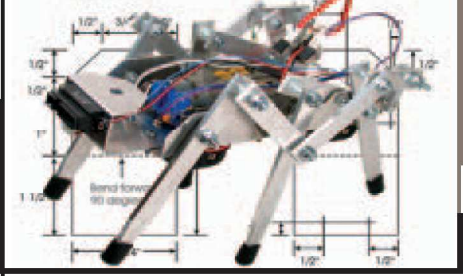


■ BY VERN GRANER

HABITAT FOR HOBBIES — PART 2

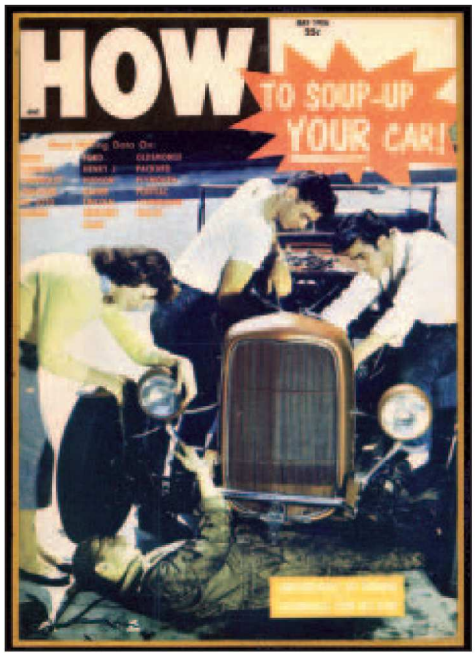
IN THE PERSONAL ROBOTICS COLUMN "Habitat for Hobbies — Part 1" (June '08 *Nuts & Volts*), I featured the workbenches of some of the *Nuts & Volts* readers. Not only did we get pictures of their environments, but many folks shared their stories and philosophies about how to create a productive and functional workspace. In this month's column, I'll complete the series by showing my own workspace (it's only fair, after all), sharing a bit of my design approach, and announcing the winners of the Workbench Design Challenge!

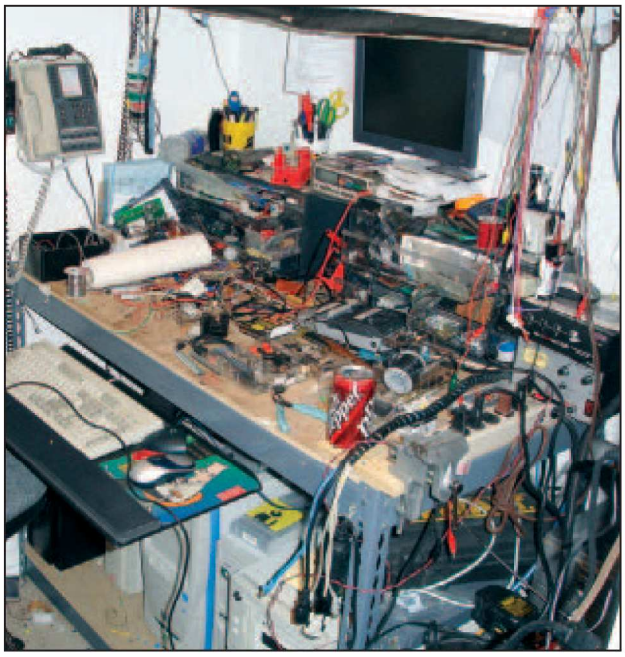
A PLACE FOR EVERYTHING AND EVERYTHING OUT OF PLACE?

As a kid growing up, my dad had a well-equipped workbench in the garage. He used it for maintaining our vehicles, fixing toys (i.e., reassembling things someone took apart), and reviving the occasional kitchen appliance. He had a typical mechanic's toolbox with wrenches, screwdrivers, socket sets, and the like. Many of his tools were decades old and proudly bore the grease stains of their use. When my dad was in high school, he decided he wanted a car so with the help of his friends he built one (from the ground up!) in his garage with those tools. The car ended up winning quite a few drag races and even ended up on the cover of HOW *Magazine* in 1957 (Figure 1). Maybe that's where I get the fearless approach I have to tackling big projects.

