Model Predictive Control Toolbox 3.3

Design and simulate model predictive controllers

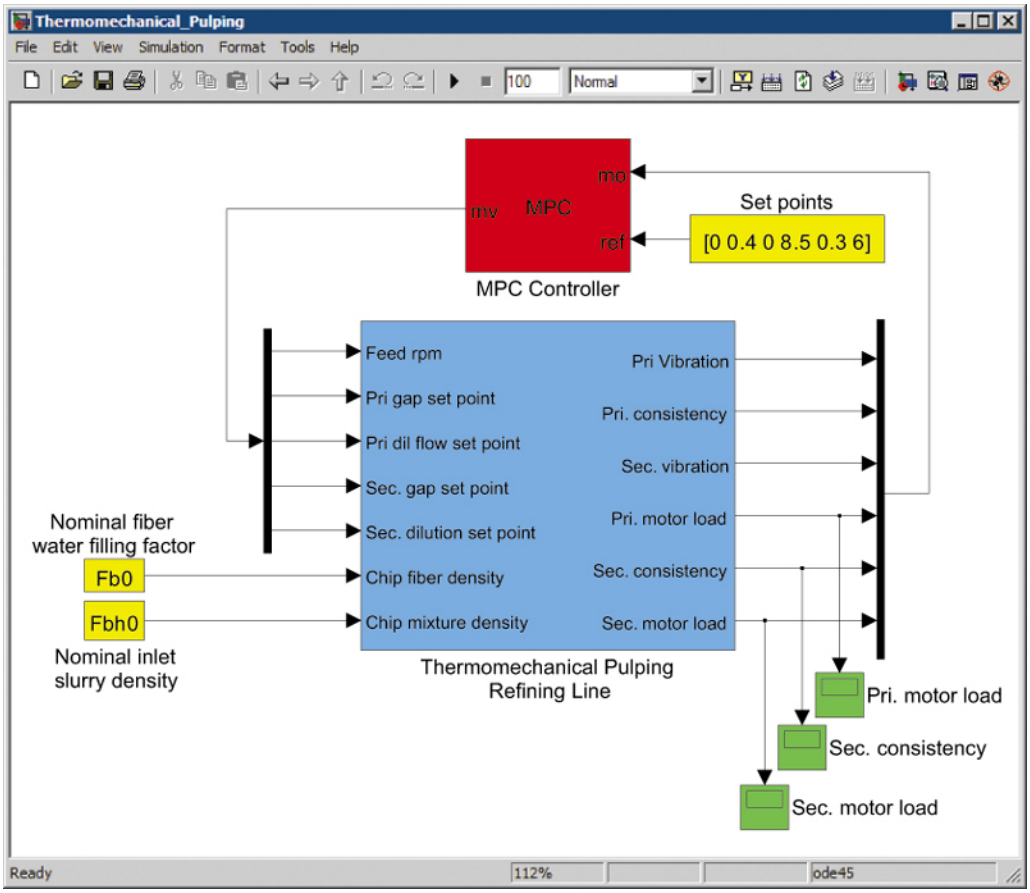
Model Predictive Control Toolbox™ provides MATLAB® functions, a graphical user interface (GUI), and Simulink® blocks for designing and simulating model predictive controllers in MATLAB and Simulink. These controllers optimize the performance of multi-input/multi-output systems that are subject to input and output constraints.

The toolbox lets you define an internal plant model used by the model predictive controller in three ways. You can estimate the model from experimental data (with System Identification Toolbox™), obtain it from a linearized Simulink model, or specify it directly as a linear time invariant object, such as a transfer function, or a state space model. The plant model can include delays.

You can implement the model predictive controller by generating C code (with Simulink Coder™).

Key Features

- Graphical user interface and MATLAB commands for designing and simulating model predictive controllers
- Ability to define an internal linear plant model from experimental data or linearized Simulink model
- Simulink blocks for designing and simulating model predictive controllers directly in Simulink
- Control of nonlinear plants using multiple model predictive controllers with bumpless control transfer
- Ability to handle time-varying constraints and weights, off-diagonal weights, and custom unmeasured disturbance models
- Ability to generate C code for application deployment (with Simulink Coder)



Using one of the two blocks available in Model Predictive Control Toolbox to design and simulate a controller directly in Simulink.

