

# Emerging Technical Opportunities VI

It is once again time to survey some happenings that just might offer outstanding potential for individual development and small scale startups. Besides leading to winning school papers. Or even thesis topics.

Earlier emerging opportunities in this series are in my [www.tinaja.com/blat01.html](http://www.tinaja.com/blat01.html) Especially in [EMERGOP1.PDF](#) to [EMERGOP5.PDF](#). Or [www.tinaja.com/glib/resbn63.pdf](http://www.tinaja.com/glib/resbn63.pdf)

This time around, I thought we might look at some of the more esoteric stuff that seems to be coming down...

**Pulse radio**– Make some sudden change in an antenna's current, and a special radiation time pattern known as a *Gaussian Pulse* results. Your energy distribution ends up extremely wide band and uniform. Most of the energy in a one nanosecond risetime current change will be under one GigaHertz in frequency.

A new field known as *pulse radio* is exploring these ultra wide spread spectrum signals. Especially for shorter range comm and for precise distance measurements. Pulse radio needs no tuning components, is otherwise very simple, is still license free, and is amazingly resistant to multipath and fading. Power needs are also remarkably low for comm over hundreds of feet and more. Data rates or measurement accuracy can end up exceptionally high. With suitable code choices, pulse radio has minimum interference with itself or with conventional radio transmissions.

You can start with my tutorial and resource listing in [www.tinaja.com/glib/muse135.pdf](http://www.tinaja.com/glib/muse135.pdf). You'll find an *Ultra Wide Band Working group* at [www.uwb.org](http://www.uwb.org). A great link farm is provided by *Ultralab* up at [commsci.usc.edu/ulab/links.html](http://commsci.usc.edu/ulab/links.html) Other sites are reached through [www.time-domain.com](http://www.time-domain.com) You can key *pulse radio* or *impulse radar* into [www.hotbot.com](http://www.hotbot.com) for hundreds of additional sites to explore.

One useful magazine is Randy Robert's *Spread Spectrum Scene*. The definitive book author seems to be a Helman Harmuth. You can start with his *Radiation of Nonsinusoidal Electromagnetic Waves*. More details on this and related text are found at [www.tinaja.com/amlink01.html](http://www.tinaja.com/amlink01.html)

**Metalloradicals**– Yeah, their last album did go platinum. Actually metalloradicals just may be the long sought key secret step required to explain and exploit photosynthesis. As well as improving solar-to-electric conversion.

Picture a closed loop linked grouping of five chemical reactions involving an organic manganese metalloradical. Step one accepts water and solar energy as inputs and kicks off an electron and a hydrogen ion. Steps two, three, and four also kick off an electron and a hydrogen ion. State five

burps out a new diatomic oxygen molecule as its "waste product". And then reverts back to state one.

In other words, you have a magic box. Pour water and energy in the top, and you will get hydrogen out the right, electricity out the left, and oxygen out the bottom.

And all of the magic gets done closed loop. And all of it in thermodynamically favorable reactions.

I have got a summary of this exciting breakthrough at [www.tinaja.com/glib/muse120.pdf](http://www.tinaja.com/glib/muse120.pdf) For the key research, see Hoganson and Babcock's *A Metalloradical Mechanism for the Generation of Oxygen from Water in Photosynthesis* paper in *Science* for September 26, 1997. Pages 1953-1956. Updated papers are in *Science*, Dec 4, 1998. pp 1842 and 1853.

Additional related material appears in a *Symposium on Multinuclear Enzymes in Oxygen Metabolism*. Find this one at [cuprum.chem.umn.edu/boston98.html](http://cuprum.chem.umn.edu/boston98.html)

**"D" cell turbines**– Gasoline is pretty amazing stuff. First, it is a true fuel, clearly delivering net BTU's of energy to the on-the-books economy. Second, it offers incredible energy storage of 9000 watt hours per liter and 13,500 watt hours per kilogram. Compare this to the best of today's lithium batteries at 300 wh/liter and 150 wh/kg.

Thus, a D cell sized container of gasoline could store something like 30 times as much energy as a battery. Even when burned in a 20 percent efficient turbine or engine, gasoline still may offer six times your deliverable energy storage per volume and twelve times the energy storage by weight. Compared to the best of today's batteries.

So, why not build a turbine and a gas tank into a device the shape of a D cell? Batteries for laptops and cell phones could last a lot longer and may end up much cheaper.

While consuming fewer exotic materials.

Just like ants, it turns out that as you reduce the size of mechanisms, their power-to-weight ratio increases sharply. So, an engine and generator the size of a cubic centimeter should be able to deliver power in the ten to one hundred watt range. While this sounds amazing, these figures are comparable to today's aircraft engines.

Besides obvious battery replacement uses, micro turbine technology can also get applied to cooling, heat pumping, compressing, and precise movement of liquids.

A leading proponent is Alan Epstein at the *Massachusetts Institute of Technology* with their *MIT Microengine turbine*. See [www.eecs.mit.edu/AY96-97/events/19.html](http://www.eecs.mit.edu/AY96-97/events/19.html) for a few further details. Useful search web words for this exciting development are *MEMS* and *turbine*.

