Don Lancaster's

Tech Musings

March, 1997

Low priced aerial photos
Fundamentals of NTSC tv
A new character generator
Resources for video and tv
An analog video fader chip

I just got hold of a brand new *Videonics PowerScript* PS-1000 NTSC animated video character generator. Among its bunches of impressive features, this is one of the first stand-alone units which extends the PostScript computer language for work in professional video animation and editing. You get instant access to nearly unlimited fonts. Plus all of the paint and illustration programs.

Before we get into more details, though, I thought it might be a good time to once again go over…

A Few Film and Video Fundamentals

Motion pictures predated video. A typical theater film consists of one or more reels of multiple 35 millimeter or larger *frames*. The main difference between a single frame of a motion picture and a slide from your home 35 mm camera is that the frames are usually arranged *landscape* across a film, rather than *portrait* along it.

During projection, the frame gets violently jerked into position by the *film gate*, held there, then violently jerked away. By using a *Geneva Stop Mechanism*. A rotating shutter behind the film then illuminates each frame *twice*. Projecting your image through optics to the screen.

Each illumination can be called a *field*. There are usually 48 fields per second and 24 frames per second.

Your most significant reason for two-fields-per-frame is to reduce the *flicker*. Depending on a few highly subjective factors, less than 40 fields per second or so might seem to blink badly. More than 40 fields per second will be perceived by the eye and the brain as continuous motion.

Black and white television largely tried to imitate film. But unlike film, early video was only able to "project" one single dot at a time. And all that could get controlled was that dot's position and brightness.

A typical early television set had an electron beam in its CRT (cathode ray tube) *scan* rapidly to the right and slowly downward. Every trip across the screen generated one *horizontal scan line*. As before, each completed downstream trip was a *field*.

A sneaky trick was used to try and improve the flicker. As with movies, two fields per frame were used. Only this time, the *odd* field started in the *upper middle*, scanned on down and finally ended up at the extreme *right* of the screen bottom.

The *even* field started in the *upper left*, scanned on down and ended up at the *bottom middle*. Thus using an *interlace* to combine the two fields.

Into one single frame.

At the time, interlace sounded like a good idea. It very much reduced the flicker and bandwidth. And it worked just fine for *Captain Video* or *Roller Derby*. But interlace reduces flicker *only if adjacent scan lines are pretty much the same.*

These days, an interlace is *totally useless* for character displays or other high res video. Because the adjacent lines are rarely similar. Especially on the dots in small characters.

Original b/w tv used a *horizontal scan frequency* of 15,750 Hertz and a *vertical field frequency* of 60 Hertz. Even and odd fields both had 262-1/2 scan lines for a 525 line total.

The *vertical resolution* of a simple video display is set by the number of scan lines. The *horizontal resolution* depends on the *channel bandwidth*. Or how fast you can change the video information. Because of bandwidth limitations of broadcast tv channels, their video bandwidth was limited to four Megahertz or so.

But much less on cheap sets. This choice made both the horizontal and vertical resolution nearly the same. Nobody knew at the time that they were severely restricting their ability to show alphanumeric data.

Unless you go to some very sneaky tricks, it is quite difficult to display more than *forty* characters across the screen of a normal tv.

Er, even less than that actually. In those days, voltage regulation was an unheard of luxury. To prevent ugly black stripes from showing up on the sides and tops of home tv sets, "they" *overscanned*. Purposely wrapping the picture around the unwatchable *sides* of your receiver.

Which leads to the concept of the *safe area* or *safe title area*. The safe area is that blob in the middle of the screen where you are reasonably sure to be able to read an entire message. Any decent tv cameraperson knows to always keep the action and interest inside the safe area.

And certainly all video titles.

