Don Lancaster's

Tech Musings

December, 1995

Superb aviation history book
A new RGB to NTSC encoder
Lamps and lighting efficiency
Emerging ultra-fast computers
Product development concepts

I just got a helpline call from an "inventor" trying to "protect" a "new" auto headlight idea. To stop "Detroit" from stealing it.

I've never heard of "Detroit" *ever* paying *any* outsider for any untested, undeveloped, or unproven idea.

Instead, "Detroit" buys parts from suppliers and bolts them together to make cars. They are in the process of outsourcing much of their product engineering. They are significantly *reducing* their number of suppliers. And holding them to the tightest of razor thin margins.

Uh, strike one.

Illumination engineering is one of the very few things that Fortune 500 companies happen to do very well. A multi-skill project team approach is usually required, combined with ray tracing computers, arcane production engineering, and outstanding access to the world's research base.

So, those big boys clearly have an unbeatable home turf advantage here.

For strike two.

Your really big issue on *all* future headlights is *efficiency*. Because of downsizing in general and electric or hybrid cars in particular. Anything less than 100 Lumens per Watt won't hack it. You can bet that tomorrow's headlights will most definitely *not* be based on a heated filament.

I got the impression the caller was not a member of the SAE. Nor the IESNA. Nor did he seem to be at all into trade journals or online literacy. He seemed to feel that car headlamp efficiency was "not important." And apparently did not have the slightest idea how woefully inefficient his new design was. For a self-inflicted swing and a miss for strike three.

A Realistic Alternative

Let us assume that you genuinely feel that you do have a great "new" headlamp design. What could you do that works out in the real world? Step one is to get yourself trade journal, association, and online literate. To make sure you aren't talking about a product that's been sold for decades. Or one that long ago fell off the shelf because of inherent problems.

Step two is to ask yourself "Who is it that (A) likes bright headlights, and (B) has their own wallet in their own back pocket?

Well, out here on my sand dune, the answer is glaringly obvious: 4WD desert off-roaders. To these folks, a "map" light is 50,000 candelpower.

And a "running" light can vaporize troublesome boulders at 75 paces.

On low beam.

So, firstoff, you would have a few four wheelers critique your design. If it is any good, you then let the local 4WD club beta test it. Once you have your tested and proven product well received, you sell a few at regional meets. Then you publish it in all the offroad mags.

Next you seek out one or more of those off road lighting outfits. *K.C. Manufacturing* is but one of the name brand biggies out here. Competitors include *Dick Cepek*, *Hella*, *Explorer*, and *Piaa* corp.

But be sure to remember the key insider secret rule for *all* successful new product development: *They must come to you*. And *never* vice versa.

Do note that you are *not* selling an idea. Ideas are worth ten cents a bale in ten bale lots. You are instead now offering a proven, in-demand, and a ready to manufacture product. here you have already completed most of the high risk steps.

More on becoming a purveyor of risk reduction in RISKDOWN.PDF on *www.tinaja.com* And much more in general on idea development in my *Blatant Opportunist* and my *Case Against Patents* packages.

A RGB to NTSC Converter

I get all sorts of helpline calls from folks who want to use an ordinary color tv set for their computer output. Preferably via the antenna input.

Instead of buying a pricey high resolution RGB monitor. Well, these days, yew jest caint get there from here. The tv resolution is too low and

