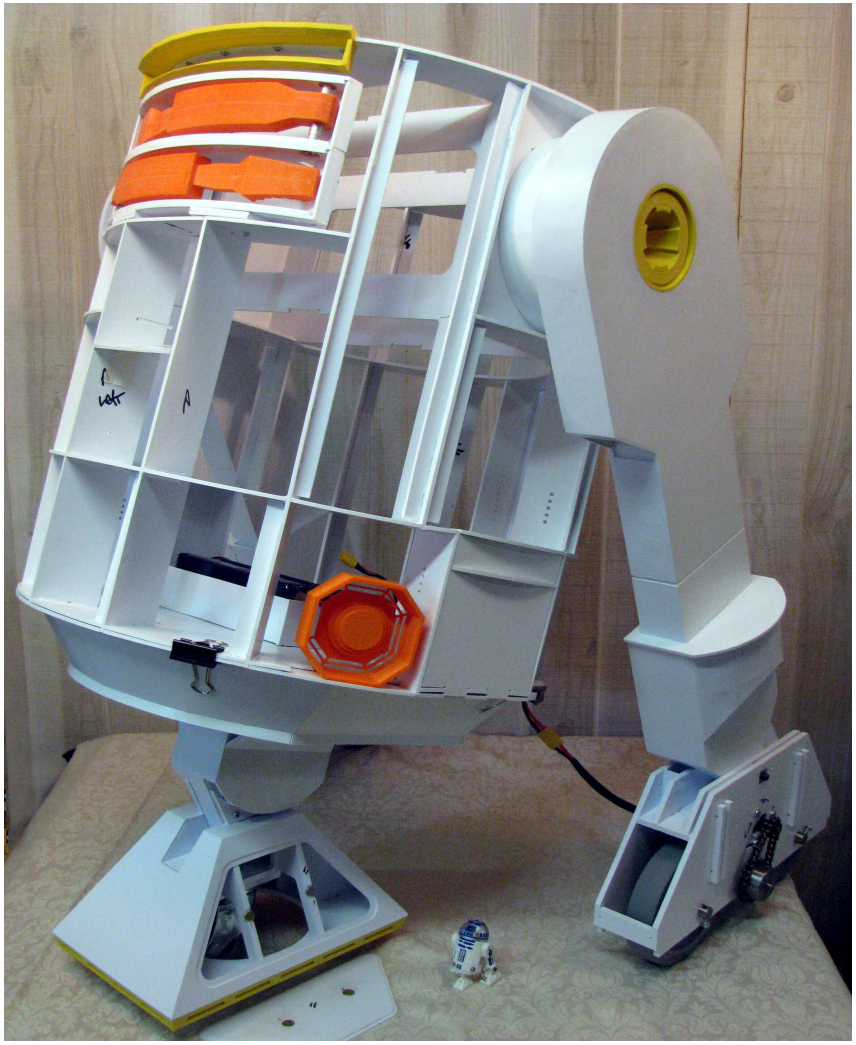
Droid Building with CNC Cut Styrene Parts



Outline

- Introduction & My Background
- What is a CNC Router
- What are it's Cutting Abilities & Limits
- Why I design R2 parts
- How I design R2 parts
- Frame Assembly Demonstration
- References

Introduction & My Background

- Grew up in a Machine Shop/Home Shop
- Engineer by training, EE & CS degrees
- Spent first 1/2 of my career doing Engineering Projects (fun!)
- Spent second 1/2 of my career in management (not nearly as much fun!)
- Retired 1999 and again in 2003

May 2008 Servo

What is a CNC Router ?

- CNC = Computer Numerical Control
- Computer Aided Design (CAD) Software creates drawings
- Computer Aided Manufacturing (CAM) converts them to machine instructions (G-code)
- CNC machine runs LinuxCNC software to drive stepper motors following G-code instructions to cut parts
- But – Why bother with CNC?
  - Poor Coordination & Accidents
  - Chance to build a better mousetrap
  - Features difficult to get using other methods

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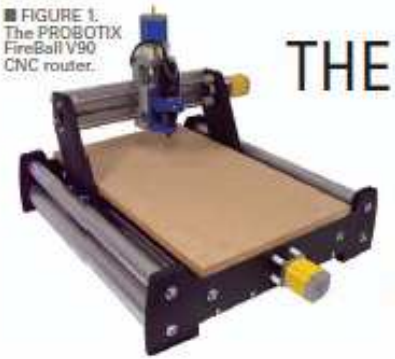
PERSONAL ROBOTICS

UNDERSTANDING, DESIGNING & CONSTRUCTING ROBOTS & ROBOTIC SYSTEMS

■ BY VERN GRANER

■ FIGURE 1. The PROBOTIX FireBall V90 CNC router.



THE PROBOTIX FIREBALL V90 CNC ROUTER

IN THIS MONTH'S ISSUE, WE CONSTRUCT THE PROBOTIX FireBall V90 CNC router from a kit and then put it through its paces.

TEA. EARL GREY. HOT.

Jean Luc Picard of *Star Trek* fame had high tech replication gadgets at his disposal. In his Utopian sci-fi future, these devices would be so common that they were used for such mundane tasks as making a cup of tea in the captain's quarters. Although we have a long way to go before we can expect any item we ask for to pop into existence from a wall-mounted gadget, some intrepid folks are diligently working in that direction, starting with automating the creation of parts.

When building things both robotic and mundane, I've found myself sanding, cutting, shaping, bending, and otherwise changing the physical shape of some item used in

I SEE, CNC!

