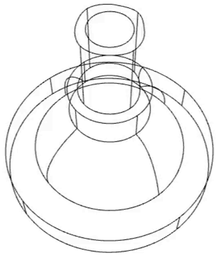
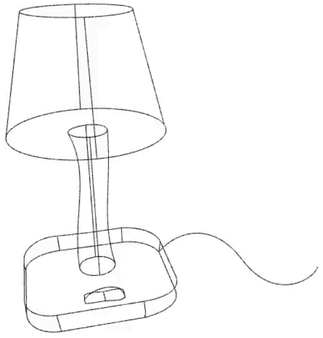
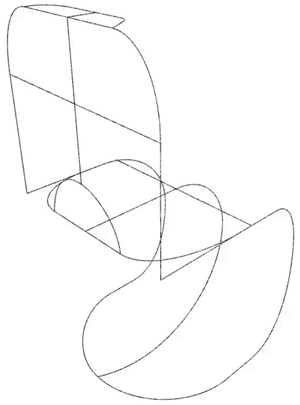
ScaffoldSketch

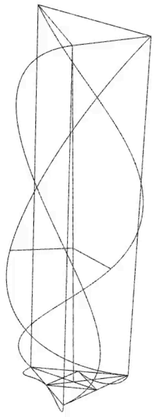
Accurate Industrial Design Drawing in VR

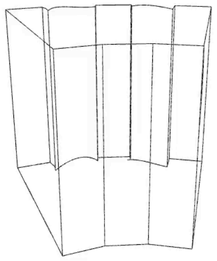
Xue Yu	George Mason University
Stephen DiVerdi	Adobe Research
Akshay Sharma	Virginia Tech, Iowa State University
Yotam Gingold	George Mason University

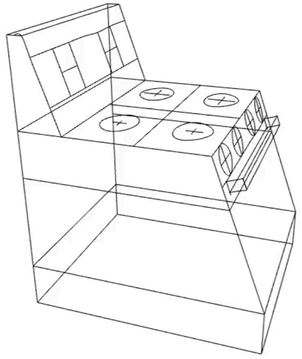


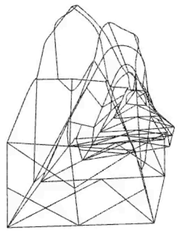


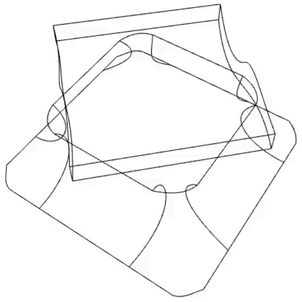


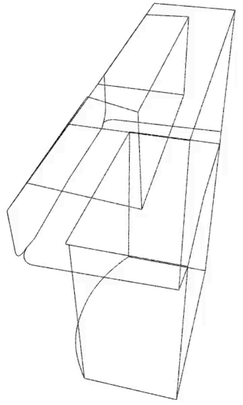


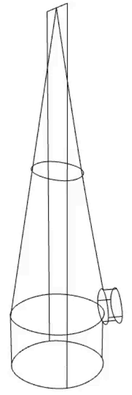


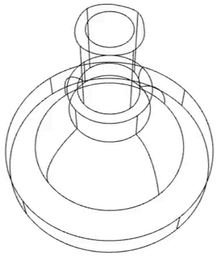


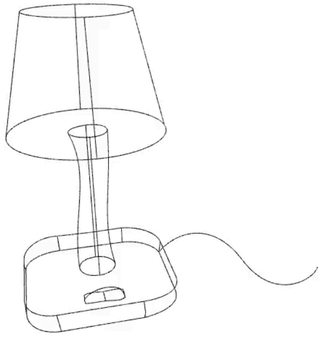


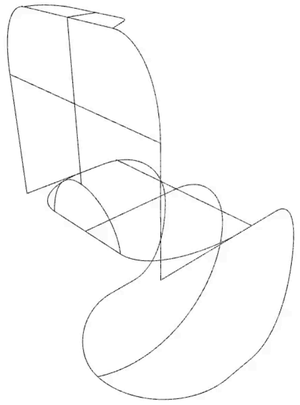


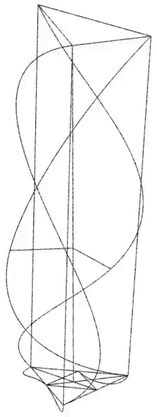


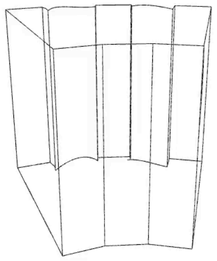


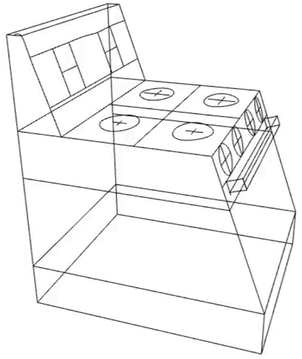


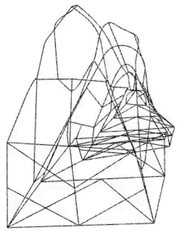


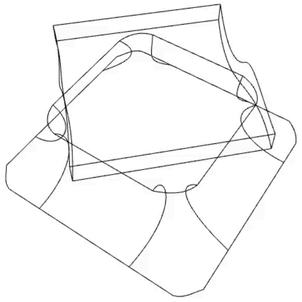


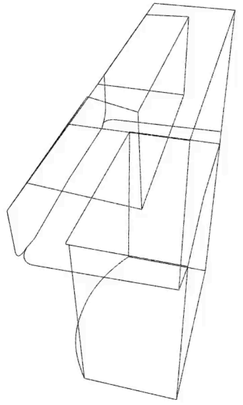


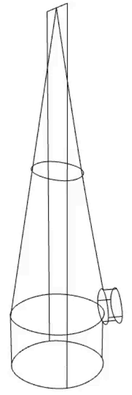












Drawing in VR is direct yet inaccurate

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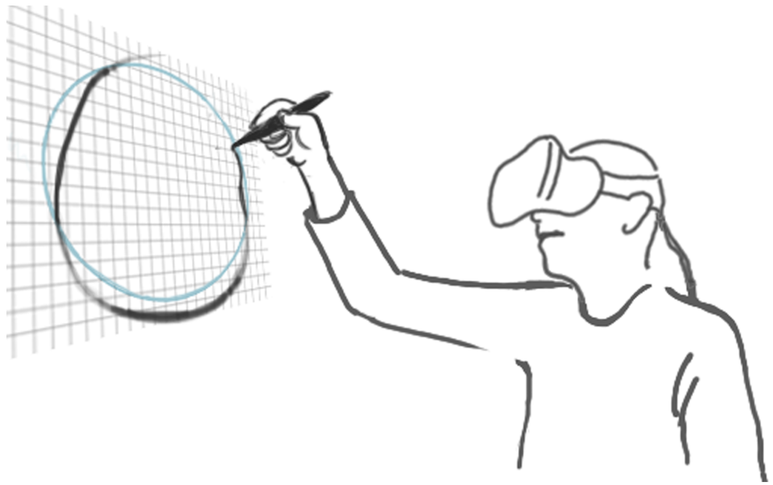
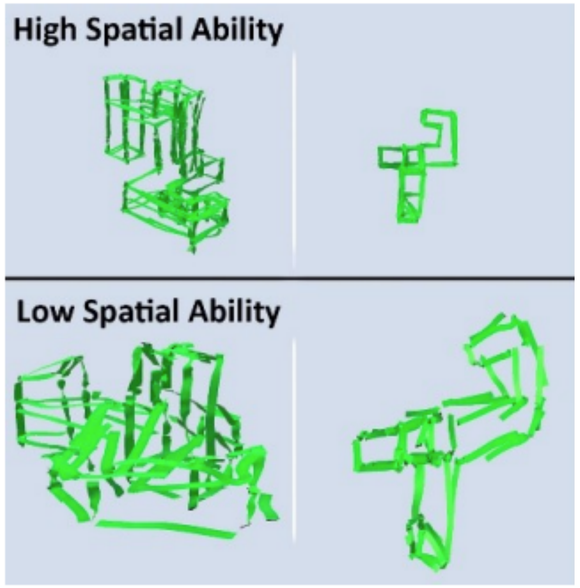
Related Work: 3D Drawing Accuracy



[Arora, Kazi, Anderson, Grossman, Singh, and Fitzmaurice 2017]



[Machuca, Stuerzlinger, and Asente 2019]

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Product designers draw accurately in 2D with scaffolds

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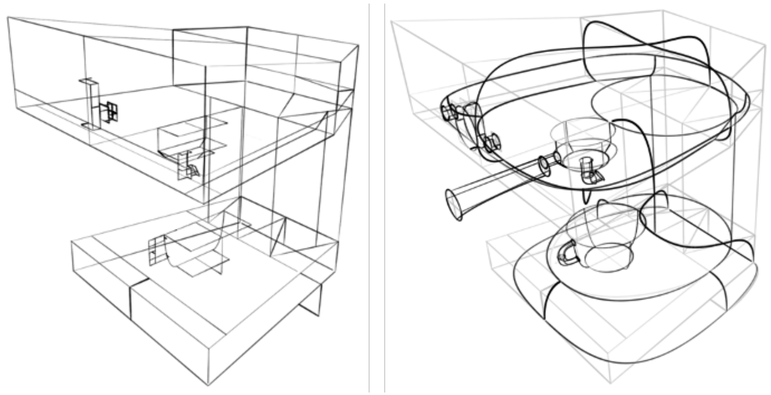
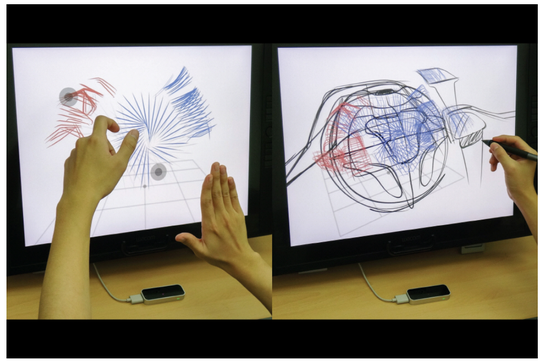
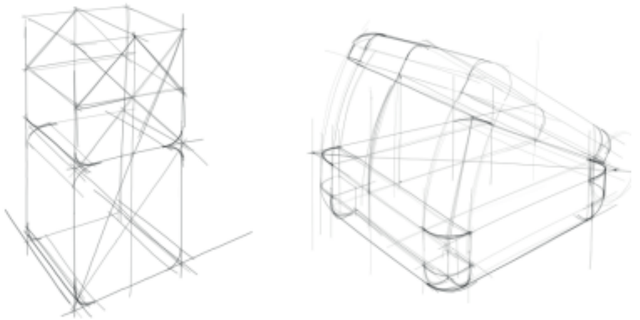
Related Work: Interpreting Scaffolds



[Schmidt, Khan, Singh, and Kurtenbach 2009]

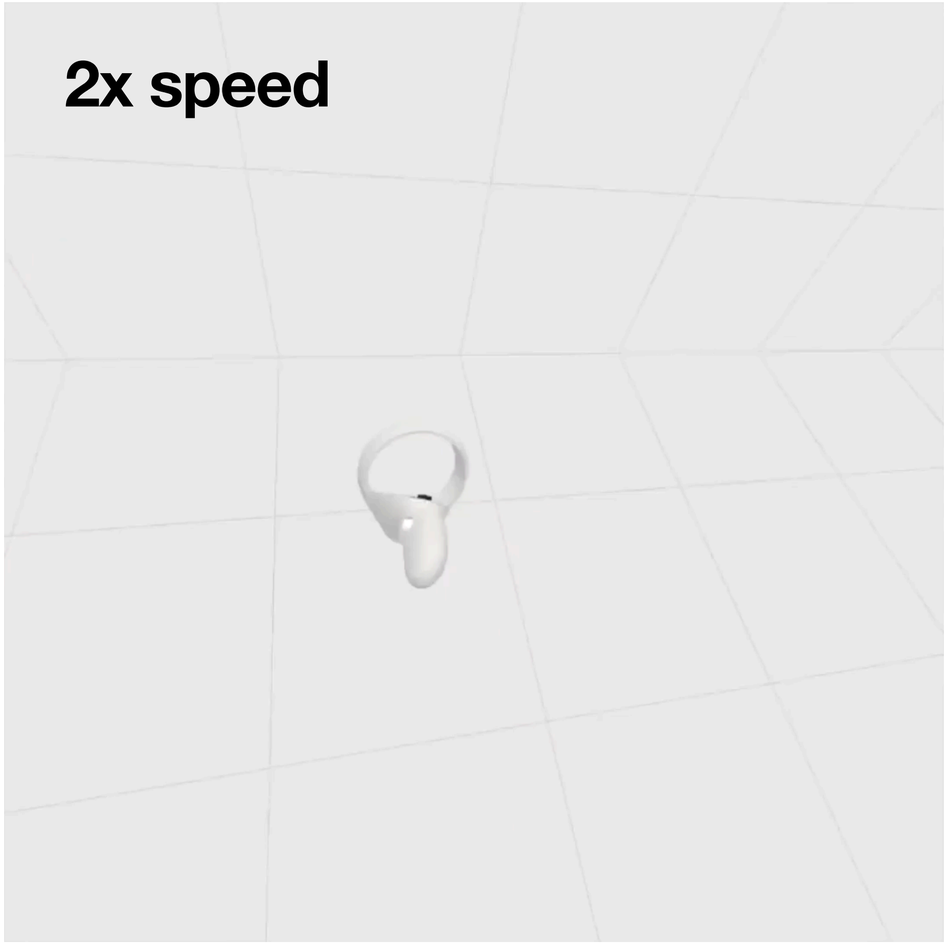


[Kim, An, Singh, Lee, and Bae 2018]



[Gryaditskaya, Sypesteyn, Hoftijzer, Pont, Durand, and Bousseau 2019]

