by Don Lancaster

$99 Flutterwumpers

I sure do receive bunches of helpline calls asking for an automated XY table that costs $99 or less. Since this is so simple and easy to do, I'm amazed that no *Midnight Engineer* has yet picked up on all the utterly incredible opportunities here.

I'll define a *flutterwumper* as any eminently hackable entity that moves and then either chomps or spits. A few horribly restrictive examples include…

- Printed circuit drills
- Animation stands
- Santa Claus machines
- CAD/CAM mills
- Paint detailing robots
- Pick-and-place positioners
- Programmable sign routers
- Waterknife cloth shaping
- Embroidery customizers
- Automated weaving looms
- Vinyl lettering cutters
- Jewelry lost wax formers
- Silk screen master makers
- Precision laser shapers
- Award engraving systems
- Cake or pizza decorators
- Spark discharge EDM

But the concept of *intrinsic flutterwumptocity* clearly transcends all of these. If, instead, you go back to the basics and attack the *generic* system fundamentals using the latest of new concepts, tools, and products, then all sorts of $99 flutterwumper solutions become painfully obvious. Opportunities that are going begging.

Let's look at some secret insider first principles of low cost flutterwumping…

Don't Sweat the Mechanics

The mechanical part of any flutterwumper is the *least* of your worries. Instead, you should tightly focus on a generic *system* of sofware, firmware, hardware, and drivers that can form the *absolute minimum* interface and control core for most *any* flutterwumper.

One that is workable with *any* choice of mechanical goodies. Of any size.

In what follows, we'll assume a 2-1/2 D flutterwumper where you want full independent motion along apparent X and Y axes, but only a simple "up-down" or "on-off" action along your Z axis.

No Gantries Need Apply

The classic XYZ gantry is just about the *worst* possible way to build a flutterwumper. *Avoid gantries at all costs!* For X has to support both Y and Z. And Y in turn has to support Z. Just like a multi-stage rocket, you need tons of machine to support ounces of payload. And your position inaccuracies are *certain* to pile up. So are your costs.

One early "semi-gantry" workaround was known as the *H system*. This worked sorta like those old parallel rule mechanism drafting tables. Two steppers sit stationary at the bottom of the H, both driving a convoluted belt. The *differential* stepper motions set X and Y positions.

If the steppers both twist in the *same* direction, you get X motion. If the steppers twist in *opposite* directions, you get Y axis motion. See the July 11, 1994 *Machine Design* for the latest reincarnation of this ancient ploy.

Divide and Conquer is a useful anti-gantry technique. Move the chomper in the X direction with one system. And move the work in the Y direction using a second system. Nicely converting a complex 2-1/2 D problem into a pair of vastly simpler 1 D and 1-1/2 D ones.

But your best way around a gantry is to *forget about Cartesian co-ordinates entirely!* Any old brain dead micro can instantly convert between reference systems. True XYZ is often a totally unneeded waste. As long as you have at least three degrees of freedom, you can fake XYZ.

Ferinstance, two pivoting linear steppers that share a common shaft slider can hit any X-Y point.

Many robots use a cylindrical co-ordinate system. Made from a rotating base and a doubly hinged arm. Nothing slides. One stepper twists for base orientation. A second twists for arm elevation; a third for upper hinge angle.

Even more elegant is a revolutionary new *virtual ways* system. Described in the August 15, 1994 issue of *Design News*. Take a base plate and place six ballscrews or linear steppers uniformly around a large circle on it. Now lean each ballscrew by 45 degrees or so and attach them all to a smaller upper head plate. The head plate can easily assume all of the normal lathe or mill motions. But *there are no precision sliding contacts anywhere!* All bearings are plain old round ones. All forces are pure tension or compression with *zero* side loadings.

Minimize Chomper Load

The less you've got to shove around, the cheaper and simpler your flutterwumper. The two usual loads on your chomper head are *side loading* and *chomper mass*.

Side loading comes about from reactions against the work being machined. Two heavy side loading examples include rotary mills and wood routers. Especially if your tools are not kept ultra sharp. Tool speeds and feed rates also get into the act. Printed circuit drills and waterknives have considerably less side loading. Zero or near-zero side loading can result with laser cutters or inkjet heads.

If possible, try and use a flutterwumper chomper having minimum side loading. Then carefully select your tool choices, sharpness, and feed rates for further reductions. Any super-cheap solution can run real slow, saved by that good old "Uh, compared to what?" factor.

The heavier your chomper, the worse the problems when you try to shove it around. See if you can't find creative alternatives to *move only what really needs moved*.

Ferinstance, instead of shoving an entire router motor around, can you support the motor high up and use a rotary shaft instead? Better yet, can you go pneumatic and use a tiny air motor and a very flexible supply hose or two? Can you make it self-advance on some sort of a Bendix? The *OralSafe* dental supply offers a $13 *disposable handpiece*. This gem is easily cut down to form a tiny air turbine the size and mass of a plotter pen.