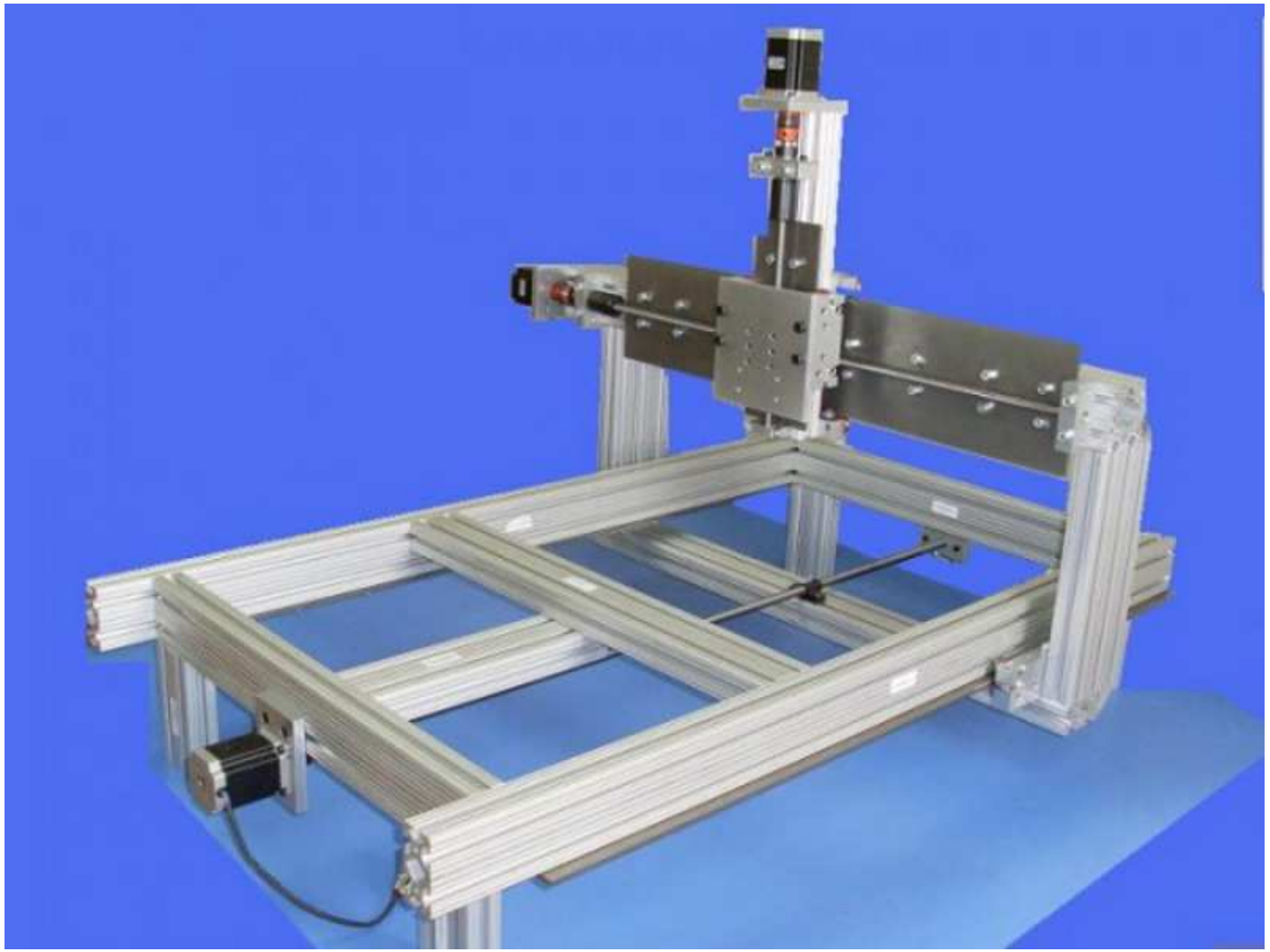
CNC or Computer Numeric Control is an acronym that refers to a tool that can cut or shape by using computer generated instructions (see the sidebar for a bit of history). Most CNC machines have a number of axes and a tool of some sort that can be guided by a computer to very precisely remove material. Originally created in the 1940s for the automation of large-scale manufacturing (Figure 2), CNC has become more capable over the years and has made its way down to small desk top fabrication systems. Though some small-project CNC systems are available to the hobbyist, most are in the multi-thousand dollar range so they

many of these tools on a typical hobby workbench.