Drawing scaffolds in VR doesn’t solve accuracy



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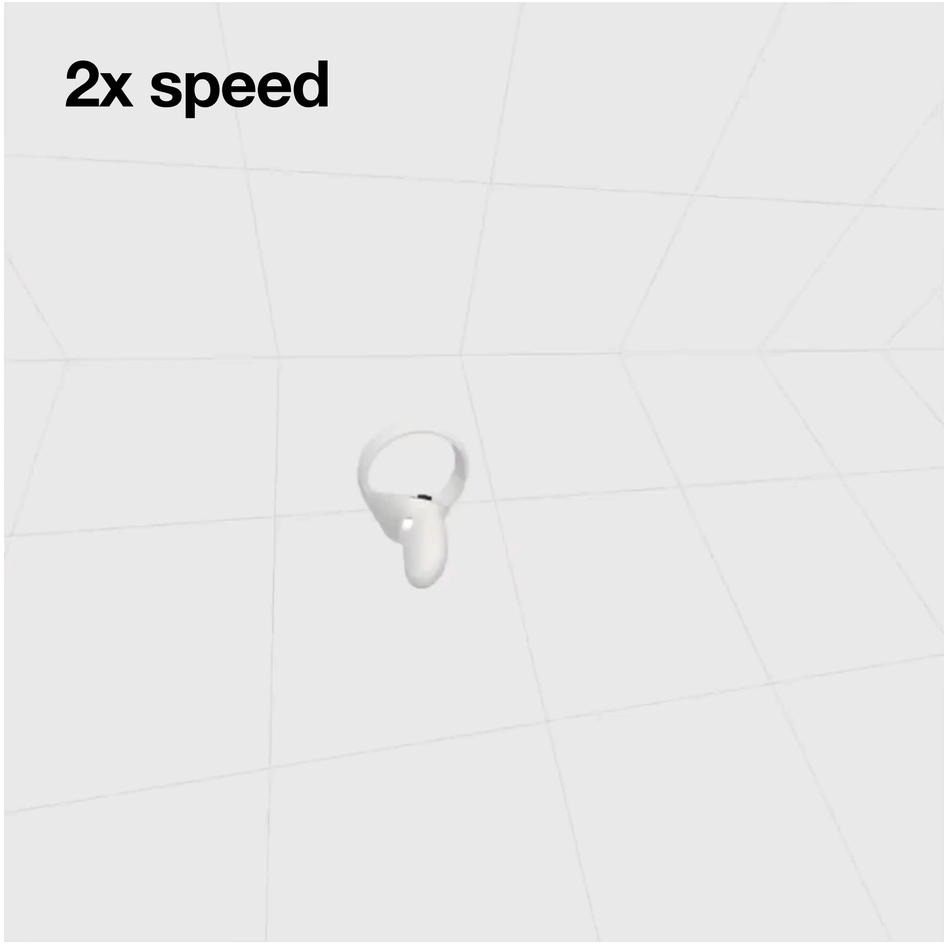

There is enough structure in scaffold and shape strokes to auto-correct

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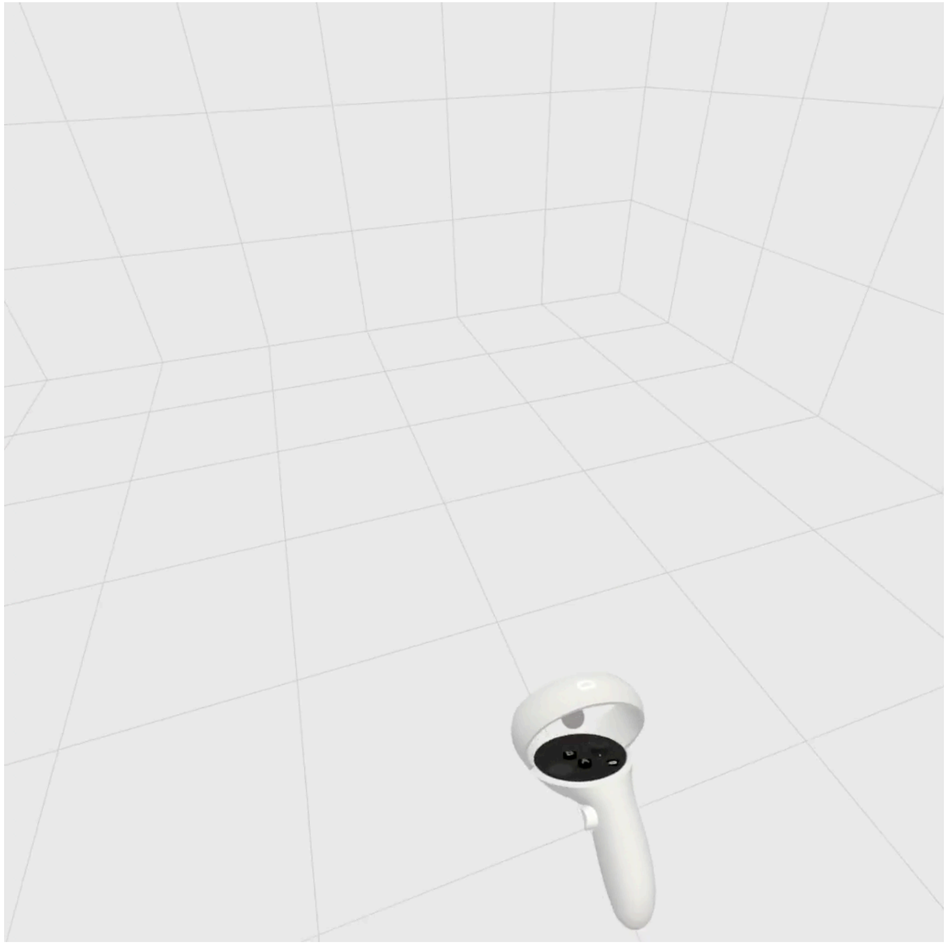
Scaffolds are straight lines with special relationships



- Attach at endpoints
- Parallel
- Perpendicular
- Same Length

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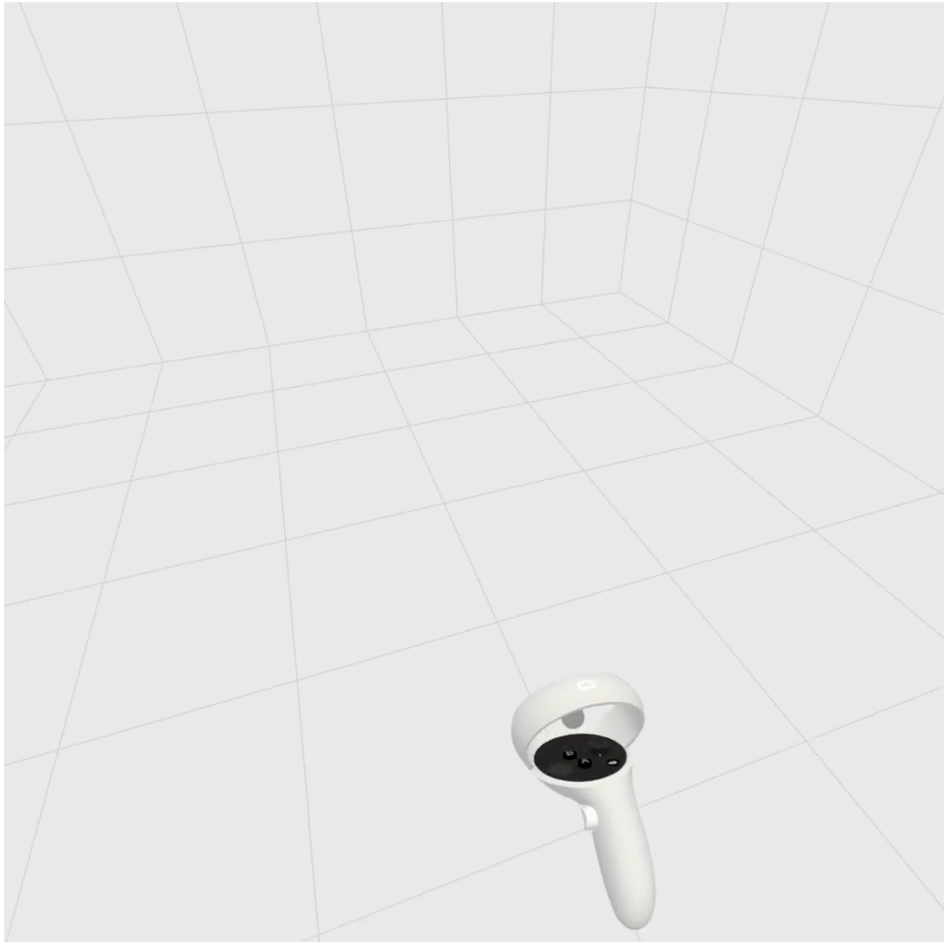

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Auto-Correcting Scaffolds

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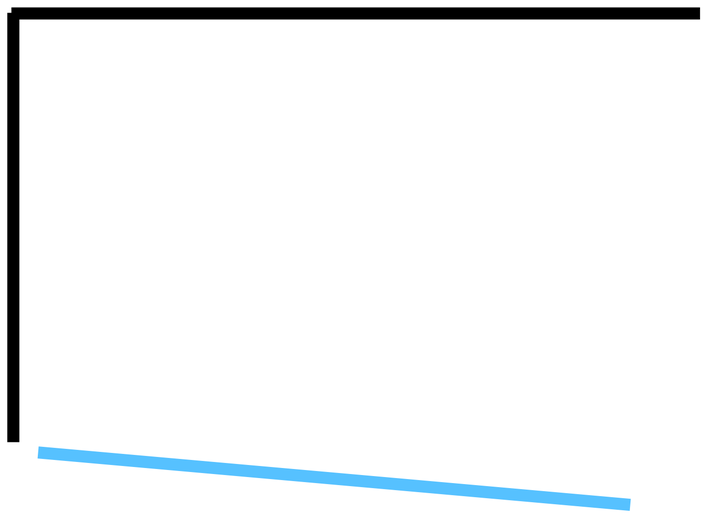

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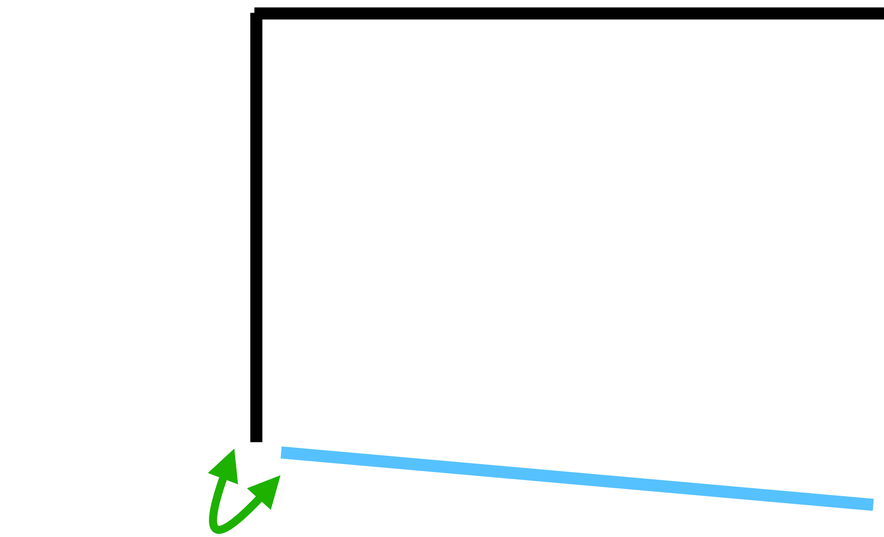

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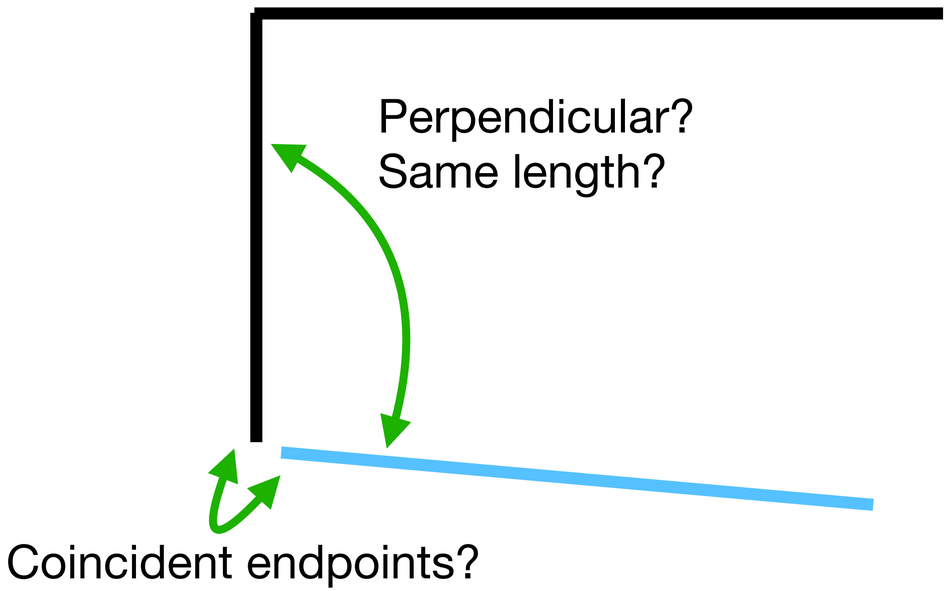

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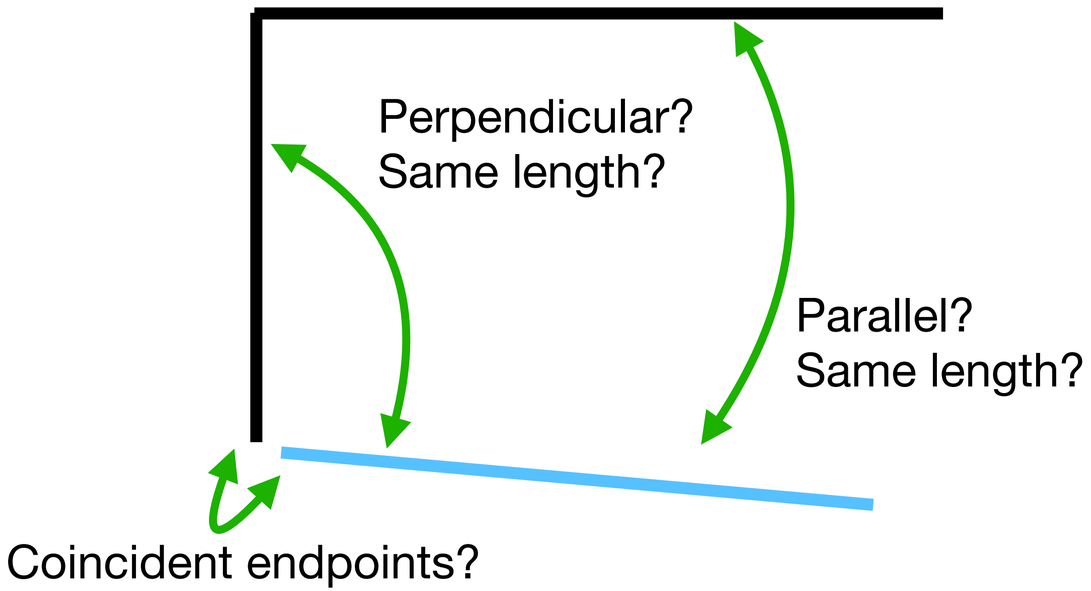

