Don Lancaster's

Tech Musings

August, 2001

Pitfalls of shuffling
Driving lots of LED's
Energy awareness basics
Some n-connectedness math
VB ASP banner rotation code

I sure find perverse joy when I watch all those *Bill Beaty* and *Keelynet* denizens showing off their utter cluelessness of even the most basic scientific principles.

So, I guess it may be a good time to review a few…

Energy Fundamentals

Let us briefly look at a few of the topics you will need to understand to intelligently evaluate new alternate energy claims…

energy and power— Uh, for starters, *energy* is the *ability* to do work, and *power* equals the *time rate* of doing work. So, energy is "how much?" and power is "how fast?".

One unit of energy is the *BTU*, or *British Thermal Unit*. Which equals the amount of energy needed to raise the temp of one pound of water one degree Farenheit. Roughly the energy in one kitchen match.

An alternate unit of energy is the *Joule*. A Joule equals the heat energy provided by one Ampere of current routed to a one Ohm resistor from a one volt dc source for one second. A Joule also happens to equal .000948 BTU's. Or 0.73756 foot pounds.

One unit of power is the *Watt*. Or an energy time rate of *one Joule per second*. A watt also equals one amp of current across one dc volt.

A second power unit would be the *horsepower*. One horsepower equals 745.7 watts, 745.7 Joules per second, or 0.707 BTU's per second, or 550 foot pounds per second.

Going back to energy units, a *watt second* of energy equals a Joule. One *watt hour* is 3600 Joules.

One hundred watt hours of energy are easily visualized as a larger light bulb or running up stairs for an full hour. Or eight minutes of microwave cooking. Or 20,000 hours of pv solar calculator use.

sources, carriers, sinks— I'll define an energy *source* as any substance or process that is capable of delivering *net* BTU's or Joules of *useful* energy to the on-the-books economy.

Gasoline is an energy source since it takes something like the energy in one quart of old gasoline to produce and deliver a gallon of new gasoline.

An energy *carrier* is any substance or process that has to be "filled" with old energy before it can be "emptied". Examples include batteries, terrestrial hydrogen, or flywheels.

The filling and emptying process is *always* lossy. So, more initial energy input is *always* needed than you can ever hope to get back.

An energy carrier can not ever in any manner be called "nonpolluting", since it assumes the characteristics of the original net energy sources. And then wastes a fraction of them.

An *energy sink* is any substance or process which consumes significantly more old energy than it is capable of delivering new. Corn ethanol under American Farm economy conditions is an energy sink because it takes the energy in three gallons of gasoline to produce one new gallon of ethanol. Ethanol today is neither renewable or sustainable.

Photovoltaic Solar is still an energy sink because *not one net watt hour of pv solar energy has ever gotten generated*. While the latest of panels sometimes are able to return more than their energy used to build them, they cannot yet amortize most fully burdened total solar systems.

Silicon pv cells today have a big efficiency problem: They only accept one exact energy level. Anything less or any excess gets rejected as waste heat. Solar-to-electric is more likely to end up using MEMS antennas or dye molecules. Or similar broadband efficient conversion methods.

Solar pv breakeven can be expected around eight years or so after its fully burdened cost drops under ten cents per kilowatt hour.

Depending upon the figures used and how decomm plays out, nuclear energy ends up somewhere between a staggering energy sink and a minor net source that clearly was not worth the mind-numbing hassle.

energy density— If energy delivery is to get evaluated or compared, you will need a measurement scheme.

Two obvious questions to ask are "how much does it weigh?" and "How much room does it take up?" Answers to either of these can be a measure of *energy density*.

A *gravimetric* energy density unit that makes for the easiest comparison would seem to be in *Watt hours per kilogram* or Wh/Kg.

A *volumetric* energy density unit is *Watt hours per liter* or Wh/l.

Figure one shows us approximate energy densities for a few popular energy sources, carriers, and sinks.