Working with Model Predictive Control Toolbox

Model Predictive Control Toolbox uses the Control and Estimation Tools Manager, a GUI that organizes your controller development into projects, enabling you to manage the design and evaluation of multiple controllers.

The Control and Estimation Tools Manager simplifies the tasks of importing plant models and previously designed controllers and defining plant inputs and outputs, their units, and their nominal values. It shows your controller structure in one view by indicating the number of set points, manipulated variables, disturbances, and measured and unmeasured outputs.

With the Control and Estimation Tools Manager, you can:

- Define internal plant models used in calculating future control actions
- Design a model predictive controller
- Simulate the closed-loop behavior of the controller with linear models

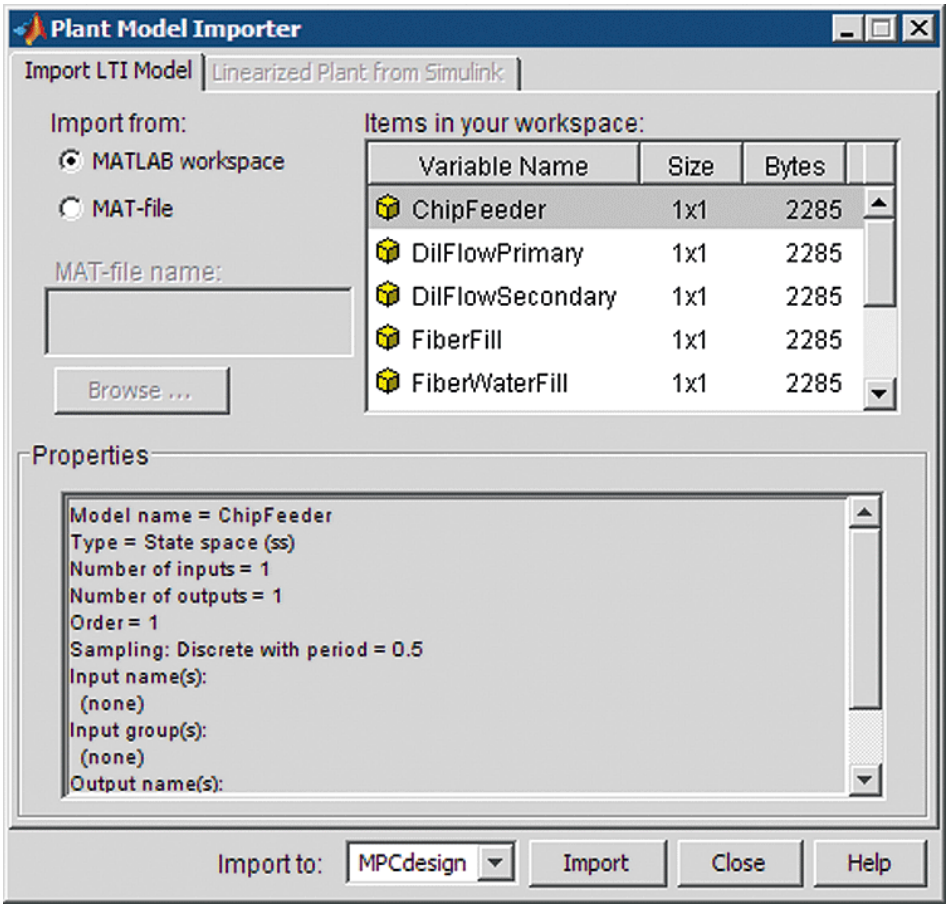
Getting Started with Model Predictive Control Toolbox *9:59*

Defining Internal Plant Models

Model predictive controllers base their control actions on an internal plant model of the process. The internal model lets the controller forecast future process behavior and respect output constraints. The ability to model process interactions makes model predictive control easier to maintain and often better performing than multiple proportional-integral-derivative (PID) control loops, which require individual tuning and other techniques to reduce loop coupling.

Model Predictive Control Toolbox uses linear time invariant (LTI) models, enabling you to use transfer function model structures common to all MathWorks control system design products. You can import multiple LTI models into the toolbox from the MATLAB workspace or a MAT-file. The toolbox also lets you directly import multiple models estimated in System Identification Toolbox.

Using Simulink Control Design™ and Simulink, you can extract a linearized form of the Simulink model that is automatically imported as the internal plant model of the controller.