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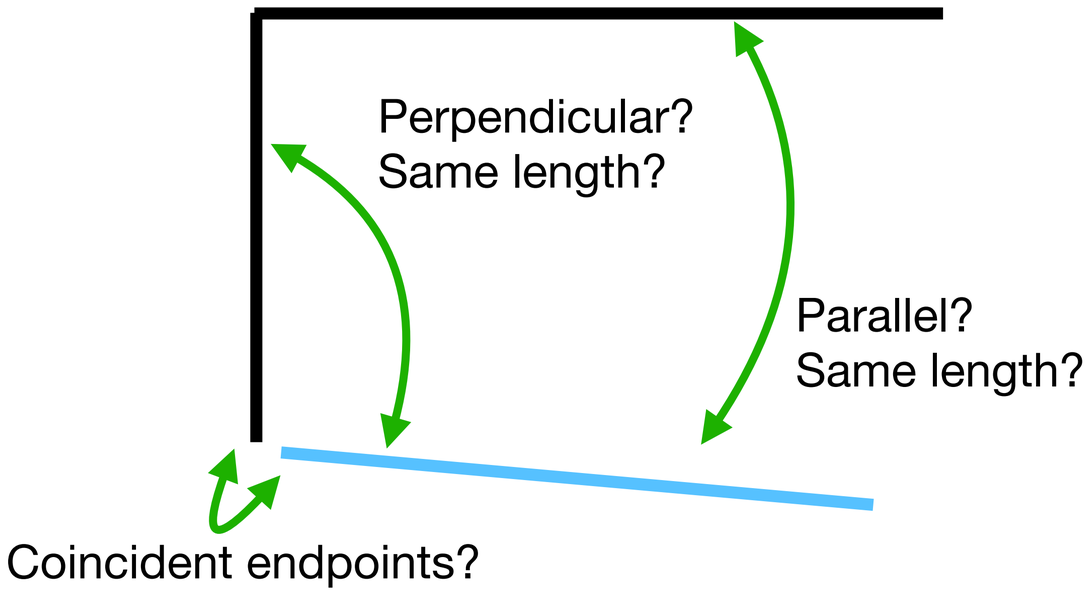
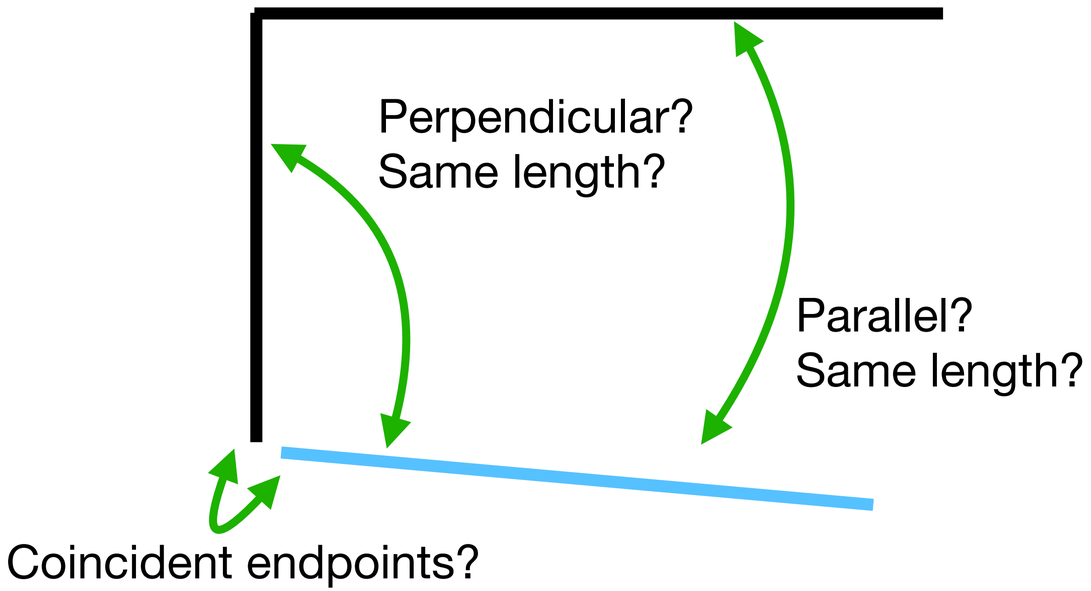


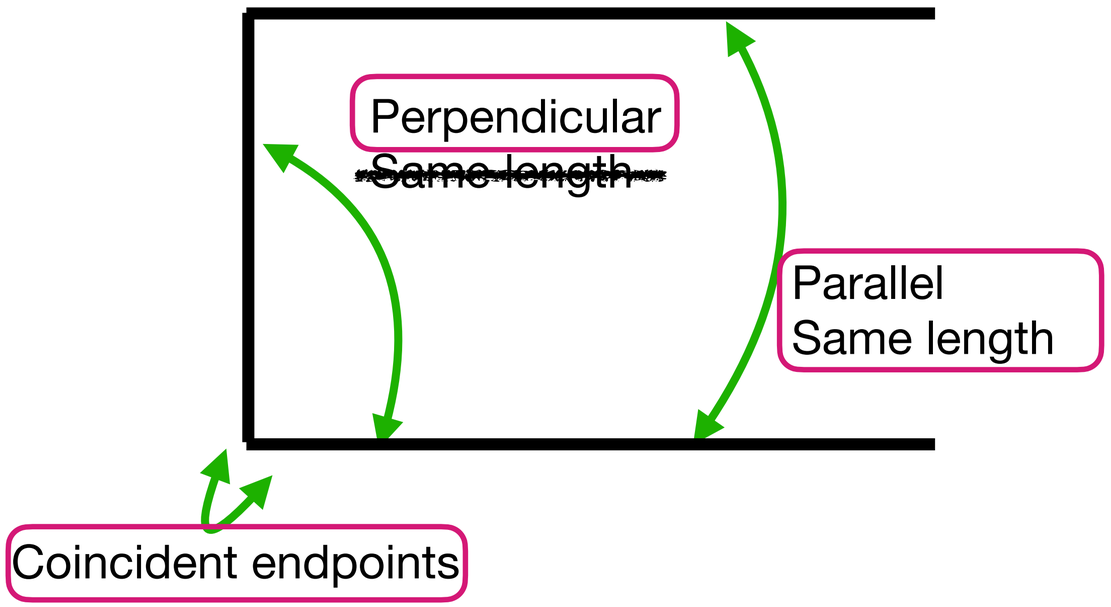
- Relationships may conflict with each other.

Auto-Correcting Scaffolds



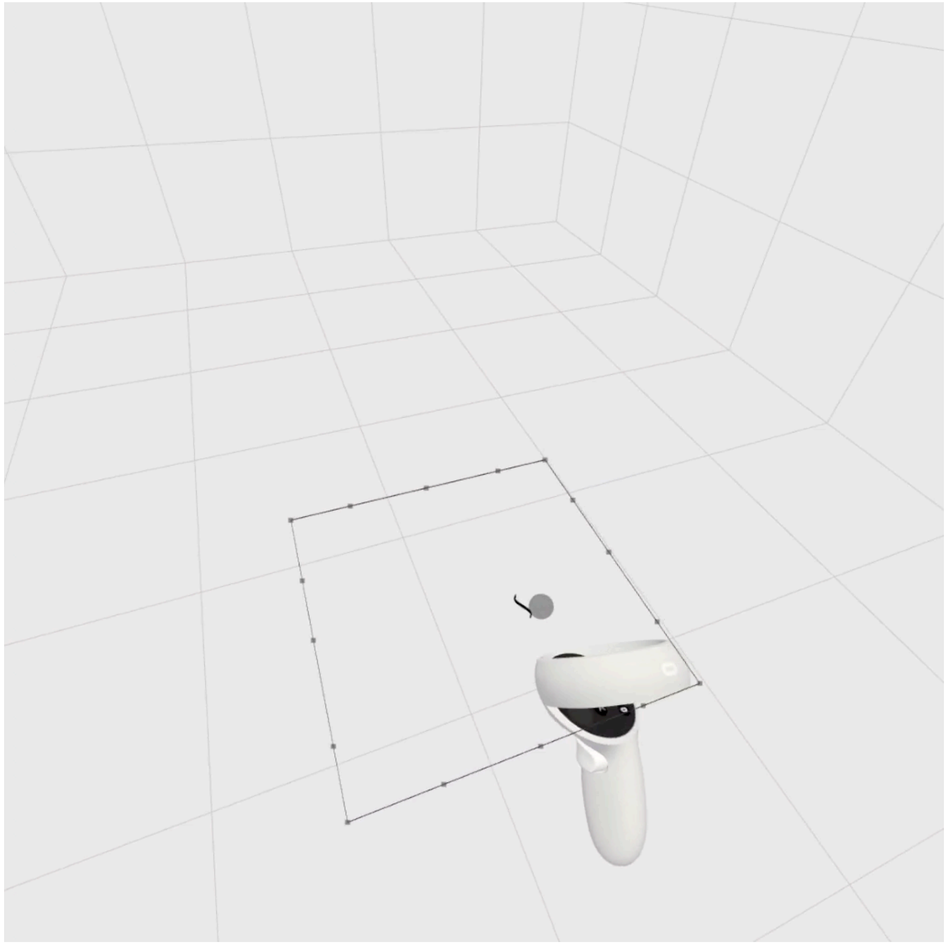
- Relationships may conflict with each other.
- Previous attempts to resolve conflicts often use heuristics or don’t satisfy any.

Auto-Correcting Scaffolds



- Relationships may conflict with each other.
- Previous attempts to resolve conflicts often use heuristics or don’t satisfy any.
- We resolve with an iteratively re-weighted least squares scheme.

Shape strokes attach to scaffolds



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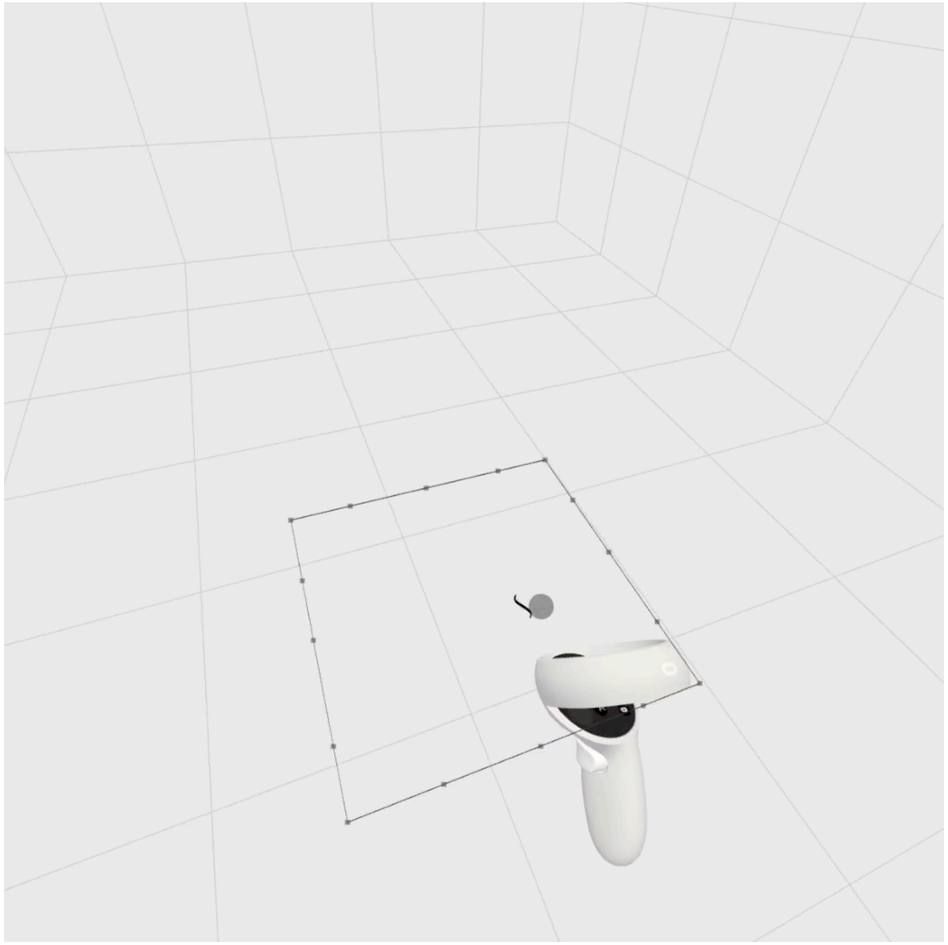
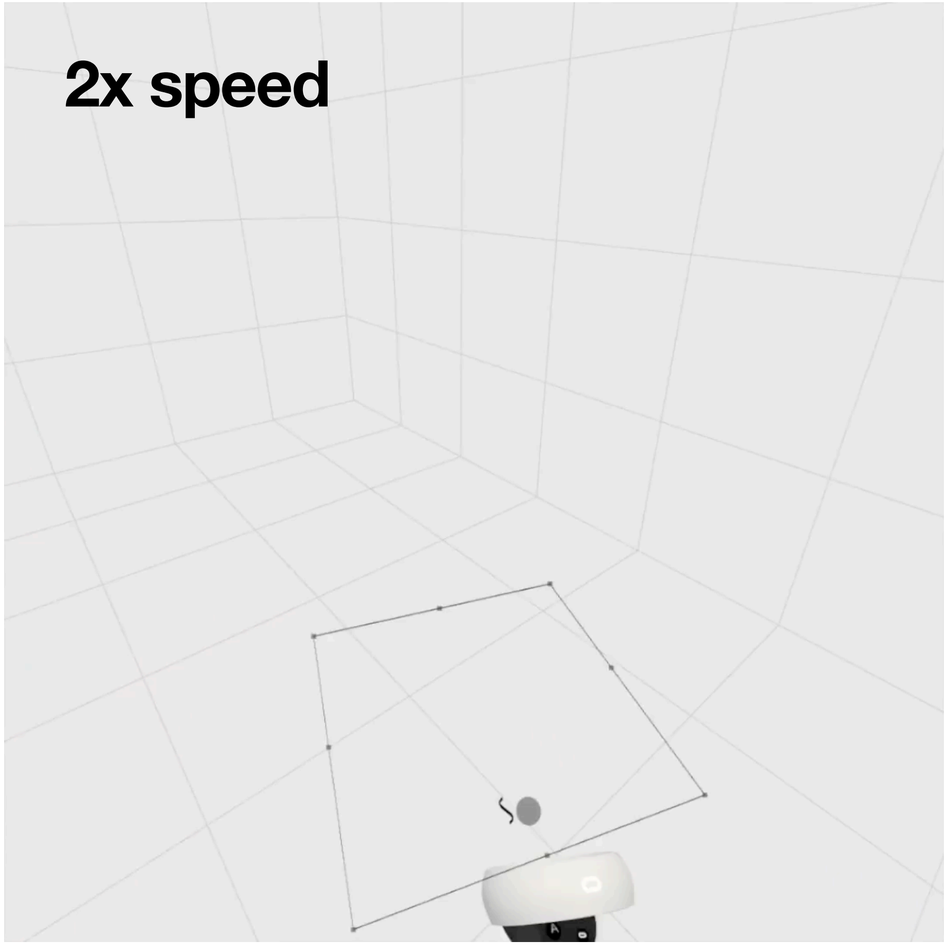


