REALTIME **SPLINE EXTRUSION** MODELING FOR **3D PRINTING**

DEVELOPING A USER FRIENDLY CUSTOMIZER

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THE PROBLEM

THE AWESOME PART ABOUT 3D PRINTING IS **PER-USER** CUSTOMIZED OBJECTS

USERS ARE ***TERRIBLE*** AT DRAWING, *FORGET* **3D MODELING**

‘CUSTOMIZER’ SERVICES ARE TOO VARIED, AND RESULT IN **USER CONFUSION**

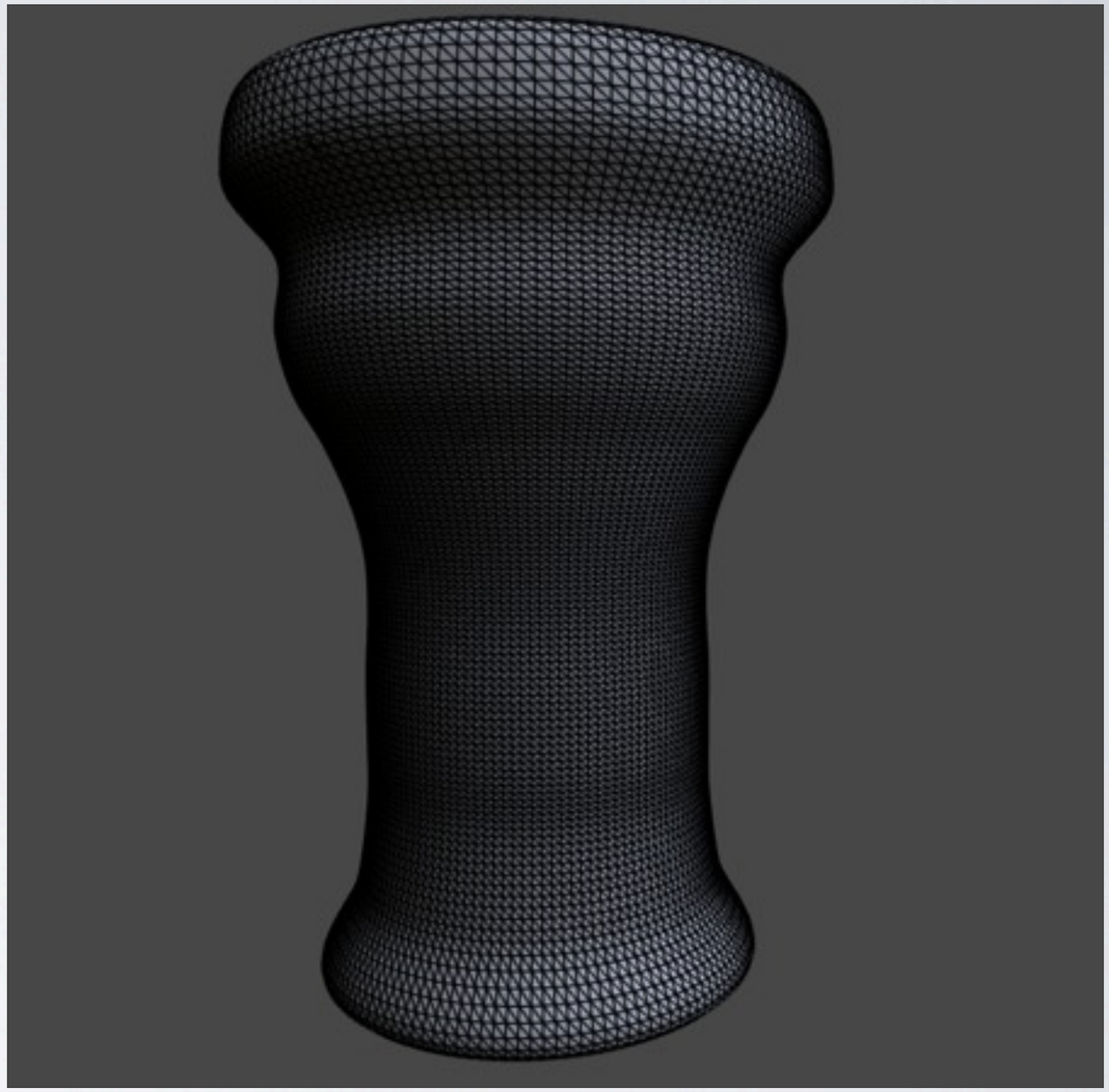
WE NEED TO **ENABLE USER AGENCY**, WHILE BOUNDING THE OUTCOMES

MY APPROACH

SPECIFIC USECASES

ORTHOGONAL TOOLS

FRIENDLY INTERFACE



THINGIVERSE HACK

~ 12 HOURS OF DEVELOPMENT

THINGIVERSE HACK

- CATMULL-ROM SPLINES
- FIXED TESSELATION
- EXPORT TO STL
- UPLOAD TO THINGIVERSE
- RUNS ON IOS & ANDROID

BÉZIER SPLINES

WHAT IS A SPLINE?

