Don Lancaster's

Tech Musings

GPS navigation update
Picking a uP, uC or DSP
New internet directories
Understanding pitot tubes
More on the mystery band

September, 1995

Maybe it is that I am sitting right here on a sand dune watching Gila Monsters in the middle of the Upper Sonoran desert. But nobody has ever accused me of being much of a boat person. At least not lately.

I do know that the binnacle goes on the top and the barnacle goes on the bottom. Interchange these two and you end up with a serious breach of maritime etiquette.

At any rate, one recent help line caller wanted to find out if I knew anything at all about…

Boat Speedometers

Especially how they operate. Not having the faintest idea at the time, I muttered several things about gyros, strain gauges, differential thermistor temperature sensing, GPS, and sonic Doppler radar shifts.

Most of which were wrong.

Let us review the normal ways of finding an answer to something I do not have the foggiest clue over: Ask some expert or visit a suitable place. In this case, a marina or any boating supply catalog or store.

Read relevant magazines and trade journals. Such as those on boating or on marine retailing. Then contact the manufacturers for useful literature. And, most importantly, seek out the reference papers and keywords.

Or get up on the Internet or some commmercial online service. Or try a surefire solution that instantly lets you find *any* answer to *any* technical question: Use the *Dialog Information Service*. Found at your local library.

Or, if there's no real rush, try my ultimate ploy: let your subconscious work on the project for a few weeks until you stumble over an answer.

Sure enough, *Motorola* sent me a new *IC Sensor Device Data* manual. And right there on page 4-166 is their ap note AN1536 on, of all things, boat speedometers. Even including the full construction plans. Plus one magic word that tells us all about how boat speedometers work – *Pitot*.

Which tells us boat speedometers work exactly the same way that plane speedometers operate. Only one uses a liquid, the other a gas.

Pitot tubes were first developed by Henri Pitot, that eighteenth century French physicist. Figure one shows details. Create a smooth flowing and non-turbulent liquid or gas channel of constant diameter.

Such as a pipe.

Measure the *differential* pressure between a radial and an axial port. The pressure difference should end up nearly proportional to the *square* of your velocity. Usually to a five or ten percent accuracy.

Your exact results depend upon the density of your liquid or gas and the temperature. Figure two reveals the curves for freshwater and saltwater boat speedometer pressures.

The speed will, of course, be that of the boat *relative* to the current.

Motorola does have a unique offset cancelling scheme which swaps the opamps around and then cancels out the difference.

Other low cost pressure transducer sources are *Sensym*, *IC Sensors*, and the *NovaSensor* folks.

The Pitot tubes are not suitable for sailboats or other rather low speed apps. Other techniques are required for ultra low velocities. Differential GPS is an obvious choice.

Ah hindsight. After thinking about this for a while, it seems I do use a boat speedometer quite a bit after all. Except that its box is plainly labeled "Fire Hydrant Flow Tester".

Seems you are supposed to test all of your fire hydrants twice each year. First to make certain they work at all. And second to verify a peak fire flow gallonage rate that can meet a given insurance rating class.

You hold this beast in the middle of an open hydrant stream and grab a reading. Then you look up the flow in a graph remarkably similar to the curves of figure two.

Tellyawhat. I still don't have any info on commercial versions of boat speedometers. So, how about sending me some data sheets of same. A free *Incredible Secret Money Machine II* for your trouble.

uP -vs- uC -vs- DSP?

What is the difference between a microprocessor, a microcontroller, or a digital signal processing chip? Why would you select one of these devices over either of the others?

Before we find the answer to this question, we should first look into a concept called *address space*. Figure three shows us some details.

The address space is the sum total "reach" of a programmable ic.

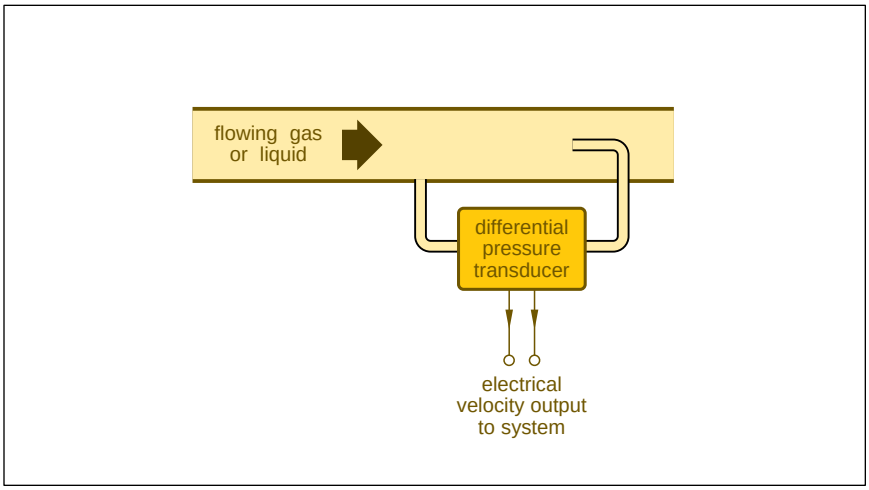

Fig. 1 – A PITOT TUBE can be used to measure the velocity of a flowing liquid or gas. Uses include boat speedometers and fire hydrant testers.