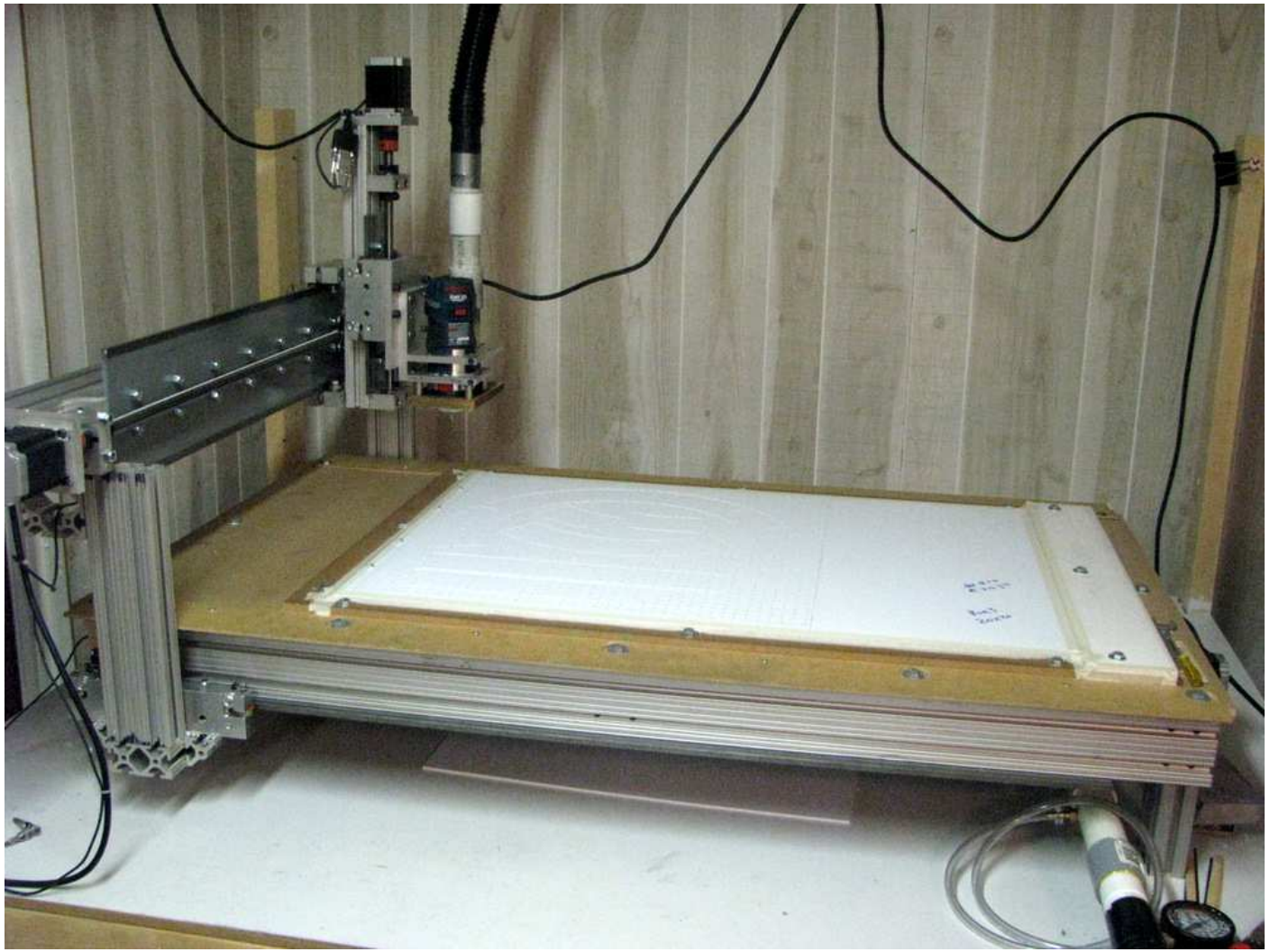
BRINGING DOWN THE PRICE

I was having lunch with long-time Robot Group member and good friend Paul Atkinson at Pok-e-Jo's BBQ restaurant here in Austin, TX where we were munching BBQ and talking tech while the electric train circled the dining room (see The TrainSaver, *Nuts & Volts*, July '06). Paul mentioned that he had recently read about a new CNC machine from PROBOTIX that seemed to have finally managed to break the $1,000

Typical CNC Machine



My CNC Router



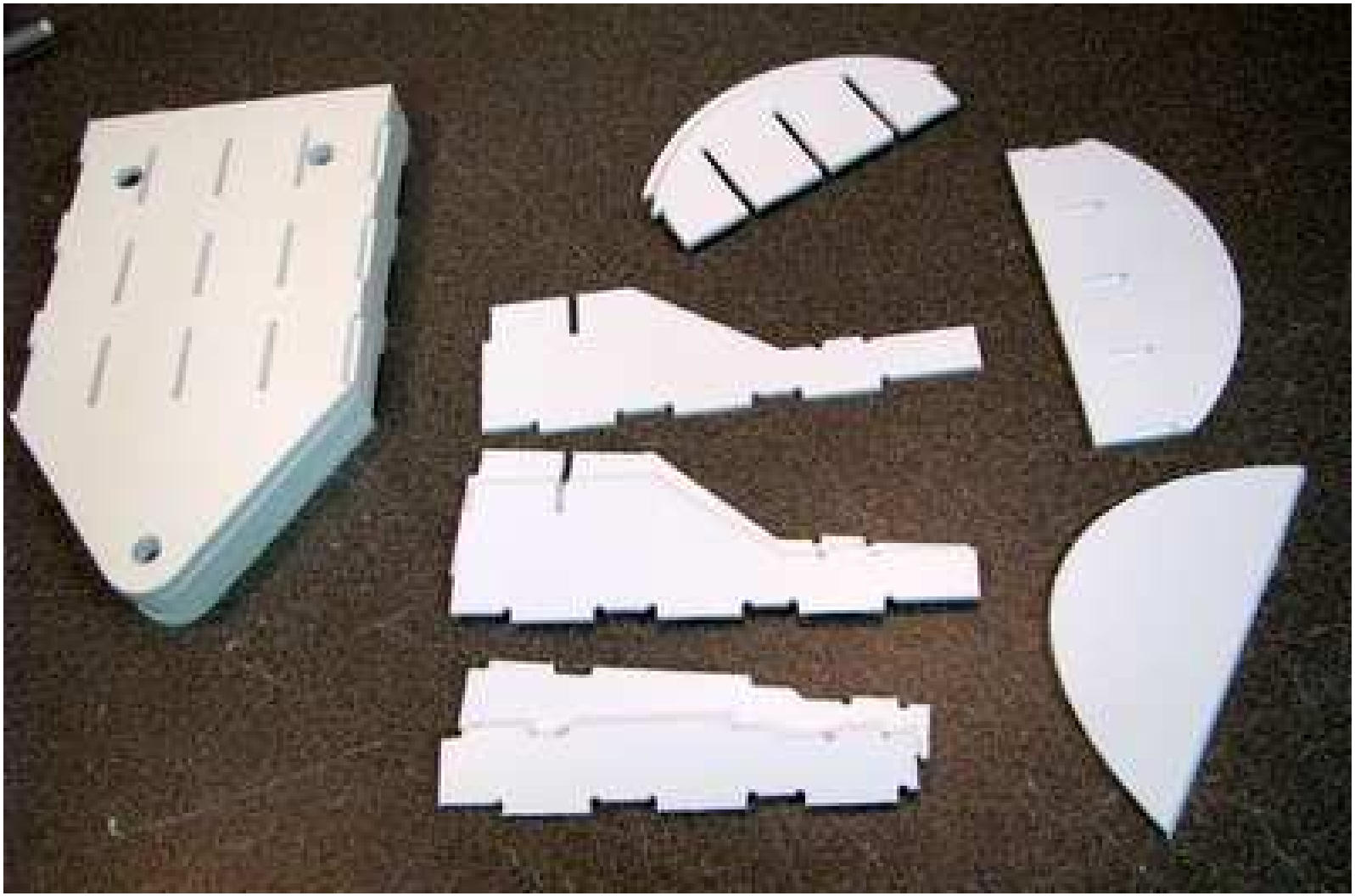
What are a CNC Routers cutting abilities & limits

- Typically 2D or 2.5D designs because the angle of the cutting head is fixed.
- Angle cuts restricted to 30,45,60 degrees by available cutters. Requires manual cutter change.
- Undercutting an edge would be difficult. Turning a part over to machine both sides also difficult.
- My machine bed is 24 in. x 36 in. Vacuum hold down 20 in. x 30 in. for sheet parts.
- Backlash limits accuracy to +/- .005 in. X and Y and bed leveling limits Z to +/- .01 in.