Plant Model Importer for bringing a model into the toolbox either from the MATLAB workspace or a MAT-file.

Designing Controllers

The toolbox lets you design controllers in MATLAB or in Simulink.

Designing Controllers in MATLAB

You can design multiple controllers and use simulation to determine the optimal design. For each controller design, you can select a plant model and specify the following controller parameters:

- Prediction and control horizons
- Constraints on the manipulated and output variables
- Weighting factors on input and output variables
- Models for measurement noise and for unmeasured input and output disturbances

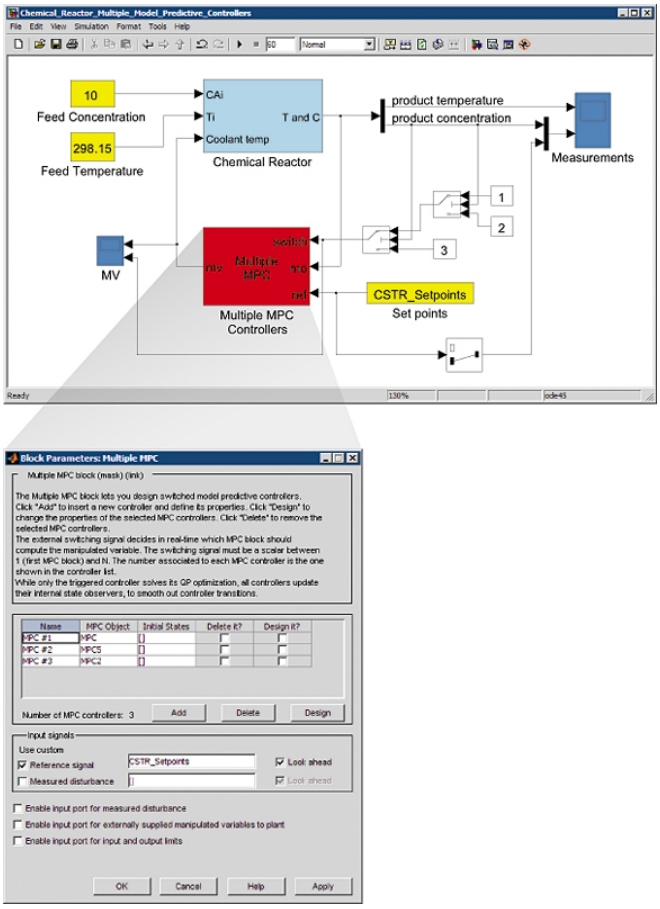
The toolbox supports time-varying constraints and weights, off-diagonal weights, and custom unmeasured disturbance models.

Designing Controllers in Simulink

Model Predictive Control Toolbox, when used with Simulink Control Design, can generate a controller directly in a Simulink model. Using an MPC block and the appropriately connected block inputs and outputs, Simulink Control Design can extract a linearized plant model and generate a controller. Model Predictive Control Toolbox uses the same GUI to specify the controller parameters in Simulink as to design a controller in MATLAB.

Using Tuning Adviser for Designing Model Predictive Controllers *7:23*

You can use the Multiple MPC Controllers block for controlling a nonlinear Simulink model over a wide range of operating conditions. With this block you can design a model predictive controller for each operating point and switch between model predictive controllers at run time. The Multiple MPC Controllers block ensures bumpless control transfer from one model predictive controller to another. You can create linear plant models for controller design at each operating point either by linearizing a Simulink model with Simulink Control Design or by specifying the plant model directly.



Multiple MPC Controllers block (red) for controlling nonlinear models over a wide operating range using multiple model predictive controllers with bumpless control transfer. With this block you can design a model predictive controller for each operating point and switch between model predictive controllers at run time.