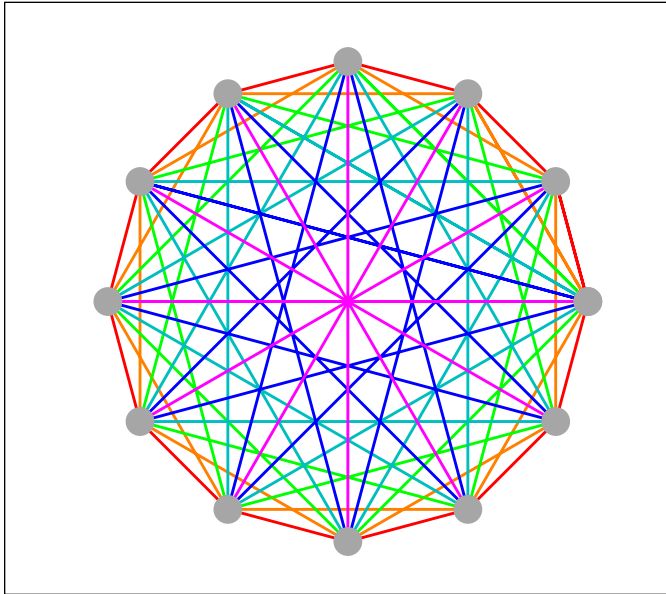|		
Gasoline	9000 Wh/l	13,500 Wh/Kg
LNG	7216 Wh/l	12,100 Wh/Kg
Propane	6600 Wh/l	13,900 Wh/Kg
Ethanol	6100 WH/l	7,850 Wh/Kg
Liquid H2	2600 Wh/l	39,000 Wh/Kg
Lithium	250 Wh/l	350 Wh/Kg
Flywheel	210 Wh/l	120 Wh/Kg
Liquid N2	65 Wh/l	55 Wh/Kg
Lead Acid	40 Wh/l	25 Wh/Kg
Compr Air	17 Wh/l	34 Wh/Kg
Hydrogen	2.7 Wh/l	39,000 Wh/Kg

Fig. 1 – SOME ENERGY DENSITY comparisons.

Fig. 2 – WHEN YOU TRY TO CONNECT n objects together, you'll find that (n)*(n+1)/2 paths are needed.

Gasoline is a useful standard for comparison at 9000 Wh/l and 13,000 Wh/Kg. The best of today's batteries are only beginning to approach **five percent** of these values. While STP hydrogen ironically is both the "best" at 39,000 Wh/kg and the "worst" at an utterly pitiful 2.7 Wh/l.

Watt hours per liter do tend to be a lot more significant for earthbound apps, while Watt hours per kilogram become crucial for deep space.

See our **Hydrogen** library page.

thermodynamics— It is very easy to convert other energy forms into heat. But only a fraction of heat energy is normally convertible back into other forms of energy. The study of this raw deal is called **thermodynamics**.

Nearly every physical or biological system ends up thermodynamically limited in one way or another.

The three main thermo "laws" are (1) You can't win. (2) You can't break even, and (3) You can't even get out of the game. No exceptions to these have **ever** been found

Two key thermodynamic concepts are **Carnot's Law** and **reversibility**.

Carnot's Law places an inherent efficiency limit to conversion of heat to any other energy type. **You always have to waste a lot of heat if you try to convert a little**.

The highest possible efficiency you can have would be in a **Carnot Cycle** that gets limited by your temperature difference between input and output.

Ferinstance, an auto engine will be about 35% efficient, while the best of utility power plants are approaching a 60% efficiency. Most low temp heat recovery schemes appear doomed to failure because of their unavoidably low efficiency limits.

A **reversible** process is one that is produces zero low grade waste heat. Regardless of the direction in which it is run. Examples include **adiabatic** ones which neither add nor remove heat, or **isothermal** ones that occur at constant temperature.

Reversible processes are essential for energy efficiency. The bladeless **Tesla Turbine** is one example of a system that **demands** irreversibility to work at all. And is thus inherently inefficient.

All of those **Peltier** thermoelectric modules are also irreversible due to their ludicrous inefficiency.

