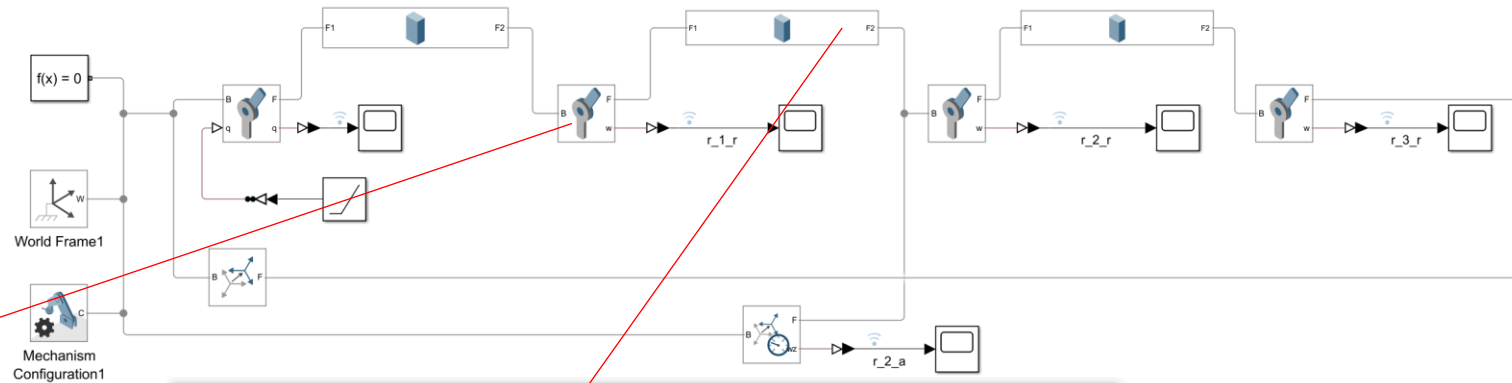
Tvorba modelu

- Štvorkĺbový mechanizmus

Block Parameters: Revolute Joint1

Revolute Joint Auto Apply

NAME	VALUE
Z Revolute Primitive (Rz)	
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

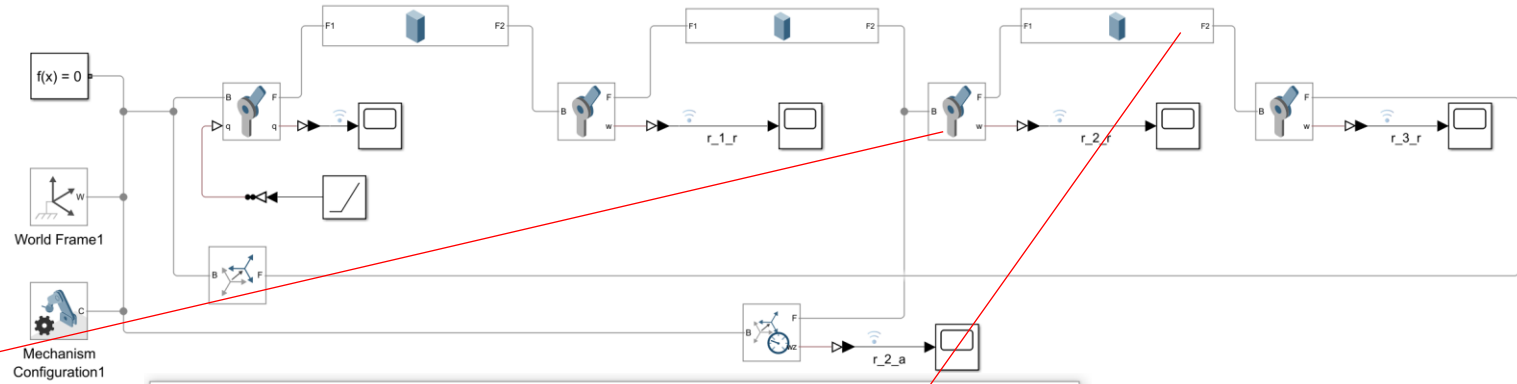
Solid

NAME	VALUE
Geometry	
Dimensions	[80 1 1] cm Compile-time
Inertia	
Graphic	
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. The brick is colored green and is positioned on a grey surface. A green line is drawn across the brick, representing a revolute joint axis. The brick is labeled 'Brick Solid2' and has a 'HOME' button. The view is set to 'VIEW' and shows a 3D perspective of the brick. The brick is labeled 'FRONT RIGHT'.

Tvorba modelu

- Štvorkĺbový mechanizmus



Block Parameters: Revolute Joint2

Revolute Joint Auto Apply

Settings Description

NAME	VALUE
Z Revolute Primitive (Rz)	
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

Solid

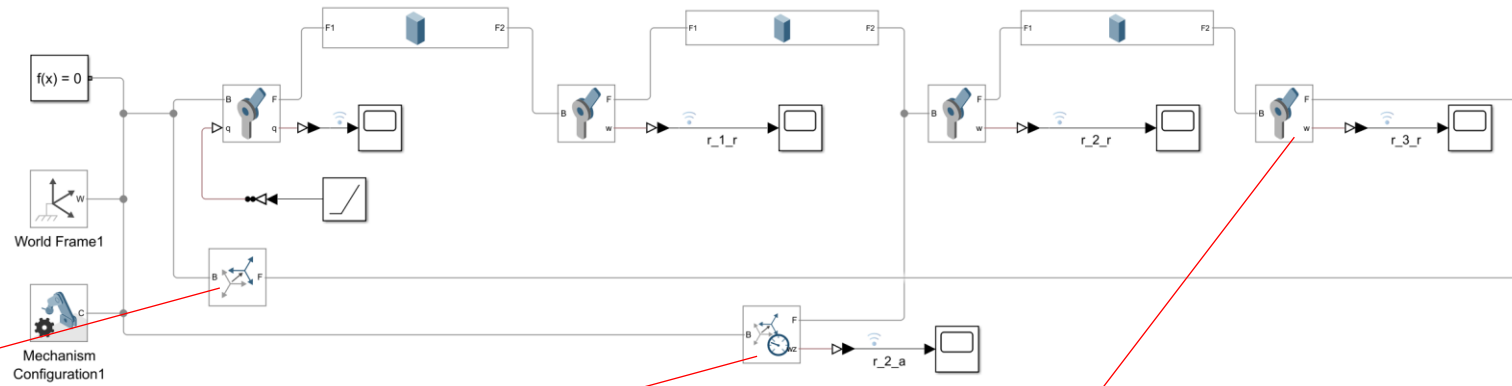
Settings Description

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

The 3D view shows a red rectangular brick solid with dimensions [30 1 1] cm. The brick is oriented diagonally in the 3D space. A small coordinate system is visible in the bottom left corner of the 3D view.

