Don Lancaster's **Tech Musings**

Octber, 1999

here sure are several lively discussions now going on in the *sci.energy.hydrogen* web newsgroup. Proponents feel that solar electric panels generating compressed hydrogen gas are their way to go for "energy independent" personal vehicles. Sadly, they seem to positively refuse to look at all the fundamental numbers or even at the extensive work that has gone before. While accusing those trying to help as being "too negative" or "getting paid by the oil companies".

Well, in the first place, *not one net watt of non-hydro solar electricity has ever been generated!* The energy costs of the research, making up the cells, supporting the cells, interfacing them, and paying for your land, time, and labor involved has yet to even remotely approach breakeven.

Inherently low efficiency limits of today's cells make hitting breakeven a daunting task. Only recently has the energy efficiency of cell manufacture even gotten addressed. Thus, *all of today's solar cells are paid for by oil or gasoline in disguise.*

The magic breakeven number is somewhere around a fully burdened eight cents per kilowatt hour. So far, solar electricity is far too valuable to waste on hydrogen apps. The energy in electricity is also of a much higher "quality" than in hydrogen. Because you can do more things with it and do so a lot more efficiently. Thus, changing from solar electric back to hydrogen can be a giant step in the wrong direction down the "exergy" chain. And a bad scene.

Further, there simply is not enough gross energy storage (3.5 watt hours per STP liter) in hydrogen gas to let you safely and cheaply gain enough vehicle range to be useful. You are talking hundreds of feet, not miles.

At least when unliquified at sane pressures. Decent storage remains *the* crucially limiting hydrogen problem.

Two key points which I might have mentioned a time or two before: An hour in the library (or on the web) is worth a month of lab time. And science works by standing on the shoulders of giants. So, ignoring what has gone before is sheer lunacy. Especially in fields with hundreds of years of history.

Realistic personal transportation alternatives are now at *www.rmi.org* and maybe at *www.homepower.com*. More on hydrogen can be linked at my *www.tinaja.com/h2gas01.html*

We'll see details on a very exciting new hydrogen storage development below. One that just *might* make it all happen. But first, let's turn to some interesting "new" developments in video displays...

Sub-Pixel Resolution

The old original Apple II computer used a sneaky display trick that could be called *sub-pixel resolution*. Which could get used to double the apparent screen content in certain hires modes. For instance, a green half-pixel and a

Anti-aliasing and grayscaling Diode rf switches & attenuators Hydrogen storage breakthrough Several ultrasonic book resources Sub-pixel resolution improvement

> purple half-pixel could get combined into a full white pixel. Details can be found way on back in my *Enhancing Your Apple II, Vol I*, plus numerous other places. Variations on this trick have recently been rediscovered and promise to very much improve the apparent small text legibility of both laptops and dynabooks.

> In fact, subpixel positioning just may be the "enabling technology" to finally blow conventional print media out of the water. Especially when it gets combined with other tricks.

> Microsoft calls their "new" take on subpixel tricks *ClearType*. The critics promptly relabeled it *HypeType*. But you are certain to see lots of variants coming up. Apple II pioneer Steve Gibson has his outstanding tutorial and sample website up on subpixel schemes at *grc.com/cleartype.htm* Including freebie interactive software demos you can explore for yourself.

When **ANTI-ALIASING**, each pixel gets replaced with a weighted average of adjacent bits according to a rule matrix such as...

1/18	2/18	1/18
2/18	6/18	2/18
1/18	2/18	1/18

Anti-aliasing works quite well to remove the "jaggies" out of graphics, but tends to blur and lighten smaller text. Anti-aliasing is easily done late in the display process and is largely independent of content.

When **GRAYSCALING**, each pixel gets replaced with the amount of gray that each individual pixel represents. Special and often custom bitmapped fonts are required for the obvious grayscaling benefits.



Fig. 1 – ANTI-ALIASING AND GRAYSCALING are two older methods to improve small text appearance on most video displays.



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Fig. 2 – "NEW" SUBPIXEL SCHEME promises to dramatically improve small text on certain LCD displays. Individually addressable color elements of a known sequence are required.

Plus links to other sub-pixel sites.

One older way of improving your display resolution is by *anti-aliasing*. With anti-aliasing as it typically gets done, you create a weighted average of adjacent pixels using a low pass filtering process.