More on thermodynamics can be found in **HACK64.PDF**

engineering economics— There are many costs associated with an energy delivery system. The feedstock price is obviously a factor. But, more often than not, your true delivery costs are dominated by your **delivery system price** and its infrastructure, the **time value of the money** used to finance the delivery system, and all the **labor** you will need to service and maintain the delivery system.

Plus external costs such as health or environmental issues. Or future decomm expenses. Further confused by any taxes or subsidies.

In the final analysis, it is only the **totally burdened system level costs** that really should matter.

SOME THERMODYNAMICS BOOKS

Kenneth J. Wark, *Advanced Thermodynamics for Engineers*
D. M. Rowe, *CRC Handbook of Thermoelectrics*
Ivo Kolin, *Evolution of the Heat Engine*
Richard Feynman, *Feynman Lectures on Physics: Kinetics and Heat*
Frank P. Incropera, *Fundamentals of Heat and Mass Transfer*
John F. Sandfort, *Heat Engines*
B. Sunden, *Heat Transfer in Gas Turbines*
J. M. Smith, *Introduction to Chemical Engineering Thermodynamics*
James R. Senft, *Introduction to Stirling Engines*
David R. Gaskell, *Introduction to Thermodynamics of Materials*
Z. Warhaft, *Introduction to Thermal-Fluid Engineering*
D. Kondepudi, *Modern Thermodynamics : From Heat Engines…*
P. W. Atkins, *The Second Law*
G. Walker, *The Stirling Alternative : Power Systems, …*
Herbert B. Callen, *Thermodynamics and Thermostatistics …*
H. C. Van Ness, *Understanding Thermodynamics …*
Christian Von Baeyer , *Warmth Disperses and Time Passes …*

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

We looked at this way on back in **HACK86.PDF**.

It is sometimes convenient to view "dollars" as being so many "gallons of gasoline". You do personally vote for this definition every time you make a withdrawal from the ATM pump at your nearby *Texaco* bank.

Those fully burdened costs of any energy system could get looked at as the diversion (or "waste") of gallons of gasoline from other uses.

Thus, today oil is at least six times more "free" than solar pv energy is. Especially when you include costs of storage batteries, fancy wiring, and synchronous inverters.

entropy and exergy— *Entropy* is a crucial thermodynamic property that tells us that, when left to their own devices, systems tend to go to hell in a handbasket. Or more precisely, will often increase their amount of chaos or disorder. Because of entropy, it is exceedingly unlikely that your pool balls will rerack or the dishes will end up washing themselves.

Not all kilowatt hours are equally useful. *Exergy* is one measure of the *value* of recoverable energy in any given form. Thus, electricity may be worth ten cents a kilowatt hour and gasoline only three. The reason being that it is easier and more efficient to convert electricity to other forms.

While *conservation of energy* tells us that energy can not normally get created or destroyed, the twin exergy and entropy factors *guarantee* that *all energy degrades in time.* Usually into irrecoverable low grade heat.

We recently looked into exergy in **MUSE151.PDF**.

energy efficiency—The *efficiency* of any system is the ratio of how much you get back compared to how much you put in. For all closed systems, the efficiency will *always* end up being less than 1.0 or 100 percent.

But it is real easy to make big time mistakes when measuring efficiency. For instance, there could be multiple energy inputs. Such as electricity and heat in any heat pump. Or hydrogen electrolysis that can be *exothermic*, *endothermic*, or *thermoneutral*.

