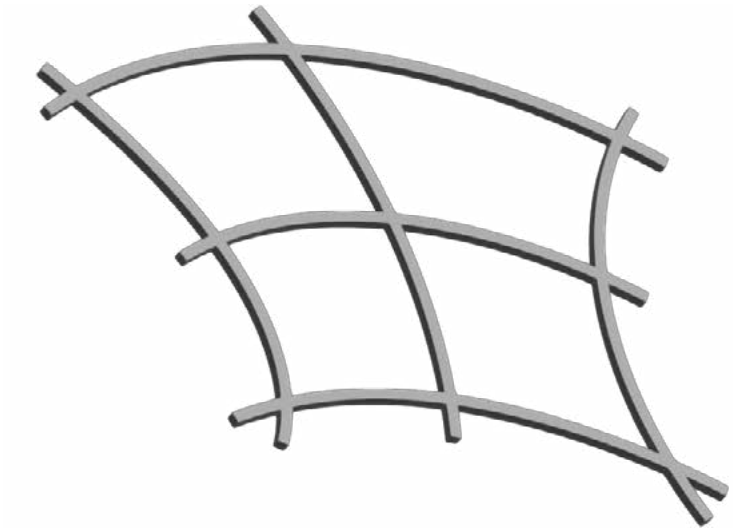


ERod

PHYSICS

ERod_1.1.0

Documentation

ERod

ERod is an open-source Grasshopper plugin for Rhino that enables designers and engineers to create and simulate X-shells [1], C-shells [2], and curved woven [3] structures. By employing the Discrete Elastic Rods model [4], ERod provides a physics-based modeling environment that accurately represents elastic beam behavior during deformation and deployment.

Key Features:

- Physics-Based Simulation: Simulate the behavior of elastic beams, facilitating the design of structures that rely on elastic deformation for form and stability.
- Forward Design Tools: Offers intuitive components for designing and modeling X-shells, C-shells, and curved woven structures within the Grasshopper environment, allowing for real-time exploration and iteration.
- Integration with Inverse Design Optimization: Prepares and exports necessary data for inverse design optimizations via Jupyter notebooks, enabling users to refine and optimize their designs based on specific performance criteria.
- Seamless Workflow: Ensures a smooth transition from conceptual design to simulation and optimization, streamlining the development process of complex elastic structures.

Erod runs on Apple Silicon Chips and Rhino 8 for Mac.