Tvorba modelu

- Štvorkĺbový mechanizmus



Block Parameters: Rigid Transform1

Rigid Transform Auto Apply

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

Block Parameters: Transform Sensor1

Transform Sensor Auto Apply

Settings	Description	VALUE
Measurement Frame		
World		
Sequence for Rotation Sequence		
X-Y-X		
Rotation		
Angular Velocity		
<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	
Angular Acceleration		
Translation		
Velocity		
Acceleration		

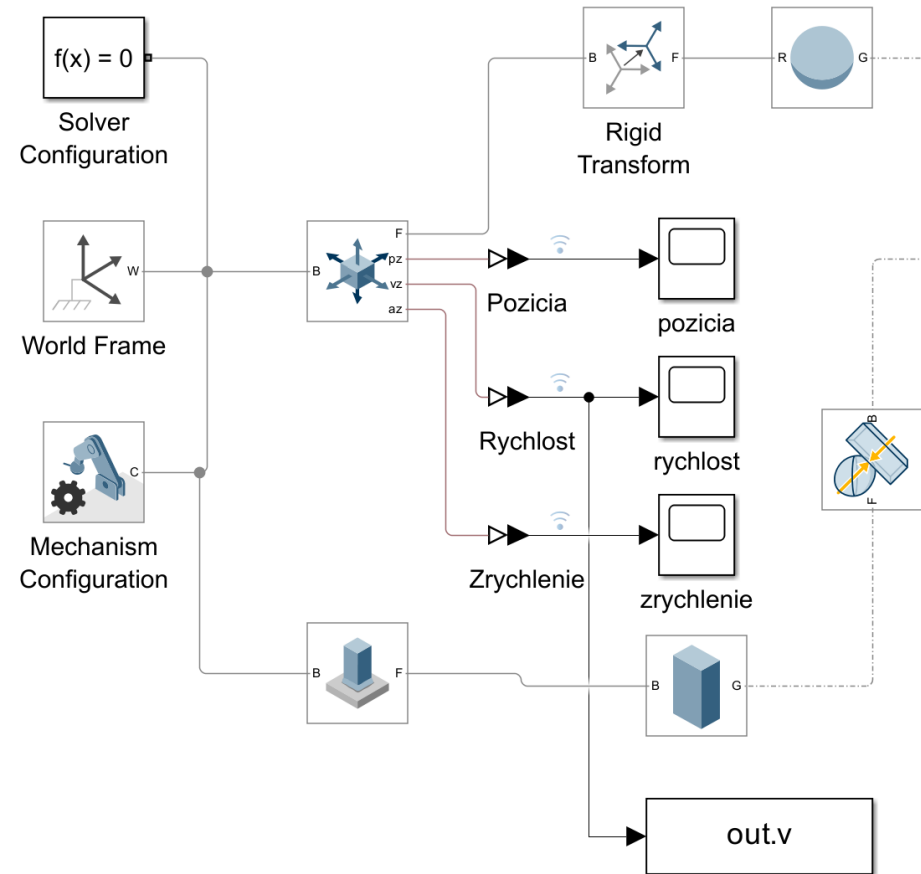
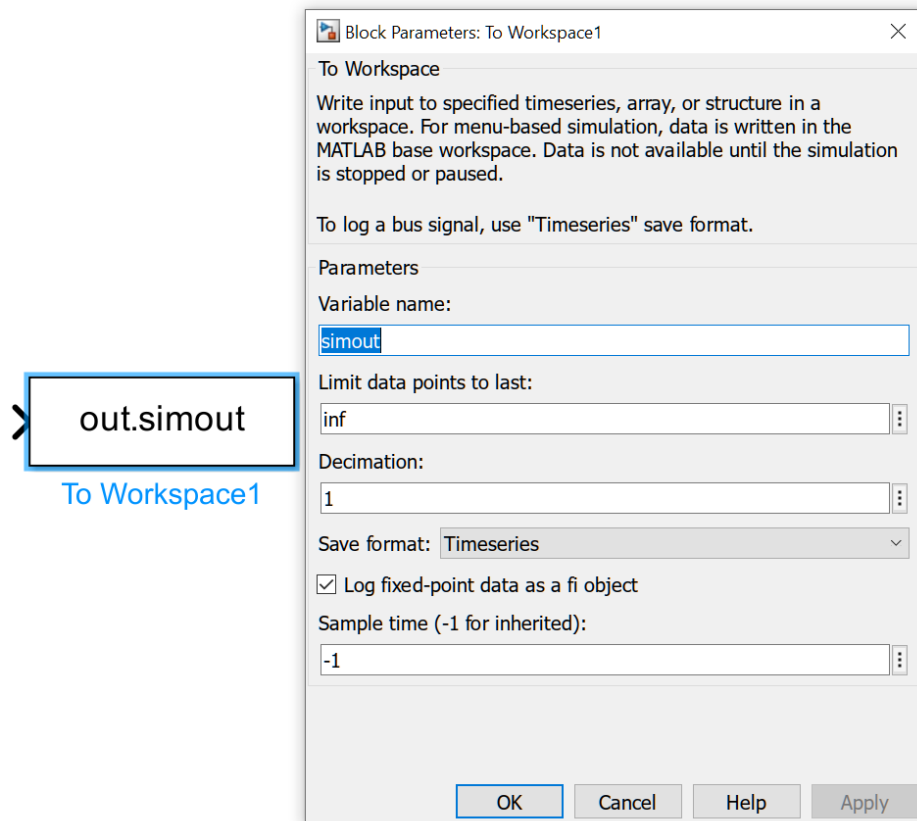
Block Parameters: Revolute Joint3