Efficiency measurements may also conveniently forget that much of the *life cycle costs* are in the labor and equipment amortization.
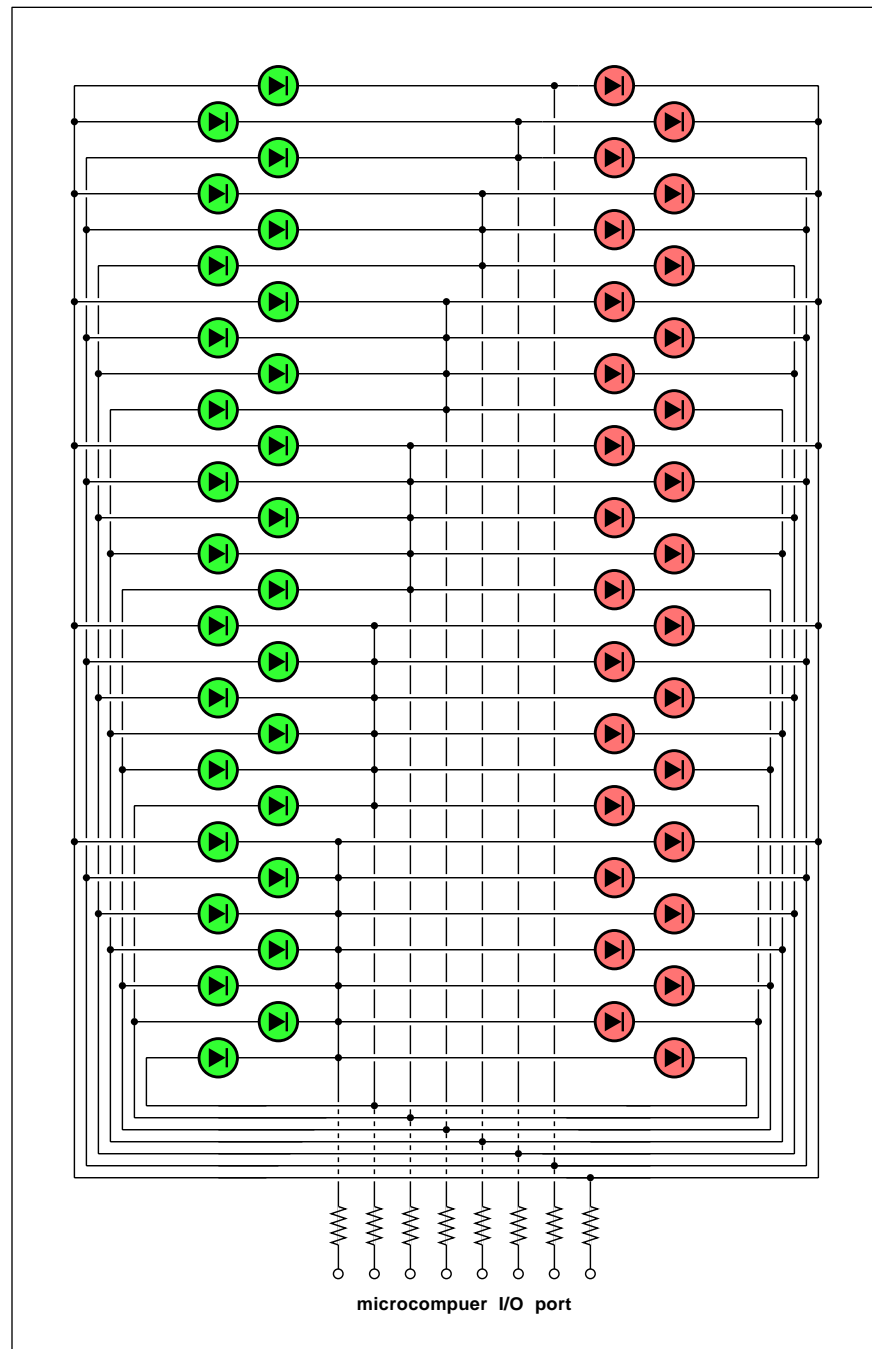

Fig. 3 – 56 LEDS can be driven from one microcomputer port by using this n-connectedness trick. No external decoding is needed!

Efficiency measurements must not ignore exergy. Hydrogen electrolysis manages to convert ten cent kilowatt hours into kilowatt hours worth only a fraction of a cent.

Electrolysis energy from on-grid electricity makes zero economic or thermodynamic sense.

It is often enormously difficult to measure power in a nonlinear system with strange waveforms. Especially if any mechanical or low delta-T heat energy is involved.