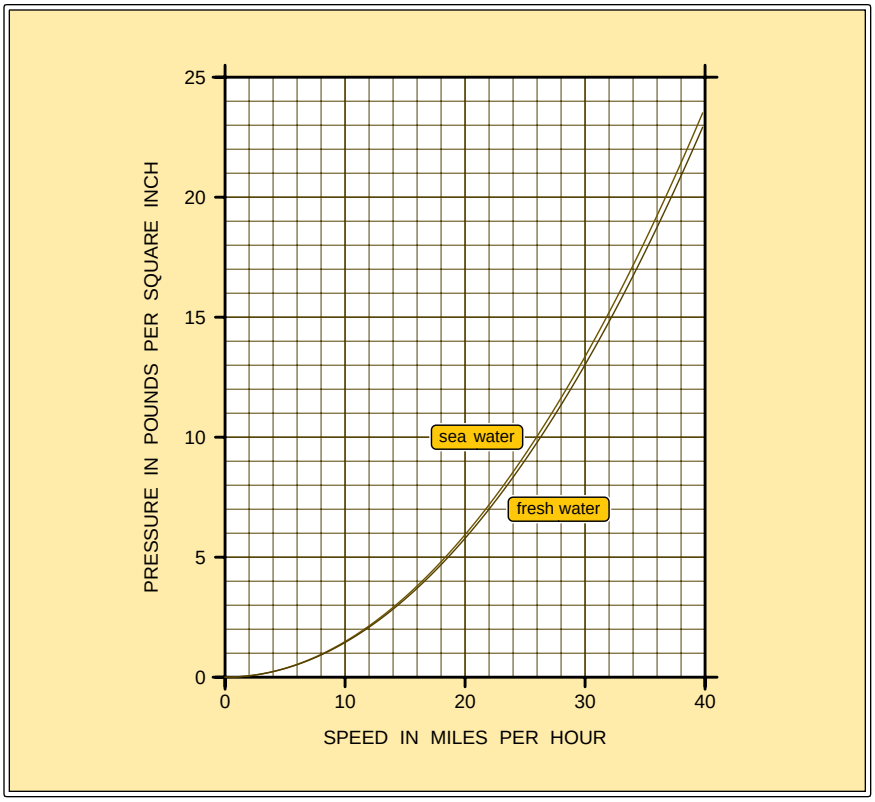

Fig. 2 – PRESSURE VERSUS SPEED for flowing water at 60 degrees F.

All of the available locations it can instantly find. As in a city directory, an address space has *locations*. Into each location, you can put one "unit" of information.

This unit of information is often called a *byte*. Any given byte can be a computer command, one piece of data, one character in a document, a musical note, or an I/O "window" to the outside world.

Quite often, bytes are eight binary bits in length. One byte is capable of representing as many as 256 different values. Multiple bytes can get used for more combinations.

The physical hardware located in any particular address space location is often RAM, ROM, I/O, or nothing. We'll call RAM any memory that is fast and easy to change. We'll call ROM any memory that stays more or less permanent. Even on any power down. These days, of course, RAM is getting very ROM like and vice versa. There is a continuum of intelligently chosen options here.

I/O is short for *input* or *output*, and is the way your computer circuit can reach the outside world. And finally, not all of the address space need end up actually used. Some of it could be simply empty; other portions can be available but not in use.

The size of the address space can end up as little as 256 bytes in certain controllers. A classic microcomputer has an address space of 64K, or 65536 locations. Newer chips have address spaces of 24 bits (for a grand total of 16,777,216 locations), or 32 bits (for a vast 4,294,967,296 locations).

The big tradeoff here is your chip count. An internal-only address space often lets you get by with a single integrated circuit. But the RAM and ROM provided ends up both fixed and restricted. An external address space lets you add nearly anything you want. Almost any way you like.

For much greater flexibility and performance at higher system cost.