Same scaffold, different shape strokes



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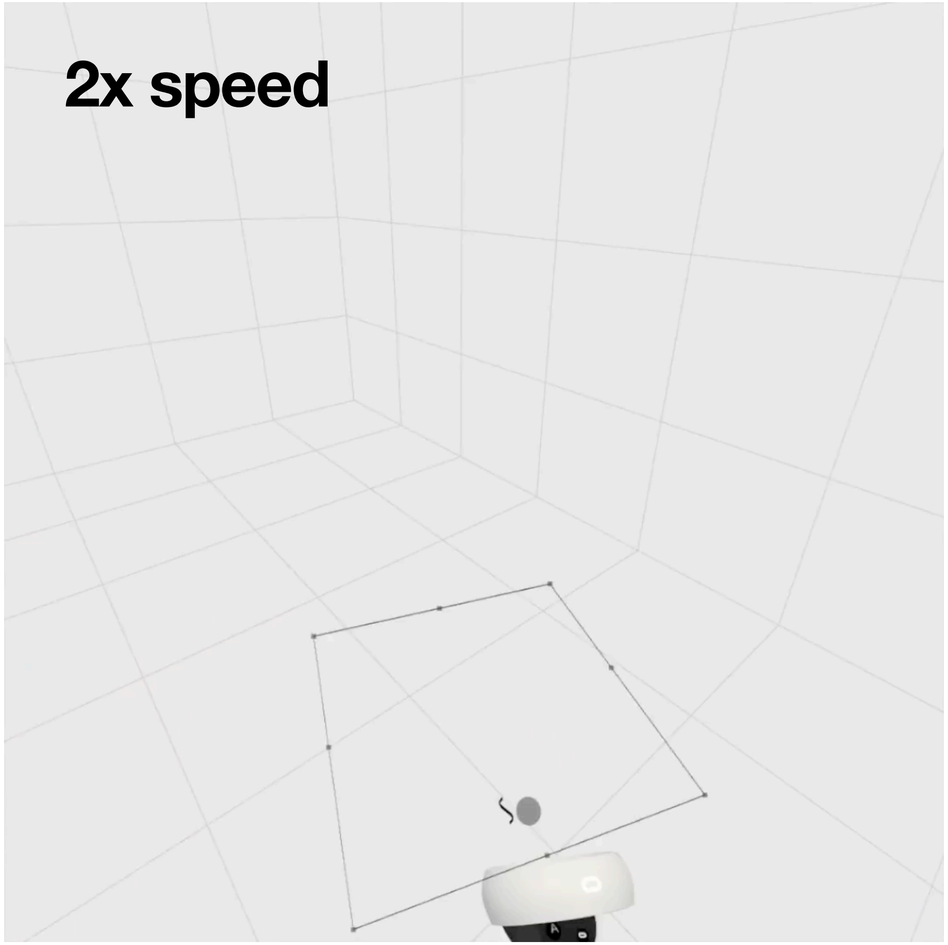
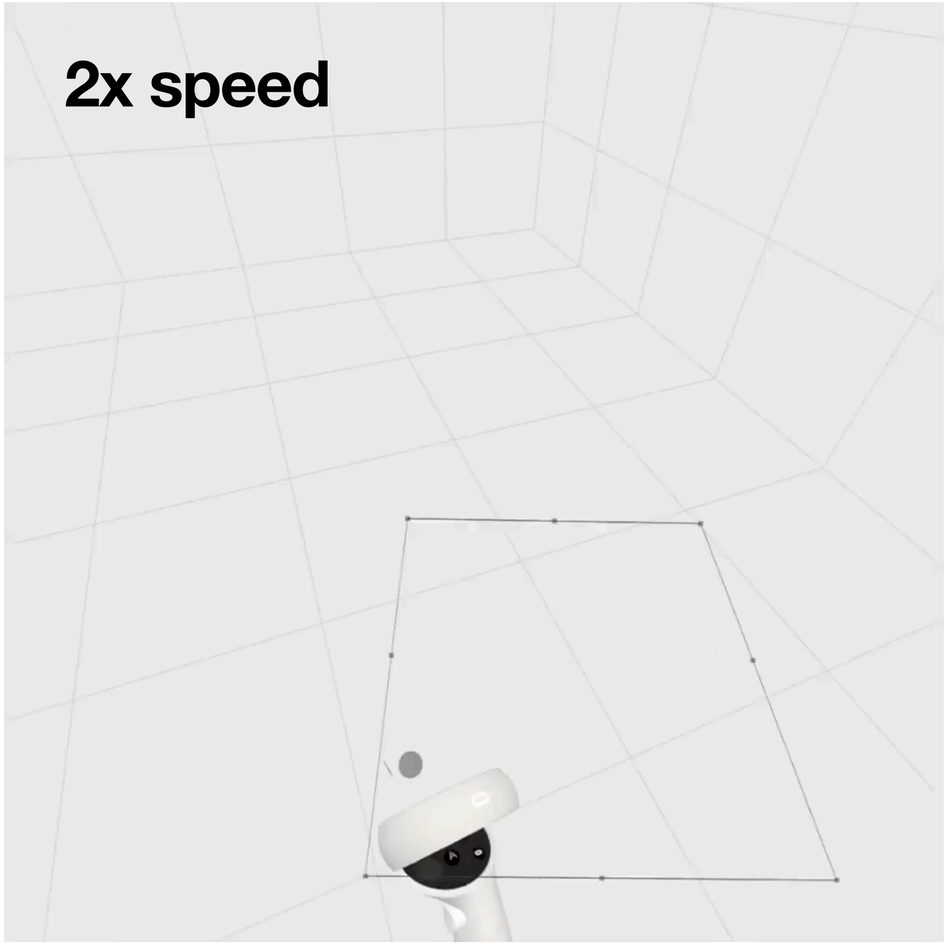


Space curves

Space curves

Tick marks



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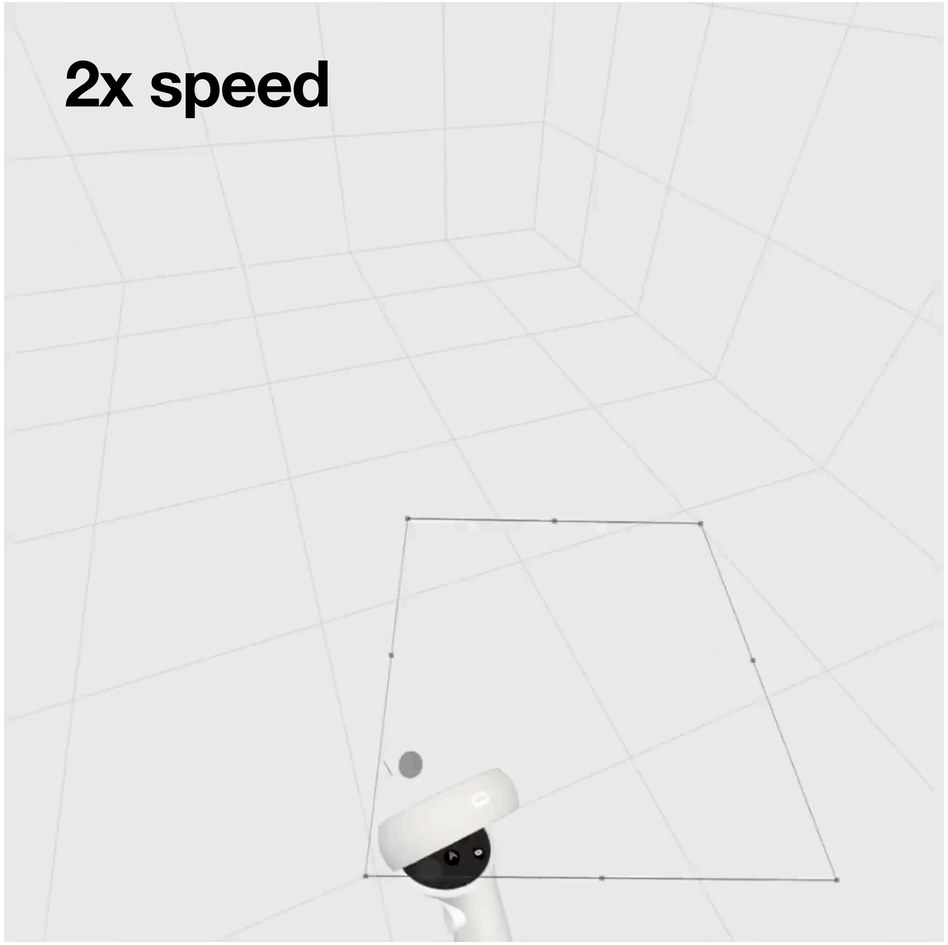
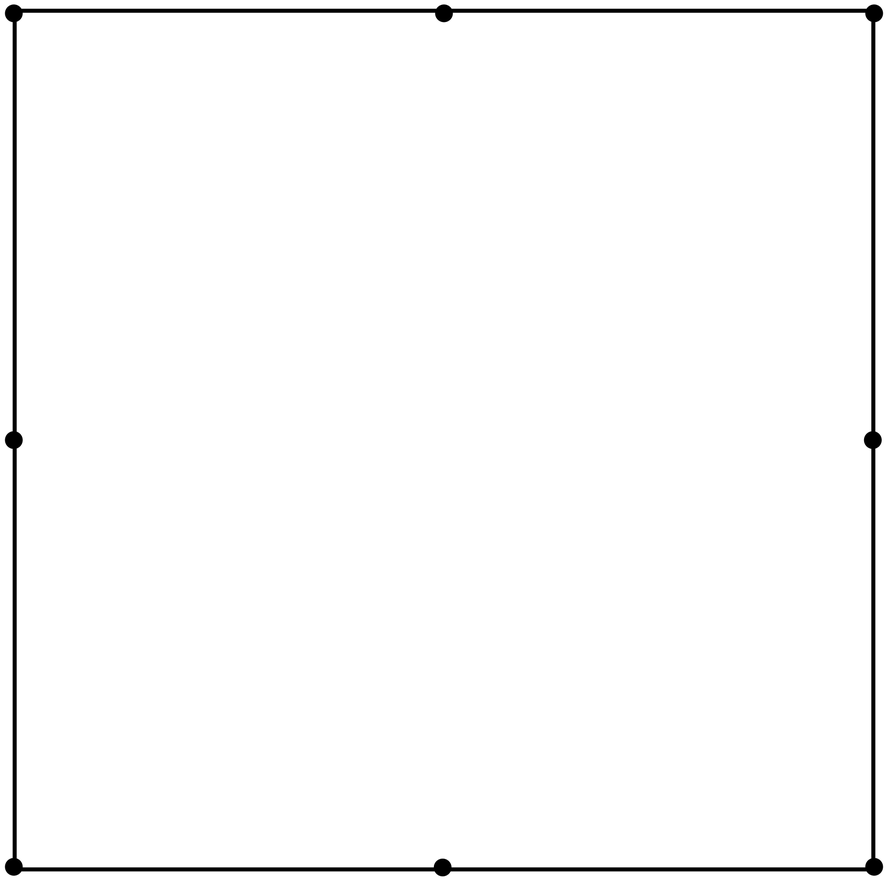


Auto-Correcting Shapes



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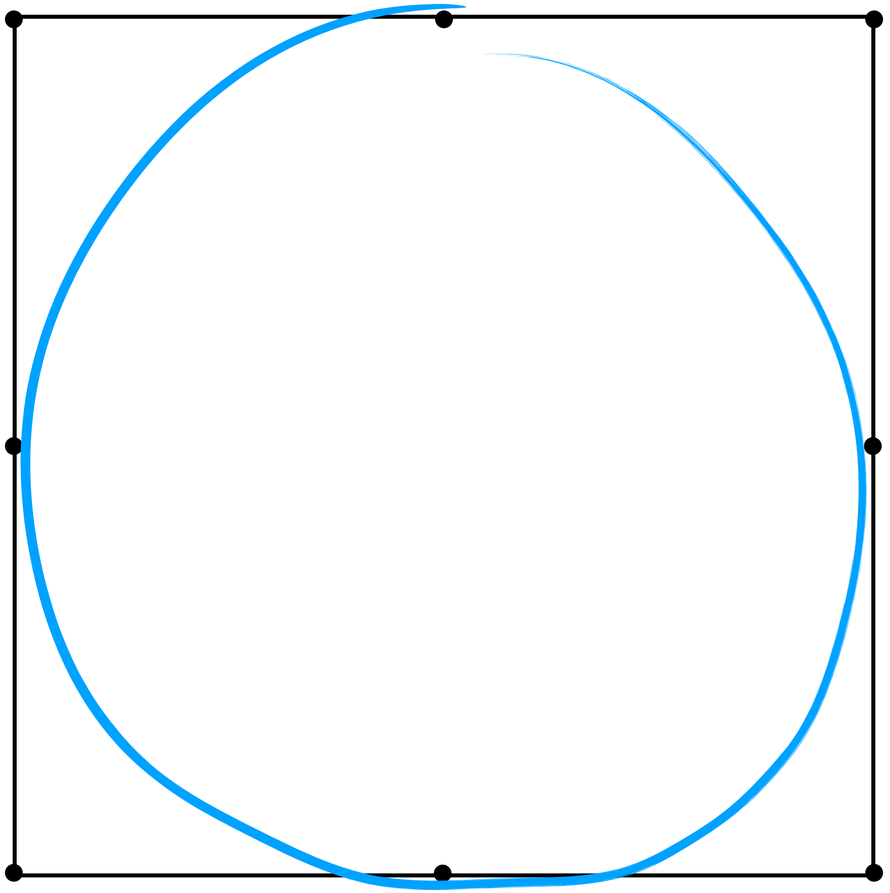

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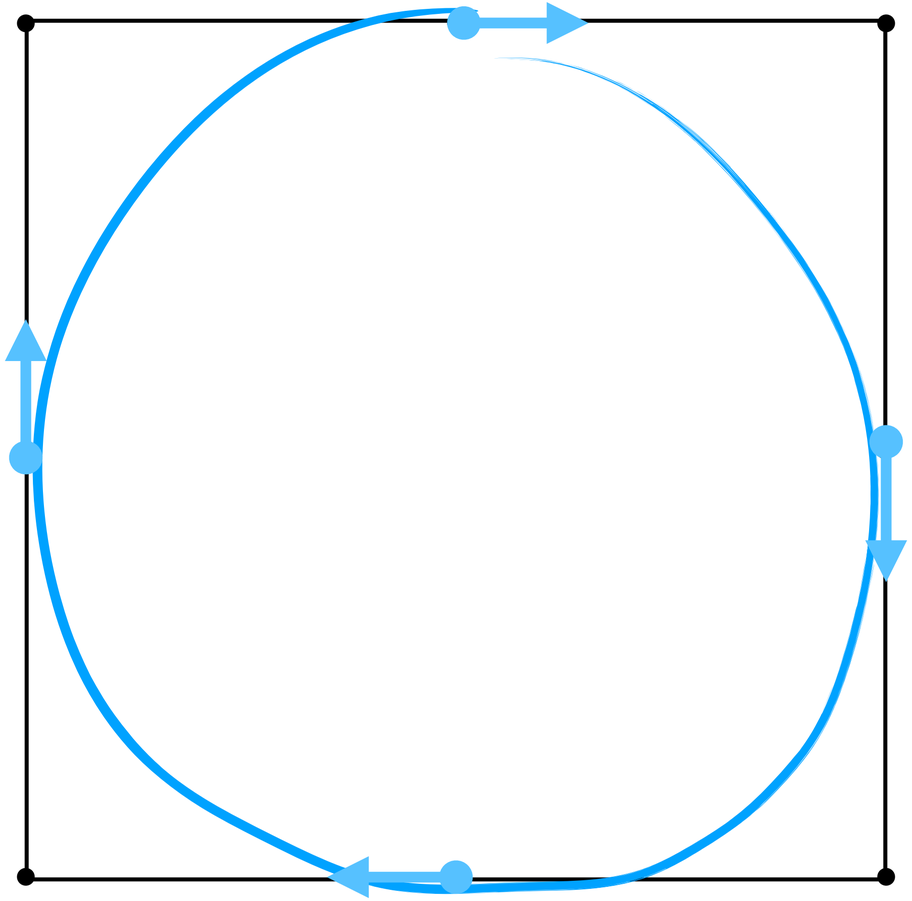