Replacing all the blacks and whites with varying grey levels allows your text to be shown in a more pleasing manner. The artifacts created by any sampling are usually at rather high frequencies. Spatial low pass filtering thus favors the original content.

As Adobe Acrobat has shown us, an anti-aliasing often improves your legibility and appearence of smaller text. But often at the cost of getting somewhat gray and blurry.

Figure one shows us the basics of anti-aliasing. In general, your normal spatial low pass anti-aliasing is great for taking the jaggies out of graphic images but only so-so and fuzzy for improving small text.

Grayscaling

There can be other sneaky ways to improve screen legibility. The main problem with anti-aliasing is that it is a general spatial low pass filtering after the fact. It's fast and cheap, but done late in the process. And one that always blurs and smears. Because no more information content gets made

available when anti-aliasing.

What happens if you instead match each pixel only to its wanted internal data beforehand? By replacing each intended pixel with that fraction of grey (or other color) it is intended to optimally represent?

Figure one also lets you compare this grayscaling alternative against bitmapping and after-the-fact low pass filter anti-aliasing. As you can see, the *Palatino* improvement at ten points is dramatic. But hand crafted and bit mapped fonts are required for truly optimum results.

What got me started on this is that I was retouching a bitmap image for my new www.tinaja.com/barg01.html surplus bargain web page and noted that the word PULL can be shown legibly with a 2x3 dot matrix!

Start with an accurate character. To do grayscaling, optimally overlay the accurate character onto an n by mmatrix. Calculate the exact energy in each matrix block. Replace that part of the character with the equivalent gray. Since the eye can resolve up to 64 bits of gray information, you are providing up to 64 times the info before quantizing into pixels. Your screen now has lots more information that it can work with.

Raw PostScript is amazingly adept at this sort of thing. Especially its little known infill operator. Your font capture and grayscale coding can be automated. And this technique should work with most color combinations. Character sets will often have to get generated ahead of time to specific resolution sizes. One big advantage would be platform independence.

This should work better with fonts optimized for low resolution screens. Such as Stone.

Apparently I am not the only one playing with pixels. One grayscaling variant is known as hand anti-aliased fonts. Demos are at *www.airwindo* ws.com/shareware/fonts/index.html Here somewhat oversized fonts are retouched and then downcoded into appropriate grays.

Subpixel Secrets

The "new" subpixel scheme in our figure two can end up quite simple. If you have a display in which you can individually and separately address single and sequential red, blue, and green elements, and *if* you know the exact sequence of all those elements, then you can increase your apparent display resolution in one direction.

The subpixel trick works because the eye is much better at seeing detail than it is color. The small text quality improvement on a typical laptop is stunning. At the cost of display limits and special drivers.

As you can clearly see, combining subpixel techniques with grayscaling is a potent combination.

But there are lots of gotchas to be aware of. The idea applies mainly to LCD displays. No way is yet known to use a stock CRT monitor. Nor is one likely to be found. Why? because the electron beam usually addresses many phosphor dots at once. And the multiple blue dots are not particularly left or right of the other colors.

You have to know the *exact* LCD color stripe sequence and match your software to it. Most LCD's are now RGB, but a few are BGR.

Your resolution improvement only works in one direction. You'll want this to be horizontal, because most character details, bolding, italics, and kerning are all horizontal sensitive.

Thus, you are currently limited to landscape displays. Unless someone builds a portrait-specific triad-rotated LCD display. You are mostly limited



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to black text on a white background. There could be some color fringing, but it is apparently not too bad. And almost certainly can get reduced by sneaky tricks or special displays.

You do not end up tripling your resolution because of positioning considerations. A doubling is more reasonable. But it sure looks better.

You are also restricted to specific text sizes that all must get carefully matched to the display resolution. At least for the finer print. But this is not necessarily a serious problem in a book-viewer type of machine.

Some color fringing is created by subpixel techniques. On the left side of each black font character in RGB sequence, chances are that blue may be weak or missing. Thus giving you a possible orange fringe. On the right side, chances are that red is weak or missing, giving you aqua.

That modest LCD subpixel color fringing can probably be minimized by going to special displays whose color sequence shifts by one pixel on each horizontal line. Sort of a triple "super-PAL" mono mode.

Adobe has been strangely silent so far, but we can expect subpixel plug ins for their *Acrobat* products.

