

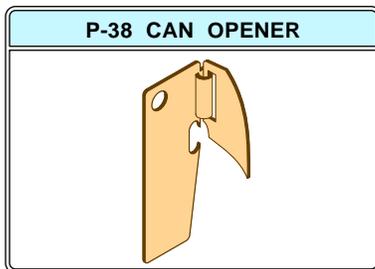
# Elegant Simplicity

One of the goals I have consistently sought out over the years is to develop designs and products which inherently possess an *elegant simplicity*. Like many truly great concepts, elegant simplicity can be hard to pin down. But you sure know it when you've got it.

One clue is when industry insiders end up shaking their heads in stunned disbelief.

Elegant simplicity combines the best of Schumacher's "do more with less" and Buckminster Fuller's "appropriate technology". Yeah, *Whole Earth Catalog* stuff. It goes way on back to that ancient *Ockham's Razor* principle of the most fundamentally direct explanation often ending up the most correct. Or Einstein's "Always seek out the simplest possible solution – *but none simpler*".

Probably the best way we can get a handle on elegant simplicity is to look at several products and designs that clearly have it. Here are my selections for a few of the all time winners...



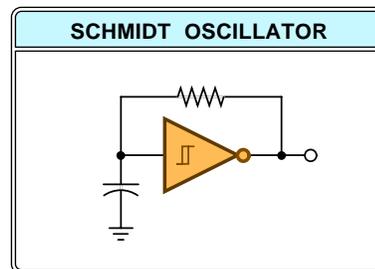
I consider the P-38 can opener to be by far the finest invention of the twentieth century. Bar none. Compared to the P-38, such utter frivolities as radio, television, autos, or aviation are not even in the same league. Yes, even *Hostess Twinkies* pale by comparison.

For sheer bang for the buck and inherent ergonomics, nothing can remotely compare. The P-38 opens cans. Any classic tin can, any time, any place. It runs forever. No batteries required. Fully portable. Self-protecting. Cost is zilch. No user manuals or tutorials.

Let's see what we got here. Two tiny pieces of stamped steel. One is grooved for extra strength. The blade folds flat for storage or pops open for use. The first time you see one, you will swear that it couldn't possibly work. But it sure does. The secret is "walking" around the folded rim present on all classic cans. Your thumb and forefinger form a double lever that pivots on that rim. With a surprising amount of force magnification. Probably many *tons* of pressure per square inch at the blade edge.

The elegant simplicity here is profound: ultra low cost

and very small size. Perfectly matched to both the user and the job to be done. Use of the absolute minimum of force concentration to reliably carry out one well defined task. While a throwaway item intended for one time use, these last forever. A classic in every sense of the word.



What is the simplest possible electronic oscillator you can build? For square waves, the *Schmidt Oscillator* wins hands down. It uses 2-1/6 parts, always self starts, is fairly temperature and voltage stable, and outputs more or less symmetric square waves. This dude can be micropower at low frequencies and drives fairly heavy loads.

The key is to pick any CMOS gate or inverter that has *Schmidt Trigger* inputs having *hysteresis*. One-sixth of a 74HC14 is a good four cent starting point. If a *rising* input voltage goes past an *upper trip point*, the output goes *low*. If a *falling* input voltage goes below the *lower trip point*, the output goes *high*.

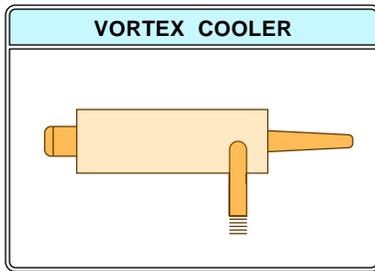
On power up, the capacitor cannot instantly charge, so the input will stay low, and the output will flip high. This starts charging the cap, slowly raising your input voltage. When the input voltage reaches your upper trip point, the output flips low. Now, the resistor starts discharging the capacitor towards ground. When it hits the lower trip point, the process repeats.

The choice of resistor and capacitor value determines the time constant and thus your oscillation frequency. Start off with a 220K resistor and a 0.001 microfarad capacitor for something in the mid audio range. Variable resistors or switched capacitors can be added to extend the range.

All of which gives us a nearly pure implementation of integrating a square wave to get a triangular wave and then comparing the limits of the triangular wave to produce an inverted square wave.

Self-starting is inherent. The very first cycle on power up will be longer than the others. Which can be handy for such things as auto-repeat functions on a keyboard.

More details on Schmidt oscillators can be found in my *CMOS Cookbook*.



This one is nothing but a Tee shaped pipe. Blow air in the middle arm, and hot air comes out one end and cold air out the other. To -40 degrees and tons of refrigeration.

With zero moving parts.

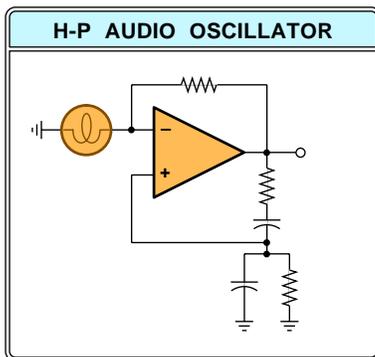
Important uses are electronic cabinets, sewing machines, and general machine shop aps.