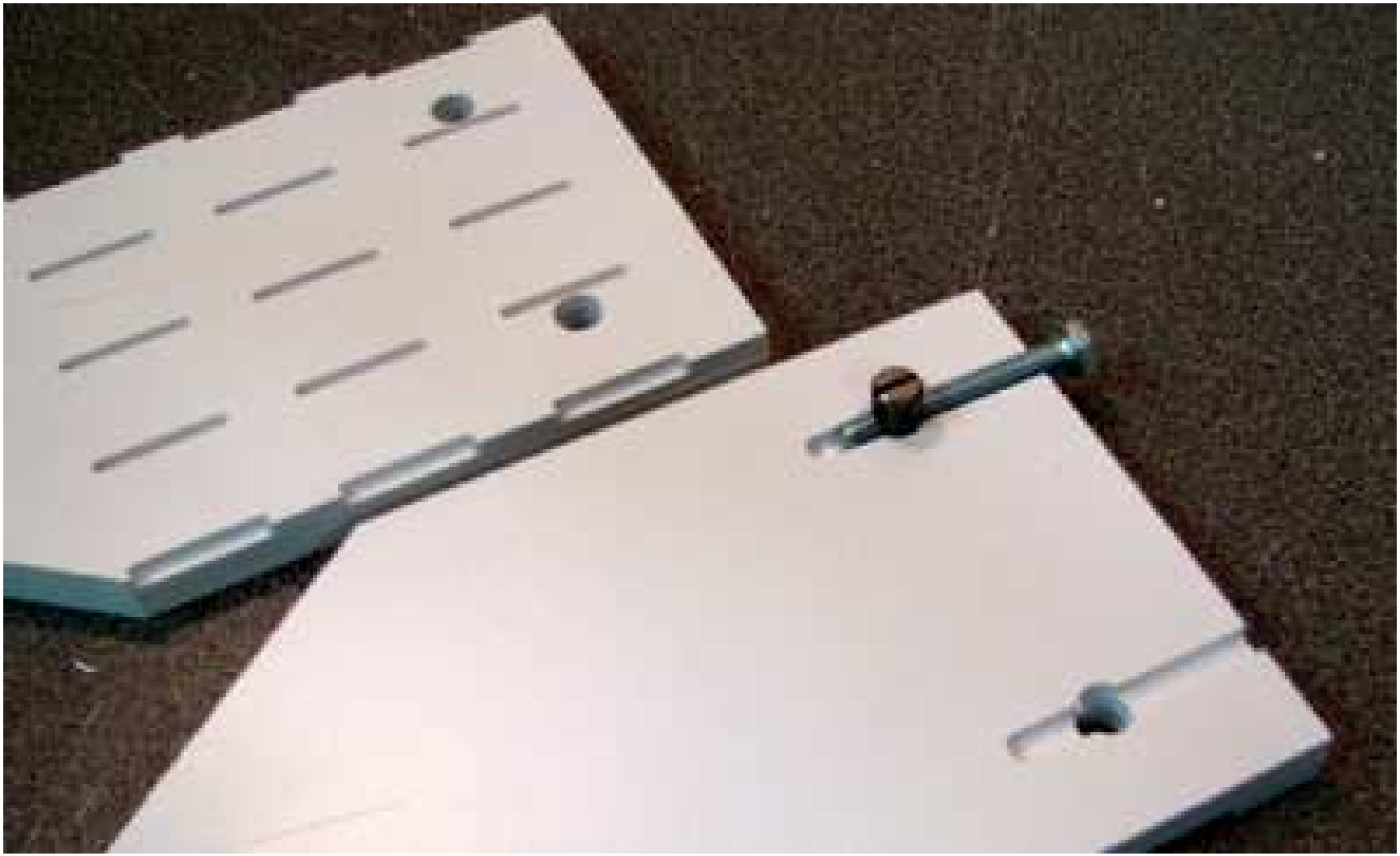
Why I design R2 parts

- Chance to build a better mouse trap
- Egg Crate designs add strength in the same way that an I-Beam is stronger than a flat piece of plastic
- Tab-in-Slot facilitates easy assembly by simplifying part registration.
- Sometimes I'm even smart enough to make it difficult/impossible to assemble wrong. But not always!
- CNC enables blind holes/slots
- Incorporate metal fasteners into Styrene Design.

