

Termite 1.4

Termite is a modular, open-source slicer for Grasshopper, developed specifically for Liquid Deposition Modeling (LDM) 3D printers with recommended nozzle sizes ranging from 0.1 to 50 mm. It supports systems such as the WASP 40100 LDM and Delta WASP 2040 Clay, while also being compatible with a wide range of other printers and custom setups capable of interpreting G-code, including Cartesian printers, polar printers, and robotic arms. Termite is suitable for 3D printing with a broad range of paste-based materials, including clay- or earth-based mixtures, concrete, food-grade substances, biopolymers, and biomaterials. No warranty regarding functionality or safety is being provided.

Termite requires Rhino 6 or later. It is necessary to set Rhino units to mm while working with Termite.

Printing paths based on lines, curves or surfaces can be designed in Rhino and Grasshopper. Furthermore, Termite components of the component sub-category “Create” can be used for the most basic operations for 3D printing.

When referencing Rhino geometries, the order of selecting will determine the order of printing. Otherwise, Termite components of the sub-category “Sort” can be used for sorting and optimising. Make sure to control the orientation of each path.

To make use of varying printing parameters, place the printing paths on Rhino Layers or Sublayers named “Default”, “Travel”, “Slow” or “Fast” while making sure that “Read Multi Layer Names” is turned on at the Main G-code Generator component. If turned off, all paths will be printed with the parameters of “Default”. With “Connect Multi Layer Paths” enabled at the Main G-code Generator component, Termite will automatically try to join adjacent paths even if placed on different Rhino layers, while retaining the respective printing parameters. If necessary travel paths can be added connecting and thereby sorting the relevant printing paths.

The default settings of each component are meant for using a WASP 40100 LDM Extruder XL 3.0 with a 4 mm nozzle.

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Windows: The installer will place all Termite Grasshopper User Objects (.ghuser) at C:\Users\{username}\AppData\Roaming\Grasshopper\UserObjects. Termite Grasshopper Assembly files (.gha) at C:\Users\{username}\AppData\Roaming\Grasshopper\Libraries\Termite. And Example files (.gh) at C:\Users\{username}\AppData\Roaming\Grasshopper\Libraries\Termite\Example Files. If the plugin does not load correctly, place all files manually as mentioned above and make sure that the files are not blocked under properties. To uninstall, run the uninstall file in the program directory which will remove all files including the Grasshopper User Objects.

Mac: To install, manually drag and drop all 19 Termite .ghuser files into the Grasshopper canvas. Example files containing all components and corresponding input components can be found in the downloaded .zip folder. To uninstall, navigate to File -> Special Folders -> User Object Folder and remove all Termite .ghuser files.

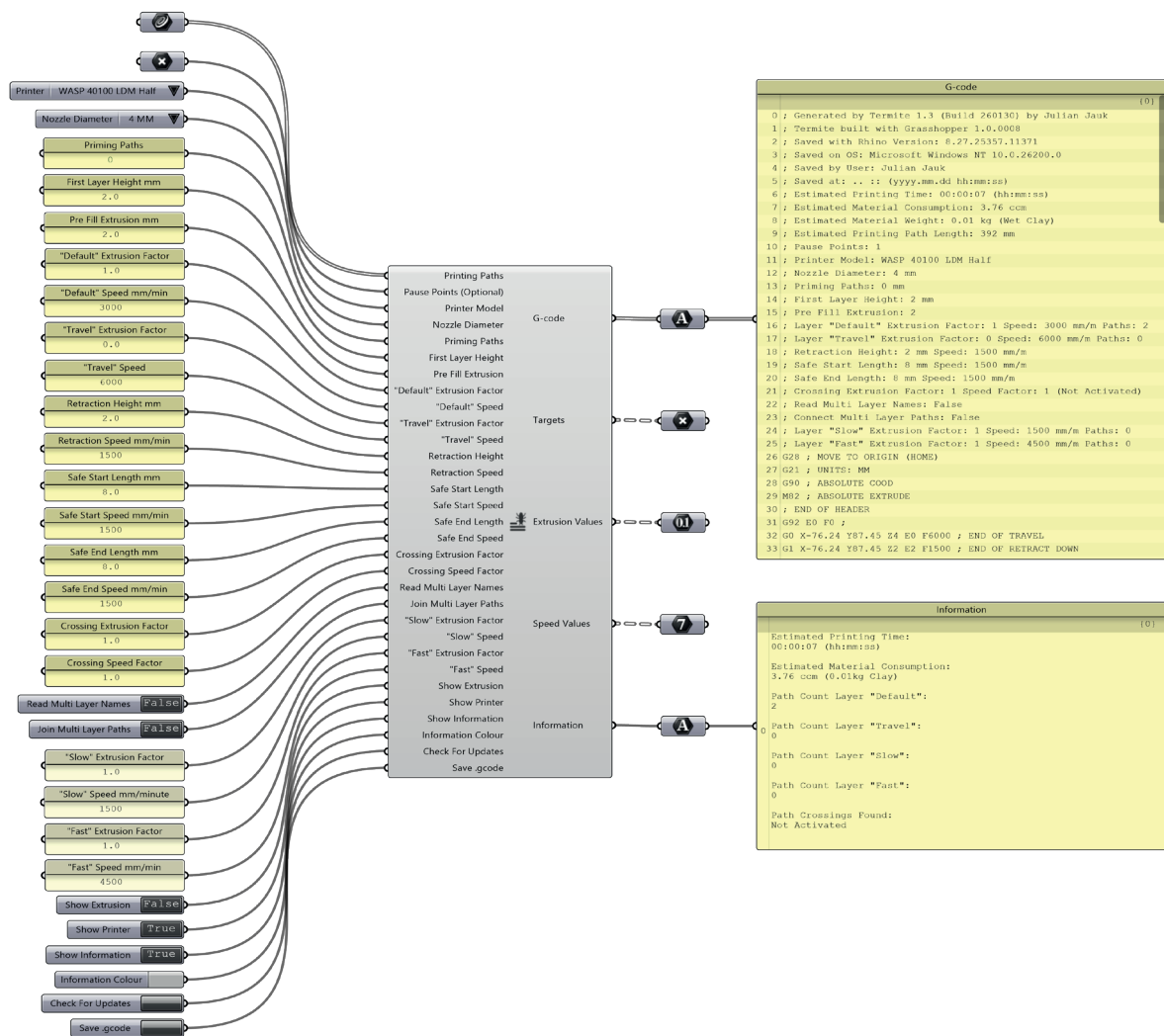
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Detailed explanations of all components of the sub-categories “Main”, “Create”, “Sort”, “Display”, and “Example” can be found on the following pages. For troubleshooting and feedback, please feel free to contact julian.jauk@gmail.com