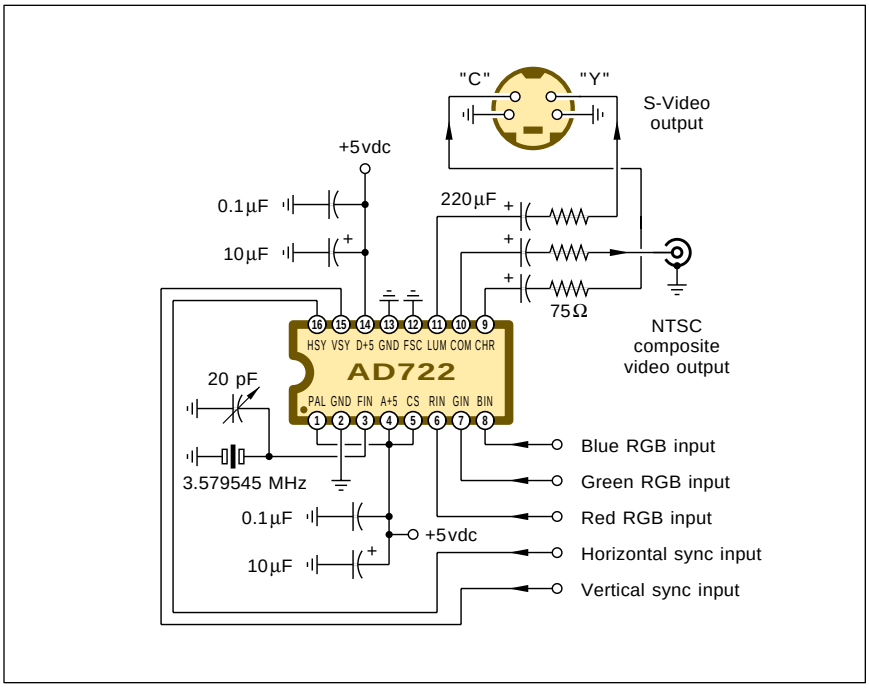

Fig. 1 – A NEW $8 RGB TO NTSC CONVERTER CIRCUIT. But note that your sweep rates, interlace, overscan, and your program content must all be made tv-compatible if you want useful results.

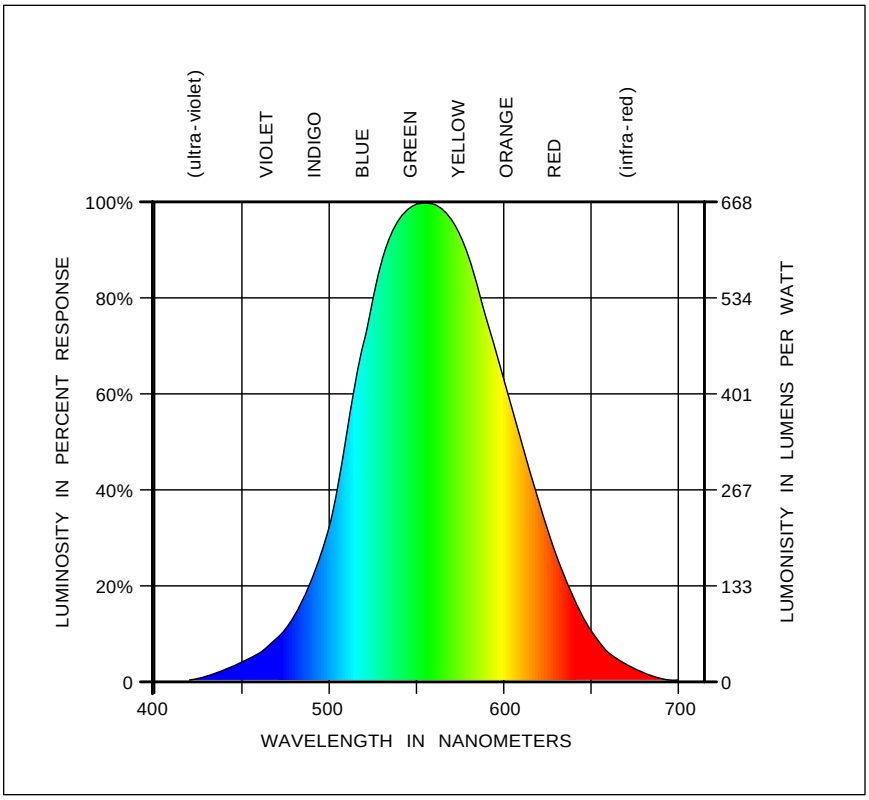

Fig. 2 – THE LUMINOSITY RESPONSE of the human eye varies with color. It is highest for a yellow-green and lower for red or blue. Thus, white light sources are inherently less efficient than lime green ones.

the computer screen info content is way too high. Why do you suppose they went to all of those fancy hires monitors in the first place?

No matter what you do, there is *no way* you that can display "ordinary" modern computer color spreadsheet or word processor output by rf entry on an unmodified television! All you will get is a hopelessly smeared and violently flickering illegible mess.

