

A reminder once again that I do try to gather most of our mentioned items into a pair of sidebars. You will usually find one for all the regular *Names & Numbers*, and a second that targets a special resource category.

We try to triple check all entries. First by my own research. Second by Kathy, our superb proofer and fact checker. And third by EN editorial spot checks.

To date, I have received over two hundred helpline calls asking me for the *Integrated Circuit Systems* source from two columns back. Well, it was right where it belonged. Smack dab in the middle of that *Names & Numbers* sidebar. Complete with reader service number.

Before calling my no-charge tech helpline, please read the *entire* story, double check both sidebars, and have a pencil or pen ready.

A new microcontroller

As figure one shows us, the *BASIC Stamp* from *Parallax* is a brand new \$39.00 hacker computer the size of a commemorative postage stamp. This is basically a PIC16C56 microcontroller, a 256 byte EEPROM, a resonator and a voltage regulator. Eight I/O lines form your real world interface. These are provided for in a breadboard area. *Microchip Technology* is the supplier of the CPU.

This one is cute as a bug.

An approximate schematic appears in figure two. Burned into the custom CPU is a BASIC interpreter. The fully tokenized instructions are prestored into the companion serial EEPROM and then automatically interpreted on each power up.

The total program and data storage area is only 256 bytes in the EEPROM plus an additional 16 internal working registers.

No, you can not run multi-tasking UNIX on this machine. But since each tokenized BASIC command requires only a very few bytes, and since some very fancy macros are available, you can create surprisingly sophisticated

programs on your own.

Program development is normally done on your PC host, using the fancy editor and interpreter provided. On the host, you are working directly in BASIC. And have all of your normal resources available. The interpreter then tokenizes the final program and uploads it to the BASIC Stamp via a three-wire cable that connects to your host's parallel port.

Once uploaded, your BASIC Stamp becomes a dedicated computer which can be used just about anywhere.

Power can come from a clip-on 9 volt battery. Power consumption is an impressive 2 mils when running and a mere 20 microamps when asleep.

Figure three shows the instruction set. Besides all the usual tiny BASIC commands, there are some powerful macros offered. BUTTON debounces input contacts. With a lot of options.

DEBUG returns variables to your host for debugging and analysis. A BRANCH macro offers a direct option picking. Just like the CASE command in fancier languages.

PAUSE gives you selectable time delays. POT is an 8-bit A/D converter that reads a potentiometer input. It can also read a photocell, thermistor, or whatever. PULSIN can measure the duration of any input pulse with a ten microsecond resolution. The similar

PULSOUT command delivers a timed output signal.

PWM directly outputs pulse width modulation. Adding a resistor and a capacitor can change this to an 8-bit accurate analog voltage.

Now for the neat stuff. The SERIN macro is a full serial data receiver with selectable baud rates from 300 to 1200. This can become *self-qualifying* in which you can wait for a specified character sequence. SEROUT directly generates serial output data for RS623 use. RS232 with an external driver.

A SOUND output can produce 128 tones and 128 noise effects.

A RANDOM number generator is even included. Use this one for white noise audio sources or to randomize video game effects. Naturally, you can selectively read, toggle, or write any individual I/O line. You can also temporarily or permanently go into sleep mode. You get out of the sleep mode by cycling your power off and then back on. Sixteen subroutines are allowed, nested two deep.

The PIC series of microcontrollers use a non-Von RISK architecture. The 12-bit instruction words are used in conjunction with 8-bit data words.

The chips by themselves (less any custom operating system code) can be bought for as little as \$2.70 each.

See the *MicroChip Data Book* and their companion *Embedded Control Handbook* for additional details.

Speeds? The PIC series blows away pretty near all of their competition in execution time and code length.

On the other hand, serial EEPROM access for your tokens does slow you down considerably. But hundreds of internal machine language commands may get executed at full speed for any one token fetch. Clock frequencies as high as 20 Megahertz can be used. So long as low power is not critical.