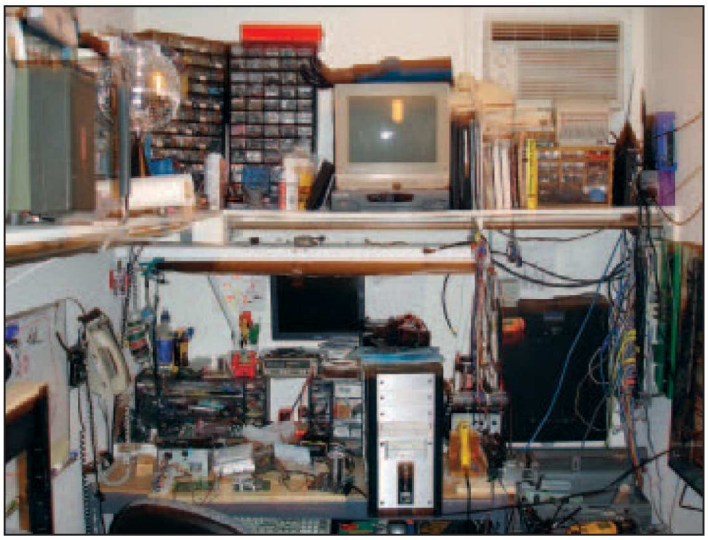
My understanding of tools and workbench design was inspired by my dad and how he kept his bench. However, I must admit that my dad's approach to workbench layout was much more organized than mine has turned out to be. I don't know if I'm just inherently less organized than "dear 'ol dad" or if it's more a matter of "form follows function." For example, the function of his workbench seemed to be focused on taking existing things and restoring them to functional states (or performing maintenance to keep them functional). There was usually a clear task to perform and specific tools required to do it. Whereas *my* workbench

■ FIGURE 1. The 1957 *HOW Magazine* cover featuring Wally Graner's home-built flathead V8. Also on the cover were (top) Don Johnson, (right) Al D'minco, (left) Marilyn Dobbins, and (bottom) Wally Graner.





■ FIGURE 2. Vern Graner's workbench — a converted closet approximately 6' x 10' showing how it looks during the course of a typical project.



■ FIGURE 3. Notice the air conditioner unit in the top right corner? Lights, computers, soldering irons, and other equipment give off quite a bit of heat!

■ FIGURE 4. Storage rack to the left of my workbench holds partially assembled projects, broken "junk" pieces, parts, and (in many cases) inspiration.

has to be able to support the creating or inventing of things that only exist in vague concepts or rough sketches. In many cases, I don't know exactly what I will need till I'm done with a build! Have a look at the Ponginator (*N&V* December '07), the RoboSpinArt machine (*N&V* January '08), the Ping Pong Printer (*N&V* February '08), or the Power Flowers (July '08) for good examples of what I'm talking about (see Resources for links to videos).

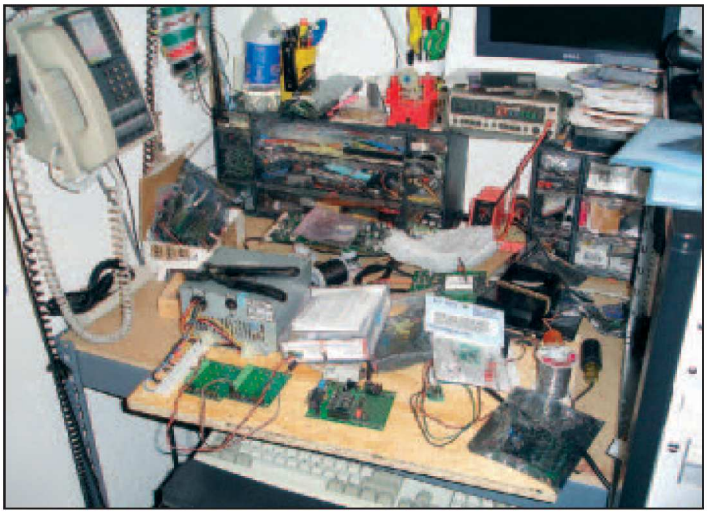
I KNOW IT'S HERE SOMEWHERE ...