Revolute Joint Auto Apply

Settings	Description	VALUE
Z Revolute Primitive (Rz)		
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		

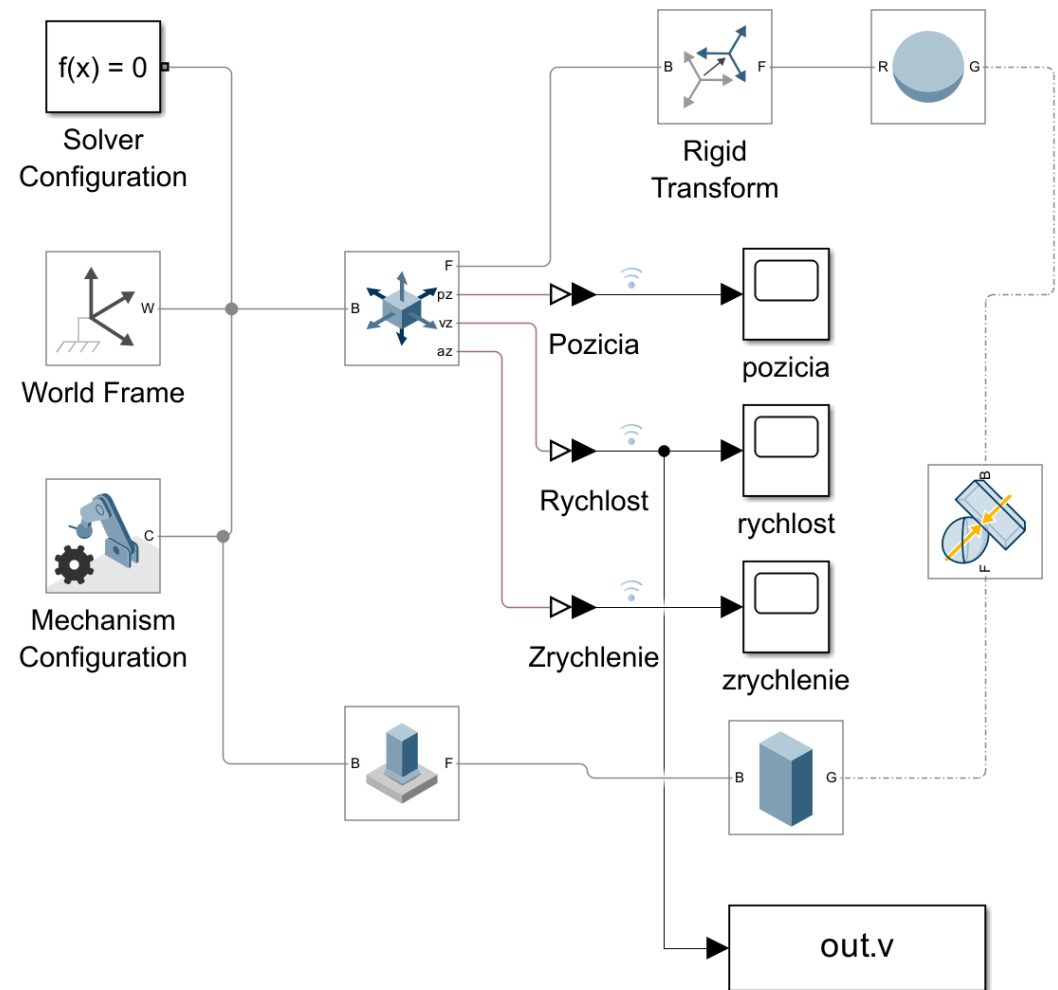
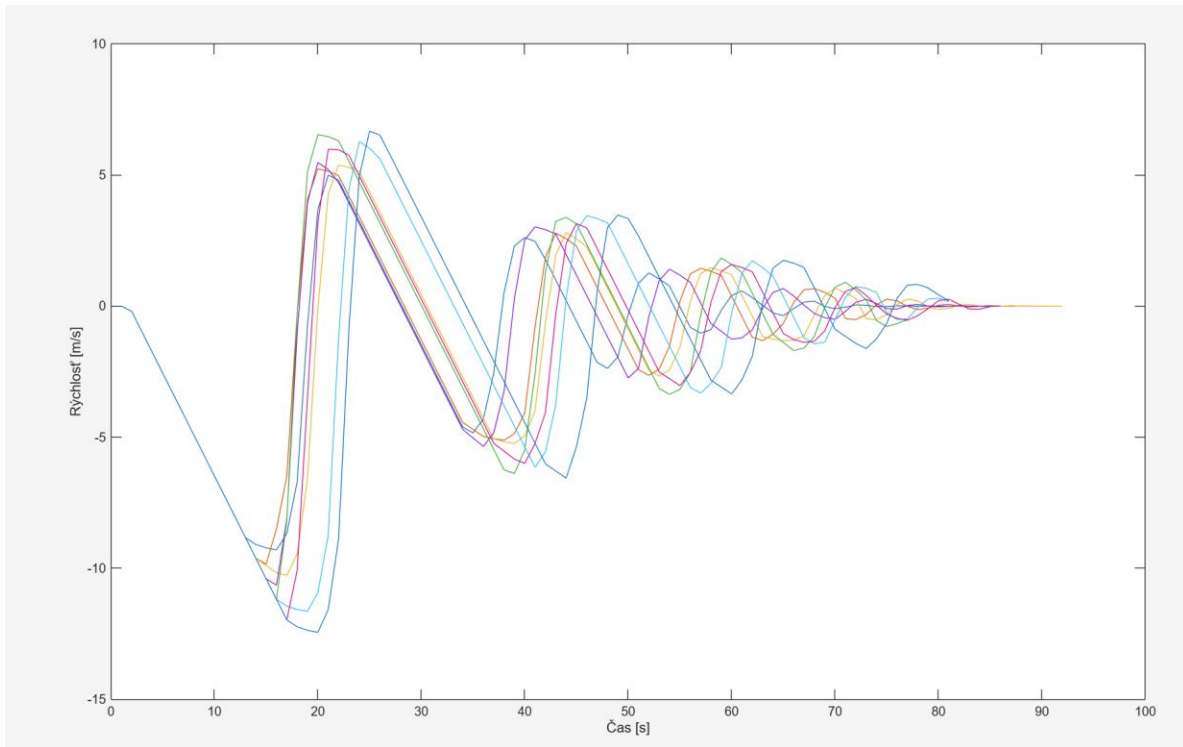
Tvorba modelu

