

## ABSTRACT

Representing data after it has undergone a fundamental topological change, such as cracking, ripping, or folding, or after the introduction of arbitrary feature curves, as happens during the creation of darts, corners, or fractures, continues to be a significant challenge. Ideally, the representation is modified without having to reformulate the representation entirely. If the original model is composed of faceted polyhedra, it is possible to do this. However, many models today are being represented by smooth parametric tensor product surfaces such as B-splines, which do not easily support arbitrary discontinuities. During the design process, when discontinuities are introduced, such models are often tessellated into triangles, which would henceforth be the model's representation. In this case, the resulting model is often not useful for further design. This thesis introduces an extension of the B-spline surface representation, called the *torn B-spline surface*. The torn B-spline representation provides flexibility not previously found in similar parametric surfaces by incorporating *tear* curves, *crease* curves, and other arbitrary  $C^{(-1)}$  feature curves into the representation itself. Simulation events or other design processes which result in discontinuities in the representation do not necessitate a change in representation, and it is possible to use B-spline design methods on the resulting torn surface model. This makes design with discontinuities more viable. The representation and associated algorithms used to support it are introduced, as well as some higher-order design operators which take advantage of this representation and some example applications.