Nanoinjector

INSPIRATION: Kirigami is a branch of origami in which the paper may be cut as well as folded, a practice prohibited in most traditional origami. This combination of cutting and folding can create structures and motions common in pop-up books, and this behavior was the inspiration for the nanoinjector. At the microscopic scale, traditional mechanisms are difficult to construct and operate, but this type of pop-up mechanism can be constructed relatively easily and operated consistently. Its motion is so well defined that it can rise up from the flat state and then inject DNA into a mouse egg cell with minimal damage to the cell wall.

APPLICATION: This mechanism is used for transgenic research by injecting DNA into cells. This type of research can be helpful in the study of genetic diseases and cancer research, among other things. The small scale makes the work challenging, and that is where this mechanism shines. The nanoinjector’s needle is 1/100th the size of a human hair. This is ten times smaller than the alternative microinjector used for similar work, resulting in less damage being done to the injected cells.

Materials: Polycrystalline Silicon
Size: 1.3mm x 0.6mm
Lance: 200µm long, elevates to 45µm
A. This simple pattern of cuts and folds gives rise to the nanoinjector's basic upward and then forward motion.
B. Similar to what is seen in pop-up books, the nanoinjector can lie flat and thin and then spring up out of the page into its active form. The height and orientation of the deployed state can be adjusted by moving some of the cuts and folds in the basic pattern.
C. To adapt the design for use with nonpaper materials, the folds were replaced with two interlocking layers of rigid material that slide past and through each other to replicate the motion of the paper model.

D. The nanoinjector before and during DNA injection into a mouse egg cell. High precision is required to accomplish this without causing serious damage to the cell.
Tessel Jet Pack Backpack

INSPIRATION: The Tessel design was inspired by origami tessellations. A tessellation is a repeatable tiling pattern composed of one or more geometric shapes (tiles). In the case of origami tessellations, folds in the paper create the geometric tiles, and some of these patterns are infinitely repeatable in at least one direction. The ability to incorporate three-dimensionality into origami tessellations sets these apart from most other tessellation arts, which are typically created on a flat surface and restricted to two-dimensional planes.

A. Origami tessellations such as the Miura-Ori and triangulated Resch’s patterns shown here provided the visual inspiration for the Jet Pack’s faceted material. B. The final pattern preserves the repeatability and crisp geometric aesthetic of origami tessellations while improving the ability to conform to different 3-D shapes. C. Whether completely full or mostly empty, the interactions between facets give this backpack a unique and stylish look. D. A reflective finish on the Tessel material highlights the angularity and interesting orientation of neighboring panels.

Materials: Nylon fabric, polyurethane foam
Size: 17" x 11" x 5"
Courtesy of Tessel Supply.
APPLICATION: The faceted material was designed with the visual aesthetic of origami tessellations in mind. In addition to its clean, geometric look, the material also has a playful tactile and interactive feel. This material was incorporated into the Jet Pack, resulting in a backpack that is as fun as it is functional.
INSPIRATION: The origami kaleidocycle provided the initial inspiration for the Circle/Circle Table’s design. The kaleidocycle is unique in that it is capable of continuous rotation despite its lack of pins or other joints generally deemed necessary for this kind of motion. The table displays a portion of the kaleidocycle’s motion as the legs transform between the flat and upright configurations.

APPLICATION: When the table is not in use, such as during storage or shipping, the legs can be folded flat and stacked with the tabletop to become a disc that is two feet across and only a few inches thick. The transforming leg assembly can be constructed with only three separate pieces if a compliant material such as polypropylene is used, but six pieces are needed when a more traditional structural material is selected.
A. As a kaleidocycle continuously rotates, the different faces alternate between facing away from the center and toward the center.

B. A rigid-body kaleidocycle can be constructed by joining six identical rigid links, each of which has pins at both ends that are offset from each other by 90 degrees.
C. The Circle/Circle Table’s legs are made of wood with six traditional rotating joints, but others have been built using polypropylene with three compliant “groove” joints as well as three traditional pin connections.

D. When laid flat, the legs have the same two-foot diameter footprint as the table-top so the two items can be stacked into a small, portable package.