Scientific abstract, Advanced Mathematics and Industrial Design, A Symbiotic Relation

Fields such as mathematical-physics, mathematical-biology and of course the connection to computer science are natural. In this proposition, I provoke a new symbiotic relationship between industrial design and abstract mathematics with the following three concealed goals. First, to show how abstract mathematics concepts can be powerful tools to the designer, and can be 'activated' for the designer's demand, as in 'Dynamical tilying' below. Secondly, mathematicians are always seeking inspiration to formulate new theoretical ideas. In my opinion, design has a lot to offer, aesthetics is a good example that in a way may define mathematics, see below 'Gradient topology'. Lastly, undergraduate mathematics students need to be educated to be problem solvers, where the problems can be raised in various fields. I encourage my students in mathematics to take part in design-math collaboration to show how powerful their major studying field. I intend to turn these abstract mathematical concepts into vivid visualizations, with the right construction and materials. I will demonstrate, with the help of my team, the utility of our visualization approach in three academic fields that seemingly have not much in common with math: art/design and music, but indeed have a powerful symbiotic relation. These are the purposes researches:

(1) **Classifying and defining songs as three-dimensional objects (Aim 1)**. Can a given song in Western music be modeled as a collection of curves, surfaces, or even be defined as a tangible object? If they indeed can be modeled in a pure mathematical fashion, can we sort songs by equivalence relation? This research involves music, industrial design, differential geometry, algebra, and topology.

(2) **Gradient topology (Aim 2)**. Gradient is an important concept in mathematics, surprisingly this concept is also well defined from a designer's point of view as a soft color-changing (which contains the mathematical definition) in a given image. As a mathematician this simple design-gradient, although it has a geometrical property, reminds us the construction of a cylinder from the respective fundamental polygon, which is obtained by attaching the identical edges. This observation led us to think is it possible to define design-gradients for different topological surfaces. This research involves design, topology, combinatorics, and complexity; and all is influenced by design concepts.

(3) **Defining dynamical tiling's in industrial design (Aim 3)**. It turns out that algebraic structures can help designers in the planning steps to know if a dynamical transformation of the components can be obtained, all by a respective mechanism which defines movement between different patterns/arrangements, each of which accomplishes a different goal. I intend to generalize this result to spherical patterns and especially for geodesic domes. This research involves design, mechanics, differential geometry, and groups.