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Termite Main G-code Generator



This component serves as the nucleus of the plugin. It accumulates inputs such as printing paths, optional pause points, toggleable printing and display options, as well as printing parameters for multiple layers. The output is a ready-to-print .gcode file, along with the generated targets presented as grouped points within Grasshopper. Like all other components in the Create category, this component features an info panel. Upon successful execution, this panel provides a summary of the outcomes. In case of any errors, it indicates the specific circumstances that led to the error when possible.

As input for printing paths, lines and curves of all types are accepted. The generator divides these into individual targets and traverses them in the user-defined sequence. Depending on the settings, the amount of extruded material is primarily determined by the length of the printing paths. Pause points allow for optional halts of the machine at user-defined positions. These points can be chosen on or near a printing path, where the machine pauses the printing process, lifts the extruder by 5 cm, and awaits user input at the machine. This function can be utilized to allocate specific time for physical interventions during the printing process. Toggleable printing options facilitate layer-specific allocation of printing parameters to individual printing paths, the automatic connection of adjacent printing paths located on different Rhino layers, displaying the printer in the Rhino Viewport, showing printing information (numbering, orientation, travel paths), and saving a .gcode file to a desired file path. The Save Button will store the generated text as a .gcode file in a desired file path. In addition to a list of targets defined by coordinates (x, y, z), an extrusion value, a speed, and any annotations to support the user's orientation, each

G-code also incorporates a header that lists several parameters. This header encompasses the version of *Termite* utilized, the user responsible for generating the G-code, and the respective time of generation. Furthermore, the estimated duration and material consumption are indicated. Additionally, all parameters (material flow, speed, safe start, safe end, etc.) of the G-code generator are compiled to ensure repeatability and facilitate minor adjustments in case of subsequent regeneration. In addition to the values presented to the user as an overview, the printer is provided with commands for auto homing, as well as the establishment of millimeters as the unit and the directive to interpret the subsequent coordinates and extrusions as absolute. Finally, commands are issued to display on the LCD screen of the printer the current working section in which it is situated. Upon completion of the printing process, the printer will once again move to the home position.

The printing parameters are divided into optional assisting values and mandatory values that can optionally be allocated to different layers with varying settings. The mandatory values, Extrusion and Speed, define the extrusion factor of each printing path and the speed in millimeters per minute at which it should be printed. When “Read Multi Layer Names” is turned off, the values of the “Default” layer are used for all printing paths. When “Read Multi Layer Names” is turned on, printing paths can be manually assigned to Rhino layers named “Default,” “Travel,” “Slow,” or “Fast” before generating the G-code. The values of Extrusion and Speed can then be assigned differently. This multi-layer function allows for variable control of material flow within a closed curve, for instance. The individual adjustment of speed allows for cautious printing of sensible areas of the geometry. Moreover, travel paths can thereby be manually created. The general layer height is defined by the positions of the delivered print paths and cannot be manually set here. It is recommended to adjust the height to half the diameter of the used nozzle. This results in squishing the circular extrusion into a rectangular cross-section with a 1:2 aspect ratio, ensuring sufficient layer adhesion. From this point, the layer height can be optionally minimized to increase the object’s resolution and achieve a smoother outer surface. Increasing the layer height will lead to insufficient bonding of the layers. The “First Layer Height” option allows for optionally setting the first layer to a lower value to enhance squishing and thus improve adhesion for objects with a smaller contact area to the bed. The extrusion width behaves in a similar manner. By increasing the material flow, the extrusion width can exceed the actual nozzle diameter, resulting in swelling patterns on the surface of the extrusion. In very dry mixtures, this inflation can lead to cracking on the surface. Conversely, when aiming to decrease the extrusion width, it is essential to avoid reducing the material flow arbitrarily, as doing so can result in the extrusion strand breaking when it falls below the nozzle diameter.

As assisting values, the following parameters are available: 1) “Pre Fill Extrusion”: This value allows for additional material extrusion before each printing path, compensating for missing material, especially with larger nozzle diameters, ensuring an adhesive start of each print. 2) “Safe Start” Length and Speed: This approach can guarantee that each printing path is executed more cautiously, and at a slower pace, solely during the crucial initial millimeters. Meanwhile, the subsequent parts of the print can be executed at a higher speed. 3) “Safe End” Length and Speed: These values define the length and speed of a smoothing movement after each printing path. For open curves, the clay extrusion continues in the direction of the last segment, and for closed curves, the print is flattened according to the geometry of the path. This results in a particularly clean and stable ending for each printing path. 4) “Crossing”: For each automatically detected intersection (including self-intersections) of printing paths within one plane, the extrusion and speed of a segment (as long as the nozzle diameter) of all subsequent paths crossing the intersection (except the first) can be multiplied by the given factor to prevent material buildup. 5) “Retraction” Height and Speed: These values determine the vertical distance and speed of the movement before and after each printing path, before the printing process resumes. Increasing this safety distance might be necessary in some situations to avoid collisions. Additionally, using a lower speed compared to the standard travel speed can achieve a cleaner and more stable conclusion of the printing path.

Description: Termite main component for generating and saving .gcode files containing the coordinates of the printing paths as well as various input parameters.