One possible trick: Use the BASIC Stamp to develop your ap. Then you switch to plain old machine language for full speed and ultra low cost on your production units.

Much more on the fundamentals of working with microcontrollers can be

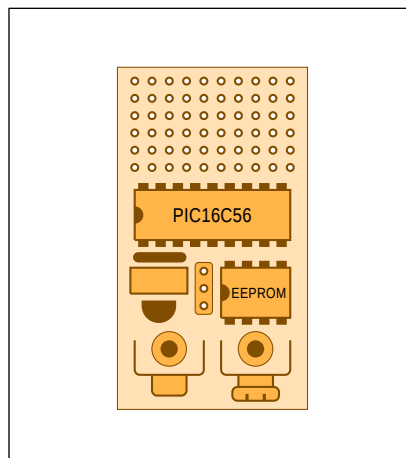


Fig. 1 – THE BASIC STAMP is a \$39.00 hacker microcontroller using a Microchip Technology CPU.

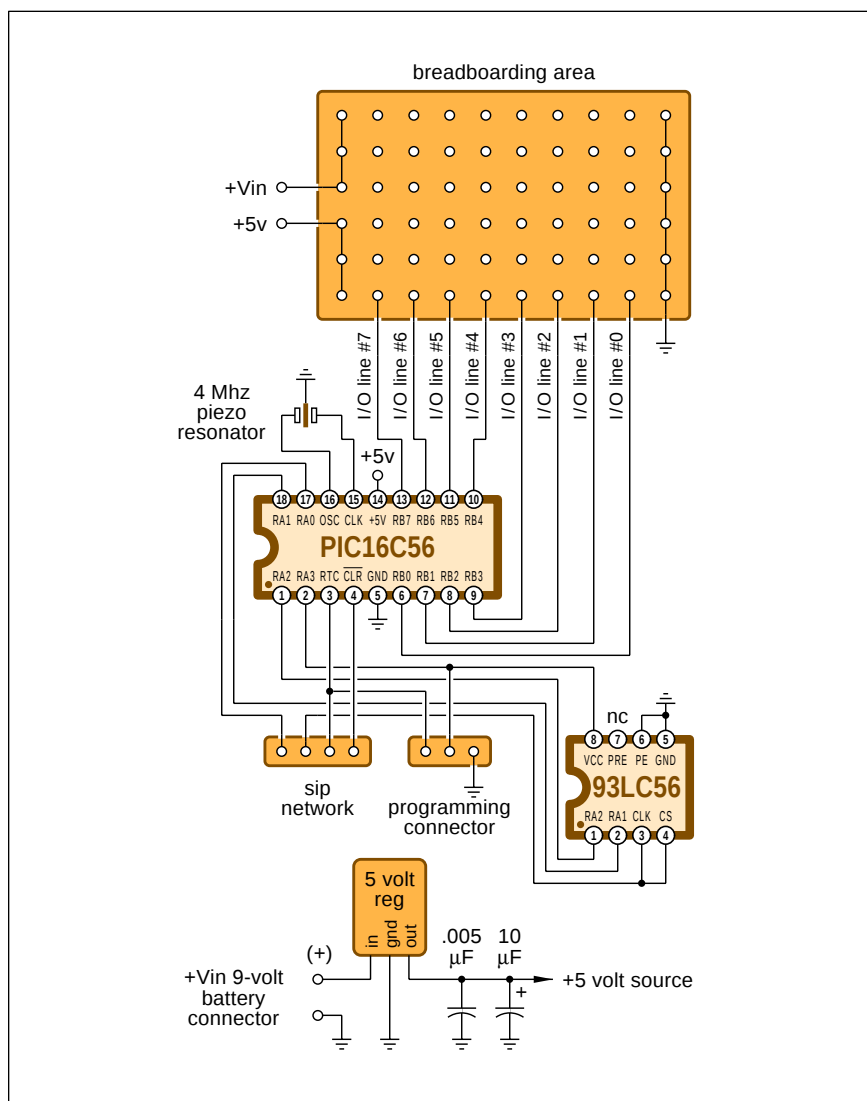


Fig. 2 – SCHEMATIC DIAGRAM of the BASIC Stamp.

found in my older *Micro Cookbooks*, volumes I and II.