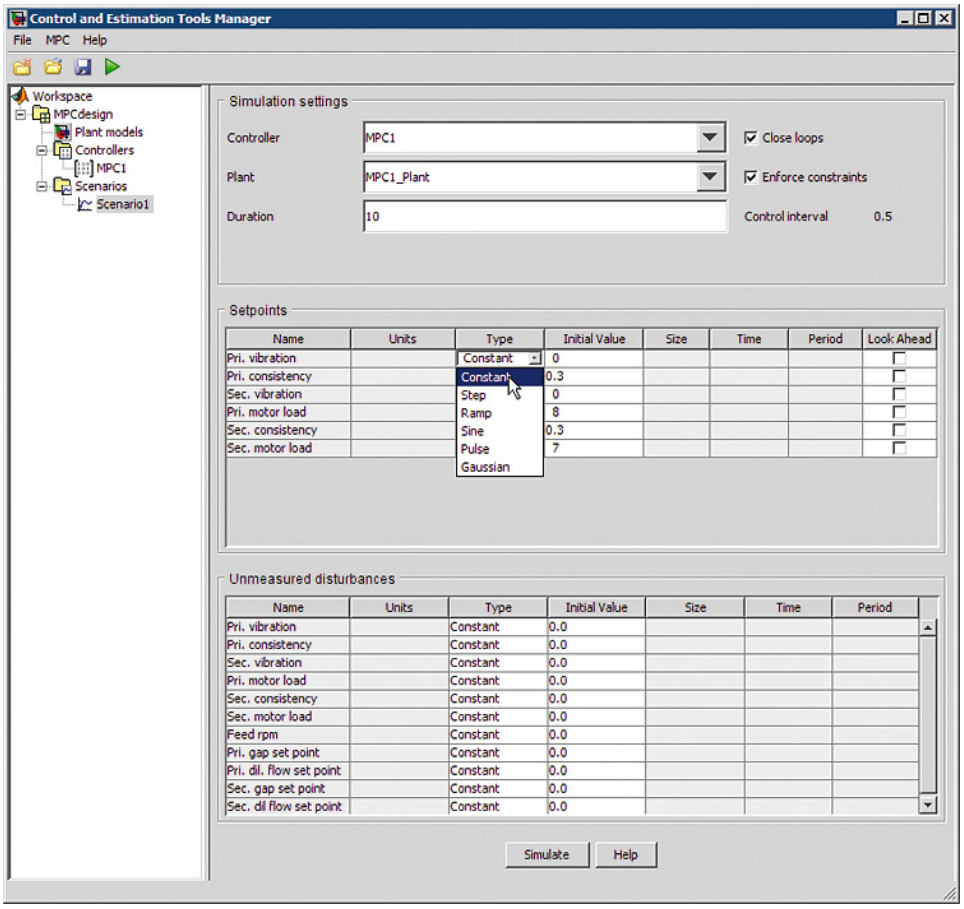
Simulating Closed-Loop Behavior

You can simulate your controller in MATLAB or Simulink to evaluate its performance.

Simulating in MATLAB

You can use MATLAB functions or the Control and Estimation Tools Manager to run closed-loop simulations of your model predictive controller against linear plant models. The Control and Estimation Tools Manager lets you set up multiple simulation scenarios. For each scenario you can input controller set points and unmeasured disturbances from the following signal profiles:

