

PERSONAL ROBOTICS

UNDERSTANDING, DESIGNING & CONSTRUCTING ROBOTS & ROBOTIC SYSTEMS

■ BY VERN GRANER

A DROID OF YOUR OWN

IS IT POSSIBLE TO BUY A “KIT” OF R2-D2 parts and make your own full-sized replica R2-D2 droid? Nope. Is it possible to find a group of talented builders and crafters who are passionate about building droids and who will go to great lengths to help you create your own? You betcha!

The year was 1977 ... the theater in downtown McAllen, TX was playing *The Exorcist II* on screen 1 and on screen 2, was a little film called *Star Wars*. Since I was 14 at the time and I couldn't see *The Exorcist* (the ushers were sticklers about IDs), so I opted for *Star Wars*. Though I liked the horror genre, I'd always been a big science fiction fan, so there really wasn't much of a choice there to begin with. Though *Star Wars* was a

movie full of action and adventure, high drama, and low villains, it also introduced me to a little fellow whose model number has become synonymous with small robots – R2-D2.

Though the English-accented C3PO had his own unique charm, his sidekick R2-D2 was just beyond cool! Fitting perfectly into the ranks of other Hollywood robots such as B9 (a.k.a., The Robot) of *Lost In Space* fame, Robby from *The Forbidden Planet*, and even Huey, Dewey, and Louie from *Silent Running*, “artoo” (as Luke called him) was cute, lovable,

and very different from other robots seen previously on the silver screen. Though some have commented that R2 looks more or less like a rolling trash can – or even a futuristic shop vac – his shape and size, combined with his unique vocabulary of sounds has made him unmistakable to a generation of science fiction fans.

EVERYBODY WANTS ONE ... I WANT ONE TOO!

With the personal computer boom of the late 1970s and early '80s, a number of manufacturers rushed in with various personal robotic offerings, some of which were clearly inspired by the R2 droid. A good example is the RB5X from General Robotics Corporation (Figure 1). Like many kids at that time, I dreamed of owning a shiny plastic robotic companion, however the majority of robots marketed for home use in the 1980s were just too pricey to be affordable for regular folks. Most cost many thousands of dollars and were more likely to be purchased by

■ Sami Graner posing with Chris James' R2-D2 droid at RoboGames 2007.



■ FIGURE 1. The RB5X robot from General Robotics Corporation.

a school district or a university computer department than by a parent for some kids' birthday gift.

In the late 1980s, I did finally manage to acquire an R2-inspired robot from IDEAL toys — the Maxx Steel robot (Figure 2). Maxx was roughly the same height as an R2 (actually, a bit shorter) and he had dual arms that he could raise and lower. At the end of the arms he sported a rubber-lined "claw" that could hold a soda can, but not much else. He also spoke using a limited set of plain English canned phrases that you could string together to make sentences. You could program sounds, lights, music, and motion to make little "shows" he could perform on cue. Though cute and fairly advanced for his time, he was really more of a toy and frankly, he just wasn't R2.

A LONG TIME AGO ... IN A BROWSER FAR, FAR AWAY ...

Flash forward a few years (decades?) and I somehow ended up as the president of The Robot Group, Inc., a very active art and technology non-profit group. We have lots of talented members and a history of using our technological creations for community outreach and technological evangelism. Before one of our meetings, I was rummaging around the Internet for some clip art when I stumbled across the R2-D2 Builders Club (see Resources for link). They had an amazingly active membership and had even managed to compile a complete set of plans that would help someone to build their own R2-D2 unit!

I read through their message forum with excitement and drooled over galleries full of pictures of droids in various stages of construction and complete, fully-operational R2-D2 droids, as well! Creating an R2-D2 would be a perfect fit for our group, and would also be perfectly in line with our interest and events (not to mention it would place a real R2 within touching distance!).

I downloaded some of the plans and after having a closer look, my

■ FIGURE 2. The author's Maxx Steele robot.

enthusiasm was dimmed a bit when I realized just how much metalworking and/or wood crafting would be required to create some of the custom parts for an R2 unit. Though I knew that myself and other members of The Robot Group would be able to help out with the wiring, programming, radio control, and other robotic aspects of the droid, it would take a specific kind of experience and skill to create the movie-accurate mechanical "skeleton" of R2. We would need to find an expert for that. Luckily, we knew just where to look.

THOSE WHO CAN'T DO ... FIND SOMEONE WHO CAN!