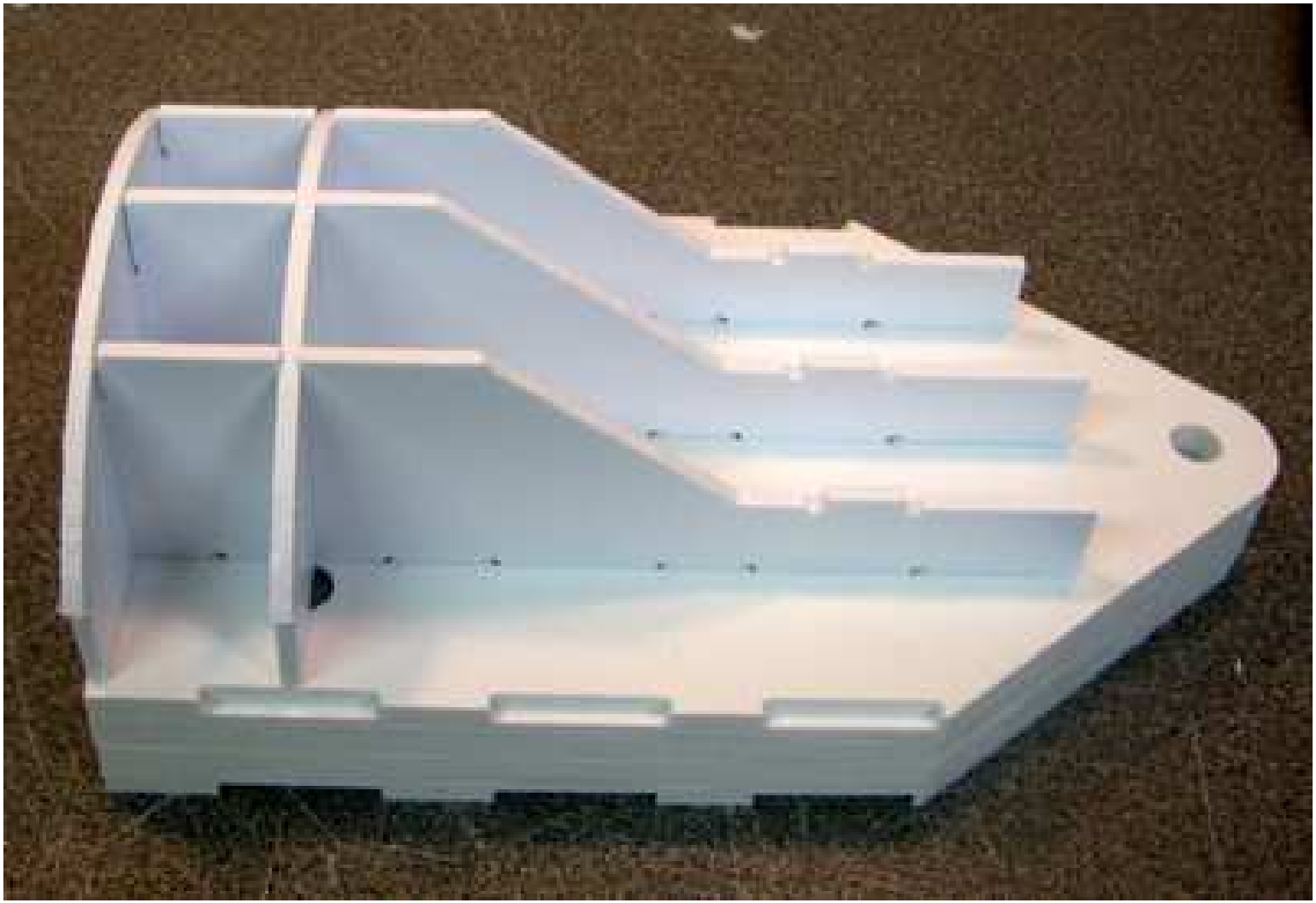
Part Features Example



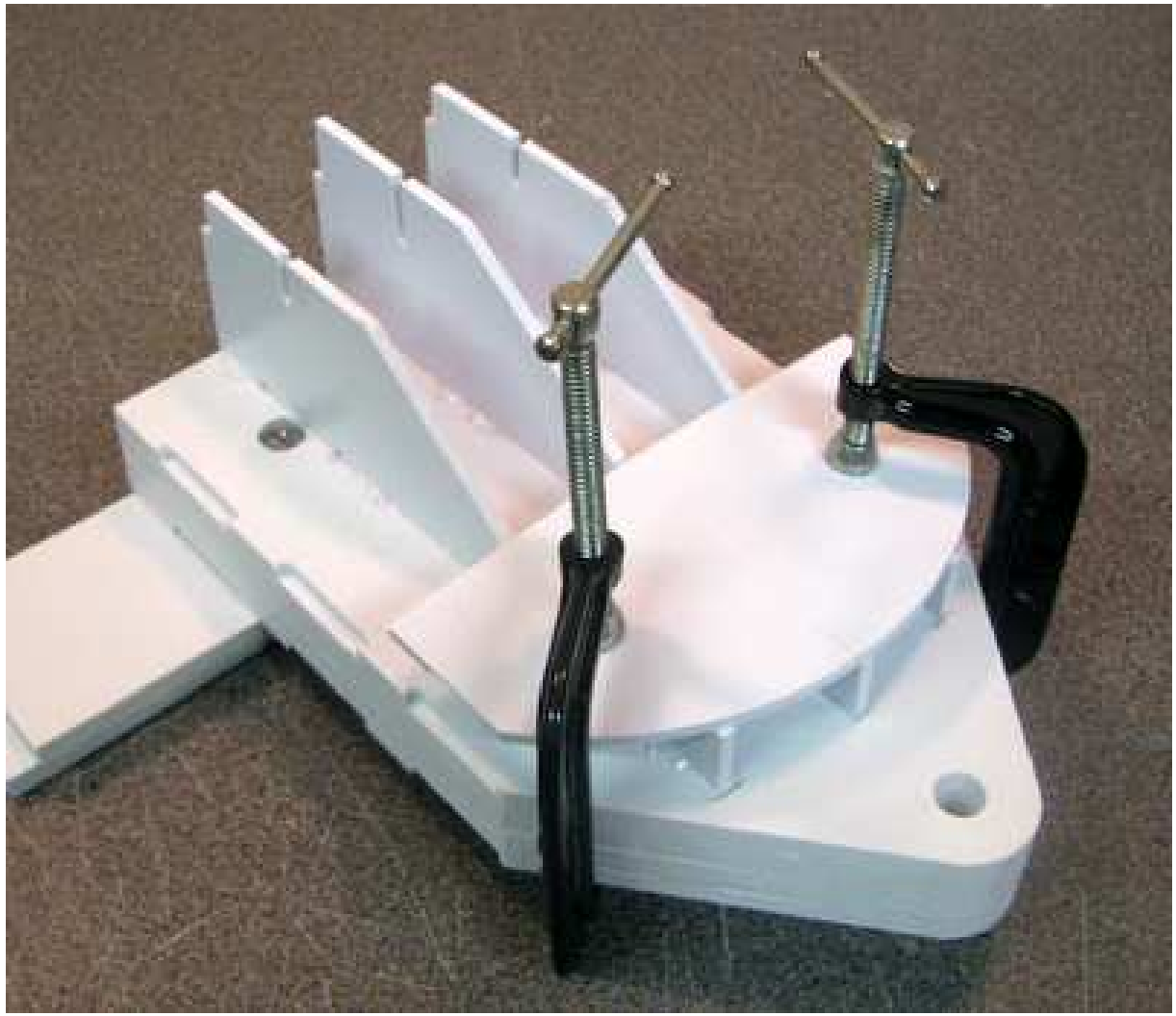
Metal Fasteners



Part Registration



Blind Features



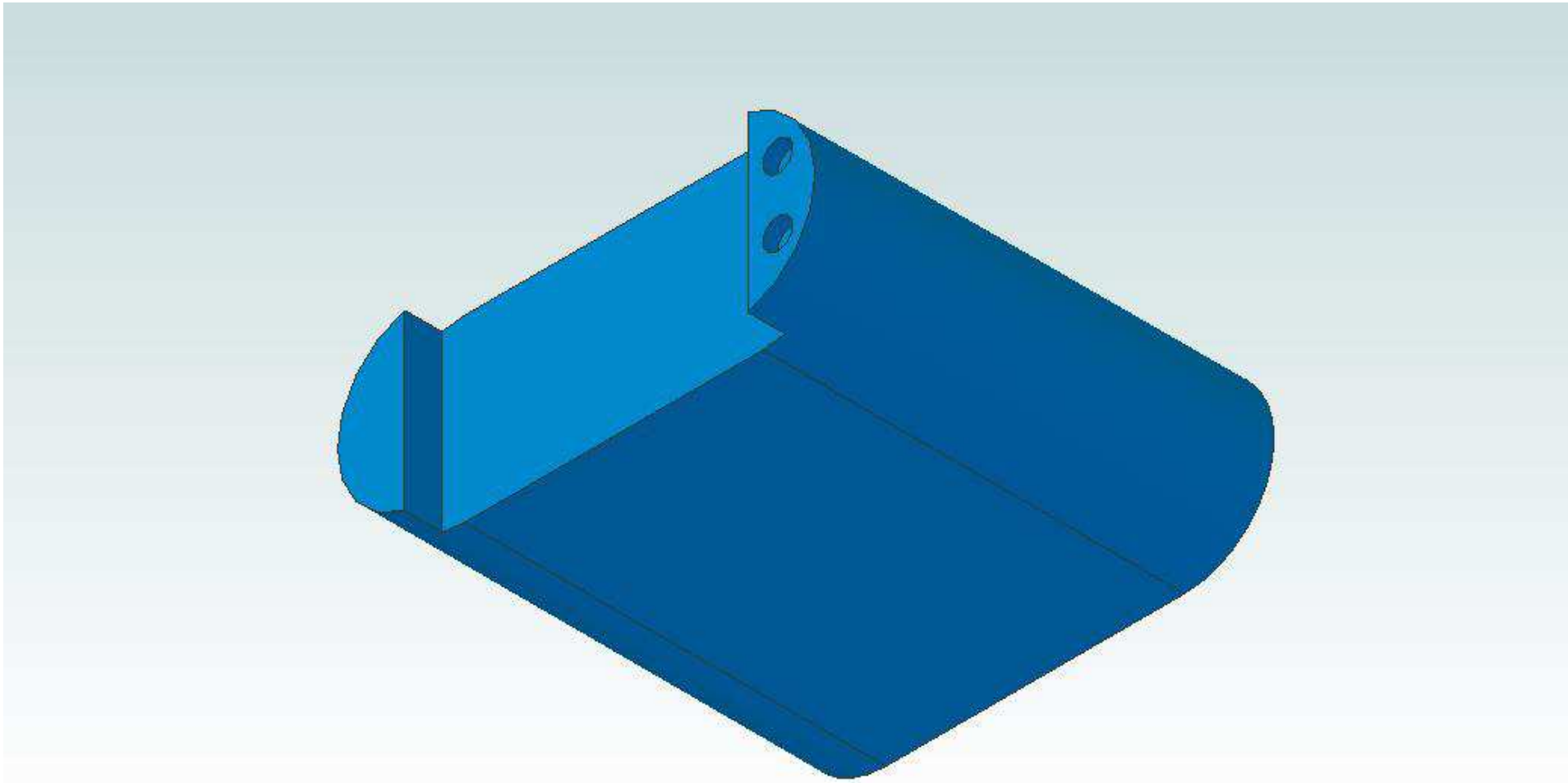
Part Strength

Part Strength

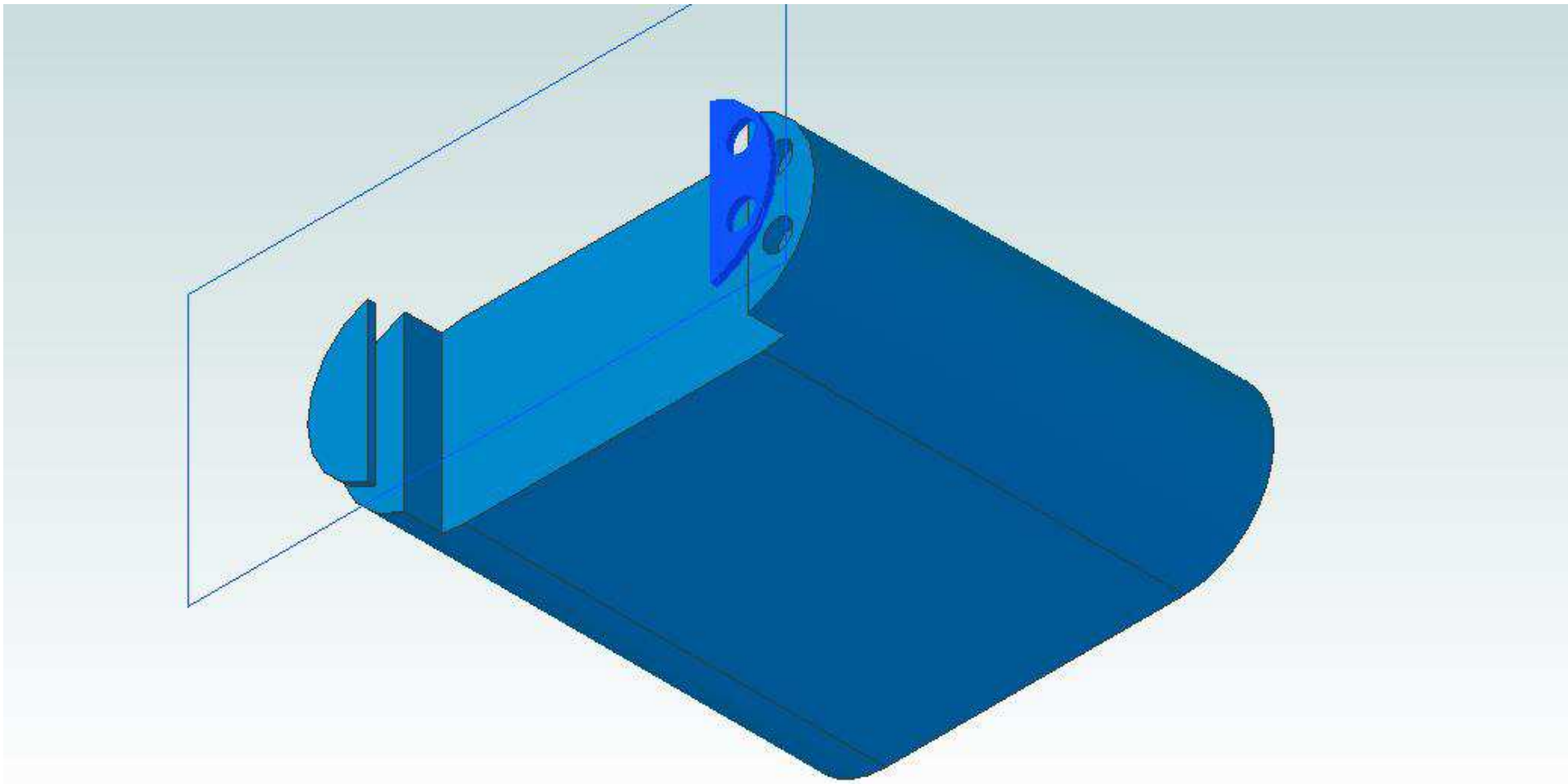
How I design R2 parts

- R2BC Source documents used for dimensional information to create 3D designs.
- Internal structures based on external constraints.
- 3D CAD design software lets me visualize parts and assembly process before cutting parts. I use Geomagic Design (formerly called Alibre Design).
- 2D parts placed on cutting grid to create ”panels”. Process sometimes referred to as part “nesting”. Further constrained by grid of holes used for vacuum hold down.
- Vectric Cut2D CAM software translates .dxf files from Alibre into G-code for the CNC machine.