Virtually all typical low budget power measurements are flat out wrong! The usual problems are not appreciating the difference between average and rms measurements. Or not understanding *crest factors*. Or realizing how nasty low delta-T heat

```
% VISUAL BASIC .ASP MULTI-SLOT BANNER ROTATOR
% ================================================

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% These Visual Basic code fragments show you how to have multiple banners appear
% in several slots on a web page, autorotating without any repeats. Each end
% user sees a new banner grouping every time they reload or refresh. One easily
% changed master data base handles dozens or hundreds of individual web pages.

% You can Click Here for a demo. Use your refresh repeatedly.

% First, create a data base file of banner advertiser info having array strings for url,
% text, and image. Such as This Example Typical entries might be...

        blnk(3) = "http://www.thirdadvt.com"
        bimg(3) = "thirdadvt.gif"
        balt(3) = "Third Advertiser Text Blurb."

% This textfile gets stored at a reachable place on the ISP's site. Next, create a
% typical .HTML page renamed as a .ASP file, using default Visual Basic. Near the
% beginning of the body, add...

        <% ' banner rotation module
        bannslots = 8      ' must be equal or less than a(n)
        dim a(8) a(0) = "a"  a(1) = "b"  a(2) = "c" a(3) = "d"
        a(4) = "e" a(5) = "f"  a(6) = "g" a(7) = "h"  x = "z"

        <!--#include virtual="/banners/bandata1.txt"--><%

        Randomize For i = bannslots - 1 to 1 Step -1 j = Int(Rnd* (i + 1))
        x = a(j) a(j) = a(i) a(i) = x Next

        pattern = a(0) & a(1) & a(2) & a(3) & a(4) & a(5) & a(6) & a(7) & a(8)  %>

% This code defines eight letters in an array. It then loads the banner data. It
% then creates an eight character string having the eight letters randomly shuffled.

% Later on your page, you create a banner image location in the usual way, most
% often as a table entry that includes this code...

        <%kk = (InStr(pattern, "a"))%>
        <a href="<%=blnk(kk)%>">
        <img src="http://www.tinaja.com/banners/<%=bimg(kk)%>"
        lowsrc="newsum.jpg" alt="<%=balt(kk)%>" >

% This says to find the numeric position of letter "a" in the string. The image url for
% bink(position) is combined with the src and alt text for the desired url.

% You repeat the process with <%kk = (InStr(pattern, "b"))%> for the second banner
% slot, continuing as needed to complete the page.

% More examples in BOUNCY.PDF. Some ASP Books are found here.
% For InfoPack consulting: don@tinaja.com
```

Fig. 4 – VISUAL BASIC .ASP CODE for a custom banner rotator.

measurements can get. Only recently have low cost chips gotten developed for accurate power measurement.

Some of the perils and pitfalls that are involved are in *MUSE112.PDF*, in *MUSE113.PDF*, *MUSE125.PDF*, or others in our *Tech Musings* library.

Home Power is a useful but overly optimistic resource for energy info. Also see our *Its a Gas* library page or our custom *InfoPack* services.

N-Connectedness

Sometimes one math concept can end up with many uses. One example might be called the *N-connectedness* problem. Which asks us "How many different paths are possible between n different objects?

Figure two gives an example where we see the 66 possible paths between 12 objects. Play with several values of n for a while, and you'll see that the generalized formula is $(n^2+n)/2$. Or $(n)*(n+1)/2$. The connections start off slow, but end up building nearly at the square of n.

String art anyone?

One use would be in peer-to-peer networks. But n-connectedness also explains why adding surprisingly few people to a group may dramatically change the dynamics and create lots of new problems.

It might be interesting to build a real time n-connectedness map of a website where the *thickness* of your connections revealed the popularity of each page access and the *color* the from-to direction. Revealing all of your site strengths and weaknesses. We may save this for later.

Those *Microchip Technology* folks have developed a unique *elegantly simple* use for n-connectedness. One that involves...

Interfacing LED Displays

How many light bulbs does it take to change a microcomputer port? If you are building something using a moving message ad display, or just want to use lots of LED's, this can get to be a very real question.

A typical micro port line has three states: A high impedance for inputs, a logic low output, or a logic high output. A LED will only light when a current limited voltage of just over two volts is applied.