There is also an obvious but very expensive solution of increasing the display resolution. But it makes the most sense to make each portion of every pixel count the utmost before you demand more of them.

The PostScript code used to create these demos is in MUSE141.PSL You could easily explore these concepts further on your own. Consulting and code services are also available. See http://www.tinaja.com/info01.html

Diodes as rf Switches

I've gotten several helpline calls and emails on this topic, so it is time for an update and review.

There's all sorts of times when you might wish to turn a rf signal on or off, switch between two or more rf signals, activate a trap, change your channels or bands, or adjust rf signal levels. These days, we have all sorts of options. Stock CMOS 4016 or 4066 analog switches can perform well at lower frequencies. Look at my *CMOS Cookbook* or *Maxim* for details.

We also have new mid frequency bus switch variations from Cypress,



Fig.3 – ON ITS "KNEE", the slope of an ordinary diode is given by 26/i in milliamperes. Thus, a half mil dc current causes the diode to look like a 52Ω resistor to small rf signals.

IDT, Pericom, Quality, and others. More info from www.questlink.com. Lots of ads for fancy and ready-to-go microwave switches and attenuators are found in such trade journals as Wireless Product News, Wireless Design & Development, RF Design, or Microwaves & RF.

But plain old diodes can also still be used here. As can their improved offspring. Figure three shows us the forward curve of an ordinary silicon diode such as a 1N914. Since this is a plot of current versus voltage, your *slope* at any point should also be the equivalent *resistance*. At one mil, the equivalent small signal resistance of a silicon diode is roughly 26/i where *i* is the current in milliamperes.

Thus, any dc current of half a mil



Fig. 4 – SIMPLIFIED SCHEMATIC of a high performance PIN diode rf switch or attenuator. The Π network arrangement gives a constant input and output impedance. Control voltages must be carefully set for best restults.



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SOME SELECTED ULSTRASONIC BOOKS

1996 IEEE International Ultrasonics Symposium (FEFCS IEEE) Clinical Sonography: A Practical Guide (Roger Sanders) Diagnostic Ultrasound (Stewart Bushong) Fundamentals of Ultrasonic Nondestructive Eval... (L. Schmerr) Handbook on the Ultrasonic Examination of Aus... (Am Weld Soc) Micromachined Ultrasound Proximity Sensors (Mark Hornung) Nondestructive and Ultrasonic Testing for Aircraft (FAA Staff) Piezolectric Actuators and Ultrasonic Motors (Kenji Uchino) Power Sonic and Ultrasonic Transducer Design (B. Hamonic) Three-Dimensional Ultrasound (Thomas Nelson) Transducers for Sonics and Ultrasonics (M. McCollum) Ultrasonic Bioinstrumentation (Douglas Christensen) Ultrasonic Communication by Animals (Gillian Sales) Ultrasonic Instruments and Devices (R. Thurston) Ultrasonic Liquid Atomization (Harvey Berger) Ultrasonic Measurements for Process Controls (L. Lynnworth) Ultrasonic Measurement Methods (R. Thurston) Ultrasonic Methods of Non-Destructive Testing (J. Blitz) Ultrasonic Motors: Theory and Applications (S. Ueha) Ultrasonic Sensors for Chemical and Process... (R. Asher) Ultrasonic Transducer Materials (Oskar Mattiat) Ultrasound: Biological Effects and Potential... (A. Williams)

For more details, see www.tinaja.com/amlink01.html

makes a diode appear like a 52 ohm resistor to very small ac signals. The higher the current, the lower will be the apparent rf resistance.

The trick is to set up *two* paths. A *signal* path that accepts low level rf signals and is capacitively coupled. And a dc coupled *bias* path that turns the diode on or off.

Resistors or inductors are used in the bias path to only lightly load the signal path. Capacitors block the bias currents in the signal path.

The diodes are largely "off" with zero current and act as fixed resistors with carefully set bias currents of a few milliamperes.

These days, there's an even better device known as a *PIN diode*. PIN diodes are diodes that are purposely designed to have exceptionally *long* carrier lifetimes with *slow* reverse recovery times.

As such, they make useful *current controlled resistors* for all vhf and microwave apps. These are low in cost and the bias current sets the resistance for you. Down to a fraction of an Ohm or less.