Input: Printing Paths: Termite is expecting curves or lines as input of printing paths

Input: Pause Points: Termite is expecting points as input for optional pause points for the printer to pause until manual interaction. Termite will use the G-code command M0 to trigger the pause

Input: Printer Model: Termite is expecting an integer choosing which printer to work with (WASP 40100 LDM half = 0, WASP 40100 LDM Full = 1, Delta WASP 2040 Clay = 2, Shapelab Argos 140200 = 3, Other = 4)

Input: Nozzle Diameter: Termite is expecting a number defining the diameter in mm of which nozzle size to work with. This value will not affect the extrusion factor and is only used to estimate the material consumption, compute crossings, and display the material thickness (0.1- 50)

Input: Priming Paths: Termite is expecting an integer defining the amount of priming paths around the object(s)

Input: First Layer Height: Termite is expecting a number in mm defining the height of the first layer (0- 1000)

Input: Prefill Extrusion: Termite is expecting a number defining the amount of material that is being extruded before each printing path (-100- 100)

Input: "Default" Extrusion Factor: Termite is expecting a number multiplying the amount of material that is being extruded for printing paths on a Rhino Layer called "Default" (0.0- 10.0) (Default Value = 1)

Input: "Default" Speed: Termite is expecting a number defining the speed of the printing paths on a Rhino Layer called "Default" in mm per minute (100- 20000)

Input: "Travel" Extrusion Factor: Termite is expecting a number multiplying the amount of material that is being extruded for printing paths on a Rhino Layer called "Travel" (0.0- 10.0) (Default Value = 0)

Input: "Travel" Speed: Termite is expecting a number defining the speed of the printing paths on a Rhino Layer called "Travel" in mm per minute (100- 20000)

Input: Retraction Height: Termite is expecting a number defining the height of Retraction in mm before and after each printing path (0- 1000)

Input: Retraction Speed: Termite is expecting a number defining the speed of Retraction in mm per minute (100 - 20000)

Input: Safe Start Length: Termite is expecting a number defining the safe start length in mm of each printing path (0- 100)

Input: Safe Start Speed: Termite is expecting a number defining the safe starting speed of each printing path in mm per minute (100- 20000)

Input: Safe End Length: Termite is expecting a number defining the length of a Safe End movement in mm after each printing path (0- 100)

Input: Safe End Speed: Termite is expecting a number defining the speed of a Safe End movement in mm per minute (100- 20000)

Input: Crossing Extrusion Factor: Termite is expecting a number defining the extrusion multiplication factor applied when crossing a printed path. For each intersection (including self-intersections) of printing paths within the same XY plane, the extrusion of a segment with a length equal to the nozzle diameter is reduced for all subsequent paths crossing that intersection, in order to prevent material buildup. Intersections occurring at start points, end points, or seam points of subsequent paths are excluded. Set the value to 1 to disable this feature (0.0-10.0)

Input: Crossing Speed Factor: Termite is expecting a number defining the speed multiplication factor applied when crossing a printed path. For each intersection (including self-intersections) of printing paths within the

same XY plane, the speed of a segment with a length equal to the nozzle diameter is multiplied for all subsequent paths crossing that intersection, in order to prevent material buildup. Intersections occurring at start points, end points, or seam points of subsequent paths are excluded. Set the value to 1 to disable this feature (0.0-10.0)

Input: Read Multi Layer Names: Termite is expecting a boolean value whether printing parameters such as Extrusion and Speed are organized by the printing path's Rhino layer or values of "medium" should be taken for all paths (False = 0, True = 1)

Input: Join Multi Layer Paths: Termite is expecting a boolean value whether or not it will automatically attempt to join adjacent paths, even if placed on different layers, while retaining the respective printing settings from each layer. If necessary travel paths can be added to connect and thereby sort printing paths. (False = 0, True = 1)

Input: "Slow" Extrusion Factor: Termite is expecting a number multiplying the amount of material that is being extruded for printing paths on a Rhino Layer called "Slow" (0.0- 10.0) (Default Value = 1)

Input: "Slow" Speed: Termite is expecting a number defining the speed of the printing paths on a Rhino Layer called "Slow" in mm per minute (100- 20000)

Input: "Fast" Extrusion Factor: Termite is expecting a number multiplying the amount of material that is being extruded for printing paths on a Rhino Layer called "Fast" (0.0- 10.0) (Default Value = 1)

Input: "Fast" Speed: Termite is expecting a number defining the speed of the printing paths on a Rhino Layer called "Fast" in mm per minute (100- 20000)

Input: Show Extrusion: Termite is expecting a boolean value whether or not the material extrusion is displayed in the respective thickness in Rhino Viewport. It is important to note that enabling this feature for complex printing paths may result in increased computation time. The quality of the mesh is automatically defined by the complexity of the given printing paths (False = 0, True = 1)

Input: Show Printer: Termite is expecting a boolean value whether or not the printer is displayed in Rhino Viewport (False = 0, True = 1)

Input: Show Information: Termite is expecting a boolean value whether or not various information is displayed in Rhino Viewport (False = 0, True = 1)

Input: Information Colour: Termite is expecting a colour for displaying various information in R,G,B (0- 255)

Input: Check For Updates: Termite is expecting a boolean value as a trigger to check for updates on Food4Rhino. Internet connection required (False = 0, True = 1)

Input: Save .gcode: Termite is expecting a boolean value as a trigger to save the G-code. Use the Grasshopper Button to trigger the event (False = 0, True = 1)

Output: G-code: G-code as plain text ready to be executed by the printer

Output: Targets: A list of all targets, with a branch of data for each printing path. These targets are intended for use with other cnc machines such as 6-axis robotic arms

Output: Extrusion Values: A list of all extrusion values, with a branch of data for each printing path. These values are intended for use with other cnc machines such as 6-axis robotic arms

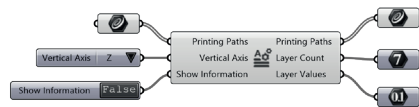
Output: Speed Values: A list of all speed values, with a branch of data for each printing path. These values are intended for use with other cnc machines such as 6-axis robotic arms

Outputs: Information: Information summarising various printing parameters

Termite Create

This category encompasses all those components that generate printing paths, specifically designed for 3D printing with clay, based on inputs such as lines, curves, or surfaces. The components encompass components for printing all conventional elements of a 3D printed object, such as base, wall, etc. For specific design tasks, the modular approach of the plugin allows manually designed or parametrically designed printing paths to be used or supplemented, as needed.