On a laser cutter, mount the laser solidly on the *side* of the flutterwumper frame and then use mirrors to deliver the beam energy to the chomper head. For minimum mirror problems, use large and defocused delivery beams.

Regardless of your flutterwumper goals, spend lots of time and thought minimizing your chomper head mass and side loadings. Ask yourself what the absolute minimum work action is needed.

And then deliver it. As baggage-free as you can.

Car Alternator Steppers?

There's two choices in flutterwumper motion controls: *open loop* or *closed loop*. When in open loop, you tell the flutterwumper where to go and hope it gets there. Often using digital *stepping* motors that move in discrete chunks. Positioning errors may pile up due to backlash, calibration accuracy, or tool wear. In closed loop, you continuously measure where you are, derive an error signal and then you force motions closer to your desired position. Often using analog *servo* motors that seek out a low error.

Closed loop is usually more expensive and complex. It also can be gross overkill. If you do go closed loop, note that *PCIM* is a good magazine here, that *Hewlett Packard* makes position encoders, and that a new technology called *binary chain codes* has big advantages over those Gray encoders. See HACK80.PDF for details.

Except for its ludicrous cost, the *Hurst* SLS is a dandy linear stepper. Twenty pounds of force in four mil steps.

Useful hacker sources for steppers and such include *American Science & Surplus*, *C&H Sales*, *Herbach and Rademan*, *Fair Radio Sales*, *Burden's Surplus Center* or *AST Servo Systems*. But big steppers are kinda pricey.

Can car alternators be used as power steppers? The amazing answer is that they can. They are ultra cheap and deliver an amazing amount of kick. The secrets involve accessing the "wye" center tap; rewinding the ampere turn maximized coils so they span a single pole; and using a three-phase drive setup.

Full details appear in a superb *John Rees* video.

FLUTTERWUMPER RESOURCES

Adobe PostScript
PO Box 7900
Mountain View, CA 94039
(800) 833-6687

Allegro-Sprague
Box 15036
Worcester, MA 01605
(508) 853-5000

American Sci & Surp
601 Linden Place
Evanston, IL 60202
(708) 475-8440

AST Servo Systems
115 Main Road Box 97
Montville, NJ 07045
(201) 335-1007

Burden's Surplus Center
PO Box 82209
Lincoln, NE 68501
(800) 488-3407

C&H Sales
PO Box 5356
Pasadena, CA 91107
(800) 325-9465

Design News
275 Washington Street
Newton, MA 02158
(617) 964-3030

Scott Edwards
964 Cactus Wren Lane
Sierra Vista, AZ 85635
(602) 459-4802

Fair Radio Sales
PO Box 1105
Lima, OH 45802
(419) 227-6573

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

Gerber Scientific
83 Gerber Road
S Windsor, CT 06074
(203) 644-1551

Grainger
2738 Fulton Street
Chicago, IL 60612
(312) 638-0536

Herbach & Rademan
401 E Erie Avenue
Philadelphia, PA 19134
(215) 426-1700

Hewlett Packard
PO Box 10301
Palo Alto, CA 94303
(415) 857-1501

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

Machine Design
1100 Superior Avenue
Cleveland, OH 44144
(216) 696-7000

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

Motorola
5005 E McDowell Road
Phoenix, AZ 85008
(800) 521-6274

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

OralSafe
43529 Ridge Park Drive
Temecula, CA 92590
(800) 237-8825

Parallax
3805 Atherton Road #102
Rocklin, CA 95765
(916) 624-8333

PCIM
2472 Eastman Avenue #33-34
Ventura, CA 93003
(804) 658-0933

John Rees
Rt 1 Box 1551
Sautee, GA 30571
(706) 865-5495

SGS
1000 E Bell Road
Phoenix, AZ 85022
(602) 867-6259

Small Parts
PO Box 4650
Miami Lakes, FL 33014
(305) 557-8222

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

Use Modern Drivers

The days of on-off control of a stepper winding by a big ole Darlington power transistor are long gone. Still, it should cost you no more than $5 per axis maximum for your power driver interface.

For maximum speed and the most tail twisting, you'll need a *current* drive or a *pulse modulated* drive. With provisions for lower holding currents that minimize heat losses between actual motions.

These days, a full dedicated microcomputer makes more sense than a stepper driver chip. Among other reasons, the dedicated micro is cheaper and easier to debug.

While *Allegro-Sprague*, *Motorola*, and *SGS* remain popular sources of stepper chips and power drivers, the new *Power+Arrays* series from *Texas Instruments* are ultra simple and cheap. In particular, do check out their three channel TIPC2301 for car alternator drives.

Pick a Two-brainer

The secret insider trick for flutterwumper intelligence is to split your problem in half. *Use only the simplest and scungiest brain-dead dedicated micro for only those unique custom tasks that are absolutely essental*. Do everything else using a stock computer or a PostScript printer.