- Constant
- Step
- Pulse
- Ramp
- Sine
- Gaussian

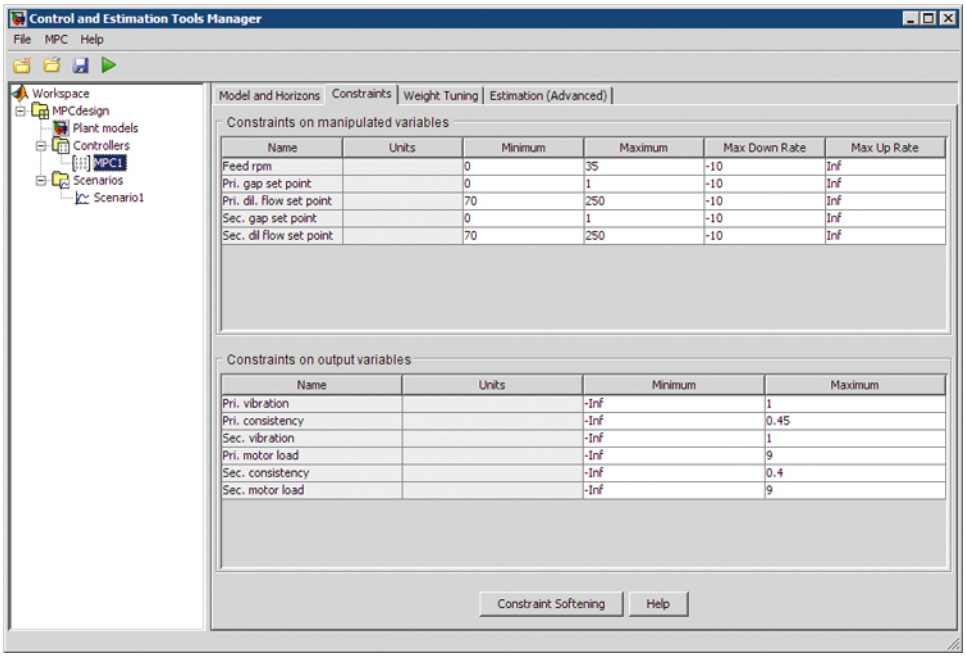


Configuring and running a simulation to test a controller using the Control and Estimation Tools Manager.

You can compare controller and plant model configurations to judge the effects of model mismatch and different weighting factors on constraints and variables. Constraints can be disabled to evaluate the characteristics of the closed-loop dynamics, such as stability and damping.

Simulating in Simulink

You can use Simulink blocks provided with Model Predictive Control Toolbox to run closed-loop simulation of your model predictive controller against a nonlinear Simulink model.

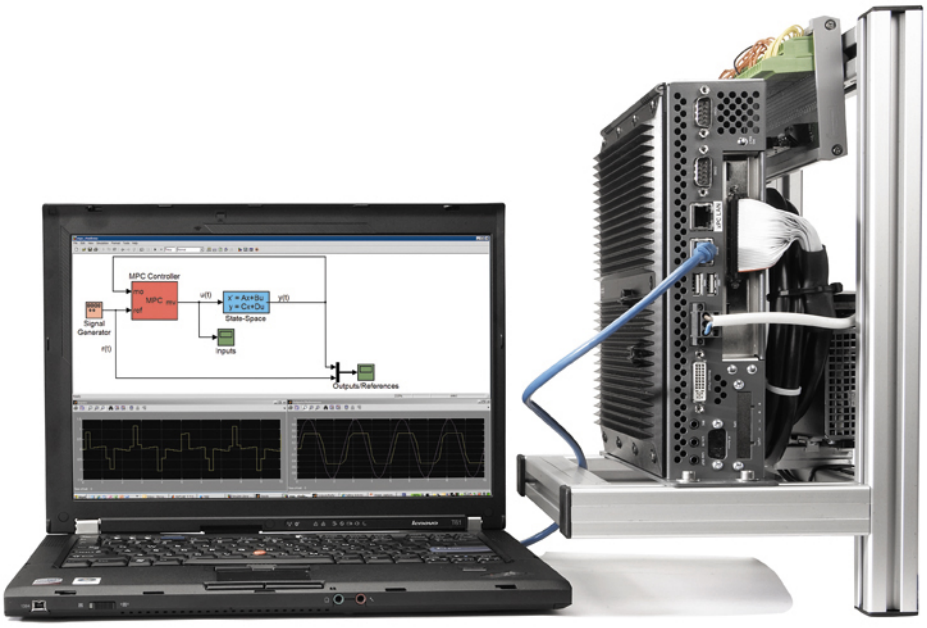


Setting constraints on manipulated and output variables with the Control and Estimation Tools Manager.

Deploying Model Predictive Controllers

Online System Identification and Control Using OPC Communication *18:06*

The toolbox provides two ways to deploy a controller in an application. You can use Simulink Coder to generate C code from Simulink blocks provided with Model Predictive Control Toolbox and deploy the code to a target system for implementation or rapid prototyping. (For a list of supported targets, see the section "Using Model Predictive Control Toolbox with Simulink Coder" in the product documentation.) Using OPC Toolbox™, you can connect a controller operating in MATLAB directly to an OPC-compliant system.



Rapid prototyping of a model predictive controller on PC-compatible hardware using Simulink Coder and xPC Target.

Resources

Product Details, Demos, and System Requirements
www.mathworks.com/products/mpc

Trial Software
www.mathworks.com/trialrequest

Sales
www.mathworks.com/contactsales

Technical Support
www.mathworks.com/support

Online User Community
www.mathworks.com/matlabcentral

Training Services
www.mathworks.com/training

Third-Party Products and Services
www.mathworks.com/connections

Worldwide Contacts
www.mathworks.com/contact