Termite Create Alternated Layers



This component can be used to alternate the printing direction of all paths in every second layer. The process works by first sorting all paths along a specified axis, then grouping them into layers that share the same axis value, and finally flipping the direction of all paths in every second layer. This helps to evenly distribute forces within the material (e.g., shrinkage during drying).

Description: Termite component for creating printing paths sorted along a given axis, with the printing direction of every second layer flipped

Input: Printing Paths: Termite is expecting lines or curves as input, which it layers along a chosen axis while alternating the path direction for every second layer

Input: Vertical Axis: Termite is expecting an integer defining which axis to take for layering of the given paths (X = 0, Y = 1, Z = 2).

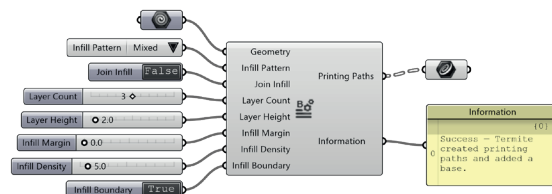
Input: Show Information: Termite is expecting a boolean value whether or not the numbering of the printing paths is displayed in Rhino Viewport (False = 0, True = 1).

Output: Printing Paths: Print paths sorted and stacked along the given axis, with the direction of all paths in every second layer flipped.

Output: Layer Count: Number of individual values along the given axis as integer

Output: Layer Values: Individual values along the given axis as numbers

Termite Create Base



This component facilitates the automated creation of a base surface. It employs various infill patterns, such as an orthogonal grid that is being rotated by 90° on each ascending level, or an iterative offset of the contour curve of the given object. A hybrid form of these two infill patterns is also attainable, offering enhanced stability by avoiding overlapping seam curves. The spacing between the curves can be adjusted separately based on the nozzle diameter and the desired strength of the base. The number of base surfaces can also be configured. Open

or closed surfaces are accepted as input for this component.

Description: Termite component creating a base to form a solid base plate for tube-like surfaces or planar closed curves by using different filling patterns

Input: Geometry: Termite is expecting a surface, polysurface, mesh, or a planar closed curve for adding a base

Input: Infill Pattern: Termite is expecting an integer defining which pattern is used for the infill (Grid = 0, Offset = 1, Mixed = 2)

Input: Join Infill: Termite is expecting a boolean value that specifies whether, for each layer, as many infill curves of the grid pattern as possible should be joined (False = 0, True = 1)

Input: Layer Count: Termite is expecting an integer defining the number of layers to be added for building the base (1- 10)

Input: Layer Height: Termite is expecting a number defining the height of all layers in mm (0.1- 20)

Input: Infill Margin: Termite is expecting a number defining the outer offset distance in mm from a given surface before starting the infill pattern (0- 50)

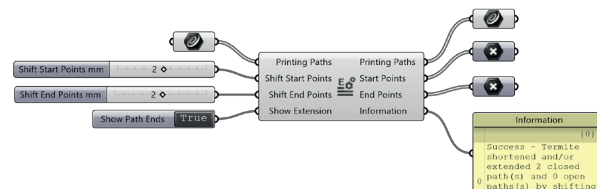
Input: Infill Density: Termite is expecting a number defining the distance in mm between printing paths being added to build a base (0.1- 50)

Input: Infill Boundary: Termite is expecting a boolean value indicating whether a smooth outer boundary should be added to layers with a grid infill (False = 0, True = 1)

Output: Printing Paths: Printing Paths created by filling the base of a given surface

Output: Information: Information about created printing paths

Termite Create Shifted Ends



Extending or reducing a given set of printing paths can yield various effects. In cases of intersecting printing paths, surplus material can be mitigated by typically interrupting one of the intersecting paths and shortening both ends by half the nozzle diameter. Additionally, closed curves can also be extended, resulting in a particularly robust seam point due to a surplus of material.

Description: Termite component for creating extended or shortened curves of given printing paths to ensure strong connections of start and end points

Input: Printing Paths: Termite is expecting curves or lines as input for printing paths

Input: Shift Start Points: Termite is expecting a number defining the shorten/extend length in mm at the start of each printing path

Input: Shift End Points: Termite is expecting a number defining the shorten/extend length in mm at the end of

each printing path

Input: Show Extension: Termite is expecting a boolean value whether or not the extensions of the printing paths are displayed in Rhino Viewport (False = 0, True = 1)

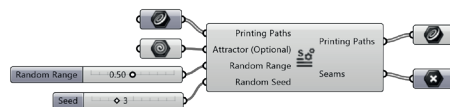
Output: Printing Paths: Printing Paths created by extending given paths

Output: Start Points: Start Points created by shortening or extending given paths

Output: End Points: End Points created by shortening or extending given paths

Output: Information: Information about created printing paths

Termite Create Shifted Seams



Through randomly shifting the seam points of closed printing paths, the potential for vertical alignment of such seam points, which may manifest during processes like vertical replication or contouring, can be averted. This process ensures the uniform distribution of weaker areas across a given object, thus preventing critical damage during the printing process.