- Prepojenie MATLABu a Simscape Multibody



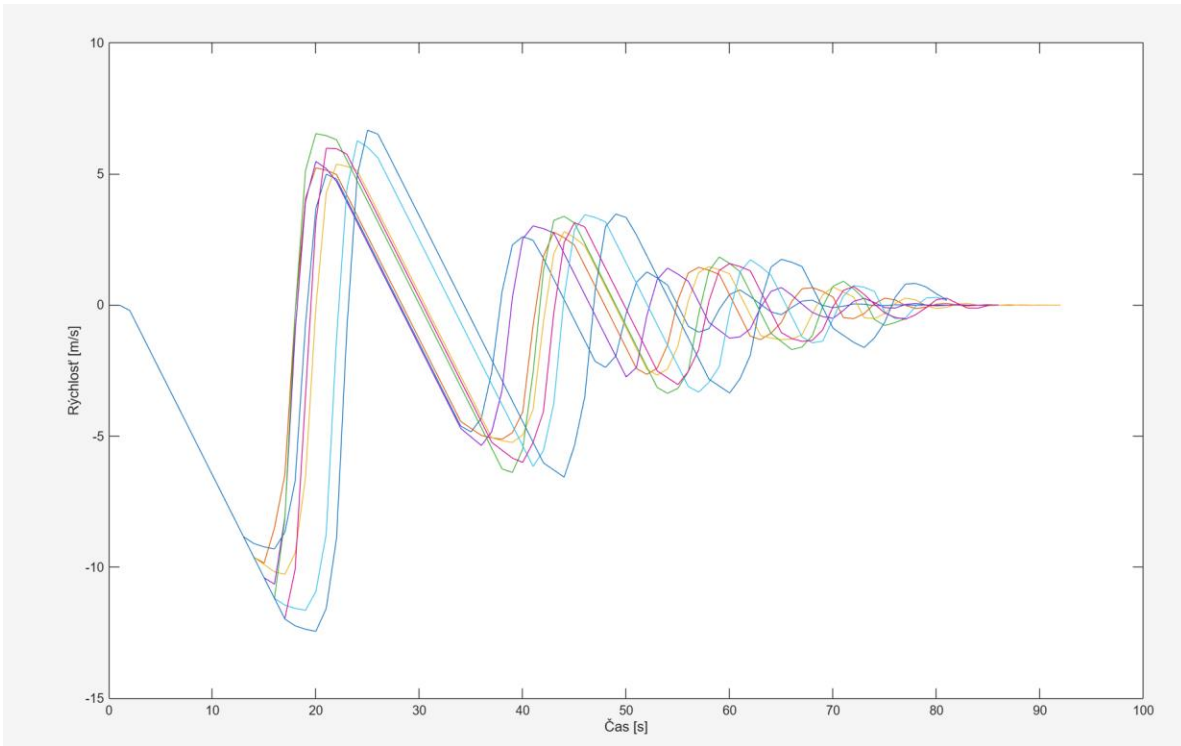
Tvorba modelu

- Optimalizácia výšky loptičky



Tvorba modelu

- Optimalizácia výšky loptičky



```
% 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;

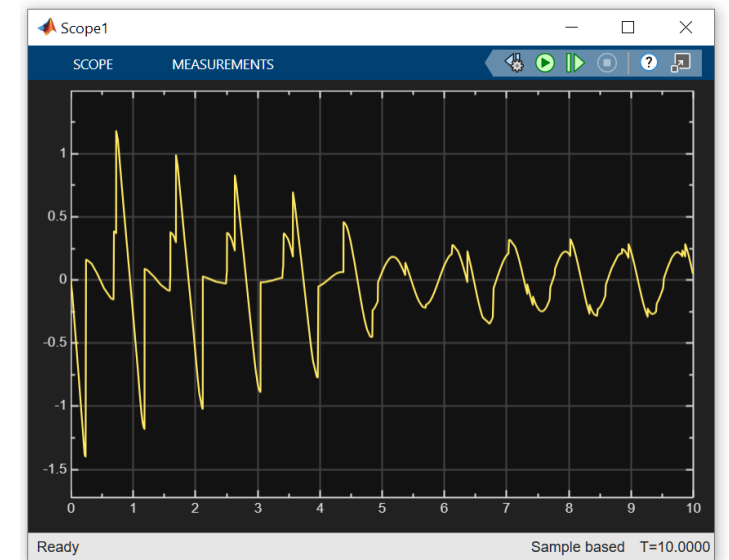
