by Don Lancaster

Emerging Technical Opportunities IV

I guess it's once again time to look into some emerging new technologies. Stuff having really high *Midnight Engineering* potential. Concepts newly turning some awareness corner through rapidly shifting paradigms. Stuff that remains largely free of Fortune 500 involvement.

There are bunches of ways you might tune yourself into exploitable new developments. The foremost two are the News and Comment section of *Science* magazine and the Technology section (usually on page B4) of the *Wall Street Journal*. Also useful and handy are all the usual suspects– *Scientific American*, *Science News*, and good old *Popular Science*. Plus my favorite – *The Whole Earth Review*.

I have personally found the industry trade journals and those labor-of-love newsletters to be a treasure trove for new ideas and concepts. As I've mentioned a time or two before, *Ulrich's Periodicals Dictionary* holds the keys to the kingdom. Listing tens of thousands of trade journals and magazines. Many free to "qualified" subscribers. Find this on the reference shelf at your favorite library or online through *GEnie* or another commercial service.

For the labor-of-love pubs, there's a unique *FactSheet Five* mag. Listing thousands of underground 'Zines.

For instant access to everything about anything, use the *Dialog Information Service*. Or any of countless thousands of web sites. Use my *www.tinaja.com* for access.

Finally, I like to think that my *Tech Musings*, *Guru's Lair*, and *Resource Bin* columns can be of help in steering you to new ideas. As usual, these columns and the files mentioned below are available on my *www.tinaja.com*. For starters, you can pick up earlier emerging technologies as EMERGOP1.PDF EMERGOP2.PDF, or EMERGOP3.PDF. For paradigm chasing, you can try PARADIGM.PDF.

Here's my current crop of new candidates…

Push Me Pull You

It is very rare that any fundamentally new mechanism emerges. Picture a machine tool that looks sorta like the bottom half of a flight simulator. A heavy base. Above it "floats" a small working head. The two are connected by six crossed *jackscrews* or linear actuators.

By computer coordinating the extension or compression of each leg, any reasonable head attitude, position, and motion can be swiftly created.

Now for the unique part: *There are no precision ways!* Nothing slides on anything else. No bending moments. All forces directly push or pull. All motions are on plain old ball bearings. The machine head can go nearly anywhere and do anything. And only has to be rigid enough to allow for tool loading reactions.

Carving such things as turbine blades are now trivial.

Compared to conventional lathes and milling machines, these new devices are potentially much cheaper, stiffer, far more accurate, and significantly faster. One name for them is a *Hexapod*; another is a *Virtual Axis Machine*.

Those real time coordinate transformations required to change actuator positions into head attitude can be fairly ugly. Especially at high speed. The method only works by using the latest of microcontroller techniques.

The extensions to low end robotics and virtual reality applications are obvious.

Start with *A Floating Revolution for Automation*. Found on pages 58-63 of the August 15, 1994 Design News. Then check out *Nice Legs* on page 36 of *Scientific American* for December of 1995. Or see HACK82.PDF.

Some fundamentals of vector-to-step conversion appear in HACK83.PDF

The Mystery Band

How far is it from radio to heat? A lot further than most people suspect. Conventional microwaves top out around 300 Gigahertz. A warm human bod radiation peak checks in just over 30 Terahertz. The region from 300 Gigs to 10 Terahertz is what I call the *Mystery Band*. Others call it *submillimeter wavelengths* or *quasi-optical frequencies*.

So far, *this spectrum is almost totally unused!* The radio astronomers do have a pair of narrow atmospheric windows they research near 600 Gigs, but that's about it. There is enough bandwidth here for 1,600,000 HDTV signals, plus a dozen personal paging fax modems for nearly everybody that wants one. Using tiny high gain antennas.

Kiddies, we are talking a 30:1 frequency range here. *Almost five octaves!* Buckets upon buckets of sheer raw bandwidth. Just sitting there. Totally up for grabs.

Best of all, the *entire* mystery band remains largely license free! There is very little in the way of FCC regs. You are free to start up your own tv station at any power level you want. Any place. Any time.

The only two tiny little gotchas are that mystery band signals don't travel all that well over longer atmospheric distances. Especially in the rain. Worse, decent oscillators and amplifiers for the mystery band did not exist until very recently. So far, the radio astronomers use a "Get out of Dodge" technique where they'll immediately downconvert into manageable high microwave frequencies.

Mystery band amplifiers, especially low noise ones, do remain a big problem.

There's two brand new mystery band power generation schemes. In one, you build up an array of black antennas. Then, you whap the array with a laser. The incoming light photons get absorbed by the black, and their energy gets re-radiated in your desired mystery band frequency. See *Science* for June 25, 1995 for details.

The other is called the *accordian method*. In which you generate some microwaves in a plasma and then literally squash the plasma by blasting one end of it with a laser. The radiation upconverts by being squashed together. Sort of the exact opposite of the *Doppler Effect*. Details again in *Science*. This time in the March 24, 1995 issue.