Description: Termite component for creating shifted seams on given printing paths according to an input attractor geometry and optional random distribution to ensure an equal distribution of potential weak points

Input: Printing Paths: Termite is expecting curves or lines as input for printing paths

Input: Attractor (Optional): Termite is expecting an optional point or curves as an attractor to shift all printing path seams as close as possible to it

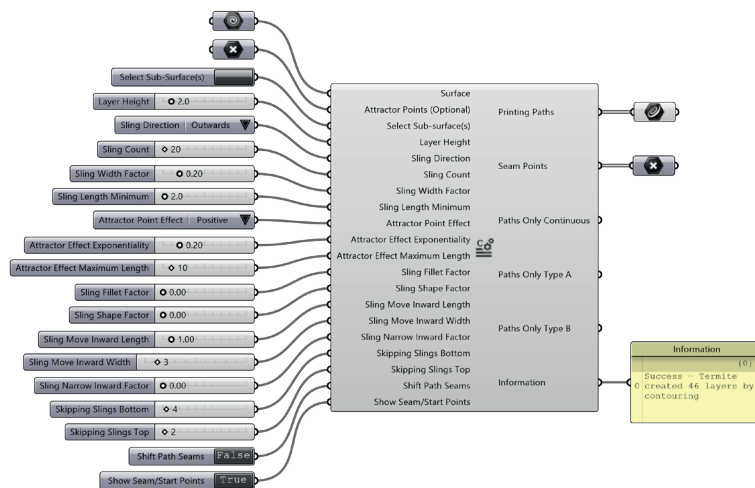
Input: Randomize: Termite is expecting a float number defining the range for randomly shifting the seams of the printing paths (0.0- 1.0)

Input: Random Seed: Termite is expecting an integer defining the seed for randomly shifting the seams of the printing paths

Output: Printing Paths: Printing paths with randomly shifted seams

Output: Seams: Randomly shifted seams of the printing paths

Termite Create Sling Contours



A popular and frequently employed design technique in 3D printing, spanning ceramics, plastics, and other materials, involves the incorporation of external loops, known as slings. In this process, the individual contour curves of a given surface deviate from the geometry during printing, generating slings depending on factors such as viscosity and speed. An array of refined parameters is at the user's disposal for tailoring these loops according to preference. This includes variables such as sling count, length, width, rounding, shape, and the option to shift slings origins towards the object's interior to prevent tipping over. Furthermore, the length of the slings can be parametrically designed through the utilization of an attractor point, thus potentially establishing a stronger connection with the overall geometry.

Description: Termite component creating contour curves containing slings with various parameters, making it versatily applicable

Input: Surface: Termite is expecting a surface, polysurface, or mesh to contour

Input: Attractor Points: Termite is expecting one or multiple optional points for slings to be positively or negatively attracted from

Input: Select Sub-surface(s): Termite is expecting a boolean value as a trigger to manually select sub-surface(s) from a polysurfaces for creating slings. Use the Grasshopper Button to trigger the event (False = 0, True = 1)

Input: Layer Height: Termite is expecting a number defining the height in mm of one spiral (0.1- 20)

Input: Sling Direction: Termite is expecting a boolean value indicating whether the slings face outwards or inwards (0 = outwards, 1 = inwards)

Input: Sling Count: Termite is expecting an integer defining the number of slings per layer (1- 1000)

Input: Sling Width Factor: Termite is expecting a number defining the multiplication factor of the width of all slings (0.0- 1.0)

Input: Sling Length Minimum: Termite is expecting a number defining the minimum length in mm of all slings (0- 100)

Input: Attractor Point Effect: Termite is expecting a boolean value whether the effect of the given attractor point on the length of all slings is negative or positive (Negative = 0, Positive = 1)

Input: Attractor Effect Exponentiality: Termite is expecting a number defining the exponentiality of the effect on all slings of the given attractor point (Linear = 0, Exponential = 1)

Input: Attractor Effect Maximum Length: Termite is expecting a number defining the maximum length in mm of all slings affected by the given attractor point (0- 100)

Input: Sling Fillet Factor: Termite is expecting a number defining the factor of the radius of a fillet for all slings (None = 0, Round = 1)

Input: Sling Shape Factor: Termite is expecting a number defining the shape of all slings (Straight = 0, Sharp = 1)

Input: Sling Move Inward Length: Termite is expecting a number specifying the distance in mm to move the ends of all path segments between each sling inward (0- 50)

Input: Sling Move Inward Width: Termite expects an integer to define the rebuild resolution of the path segment between each sling, which determines the width of the path being moved inward (2-10)

Input: Sling Narrow Inward Factor: Termite is expecting a number to define the factor of narrowing all slings on the contours (0- 1)

Input: Skipping Slings Bottom: Termite is expecting an integer defining how many contours at the bottom get skipped until contours containing slings appear

Input: Skipping Slings Top: Termite is expecting an integer defining how many contours at the top get skipped until contours containing slings appear

Input: Shift Path Seams: Termite is expecting a boolean value whether or not the curve seams are shifted gradually each layer, in order to avoid a vertical seam (False = 0, True = 1)

Output: Printing Paths: Printing Paths created by contouring and eventually adding slings

Output: Seam Points: Seam Points created by contouring that are eventually shifted

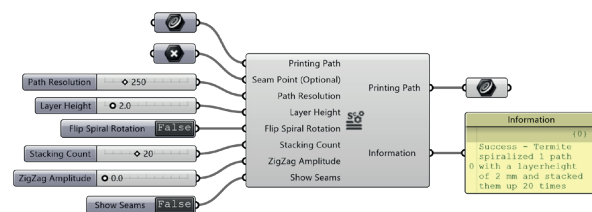
Output: Paths Only Continuous: Printing Paths of contours containing continuous paths only

Output: Paths Only Type A: Printing Paths of contours containing slings type A only

Output: Paths Only Type B: Printing Paths of contours containing slings type B only

Output: Information: Information about created printing paths

Termite Create Spiral from Curve



In order to enhance both printing speed and stability, a common practice in 3D printing involves substituting the planar printing paths of each individual layer with a continuous spiral along the Z-axis. This component takes a provided planar curve as an input and subsequently replicates and spirals it upwards according to a specified layer-height and quantity.