**Position sensitive detectors** – Accurately measuring short distances is now getting to be crucial. For everything from camera autofocus to robotics positioning to garage car alarms to restroom hand drier sensors. It turns out there is a fairly new scheme that uses *position sensitive detectors* to greatly simplify such measurements.

A PSD is just a pair of side-by-side photodetectors. At "medium" ranges, a laser or LED illuminated subject hits both sides of the PSD evenly. Closer or further away, your image should get offset, creating a proportionally stronger signal on one or the other photodetector.

A sneaky *normalization* scheme of  $(L-R)/(L+R)$  gives an output that is related to range but not to brightness. The required division is easily done digitally with a PIC.

This setup is sort of that old *parallax method* insided out. Instead of a mechanical shifting of two images until they converge, your images are focused such that their relative positional differentials can be measured.

PSD chips are becoming readily available at low costs. That Sharp GPDD02 is one older device. Other sources do include *Hamamatsu* and *Ricoh*. The newest and best parts are likely to show up at [www.questlink.com](http://www.questlink.com)

See [www.tinaja.com/glib/muse131.pdf](http://www.tinaja.com/glib/muse131.pdf) for a PSD tutorial. A good source for really useful position sensitive detector information is [ww2.whidbey.net/optoinfo/LED\\_FAQ.html](http://ww2.whidbey.net/optoinfo/LED_FAQ.html) That SPIE, or Society of Photo Optic Engineers sells many PSD papers. See their *Proceedings #2002 on Photodetectors and Power Meters*. Website is [www.spie.org](http://www.spie.org)

**Carbon nanofiber hydrides** – Terrestrial hydrogen is not a fuel. It is only an *carrier*. Albeit one that has high potential for personal vehicle solutions. If the key storage problem can get solved. STP hydrogen has an outstanding three times the energy storage of gasoline *per weight*. But only a ludicrously pitiful 1/300th the storage *by volume*.

No, costly and lossy liquification and compression are not the answer. Because there is still four times as much hydrogen in a gallon of gasoline than there is in a gallon of liquid hydrogen. Instead, chemical *hydride* solutions are sought where hydrogen gets bound into some compound.

The best naturally occurring hydride is methane, which offers a 25 percent by weight storage.

Northwestern University's Nelly Rodriguez & Terry Baker have discovered a graphite nanotube storage material. They claim their material can be used to create hydrides that can retain up to 75 percent of their weight as hydrogen. In theory, a recyclable cartridge the size and weight of a tank of gasoline could run a car for 5000 miles.

The key questions remaining are if the carbon nanotubes are stable over time and whether the experiments can be replicated. Supporting results seem encouraging.

The first announcement was done as a fall 1996 *Materials Research Conference* paper. A summary is in the *Hydrogen & Fuel Cell Letter* for February of 1997 Check [www.positron.a.s.org/BAPSMAR98/abs/S1690007.html](http://www.positron.a.s.org/BAPSMAR98/abs/S1690007.html) for their *Synthesis, Microstructure, and Hydrogen Absorption Properties of Nanofiber Carbon* title. Patent 5,653,951 may also be of interest. Find this at [www.tinaja.com/patnt01.html](http://www.tinaja.com/patnt01.html)

I've got hydrogen tutorials up as files [RESBN88.PDF](#) and [MUSE115.PDF](#). Books on hydrogen and related topics are at [www.tinaja.com.amlink01.html](http://www.tinaja.com.amlink01.html). Links to hydrogen sites can be found at [www.tinaja.com/h2gas01.html](http://www.tinaja.com/h2gas01.html)

**Electrochemical Impedance Spectrography** – Sometimes a field is too arcane for its own good. EIS is a method for measuring the frequency response of batteries and other electrochemical devices. Such as hydrogen electrolysis cells. EIS is destined to play a more and more important role in efficient and safe battery recharging, in hydrogen systems, development of energy sources, battery life extensions, paint testing, and even cancer research.

To date, EIS is extremely expensive and specialized. But there is no reason that low cost PIC and PC based devices cannot be easily developed.

There's long been outrageous "perpetual motion" claims that seem to magically recharge "dead" batteries from badly sparking and poorly designed motors. Could recycling of some fraction of a battery's energy as higher current low duty cycle pulses in fact extend the useful battery life? And do so economically and safely? Your credible mechanisms are simple heating as well as polarization reduction by a reverse current. Like those electroplaters who occasionally reverse current to clean up their act.

There's also claims that "pulses" can somehow improve electrolysis. EIS can resolve these questionable beliefs.

One EIS url is [www.rwth-aachen.de/isea/Ww/test/eis\\_text.html](http://www.rwth-aachen.de/isea/Ww/test/eis_text.html) For more on EIS, see [www.tinaja.com/glib/muse137](http://www.tinaja.com/glib/muse137) Two current EIS instrument suppliers are ISEA and Gamry.