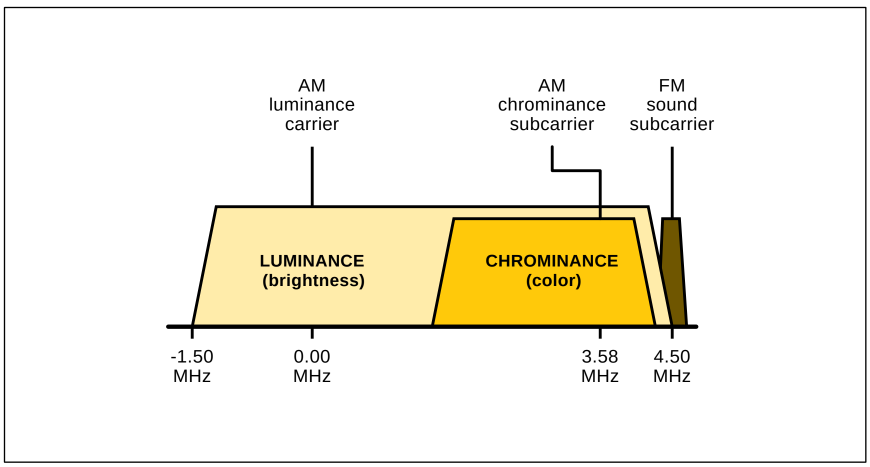

Fig. 1 – NTSC COLOR TV broadcast channel. The chroma and luminance sampled data spectra do not share identical frequencies. Instead, their energy distributions magically interleave with each other. Vestigal sidebands improve fringe reception. Chroma bandwidth is low and color dependent.

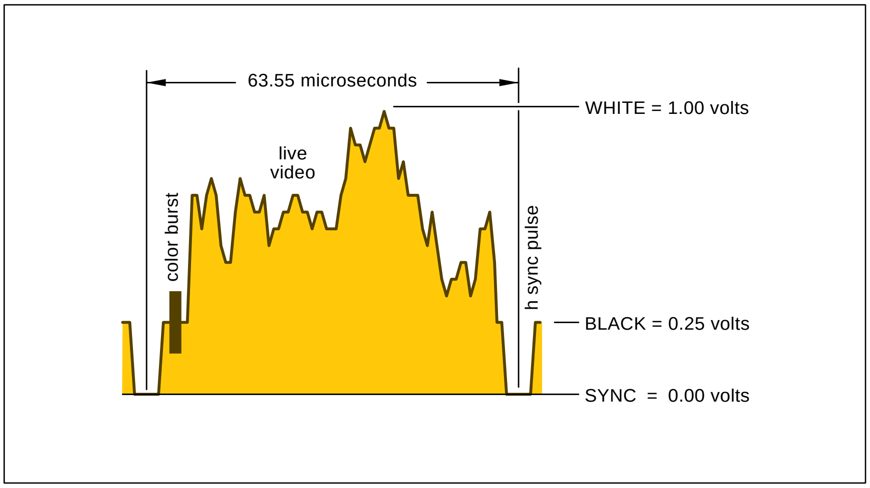

Fig. 2 – TYPICAL NTSC HORIZONTAL scan line, shown as baseband video.

NTSC Color

In the early fifties, "they" decided to devise a compatible way to stuff color into existing black and white tv channels. Which ultimately led us to today's utterly horrible *NTSC*.

Short for *Never the Same Color*.

Unlike black and white tv, *three* pieces of info are needed to specify a *pixel* in a given screen position. One method uses HSB, short for *hue* (the color), *saturation* (how much white has to be mixed with the color), and the *brightness* (how much energy the pixel radiates). For compatibility, we already have got the b/w brightness. What remains is some way to include the hue and the saturation.

Monochrome tv is an example of a *sampled data system*. Look into the spectrum, and you'll find clumps of harmonic energy repeating in 15 kHz spaced steps. *But very little energy in between.* Thus, there will be a lot of repeating "holes" in the spectrum of a mono video signal. So, the color info was placed onto a carefully designed *subcarrier* that more or less filled the holes in the existing signal.