Description: Termite component for creating a spiral along the Z-axis from a given closed planar curve

Input: Printing Path: Termite is expecting one closed, planar curve as input for printing path

Input: Seam Point (Optional): Termite is expecting an optional point defining the position of the start of the spiral

Input: Path Resolution: Termite is expecting an integer defining the amount of control points of one spiral (10-1000)

Input: Layer Height: Termite is expecting a number defining the height in mm of one spiral

Input: Flip Spiral Rotation: Termite is expecting a boolean value whether or not to flip the direction of rotation of the created spiral (False = 0, True = 1)

Input: Stacking Count: Termite is expecting an integer defining the count of the spirals to be stacked along the Z-axis

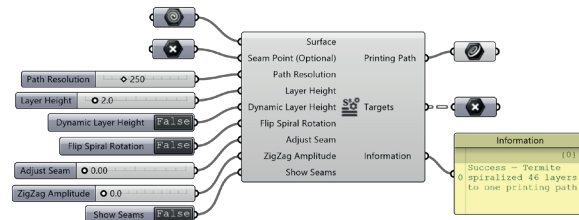
Input: ZigZag Amplitude: Termite is expecting a number to define the amplitude of an eventual ZigZag pattern of printing paths. The frequency of the pattern is defined by the Path Resolution (0 - 10)

Input: Show Seams: Termite is expecting a boolean value whether or not the printing path seams are displayed in Rhino Viewport (False = 0, True = 1)

Output: Printing Path: Printing Path spirialized and eventually stacked along Z-axis

Output: Information: Information about created printing path

Termite Create Spiral from Surface



Analogous to the previously mentioned component, a spirialized printing path is generated here. In this instance, a surface that permits such geometry (closed and non-branching surfaces) can be chosen as input to be printed as a continuous spiral. Analogous to the preceding component, aside from determining the layer height, the resolution of the spiral can also be defined to efficiently configure the spiral pattern in accordance with the input geometry (minimizing the target count while sufficiently adhering to the provided geometry).

Description: Termite component for creating a spiral along the Z-axis from given tube-like and non-branching surfaces

Input: Surface: Termite is expecting a surface, polysurface, or mesh to spirialize

Input: Seam Point (Optional): Termite is expecting an optional point defining the position of the start of the spiral

Input: Path Resolution: Termite is expecting an integer defining the amount of control points of one spiral (10-1000)

Input: Layer Height: Termite is expecting a number defining the height in mm of one spiral

Input: Dynamic Layer Height: Termite is expecting a boolean value indicating whether the layer height should be reduced to compensate for overhangs (False = 0, True = 1)

Input: Flip Spiral Rotation: Termite is expecting a boolean value whether or not to flip the direction of rotation of the created spiral (False = 0, True = 1)

Input: Adjust Seam: Termite is expecting a number defining the position of the start of the spiral (0.00- 1.00)

Input: ZigZag Amplitude: Termite is expecting a number to define the amplitude of an eventual ZigZag pattern of printing paths. The frequency of the pattern is defined by the Path Resolution (0 - 10)

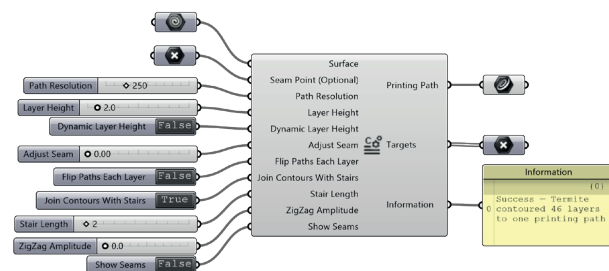
Input: Show Seams: Termite is expecting a boolean value whether or not the printing path seams are displayed in Rhino Viewport (False = 0, True = 1)

Output: Printing Path: Printing Path created by spiralizing a surface

Output: Targets: List of all targets of each printing path

Output: Information: Information about created printing path

Termite Create Stair Contours



This command exceeds the existing contour command of Rhino and Grasshopper by automatically connecting the horizontal contour curves along a stair of a given length. This results in a continuous curve, similar to that of the components for spiralizing, but characterized by having with horizontal printing paths predominantly. Optionally, the generated printing paths can be provided with a zigzag pattern.

Description: Termite component for creating contours along the Z-axis from a given surface, with optional stairs to connect them into a continuous printing path

Input: Surface: Termite is expecting a surface, polysurface, or mesh to contour

Input: Seam Point (Optional): Termite is expecting an optional point defining the position of the start of the spiral

Input: Path Resolution: Termite is expecting an integer defining the amount of control points of one contour (10- 1000)

Input: Layer Height: Termite is expecting a number defining the vertical distance in mm between each contour

Input: Dynamic Layer Height: Termite is expecting a boolean value indicating whether the layer height should

be reduced to compensate for overhangs (False = 0, True = 1)

Input: Adjust Seam: Termite is expecting a number defining the position of the start of the contours (0.00-1.00)

Input: Flip Paths Each Layer: Termite is expecting a boolean value whether or not to flip all printing paths of every second layer (False = 0, True = 1)

Input: Join Contours With Stairs: Termite is expecting a boolean value whether or not to join all contours with stairs (False = 0, True = 1)

Input: Stair Length: Termite is expecting a number to define the length in mm of the step connection each contour. When set to "0" no stair is made (0- 500)

Input: ZigZag Amplitude: Termite is expecting a number to define the amplitude of an eventual ZigZag pattern of printing paths. The frequency of the pattern is defined by the Path Resolution (0 - 10)

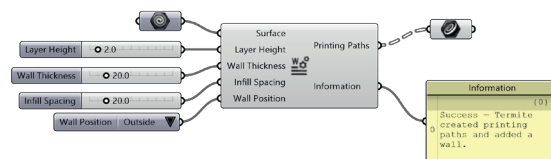
Input: Show Seams: Termite is expecting a boolean value whether or not the printing path seams are displayed in Rhino Viewport (False = 0, True = 1)

Output: Printing Path: Printing Path created by contouring a surface

Output: Targets: List of all targets of each printing path

Output: Information: Information about created printing paths

Termite Create Wall



This component facilitates the quick and automated creation of double-layered walls with zigzag infill structures. Open or closed surfaces can be used as input, and based on the preference, the printing paths can be generated inwards, centered, or outwards to form a wall with the desired thickness. The infill structure significantly enhances stability and enables the production of objects with greater thickness despite a small nozzle diameter.