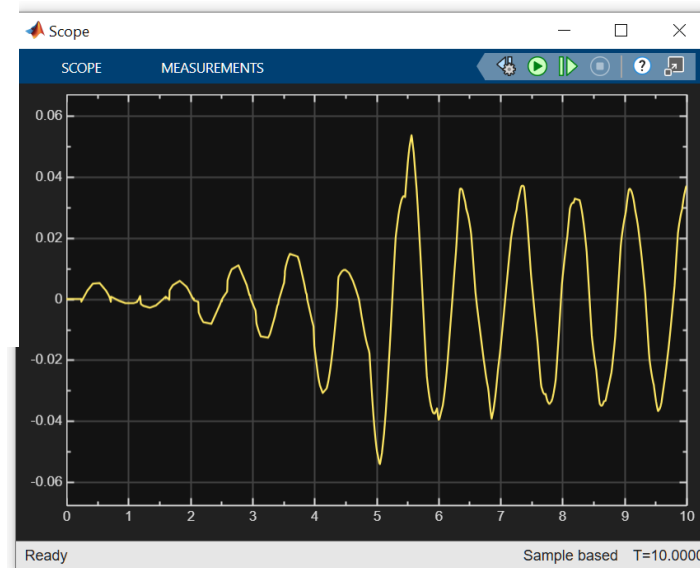
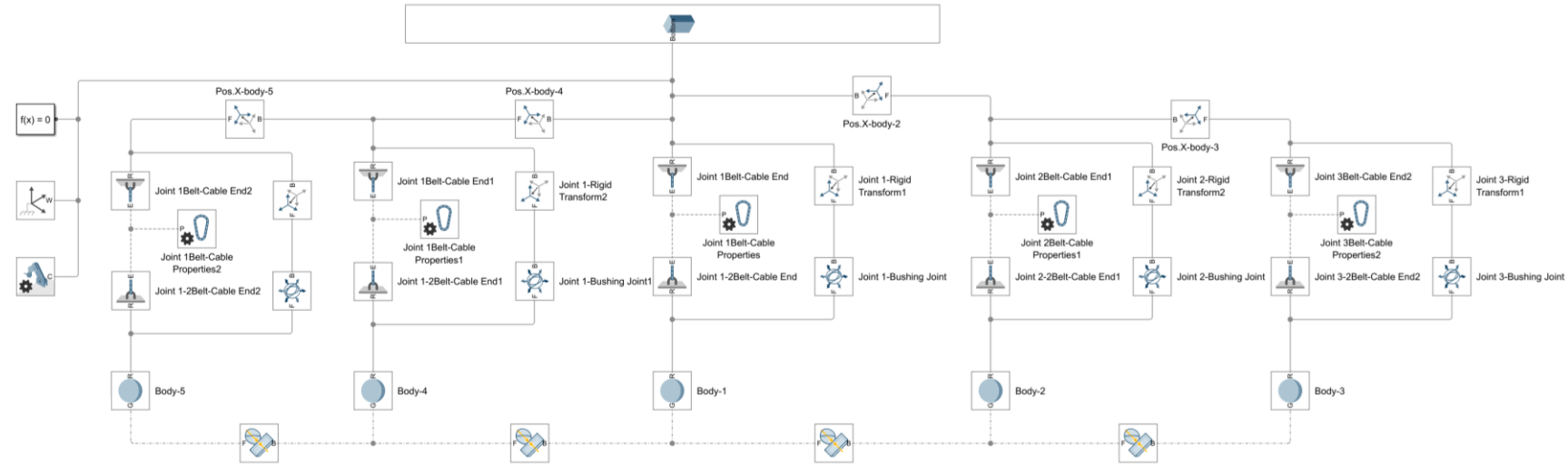
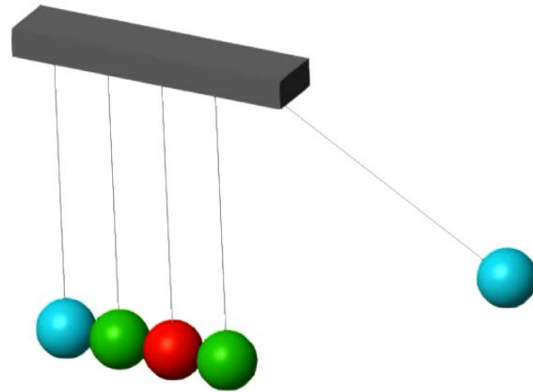
% vykreslenie priebehu rýchlosti
figure
plot(rychlost)
xlabel("Čas [s]")
ylabel("Rýchlosť [m/s]")
drawnow

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)
```