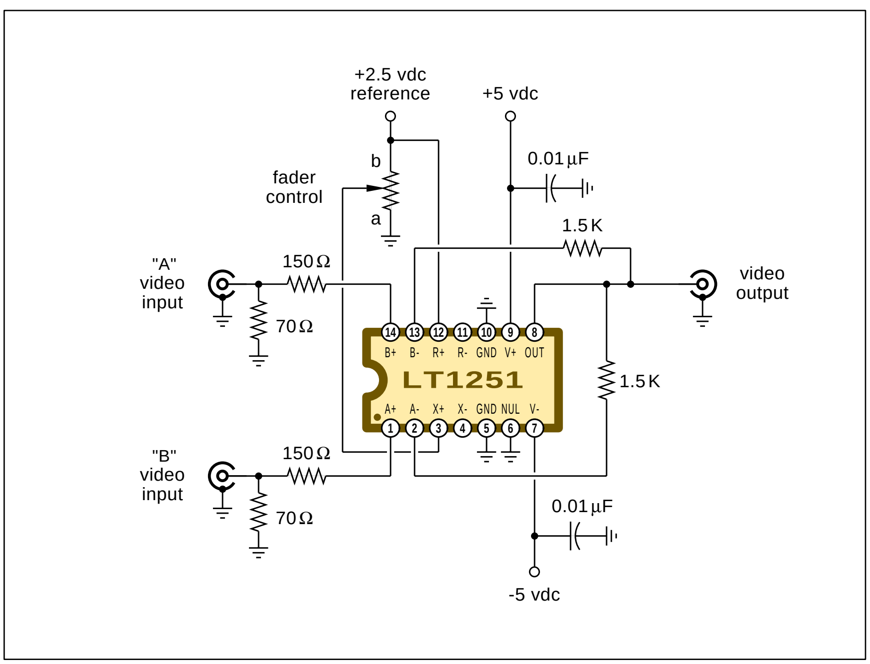

Fig. 3 – AN ANALOG VIDEO FADER using the new Linear Technology LT1251. Both inputs must be fully synchronized at all times. An external input or a D/A converter may be substituted for the potentiometer shown.

That subcarrier was at the magic frequency of 3.579545 Megahertz. To make everything work, numbers were adjusted slightly. Ending up with a horizontal scan rate of 15,735 Hertz and a 59.94 vertical field rate.

Many compromises were involved. Not the least of which was restricting your color bandwidth so that *a color could only be specified over a small group of pixels.*

Figure one shows us what a typical six Megahertz wide NTSC broadcast tv channel looks like. The full upper sideband and a *vestigal* (or reduced) lower sideband is used. The vestigal lower sideband increases the received energy in the syncronizing pulses and gross picture energy. For improved reception in weak signal areas.

The black and white (or the color luminance) material gets amplitude modulated onto the rf carrier. The color info gets placed on a 3.579545 Megahertz color subcarrier. Where it nicely plops into the "holes" of the b/w luminance spectrum.

The *phase* of this subcarrier sets your *hue*, and the subcarrier *strength* sets the *saturation*. A second narrow subcarier is at 4.5 Megahertz and gets frequency modulated for sound.

To reduce *Moire* effects and color artifacts, *the color subcarrier phase gets reversed on every line and every frame*. Thus, your basic transmitted "unit" consists of *two* frames, or *four* fields. This gets important for serious video editing. Where it always pays to work in synchronized units of two frames, and four fields. Of which you get *fifteen* per second.

Figure two shows us one scan line of NTSC color. You'll find an *active* portion of the scan line where video actually gets sent. There is a *retrace* portion of the scan line that gives the set a chance to get back from right to left to start the next line. This retrace portion is also known as the *blanking interval*. Since you obviously do not want anything to show whenever an electron beam is resetting itself.

You have to fully *synchronize* the transmission and reception of a tv signal. Fail to do so and the picture rolls, tears, or provides wildly wrong colors. Three synchronizing features are required. A *horizontal sync pulse* takes place once each scan line. It is used to lock individual scan lines.

A much larger and longer *vertical sync pulse* happens once each field. It is used to lock entire fields together. The vertical sync is fairly fancy. This interval has to keep providing useful horizontal lock information. And also provide for the *equalizing pulses* that properly set up interlace.

Over time, other useful stuff also got put into the vertical sync interval. Such as test and color quality signals, close captioning, data services, and various timing signals.

Color locking is both the trickiest and your most critical. A *color burst* of eight cycles of 3.579545 MHz is placed in the blanking interval on the *back porch* of your horizontal sync pulse. This reference burst can get captured with a *sampled phase lock loop* or a similar circuit to provide a continuous *zero phase reference*.