More on PIC's at [www.tinaja.com/picup01.html](http://www.tinaja.com/picup01.html).

Two background books are *Electrochemical Engineering Principles* by Geoffrey Prentice and *Modern Batteries: An Introduction to Electrochemical Power Sources* by Colin Vincent. More details at [www.tinaja.com/amlink01.html](http://www.tinaja.com/amlink01.html)

One trade journal is *Battery Products News*.

**And a few other candidates** – Federal labs rarely come up with anything useful, but Argonne Labs do newly describe some *ionic conductor filters*. These can get used to extract oxygen from air, separate hydrogen from gas streams, and do lots of other neat things. Check out their Volume 9, #4 of their *Tech Transfer Highlights*.

Short range *RFID identification* based on backscatter and other principles is emerging at an explosive rate. Typically, a price tag or a cow or whatever gets interrogated using a 13 MHz self-powering signal. An "answer" serial number or other data gets returned by using lossy backscatter.

Good trade journals here are *Identification Products* and *Automatic ID News*. Chip suppliers include *Dallas*, *Micron*, *Microchip*, and *Maxim*.

*Field Programmable Gate Arrays*, or *FPGA's* from *Xylinx* and elsewhere are now big enough and cheap enough that you can easily build your own microprocessor chip. At least as fancy as 6502 or Z-80 class devices. Which lets you do your things your ways, gives useful security, and makes for outstanding student projects and learning experiences. Support for FPGA's includes *Space-Time Productions* at [www.tefbbs.com/spacetime/index.html](http://www.tefbbs.com/spacetime/index.html) and *Ultra Technology* at [dnai.com/~jfox](http://dnai.com/~jfox).

Finally, there is soon-to-arrive *human brain parity*. The web on an off day does bunches more computing than any human brain is capable of. Very shortly, small and personal "smarter than people" machines will be commonplace. The opportunities and consequences here are profound. Start with Ray Kurzweil's *Age of Intelligent Machines* and Neil Gershenfeld's *When machines start to think*.

## SOME MENTIONED RESOURCES

**Argonne Natl Lab**  
9700 S Cass Ave  
Argonne IL 60439  
(800) 627-2596

**Battery Technology**  
5700 Bandini Blvd  
Commerce CA 90040  
(800) 982-8284

**Dallas Semiconductor**  
4401 Beltwood Pkwy S  
Dallas TX 75244  
(972) 450-0400

**Gamry Instruments**  
607-C1 Easton Road  
Willow Grove PA 19090  
(215) 830-9886

**Hamamatsu**  
360 Foothill Rd  
Bridgewater NJ 08807  
(201) 231-0960

**Hydrogen & FC Letter**  
Grinnell St PO Box 14  
Rhinecliff NY 12574  
(914) 876-5988

**Materials Research Soc**  
9800 McKnight Rd #327  
Pittsburgh PA 15237  
(412) 367-3003

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

**Microchip Technology**  
2355 W Chandler Blvd  
Chandler AZ 85224  
(602) 786-7200

**Micron**  
2805 E Columbia Rd  
Boise ID 83706  
(208) 386-3900

**Ricoh**  
3001 Orchard Parkway  
San Jose CA 95134  
(800) 957-3436

**Sharp Optoelectronics**  
5700 NW Pacific Rim Blvd  
Camas WA 98607  
(360) 834-2500

**Space-Time Productions**  
219 N Vale Ave  
Rockford IL 61107  
msimon@tefbbs.com

**SPIE**  
PO Box 10  
Bellingham WA 98227  
(360) 676-3290

**Spread Spectrum Scene**  
PO Box 2199  
El Granada CA 94018  
(800) 524-9285

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

**Ultra Technology**  
2512 10th Street  
Berkeley CA 94710  
(510) 838-2149

**Xilinx**  
2100 Logic Dr  
San Jose CA 95124  
(800) 244-7778

### For More Help

Several levels of further help is now available on these and related subjects. The complete collection of the entire emerging opportunity series is available in printed form as my *Emerging Tech Opportunity* Special Interest Packet from [www.tinaja.com/synlib01.html](http://www.tinaja.com/synlib01.html)

Personal consulting services are now available through [www.tinaja.com/info01.html](http://www.tinaja.com/info01.html). As an *InfoPack* cash and carry basis or as ongoing programs. Other recommended and highly capable consultants might be contacted through my [www.tinaja.com/consul01.html](http://www.tinaja.com/consul01.html).

A new *Guru's Lair* forum is reachable by clicking on the **FORUM** box at [www.tinaja.com](http://www.tinaja.com). Finally a free US service is available by way of phone or email when a brief and simple answer might be all you really need. To participate, email [don@tinaja.com](mailto:don@tinaja.com) or call (520) 428-4073. ♦

*Microcomputer pioneer and guru Don Lancaster is the author of 35 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 consulting services.*

*Don has catalogs at [www.tinaja.com/synlib01.html](http://www.tinaja.com/synlib01.html) and at [www.tinaja.com/barg01.html](http://www.tinaja.com/barg01.html)*

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