



## Application of Axiomatic Design Starts Microcellular Polymer Industry

**Problem:** Kodak, the photographic film company, annually mass-produces thousands of plastic items such as the black plastic film canisters sold with Kodak film. The film company was looking for ways to reduce the amount of plastic needed to create these and other disposable plastic items without compromising the mechanical properties of the item. Kodak turned to MIT and axiomatic design to find the solution to this problem.

**Solution:** Working on the problem, MIT researchers developed a completely innovative structure for the plastic. They theorized that by creating a network of very small, almost microscopic holes in the plastic (100 m or less), these holes or cells would actually strengthen the plastic instead of weakening it. The theory proved correct and the MIT researchers implemented axiomatic design to develop this new microstructure solution. The solution ended up lowering part weight by up to 50%, consuming 15% less material and increasing toughness by 15% while improving dimensional stability.

A new technique was also needed to produce the microcellular plastic and axiomatic design filled that need. The design equation that solved for the production of the microcellular plastic was:

$$\begin{Bmatrix} DP_1 \\ DP_2 \\ DP_3 \end{Bmatrix} = \begin{Bmatrix} \text{Cell density} \\ \text{Cell size} \\ \text{Shaping} \end{Bmatrix} = \begin{pmatrix} A_{11} & A_{12} & x \\ A_{21} & A_{22} & x \\ A_{31} & A_{32} & A_{33} \end{pmatrix} \begin{Bmatrix} \text{Saturation pressure} \\ \text{Time-temp exposure} \\ \text{Deformation} \end{Bmatrix}$$

The resulting microcellular material and process were patented, and a company, Trexel Technologies, was created to exploit this discovery. Trexel, a successful Massachusetts firm, is now promoting MuCell technology around the world. MuCell technology is used in the automotive industry, in electronic goods, in the semiconductor industry as well as in many other industries and is having a profound impact on business today.

This is a dramatic example of how axiomatic design analysis created an entire industry that now employs hundreds of people.

*Axiomatic Design Solutions is a business and technology consultancy that delivers measurable results and value through the application and support of axiomatic design methods as a basis for quality-driven design processes.*

## The Axiomatic Design Process

- Improves the quality of designs
- Facilitates the creative process
- Requirements driven
- Captures design intent and traceability
- Provides early phase risk assessment
- Gives objective metrics for design evaluation
- Reduces the Design-Build-Test-Design Cycle
- Scalable from small projects to very large
- Fully compatible with:
  - Six Sigma
  - QFD
  - Lean Process