Newly emerging mystery band apps include imaging of integrated circuits and biologicals. Two papers to get you started: *Terahertz pulses create diffraction-limited images*. In *Laser Focus World* for July 95, pages 15-19. And *THz waves see through objects* in *E.E. Times* for June 12, 1995.

Your best traditional source for mystery band info is the obscure and pricey *International Journal of Infrared and Millimeter Waves*. The *Radio Observer* from the *Society of Amateur Radio Astronomers* is also handy.

Mystery band fundamentals appear in HACK84.PDF, with further details in MUSE92.PDF. For high frequency resources in general, try RESBN26.PDF.

PIC Microcontrollers

The word should be out by now. The PIC is *the* micro of the decade. It completly blows the competition away on all counts. Utterly and totally. Owing partially to its 3X speed and 3X code length advantages. But mostly to its elegant simplicity, its off-the-shelf allocation-free availability, and its incredibly clean architecture.

To the point where today it is absolutely inexcusable to ever again use, say, a 555 timer. Or any other bits and pieces TTL/CMOS hardware lashup.

Most PIC instructions are *one* byte long and execute in *one* clock cycle! Once you get with the program, it is a simple matter to do a multiply-by-twelve in four bytes and four cycles. Or build a sinewave with six and six.

No matter what your *Midnight Engineering* venture, you will do a faster, better, and cheaper job if there are one or more PIC chips involved with it.

Let's see. Start with the bingo card and the *Microchip Technology*, *Parallax*, *Transdata*, *Micro Engineering Labs*, and similar ads you're likely to find scattered around this issue of *Midnight Engineering*.

Then, get the *Microchip Data Book* and *Microcontroller Applications Manual* from *Microchip Technology*. Next, pick up the *BASIC Stamp* from *Parallax*, and the *PIC Tools* from *Scott Edwards Electronics*.

Circuit Cellar is now big on PIC aps. Projects also now appear in *Electronics Now* and *Nuts & Volts*.

Speaking of which, Scott Edwards also runs a great series of PIC columns in *Nuts & Volts*.

I've got some of these up on *www.tinaja.com*, along with a lot of additional PIC tutorials and links.

I've also got bunches of my own PIC stuff here. You can check HACK87.PDF for some PIC resource listings. Or see MUSE88.PDF for PIC fundamentals, and MUSE94.PDF for a *Basic Stamp II* introduction.

Magic Sinewaves

Magic Sinewaves are very long sequences of repeating binary ones and zeros. When connected to an ordinary "H-bridge" power driver, they create premium high power sinusoidal waveforms of precisely controlled amplitude and amazingly low harmonic distortion.

Important uses of magic sinewaves include induction motor speed controls, electric automobiles, solar panel conversion, battery inverters, and home energy efficiency improvers. Compared to traditional PWM or *pulse width modulation*, magic sinewaves require far fewer switch flips to get the same or significantly better results. Thus, magic sinewave efficiency is much higher and distortion is far lower. Far less high frequency energy is involved.

Costs can also be significantly lower, owing to more economical output stages and to smaller heatsinks. Magic sinewaves are also low end micro friendly.

There are vastly more magic sinewaves than there are particles in the universe. Sadly, an exhaustive search or random grab won't hack it. The trick has been developing specialized, efficient, and effective tools to filter out the handful of useful ones. Today, magic sinewaves represent a billion dollar opportunity.

I've got a free reprint on magic sinewaves for you if you call or write me here at *Synergetics*. Formal proposals and tutorial packages on consulting, seminars, source code, working chips, and co-developer programs are also offered to serious inquirers.

The reprint is also available as MSINPROP.PDF. There are hundreds of additional magic sinewave files provided in the *www.tinaja.com* Magic Sinewave library shelf.

Solitons

Much of communication gets done by sending a pulse into a media and hoping part of it comes out some distance away at the other end. Three effects conspire to limit how far you can send a pulse: *Reflection* off lumps in the media, *Dispersion* in which the waveshape degrades over distance, and *Dissipation* where any frictional losses in the media convert the pulse energy into low grade heat.

Dispersion is often caused by certain pulse frequencies traveling faster than others. The net result is a flattening of the pulse. Limiting its detectable height and widening its measurable resolution.

By carefully selecting a suitable *nonlinear* media and then exactly controlling a pulse waveshape, a special pulse known as a *soliton* can result. Short for *solitary wave*. The nonlinear media slows down the *highest amplitude* portions of the wave, *exactly compensating* for its dispersion. The pulse goes on and on without changing its shape. Only the dissipation and reflections ultimately do it in.

Soliton pulses can easily be sent around the world on an optic fiber. They also work well on canals and on tramway cables. The big deal is that you can send signals further and faster. Starting with lower power and using fewer repeaters spaced further apart along the way.

You'll find some 8300+ Soliton references on *Dialog*. Start with Russell Herman's *Solitary Waves* in the July 1992 issue of *American Scientist*.

I've got a soliton tutorial and key paper list up for you as HACK77.PDF.