But do observe that PIN diodes are

useless below 10 Megahertz.

As with a regular diode, you set up an ac rf path and a dc biasing path. If you are sneaky, the diode's package capacitance can be resonated out or included as part of a filter.

Useful devices include the 1N5719 and others from *Hewlett Packard*, or that BA582, BAT18 and friends from *Infineon*. Who apparently used to be *Siemens*. On your BAT18 device, rf resistance at five mils is less than half an Ohm. Combined with a 100 nanosecond recovery time.

Once again, the intentionally long PIN effective carrier lifetime does not

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Phone or email all your US Tech Musings questions to:

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US email: *don@tinaja.com* Web page: *www.tinaja.com* change much on a rf cycle, making for a seemingly constant controlled resistance at rf. Which is what PIN diodes are all about.

Diodes may be combined into "L" or " Π " or "T" arrangements for more loss or better impedance matching. A simplified schematic for a multiple PIN diode Π attenuator is shown in figure five. When properly designed, Π attenuators offer a constant input and output impedance.

Use of two pairs of symmetrical back-to-back diodes can reduce the nonlinearity and distortion. Control voltages (and their diode currents) do have to be carefully adjusted to work together to get the correct attenuation and impedance. The attenuation can range from very little loss up to 70 decibels. See the *Alpha Industries* ap note *A Wideband General Purpose PIN Diode Attenuator*.

The same circuit makes a rather nice rf switch simply by going from minimum to maximum attenuation. Note that advanced construction and measurement skills are required for this simple and cheap circuit.

I have got some great prices on digitally programmable 0.5 to 30 db PIN diode rf atteunator blocks up at my *www.tinaja.com/bargps01.html* These are a part of some specialized mil *artery link receivers*. These also do include multiple stage broadband microwave amplifiers, analog PIN attenuators, and fiber optic interface parts. These are real parts bonanzas and great project starters.

Some Books on Ultrasonics

I've gathered together a few useful books on ultrasonics for you as this month's resource sidebar. It seems there are also great heaping bunches of medical ultrasound books, so I've included only a modest sampling of these many titles. More details up at www.tinaja.com/amlink01.html

New Tech Lit

From *Maxim*, a new full line data catalog CD on their analog switches, regulators, interface, A/D, D/A, and bunches more. Check out their new MAX1644 regulator. From *Rohm*, a similar CD on all sorts of intriguing consumer electronics chips.

A major real-world breakthrough in hydrogen storage appears as *High*

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H2 Uptake by Alkali-Doped Carbon Nanotubes under Ambient Temperature and Moderate Pressure. By Lin, Chen, Wu, and Ti. In Science, Vol. 285 July 2, 1999, pages 91-93 Website is www.sciencemag.org. If you are not an AAS member, reprints are \$5 per download. Or \$10 for 24 hour guest access to their entire page full of reprints and abstracts.

Carbon nanotubes are very good at accepting and storing hydrogen. But keeping them stable and getting them to give most of their hydrogen back simply and safely have been the huge

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problems. You might search the web under "Rodriguez" and "Hydrogen" for interesting earlier work.

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are published by the *Hanser Gardner* folks. Ultra small nuts, screws, taps and dies can be found at *J. I. Morris*. Most any variety of plastic fastener is sold by *Micro Plastics*.

Our featured trade journals for this month are *Digital Content Creator*, *Print on Demand Business*, and that *Energy User News*.

For most individuals most of the time, any involvement with patents is virtually certain to end up as a net loss of your time, energy, money, and sanity. Find out why along with lots of proven real world alternatives in my *Case Against Patents* package.

Per www.tinaja.com/synlib01.html or my nearby Synergetics ad. Also do check into those new Webmastering Secrets and similar InfoPacks.

Latest website additions now up at *www.tinaja.com* include scads of GPS and navigation stuff, columns on new antenna resources, and more great surplus bargains. Besides great techie items, you will find everything from

Micronesian flags to water soluble swimsuits to Y2K wilderness survival land to *Kinetron II* medieval torture chambers to germ warfare kits.

Online auctions, too.

As usual, most of the referenced items are in our *Names & Numbers* or *Ultrasonic Books* sidebars. Always check these first before you call our no-charge US helpline or my email of *don@tinaja.com* which are found in the nearby box.

Let's hear from you. 🔶



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