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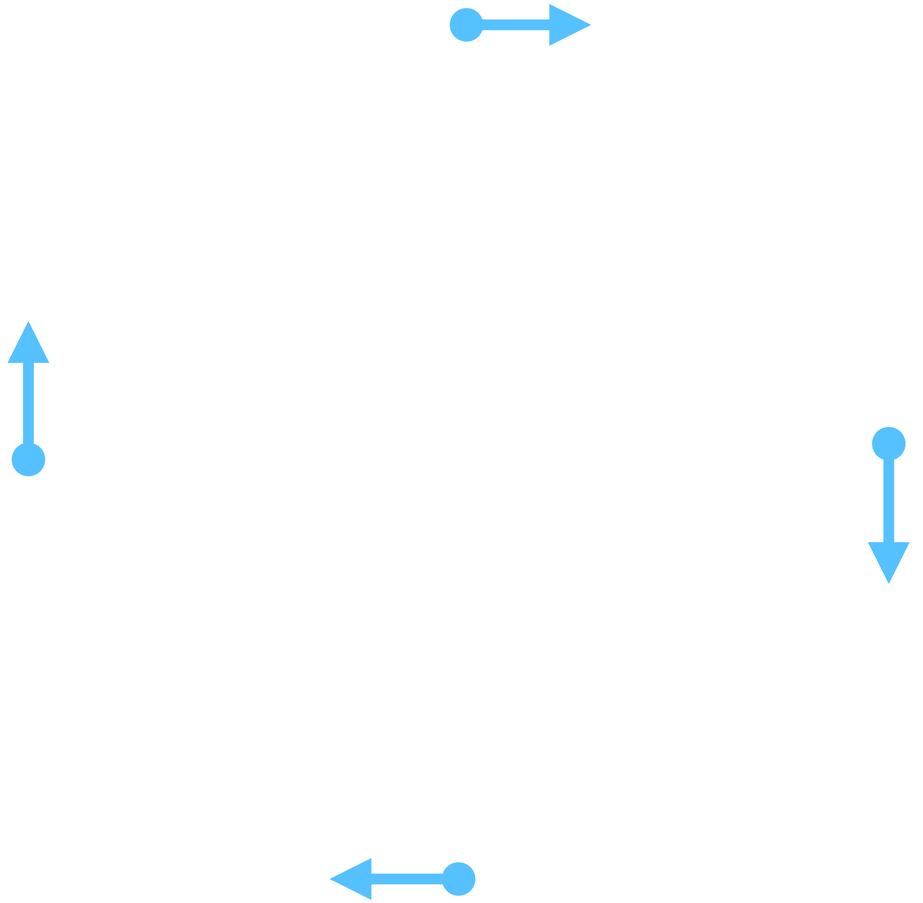

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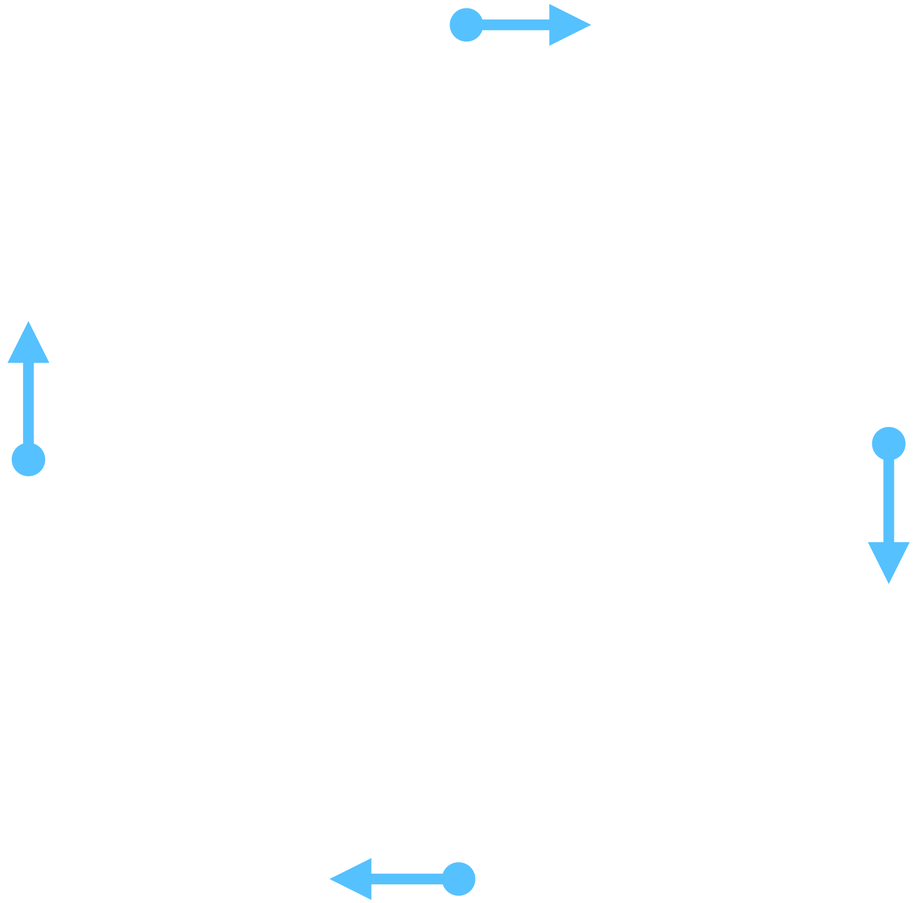

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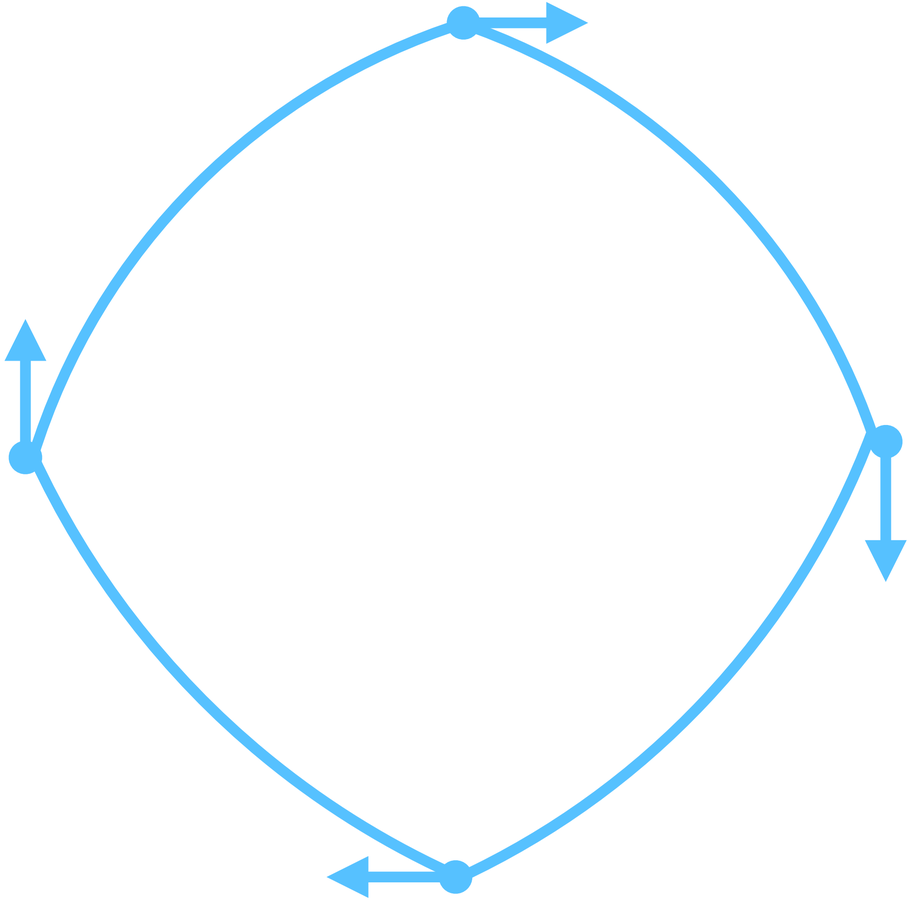

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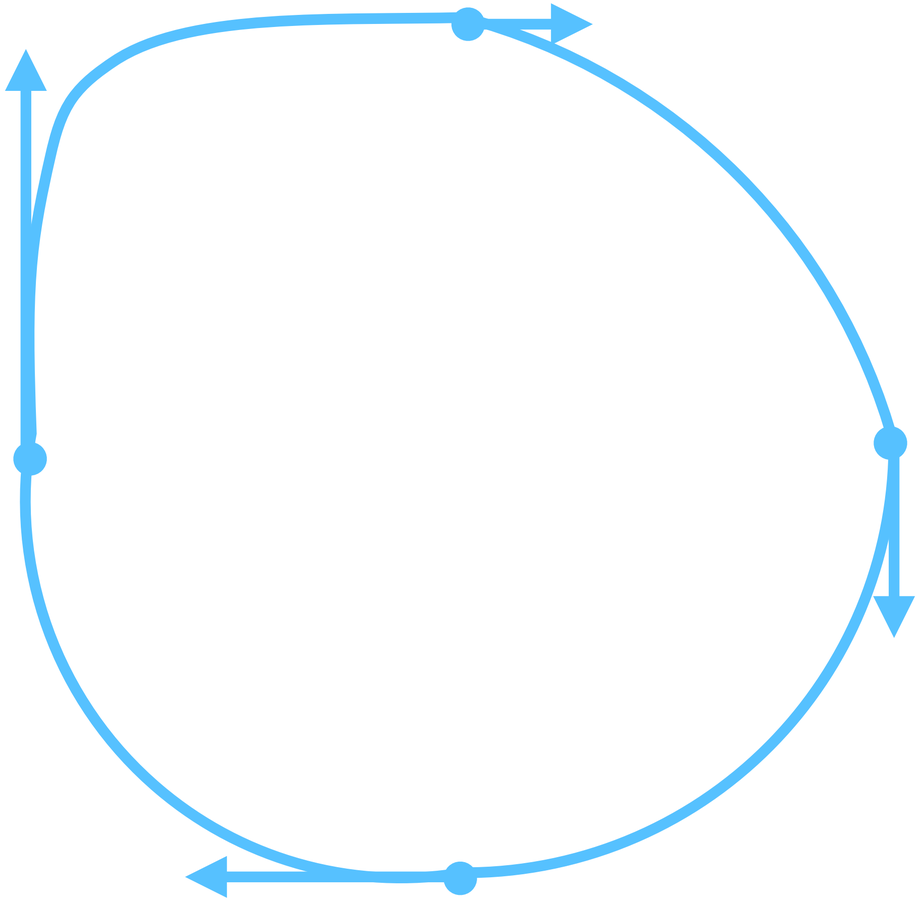

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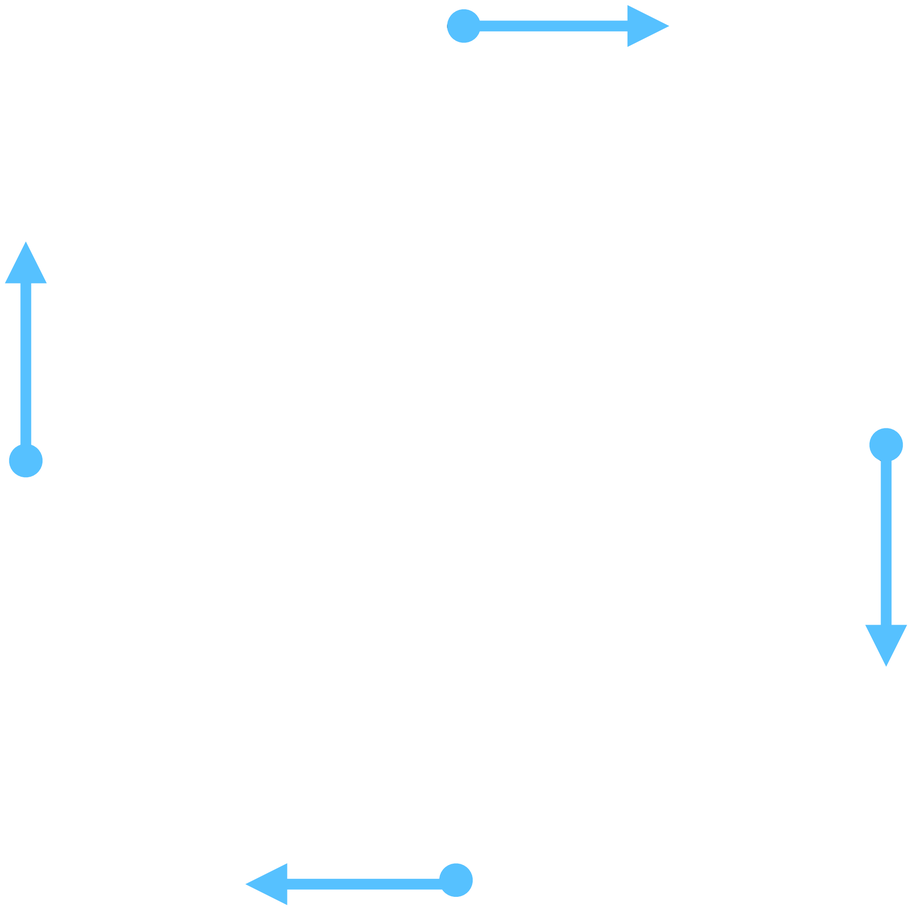