Some single chip solutions let you have the best of both worlds. While their address space stays fixed and internal, they easily let you add low cost *serial* memory chips for extra data storage and whatever. Although serial memory is much slower than memory inside of the "real" address space, it is more than fast enough for many real-world applications.

Figure four summarizes the key differences between these main three computing options.

A *microprocessor* normally has a large address space, uses generalized commands, and requires additional chips for a complete system.

A *microcontroller* normally has a small and internal address space, and commands optimized for control and other bit manipulations. They usually offer a single chip solution.

Instead, a *digital signal processor* (or DSP) is just a different name for a microprocessor. Except that it uses few and specialized commands.

These instructions are carefully optimized for digital filter uses and related tasks. And thus aren't all that great for anything else.

The specialized DSP instructions might include an ultra fast multiplier, a multiplier/accumulator that adds a small value to a large total, or some *barrel shifter* that instantly multiplies or divides by powers of two.

There are certain things that DSP chips do very well. But their highly specialized nature and their military heritage has kept them expensive and out of the mainstream.

Sadly, DSP program development and emulation remain costly hassles.

But DSP popularity is very much on the upswing. Especially for sound generation, fancy filters, and video compressors.

By far your finest choice in any microcontroller today is the PIC from *Microchip Technology*. The best way to get started using microcontrollers is by use of that *Basic Stamp* from *Parallax*. Then step up to those *Scott Edwards Tools* for full machine code access and speed.

Online reprints of the complete set of Basic Stamp manuals and ap notes are found at the *parallax* web site.

Microcontroller Resources

The usual places to start learning microcontrollers are the hobby press publications and in those mainstream electronic trade journals. We did look at these in depth in past issues, in the *Hardware Hacker* reprints, and in my NUTS08.PDF and HACK35.PDF.

But there are a bunch of virtually unknown "second tier" trade journals which focus in on topics of interest to microcontroller designers. I thought

I'd gather a few of these together for this month's resource sidebar.

GPS Update

Things are coming down fast and furious on the GPS navigation front. I'd expect a $190 device from *Radio Shack* about the time you're reading this. Probably somewhat comparable to a *Garmin 45* receiver.

What everybody is waiting for, of course, is a full set of topo maps built into a $99 handheld GPS device. With an instant and high resolution "you are here" full color 3-D display.

Some surprising giant steps have been taken towards this goal. One Israeli machine lets you slide a topo map inside it, and then can X-Y plot your current position and track for you. This one is way overpriced and clearly needs improvement.

The brand new *ScoutMaster* from *Trimble* knows an even handier trick: Besides telling you how fast you are hiking, it will tell you where you are on which topo map!

Inside the machine is a data base of 53,689 USGS topo maps in their 7-1/2 minute or "seven by nine mile" size. Not the entire map, of course, but the map name and the lat-lon for enough key points to give you your nearest 2-1/2 minute reference point. That is *one-ninth* of the map, or well inside a three mile square.

Their readout then displays your *scaled map distance* away from one of these reference points. Say an inch and a half west and three quarters of an inch north.

Which sure beats messing around with latitute and longitude.

The usual "on the run" accuracy of a single GPS measurement on most single low end receivers is only 300 feet or so. By changing to *differential* GPS techniques, you can drop this down into the twenty foot range.

By going to multiple stations and longer term measurements that need premium multi-frequency receivers, you can actually achieve a "surveyor" accuracy of one centimeter.

Anywhere in the world.

Here is how the differential GPS works: You start with *two* receivers, and place one at a fixed and known location. Let it record where it thinks it is from where it really is.

You make your real measurement with the moving receiver, and then subtract out the error difference.

Since these errors are pretty much the same over some thirty miles or so, there are now pager services and commercial FM broadcast subcarriers that will real time transmit these GPS corrections for you.

A *differential ready* handheld GPS receiver simply has a jack on the side that accepts this correction data in a standard format. Plug in a suitable service and your location accuracy can dramatically improve.

One GPS trick that newcomers do not pick up on: You can easily fake the differential results. Simply use a second and fixed position receiver and then manually or automatically record the time and the error. Then take your error out during your final plotting. The closer you can get the two readings in time, the better your final overall accuracy.

