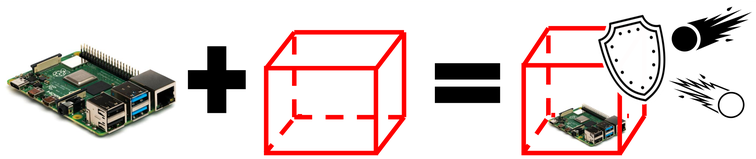
Protective PWA Housing via Compliant Mechanisms



Colin Neeson | Nolan Major |Joseph Maravilla

Mechanical Engineering
University of Colorado Boulder

Sandia National Laboratories

Acknowledgements: Miles Keeney-Ritchie, Gregory Whiting, Rebecca Komarek, James Harris, Joshua Crawford, CU Boulder Idea Forge, CU Boulder ITLL, Protolabs, MSU Denver, SolidWorks, Parametric Creo

PROJECT DESCRIPTION

Sandia National Laboratories is investigating the feasibility of additive and alternative manufacturing methods for low-volume production protective housings for Printed Wiring Assembly (PWA)'s that provide the same level of expected protection as current protective housing methods, but more cost competitive by making the housing one single piece. Use cases typically are in sensitive aerospace environments.

DESIGN CONSTRAINTS

- Single Assembly
- Single-Operation Manufacturing
- No assembly required
- PWA mounting without use of hardware
- Full Encasement of PWA
- Input Output Connection Access
- Repeat Insertion and Removal of PWA
- Limit Foreign Object Debris Ingress

RESULTS & KEY TAKEAWAYS

A toolset of different protective housing features has been developed for use in future applications with their respective manufacturing methods. Development through compliant mechanisms, additive and alternative manufacturing methods.

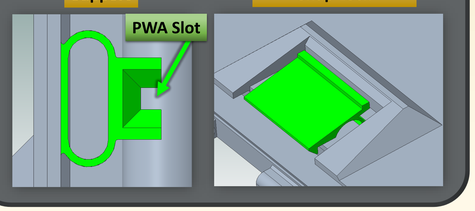
Feasible Material Suggestions

- Nylon 11 (SLS)
- Dual Durometer; Rigid/Flexible Material (Polyjet)
- ULTEM 9085 (FDM)
- ASA (FDM Dissolvable Supports)
- Smooth-On Ecoflex 00-35 Fast (Cast Mold)

Implementation Suggestions

Arc Support

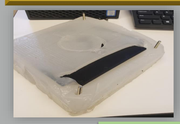
Protected Cantilever Snap Lock



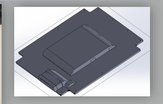
SFS (Single Flat Sheet)

Reliant on Fasteners to Prevent Side Ingress

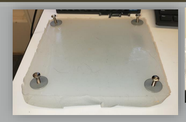
ALTERNATIVE METHODS



Fast to Create

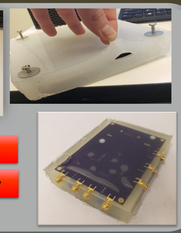


Highly Temperature Resistant



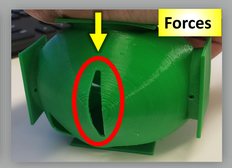
Sticky Surface

Imprecise/Messy



Silicone Molding

CLOSING METHODS



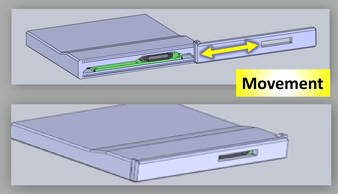
Slot Opens When Force is Applied, Closes when Force is Removed