This new zero phase reference then *synchronously demodulates* out that chrominance subcarrier into hue and saturation info. To improve the flesh tone stability, the "I" (in-phase) and "Q" (quadrature) reference channels are offset by 33 degrees.

Video amplitude levels are more or less standardized. With white being defined as 1.0 volts. Black is around 0.25 volts. And Sync is "blacker than black" at 0.0 volts.

Enter Computers and VCR's

All of which was fine for stuffing blurry terrestrial broadcast tv into the narrow channels receivable by cheap electronics. But *totally useless* for presenting any modern computer and arcade video game data.

The four key problems that make NTSC worthless for serious computer or multimedia use are (A) not enough bandwidth to present more than 40 characters across the screen; (B) the interlace which causes small text to flicker badly; (C) overscanning that hides all of the corners and much of everything else; and (D) the jamming of the chroma and the luminance into the same frequency band where they are hard to completely separate.

The *Apple II* was the first major color computer. It used some sneaky tricks to work around NTSC limits. A side-by-side green and purple dot got used for one white pixel. Orange and blue were later added by a phase shift scheme. Instead of letting the color

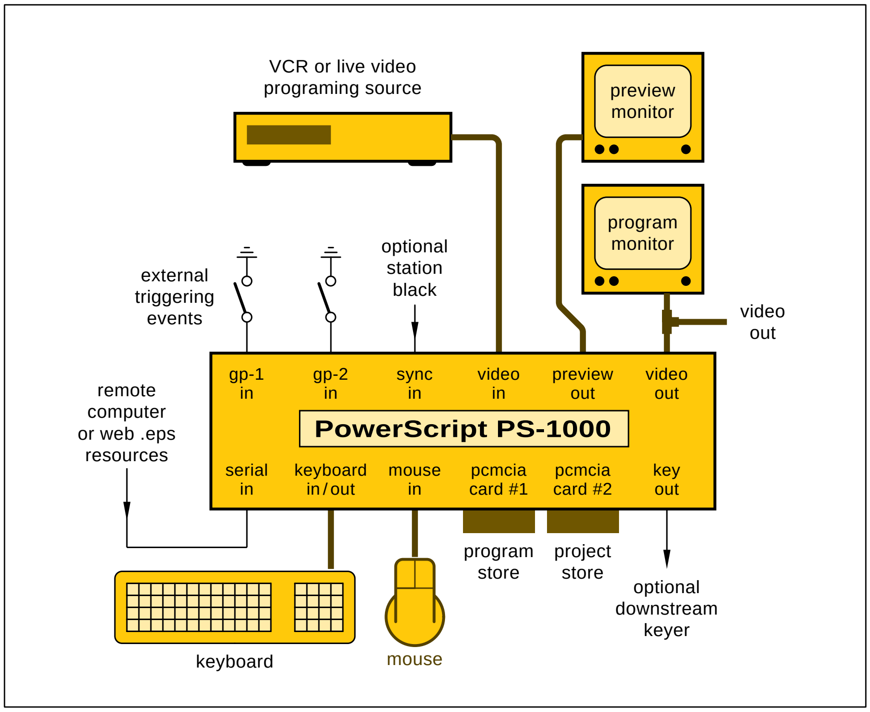

Fig. 4 – HOOKUP FOR THE PowerScript PS-1000 character generator.

phase subcarrier alternate each field and on each line, elegant timing *kept color phasing the same* (!) making it all possible. Rather than minimizing color subcarrier artifacts, their *entire* display was nothing but one giant (and most brilliantly conceived) color subcarrier artifact!

Sort of like keeping the backward running wheels and throwing away the stagecoach.

Monitor image size got reduced so you could view your corners free of overscan. Eventually, a mono eighty column text was added. But only on a custom b/w video monitor having a bandwidth *much higher* than typical rf entry on a home tv set.

The home camera, videodisk, and VCR folks then stepped up to some improved variations on NTSC. Such as raising their effective bandwidth. And placing that chroma subcarrier into a *high band* where it was easier to separate from the luminance.

And then splitting out the "Y" (or luminance) signal from the "C" (or chrominance) onto separate lines and connector pins. While also allowing for higher video bandwidths.