When looking at the pictures that came in from all around the country for the first Habitat column, I started to wonder ... am I really that much less organized than other folks, or did some of you just clean up your workbenches before sending in the photos? The bottom line is that my workspace is typically a visual cacophony of parts, tools, documentation, media, wire, and well ... just have a look at the pictures of my bench in Figures 2 and 3 and you can see quite clearly.

Somehow though, I can usually lay my hands on just about anything I need. I seem to have a "relational" memory in that I can remember approximately where something is "buried" and then home in on that area of my workspace to find it (Figure 4). I try to keep like-parts in the same place so if I can't find exactly what I set out to find, I can usually find something similar (Figure 5). Although I drool over the highly organized workspaces such as those submitted for Part 1, I imagine that if I were to create one, it would quickly become just as chaotic as my existing workspace is. I do try, though. For example, before I begin a project, I start by cleaning up my workbench and putting all the tools and parts away. However, when I'm actually creating stuff (Figure 6), I'm just too busy to put things back carefully where they belong. My wife thinks it's laziness ... I blame entropy. But

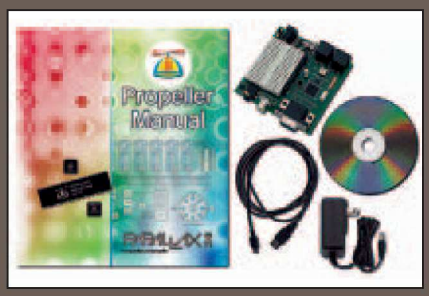
■ FIGURE 5. Main storage rack just outside the door to the 60 square-foot "shop" hold items too big to fit inside the shop.

■ FIGURE 6. The workbench at project start-up sporting the parts that would eventually become an animatronic haunt controller.



■ *1st place prize*: A Parallax USB Oscilloscope.

■ *2nd place prize*: A Parallax Propeller Starter Kit.



■ *3rd place prize*: A Parallax BASIC Stamp 1 Starter Kit.

enough about my workbench, let's have a look at some workbenches created under some unusual and rather challenging conditions.

THE $100 WORKBENCH DESIGN CHALLENGE WINNER!

I had quite a few entries in response to the challenge and I have to say it was a lot tougher to determine a clear winner than I thought it would be! After much soul searching, internal arguments, sleepless nights (okay, maybe a coin toss or two), the prizes went to the following entrants:

3RD PLACE – NICHOLAS KUCKUCK OF ROSEBURG, OR

Though only 13 years old, Nicholas did a thorough job of researching parts and tools. He was one of the first entrants to choose "surprise" packages of bulk components from vendors to save money while stocking up on parts. His entry had a good balance of parts, test gear, components, and tools.

2ND PLACE – JESS LEWIS OF CHANDLER, AZ

Jess was the first entry I received and it helped set the tone for all the entries that followed. He include a nice cross-section of tools and parts coupled with a succinct summary of the reasons for his choices. He also included links to websites where you can download free software that would allow a PC to be used as an oscilloscope and a curve tracer (see Resources). The inclusion of "grab bag" bulk items from some vendors was an added plus.

And the winner of the Workbench Design Challenge:

1ST PLACE – ANDREW AYERS OF GLENDALE, AZ

In the end, I kept coming back to the entry from Andrew Ayers of Glendale, AZ. It's pretty amazing what he managed to get done with a measly $100! Andrew spent a good portion of his entry to describe the reasoning behind his choices and topped it off by doing extensive Internet research from many different vendors to find all the things he needed. His careful shopping left him with just enough money to buy a piece of bubble gum! Check out Andrew's award-winning entry in the sidebar.