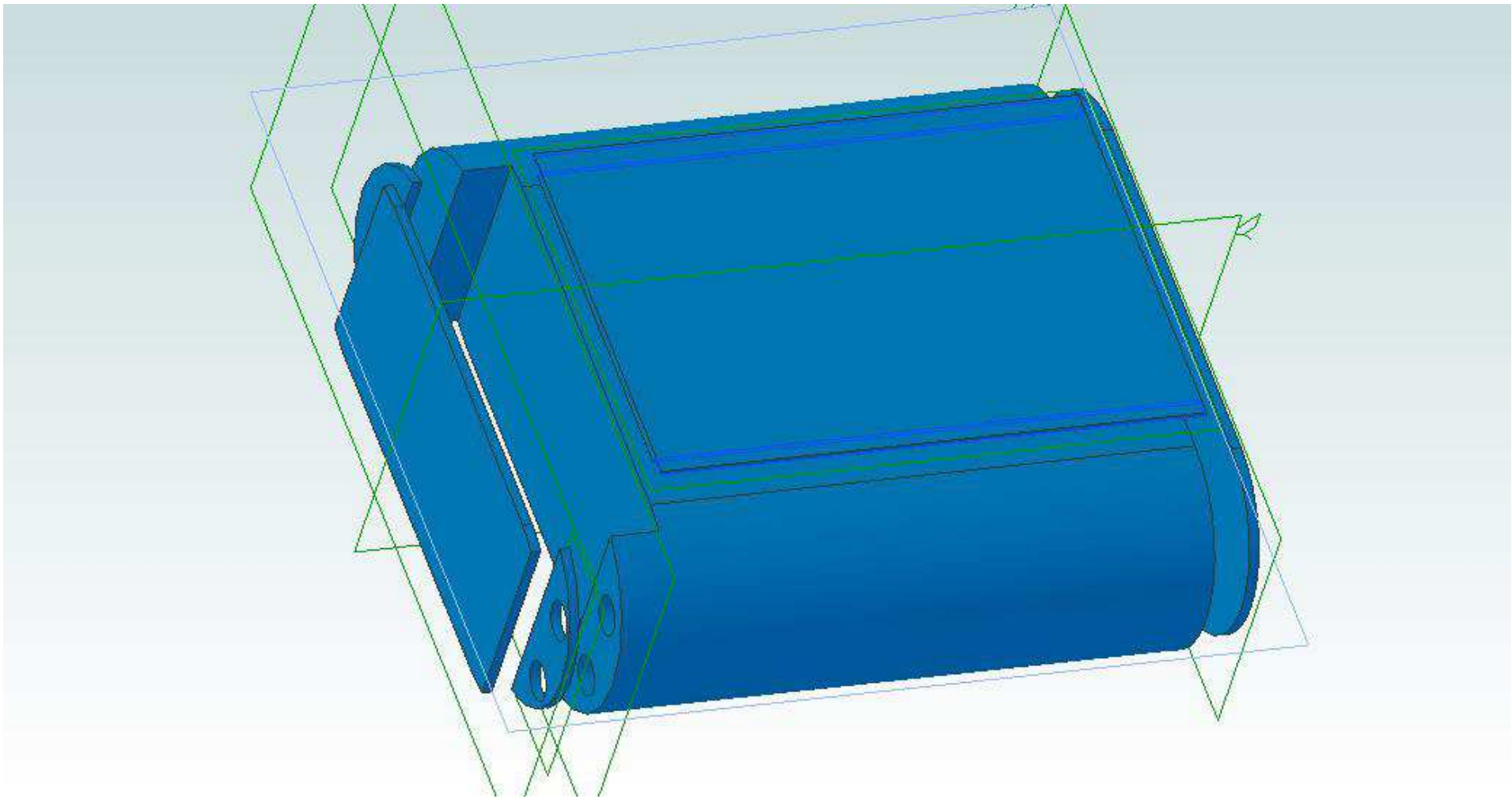
Battery Box Example



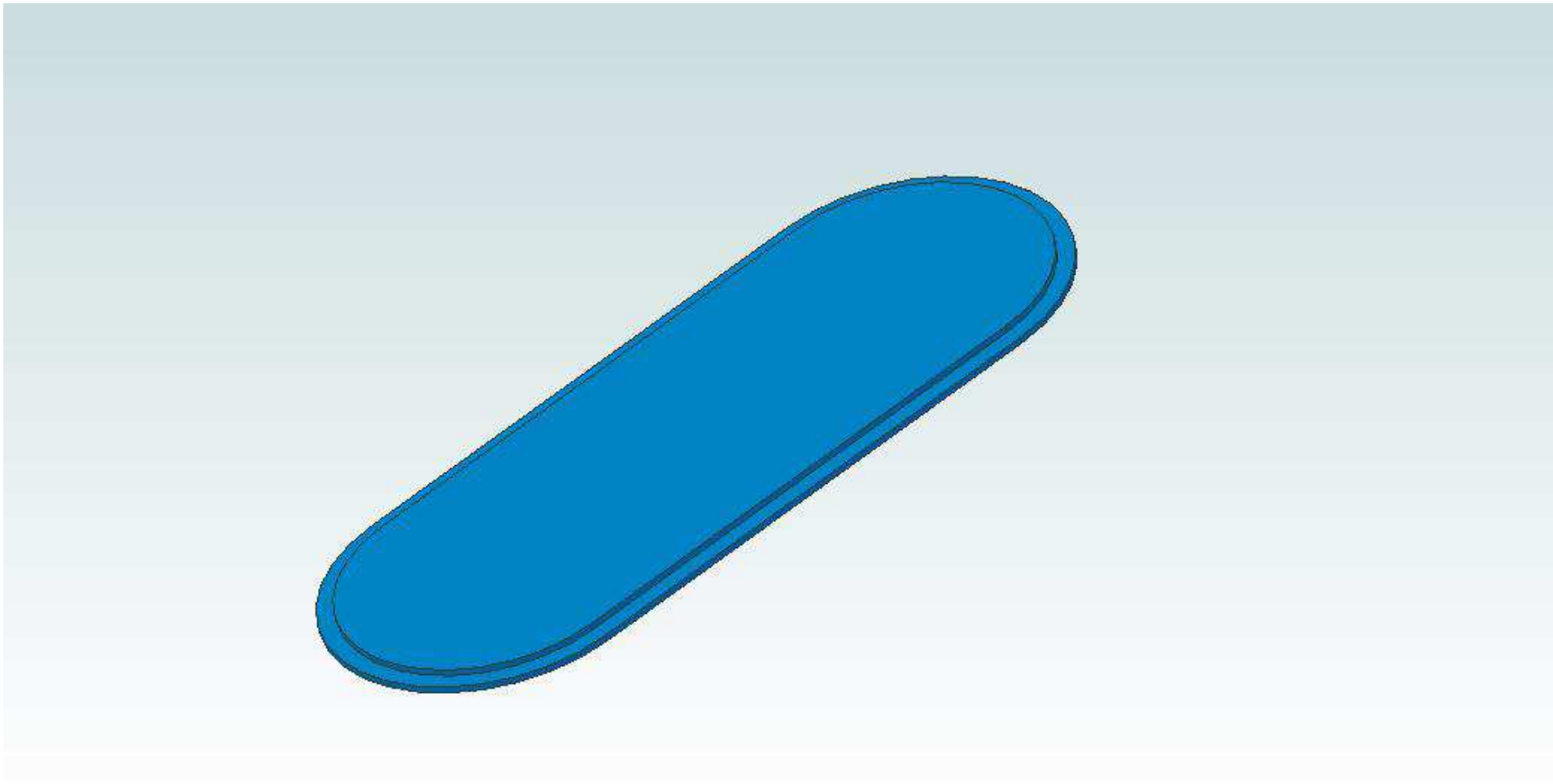
Battery Box Part Design



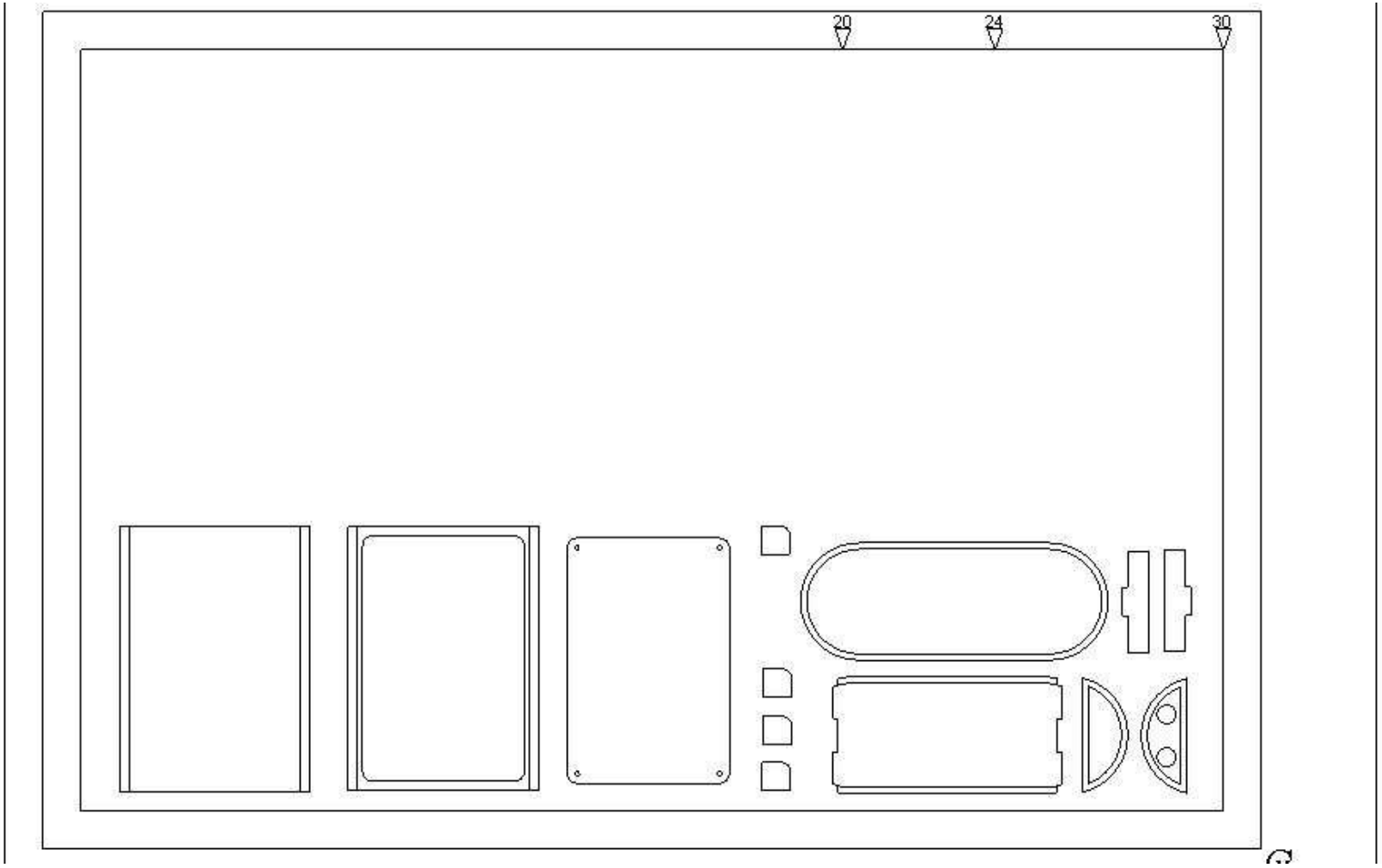
Battery Box Example



Battery Box Part Editing



Battery Box Part Nesting



Battery Box Assembly

Frame Assembly Demonstration

- I'm going to “cheat”
  - Parts already separated from panels
  - “tabs” removed
  - safety & time issues
- Using tape since this is “dry fit” trial assembly for the demo
- Once frame is assembled I'll introduce Paul Murphy, (joymonkey), who makes Single layer Milled Styrene Skins
- Together we will try to wrap my frame with a Styrene Skin
- Frame donated to DroidCon Fund Raising Raffle

References

- Media Conversions Web Sites
  - CNC machine info :http://www.cnc.media-conversions.net/index.html
  - R2D2 construction: http://www.r2d2.media-conversions.net/index.html
  - R2D2 CNC Cut Styrene Parts: http://www.r2d2-cnc.media-conversions.net/index.html
- CNC Router Parts - http://www.cncrouterparts.com
- Fine Line Automation Router Kits - http://www.finelineautomation.com/
- Geomagic Design (Formerly Alibre Design) software - http://www.alibre.com/
- Vectric Cut 2D software - http://www.vectric.com
- LinuxCNC software – http://www.linuxcnc.org/
- Paul Murphy's Single Layer Milled Skins - http://astromech.net/forums/showthread.php?t=14204
- This Presentation located at:http://www.r2d2.media-conversions.net/DroidConII

Droid Building with CNC Cut Styrene Parts