On the other hand, if you design your computer screen *content* to be consistent with what your tv set can reasonably and intelligently handle, then you certainly can display it. At least after format conversion.

Thus, computers might definitely get used for video titling, for *large* screen data or text, for video editing, for "slide show" presentations, or for abstract art effects.

Analog Devices has just come up with a greatly improved and easy to use AD722 single chip RGB to NTSC encoder. I've shown a typical lashup in figure one. You can use this chip to convert *already tv viewable* RGB computer output into signals a tv set can understand. But you *can not* use this (or any other scheme I know of) to let a tv replace a hires monitor.

Let us review some fundamentals. The NTSC, or *Never the Same Color* system is an American broadcasting standard. It was conjured up decades ago to cram color information in to the same rf bandwidth as the mono signal. This was done by creating a new color *subcarrier* frequency of 3.579545 MegaHertz.

This special frequency allows the sampled color spectrum to magically "interleave" with the black and white comb spectrum on the same channel.

Many compromises were involved with NTSC. Set mostly by technology limits at the time. And the need to be backward compatible with old tv's.

Thus, the reasons why rf entry on a color tv cannot display computer data include (A) its far too low horizontal and vertical sync rates, (B) severely limited resolution that prevents more than a few dozen color changes on any screen line, (C) its interlace that badly flickers small characters, and (D) overscan that hides corners.

If you are able to resolve *all* of the problems, then building an RGB to NTSC coverter makes sense.

Otherwise, it does not.

Briefly reviewing, an RGB system has its video on three separate red, blue and green lines. An extra line or two gets output for sync. Or else the sync gets combined onto your green channel. RGB says *nothing* about any standards or scan rates. But they are typically far higher than any tv can accept. Ridiculously so.

NTSC instead combines all of the picture information into a baseband black and white *luminance* signal and a color *chrominance* subcarrier. The chroma channel applies a quadrature modulaton for a color phase.

NTSC demands a pair of interlaced 262-1/2 line *fields* at a vertical sync rate of 59.96 Hertz. The horizontal scan rate is 15,735 Hertz. Interlace reduces flicker *only* when adjacent lines are fairly similar. Since this is *never* the case with small dot matrix characters, *interlace flickers badly on all small text*.

The NTSC signal will be purposely overscanned. Gruesomely so on older sets, Wrapping the picture around the side of the tube guarantees there will be no ugly black side stripes.

Thus *all* NTSC programming *must* guarantee that the useful stuff always ends up *only* in the *center*.

The chip is easy to use. You first apply the usual +5 volts at 30 mils. Also connect pin one to +5 to select a NTSC instead of the PAL standard. The RGB outputs go directly to the red, green, and blue inputs. Three outputs are provided: the composite video, a Y luminance output, and a C chrominance output. These latter two outputs can optionally get routed to a S-video connector.

In addition, you have to get sync and the stable color subcarrier from somewhere. You can input horizontal and vertical sync on separate pins. Or else put composite sync into pin 16 while making pin 15 positive.

If you have a 4X color subcarrier clock available, by all means use it, inputting to pin 3. If not, you hang a stock *parallel resonant* color burst crystal from this pin to ground. Note that resynchronizing to a local crystal may degrade your results.

A logic high on pin 12 selects the

4X subcarrier mode, a low picks 1X.

Be sure to carefully read the data sheet. There are several nasty gotchas to getting this chip to interact with VGA and other standards.

Conventional tv receivers require a chroma *delay line* to compensate for color shifts; a circuit equivalent to a delay line is *included* on chip so the results end up nearly identical to a broadcast signal.

The outputs are all at *twice* normal amplitude, letting you directly drive a 75Ω reverse terminated load.

Most VGA sources have provision for control by software. Once again, your sync rates and picture content *must* be NTSC compatible ahead of time. Or you'll get useless results.

Lighting Fundamentals

If you pick up any plain old 60 watt light bulb, it is likely to be rated around 850 *Lumens*. That sounds like a bunch. Until you find out what a Lumen *really* is. Then you discover how badly you've been ripped off.

Well, a *Lumen* is a measure of the *total output light power*. How many Watts of light you will get back after gathering together all the output from all directions. (Er – usually anyway. Some narrow beam spotlights cheat and use "effective Lumens" instead. Sort of like antenna gain.)