Congratulations to Andrew and to all the contest entrants. Contest winners will be receiving their prizes in the mail directly from Parallax.

I'd like to take a moment to personally thank Ken Gracey of Parallax fame for providing the prizes for this fun contest. I also want to announce that for those of you who took the time to enter (but did not win) your work was not in vain. We will be sending a small (but quite useful!) prize to each and every person who sent in an entry!

Thanks again to all those who participated. I will be posting all the entries to the *Nuts & Volts* forum so people can compare the entries and discuss workbench design. As always, if you have comments, feedback, or suggestions for articles, please feel free to email me at vern@txis.com. **NV**

RESOURCES

■ Parallax, Inc.
www.parallax.com

■ Jess Lewis Links:
Sound Card Oscilloscope Hardware and Software
http://xoscope.sourceforge.net

Curve Tracer
www.techlib.com/electronics/curvetrace.html

■ Workbench Design Challenge Discussion
http://forum.servomagazine.com/viewtopic.php?t=8204

■ Ponginator
www.youtube.com/watch?v=iPSoFYHywJw

■ RoboSpinArt
www.youtube.com/watch?v=bEKPDoNCyZk

■ Ping Pong Printer
www.youtube.com/watch?v=8Ep5OC3E02I

■ Power Flowers
www.youtube.com/watch?v=Ydkk4-6FsWk

■ The Robot Group
www.TheRobotGroup.org

■ Andrew Ayers Website
www.phoenixgarage.org

ANDREW'S $100 ELECTRONIC WORKBENCH CHALLENGE ENTRY

Early in the process of selecting items, I decided to base my purchasing decisions toward the goal of stocking an entry-level robotics and industrial automation workbench. Over the course of recent years, hobby-bench level electronics have been focusing on the usage and programming of microcontrollers. These devices have allowed for the increasing simplification in designs that would have taken many more discrete components in the past to implement. Instead, the complexity of hardware is reduced by implementing more functionality in software.

I felt that stocking a general-purpose workbench went against this reality, and so the decision was made to focus my selections around the standard, widely-used PIC16F84A microcontroller. Narrowing the focus even further to robotics applications adds an element of excitement — the student's projects can now move, and the results of their development can be seen in a tangible way.

TOOLS

I decided to focus first on the tools. I wanted them to be quality tools that the student could use potentially for a lifetime, provided they are well taken care of. At the same time, I had to be mindful of cost. This necessitated the goal of obtaining as much functionality as I could for the price from each tool in the set I assembled.

A good multimeter was a must. While certainly not a Fluke, I personally own a couple of the low-cost multimeters I selected for this workbench, and I have found them to be very capable and reliable tools for a fraction of the cost. The good selection of ranges, transistor/diode testing capabilities, and small size make this multimeter an excellent introductory choice for the workbench. The soldering iron seemed like a good selection because it is of a low enough wattage to handle some of the more fragile components without overheating, while still having enough power to solder larger components with ease. The grip seemed like it would be comfortable for longer periods of use, and the grounded plug should help with ESD issues.

The soldering iron stand combines both a third-hand with magnifier with a soldering stand complete with sponge, which means less room on the workbench taken up by individual tools (which is always a plus when prototyping and assembling circuits). The magnifier allows for easy visual inspection and correction of solder joints as needed. A small but adequate amount of 60/40 solder rounds out the soldering station supplies.

The 25 piece Velleman tool set is similar to a tool set I own. For the price, it cannot be beat on the necessary selection of tools you get: miniature wire cutters, long nose pliers, tweezers, multi-bit screwdriver, and a selection of precision screwdrivers are all included. All are very handy to have on the workbench. The carrying case is a bonus.

A desoldering tool and alligator clips complete the tool package for entry level usage. While we can strive to never make a soldering mistake, inevitably it creeps in, regardless of skill level, and the desoldering tool can save the day. Alligator clips provide quick hookup of parts that just need temporary connections during prototyping.

