

# Energy and the New AI: Global Risks and Opportunities for Korea

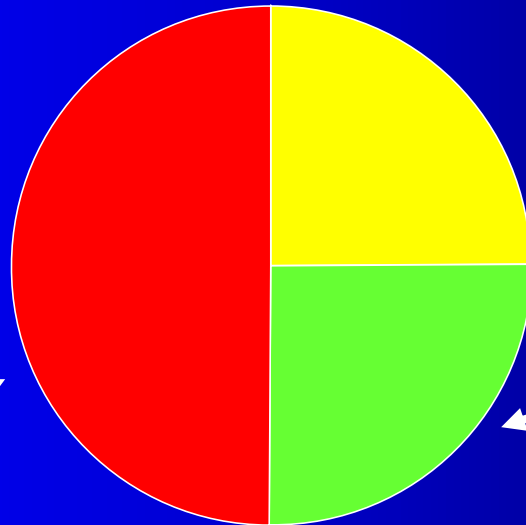
- Just 2 of many issues in Millennium Project, but big
- Will cover the new AI in more depth at AICON in Seoul tomorrow, KAIST Wednesday
- US Congressman Trent Franks: “You are only worried because you lack the facts. If you knew what I do, you’d be terrified out of your mind” EMP
- Fatal gaps in action by US and China imply big opportunities for Korea to fill in, take over

# Energy Challenges Facing Korea – And New Technologies to Address Them

- Three **Grand Challenges** – “Oil”, Climate, “Electricity”
  - Need focus on desired end state to get there, avoid waste
- Grand Strategy for How to Meet the Challenges
  - Oil: **cut cost** of plug-in hybrids **and alternate liquid fuels (better bio)**. Updated IEEE position part of [www.Werbos.com/oil.htm](http://www.Werbos.com/oil.htm).
  - Climate: threats to life much bigger than you have heard. Need new leadership in geoengineering, aquarium scale research on drivers of H<sub>2</sub>S proliferation
  - Electricity: unique problems with supply; location crucial to solar. Lines from China, or fill holes in research on energy from space (Japan, China)

# WE CAN Zero Out Gasoline Dependency: A Definite Option for 100% Renewable Zero-Net- CO2 cars & **Total Security** for Car Fuel

Highest mpg  
**Hybrids** Cut  
Gas per Mile  
By 50%



With **GEM fuel-flexible** cars,  
biofuels might supply  $\frac{1}{4}$   
of present liquid fuel  
demand trends

**Plug-in** Hybrids  
with 10kwh batteries  
get half their energy  
from electricity

GEM fuel-flexible plug-ins offer a 100% solution  
based on near-term technology!

# Optimal Strategy for Total Energy Security



## Maximize Fuel-Flexible Plug-in Hybrid Cars



Open door to US natural gas (e.g. to trucks) while it lasts

R&D for more efficient use of diverse fuels

R&D for batteries for affordable electric cars



Minimize cost and then maximize supply of renewable electricity

Maximize supply of Alternate liquid fuels  
– Not oil  
– Incentives, standards and R&D

# Plug-in Hybrids (PHEV) : A Large-Scale Opportunity Here and Now

- Hybrids cut liquid fuel use 50% already. Plug-ins cut **50% of that**.
  - “Researchers have shown .. (PHEV) offering.. electric range of 32 km will yield... 50% reduction..” (IEEE Spectrum, July/05). Shown in working Prius.



- Battery **breakthroughs in China**: from 10/07, 10kwh batteries (larger than) cost **\$2,000**. [www.thunder-sky.com](http://www.thunder-sky.com). Thus an extra \$2,000 per car can cut gas dependence in half.
- **Gives economic security in case of sudden gasoline cutoff.**
- **Does not strain grid – actually strengthens it, if done right**

# GEM Flexibly Fuel Vehicles (FFV)

One Tank To Hold Them All

Google: Methanol Policy Forum 2011

G: Gasoline



E: Ethanol



M: Methanol



With an FFV, you choose each day which to buy  
At \$100-200/car, a more open competition, level playing field,  
better unleash the power of the free market

GEM flexibility  $\Rightarrow$  use of any corrosive fuel, adaptive engine control. 2012: Big China deployment, need procurement prefs

Fuel flexibility can be brought online very quickly, much faster than hybrids merely doubling every year!



All major manufacturers which sell in US have sold such cars in Brazil!!

We can dramatically reduce cost and expand supply of biofuel, present and future, if we stop requiring so much purity in our ethanol/alcohol!