A SPLINE IS A SERIES OF CURVES, WITH THE **END POINTS CONNECTED**, AND, OPTIONALLY, **CONTINUOUS TANGENTS**.

LOTS OF SPLINES

ALL USING THE SAME MATH

- CATMULL-ROM **- USER DEFINED POINTS ON CURVE**
- QUADRATIC BÉZIER **- CLOSED FORM SOLUTIONS**
- CUBIC BÉZIER **- COMMON IN ART SOFTWARE**
- KOCHANEK-BARTELS **- UNIQUE PARAMETERS**

```
public class CatmullRom2D : ISpline2D{
  Vector2[] points;
  public Vector2 EvaluatePosition(float t){
    //the math is on wikipedia
  }
  public Vector2 EvaluateDerivative(float t){
    //dy/dt the math above
  }
}
```

```
public static class SplineMath{

  public static Vector2 EvaluatePosition(
                                    Vector2[] points,
                                    float t
                                    ){
    //the math is on wikipedia
  }
  public static Vector2 EvaluateDerivative(
                                    Vector2[] points,
                                    float t
                                    ){
    //dy/dt the math above
  }
}
```

```
public class CatmullRom2D : ISpline2D{

  private Vector2 EvaluatePosition(float t, int initialPoint){

    Vector2 previousPoint = (initialPoint == 0) ?
points[initialPoint] : points[initialPoint-1];

    Vector2 tangent1 = 0.5f*(points[initialPoint+1] -
previousPoint);

    Vector2 nextPoint = (initialPoint+2 < points.Length) ?
points[initialPoint+2] : points[initialPoint+1];

    Vector2 tangent2 = 0.5f*(nextPoint - points[initialPoint]);

    float tSquared = t*t;
    float tCubed = t*tSquared;

    return
      (2*tCubed - 3*tSquared + 1)  *  points[initialPoint] +
      (tCubed - 2*tSquared + t) *  tangent1 +
      (-2*tCubed + 3*tSquared)  *  points[initialPoint+1] +
      (tCubed - tSquared)       *  tangent2;
  }

}
```

```
void PositionVertices(){

  for(int i=0; i<rings; i++){
    for(int j=0; j<slices; j++){

      float t = Mathf.PI * 2f * ((float)j/(float)slices);

      float percent = (float)i / ((float)rings-1);

      Vector2 pos = spline.EvaluateSplinePosition(percent);

      float xPosition = pos.x*Mathf.Sin(t);
      float zPosition = pos.x*Mathf.Cos(t);

      int idx = j + i*slices;

      vertices[idx] = new Vector3(xPosition,pos.y,zPosition);

    }
  }
}
```

CONSTRAINTS

USING THE **SAME**
UNDERLYING CODE, WE CAN
DESIGN DIFFERENT CUSTOMIZERS
FOR DIFFERENT PRODUCTS BY
IMPOSING CONSTRAINTS.

SIMPLICITY
FROM CONSTRAINTS

- MATERIAL PROPERTIES
- ARCHETYPAL FORMS
- HUMAN LIMITS & SCALE
- COMMON UNITS OF MEASURE
- USER-FLOW

CERAMICS APP

DESIGN COMMON **HOUSEHOLD CERAMICS** ON A MOBILE DEVICE, CUSTOMIZED TO YOUR OWN LIKING, AND HAVE THEM **3D PRINTED**, AND **DELIVERED**.

CERAMICS

SPECIFIC CONSTRAINTS

- CLAY WALL SIZE
- COMMON MUG SIZES (2oz, 8oz, 12oz, ETC)
- KILN LIMITATIONS (NO AIR POCKETS)
- GLAZE REQUIREMENTS
- USER-FLOW & PRODUCT ARCHETYPES

NEXT STEPS

LEVERAGE **EXISTING PRODUCT TAXONOMIES**, AND BUILD SPECIFIC CUSTOMIZATION ENGINES AROUND THOSE ARCHETYPAL PRODUCTS

THANKS

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