Tvorba modelu

- Newtonovo kyvadlo



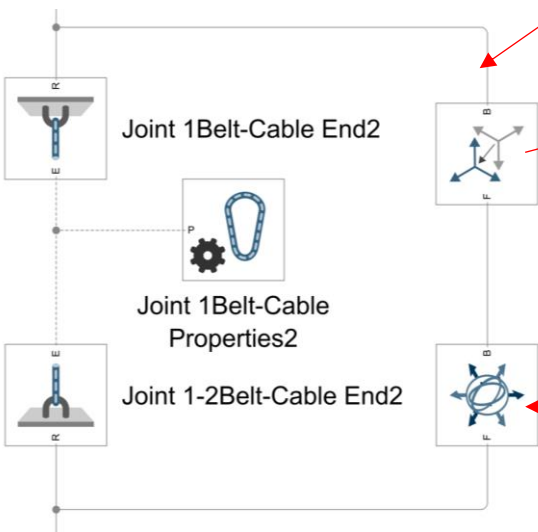
Tvorba modelu

- Newtonovo kyvadlo

Block Parameters: Mechanism Configuration

Mechanism Configuration Auto Apply

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



Block Parameters: Joint 1-Rigid Transform3

Rigid Transform Auto Apply

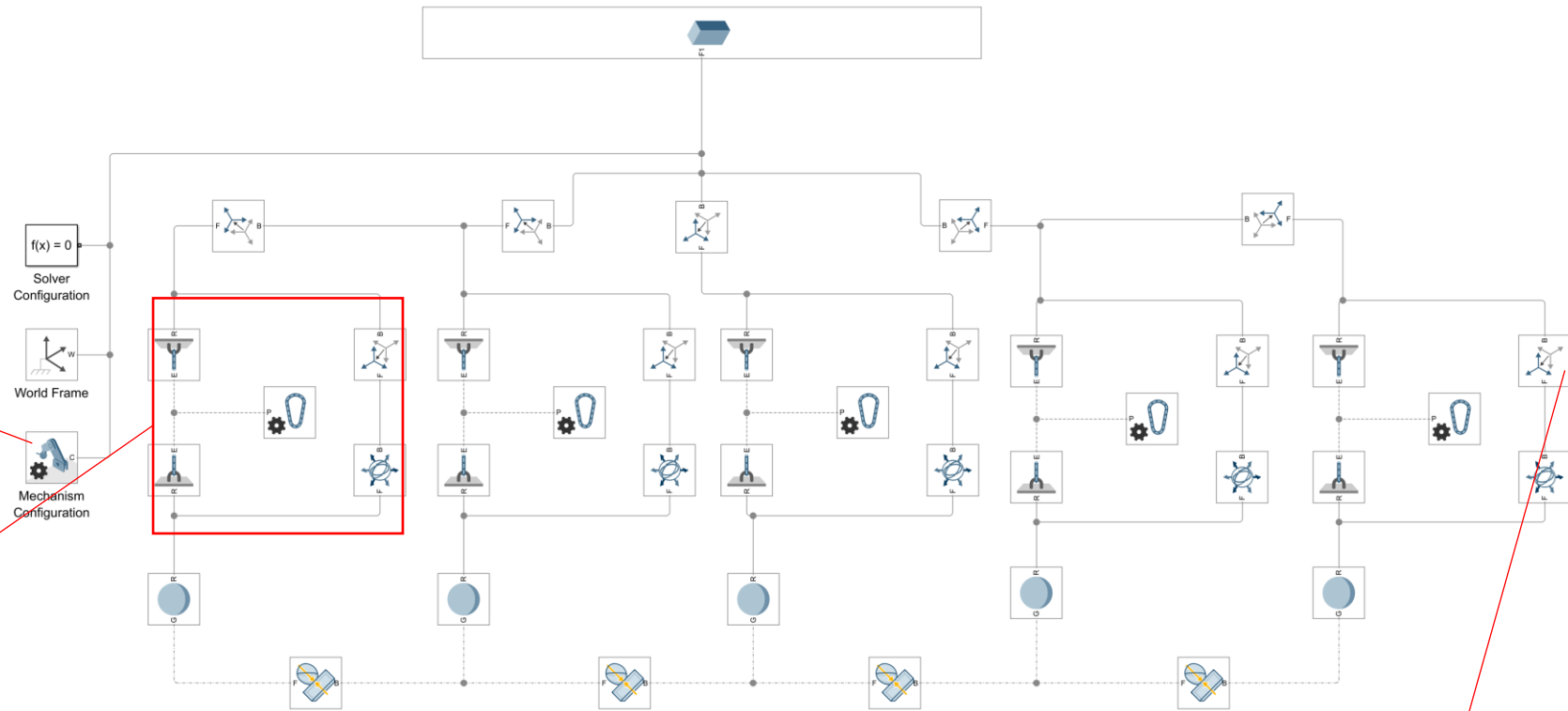
NAME	VALUE
Rotation	
Method	None
Translation	
Method	Cartesian
Offset	[0 -0.2 0] m Compile-time