Creating new *video standards*.

Most serious high end computers, the professional video producers, and most multimedia systems instead use *component color*. Where you'll find three or four totally separate channels to provide for the fully isolated color information. Three of these channels are usually for red, blue, and green. With sync signals normally provided on the green channel.

Their optional fourth RGB channel has several possible uses. The video folks call it the *alpha* channel, and apply it to set the *keying* or to define the *transparency* of an overlay. One obvious purpose of transparency is to allow the *selective* fade in and fade out of a message screen.

Component RGB gives you much higher resolution. First by increasing the number of non-interlaced scan lines. And second, by increasing the video bandwidth so that more color changes per line could get displayed. And third by providing unique color info for each pixel.

Various new schemes can reduce video bandwidth. *Compression* is any coding scheme that can remove any redundancy from a video picture so that only the essential info has to be sent or stored.

Examples include JPEG for stills or MPEG for video. And vastly better newer methods that use *wavelets* or *fractals*. Compression can be *lossless* (everything comes back exactly) or

A VIDEO RESOURCE SAMPLER

B&H Photo-Video
119 West 17th St
New York NY 10011
(800) 947-1175

Black Range Films
Star Rt 2 Box 119
Kingston NM 88042
(505) 895-5652

Cinefex
Box 20027
Riverside CA 92516
(909) 781-1917

Computer Graphics World
10 Tara Blvd 5th Flr
Nashua NH 03062
(603) 891-0123

Digital Creativity
470 Park Avenue S 7N
New York NY 10016
(212) 683-3540

Digital Magic
10 Tara Blvd 5th Floor
Nashua NH 03062
(603) 891-0123

EMedia
649 Massachusetts Ave #4
Cambridge MA 02139
(617) 492-0268

Film & Video
8455 Beverly Blvd #508
Los Angeles CA 90048
(213) 653-8053

Imaging Magazine
12 West 21 St
New York NY 10010
(212) 691-8215

MIX Bookshelf
6400 Hollis St #12
Emeryville CA 94608
(800) 233-9604

Multimedia Producer
701 Westchester Ave
White Plains NY 10604
(914) 328-9157

New Media
901 Mariner's Island #365
San Mateo CA 94404
(415) 573-5170

NewTek
1200 SW Executive Dr
Topeka KS 66615
(800) 847-6111

PC Graphics & Video
201 E Sandpointe Ave #600
Santa Ana CA 92707
(714) 513-8400

Photo Electronic Imaging
57 Forsyth St NW #1600
Atlanta GA 30303
(404) 522-8600

SMPTE
595 W Hartsdale Ave
White Plains NY 10607
(914) 761-1100

3D Design
600 Harrison St
San Francisco CA 94107
(415) 905-2200

TV Technology
5827 Columbia Pike #310
Falls Church VA 22041
(703) 998-7600

Video Toaster User
411 Borel Ave #100
San Mateo CA 94402
(415) 358-9500

Videonics
1370 Dell Avenue
Campbell CA 95008
(408) 866-8300

lossy (where an acceptably degrading approximation is made).

Since the eye is not nearly as good at spotting color changes compared to brightness changes, one color can sometimes be shared by two or more pixels. Which leads to a whole new set of *digital video standards*. With names like (4-2-2) color.

Sneaky tricks can also be played to improve what you see on screen. One is *line doubling*, where twice as many scan lines are placed down at double speed. There is no new real content, but the scan lines are now not nearly as obvious. *Genesis* is one supplier for line doubling chips.

Another trick is *anti-aliasing*. In which "slightly blurred" lines or dots are substituted. Which eliminates the "jaggies" on slanty lines and greatly improves small text legibility.

For instance, the *text smoothing* of *Adobe Acrobat* 3.0 can easily let you view three columns of tiny text on an ordinary computer monitor. See any of my MUSE, RESBN, or BLAT files for ongoing examples.

Much more info on the video and movie standards is available through *SMPTE*. Short for *Society of Motion Picture and Television Engineers*.

Character Generators

A *character generator* used to be any scheme for overlaying words and graphics on an existing video stream. But these days, we have *stand-alone character generators* or full *video production editing systems*.