Being a unit of power, there is a relationship between the output light *Lumens* and input electrical *Watts*. This relationship also depends on the eye's sensitivity to colors. The eye responds with the *luminosity curve* shown in figure two. Eye sensitivity is highest in the yellow-green.

A Lumen is defined as 0.001496 Watts of yellow-green light. Or 668.5 Lumens per Watt. A 100% efficient 60 Watt yellow-green light bulb can thus produce 40,110 Lumens.

Which means your plain old light bulb has a yellow-green efficiency of a mere 2.1%! When the other colors are considered, your total barely gets up to seven percent or so. A rating of *fourteen* Lumens per Watt. Caused by nearly all the input energy getting converted into useless heat.

The first obvious try at efficiency improvement is to operate the lamp hotter. This works, but dramatically reduces lamp life. For a workaround, the bulb folks have recently gone to a *Halogen Cycle*. Once known as the "Quartz-Iodine" approach.

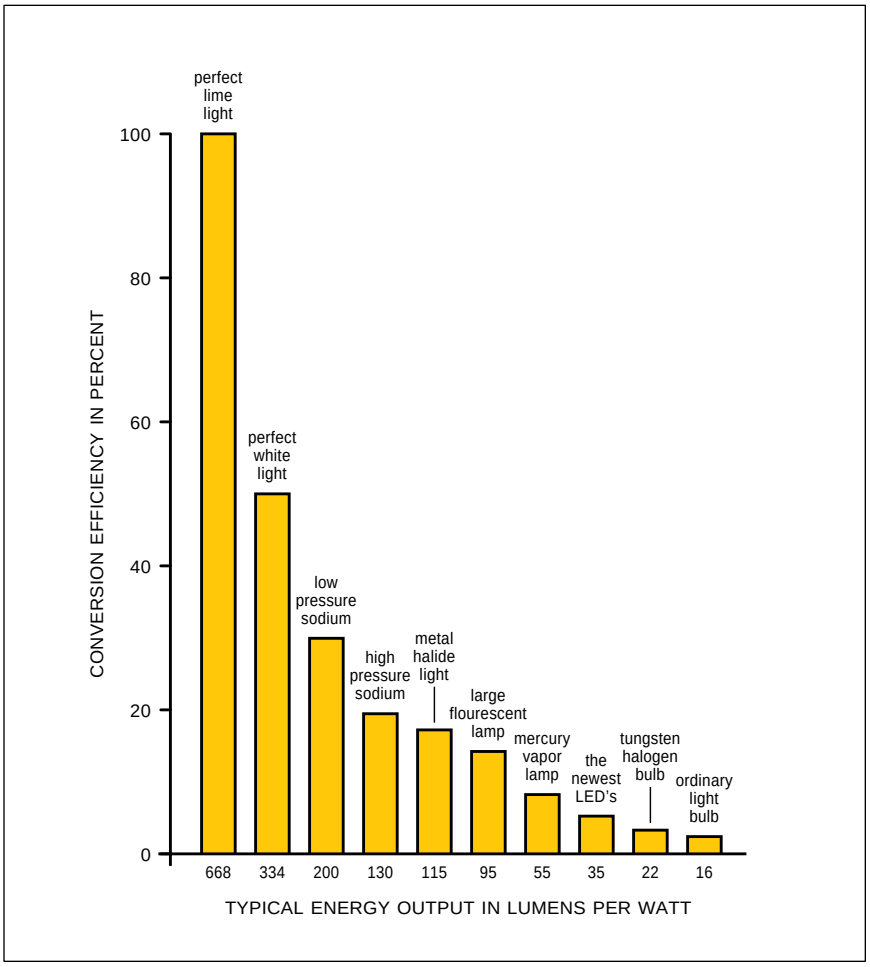

Fig. 3 – EFFICIENCY RATINGS for several emerging lamp technologies. Note that ordinary incandescent light bulbs are utterly awful.

You still do have an incandescent lamp here. That "quartz" part means the actual bulb temperature can be higher without shattering. And that "iodine" vapor part sets up a magic cycle that grabs any tungsten that got boiled off of the filament during hot times. Forming a tungsten iodide gas which is only stable when hot. The gas then redeposits the tungsten right back onto the filament during cold shutdown times.

