# Project proposal

The graphics processing unit (GPU) has gained the ability to perform a larger variety of features and for the operation of those features to be more controlled by software as opposed to hardware. (Hubert Nguyen, 2007) This has expanded the uses for the GPU beyond polygon rendering.

Splines are lines defined by a series of points. Base splines (B-Splines) are implementations of splines which use a series of Bezier curves to define their shape. Bezier curves are a method of defining a curve by the position of points in space. The Bezier curve is found by interrelating the position between the points. (Smith, 2015) Bezier curves can either contain 3 or 4 points. These are called quadratic and cubic Bezier curves respectively. (Loop and Blinn, 2005)

B-Splines have been rendered on the central computing unit (CPU). Due to the CPU’s low breath of parallel computing, had to be rendered consecutively. (Carpenter, 1984) Loop and Blinn (Loop and Blinn, 2005) and Kumar H. and Sud A. (Kumar and Sud, 2019) have propose methods for perform the render on a GPU. These techniques would process more of the data in parallel and open the CPU up for other work.

Peitkam, Anjyo and Rhee (Petikam, Anjyo and Rhee, 2021) in their work on hand crafted shadows in 3D real time applications, dismissed using B-Splines for defining their shadows due to the poor performance of rendering B-Spline in real time from the literature they found. Instead, they used a formula which gave the artist more limited shapes than B-splines. Their method was tuned to natural shapes and so could not create rectangles for mechanical characters. Implementing either Loop and Blinn (Loop and Blinn, 2005) or Kumar H. and Sud A. (Kumar and Sud, 2019), performance may improve enough to allow for both real time performance and less limited shape variety.

Kumar H. and Sud A. (Kumar and Sud, 2019) method is limited due to the need to convert from cubic Bezier curves using in many standards to quadratic Bezier curves. If implemented in special tooling for a shadow tool as described by Peikam, Anjyo and Rhee (Petikam, Anjyo and Rhee, 2021), this conversion could be made before the animation for the directions of the light are cached, removing the 64 tessellations limit and reducing the workload in GPU by skipping the tessellation shader stage.

# Question

Can S-Splines be used for manual shadows and details while retaining real time performance?