Requires Flexible Material

Allows Foreign Object Debris Ingress

Coin Purse

Sliding Door

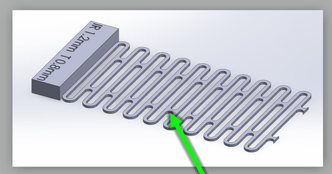


Small gaps, minimal foreign debris intrusion

Rigid, Non-Compliant

Tight Tolerances, Difficult Print

Slotted Kerf Bend Hinge



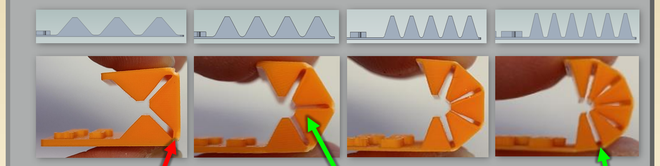
Converts Bending Forces to Torsional

Adds flexibility to stiffer materials

Has spring force that wants to return to initial print condition

Kerf Bend Hinge

More Triangles = Lower Stress & Bend Angle

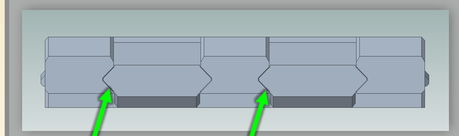


Higher Stress

Triangles Prevent Over Bending

Lower Stress

Conical Hinge

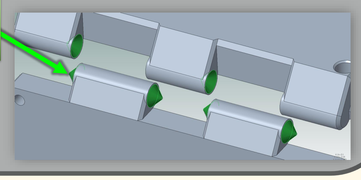


Rigid, Non-Compliant

Cannot Disassemble

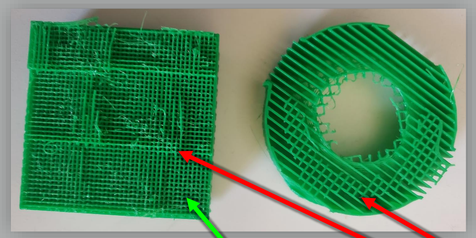
Fully Constrained excl. Rotation

45° Conical Geometry



Can Be Printed All Together with No Supports

SUPPORT METHODS

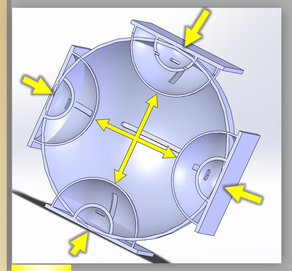


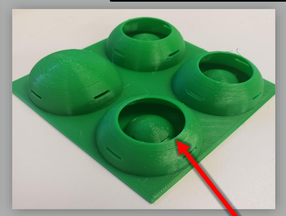
Can Generate Different Infill Patterns with Varying Density

Uneven Side Loading

Infill Support

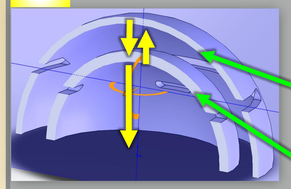
Dual-Compression-Rate Half Spheres





3D Printer Layer Printing Sensitivity

Forces



Low Associated Stiffness

High Associated Stiffness

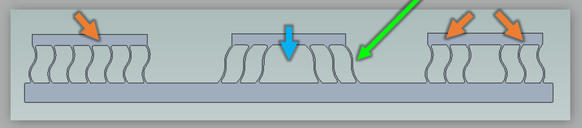
Compression Dampening

Arcs

Arcs = Simple Geometry

Compression can Exhibit Straight or Diagonal Loading

Smaller Feature or more Ribs = Stiffer Compression

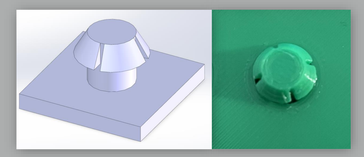


S-Curves = Complex Geometry

S-Curves normally exhibit Diagonal Loading but can be oriented to induce Straight Loading

Print Orientation Dependent

SECUREMENT METHODS



Strong Securement

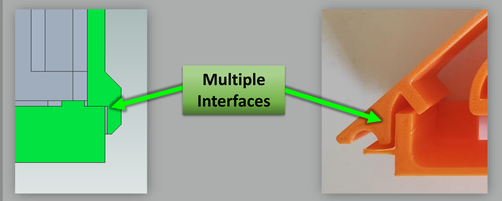
Adaptable, Variation of Shapes and Sizes

Requires more Flexible Material

Difficult to Remove Once Inserted

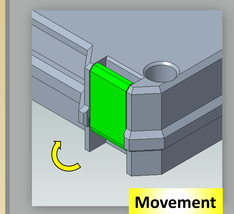
Pegs

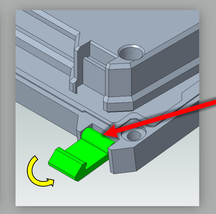
Torturous Path



Prevents FOD From Entering Housing

Clasp





Rigid, Non-Compliant

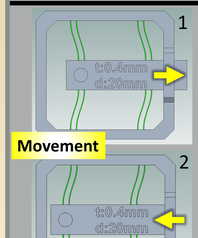
Requires Hinge

Small Space Claim

Strong Securement

Easy to Use

Pin Latch

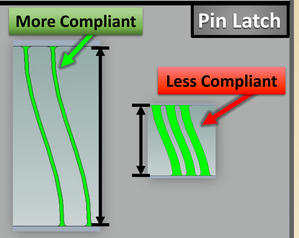


2 Position or Spring Loaded

Complex "S" Geometry

Requires Large Space Claim

Print Orientation Dependent



More Compliant

Less Compliant

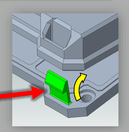
Shorter Distance, Thicker Ribs, More Ribs = Stiffer Behavior

Cantilever Snap Lock

Interior Cantilever

Exterior Cantilever

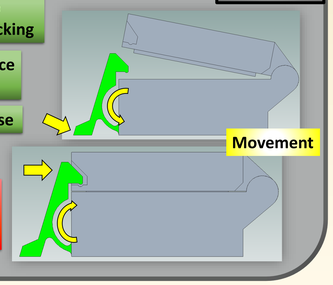
Easy to Break when Open



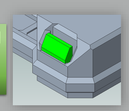
Auto Close/Locking

Small Space Claim

Easy to Use



Protected when Closed



Print Orientation Dependent