Shop air gets blown into the middle arm. This creates an internal hollow supersonic cyclone that travels at a speed of several hundred thousand RPM. The cyclone moves to the hot end, and a fraction of it exits.

Now for the tricky part: The remainder of the cyclone works its way back towards the cold end, *inside* the entry vortex. The velocity is still the same, but the radius is less. Thus, the *angular momentum* of the inner vortex has to be *lower* than the outside one. But since energy has to get conserved and since the angular momentum has obviously dropped, there has to be a net transfer of heat energy from the inner vortex to the outer one. The result is that the outer vortex heats, and the inner one cools. Finally, the highly cooled inner vortex exits via the cold air port.

An optional screw adjustment selects the cold fraction. Which lets you select your choice of maximum cooling or minimum temperature.

Two sources of vortex coolers are *Vortec* and *Exair*.



Would you believe that the entire *Hewlett-Packard* empire was based on one dimly lit pilot light?

The first H-P product was a low distortion, wide range *Wein Bridge* audio sinewave oscillator.

A *Wein Bridge* consists of a single pole RC high pass filter in series with a single pole RC lowpass filter. The gain of this network will be zero for very low or very high frequencies. The gain will be highest at a frequency where the time constants match. If the resistors are equal, the gain at the magic frequency will be 0.33 or one-third. Phase shift will also be zero at this frequency.

To make an oscillator out of this, you simply place an amplifier with a gain of 3.0 around the loop.

Whoa, not so fast. How do we get started? You have to provide a much higher gain for startup. And once you are

nicey oscillating, how do you keep your output amplitude constant and undistorted?

The key secret is to add some sort of stabilization to your amplifier. Raise the gain to start, and then carefully and continuously adjust the gain to hold your desired low distortion output. Such circuits are called AGC loops, short for *Automatic Gain Control*. As a further complication, you want your AGC loop to only respond to *long term changes* and not to those cyclic variations of each individual cycle. Otherwise, you just may increase, rather than decrease your distortion through intermodulation.

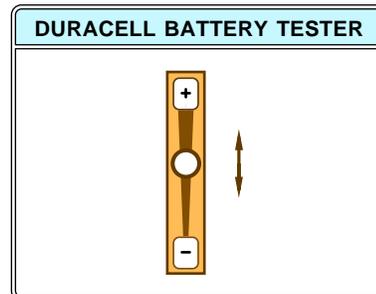
The traditional electronic solution here is to use a peak detector, integrator, and variable gain amplifier stage. A royal mess still today, but a real bear back in 1940.

Well, Mister Hewlett or Mister Packard (I forget which one) decided to use elegant simplicity instead. They noted that a pilot light is a *nonlinear resistance*. The resistance is low when cold and higher when hot. Which is why most light bulbs will burn out on power on. Further, there is a *thermal inertia* to a lamp that only allows its resistance to slowly change at the required subaudio rates.

By using a plain old pilot light as your AGC loop, you can eliminate any need for anything fancy.

On power up, the bulb is cold and you get lots of gain. During run time, the oscillator cycles at its normal safe low-distortion output value. If the gain goes up, the current through the bulb and its resistance also goes up, lowering the gain. In a tight self-stabilizing loop.

The rest, as they say, is history.



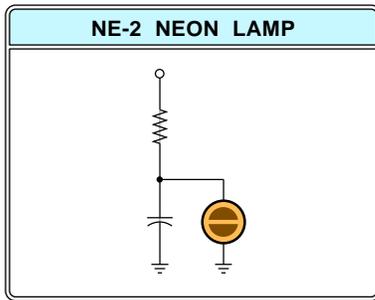
Battery testers can be a real hassle. First, you have to find a load resistor that is properly rated for the exact cell or cells you are measuring. You then actually measure the current or voltage under load and compare this against a set of design curves. Then you interpret the results.

The *Duracell* folks came up with a better way. They have literally *printed* their battery tester onto the blister package their cells come in. At stunningly low cost.

A marketing solution that is off scale when it comes to elegant simplicity. Any five year old can use it.

Here's how this gem works: A conductive pattern is first printed that forms a resistor. The resistor value is carefully matched to the cell being tested. The trapezoidal shape of the resistor is carefully selected so that the power density changes along its length. As a result, the top of the resistor gets hotter than the bottom. When connected to the test battery, a temperature gradient is formed, hot at the thin top and cooler at the thick bottom.

A temperature sensitive liquid layer has been printed on top of the test resistor. The *transition temperature* of the liquid crystal produces a bright green spot. The fresher the battery, the higher the spot moves up on the display.



Back in its vacuum-tube heyday, the nine cent NE-2 neon lamp was by far the most versatile electronic part. Besides the classic flasher circuit I have shown here, the lowly neon lamp had an amazing variety of uses.