Homebrew PostScript hacking

One potential use for the BASIC Stamp is shown in figure four. I've been doing a lot of work with the stupendously great PostScript general purpose computer language. In fact, this is the *only* language I use for *all* of my electronic design, pc layouts, stock market analysis, schematics, Book-on-demand publishing, and just about everything else.

All the *camera ready* figures you have seen here in *Hardware Hacker* for years have been done by using nothing but my word processor and PostScript. Device independently.

The only little problem has been

that PostScript I/O tends to end up a tad on the skimpy side. Usually you only have three choices: Dirtying up otherwise clean sheets of paper or plastic; writing files to the hard disk; or returning your data back to a host for recording or other reuse.

The BASIC Stamp can instantly let you extend the genuine Adobe Level II PostScript to any personal project or machine of your choosing!

Assume you've got a homebrew machine that has an x-axis and y-axis stepper, an up/down mechanism, and a "both steppers home" sensor. This can be a vinyl signcutter, engraving, or embroidery setup. Or an automated printed circuit drill, a wooden sign router, or a Santa Claus machine.

You could use two of your BASIC

Stamp lines for RS423 serial comm with your PostScript printer. Use two lines for both x-axis stepper phases. And two lines for those y-axis stepper phases. One line for pen or drill or whatever up/down. And a final line that zeros only when both steppers are in their home position.

The hidden beauty here is that all of those fancier PostScript fonts and the level 2 tools immediately become available for use on your own custom homebrew rig. At unbelievably low cost. With *zero* royalties!

Do let me know if you want more details. Meanwhile, I've posted lots on PostScript to www.tinaja.com.

In particular, be sure to check out [STARTUP.PS](#) for an intro PostScript tutorial, and [POSTVECT.PS](#) for lots of details on vector output. I've also got a free PostScript secrets brochure to get you started.

For instance, say you lash up your own vinyl sign cutter. You use your PostScript printer to create, debug, and proof all the artwork. Then you can capture the graphic paths by using PostScript's rather powerful *flattenpath* and *pathforall* operators. Next, you use POSTVECT-like code to vectorize the captured paths.

Finally, a series of *print* commands sends your cutting sequences out the serial port where the BASIC Stamp can act on them. Should any longer sequences be needed, serial feedback can be used with a *readchar* sequence to wait for task completion.

UPDATE: That new Adobe Acrobat Distiller 3.0 or higher lets you replace the laser printer with a faster and a much simpler host-based solution. See [POSTFLUT.PDF](#) for details.

Thoughts on a PC drill

The really big hacker breakthrough that everyone is waiting for is a \$199 automated printed circuit drill. The new BASIC Stamp used along with a PostScript printer seems to give us a brand new handle on this project.

I recently noticed that dentist's air turbines cost only \$30. Junkers might end up free from a reasonably curious dentist. The handle on most drills is usually empty. These turbines can be cut down to the size and roughly the mass of a plotter pen. It sure would be interesting to see if they provide enough power for board drilling.