Some of you may recall from my previous columns, the mention of a good friend and colleague of mine named Rick Abbott. Rick is a talented "old school" machinist and long-time member of The Robot Group. He always seems to be able to come through with just the right parts to make "Slot A" connect to "Tab B." I've always been a bit in awe of his skill, so I figured the project was probably well within his ability to do. What I didn't know was if building a replica R2-D2 droid would be something that would interest him. When I first broached the idea, he seemed eager to pit his skill against the challenge. I handed over all the web links and the printouts I had created from the plans and hoped for the best.

After a few weeks, he brought a small box to our weekly Robot Group meeting. He opened the box and displayed a small, finely worked piece of aluminum (Figure 3). He said "this is a shoulder hub

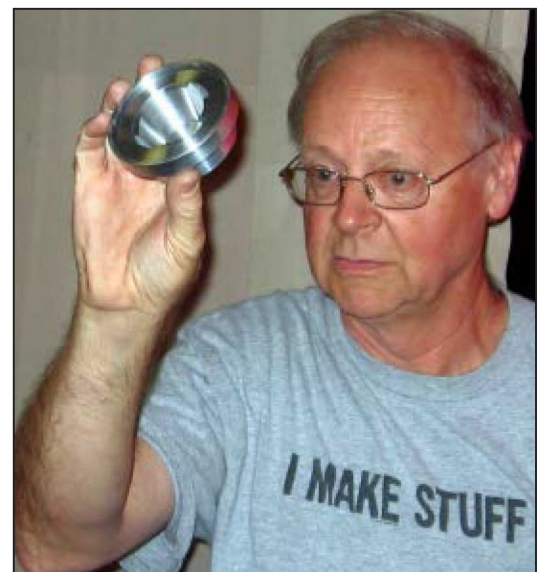
■ FIGURE 3. Rick Abbott showing his hand-machined aluminum R2-D2 shoulder hub.



for an R2-D2 robot." At that point, I knew he was hooked!

FORM FOLLOWS ... SCRIPT?

Typically, the form of a given personal or industrial robot will closely follow the parts used to create it or the function(s) it is designed to perform. Small experimental robots like the Boe-Bot from Parallax or the Hexcrawler from Crustcrawler have no discernible cosmetic features. Their





■ FIGURE 4. Rick Abbott's R2-D2 ankle cylinder.

chassis are built with functionality in mind — providing mounting points for add-on devices and making all aspects of the robot visible for demonstration, education, and experimentation. Even larger robots such as those built for robot combat will rarely have purely cosmetic components.

Though most combat robots have a “body,” it is usually there as an active part of the robot (i.e., armor). The battery cases contain,



■ Leg assembly with ankle attached.

parts. When Rick started to build the R2 unit, one of the first things he built was a very detailed and completely non-operational part called an ankle cylinder (Figure 4). He would hold it up and talk to me about the angles of the surfaces and the jigs he had to build to get it right and then he

well ... batteries, the wiring looms, and wire! If there are brackets, screws, or bolts, the loss of those parts would usually lead to the failure of all or part of the machine. In most cases, if there are any decorations added, they are an afterthought and take the form of decals or a nice paint job.

One of the more interesting aspects of building an R2-D2 replica is that the plans are very specific about the angles, sizes, colors, and shapes of just about all of the visible

would plaintively say “well, it’s pretty but it doesn’t do anything!”

This was new territory for Rick (and the rest of us, as well) since, in most cases, each thing we fabricate usually has a specific purpose. For example, when Rick built his Stirling engine (Figure 5), each part had a reason to be made, a place to be, and a purpose to perform. If he made the part incorrectly, the device would perform poorly or would simply fail. In the case of R2, many of the most intricate and difficult to create parts are purely cosmetic. This is not to say that the creation of the part is any less exacting; only that when you’re done, the ultimate test isn’t whether or not the final assembly works, but rather if it looks right.