A stand alone character generator does characters and art, limited wipes or fades, and limited animation all by itself. A video prodution editor (such as Newtek's *Video Toaster* or *Video Flyer* often includes paint programs, keyers, full 3-D animation, and lots of other features at higher costs.

More on editors in *Video Toaster User* and *Lightwave* magazines.

We'll note in passing that there are three main video editing schemes in use today: *cuts only*, *A-B roll*, and *nonlinear*. Cuts-only is the simplest and cheapest. But only permits *fade to black* transitions. And is similar to splicing two pieces of film.

With A-B roll, the new content is overlayed on top of an existing live or VCR input. Giving you unlimited fade and wipe options.

With nonlinear editing setups, one or more disk drives replaces the input feed. Giving total random access to any sequence at any time.

Much editing gets done from an EDL or *Edit Decision List*. Which is basically a *timeline* of what happens from which source when.

Four character generation rules: *Everything has to follow the exact same video standard*. *Everything has to be stable*. *Everything must be fully locked together*. And finally, *Content must be compatible with the chosen video standard in use*.

The process of locking everything together is known as *synchronization* . Your simplest synchronizer is a *gen lock*. Where you simply grab input sync pulses and count them to locate a desired position on screen. Simple gen locks are useful for such things as picture-in-picture, time codes, or use with close captioning.

More desirable is *station master sync* or *station black*, where a single timing source can be used to lock all cameras and processors together.

The *frame grabber* lets an entire input frame or pair get caught and stored in memory. Frame grabbing lets you handle such tricks as *chroma keying*, where new material replaces anything blue.

Fanciest locker of all is the *format converter*. Where the input fields are

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NAMES AND NUMBERS

Adobe Acrobat
1585 Charleston Rd
Mountain View CA 94039
(800) 833-6687

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

Butterworth-Heinemann
313 Washington St
Newton MA 02158
(617) 928-2500

Coriolis Books
7339 E Acoma Dr #7
Scottsdale AZ 85260
(602) 483-0192

Digital Graphics
2800 W Midway Blvd
Broomfield CO 80020
(303) 469-5730

EOM
13741 E Rice Place #200
Aurora CO 80015
(303) 690-2242

GEMI Store
PO Box 3623
Littleton CO 80161
(888) 333-GEMI

Genesis Microchip
2111 Landings Drive
Mountain View CA 94043
(415) 428-4277

Linear Technology
1630 McCarthy Blvd
Milpitas CA 95035
(408) 432-1900

Maxim
120 San Gabriel Dr
Sunnyvale CA 94086
(800) 998-8800

Raychem
300 Constitution Drive
Menlo Park CA 94025
(800) 227-7040

Semtech
652 Mitcher Road
Newbury Park CA 91320
(805) 498-2111

SGS-Thomson
1000 E Bell Rd
Phoenix AZ 85022
(602) 867-6259

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

digitized and written into a memory. Changing them into some acceptable number of pixels and scan lines for the intended output video standard.

Dual Port RAM chips greatly ease the design of format converters.

For synchronization, one or more additional *time base correctors* may be needed. A VCR is an unavoidably imprecise mechanism. Because tape stretches, slight jitter is inherent in any VCR generated video. The time base corrector takes out this jitter and restabilizes. Time base correctors are *essential* any time videotape is in use as an input in the edit process.

Figure three shows you a brand new *video fader* useful for character generation. The video fader lets you smoothly mix two video signals.

Anywhere from all of input A up through fifty-fifty to all of input B. Inputs A and B have to get locked together and (if needed) time base corrected for a fader to work

Older faders were analog and had a classic "T" handle on them. Push the handle up to fade in your title. Pull it down to return to your main program feed. The latest of faders are totally digital and capable of changing on a pixel-by-pixel basis.

Being able to instantly switch or fade on the pixel-by-pixel basis lets you do *keying*. Such as substituting a weather map for the blue screen that is behind the weather turkey.

Or, in the case of titles, switch in only individual opaque letters over background video. This latter trick is what the previously mentioned *alpha channel* is all about. Content on a simple alpha channel can be thought of as a *mask*. Fancier alpha channel uses permit *transparency*.