BRANCH	Option picker similar to a CASE command.*
BUTTON	Read and debounce mechanical input.*
DEBUG	Send register contents to host.*
EEPROM	Store data in memory.
END	Go into sleep mode until power cycles.
FOR...NEXT	A looping construct.
GOSUB	Execute subroutine.
GOTO	Jump to another location in program.
HIGH	Make the chosen I/O pin high.
IF...THEN	Conditionally execute instructions
INPUT	Make selected pin an input.
LET	Optional definition. Includes add, subtract, multiply hi/lo, idivide, modulo, min, max, AND, NAND, OR, NOR, XOR, and NXOR.*
LOOKDOWN	Search table for match.*
LOOKUP	Read values from table.*
LOW	Make the chosen I/O pin low.
NAP	Enter sleep mode for a selected time.*
OUTPUT	Make the chosen I/O pin an output.
PAUSE	Short selected time delay.
POT	Read a potentiometer (8-bit A/D convert).*
PULSIN	Measure input pulse width.*
PULSOUT	Output pulse of selected width.*
PWM	Output pulse width modulation (D/A convert).*
RANDOM	Generate pseudorandom number.*
READ	Read variable from memory.
RETURN	Return from subroutine.
REVERSE	Change direction of selected I/O pin.
SERIN	Read serial input and interpret format.*
SEROUT	Format and output serial data.*
SLEEP	Long selected time delay.
SOUND	Output musical notes or white noises.*
TOGGLE	Change state of selected I/O pin.
WRITE	Store data to memory.

Fig. 3 – INSTRUCTION SET FOR THE BASIC STAMP. The macros marked (*) above make the stamp surprisingly powerful.

Let's restrict our goals initially to a 4" x 6" board. An X-Y system might introduce all sorts of bad mechanical problems. Instead, the board could be moved along a single axis. The drill could be moved along a second axis. And it might be simplest to *lift* your board, rather than drop the drill. Or maybe use a raising cam and gravity feed on the turbine.

My current thinking for a stepper would be the linear *Hurst* SLS. While kinda pricey, this does offer twenty pounds of force in two mil steps. And *Texas Instruments* offers some dandy new peripheral driver chips.

Let me hear your thoughts on this great new project.

Fun with photopolymers

I have long been fascinated by the *photopolymers*. These are just plastic compounds of one breed or another

which are only partially cross-linked during manufacture. A later exposure to light and a development process will selectively harden portions of the material. Which can result in a state change from liquid to solid or a shift in dissolvability.

The results could be used for etch resists, a 3-D model, a Braille sign, a rubber stamp, a printing plate, an integrated circuit mask, a silk screen master, or a vinyl stick-on letter. Or for zillions of new aps.

Because of fundamental chemistry, most photopolymers demand strong ultraviolet light for exposure. Three minutes using a contact printer out in direct sunlight often will work well. Photopolymers are typically *negative acting*, hardening in the presence of light.

This month, I thought our resource sidebar might give you a rundown of

new from DON LANCASTER

ACTIVE FILTER COOKBOOK

The sixteenth (!) printing of Don's bible on analog op-amp lowpass, bandpass, and highpass active filters. De-mystified instant designs. **\$28.50**

RESEARCH INFOPACKS

Don's instant cash-and-carry flat rate consulting service. Ask any reasonable technical question for a detailed analysis and complete report. See www.tinaja.com/info01 for specifics. **\$75.00**

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Updated 2nd edition of Don's classic on setting up your own technical or craft venture. **\$18.50**

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Don's best early stuff at a bargain price. Includes the CMOS Cookbook, The TTL Cookbook, Active Filter Cookbook, PostScript video, Case Against Patents, Incredible Secret Money Machine II, and Hardware Hacker II reprints. **\$119.50**

LOTS OF OTHER GOODIES

Tech Musings V or VI	\$24.50
Ask the Guru I or II or III	\$24.50
Hardware Hacker II, III or IV	\$24.50
Micro Cookbook I	\$19.50
PostScript Beginner Stuff	\$29.50
PostScript Show and Tell	\$29.50
PostScript Video & secrets	\$29.50
PostScript Reference II	\$34.50
PostScript Tutorial/Cookbook	\$22.50
PostScript by Example	\$32.50
Understanding PS Programming	\$29.50
PostScript: A Visual Approach	\$22.50
PostScript Program Design	\$24.50
Thinking in PostScript	\$22.50
LaserWriter Reference	\$19.50
Type 1 Font Format	\$16.50
Acrobat Reference	\$24.50
Whole works (all PostScript)	\$380.00
Technical Insider Secrets	FREE