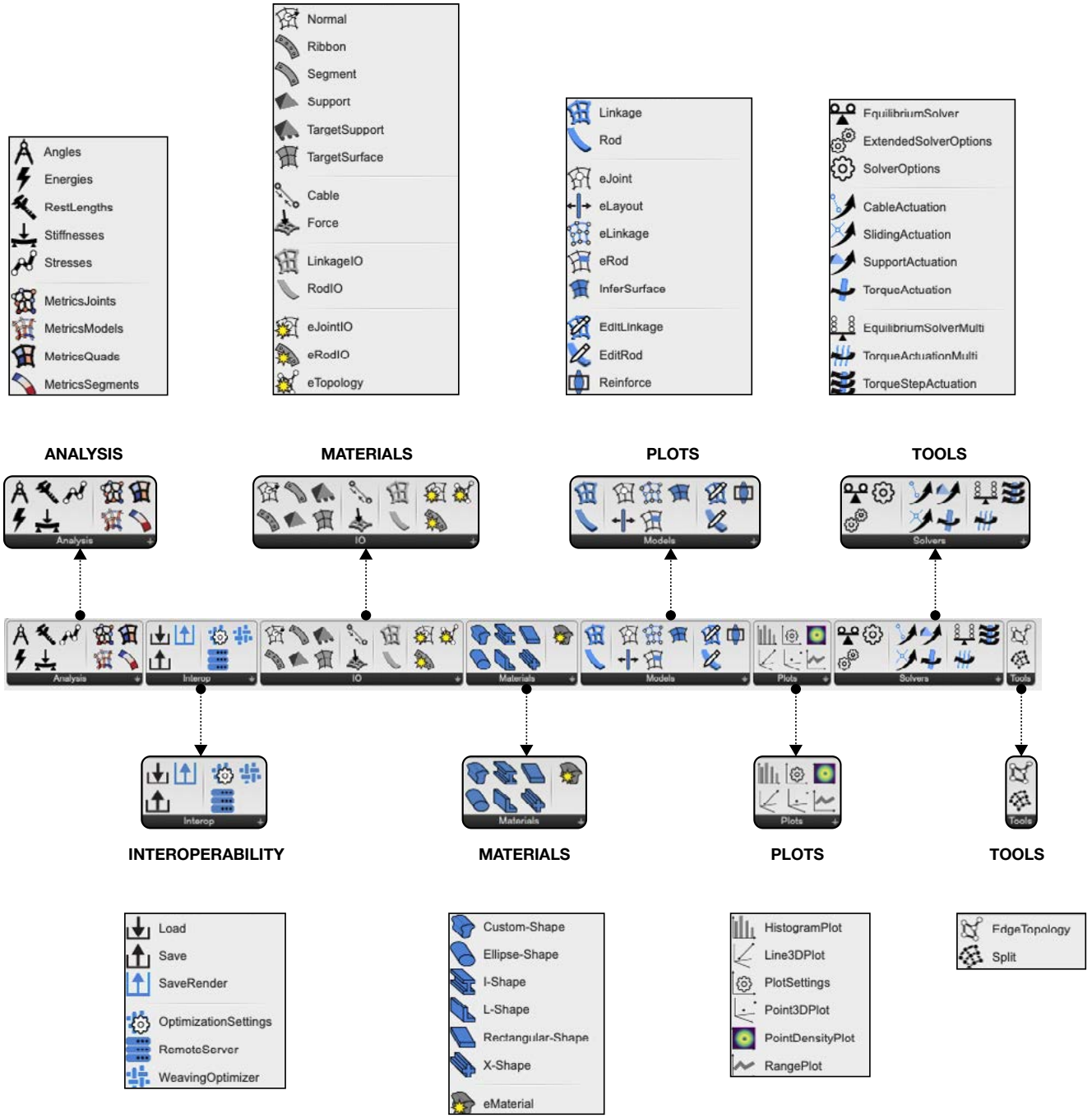
REFERENCES

[1] J. Panetta, M. Konaković-Luković, F. Isvoranu, E. Bouleau, and M. Pauly. 2019. X-Shells: a new class of deployable beam structures. ACM Trans. Graph. 38, 4, Article 83 (August 2019), 15 pages. https://doi.org/10.1145/3306346.3323040

[2] Quentin Becker, Seiichi Suzuki, Yingying Ren, Davide Pellis, Julian Panetta, and Mark Pauly. 2023. C-Shells: Deployable Gridshells with Curved Beams. ACM Trans. Graph. 42, 6, Article 173 (December 2023), 17 pages. https://doi.org/10.1145/3618366

[3] Yingying Ren, Julian Panetta, Tian Chen, Florin Isvoranu, Samuel Poincloux, Christopher Brandt, Alison Martin, and Mark Pauly. 2021. 3D weaving with curved ribbons. ACM Trans. Graph. 40, 4, Article 127 (August 2021), 15 pages. https://doi.org/10.1145/3450626.3459788d

[4] Miklós Bergou, Max Wardetzky, Stephen Robinson, Basile Audoly, and Eitan Grinspun. 2008. Discrete elastic rods. ACM Trans. Graph. 27, 3 (August 2008), 1–12. https://doi.org/10.1145/1360612.1360662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Stiffnesses
Stresses
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MetricsModels
MetricsQuads
MetricsSegments
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Ribbon
Segment
Support
TargetSupport
TargetSurface
Cable
Force
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RodIO
eJointIO
eRodIO
eTopology
Linkage
Rod
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RangePlot
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Split

EROD COMPONENTS

Analysis (Mac)

	1	**Angles**	Compute the minimum, maximum, and average joint angles of the linkage.
	2	**Energies**	Computes the energies of an elastic rod or linkage.
	3	**RestLengths**	Compute the minimum, maximum, average and total rest-lengths of the linkage.
	4	**Stiffnesses**	Computes the stiffness of an elastic rod or linkage.
	5	**Stresses**	Computes the stresses of an elastic rod or linkage.
	6	**MetricsJoints**	Calculates and visualizes the joint metrics of a linkage using their angles.
	7	**MetricsQuads**	Calculates and visualizes the quad metrics of a linkage using their areas.
	8	**MetricsSegments**	Calculates and visualizes the segment metrics of a linkage using their rest quantities.
	9	**MetricsModels**	Calculates and visualizes the metrics of an elastic model using their stresses.