All of which gives you a modest improvement in efficiency. Around fifteen percent better for a 52 Watt Halogen replacement lamp. But the higher initial costs will eat into your energy savings. These do last twice as long, though.

The larger Halogen lamps can get up to 22 Lumens per Watt. Two big gotchas here: You must *never* touch the bulb on these. The fingerprint oil causes a cold spot which can shatter the glass. And the lamps must *not* be continuously turned on and off. The halogen cycle only operates properly when the lamp remains on for hours at a time. With lots of cooling time between uses.

Improving Efficiency

Actually, the correct term here is *efficacy*, since the output energy is in a different form than the input. There are bunches of lamp technologies far more efficient than any incandescent. Figure three shows us how all these alternates compare.

Let's look at a few candidates…

Light emitting diodes– Surprisingly, many newer LED's are actually *more* efficient than incandescents. Besides lasting a lot longer. Cavers have long ago picked up on all of those orange

LAMP AND LIGHTING RESOURCES

Advance Transformer
10275 W Higgins Road
Rosemont IL 60018
(708) 390-5000

BHK
1000 S Magnolia Avenue
Monrovia CA 91016
(818) 357-9667

Bulbman
PO Box 2918
Reno NV 89505
(800) 648-1163

Bulbtronics
45 Banfi Place
Farmingdale NY
(516)249-2272

Carley
1502 W 228th Street
Torrance CA 90501
(213) 325-8474

Dick Cepek
17000 Kingsview Avenue
Carson CA 90746
(800) 992-3735

EPRI Journal
PO Box 10412
Palo Alto CA 94303
(415) 855-2000

Explorer
14100 Kingsley Drive
Gardena CA 90249
(310) 719-7285

Gilway Technical Lamp
800 W Cummings Park
Woburn MA 01801
(617) 935-4442

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

Gray
4415 Indianapolis Blvd
E Chicago IL 46312
(800) 238-2244

Hella
201 Kelly Drive
Peachtree City GA 30269
(800) 247-5924

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

Home Power
PO Box 520
Ashland OR 97520
(916) 475-3179

IESNA
120 Wall Street 17th Fl
New York NY 10005
(212) 248-5000

JKL Components
13343 Paxton St
Pacomia CA 91331
(800) 421-7244

KC Lites
PO Box 155
Williams AZ 86046
(800) 528-0950

Lighting Design & Apps
120 Wall Street 17th Fl
New York NY 10005
(212) 248-5000

Lighting Research Institute
120 Wall Street 19th Floor
New York NY 10005
(212) 248-5014

Loctite Luminescent
Etna Road
Lebanon NH
(603) 448-3444

Neon News
PO Box 668
Volcano HI 96785
(808) 967-7648

PIAA Corp
15370 SW Millikin Way
Beaverton OR 97006
(800) 525-7422

Real Goods
966 Mazzoni St
Ukiah CA 95482
(800) 762-7325

Welch Allyn
4619 Jordan Road
Skaneateles Falls NY 13153
(315) 685-4275

superbright *Hewlett-Packard* diodes as backup light sources. And Detroit is now heavily into LED tail lights. Both because of their longer life and their "instant on" feature. The latter translates to some *twenty feet* of extra safety margin at thruway speeds.

There is no fundamental physical limit restricting LED efficiency. It is more economics, material science, visual coupling, total output, and a poor performance in the blue that is holding things up.

Neon Lamps– These are just a pair of electrodes in a glass enclosure that is filled with some inert gas such as neon (orange), xenon (blue), carbon dioxide (white), helium (purple), or mercury (green). A current causes a glow discharge and output light.

These are potentially very efficient "cold light" sources. The Lumens per Watt depends on the color. Output power is normally low. High voltages are always involved. Today, "neon" tubes are used for advertising.

More on these in *Neon News*, *POP Design*, *Sign Craft* or *Sign Business* trade magazines.

Electroluminescent Panels– This is another "cold light" source. Basically a capacitor with a phosphor on one electrode. A high ac voltage (100-400 volts) is applied, whose field strength excites the phosphor. Many colors, including white. A medium green is usually the brightest.