R2-D2 TRIVIA AND LITTLE KNOWN FACTS

- The sounds R2-D2 makes are based on the inarticulate emotive sounds such as those made by babies before they attain the power of speech. This was done to increase the chances of the audience identifying with and responding to the character. The composite sounds make R2 more “human” in nature, in spite of the non-humanoid body.
- George Lucas came up with the name R2-D2 from the heading on a cue sheet for the making of the film *THX-1138*. “R2-D2” was shorthand for “Reel 2, Dialog 2.”
- In the first *Star Wars* movie, when R2 was in a two-leg stance, it was actually the actor Kenny Baker in an R2-D2 “suit” that was responsible for all the motions of the droid. When the droid was rolling, it was actually a radio controlled unit.
- When George Lucas proposed building the droids for the first movie in 1976, the animatronics experts he consulted said it would be “virtually impossible” to create mechanical beings with the functionality he described without investing thousands of dollars and multiple years. Turns out they were right.
- In the first *Star Wars* film, the prop department created R2-D2 droids in “two-foot” (i.e., standing) and “three-foot” (i.e., driving) stances for filming. They only created one prop that could transition from two-foot to three-foot stance using a simple pneumatic cylinder. However, this droid had to be manually reset into the two-foot position. Only droids built by the R2-D2 Builders Club have been able to accomplish a complete two-foot to three-foot and back again transition (called a “2-3-2”).

THE SITH IS IN THE DETAILS

Though there are plans, diagrams, and example finished droids to use as a reference, each droid is a unique creation of its builder. Almost all finished droids

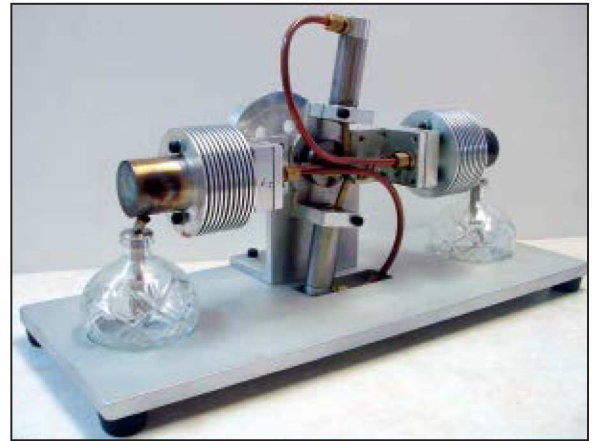
■ R2-D2 ankle assembly.



look identical on the outside, however, on the inside things can be done VERY differently on each droid. The system used to rotate the dome, the system used to drive the wheels, the various accessories such as the periscope, holoprojector eye motion, and the like may or may not be in every droid. Also, the internal wiring, motor speed controllers, sound system, radio control, and sound playback systems vary from droid to droid (Figure 6). History has also shown that a broad range of material may be used to create these droids. A basic static unit (i.e., non-motorized) can be made from relatively simple

■ FIGURE 5. Model Stirling engine by Rick Abbott.

materials such as a section of cardboard tube concrete form, wood for legs, and a painted acrylic "squirrel shield" for a dome. The more advanced builders sometimes go for a complete aluminum droid made from all machined metal parts. I have seen resin and wood R2 units that are beautiful to behold (Figure 7), but for me a full-aluminum R2-D2 is the most exciting as it has the look and



feel of a "real" droid. I'm really looking forward to Rick finishing his.

EXCERPTS FROM FREQUENTLY ASKED QUESTIONS ABOUT THE R2-D2 ROBOT BUILDERS CLUB

How the Club works

The Club is as much a social club as it is a technical forum; feel free to discuss any experiences you have had building your droid.

If you wish to ask something or discuss something that is not directly related to building an R2, just place an OT: (Off Topic) designation in the title of your post. For example, if you wish to discuss the color of C3P0 and you think someone in the group may be able to help, you may title it something like

OT: C3P0 colors?

Please note, that while the club is willing to discuss some topics not directly related to R2, you should not drift too far from the subject. Also, we do not under any circumstances discuss anything which may be considered "profiteering." We do not sell parts for profit or sell complete R2s, as this would breach copyright rules. We also do not discuss VCDs or DVDs, which have been pirated or downloaded off the net. We do not allow SPAM or sales pitches or advertising for any other products.

Also note the group individuals do not make a habit of answering questions via private email, as usually if the question is worth asking, it is

worth posting to the group. However, should a member decide that the information is not worth posting to the group they may then elect to continue a private conversation with the person with the question.

Remember, we do NOT sell complete kits.

Legalities: Copyright Generalization

To create replicas of ANYBODY'S intellectual property (including but not limited to Lucasfilms) is NOT a violation of any copyright law on the books today. To display PICTURES of a REPLICA of somebody's intellectual property and label it as such with no deception intended is NOT a violation of any copyright law on the books today. To create a replica of somebody's intellectual property and then try to SELL it for a profit (even as little as one cent) IS a violation of copyright law. To create a replica of somebody's intellectual property and then try to REPRESENT it as the ORIGINAL (even if it's not for profit) IS a violation of copyright law.

