Autodesk® Moldflow® Insight 2012

AMI Runner Balance Analysis

Autodesk®

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The Runner Balance Analysis is used to determine the optimum volume for the sections of the runner system. This analysis ensures that the part fills evenly and there is an acceptable pressure magnitude in the cavity, minimizing runner volume.

The Runner Balance analysis is supported for the following analysis technologies:

- Midplane
- Dual Domain

How it works

Runner systems should be balanced to reduce overpacking during the filling phase. During a Runner Balance analysis, the runner system dimensions are altered to ensure that parts fill simultaneously and the volume of the feed system is minimized.

A well-balanced runner system can make considerable savings in material usage. Before performing a Runner Balance analysis, you should check the Fill analysis and ensure that you are satisfied with each of the following:

- Molding conditions.
- Gate locations.
- Cavity balance.

The Runner Balance analysis is for a model with an attached runner system. A runner system that is added after a Fill+Pack analysis helps you balance the cavities. The aim is to achieve runner dimensions with the following characteristics:

- The same pressure drop in all flow paths, which fills all cavities simultaneously
- Controlled shear heating, which minimizes stress levels without using a high melt temperature
- Minimized volume of runner material relative to cavity volume, which achieves the highest possible pressure drops in the runner system

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TIP: It is useful to perform a Runner Balance analysis without runner balance constraints, and then use these new dimensions as the basis on which to set constraints. This reduces the risk of over-constraining a part and restricting the program's ability to provide a balanced runner system design.

TIP: To find an appropriate pressure range for the Runner Balance analysis, run a Fill analysis with the switch over point set to 100% and the packing set to 100%. Find the spike in the slope of the **Pressure at injection location: XY Plot** to find the range for the target pressure.

When you launch a Runner Balance analysis, a new study is automatically created in the **Project View** pane. When the Runner Balance analysis is complete, the results, including the balanced dimensions and a completed Fill analysis, are associated with the newly created study.

Runner Balance analysis

The Runner Balance analysis is used to determine the optimum volume for the sections of the runner system.

Setting up a Runner Balance analysis

The following table summarizes the setup tasks required to prepare a Runner Balance analysis

The setup tasks below are for non fiber-filled, or fiber-filled thermoplastic materials.

Setup task	Analysis technology
Molding processes	
Runner System Wizard	
Meshing the model	
Checking the mesh before analysis	
Analysis sequence	
Selecting a material	
Injection locations	
Process settings	

Optional setup tasks

Setup task	Analysis technology
Runner balance constraints on page 7	

Running a Runner Balance analysis

Run a Runner Balance analysis to alter runner dimensions, within constraints, to ensure part quality and identical cavity sizes. Creating a well-balanced runner system can result in considerable savings in material usage.

You can only perform a Runner Balance analysis if you have selected a multi-cavity mold type and created a runner system.

1 Open a model.

2 Click **Home tab > Molding Process Setup panel > Analysis Wizard**.

3 In the **Sequence** tab, select the **Runner Balance** check box.

4 Click **Finish** to close and save the analysis entries, or **Analyze** to launch the analysis.

NOTE: Alternatively, click **Start Analysis!** from the **Study Tasks** pane, or **Home tab > Analysis panel > Start Analysis**.

Once the analysis has finished, the **Summary** pane appears.

NOTE: Click **Home tab > Analysis panel > Job Manager > Abort Job** to abort the analysis.

Balancing a runner system

Use the Runner Balance analysis to balance plastic fill through a runner system that is not naturally balanced.

The Runner Balance analysis investigates the mold and determines which runner sections should be made thicker or thinner. The runner layout will stay the same.

1 Open or create a model with a runner system.

TIP: Set runner balance constraints for your runners to optimize them to within a minimum and maximum range, where possible, or to stop them from resizing.

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2 Click **Home tab > Molding Process Setup panel > Analysis Sequence**.

3 Select **Runner Balance** from the **Select analysis sequence** list, and then click **OK**.
Once the analysis is finished the results appear in the Analysis Log.