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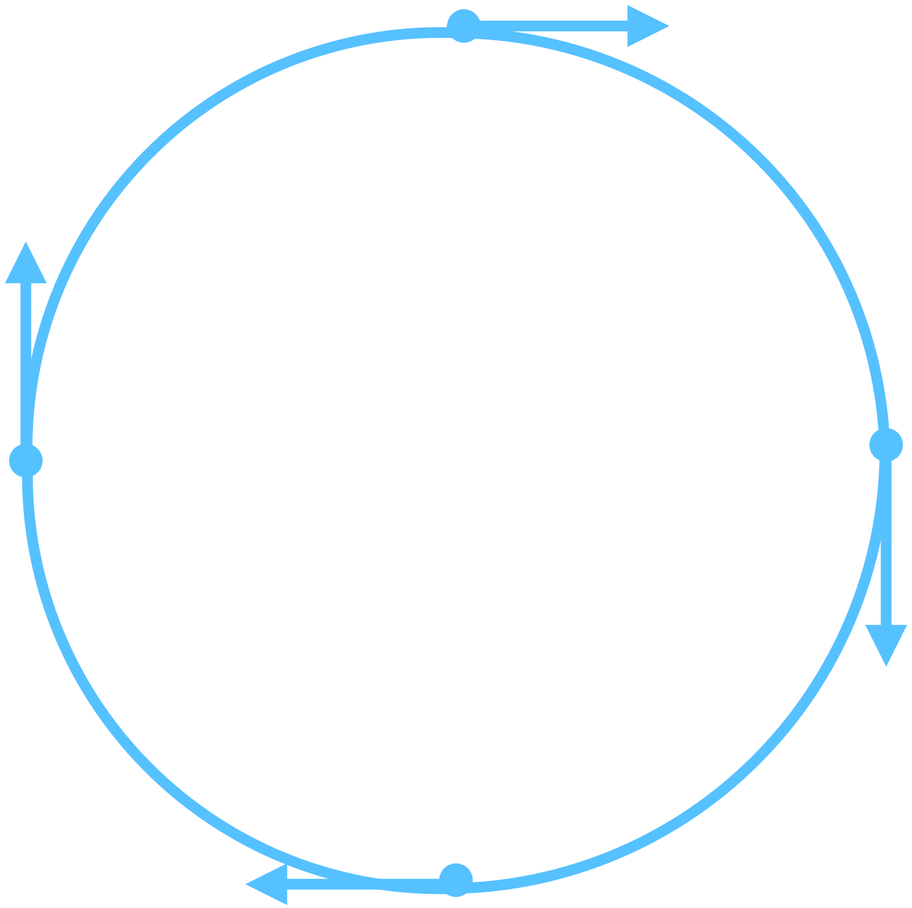

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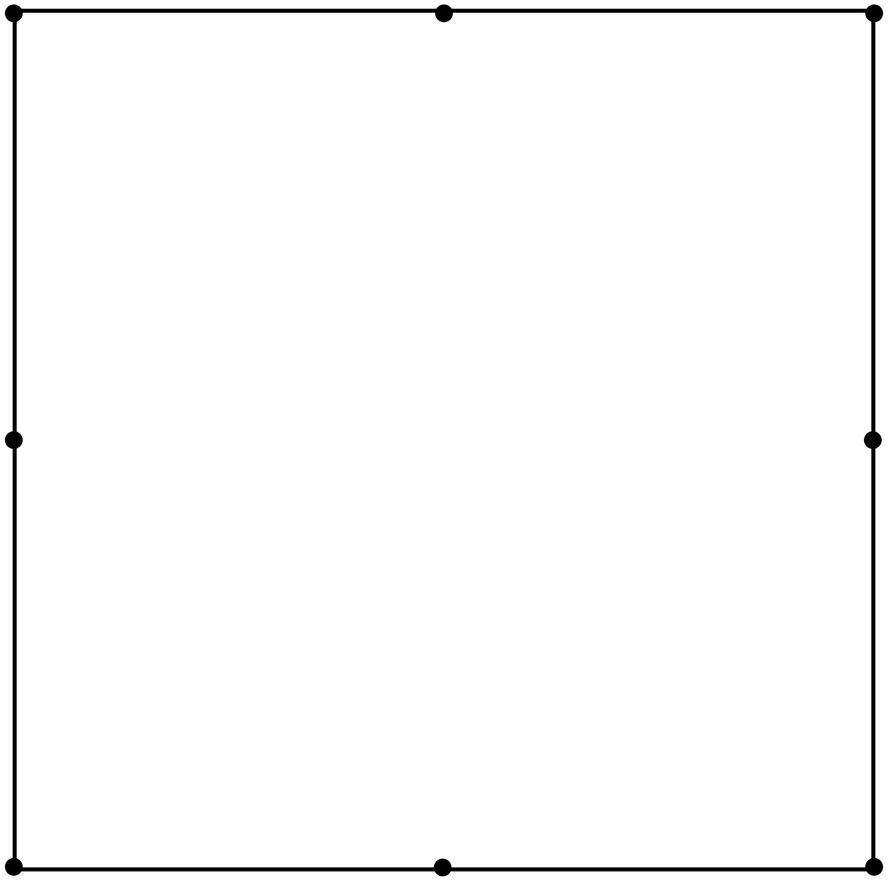

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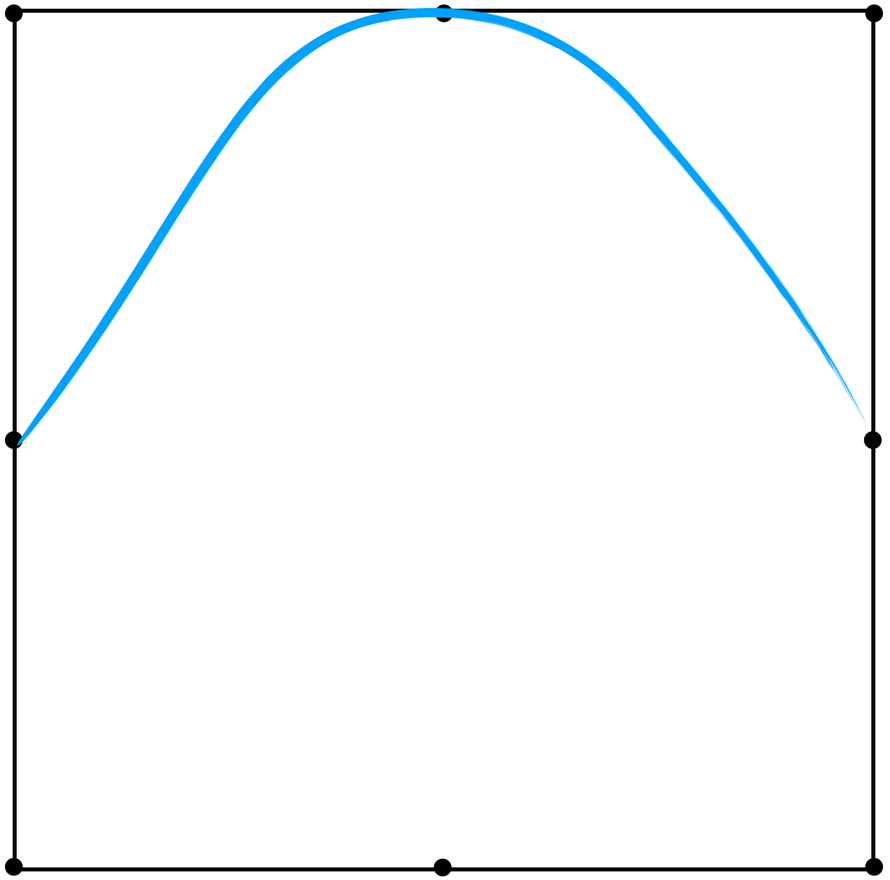
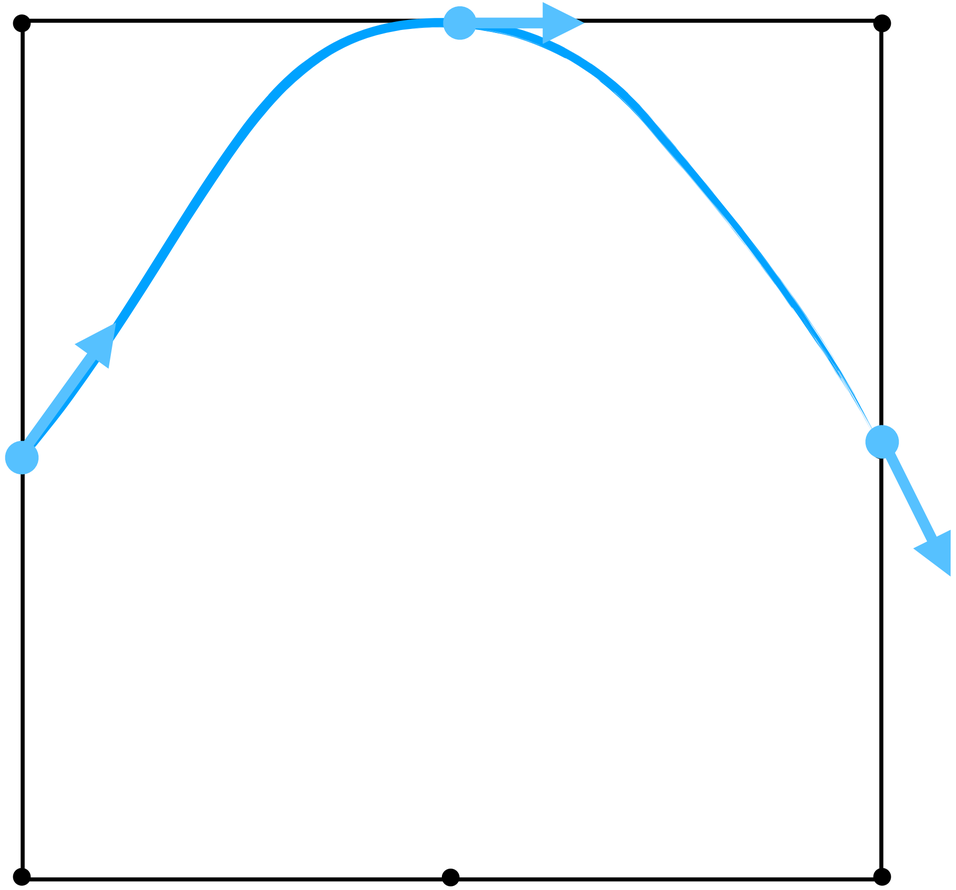


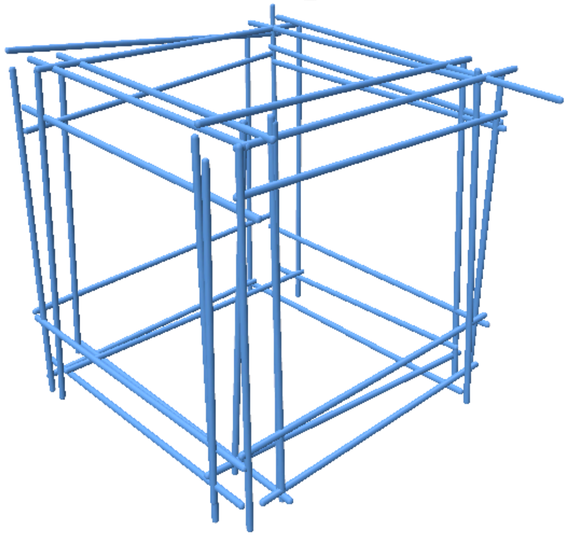
Auto-Correcting Shapes



Example

Scaffolds

User Input



Example

Scaffolds

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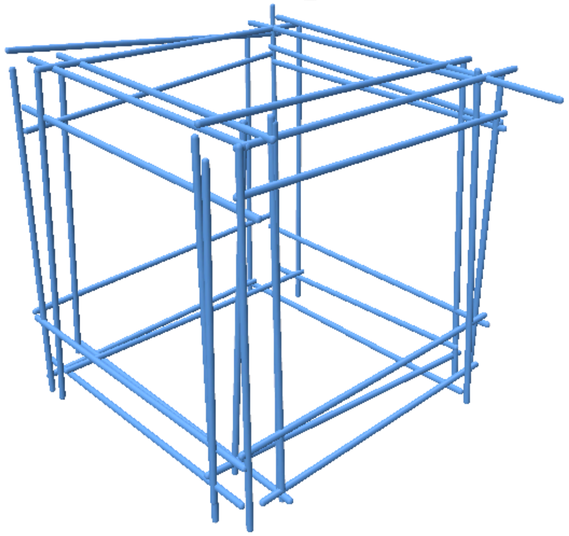

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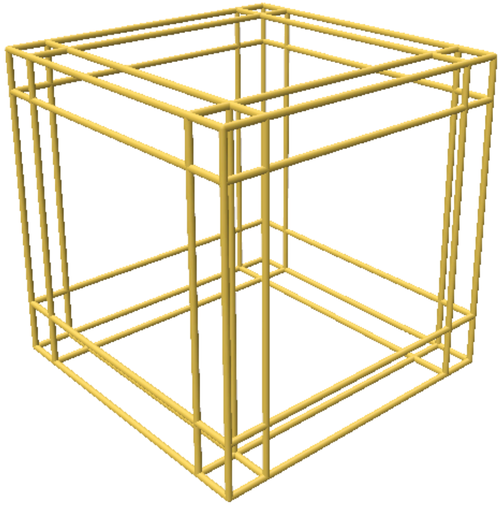