Bushing joint

Block Parameters: Rigid Transform8

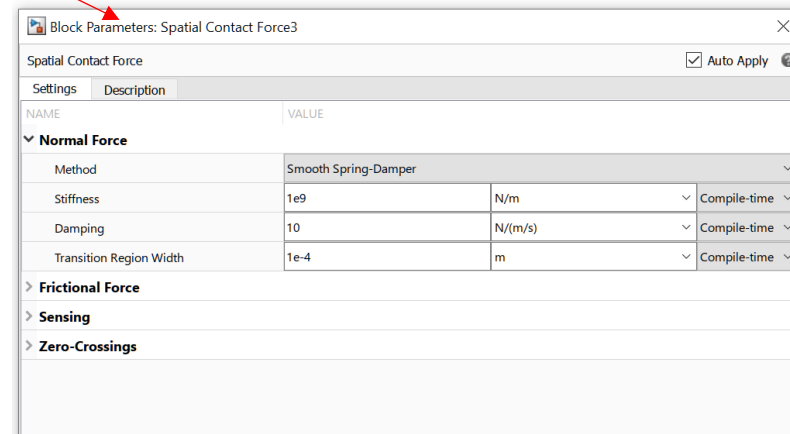
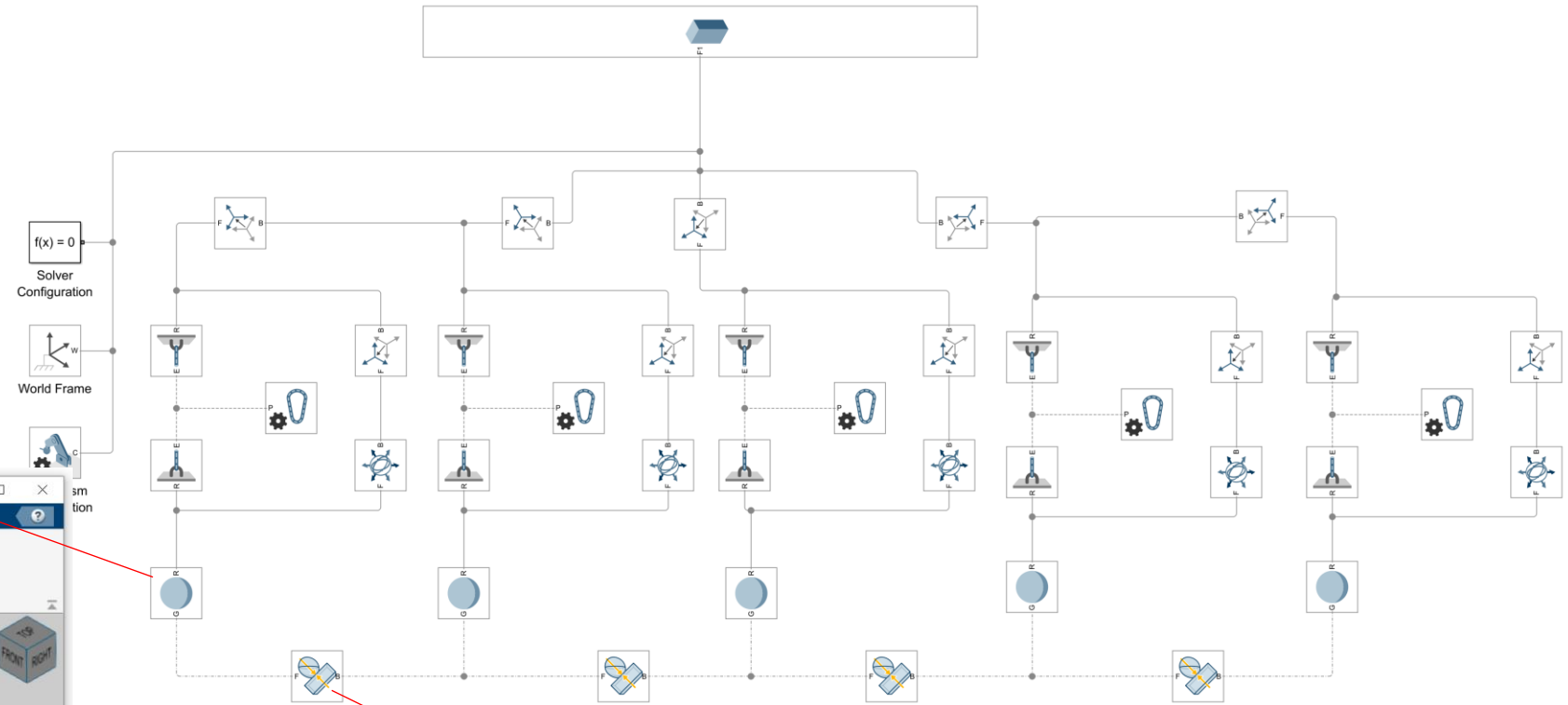
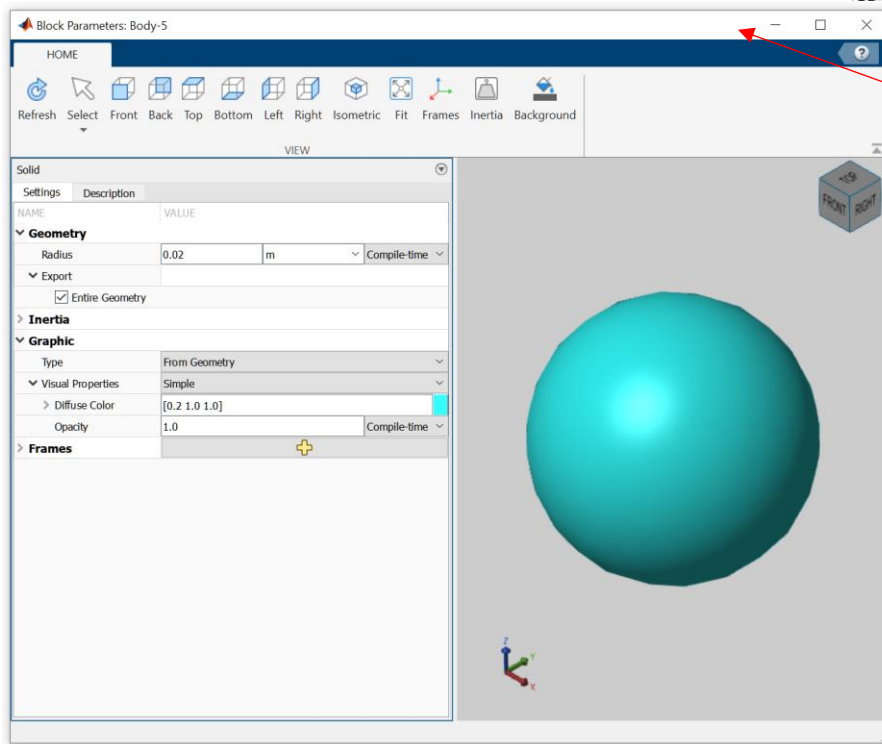
Rigid Transform Auto Apply