NOTE: If necessary, adjust the Process Settings to comply with the pressure tolerance.

Runner Balance analysis

Use this dialog to specify settings for a Runner Balance analysis.

Process Settings Wizard dialog—Runner Balance Settings

This page of the **Process Settings Wizard**, is used to specify the runner balancing related process settings for the selected analysis sequence. To access this dialog, ensure that you have selected a Runner Balance analysis.

Click  (**Home tab > Molding Process Setup panel > Process Settings**), and then click **Next** to navigate to the **Runner Balance Settings** page of the Process Settings Wizard.

Target pressure	Specifies the pressure for the runner balance analysis to iterate towards in the runner system.

Runner Balance Advanced Options dialog

This dialog is used to specify the runner balancing analysis related advanced options for the selected analysis sequence.

To access this dialog, ensure that you have selected the analysis sequence Runner Balance, click  (**Home tab > Molding Process Setup panel > Process Settings**), click **Next** one or more times to navigate to the **Runner Balance Settings** page of the Wizard, then click **Advanced options**.

Mill tolerance	Enter the distance (mm) by which you want runners incrementally resized on your model.
Maximum iterations	Specifies the maximum number of iterations that the runner balancing algorithm will use when performing the calculations to balance the runner system.
Time convergence tolerance	Tightening a convergence tolerance may improve the solution accuracy, but will increase analysis time and may lead to convergence problem warnings.
Pressure convergence tolerance	Tightening a convergence tolerance may improve the solution accuracy, but will increase analysis time and may lead to convergence problem warnings.

Runner balancing process settings defaults dialog

The **Runner balancing process settings defaults** dialog is used to specify default values for the analysis inputs to a Runner Balance analysis.

The value specified in the **Runner balancing process settings defaults** dialog is used by default when a Runner Balance analysis sequence is selected.

NOTE: The values used for the current analysis sequence may be changed by entering the desired values on the Process Settings Wizard—Runner Balance Settings dialog.

Runner balancing 2

During a runner balance calculation, runner dimensions are altered within, or as close as possible without affecting the balanced fill, any constraints set, to ensure that cavities fill at the same time and that the volume of the runner system is minimized.

Considerable savings in material usage can be made by creating a well balanced runner system.

You can only balance runner systems for single-gated parts.

When you create the original runner system, make the runner sizes too big. This will help the runner balance calculation arrive at a sensible solution.

It is important to ensure that you are satisfied with each of the following aspects from the Fill analysis before you run a runner balance:

- Molding conditions.
- Gate locations.
- Runner layout.

The aim is to achieve runner dimensions which:

- Have the same pressure drop in all flow paths, so that all cavities fill at the same moment.
- Minimize the volume of runner material, relative to cavity volume, by achieving the highest possible pressure drops in the runner system.
- Generate controlled shear heating, to minimize stress levels without using a high melt temperature.

Runner balance constraints 3

For a **Runner Balance** analysis to determine the correct runner dimensions for balanced flow to multiple cavities, you need to specify the maximum size to which the runners can be resized.

Runner balance constraints

For a **Runner Balance** analysis to determine the correct runner dimensions for balanced flow to multiple cavities, you need to specify the maximum size to which the runners can be resized.

Specifying runner dimension constraints

In general, it is a common design principle that the minimum dimension of a runner section be 1.5 mm greater than the thickness of the part (mm). This allows the cavity to pack evenly and produce an even volumetric shrinkage.

TIP: It may be useful to run an auto runner balance without any runner constraints as a first pass, then use these new dimensions as the basis on which any constraints are set. This helps to avoid the risk of over-constraining a part, restricting the program's ability to provide a good balance for your runner system design.

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1. Click  (**Select**).
2. Click on the runner to select it.

   The runner section should be highlighted.
3. Right-click on the selected runner section and select **Properties**.