What will it cost me?

This question has SO many variables. The main one is you and what kind of handyman you are. You can spend anything from \$100 to \$3,000 depending on materials, finishes, and electronics.

If you make the parts yourself, the cost can be in the low/mid hundreds, taking a year or two. If you buy most parts, the cost can be in the thousands and take about a year. If you add motors and R/C, add on several months and a couple

hundred. You have to factor in how handy you are, how much time you want to put into this, and what you want your R2 to do.

It also depends if you have a good set of tools to work with; the actual costs of materials can be quite inexpensive, however if you are required to buy tools you do not have to build it, then that becomes an added cost.

It will also depend on what material you want your parts made of: plastic, aluminum, or wood.

The finished result will be up to you; even a very cheaply built R2 can be very accurate.

A good recommendation is to leave the electronics/motors and R/C equipment purchases till last. This way, if your budget changes or your building designs change you will not be spending money on equipment that you may not need at the end. These are also the more expensive parts of any droid.

Where do I get a kit?

You will not find an "R2-D2 in a Box" type kit from this club. This group is based on communicating with each other on how we built our own droids. You will find a number of members offer individual parts but not an entire kit.

Try posting what you're looking for, one or two individual parts at a time. The people that supply those parts will be able to contact you.

The above excerpt is courtesy of the R2BC and the robotbuilders.net website. The complete FAQ is available at www.robotbuilders.net/r2.



■ Rick Abbot with R2-D2 frame.

THIS IS THE DROID YOU ARE WORKING FOR

Though Rick has made amazing

■ FIGURE 7. Dave Calkins' wood and resin R2-D2.



■ FIGURE 6. Chris James' R2-D2 internal wiring and control electronics.

it was quite a sight. The people streamed along behind his droid like it was the Pied Piper and — in a way — it really was! Chris can use his remote control to trigger the droid to play the “Cantina Band” song from its little speaker. The kids all start to dance around while the parents tap their feet in time and Chris wiggles the joystick to make R2 dance. It’s really an amazing sight. No matter where he and his droid go, they’re sure to put a smile on every face.

R2 B.C.

No, we’re not talking about a prehistoric droid. We’re talking about the R2-D2 Builders Club. Founded by Dave Everett in Australia in 1999, this is the place to go if you are interested in building a droid of your own. To learn more about R2-D2 builders and the amazing and touching story of how

progress towards a complete R2-D2, he’s not far enough along yet to actually drive it around and show it off (Figure 8). However, I was lucky enough to meet up with someone who had a completed droid at RoboGames in 2007. Chris James rolled his R2 unit up to the *Nuts & Volts* table and

■ FIGURE 8. Rick’s R2-D2 at Maker Faire Austin in 2007.



RESOURCES

- The Official R2 Builders Group website (need a password to enter) www.astromech.net
- R2-D2 Trivia Source www.starwars.com/episode-i/bts/profile/f19990414
- R2-D2 plans, photos, and message board <http://movies.groups.yahoo.com/group/r2builders/>
- Hexcrawler robot from Crustcrawler www.crustcrawler.com
- The Robot Group www.TheRobotGroup.org
- Boe-Bot from Parallax www.parallax.com
- Chris James www.artoo-detoo.net

a pink droid named "R2-KT" came to be, please pick up this month's issue of *SERVO Magazine* and check out the feature article "The R2 Builders Club and the Jedi Code." In the meantime, Rick will be continuing to build parts for his R2 unit and as he progresses, I'll make sure to take lots of pictures and share his progress in the future. **NV**

Special thanks to Rick Abbott, Chris James, and the good folks at the R2-D2 Builders Club!

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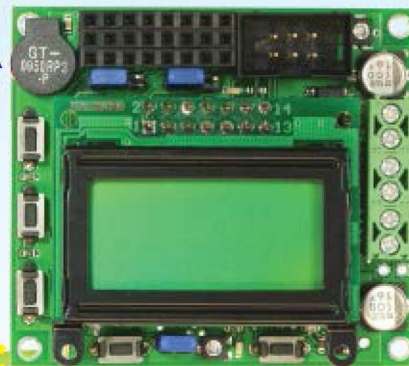
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