Important sources of video faders and other chips useful for character generators include *Analog Devices*, *Linear Technology*, and *Maxim*.

The Videonics PowerScript PS-1000

The PS-1000 NTSC is one premium ($3000 list) stand-alone character gen having some innovative and unusual new features. This is intended mostly for serious amateurs, for interpretive kiosks, smaller tv station sports and weather departments, or for use with local cable front ends.

Innovations include superb 17 nsec switching, and using a clone of the PostScript language for zillions of high quality fonts and unlimited art. Editing is arranged by objects, pages, and projects. Their supported objects include text, graphics, time displays, and anything you can represent as an *.eps* PostScript file.

A TBC is included.

Just as any PostScript printer will compose to paper, their PowerScript instead composes PostScript objects to a color video screen.

The unit is basically a rack-sized, inch high dedicated computer having the usual keyboard and mouse. Inside is a power supply, a custom 40 Mhz computer that looks vaguely 486ish, and a video switcher/fader card.

Their menu driven graphics seem roughly comparable to Windows 3.1 or so. But with cruder res, since they do have to display on a NTSC screen. One or more PCMCIA cards serves as program and project storage.

Figure four shows you the typical setup. You input live or VCR video in an NTSC or Y-C format. You hook a composite monitor to your *preview* output. You hook a second monitor (and your output feed, your recording VCR, or whatever) to the NTSC or Y-C *program* output jacks.

An external computer or even the web can get used to input fonts and .eps graphics. Serial comm and PPP network protocols are supported. You can also insert an ethernet card into the second memory slot.

The absence of an alpha channel in PostScript level II is gotten around by using CMYK color. And by then sneakily redefining that "K" or black channel as alpha transparency.

Their 2-D animation is somewhat restricted, but otherwise impressive. You can crawl, slide, or bounce your message or artwork around.

Even changing its color or size as you go along. The pages can be much larger than your screen. Tweening is automatic. Set the initial and final point of any move, tell PowerScript how long the motion is to take, and it handles all the rest for you. Curved paths are done with *key frames*.

Most of their effects can get done in real time. These can be externally synchronized by using the GP timing inputs. But fancy fonts and complex graphics may impose minimum scene display time limits.

Lots of other *Videoinics* machines and software are available. Over a broad price and performance range. The Videonics web site can be found at www.videonics.com

I've gathered more video stuff into this month's resource sidebar.

Names & Numbers

From *SGS Thomson*, their ST7537 power line modem circuit for home automation. From *Raychem*, a new *Circuit Protection Databook*.

From *Semtech*, their *Battery Power Management Products* catalog.

An innovative source for the latest and best in computer language books and such is Jeff Dunteman's *Coriolis Books*. Who have both a free catalog and a web site at www.coriolis.com. Five of their latest titles include *Java Database Programming*, an updated *The Power Mac Book* second edition, the *Sybase Client/Server*, *Networking with NT4*, and *Real-World Internets*.

Most with companion CD's.

I've got a link here on my *Guru's Lair* at www.tinaja.com

Two newer trade journals: *Digital Graphics* on the *big* color printing for posters, billboards, or vehicles. And *EOM* for geographic, mapping, and earth information.

One of the *EOM* advertisers is *The Gemi Store*. Who offer high res aerial photos of anywhere in the world for as little as $10 per square mile.

More on sonoluminescence can be located in that Nov 1st, 1996 issue of *Science* on pages 718-719.

Unusual resources and materials for printshops and home publishing appear in the *Helene's Hotline* online newsletter. For your sign up, email hottalk@printer-net.com and using a single word *subscribe* message.

A reminder here that my *CMOS Cookbook* is now back in print. With *Butterworth Heinemann* as my brand new publisher. I've got autographed copies here at my *Synergetics*. Either by themselves or as a portion of the bargain priced *Synergetics Classics Library*. Also still have a few mint Tek 1230 logic analyzers and pods from our recent surplus sale.

As usual, most of these mentioned resources show up in that *Names & Numbers* or *Video Resource Sampler* sidebars. Be sure to check here first before you visit my www.tinaja.com website or calling our US technical helpline. Let's hear from you. ✦