Description: Termite component creating a ZigZag wall from a given surface

Input: Surface: Termite is expecting a surface, polysurface, or mesh to be transformed into a double-layered wall with a ZigZag infill

Input: Layer Height: Termite is expecting a number in mm defining the layer height of all layers (0.1- 20)

Input: Wall Thickness: Termite is expecting a number in mm defining the wall thickness without the extrusion width being added (0.1- 1000)

Input: Infill Spacing: Termite is expecting a number in mm defining the spacing of the ZigZag infill (0.1- 1000)

Input: Wall Position: Termite is expecting an integer defining the position of the created wall (Inside = 0, Outside = 1, Center = 2)

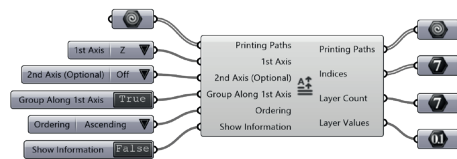
Output: Printing Paths: Printing Paths created by transforming a given surface into a wall

Output: Information: Information about created printing paths

Termite Sort

This category encompasses components exclusively focused on the controlled ordering of inputs such as points, lines, and curves. This step is essential for generating most objects, but it can also serve as an optimization technique in printing by minimizing travel paths. Analogous to components with predefined functions, users have the choice to either manually arrange the printing paths or adopt a sequential methodology established through an alternative approach.

Termite Sort Along Axis



To avoid dependence on manual selection or the chronological sequence of path creation, the practice of sorting a specified quantity of paths along an axis is frequently advantageous. This component streamlines the process of sorting printing paths according to a designated axis. Alternatively, a first procedure of sorting and grouping along a single axis can be followed by a secondary sorting along a second axis within each subgroup. Activation of the optional grouping feature allows for a layer-wise processing of printing paths, thus enabling compatibility with another sorting component. Optionally, the printing paths of every alternate layer can be mirrored to alternate the direction of printing layer by layer. This crisscrossing mitigates twisting or uneven shrinkage during the drying process.

Description: Termite component for sorting printing paths along one or two axes with the option to group equal values along the first axis into individual branches. This component is rounding numbers to 2 digits after comma

Input: Printing Paths: Termite is expecting curves, lines or points as input for printing paths

Input: 1st Axis: Termite is expecting an integer defining which axis to take for sorting (X = 0, Y = 1, Z = 2)

Input: 2nd Axis (Optional): Termite is expecting an optional integer defining which axis to take for consecutive sorting (X = 0, Y = 1, Z = 2, Off = 3)

Input: Group Along 1st Axis: Termite is expecting a boolean value whether or not to group equal values along the first axis into individual branches (False = 0, True = 1)

Input: Ordering: Termite is expecting an integer whether the printing paths get sorted ascending or descending according to their value on a given axis (Ascending = 0, Descending = 1)

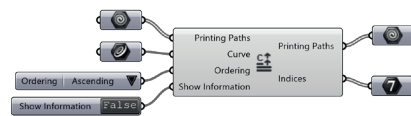
Input: Show Information: Termite is expecting a boolean value whether or not the numbering of the printing paths is displayed in Rhino Viewport (False = 0, True = 1)

Output: Printing Paths: Printing paths sorted along the given axis

Output: Layer Count: Number of individual values along the first axis as integer

Output: Layer Values: Individual values along the first axis as numbers

Termite Sort Along Curve



This component enables sorting along a user-defined curve, allowing printing paths to be ordered based on a specific logic. Be aware that the orientation of the given curve will influence the sorting order.

Description: Termite component for sorting printing paths along a given curve

Input: Printing Paths: Termite is expecting curves, lines or points as input for printing paths

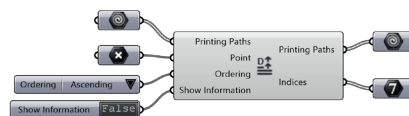
Input: Curve: Termite is expecting a curve to sort printing paths along it

Input: Ordering: Termite is expecting an integer defining whether the printing paths get sorted ascending or descending by the distance from the given point (Ascending = 0, Descending = 1)

Input: Show Information: Termite is expecting a boolean value whether or not to display numbering of the printing paths (False = 0, True = 1)

Output: Printing Paths: Printing Paths sorted along a given curve

Termite Sort By Distance



In situations where sorting is not directed along a particular axis but pertains to scenarios such as a baseplate featuring numerous concentric circles, wherein sorting is requisite from the center outward or vice versa, this component finds utility. It specifies a point from which a given number of printing paths should be sorted either in ascending or descending order based on their distances.

Description: Termite component for sorting printing paths by distance from a given point

Input: Printing Paths: Termite is expecting curves, lines or points as input for printing paths

Input: Point: Termite is expecting a point to measure the distance to each printing path in order to sort them

Input: Ordering: Termite is expecting an integer defining whether the printing paths get sorted ascending or descending by the distance from the given point (Ascending = 0, Descending = 1)

Input: Show Information: Termite is expecting a boolean value whether or not to display numbering of the printing paths (False = 0, True = 1)

Output: Printing Paths: Printing Paths sorted by the distance from a given point

Termite Sort By Length



This straightforward component enables the sorting of printing paths based on their lengths. This can be particularly advantageous when short individual segments (< 5 mm) within a layer are to be printed after longer printing paths. These printing paths, otherwise, suffer from insufficient adhesion to the print bed and detach when the nozzle lifts.

Description: Termite component for sorting printing paths by length

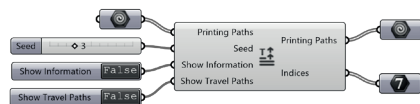
Input: Printing Paths: Termite is expecting curves or lines as input for printing paths

Input: Ordering: Termite is expecting an integer defining whether the printing paths get sorted ascending or descending by length (Ascending = 0, Descending = 1)

Input: Show Information: Termite is expecting a boolean value whether or not to display numbering of the printing paths (False = 0, True = 1)

Output: Printing Paths: Printing Paths sorted by length

Termite Sort By Travel Path



This component employs a basic Traveling Salesman Algorithm to sort a given number of printing paths in a manner that minimizes the total length of travel paths needed to print them. Although it does not provide a guarantee of achieving an optimally arranged configuration, several internal iterations of the algorithm are adequate to yield an approximate reduction of about 70% in the average length of travel paths. Additionally, like most other components, this component allows a grouped input, enabling path optimization on a layer-by-layer basis. This is also advantageous for the material flow, as it reduces interruptions that could lead to material separation (water being squeezed out). In general, a more continuous and consistent flow of material during printing results in a more homogeneous extrusion.