Interoperability (Windows/Mac)

	10	**Load**	Load a JSON file with input data to build an elastic model.
	11	**Save**	Write a JSON file with input data to run a Jupyter notebook.
	12	**SaveRender**	Write a JSON file with data for rendering.

	13	**OptimizationSettings**	Transfinite constraints to explicitly defined a structured distribution of an n-number of vertices on a given curve.
	14	**RemoteServer**	Set the credentials for connecting to a remote server for running optimization tasks. Ensure that the server has an instance of the optimization code already deployed.
	15	**WeavingOptimizer**	Weaving optimizer running on a remote server.

IO (Windows/Mac)

	16	**Normal**	Set a vector to be the normal of a joint.
	17	**Ribbon**	Build a ribbon from a curve with parameters to define the joints.
	18	**Segment**	Build a segment of a ribbon from a curve.
	19	**Support**	Set support condition using a reference point.
	20	**TargetSupport**	Set a target surface mesh to attract the linkage.
	21	**TargetSurface**	Set a target surface from a mesh to attract the linkage.
	22	**Cable**	Compute forces excerted by an elastic cable.
	23	**Force**	Set a vector to act as an external force on the model.
	24	**LinkageIO**	Assemble all input data to construct an elastic linkage.
	25	**RodIO**	Assemble all input data to construct an elastic rod.
	26	**eJointIO**	Deconstruct JointIO data.

	**27**	**eRodIO**	Deconstruct an elastic rod or a rod segment from a linkage.
	**28**	**eTopology**	Deconstruct the topology of a linkage.
		Cross-Sections (Windows/Mac)	
	**29**	**Custom-Shape**	Build a cross-section using a custom profile.
	**30**	**Ellipse-Shape**	Build a circular cross-Section.
	**31**	**I-Shape**	Build a cross-section using an I profile.
	**32**	**L-Shape**	Build a cross-section using an L profile.
	**33**	**Rectangular-Shape**	Build a cross-section using a rectangular profile.
	**34**	**X-Shape**	Build a cross-section using an X profile.
	**35**	**eMaterial**	Analyze a cross-section
		Model (Mac)	
	**36**	**Linkage**	Construct an elastic linkage.
	**37**	**Rod**	Construct an elastic rod.
	**38**	**eJoint**	Deconstruct a joint from a linkage.
	**39**	**eLayout**	Extract the layout of ribbon families (if they exist) from an elastic linkage
	**40**	**eLinkage**	Deconstruct an elastic linkage.

	41	**eRod**	Deconstruct an elastic rod or a rod segment from a linkage.
	42	**InferSurface**	Construct a surface that best fits the deployed geometry of an elastic linkage.
	43	**EditLinkage**	Modify an elastic linkage.
	44	**EditRod**	Modify an elastic rod.
	45	**Reinforce**	Adjust the bending and twisting stiffness within specified regions.

Solvers (Mac)

	46	**EquilibriumSolver**	Equilibrium solver.
	47	**ExtendedSolverOptions**	Extended Newton solver options.
	48	**SolverOptions**	Newton solver options.
	49	**CableActuation**	Deployment via cable actuation (WIP).
	50	**SlidingActuation**	Linkage deployment via sliding actuation at selected joints.
	51	**SupportActuation**	Deployment via support actuation.
	52	**TorqueActuation**	Linkage deployment via torque actuation.
	53	**EquilibriumSolverMulti**	Equilibrium solver for multiple models.
	54	**TorqueActuationMulti**	Deployment via torque actuation for multiple models.

	**55**	**TorqueStepActuation**	Linkage deployment via torque actuation at joints. This solver generates a copy of the linkage at each deployment step.
		Plots (Windows/Mac)	
	**56**	**HistogramPlot**	Creates a histogram chart .
	**57**	**Line3DPlot**	Creates a line 3D plot.
	**58**	**PlotSettings**	Graph plotter Settings.
	**59**	**Point3DPlot**	Creates a three-dimensional point chart.
	**60**	**PointDensityPlot**	Creates a point density plot which combines a scatter plot and a histogram with 2d contours.
	**61**	**RangePlot**	Creates a chart to indicate some property of data that lies in a certain range around a central value.
		Tools (Windows/Mac)	
	**56**	**EdgeTopology**	Build the topology of a collection of curves.
	**57**	**Split**	Split curves by computing the intersection of multiple curves.