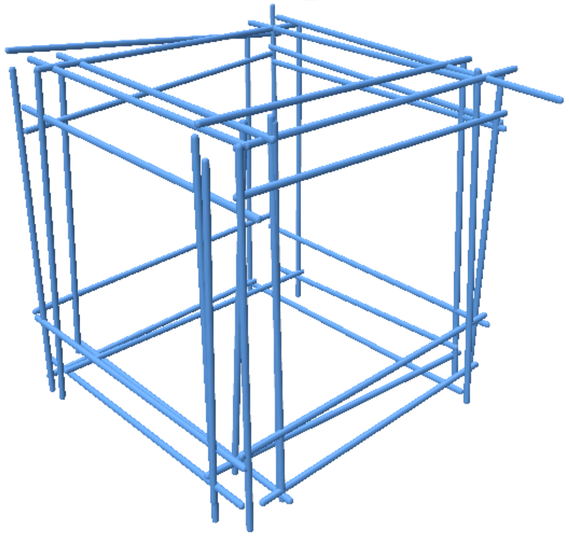
Example

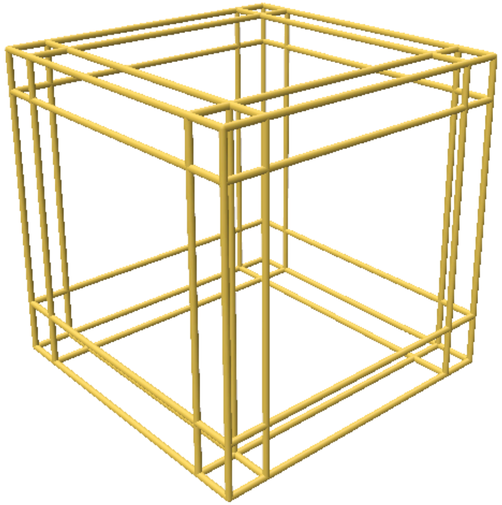
User Input

Auto-Corrected

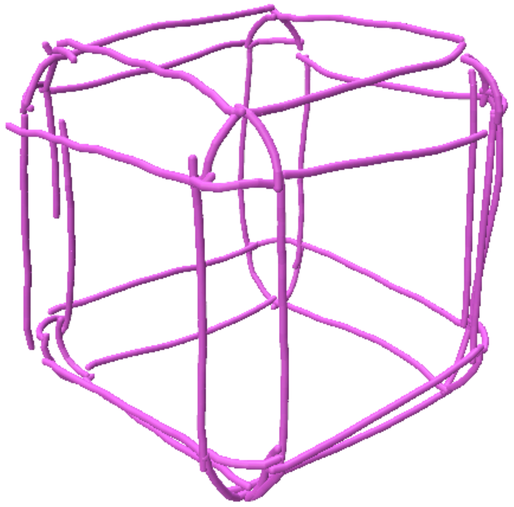
User Input

Scaffolds

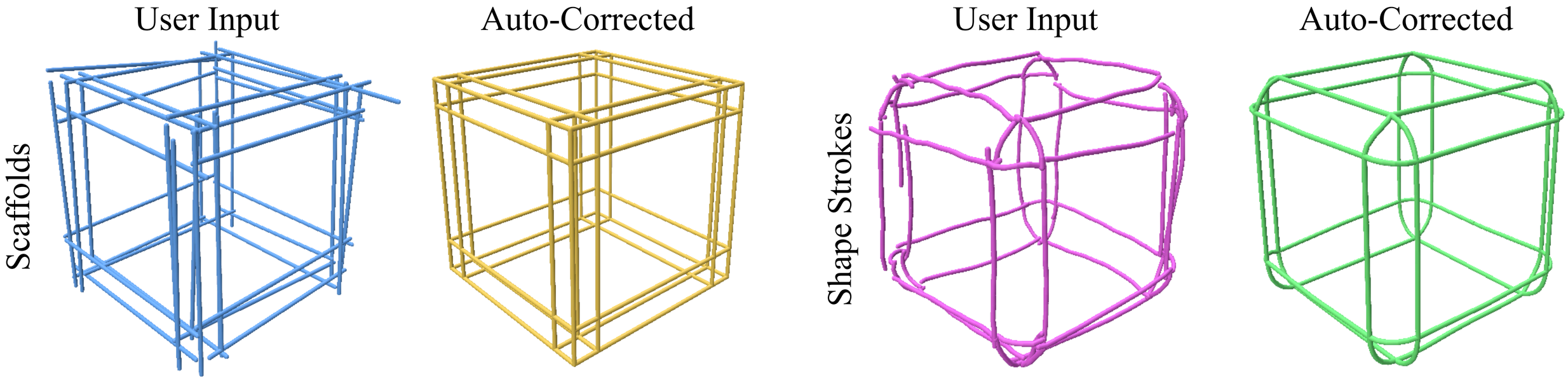




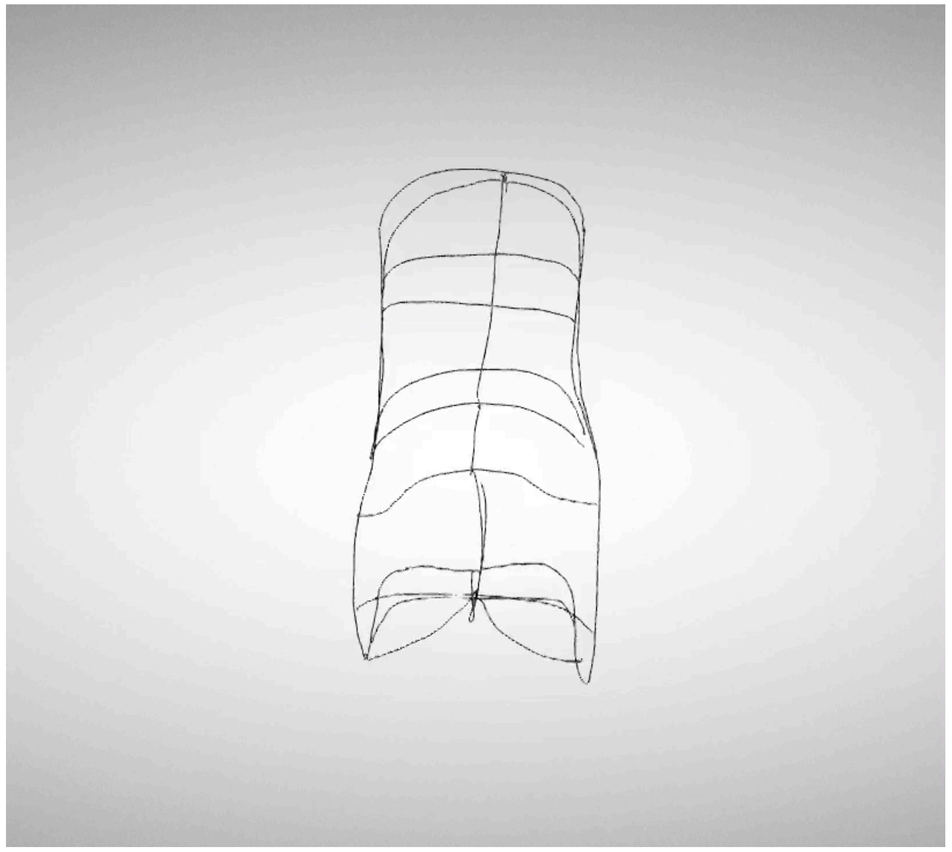
Shape Strokes



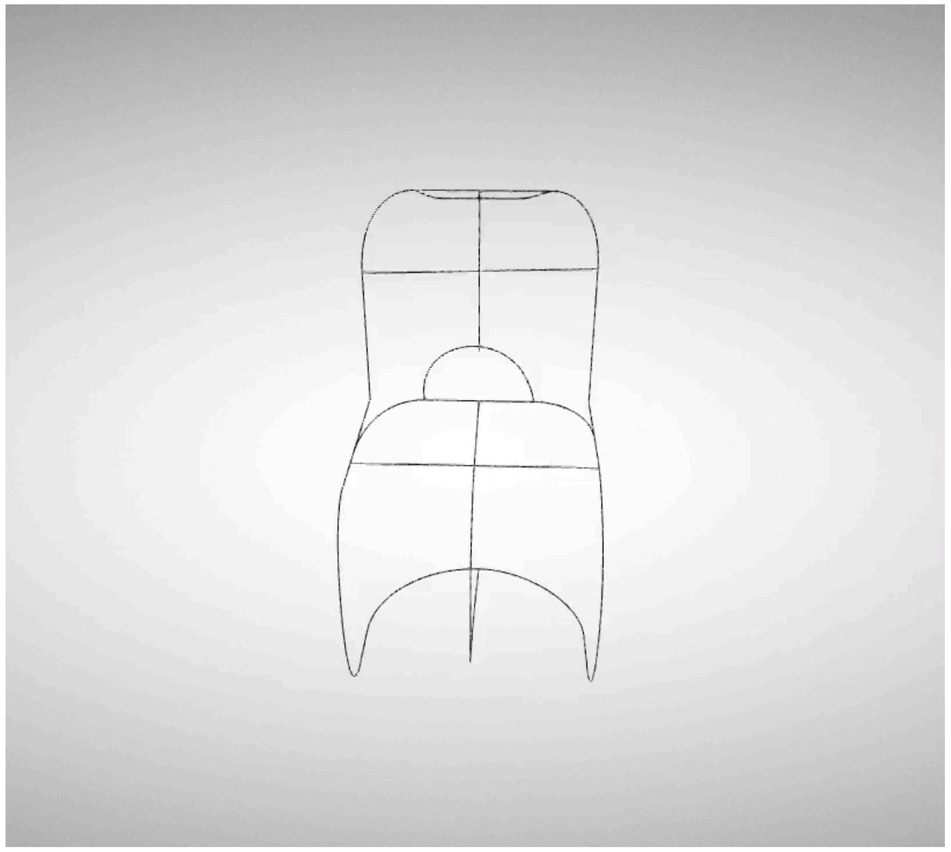
Example


User Input
Auto-Corrected
User Input
Auto-Corrected
Scaffolds
Shape Strokes

User Study

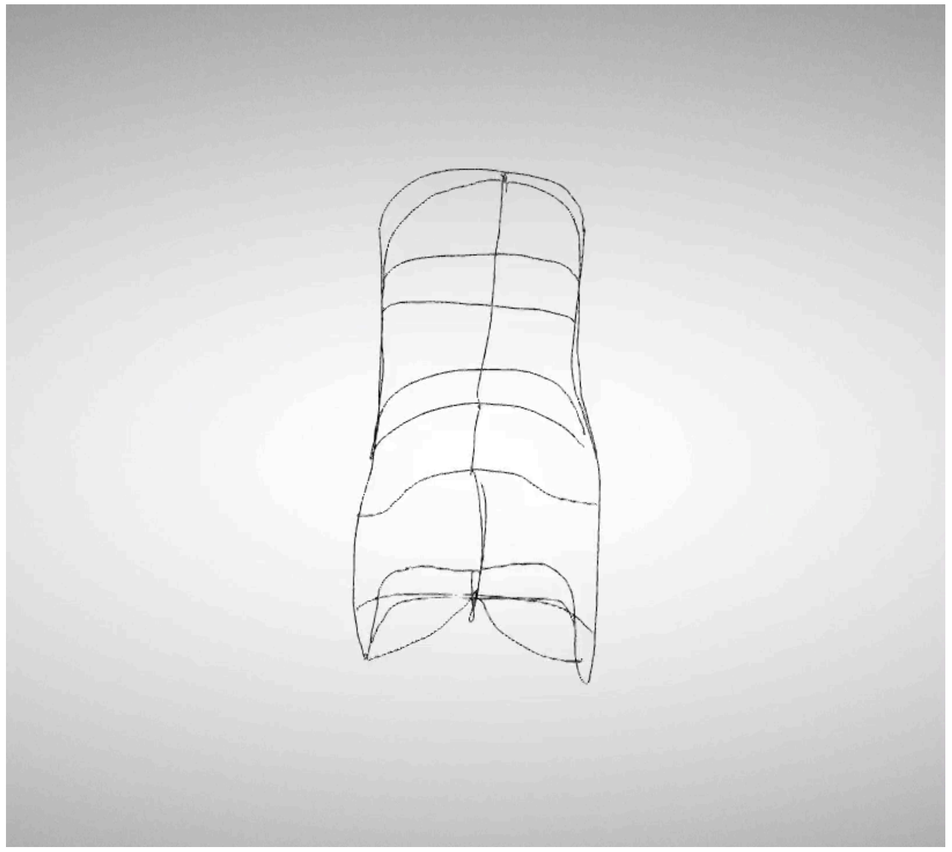


Without Auto-Correct



With Auto-Correct

User Study



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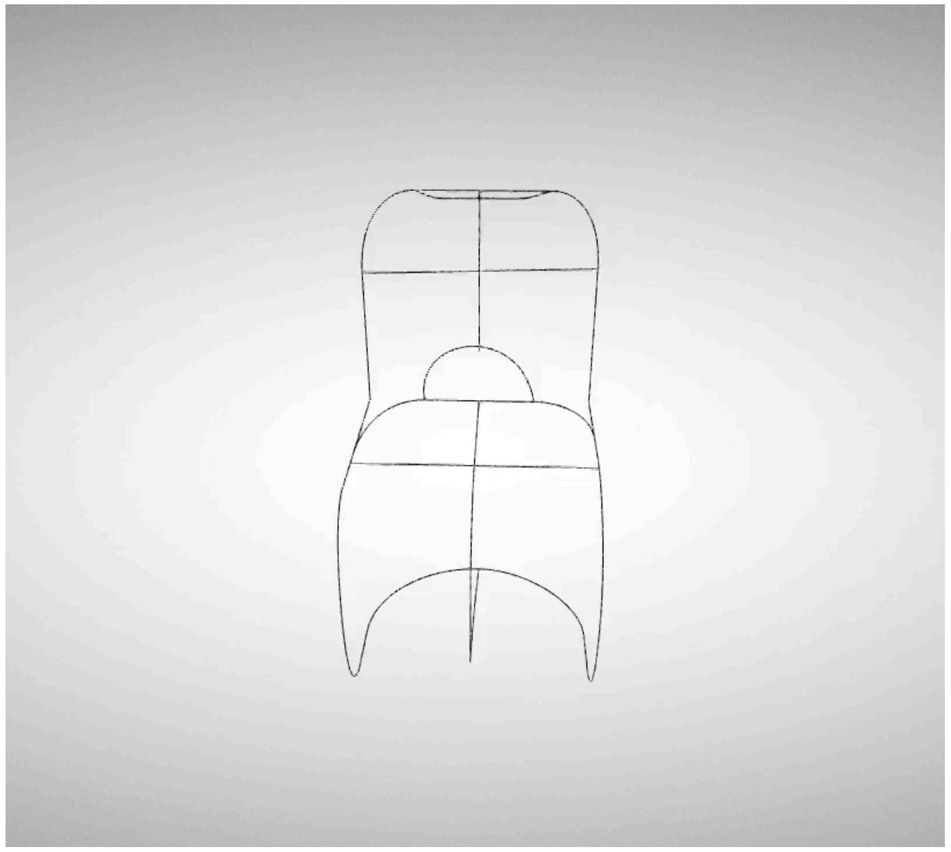
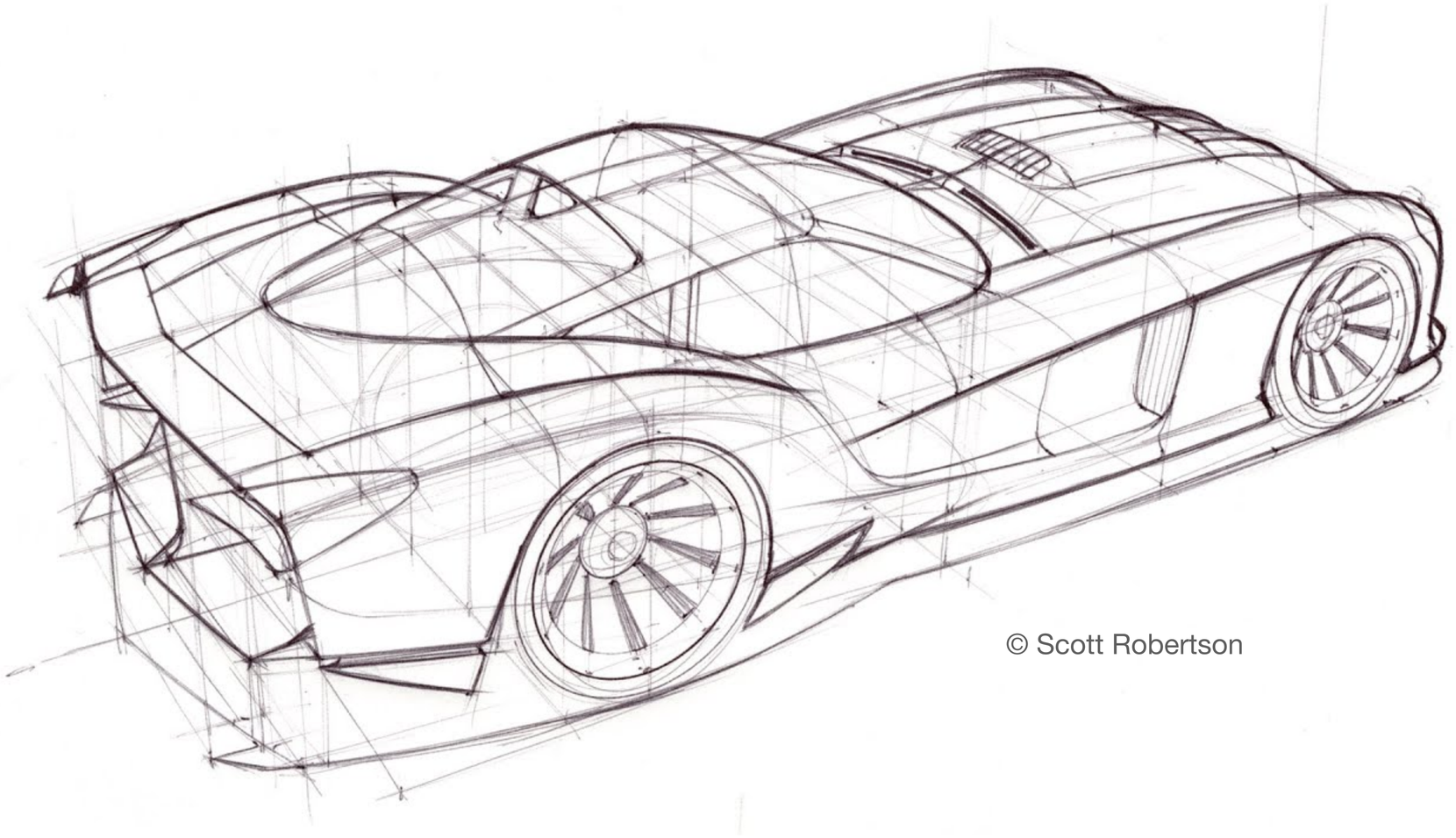