Best results are obtained at mid audio frequencies. Total light output is low, and the lousy power factor makes for big time drive problems. Your brightness drops significantly with time and contamination. Not much seems to be happening lately in new developments here.

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*

Loctite Luminescent is one info and parts source.

Fluorescents– A fluorescent lamp has a much better efficiency than any incandescent. Up to 100 Lumens per Watt. A fluorescent lamp works in two stages. First an ionized plasma discharge generates strong and narrow band ultraviolet light.

That invisible ultraviolet light then impinges on a *phosphor* which will downconvert most energy radiation into the visible range.

Because these are current operated, a regulator in the form of a magnetic or electronic *ballast* is required. Electronic ballasts do offer *electrical* efficiencies of 85 percent and higher. They also can excite the phosphor at higher frequencies. Both for more light and lower flicker. Dimming is a brand new electronic option.

RF Fluorescents– A new scheme where a phosphor is directly excited by a radio frequency source. While it is too new to tell, the efficiency should be "high". If the costs, circuit complexity and rfi problems can be overcome. Watch for overblown hype

and investment scams on these.

Mercury Vapor lamps– These are just a tiny blob of mercury and two electrodes. The mercury gets heated somehow. Either by direct arcing, or by neon or some other gas discharge warming it. The vapor supports a current limited arc discharge. They produce a bluish white light. The efficiency is 50 Lumens per Watt.

Because all these lamps produce a dangerous amount of short wave uv, safety filters are a must. Their life is extremely long at 24,000 hours. Color rendition is only poor to fair. I get the impression their popularity has clearly peaked.

Arc lamps– Those old carbon arc lamps offered very high brightness. Their efficiency is not half bad at 120 Lumens per Watt. But the traditional designs consumed carbon rods and needed continuous adjustment. And they did not scale down well.

The *Welch-Allyn* folks have come up with a newer sealed variant called a *short-arc* lamp. This 21 watt point source device offers 75 Lumens per Watt and is intended for scientific and fiber optic apps. A special ballast is needed. Because it is as much as 4X more efficient than halogens, this seems ideal for battery powered apps.

But pretty expensive, though.

Metal Halide lamps– By far your most popular bulb for commercial and industrial lighting, these new designs offer efficiencies as high as 125 Lumens per Watt and good color rendition. Life can approach 20,000 hours. Typical sizes vary from 25 on up to 2000 watts. Special ballasts are required, as is an ultra violet safety filter. The filter is often built into the glass itself. Expect to see these move into home and vehicular lighting.

I'd guess that these would be the obvious choice for most future auto headlights. Until something better comes along.

Low Pressure Sodium– A clear cut efficiency winner at 200 Lumens per watt, these "street lamps" do offer extreme life, low running costs and outstanding nighttime visual acuity. Astronomers love them because they can dramatically minimize any visual pollution. Sadly, their distinctive orange color gives a mesmerizingly awful color rendition. Sizes as small as 18 watts are newly offered.

High Pressure Sodium– Another sodium lamp variant, this one trades off extreme efficiency for a greatly improved color rendition. At low gas pressures, the emission takes place in distinct spectral lines. As pressure increases, the lines first broaden, and then become more continuous. These can offer 120 Lumens per Watt with no ultraviolet filter hassles.

A 10,000 hour life is common. The sizes range from 35 up to 1000 watts. The cost is around $90 in singles. Mercury vapor ballasts can be used. Most operate in any position.

Some Lighting Resources

I have gathered up a few lighting resources for you as this month's sidebar. Besides those I have already mentioned, a few deserve comment.

IESNA seems to be the main trade association. They publish a *Lighting Design and Application* magazine plus a technical research journal. There is also a *Lighting Research Institute* in the same building.

The *EPRI* journal is by the *Electric Power Research Institute*. Who offer fine reference materials.

The leading industrial source for lamps is *Grainger*. The graphics arts lamps are usually sold by *Bulbman*, *Bulbtronix*, *Gray*, and *HID Systems*, among many others.

Two manufacturers of the smaller lamps are *Gilway* and *Carley*. *JKL* is a good source for low cost miniature fluorescent lamps, while *BHK* offers specialized uv lamps. *Advance* is the leading ballast supplier.

Home Power is a fine magazine for off grid lighting apps. A high profile lamp and alternate energy supplier is *Real Goods Trading*.