Note that two or more series LED's will not light if they are in parallel with a single lit LED. Because their combined thresholds are too high. Note also that a LED will withstand five volts of reverse voltage. Thus, a LED will *not* light when it is reverse biased or if its voltage is too low.

Figure three shows us a unique n-connectedness setup that lets you control an amazing 56 LED's from a single 8-bit port. Any particular LED is lit when one terminal is set to logic zero and the other to logic one. All other port lines are made inputs.

Yes, there's all sorts of sneak paths of two or more lamps. But, as we've just seen, they can not light because of the combined thresholds or the reversed polarities.

To light several LED's at once, you have your software scan the needed outputs at a rapid rate. The bulbs will get dimmer as their duty cycle drops. External tri-state drivers can be added for more brightness. Note that only one LED can be lit at a time, or sneak paths will result.

Also note that you get two LED's per path, one for each direction.

Certain LED's will actually be more efficient at higher current levels. Four times the current for one fourth the time may actually end up brighter than normal. Check your *LED Data Sheets* to be sure.

Normally, some current limiting is

152.4

NAMES AND NUMBERS

Bell Jar
35 Windsor Dr
Amherst NH 03031
(603) 429-0948
www.tiac.net/users/shansen

Binding Finishing & Distribution
PO Box 1226
Voorhees NJ 08043
(856) 770-0283
www.BFDonline.com

e-Drive
7355 E Orchard Rd Ste 100
Englewood CO 80111
(800) 803-9488
www.e-driveonline.com

Home Power
PO Box 520
Ashland OR 97520
(916) 475-3179
www.homepower.com

ISD
2841 Junction Ave #204
San Jose CA 95134
(408) 428-1400
www.isd.com

LSI/CSI
1235 Walt Whitman Rd
Melville NY 11747
(516) 271-0400
www.lsicis.com

Microchip Technology
2355 W Chandler Blvd
Chandler AZ 85224
(480) 786-7200
www.microchip.com

Midwest Products
400 S Indiana St
Hobart IN 46342
(800) 348-3497
www.midwestproducts.com

Print On Demand Business
445 Broad Hollow Rd
Melville NY 11747
(800) 308-6397
www.podb.com

Snaptron
2468 E 9th St
Loveland CO 80537
(970) 663-2820
www.snaptron.com

Synergetics
Box 809
Thatcher AZ 85552
(914) 428-4073
www.tinaja.com

Ulrich's Dictionary
121 Chanlon Rd
New Providence NJ 07974
(908) 771-7714
www.ulrichsweb.com

needed with LED's that is provided with appropriate resistors. Only eight are needed as shown. But often port characteristics and port "on" times can get matched to the LED in use to safely current limit to an attractive brightness level.

The actual resistor values vary with your use. Typical values might be in the range of 27 Ohms or so. Set by the brightness and duty cycle.

The brightness for many bulbs lit will depend on the allowable duty cycle. Some sort of protection in the form of a capacitively coupled driver or whatever might be a good idea. Something to prevent the port lines ever getting "stuck" with one always on and badly overloaded LED.

The problems are greatly eased by using those new superbright LED's.

You could control 132 LED's with 12 port lines and 240 with 16. As the n-connectedness math tells us.

Additional sourcecode and design assistance can get found in ap notes on their *Microchip Web Site* or by way of my *InfoPack* service.

Shuffling Right Along

I needed to shuffle eight positions for our upcoming banner rotator, so I thought we'd review a pair of those *shuffling options* we looked at in my *Apple Assembly Cookbook*.

Shuffling with replacemet means you put the number back after you use it. Such as in one roll of a die. This is easily handled by most any random or pseudorandom number generator per the details in my *CMOS Cookbook*.

NEED HELP?

Phone or email all your US Tech Musings questions to:

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Shuffling without replacement says that once you've used a number, it gets removed from your pool of future available numbers. Such as one card dealt from a deck.

It turns out there is a subtle flaw in the "obvious" shuffling algorithm of "exchange each card at random with itself or any other".

Consider three cards. There could only be *six* shuffling outcomes (ABC, ACB, BAC, BCA, CAB, CBA), but there are *twenty-seven* possible results of any of three cards swapped with itself or the two others.

