Computational Geometry for Playful Creation and Control

a capstone project

We can implement ***Bezier curves*** via code. We use these curves to create and control the design of our toys.

ABSTRACT

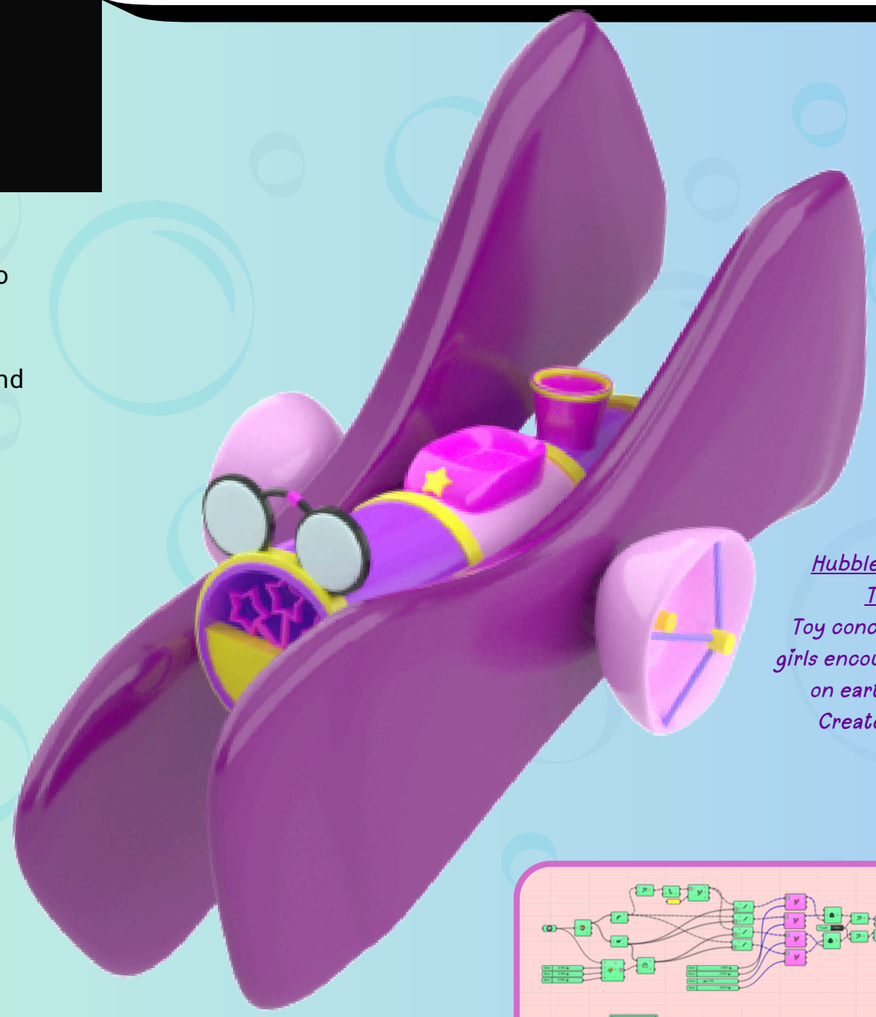
Computational geometry is a computer science application of algebraic geometry that allows for the creation of and control over curves in popular CAD-based programs like Rhino 3D. We illustrate (as well as model) the benefits gleaned from the development of computational geometry alongside 3D modeling for contemporary toy designers and explore the interplay of creativity & computation via code.

*We can also compute fun facts about curves using **Grobner bases** . . .*

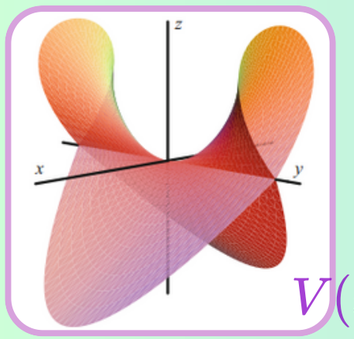
```
i1 : R = QQ[x,y,z]
o1 = R
o1 : PolynomialRing
i2 : curve1 = ideal
(x + y, x -y)
o2 = ideal(x+y,x-y)
o2 : Ideal of R
i3 : g = gb curve
o3 : GroebnerBasis
i4 : gens g
o4 = (yx)
o4 : Matrix R1←R2
i5 : curve2 = ideal(x,y)
o5 = ideal(x,y)
o5 : Ideal of R
i6 : g = gb curve1
o6 = GroebnerBasis
i7 : gens g
o7 = (yx)
o7 : Matrix R1←R2
i8 : curve1 == curve2
o8 = true
```

*Which are **unique**, just like every good design!* 😉

Recall toys need to have smooth edges and soft features for gentle hands and hearts.



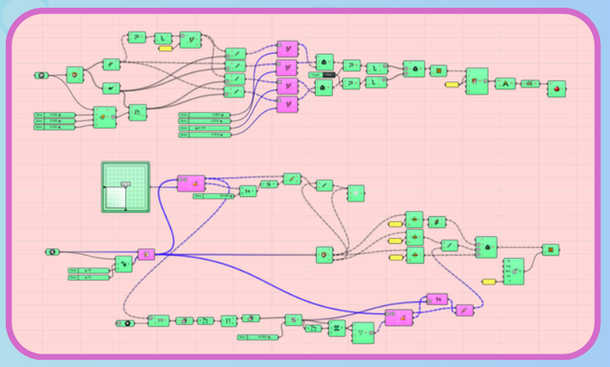
Hubble Double Bubble Telescope:
Toy concept for preschool girls encouraging exploration on earth and in space. Created in Rhino 3D.



$$V(x^2 - y^2z^2 + z^3)$$

The algebraic geometry behind programs like Rhino 3D allow us to meet design parameters. ***Parametric equations*** in fact define the shapes behind our design intent. We can create a "variety" of forms using Bezier curves (which are an ***affine variety*** themselves).

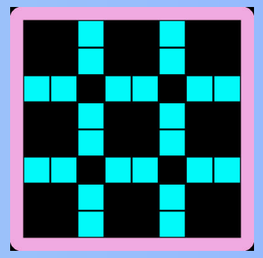
Most toy students click to create, but one can also design parametrically via Grasshopper visual programming, or even more directly via Rhino.Python for workflow benefits.



There are many ways to use code creatively! Go explore!

References

- ekimroyrp, Palette, 2018.
- David A. Cox, Donal O'Shea, and John B. Little, Ideals, varieties, and algorithms, Springer, 2018
- Daniel R. Grayson and Michael E. Stillman, M2,www.macaulay2.com.



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