PROTOTYPING

All electronic workbenches need prototyping tools. The solderless breadboard chosen affords the student plenty of room to develop and test a variety of microcontroller interfacing circuits. Hookup wire can be used for soldered connections or as wire jumpers on the solderless breadboard, at a price point much lower than formed wire jumpers. A battery holder and connectors with four AA batteries provides a simple and portable DC power source for development. Finally, the prototyping PCB — with parts — can be assembled as a carrier board for the microcontroller, which can then be easily interfaced to circuitry developed on the solderless breadboard.

COMPONENTS

As mentioned previously, the standard, easy-to-use PIC16F84A was selected as the microcontroller for this workbench. A 20 MHz part was chosen to allow for future upgrades in speed, if so desired. The prototyping PCB discussed above was designed to use a 4 MHz oscillator crystal/resonator. The PIC selected can run at this lower speed, being rated for DC-20 MHz operation. To allow the user to program the PIC, a programmer is necessary. The following design was selected due to the simplicity of its construction, and the need for only standard and simple parts. Power for programming is derived from the host PC's serial port. Parts for the programmer are included in the list, while leaving enough parts for the student to prototype and construct other circuitry on the solderless breadboard, or elsewhere. The PIC16F84A is plugged into a socket on the programmer. The assembled hex file is uploaded to it, then the PIC is moved to the carrier board and interfaced to controlled circuitry as desired. The development software for creating the hex files can easily be found as open source software for most platforms, and is thus free for use by the student.

Various other passive and active components are provided to allow the student the capability to construct a variety of control and automation circuits. LED flashers and sequencers, relay and H-bridge motor control of a small DC motor, control of RC servos, and input from buttons and leaf switches are all capable of being constructed using the components provided, allowing the student to develop a wide set of skills and knowledge of robotics and industrial automation.

Projects utilizing these parts can be easily found on the Internet by the student. There is a plethora of designs and code available for the PIC16F84A; it is easily one of the most utilized microcontrollers in existence, mainly due to its simplicity and low cost.

CONCLUSION

I was unable to include everything I wanted to in this workbench (in particular, I wanted to add a simple oscilloscope or at least a logic probe, but neither were in the cards). By careful selection and research, I believe I have managed to include the necessities needed for the introductory student to explore a large swath of territory within the fields of robotics and industrial automation.

This contest proved quite an eye-opener for me. I had thought it was going to be simple; a virtual walk in the park. Instead, I found myself neck deep quite quickly, making decisions on parts and vendors based on costs, quantities available, and quality. I ended up with a new respect for individuals who have to do this on a regular basis — for their job, their students, or otherwise. Total cost for the entry $99.36 with $0.64 left over for some bubblegum (well, maybe not at today's prices!).

CATEGORY: TOOLS

Qty	Item	Vendor	Part #	Price/ea
1	Multimeter	jaycar.com	QM1500	$4
1	Soldering Iron	circuitspecialists.com	200PHG-25WATT	$6.95
1	Soldering Stand	goldmine-elec-products.com	G12810	$4.98
1	Solder	allelectronics.com	TS-110	$1.25
1	Toolset	designnotes.com	VTTS	$9.85
1	Desoldering Pump	electronics123.com	VTD1	$2.91
1	Alligator Leads	circuitspecialists.com	M000F0003	$2.49
			TOTAL	$32.43

CATEGORY: PROTOTYPING

Qty	Item	Vendor	Part #	Price/ea
1	Breadboard	pololu.com	352	$4.95
1	Hookup Wire	jaycar.com	WH3025	$2.25
1	Battery Holder 4AA	electronics123.com	H341B	$0.53
1	Battery Clip 9V	electronics123.com	SNAP9V	$0.21
1	Batteries 4AA	electronics123.com	BB099	$0.89
1	Prototyping PCB	imagesco.com	PCB-27WP	$14.95
			TOTAL	$23.78