I am using GPS on that historical archeology project I've got going on

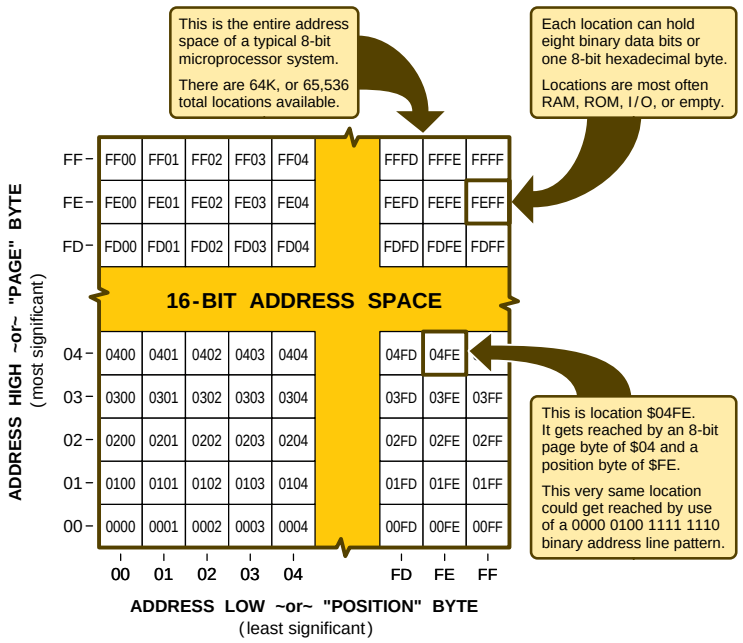

Fig. 3 – THE ADDRESS SPACE of a classic microprocessor.

Most **MICROPROCESSOR** chips have a large and external address space. Into which you place your choice of additional RAM, ROM, I/O or nothing. The instruction set is a general one, often optimized for file manipulation and complex computing tasks.

Instead, a **MICROCONTOLLER** offers a single chip solution with a smaller and fixed internal address space. All resources are defined on chip, with the possible exception of some slower and serial EEPROM memory. The usual instruction set has additional commands in it that favor simple I/O tasks. Such as bit sets, clears, or tests.

Finally, a **DIGITAL SIGNAL PROCESSOR** also usually has a large and an externally accessible address space. But its instruction set is often strictly limited to specialized tasks. Such as a very rapid multiplier, one or more adder/accumulators, or a barrel shifter.

Fig. 4 – WHICH COMPUTER CHIP TO USE?

OBSCURE MICROCONTROLLER PUBLICATIONS

AI Expert
600 Harrison Street
San Francisco CA 94107
(415) 905-2200

C++ Report
71 West 23rd Street 3rd Floor
New York NY 10010
(212) 785-5996

CADence
600 Harrison Street
San Francisco CA 94107
(415) 905-2200

Compliance Engineering
One Tech Drive Ste 215
Andover MA 01810
(508) 264-4208

Computer-Aided Engineering
1100 Superior Avenue
Cleveland OH 44114
(216) 696-7000

Dr Dobb's Journal
411 Borel Ave #100
San Mateo CA 94402
(415) 358-9500

DSP & Multimedia Technology
PO Box 1603
Los Altos CA 94023
(415) 969-6920

Embedded Sys Programming
600 Harrison Street
San Francisco, CA 94107
(415) 905-2200

Forth Dimensions
PO Box 2154
Oakland CA 94621
(510) 525-1295

IC Card Systems & Design
6300 S Syracuse Way, #650
Englewood CO 80111
(303) 220-0600

Integrated System Design
5150 El Camino Real Ste D31
Los Altos CA 94022
(415) 903-0140

Microsoft Systems Journal
411 Borel Avenue Ste 100
San Mateo CA 94402
(415) 358-9500

Personal Engineering
Box 430
Rye NH 03870
(603) 427-1377

Surface Mount Technology
17730 W Peterson Road
Libertyville IL 60048
(708) 362-8711

the utterly astounding aerial lumber tram that's literally in my front yard. See my *Blatant Opportunist* reprints or download my GRAMTRAM.PDF on *www.tinaja.com* for more details.

Yeah, I could use some help on some of the more gruesome portions of the terrain on this project.

One good source of GPS receivers, books, and tutorials is *Navtech*. Who resell the Garmin, the ScoutMaster, and many others. The horse's mouth tutorial documents are provided by the *Institute of Navigation*.

The main source for FM services is *Differential Corrections*. The leading trade journal is *GPS World*. They also publish a *GPS Showcase* shopper.

A New Internet Directory

While not well known, your three leading suppliers of library reference directories are: *Bowker*, *Oxbridge*, and *Gale Research*. Which are where such resources as *Books in Print*, *Ulrich's Periodicals Dictionary*, the *Encyclopedia of Associations* and related goodies come from.

Sadly, these valuable directories are too pricey for most individuals. Besides being unloanable references at most libraries. Many are, however, newly available both online and as CD ROM based products.