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The reprints from all Don's Midnight Engineering columns. Includes a broad range of real world, proven coverage on small scale technical startup ventures. Stuff you can use right now. **\$24.50**

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A complete collection of all Don's Nuts & Volts columns to date, including a new index and his master names and numbers list. **\$24.50**

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FREE US VOICE HELPLINE VISA/MC

SYNERGETICS
Box 809-EN
Thatcher, AZ 85552
(520) 428-4073

PHOTOPOLYMER RESOURCES

Advance Process Supply

400 N Noble Street
Chicago, IL 60622
(312) 829-1400

Dick Blick

Box 1267
Galesburg, IL 61401
(800) 447-8192

Cooley Sign Systems

50 Esten Avenue
Pawtucket, RI 02860
(800) 992-0072

Dynachem/Thiokol

2631 Michelle Drive
Tustin, CA 92680
(714) 730-4200

Dynamark

3M Center Bldg 220-7W-03
Saint Paul, MN 55144
(800) 241-4819

Eastman Kodak

343 State
Rochester, NY 14650
(716) 724-4000

Grantham Polly-Stamp

418 Central Avenue NE
East Grand Forks, MI 56721
(218) 773-0331

IMEC

Rt 4, Box 79
Monell, MO 65708
(417) 235-3053

Jet USA

1116 MacDate Boulevard
Collingdale, PA 19023
(800) 528-1153

Kepro Circuit Systems

630 Axminister Dr
Fenton, MO 63026
(800) 325-3878

Kimoto

2915 182nd Street
Redondo Beach, CA 90278
(213) 370-7411

M&R Marking Systems

100 Springfield Avenue
Piscataway, NJ 08855
(908) 562-9500

Merigraph

Box 3064
Naperville, IL 60566
(800) 323-1832

Southern Sign Supply

127 Roesler Road
Glen Burnie, MD 21060
(410) 768-8600

RA Stewart

641 S Palm, Unit H
La Habra, CA 90631
(310) 690-4445

3-D Systems

26081 Avenue Hall
Valencia, CA 91355
(805) 295-5600

3M/Color Key

3M Center Bldg 223-2N-01
Saint Paul, MN 55144
(800) 328-1303

Ulano

255 Butler Street
Brooklyn, NY 11217
(718) 622-5200

the more hackable photopolymers.

The classic one you might be most familiar with is spray-on etch resist, often in the form of KPR by *Eastman Kodak*. And stocked by *Radio Shack*. More modern substitutes are the *dry film photoresists* such as those now offered by *Dynachem*. These are both uniform and pinhole free. They also develop with sodium triphosphate, a low cost garage floor cleaner.

Kepro is a fine stocking supplier of printed circuit supplies. A good trade journal here is *Circuits Assembly*.

Photopolymer solder mask resists are also readily available.

Photopolymers offer lots of options for silk screen printing. The leading film supplier is *Ulano*, while *Advance Process Supply*, *Southern Sign*, and *Dick Blick* offer smaller quantities.

3-M, the *Scotch Tape* folks, have a number of interesting photopolymer products. One is known as *Color Key*. Actually, this is more a diazo-like process, but it uses the same drill of contact print exposing and wiping on glop to alter selected areas. What you end up with is a clear polyester sheet that has translucent or opaque color areas selectively applied to it. Dozens of color options. Lots of graphic arts uses here.

Their *Dynamark* imaging products seem great for labels and prototype dialplates. Typically, you will have a white self-stick vinyl having a color overlay. You then selectively remove the color by exposing. Then you use a wiper pad to develop. Any "reverse" effects get done by using positive art. Aluminum backed versions are also offered. Price is in the \$8 per square foot range.

The photopolymers have long been essential for *flexographic* printing as used on cardboard containers. One leading supplier for the materials in larger quantities is *Merigraph*, while *R. A. Stewart* is a wholesale source in more modest amounts.