On the brain-dead end, those PIC series micros from *Microchip Technology* make the most sense. Because these totally blow away anything from Intel or Motorola. They cost as little as two bucks each. Fine low cost development support is also offered. Especially that *Basic Stamp* from *Parallax*, and the *PIC Design Tools* from *Scott Edwards*. Scott also offers a $25 *stamp extender* that can easily be reprogrammed to do your *entire* flutterwumper.

You have your smart and big generic computer talk to your little and dedicated one by using some sort of meta language. While either HPGL or *Gerber* standards could be used, these may conflict with your $99 cost goal.

Instead, I feel that an ultra simple meta language using the absolute minimum of single character ASCII codes makes the most sense. Say N, E, S, W, U, D, and H for instance. Sent over a higher speed stock RS232 serial channel. Later on, after your costs are under control, you can add such features as vector motions, repeats, speedup, back-channel feedback, and comments.

Let the big computer do the co-ordinate transformations. Let the little one use raw native motions.

Regardless of your choice of a meta language, *make positively certain it is open and fully documented*. And is freely available to anyone at *zero* cost.

What about your smart computer? The big one that does all the work. For that, we'll send…

PostScript to the Rescue

The general purpose *PostScript* computer language offers compellingly strong advantages for flutterwumpers. PostScript easily handles graceful curves, fancy fonts, tool path compensation, and microsizing. Exotic co-ordinate transforms are trivial. The majority of the most powerful graphic design tools in the world use PostScript. Others are easily convertible.

Besides, PostScript can be available *free*. And is simple and fun to use.

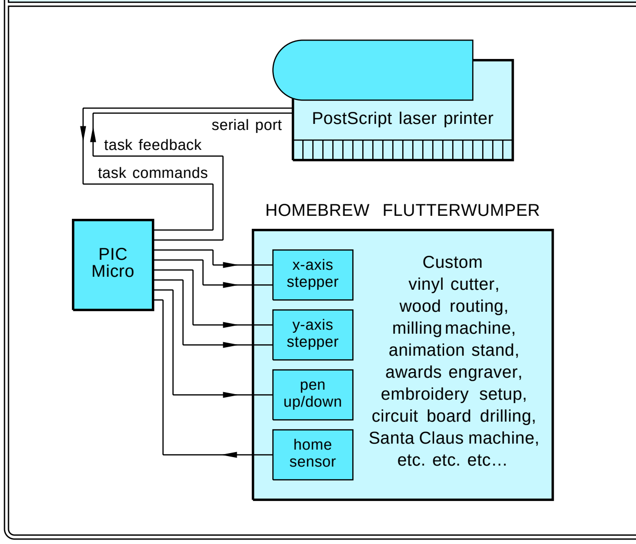
There are three possible routes here. By a *crossporting* technique, you can simply use a laser printer as a general purpose PostScript computer, writing your meta language commands out a suitable port. Your flutterwumper then becomes a laser printer peripheral.

Or, you use a PostScript laser printer to write a meta language file *back* to your host for recording. From there, you'll stash the file in a disk library or resend it at your convenience. Using ordinary serial comm.

Finally, there is a shareware version of PostScript called *GhostScript* that can run on most any host. GhostScript is available for the downloading from PSRT and many other on-line sources. Be sure to get 3.0 or higher. Since the full sourcecode is *included* with GhostScript, you can easily customize it any way you like.

Here's one approach to a…

POSTSCRIPT DRIVEN FLUTTERWUMPER



Any reasonable line art you can draw on paper can be sent to your flutterwumper. You first persistently download a special header to your PostScript printer, and then accept routine and *unmodified* artwork. The header intercepts the usual *showpage* and other commands and works some magic instead.

Being a general purpose computer language, PostScript easily outputs to your meta language, transforming on the fly. PostScript generates *paths*. Either directly or through use of the *pathforall* operator. The paths can be converted to vector steps with the *flattenpath* operator. From here, a few lines of code will convert to your meta language in the desired flutterwumper resolution.

Full details in POSTVECT.PS and FLUTUTIL.PS.

For More Help

Our resource sidebar gathers up several names and numbers needed for serious flutterwumper work. Besides those I've already mentioned, *Small Parts* is a great source for bits and pieces, while useful bigger lumps are offered by *Grainger* and *MSC Specialties*.

Additional support can be found on the *Flutterwumper Library* shelf of my *www.tinaja.com* web site. And in my *Blatant Opportunist* reprints.

Consulting services are also available on the concepts shown. Let's hear from you. ◆

Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless articles. Don maintains a US technical helpline you'll find at (520) 428-4073, besides offering all his own books, reprints and various services.

Time and funding constraints limit this service to US callers only.

Don has a free new catalog crammed full of his latest insider secrets waiting for you. Your best calling times are 8-5 weekdays, Mountain Standard Time.

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