Stuff like a universal power tester, lightning protection, surge arresting, lamp dimming, electronic organ tone generation, bistable and astable flip flops, ultra cheap voltmeter replacements, twinkle lights, hot-chassis warning devices, polarity indicators, microammeters, radio tube filament checkers, long life pilot lights, pulse generation, electronic switch, threshold detector, ac-dc discriminator, touch switch, strobe light, synchronizer, radiation detector, ultraviolet sensor, threshold comparator, voltage regulator, turntable speed control, reference supply, dc coupler, or a sawtooth signal source. Plus bunches more.

Basically, you've got a small glass tube filled with low pressure neon gas, supporting two wire electrodes. While normally an open circuit, the neon ionizes when the supply voltage exceeded 90 volts. Once ionized, the lamp lights brightly and conducts heavily. When the supply voltage under the high current discharge drops below 55 volts, the lamp will extinguish and the cycle repeat. Only the positive terminal lights under DC. Both light under AC.

Sadly, the generally lower voltages of the solid state revolution sidelined the NE-2 into an undeserved early retirement. Yeah, they still cost less than a dime.

### What else?

Let's see. What else passes our elegant simplicity test? *Vise Grip* pliers fer sure. That old plastic nut starter from *Heathkit*. Or their integrated circuit extractor that can be approximated by a bent nail.

I kinda did like those *Conanda Effect* auto windshield washers that showed up a way back. Two fixed grooves in a simple fluidic nozzle that swept the washer glop all over the glass. Or Volkswagen's *Synchro* 4WD van that once and for all solved positraction problems by its optionally shoving a locking pin through the differential.

I'm also impressed by those new Analog direct storage EPROM speech recorders by *Information Storage Devices* and *Radio Shack*. Single chip solutions that eliminate any need for fancy A/D and D/A conversion. And that *Basic Stamp* microcontroller from *Parallax*.

Or that ultra low cost circuitry used in EKG pulse rate monitors. A complete micropower short-haul telemetry system in a cheap throwaway module.

Also by nearly any product that *Dallas Semiconductor* makes. Especially their "time in a can" dogtags.

What about the computer languages? Most fail elegant simplicity and do so abysmally. In fact, one good working definition of elegant simplicity is *What UNIX ain't*.

### ELEGANT SIMPLICITY RESOURCES

**Adobe PostScript**  
1585 Charleston Road  
Mountain View, CA 94039  
(800) 833-6687

**Dallas Semiconductor**  
4401 Beltwood Pkwy S  
Dallas, TX 75244  
(214) 450-0400

**Exair**  
1250 Century Circle N  
Cincinnati, OH 45246  
(513) 671-3322

**GEnie PSRT**  
401 N. Washington St.  
Rockville, MD 20850  
(800) 638-9636

**Information Storage Dev**  
2841 Junction, #204  
San Jose, CA 95134  
(408) 428-1400

**Parallax**  
6359 Auburn Blvd, Ste C  
Citrus Heights, CA 95621  
(916) 721-8217

**Vortec**  
10125 Carver Road  
Cincinnati, OH 45246  
(800) 441-7454

**Whole Earth**  
27 Gate Five Road  
Sausalito, CA 94965  
(415) 332-1716

One superb example of elegant simplicity is WPL. An obscure scripting language for the Apple IIe *AppleWriter* word processor written by Paul Lutus. This real gem is a interpretable language that can automate word processing tasks. Elegantly and gracefully.

The WPL interpreter was written in a mere 1700 bytes of lovingly hand-crafted machine language code!

Portions of the general purpose PostScript computer language clearly offer elegant simplicity. Particularly its total device independence, its use of procedural character paths, graceful sparse curves, and powerful dictionary structures. Plus all the continuous on-the-fly high speed graphical transformations. Not to mention the power goodies in level II involving forms, FAX, open font paths, and outstanding color options.

My own personal favorite elegant simplicity ploy? Way back when I was in college, I used to consistently get the highest grades on my lab reports. Mostly because my lab reports were always thicker than the rest. The key secret to writing thick lab reports? *Thick paper!*

I have shown some follow-up names and numbers in the *elegant simplicity resources* sidebar. More on PostScript and such appears on [www.tinaja.com](http://www.tinaja.com).

But what did I miss? Surely you have several favorite examples of your own. Let's make a contest out of it. Just jot down your best shot at elegant simplicity and send it to me at *Synergetics*. There will be a dozen or so *Incredible Secret Money Machine II* books going to the winners, with an all all expense paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all. Let's hear from you. ♦

*Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless articles. Don maintains a US technical helpline you'll find at (520) 428-4073, besides offering all his own books, reprints and various services.*

*Don has a free new catalog crammed full of his latest insider secrets waiting for you. Your best calling times are 8-5 weekdays, Mountain Standard Time.*

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*Don is also the webmaster of [www.tinaja.com](http://www.tinaja.com) where a special area has been set aside for *Midnight Engineering* readers. You can also reach Don at *Synergetics*, Box 809, Thatcher, AZ 85552. Or email [don@tinaja.com](mailto:don@tinaja.com)*

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