Description: Termite component for sorting printing paths or points with a shortest possible total travel path by using a basic Traveling Salesman Algorithm

Input: Printing Paths: Termite is expecting curves, lines or points as input for printing paths

Input: Seed: Termite is expecting an integer to select different approaches for nesting (0-10)

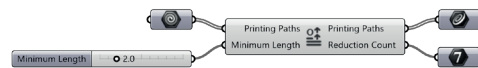
Input: Show Information: Termite is expecting a boolean value whether or not the numbering of the printing paths is displayed in Rhino Viewport (False = 0, True = 1)

Input: Show Travel Paths: Termite is expecting a boolean value whether or not the travel paths between each printing paths are displayed in Rhino Viewport (False = 0, True = 1)

Output: Printing Paths: Printing Paths sorted by the shortest travel paths

Output: Indices: List of indices as integers after optimization for eventual synchronisation of additional data

Termite Sort Out by Length



Diverging from the conventional practices within this category, this component departs from the act of sorting printing paths. Instead, the component excludes those paths whose length is less than a specific predetermined threshold. This becomes particularly helpful when contouring complex geometric shapes results in very short printing paths. Paths shorter than the nozzle diameter are not printable with accuracy. Further, segments that are too short to be seen in the viewport of Rhino, will still contribute to increased print time due to extra travel paths. This component allows the rapid removal of such impractical printing paths.

Description: Termite component for sorting out printing paths by length

Input: Printing Paths: Termite is expecting curves or lines as input for printing paths

Input: Minimum Length: Termite expecting a number defining the minimum length in mm of a printing path

Output: Printing Paths: Printed paths minus the ones sorted out by length

Output: Reduction Count: Count of paths being sorted out by length

Termite Display

This final category consists of three components focused on the reconstruction and visualization of existing G-codes. They serve as help and verification tools.

Termite Display Clipping Planes



This component enables quick and easy activation of two standard Rhino clipping planes in the Rhino viewport. By specifying upper and lower Z values, a horizontal section of the design can be visually isolated, making it easier to inspect specific layers when working with large or complex printing paths.

Description: Termite component for displaying a simulation of the printing procedure in order to check for eventual collisions (Grasshopper Trigger component needed for Animation)

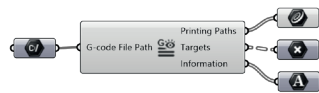
Input: Activate Clipping Planes: Termite is expecting a boolean value whether or not to activate the clipping planes in Rhino Viewport (False = 0, True = 1)

Input: Upper Z Height: Termite is expecting a number defining the Z value of the upper clipping plane (0.1- 1000)

Input: Lower Z Height: Termite is expecting a number defining the Z value of the lower clipping plane (0.1- 1000)

Output: Information: Information about the created clipping planes

Termite Display G-code



This component reconstructs G-codes previously generated with *Termite* into Rhino-compatible geometry. Essentially, it provides a precise reversal of the Main G-code Generator. This can prove useful in scenarios where the original Rhino file is lost over time, but the .gcode file remains accessible.

Description: Termite component for displaying and reconstructing the printing paths of a given .gcode file that was previously generated by Termite

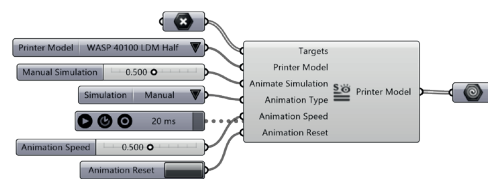
Input: G-code File Path: Termite is expecting a .gcode file path previously generated by Termite

Output: Printing Paths: Printing paths reconstructed by reading a given .gcode file

Output: Targets: List of printing path targets with each printing path having its own branch of data

Output: Information: Information summarising various printing parameters

Termite Display Simulation



This component is typically located at the very end of a Grasshopper definition generated with *Termite*. It employs the Targets output from the Main G-code Generator as input. Each individual target within the G-code can be moved to, simulating the extruder's position as well as the three axes of the Delta printer at every point in the G-code. This is particularly valuable for identifying potential collisions with previously printed paths or supporting objects. Furthermore, in a final step, the printing paths can be reviewed in terms of order and orientation. A Grasshopper Trigger component is necessary to automate the animation process.

Description: Termite component for displaying a simulation of the printing procedure in order to check for eventual collisions (Grasshopper Trigger component needed for Animation)

Input: Targets: Termite is expecting points provided by the Targets output of the Termite G-code Generator

Input: Printer Model: Termite is expecting an integer choosing which printer to work with (WASP 40100 LDM half = 0, WASP 40100 LDM Full = 1, Delta WASP 2040 Clay = 2, Shapelab Argos 140180 = 3)

Input: Simulation Position: Termite is expecting a number to display a specific frame of the simulation (0.0- 1.0)

Input: Simulation Type: Termite is expecting a boolean value to switch between manual and animated simulation (Grasshopper Trigger component needed)

Input: Animation Speed: Termite is expecting a number defining the speed of the animation (0- 1) (Grasshopper Trigger component needed)

Input: Animation Reset: Termite is expecting a boolean value whether or not the animation will be reset (False =

0, True = 1) (Grasshopper Trigger component needed)

Output: Printer Model: Breps containing the printer model at a given position of the printing procedure

Termite Example

This category includes two components that, when dropped into the Grasshopper canvas, automatically open Termite Example File 1 of 2 or Termite Example File 2 of 2 in a new Grasshopper tab. The same example files are also available in the user-defined directory after installation. It is recommended to begin each Termite workflow with a fresh copy of Termite Example File 1 of 2, as it contains all relevant inputs and outputs of the components, enabling a streamlined workflow.

Termite 1.4 - Software License Agreement

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This software has been developed by a researcher working at IAM (Institute of Architecture and Media).
Institute of Architecture and Media (IAM), Kronesgasse 5/3, 8010 Graz, Austria

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