The same material can make great "rubber" stamps. Any "real" rubber stamp will be pink or black, while a photopolymer stamp will be clear to translucent. The photopolymer ones often last longer and provide sharper images. Of the many rubber stamp photopolymer suppliers, *Grantham Polly-Stamp* and the *M&R Marking Systems* are my favorites.

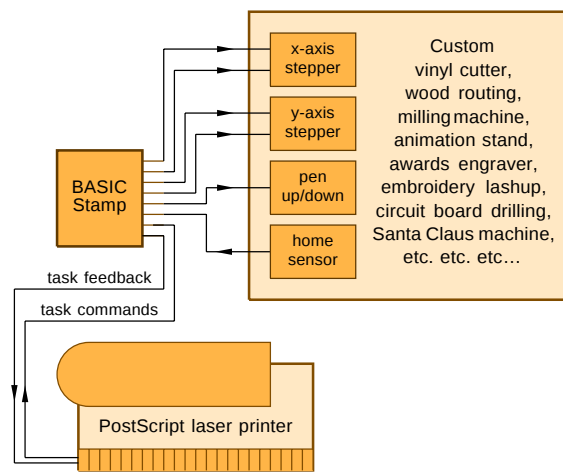


Fig. 4 – THE BASIC STAMP can be used as a royalty-free interface to let you apply real Adobe PostScript level 2 to any old homebrew project!

We've seen in previous issues how Santa Claus machines are starting to revolutionize prototyping. A leading firm here that uses ultraviolet curing photopolymers is *3-D Systems*. More on Santa Claus stuff in future issues and the *Hardware Hacker* reprints.

The photopolymer that I am really waiting for is a vinyl one which has only been partially cross linked. You do your PostScript artwork master on your laser printer and then you'll contact print. Expose and then wipe on some glop. A repositionable and pre-weeded cut vinyl letter or a logo results. Without needing a costly sign cutter. I do keep hearing persistent rumors of these. But no results.

Meanwhile, there are now two new products that come close.

One of these is that *Etch-n-Peel* system by *Kimoto*. This is basically a self-stripping "rubylith". While great for its intended graphics art stripping purposes, you are stuck with red, and the results are not repositionable.

The other one is known as *Cooley Brite Eradicable Sign Material*. This is an opaque white and fully outdoor rated reinforced vinyl. Color glop has been preapplied to its surface. In your choice of seventeen flavors.

A magic developer will dissolve *only the color*. To do this, put a vinyl cover (or any suitable mask) onto the material. Then simply scrub the color away in selected locations.

In the daylight, you have a color over white. At night and backlit you get white light or translucent colors per your selection. Neat stuff. Sanely priced. And eminently hackable.

Finally, there is an interesting new variation on photopolymer printing plates that should open up all sorts of new hacker ideas. The *Jet USA* folks are using photopolymers for Braille and other low cost raised letter ADA signage. What you really have here is a metal plate with some raised plastic selectively applied exactly where you want. Unique business cards are one possibility.

There is a slight chamfer to their resin, improving the appearance. Cost is in the twenty cents per square inch range. Jet's processing equipment is ridiculously expensive, but it should be easy enough to fake.

Their photopolymer offers a very high durometer. Free samples.