EMERGING OPPORTUNITY RESOURCES

American Scientist
Box 13975
Research Tri Pk NC 27709
(919) 549-0097

Circuit Cellar Ink
4 Park St #20
Vernon CT 06066
(203) 875-2751

Design News
8773 S Ridgline Blvd
Highlands Ranch CO 80126
(303) 470-4000

Dialog Information Services
3460 Hillview Ave
Palo Alto CA 94304
(415) 858-2700

Scott Edwards Electronics
964 Cactus Wren Lane
Sierra Vista AZ 85635
(520) 459-4802

EE Times
600 Community Dr
Manhassat NY 11030
(516) 365-4600

Factsheet Five
R Seth Friedman
PO Box 170099
San Francisco CA 94117

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

Int Jl Infrared & mm Waves
233 Spring St
New York NY 10013
(212) 620-8000

Laser Focus World
One Technology Park Dr
Westford MA 01886
(508) 692-0525

Microchip Technology
2355 W Chandler Blvd
Chandler AZ 85224
(602) 786-7200

microEngineering Labs
Box 7532
Colorado Springs CO 80933
(719) 520-5323

Nuts & Volts
430 Princeland Court
Corona, CA 91709
(909) 371-3052

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

Photocraft Inc
PO Box 408
Geneva IL 60134
(815) 786-2885

Popular Science
2 Park Ave
New York NY 10016
(212) 779-5000

Radio Observer
7605 Deland Ave
Ft Pierce FL 34951
(407) 464-2118

Science/AAAS
1333 H St NW
Washington DC 20005
(202) 326-6400

Science News
1719 N Street NW
Washington DC 20026
(202) 785-2255

Scientific American
415 Madison Ave
New York NY 10017
(212) 754-0550

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073

Transdata
14330 Midway Road #104
Dallas, TX 75224
(214) 980-2960

Ulrichs Dictionary
121 Chanlon Rd
New Providence NJ 07974
(908) 771-7714

Wall Street Journal
420 Lexington Ave 14th Fl
New York City NY 10170
(212) 808-6960

Whole Earth Review
27 Gate Five Rd
Sausalito CA 94965
(415) 332-1716

Wired
544 2nd St 3rd Fl
San Francisco CA 94107
(415) 904-0664

DNA Computing

The human genetic code represents the ultimate hack. As you might suspect, folks are scrambling fast and furious here. The genome map itself seems the current big bucks biggie. The December 22, 1995 issue of *Science* has full secret insider details on their latest 15,000 landmark map. On pages 1919 and 1945-1954.

An alternate take on DNA possibilities appears in *Wired* for July 1995 on pages 120-124.

DNA is neat stuff. Besides building your own custom rhinopotamus, the glop makes a great chemistry kit. Seems there are four different molecules you can string together (A,C,G, and T) into arbitrarily long digital words. You can then *simultaneously* work with these words in *billions* of parallel processes. At costs and energy levels that make a Pentium an outright joke.

Ferinstance, a calculation that's related to the traveling salesman problem gets done a thousand times faster than the best supercomputer. Again in *Science*. November 11, 1994 this time, pages 993 and 1021-1023. Also see the follow up in *Science* for April 28, 1995. Where you'll find computers that far exceed human brain capacity.

Or, heading off in a different direction: Until recently, DNA was thought to consist of 96 percent useless "junk" and only 4 percent "good" DNA. Now, it turns out that a language – any language – has this remarkable property: Oversimplifying, the fifth most popular word gets used one-fifth as much as the most popular word. The hundredth most popular word gets used 1/100 as often. No matter whether its *Cobol* or *Swahili.*

Guess what? "Junk DNA" statistics *exactly* obey the *same* rules as *all* known human and computer languages! And the "good DNA" instead seems to obey the same rules as does efficiently compressed data! Details in *Science* for November 24,

Curiouser and curiouser..

If you want to make a real quick buck on this, just publish the pocket reference card for the DNA language.

Show us how to access a utility subroutine or two.

There's several emerging alternates to DNA computing. See *Secrets of Quantum Computing* in *Scientific American* for October 1995. And especially *Science* for September 8, 1995 on pages 1363-1364. Also see the summaries shown in MUSE95.PDF and MUSE96.PDF.

Binary Chain Codes

Binary chain codes are another group of repeating binary sequences. Chain codes have a remarkable property: *They are self-positioning*. Any short sample can tell you exactly where you are in the entire series.

The most obvious use for any binary chain code is in a rotary position encoder. Compared to the usual *Gray Code* position encoders, the binary chain encoder is simpler and cheaper and allows much sloppier tolerances.

Other possible uses include self-organizing geographical data bases. Topo maps, anyone?

Photocraft is one source of ready-to-go binary chain code encoders. I have posted a chain code intro up as my HACK80.PDF. Additional technical details do appear as my BINCHAIN.TXT and MORCHAIN.TXT

What can you come up with here? ✦

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.

US callers only, please.

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.

Don is also the webmaster of www.tinaja.com where a special area has been set aside for Midnight Engineering readers. You can also reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or email don@tinaja.com