



Robot Modeling Challenge Rules
15 September 2021

Contents

Section 1 Robot Modeling Challenge..... 3

 1.1 Overview 3

 1.2 Schedule..... 3

 1.3 Rules..... 3

 1.4 Prerequisites 4

 1.5 Protocol..... 4

 1.6 Evaluation 4

 1.7 Awards 5

 1.8 Participation Instructions..... 5

 1.8.1 Scheduled Activity Signup (National Registry Workflow) 5

 1.8.2 Online Meetings / Streaming..... 6

 1.9 Training & Resources 6

Section 1 Robot Modeling Challenge

1.1 Overview

Modeling and simulation of multibody mechanical systems in a 3D environment is very common in engineering today. It helps engineers develop control systems and test system-level performance of their products.

The Robot Modeling Challenge allows BEST students an opportunity to experience this unique and integral part of system development and testing. Students will learn to utilize industry accepted tools as they attempt to model their BEST robot design in a 3D virtual environment and demonstrate its functionality through simulation and animation. Mathworks Simscape Multibody™ is the platform students will be using. This same system is how the BEST Online virtual game is modeled. This challenge takes it one step further with a more complex robot design, your team-designed robot.

With Simscape Multibody, you can model multibody mechanical systems using blocks representing bodies, joints, constraints, force elements, and sensors. Simscape Multibody formulates and solves the equations of motion for the complete mechanical system. You can import complete CAD assemblies, including all masses, inertias, joints, constraints, and 3D geometry, into your model. An automatically generated 3D animation lets you visualize the system dynamics. You can then connect your virtual robot to a MATLAB/Simulink control program to simulate active controls.

1.2 Schedule

1. The hub will determine the schedule for Robot Modeling demonstration(s). Look on your Team Workflow page in the National Registry for details and registration for this scheduled activity.

1.3 Rules

1. The Robot Modeling Skills Challenge is an OPTIONAL activity.
2. The goal is to model the robot you designed for the BEST competition and demonstrate it in a virtual world. Model as much of the robot as you can. Points are awarded for your accomplishments.
3. The functionality and movements to be demonstrated are left up to the team. The entire functionality of your robot does not have to be modeled.
4. The robot must be modeled using the [Mathworks Simscape Multibody](#) tool.
5. The robot will be demonstrated through a simulation in a special [Robotics Playground arena](#).
6. The robot may be designed [from scratch](#) in the Simscape Multibody tool or [parts that were developed in your CAD tool of choice may be imported](#).
7. Points are awarded for the level of modeling completed and demonstrated. See the Evaluation section for details.

8. As with all BEST activities, the student(s) should be the primary developer(s) of the model.

1.4 Prerequisites

1. Minimum computer system requirements – Windows, mac or unix computer meeting minimum [MathWorks system requirements](#). We recommend at least 25GB of free disk space.
2. MathWorks MATLAB/Simulink Software – ONLY the package that is provided free to teams will be sufficient. You can request access to download the free software at <http://www.mathworks.com/best-robotics>. Do NOT attempt to use another version or a package available through your school/university.
3. Internet access is required for demonstrating the Robot model to judges through an online meeting.
4. Appropriate online meeting software/app as defined by the hub.

1.5 Protocol

1. Teams will be allowed up to 9 weeks from their competition Kickoff date to complete the modeling of their robot. Modeling should occur in parallel with other design activities to ensure adequate time is available to complete the task.
2. Refer to the *Awards and Judging Hub Logistics Document* for the **exact time allowed** between your hub kickoff and the evaluation period.
3. To access a default robot modeling template and environment to begin your work, open the “BEST Robotics” App from the MATLAB APPS tab. This App is installed when you install the Robotics Playground. The App will contain links to the default templates for the Robot Modeling Challenge that can be used as a starting point and for reference.
4. Simscape Multibody models are available for most BEST Return Kit and Consumable Kit items. Look for a folder in the BRI File Manager under “Public Resources & Training/CAD Models”
5. The demonstration of the modeled robot will take place as a scheduled online meeting at time(s) selected by the Hub.
6. A minimum of one student will take part in the demonstration. Teachers and other adults may oversee/guide but may not actively participate in the demonstration.
7. The team can choose the format and content of the demonstration to judges.

1.6 Evaluation

1. At least 2 judges will take part in the evaluation and demonstration of the team’s model.
2. All judging will occur during the demonstration time.

3. Points are awarded for the demonstration of any of the following table

Category	Criteria
Design/Importing	Parts and/or assemblies of a robot 3D model are represented in the Simscape Multibody environment (designed from scratch or imported CAD models)
Motion	Ability to move part(s) of the robot (e.g., arm); i.e., movement of a joint
Mobility	Ability to move the robot across the environment (roll, step, etc.)
Spatial Contact/ Collisions	Ability to move other object(s) with the robot
Dexterity	Ability to pick up object(s) with the robot. Ability to place object(s) with the robot (object on the robot, object that was picked up, etc.).
Integration	Integration of parts from the 2021 game field into the demonstration.
Complexity	# of joints where motion is modeled # of separate items where contact/collision is modeled # of unique parts modeled
Quality	Quality of the model and demonstration by the students

1.7 Awards

1. The BEST Robot Modeling Award will be presented to the team that accumulates the highest score during the evaluation period.
2. A hub will present an award for the first-place team, as a minimum. Awards for additional placing (2nd, 3rd, etc.), is at the discretion of the hub.

1.8 Participation Instructions

1.8.1 Scheduled Activity Signup (National Registry Workflow)

1. Modeling of the robot is accomplished by the students over the specified period.
2. The demonstration will be setup as a scheduled activity on the BEST National Registry Team Workflow page. Teams will need to register for their demonstration time slot from the times available.

3. It is recommended that the hub allow 30 minutes for the demonstration. It is not necessary to use the entire time. See the Awards and Judging Hub Logistics Document for exact time allowed by your hub. This duration will be reflected in the scheduled activity time slot that teams sign up for.

1.8.2 Online Meetings / Streaming

1. The demonstration will be conducted as an online meeting.
2. During the meeting, team members will share the Simscape Multibody environment window, discuss the construction of their model, and demonstrate a simulation of the modeled robot functionality.
3. The activity may be streamed for the public, if desired.

1.9 Training & Resources

Training materials and videos are available through MathWorks website (www.mathworks.com).

- **Summary and Example (Blog)**
 - [Creating a Virtual Robot Environment in Simulink for a VEX Clawbot](#)
- **Video Tutorials**
 - [Introduction to Simscape Multibody](#)
 - [Building Simple Components](#)
 - [Building Mechanical Assemblies Part 1](#)
 - [Building Mechanical Assemblies Part 2](#)
 - [Importing CAD Models](#)
- **Detailed Product Documentation**
 - [How to Build a Model](#)
 - [How to Add Contact Forces](#)
 - [Simscape Multibody](#)
- **Additional Example Models**
 - [Robotics Playground](#)
 - [Documentation Examples](#)

A special MATLAB App will be available that provides links to the Robotics Modeling blog and BEST Kit parts.