There is one brand new $95 *Gale Guide to Internet Data Bases* which should turn into a major and highly useful printed Internet directory. The Internet has been defined by some as a humongous library without shelves, librarians, reference numbers or card catalogs. In front of which numerous truckloads of new books get dumped daily. And from which lots of other texts vanish without a trace.

Two random selections here: #710 *Gargoyles Then and Now* and #629 *Fact and Fiction About Armadillos*. The current directory contains around 2000 data bases and 8000 individual files. I would expect future editions to expand this greatly.

Two other useful Internet guides do include *Boardwatch* and *Internet World* magazines.

Your quickest and easiest way to pick up Internet access these days is by way of some commercial online service. By use of *America Online*, *GEnie*, or *CompuServe*.

New Tech Lit

Lots of exciting things happening in that *mystery band* we looked at back in my HACK84.PDF. Start off with *Tuning up an Electromagnetic Accordian* in *Science* for March 24, 1995. TeraHertz waves get generated by generating much lower frequency microwaves in a plasma and then by blasting that plasma with a laser.

Literally squashing the wave!

The sudden compression magically upconverts the output frequency. Sort of a mega *Doppler* effect. Resulting in coherent, tunable, and high power TeraHertz waves.

In fact, it looks as if mystery band transmissions are going to be called *T-Rays*. See *Science* for June 23,1995 for the second brand new method of T-ray generation. In this scheme, ultra-short laser pulses get blasted at a suitably blackened array of tiny dipoles. The light becomes an energy impulse that "rings" the dipoles at the correct frequency. Opening a whole new world of imaging tools.

You can expect lots of exciting new developments where these came from. The T-band is an incredibly large chunk of spectrum up for grabs.

From *Sony*, the *CCD Area Sensor* data book. And a *Lattice Data Book*, covering programmable logic chips and development tools.

Two unusual trade journals include *Die Casting Engineer* and *Fastener Technology*.

New from *Texas Instruments*: Free samples of their TPS2013 high side power control switches.

The old *HP-GL/2 Reference Guide* from *Addison-Wesley* gives you full details on the innards of the *Hewlett Packard* plotter language.

The HPGL is an older and simpler

NEED HELP?

Phone or write all your US Tech Musings questions to:

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NAMES AND NUMBERS

Boardwatch
8500 W Bowles Avenue #210
Littleton CO 80123
(303) 973-6038

RR Bowker
121 Chanlon Rd
New Providence NJ 07974
(908) 464-6800

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

Die Casting Engineer
9701 W Higgins Road #880
Rosemont IL 60018
(708) 292-3600

Differential Corrections
10121 Miller Ave #201
Cupertino CA 95014
(800) 446-0015

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

Fastener Technology
3869 Darrow Road Ste 101
Stow OH 44224
(216) 686-9544

Gale Research
835 Penobscot Blvd
Detroit MI 48226
(313) 961-2242

Garmin
9875 Widmer Road
Oenexa KS 66215
(800) 800-1020

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

GPS World
859 Willamette St
Eugene OR 97440
(503) 343-1200

Institute of Navigation
1800 Diagonal Rd #480
Alexandria VA 22314
(703) 683-7101

Internet World
11 Ferry Lane West
Westport CT 06880
(203) 226-6967

Lattice Semiconductor
5555 NE Moore Ct
Hillsboro OR 97124
(503) 681-0118

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

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

Navtech Info Services
2775 S Quincy St #610
Arlington VA 22206
(800) NAV-0885

Oxbridge
150 5th Ave #202
New York NY 10011
(212) 741-0231

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

Sony Semiconductor
10833 Valley View St
Cypress CA 90630
(714) 220-9100

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

Trimble Navigation
585 N Mary Ave
Sunnyvale CA 94086
(800) TRI-MBLE

ASCII character based format. With such commands as PD for *pen down*, and so on. It has no intelligence, and woefully limited font capabilities.

There's lots of interest these days in converting HPGL from or to that infinitely more versatile, powerful, and flexible PostScript langauge. Do see PS2VECT.PS and FLUTOOLS.PS for lots more details.

For those fundamentals of creating your very own tech venture, try my *Incredible Secret Money Machine II*. And we just got a great heaping new shipment of *Active Filter Cookbooks*. Published by my *Synergetics Press*.

Included are lowpass, bandpass, and highpass "instant design" filters. Including *State Variable*, *Sallen-Key*, and *Multiple Feedback* designs.

Yes, all new resellers are certainly welcome. Distribution is one of the major hassles of self publishing. See my *Book-on-demand Resource Kit* for more insider info.

As usual, instant help answers, preprints and reprints of most of my stories and all referenced files are available on *www.tinaja.com*

Let's hear from you. ✦