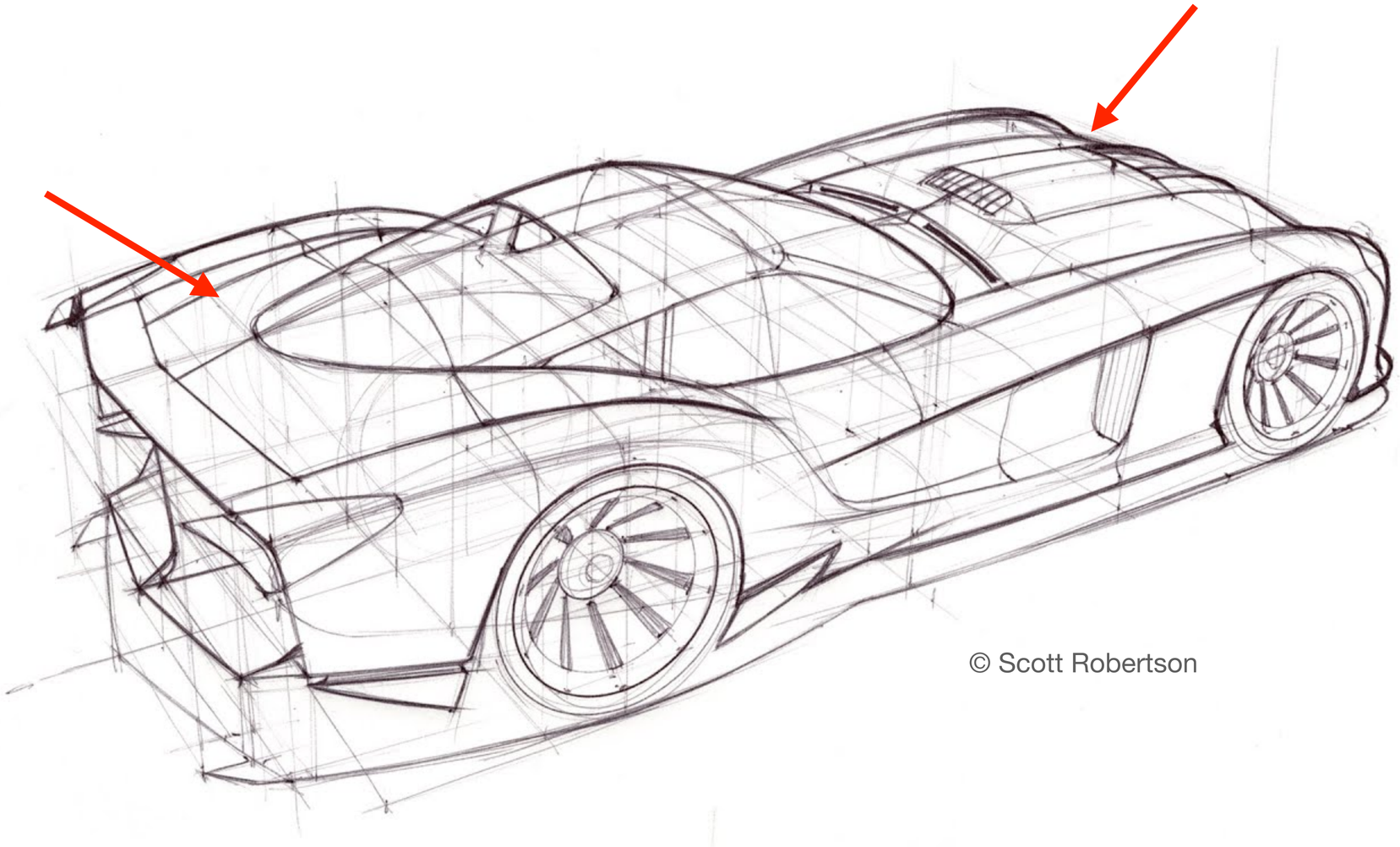
With Auto-Correct

Limitations and Future Work

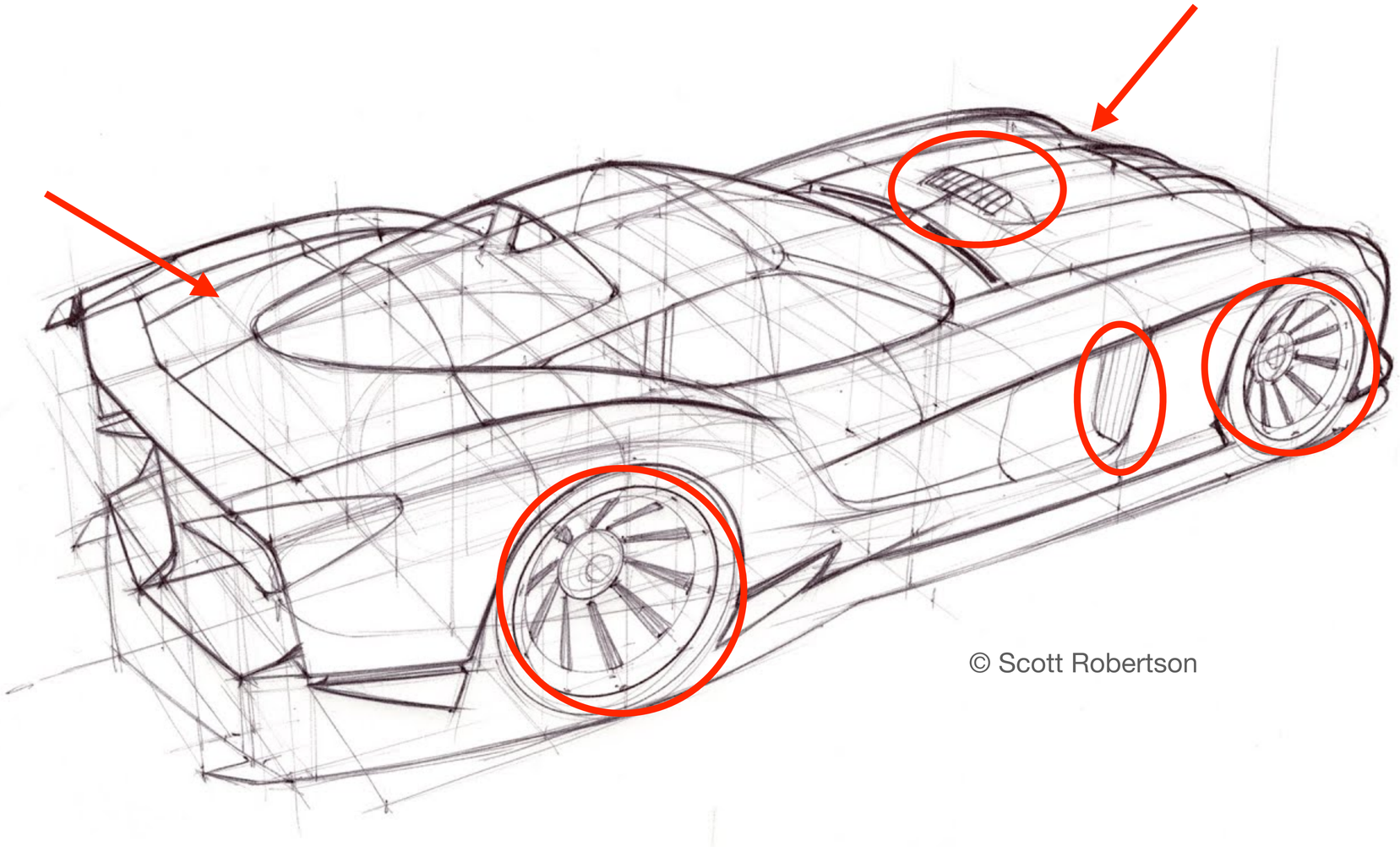


© Scott Robertson

Limitations and Future Work

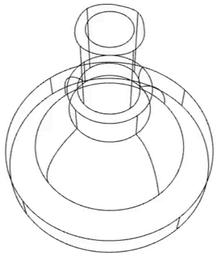
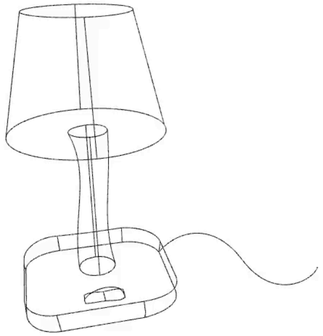
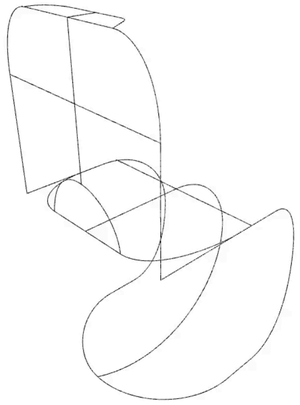
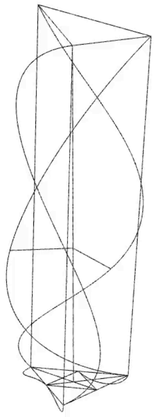
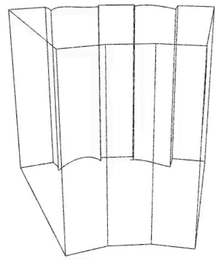
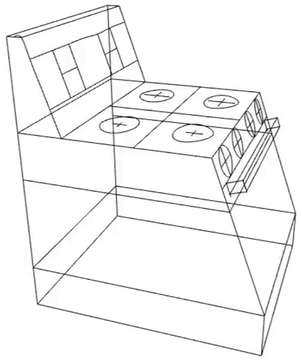
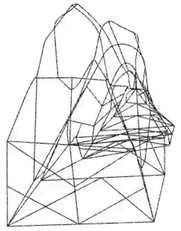
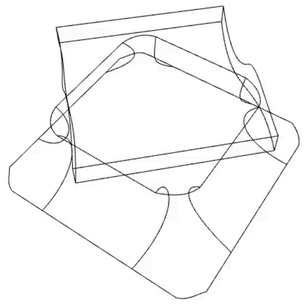
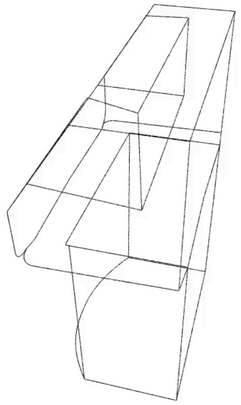
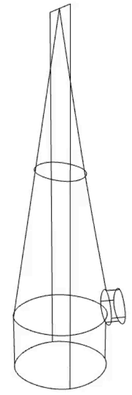


Limitations and Future Work



Conclusion

- ScaffoldSketch…
  - … enables precise 3D curve drawing by decomposing auto-correct into scaffold and shape stages.
  - … lets people transfer industrial design drawing skills into 3D.
  - … resolves conflicting constraints with an iterative re-weighting scheme.

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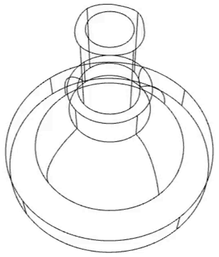
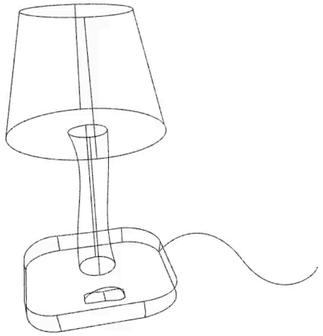
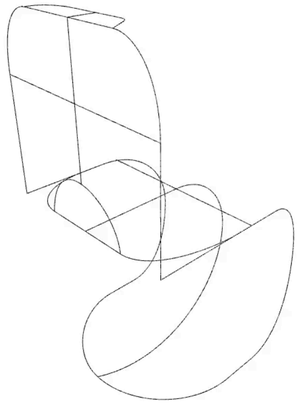
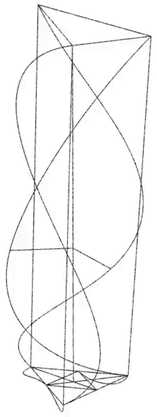
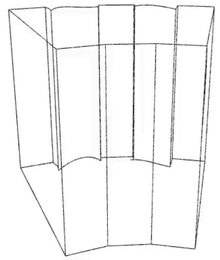
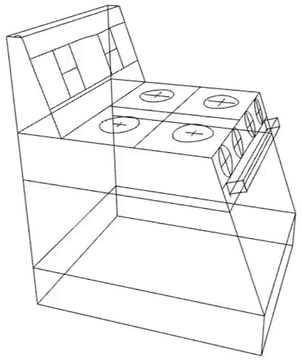
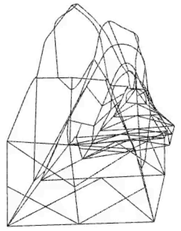
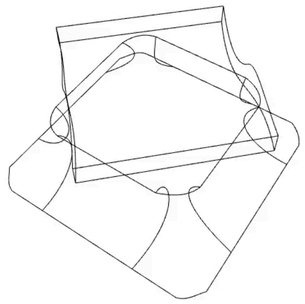
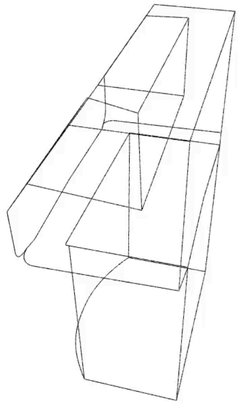
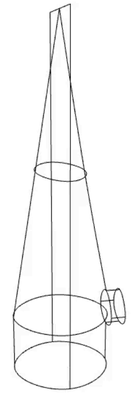

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