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



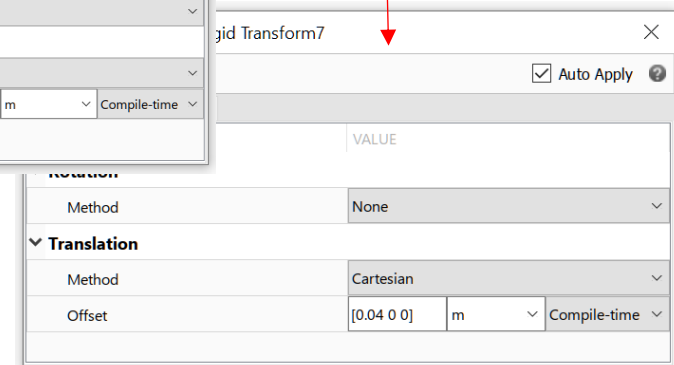
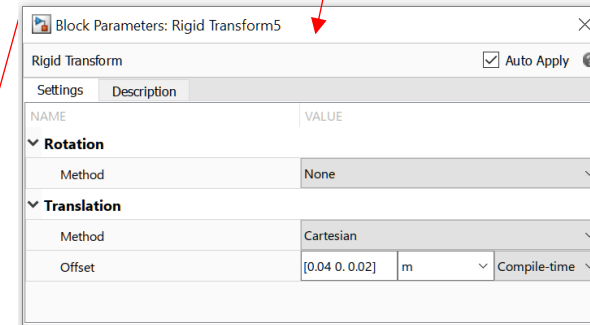
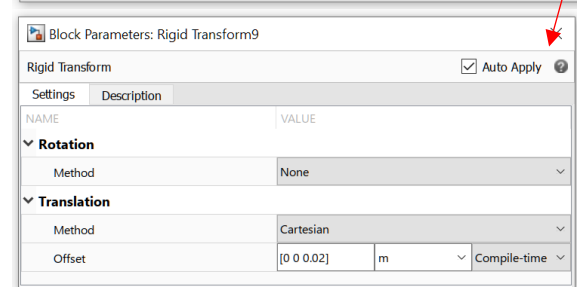
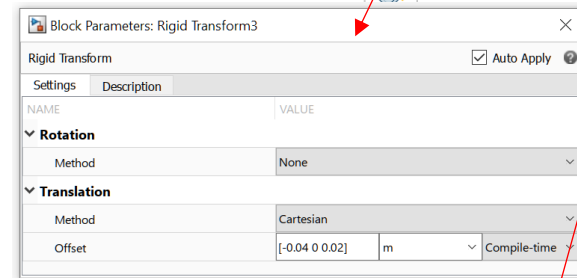
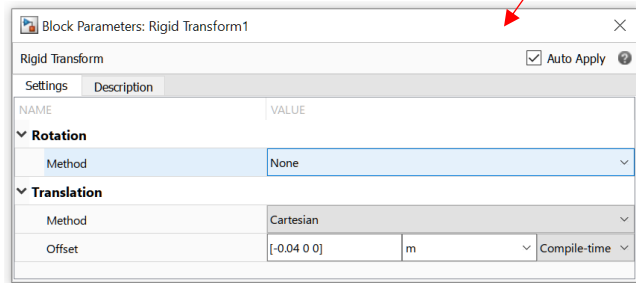
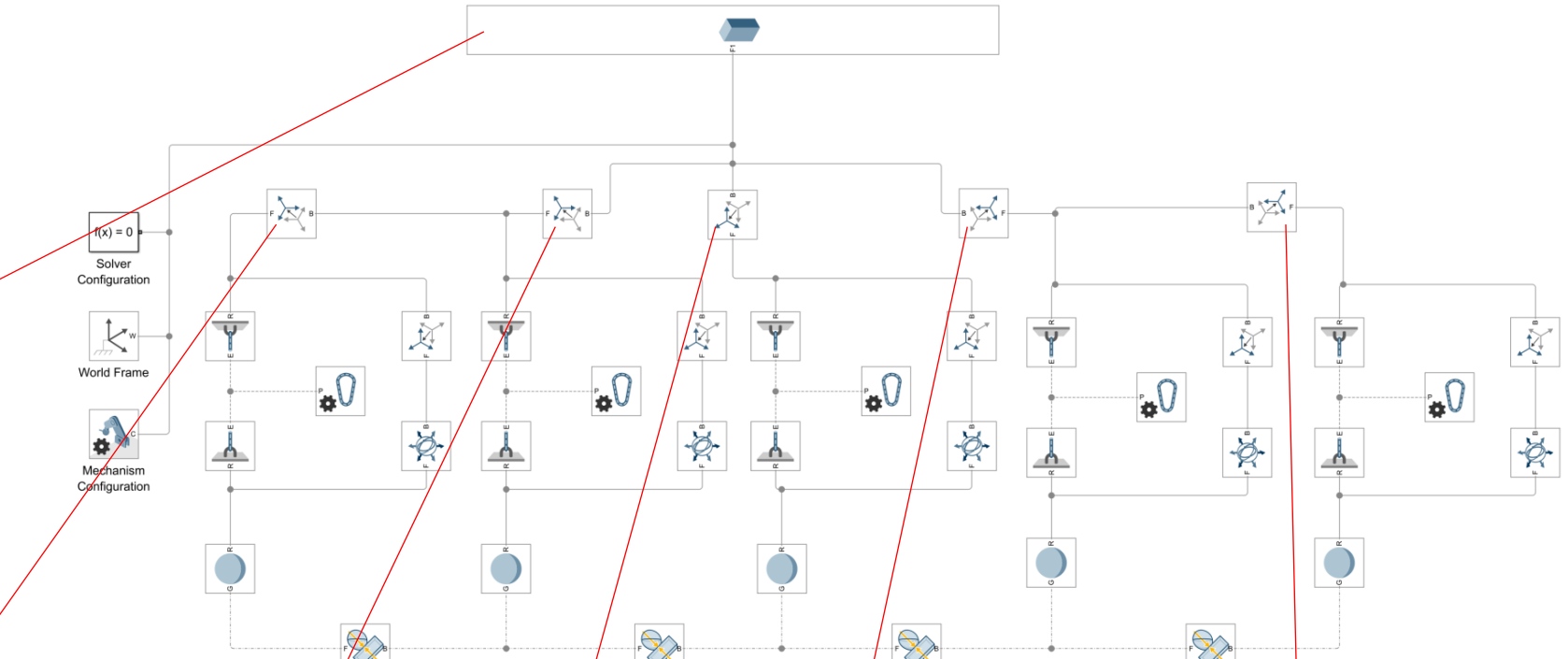
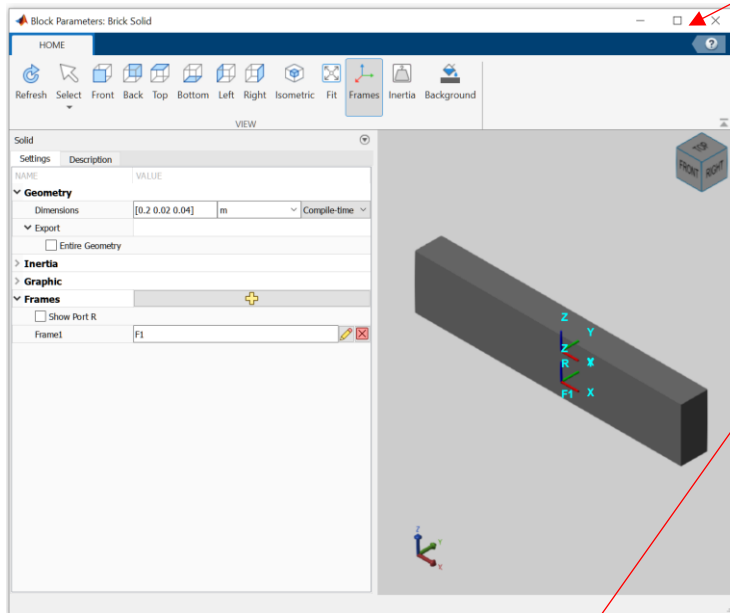
Tvorba modelu

- Newtonovo kyvadlo



Tvorba modelu

- Newtonovo kyvadlo





Ďakujem za pozornosť

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