It is not possible to arrange 27 whole objects into 6 equal sized piles.

Which says that some of your outcomes will be more likely than the others. This bias does become quite small as n increases, but it still is an obvious no-no for a true shuffle.

Instead, use this algorithm…

> *To shuffle n items, replace all items with themselves or any other item lower in the deck, chosen at random.*

By swapping only equal or lower cards, you eliminate the favoritism and end up giving equal odds to all outcomes.

The details vary with your choice of language and device. Basically you start a countdown loop that picks a random number *equal or less than* your current card.

Since few languages include a swap command, you copy the swapper to a temp location, move the swappee to your original swapper location, and finally move temp into swapee.

A Visual Basic example is shown as part of upcoming figure four.

Banner Ad Rotation

How can you make unique images show up in different places on a web page? Such that each and every user views a different display every time they return or refresh?

The trick is to go to .ASP or *Active Server Pages* that might let your ISP dynamically generate new pages "on the fly" when and as needed.

I have recently covered some .ASP tricks in *BOUNCY.PDF* and have got a handy list of .ASP titles on our *Book Access* page.

An .ASP file usually includes both HTML code and scripts. When called,

the .ASP file dynamically generates a final delivered web page by following the script commands.

I wanted some features that were different than a stock banner rotator could deliver. I wanted to have eight slots per page which would fill with different ad banners. With no repeats and fresh delivery each time. And with **one** data file that automatically updated hundreds of site pages.

Figure four shows some details. You can view a demo on our *Guru's Lair* home page just by hitting your refresh button several times.

Basically (literally since I used VB), you set up an **abcdefgh** string. You then randomly shuffle this string to build a new string with all the letters rearranged. Such as **hbfecgdag** We then find out what position ad "a" is supposed to be in, and then put it there. The process repeats for ads "b" thru "h" autorotating all of the ads into appropriate slots.

Note that .ASP pages have to be tested "live", because only your ISP normally has the code to use them to generate the desired output. The file delivered to your end user is **not** the original .ASP file! A simple "View Source" won't hack it.

More on banner possibilities are in BANNYEAR.PDF and *advt01.asp* .

Thermodynamics Books

I have gathered some of the better thermodynamics titles together for you as this month's book reference. These also can be picked up on our *Book Access* page. A reminder that you can support the *Guru's Lair* at no cost to yourself by buying **all** of your books through this link.

My favorite popular thermo book remains Sandforth's **Heat Engines** See if you can't find it as the ancient *Doubleday Science Series* paperback.

New Tech Lit

From *ISD*, a nice CD ROM on their line of speech recording chips.

Free snap dome switch samples are offered by *Snaptron*, while micro cut quality woods are sold by the folks at *Midwest Products*.

A few assorted web links: Access to *Ulrichts Periodicals Dictionary* is now at last online. Superb coverage of older Tektronix oscilloscopes is clickable at the *Tektronix Resource Site* . One of the site webmasters is

Stan Griffiths, who is the author of *Oscilloscopes: Restoring a Classic* .

Some Heathkit schematics are up at *Circuit Archive* , and a linked list of major newspapers is at *Inkpot* .

This *Free Energy Fraud* forum traffic seems light. And is mostly the sameold sameold from the usual suspects. A key problem with manic pursuit of anything is that you may become what you attack. Finally, the *NREL* has posted a rather well done *Hydrogen Energy Economics* paper .

Trade journals for this month include Steve Hansen's labor-of-love *Bell Jar* on homebrew high vacuum . Plus *e-drive* on electric vehicles, and *binding finishing & distribution* and *Print-on-Deamand business*.

A reminder that many outstanding *Surplus Bargains* can be found *here*, and are offered on *eBay* as well.

For all the fundamentals of active filter circuits, do be sure to check out my **Active Filter Cookbok**. Find it at *www.tinaja.com/amlink01.asp*

And a final reminder about our cash-and-carry InfoPack consulting at *www.tinaja.com/info01.asp*.

Let's hear from you. There are lots of new possibilities here.❖