Please let me know if I missed any of your favorite sources here. A free *Incredible Secret Money Machine II* for your trouble.

A Great Read

I was genuinely impressed by *The Shoulders of Giants*, a history of early avaition. Written by Phil Scott and published by *Helix Books*.

There was a government avaition fiasco at the time of Kitty Hawk that did cost hundreds of times more. The

NAMES AND NUMBERS

Analog Devices
PO Box 9106
Norwood MA 02062
(617) 329-4700

Atmel
2125 O'Nel Drive
San Jose CA 95131
(408) 441-0311

Flexible Circuits
6195 Corte del Cedro #110
Carlsbad CA 92009
(619) 431-2869

Focal Press
313 Washington Street
Newton MA 02158
(617) 928-2500

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

Helix Books
Addison-Wesley
Reading MA 01867
(617) 944-3700

Image Processing Resources
PO Box 207
T or C NM 87901
(800) 735-3596

Intel Corporation
2200 Mission College Blvd
Santa Clara CA 95052
(800) 548-4725

The Mart
899 Presidential #110
Richardson TX 75081
(800) 864-1155

P-O-P & Sign Design
7400 Skokie Blvd
Skokie IL 60077
(708) 675-7400

Power Transmission Design
1100 Superior Avenue
Cleveland OH 44114
(216) 696-7648

Riteco Supply
12999 FM 529
Houston TX 77041
(713) 896-6200

Roland Users Group
7200 Dominion Circle
Los Angeles CA 90040
(213) 685-5141

SAE
400 Commonwealth Drive
Warrendale PA 15096
(412) 776-4841

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

Sign Business
1008 Depot Hill Office Pk
Broomfield CO 80020
(303) 469-0424

SignCraft
PO Box 06031
Fort Myers FL 33906
(813) 939-4644

Siliconix/Temic
2201 Laurelwood Road
Santa Clara CA 95054
(800) 554-5565

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

Tiare Publications
PO Box 493
Lake Geneva WI 53147
(800) 420-0579

program only succeeded in filling the Potomac River with broken bits and pieces of planes and pilots.

The Wright Brother's patent fights clearly set US avaition back far more than their early flights ever advanced it. For decades, even.

That initial transcontinental flight crashed so many times that only an original wing spar and most of the pilot actually ended up on the west coast. And, of course, the Red Baron failed his flight test three times.

New Tech Lit

From *Atmel* a new *Flash Memory Application Book*. From *Siliconix*, a data book on the *Little Foot* and *Lite Foot* mini power MOSFETs. These require surprisingly little in the way of heatsinking. From *Intel* a new free CD on their full *i960 Microprocessor Electronic Library*.

Computers that can be *billions* of times faster than a Pentium (and far cheaper) are described in *Science* for September 8, 1995 on page 1363-64. One of the many options is *quantum computing*. Expanded upon on pages 140-145 of *Scientific American* for October of 1995.

Roland magazine is a free pub on synthesizers and related electronic music topics. They've also come up with a new *Sound Canvas*. An entire synth in a single PCMCIA card.

Power Transmission Design is a new trade journal on motion systems. *The Mart* is a big-time major shopper on phone parts and systems.

Flexible Circuits Engineering is a brand new trade journal on bendable printed circuit materials.

Hoop Pine Plywood is a flexible wood suitable for modelmaking and prototypes. Free samples are offered by the *Riteco Supply* folks.

The free *Media Arts Catalog* from *Focal Press* stocks hundreds of titles on everything from nonlinear editing to time codes to scriptwriting.

For high end hardware, try *Image Processing Resources*. For lighting, lenses, cameras, frame grabbers, and more. Lots of great cartoons in their free catalog.

A *BBS Radio* directory is available from *Tiare Publications*. But do note that these are the hobby listings only. That outstanding RADIO board up on *GEnie* is not mentioned. Nor is any other major commercial resource.

There are lots of new opportunities in self publishing these days. For the latest and best info, check into my new *Book-on-demand Resource Kit*. Available per my *Synergetics* ad.

The usual reminders that most of those items mentioned appear in the *Names & Numbers* or in the *Lighting Resources* sidebars. Be sure to check here before you call our no-charge tech voice helpline. ✦