NAMES AND NUMBERS

Amateur Television Quarterly

1545 Lee Street
Des Plaines, IL 60018
(708) 298-2269

Colorado School of Mines

SPACE
Golden, CO 80401
(303) 273-3321

EAA Aviation Center

3000 Poberezny Drive
Oshkosh, WI 54903
(414) 426-4800

GENie

401 N Washington Street
Rockville, MD 20850
(800) 638-9636

Hurst Manufacturing

Box 326
Princeton, IN 47670
(812) 385-2564

Integrated Circuits Systems

PO Box 968
Valley Forge, PA 19482
(215) 666-1900

Dan Levels

PO Box 1125
Tellevast, FL 34270
(813) 356-2788

McMaster-Carr

Box 54960
Los Angeles, CA 90054
(310) 692-5911

Microchip Technology

2355 W Chandler Blvd
Chandler, AZ 85224
(602) 963-7373

MSC

6700 Discovery Blvd
Mableton, GA 30059
(800) 645-7270

Parallax

6359 Auburn Blvd Ste C
Citrus Heights, CA 95621
(916) 721-8217

Resonance Research

E11870 Shadylane Road
Baraboo, WI 53913
(608) 356-3647

Roadable Aircraft

338 8th Avenue South
Edmonds, WA 98020
(206) 778-0423

Rotary Flight International

5555 Zuni SE #281
Albuquerque, NM 87108
(505) 298-9362

Small Parts

13980 NW 58th Court
Miami Lakes, FL 33014
(305) 557-8222

Synergetics

Box 809
Thatcher, AZ 85552
(602) 428-4073

Texas Instruments

PO Box 809066
Dallas, TX 75380
(800) 336-5236

Don Thompson

23072 Lake Center Dr #100
El Toro, CA 92630
(714) 855-3838

Needless to say, *any* hacker work involving photopolymers can be very much improved by using PostScript. Full details on www.tinaja.com. One little known capability of PostScript is its *microsizing* ability. This lets you get the final size of your printed circuit layout exactly right, even on a printer with sloppy tolerances and paper that swells or shrinks.

In flexographic printing and other places where images stretch as they are bent around a drum, anamorphic scaling using PostScript gives you a fast, simple, and accurate fix.

Two contests

Let's have two contests this month. Either (A) dream up a new ap for the BASIC Stamp, or else (B) see if you can come up with some non-obvious hacker use for photopolymers.

As usual, there will be a dozen or

so of my recently updated *Incredible Secret Money Machine* book prizes, along with an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all.

Be sure to send your *written* entries directly to me here at my *Synergetics*, and not to *Electronics Now* editorial.

Let's hear from you.

New tech lit

We have a super selection of new goodies this month. For great books and mags on ATV, try the *Amateur Television Quarterly* folks.

Gyro Gearloose is alive and well! *Roadable Aircraft* is a unique labor of love Ron Borovec newsletter for all of you flying car enthusiasts. Similar pubs include *Experimental Aircraft* from the EAA Aviation Center and the *Experimental Rotorcraft* from Rotary Flight International

All the fundamentals of telephone operation are well covered in a new self-published *Tech Notes from a Telephone Engineer* by Dan Levels.

Science Under Siege is a new book by Michael Fumento. It explores the nature of evidence and statistics in a scientific controversy, and does cover everything from the Alar worries to ELF radiation. In a typical chapter, strong evidence is given that alcohol is one outright scam rather than any useful motor fuel. Grain alcohol uses much more energy than it delivers and increases air pollution. This one is a must read.

The *Colorado School of Mines* just completed their fourth *Subsurface Exploration Technology* symposium. Mostly on underground radar used for mining, caving, and archaeological uses. Proceedings are available.

NEED HELP?

Phone or write all your US Tech Musings questions to:

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US email: don@tinaja.com
Web page: www.tinaja.com

A video on *Designing and Building High Performance Tesla Coils* is now available from *Resonance Research*.

New videos, parts kits, and training seminars on laser printer repairs are available through *Don Thompson*.

Small Parts now ships a new and free *Catalog #14*. These folks run the

greatest robotic resource in the world. They have everything your hardware store never heard of. And then some.

MSC is a *McMaster-Carr* alternate that carries extensive local stocks of machine shop supplies and hardware. They are also a no-hassle source of the EDM wires and dielectric oils. A 2000 page catalog is offered.

Turning to my own products, my new *Book-on-demand Resource Kit* contains lots of self-publishing info; and my new *Resource Bin I* gives you insider access to scads of my secret supply sources. Or if you really want to get into PostScript in a big way, try my *Whole Works* package. See my nearby *Synergetics* ad for more info.

A reminder here that most of the sources mentioned also appear in the *Names & Numbers* appendix.

Let's hear from you. ♦