   A Runner dialog appears and all runners on the model with the same properties should now be selected.
4. In the **Cross-section is** drop-down list, select the required runner cross-section type.
5. In the **Shape is** drop-down list, select the required runner cross-section shape.
6. Click **Edit dimensions...** and enter the starting runner sizes and/or angles of the runners.
7. Click **Edit runner balancing constraints**.

   This allows you to enter the runner dimension constraints for the runner balance analysis to use when determining the optimum runner size.

8 In the **Runner Balancing Constraints** dialog, select **Constrained**.

9 Click **Edit dimensional limits...** and enter the minimum and maximum runner dimension constraints.

10 Click **OK** in all of the dialogs.

Runner balance constraints

You can set the dimensions for the hot and cold runners.

Runner Balance constraints dialog

This dialog is used to specify how you want the runner balancing analysis to treat the dimensions of the selected cold or hot runners.

Runner Balancing Dimensional Limits dialog

This dialog is used to specify constraints for a specific dimension of the selected cold or hot runners. The specified minimum or maximum dimensions will be adhered to by the runner balancing analysis when balancing the runner system. The specific option on the dialog will depend on the cross-sectional shape of the runner being constrained.

Runner balance constraints—Runner types

Runner balance constraints are an optional analysis input that you can set for a Runner Balance analysis.

These constraints allow you to determine the appropriate size for the runners in your model to achieve balanced flow to your cavities. In order to ensure that all cavities fill at the same time and with equal pressure for a multi-cavity mold, perform a Runner Balance analysis.

Supported Runner Types

The Runner Balance analysis, which determines the correct runner dimensions for multi-cavity balanced flow, can be performed on the following runner system cross-sectional shapes:

- Circular
- Circular tapered
- Semi-circular
- Semi-circular tapered
- Trapezoidal
- Trapezoidal tapered
- U-shape
- U-shape tapered

- Rectangular
- Rectangular tapered
- Internally heated annular
- Customizable cross-section shape.

Runner balance constraints

Runner balance constraints are an optional analysis input that you can set for a Runner Balance analysis.

These constraints enable you to determine the correct size for the runners so that a balanced flow to the cavities is achieved. The Runner Balance Analysis is then performed to ensure that all cavities in a multi-cavity mold fill simultaneously with equal pressure to each cavity.

Runner balance constraint guidelines

It is a common design principle that the minimum dimension of a runner cross-section be 1.5mm greater than the thickness of the part. This enables the cavity to pack evenly and produce an even volumetric shrinkage. The choice of minimum dimensions may be affected by the material and design of the part. Runner dimensions are often determined by the type of material that is used. For example, on ejection from the die, one millimeter of styrene may snap and one millimeter of nylon may flex. There should be no "reversed tapers" in the mold or runner system, which prevent the runners from being ejected.

TIP: It is useful to perform a Runner Balance analysis without runner balance constraints, and then use these new dimensions as the basis on which to set constraints. This reduces the risk of over-constraining a part and restricting the program's ability to provide a balanced runner system design.

For models which have a combination of both hot and cold runners, only the cold runners will be balanced using the auto-runner balancing algorithm. Models which contain only hot runners will automatically be balanced using the runner balancing algorithm.

You may not want the program to alter the dimension of a particular runner cross-section because it is impractical to do so, or you want to restrict the dimensions of particular runners to maximum or minimum limits. With annular runners, ensure that you do not make the minimum outer dimension less than the maximum inner dimension.

Runner balance derivation 4

Runner balancing is performed as a conditional minimization of a criterion function, calculated using the results of a Fill analysis.

A runner system with dimensions that satisfy the criterion function is considered to be a balanced system.

The criterion function

The criteria function is based on Fill results and uses the following factors:

- Time imbalance. The difference in the filling time between the most difficult cavity to fill and the easiest cavity to fill is considered.
- Pressure imbalance. The difference between the maximum injection pressure for the iteration and the user defined target pressure is considered.
- Section imbalance. This is a measure of the change of the runner size throughout the feed system.

The optimization stops when the value of the criterion function for an iteration is less than a set value, or when the limit for the number of iterations is reached.