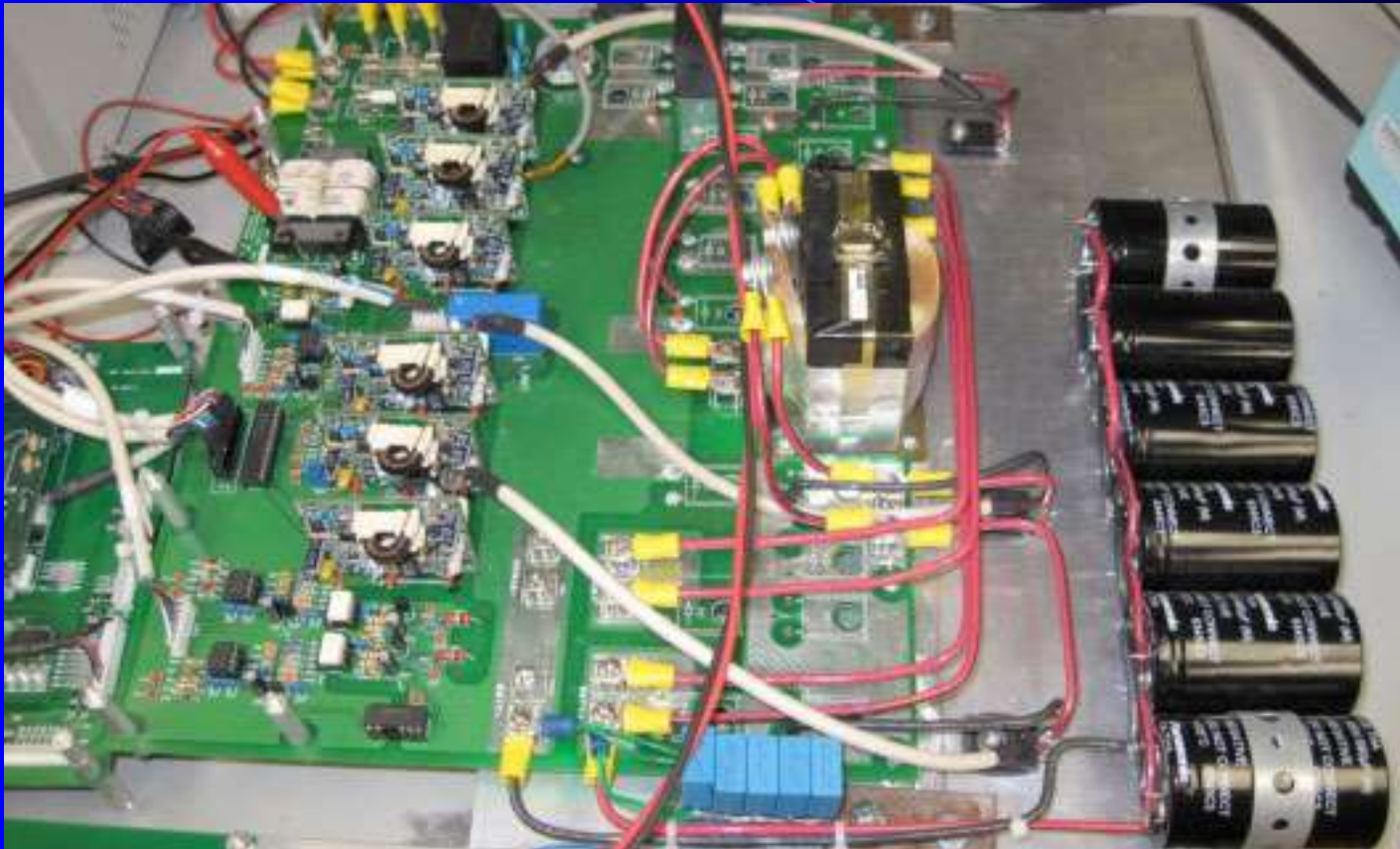
We need to give this guy permission to compete with Saudi Arabia and Iran for the car fuel market! He doesn't need a subsidy – only more freedom and an open door! Just give him a chance, and within 15 years...  
(Also, try a google on “forest industry” methanol.)



# What limits rate of deployment of hybrids & plug-ins? Cost, cost, cost... (and recharge: don't fall into chademo!)

- Hybrid Prius vs. regular Prius: cost penalty = **\$3000** (2006 data Car & Driver, Financial Times) about enough to pay off at \$3-4/gallon without interest
- About **\$2000** of the \$3000 is for **small fast battery**, was nickel hydride less than 1kwh. Rest is for power electronics; same big two but more for plug-ins 10K
- **\$1,000-\$2,000 tax incentive** per car, for the first million hybrids from each manufacturer, essential to speed of development, becoming cheaper, **in US**
- **Outside the US**, higher gas price bigger market now

- Example of NSF Funded Work: Alireza Khaligh
- (Similar megawatt work by SMazumder for solar farms)



- New integrated power electronics can cut cost of total power electronics for cars
- like Volt by 1/3 – 1/2 while adding a flexible AC/DC fast recharge capability
- making fast recharge stations “free” instead of \$100,000-\$200,000 each
- Similar technology crucial to distribution level (Rahman issues) constraints

# Beyond Li-Ion: Lonnie G. Johnson

- Founder and President
- NASA (Voyager, Mars Observer, CRAF, Cassini, Galileo)
- Holds over 90 patents
- B.S. in Mechanical Engineering, Tuskegee University
- M.S. in Nuclear Engineering, Tuskegee University
- Ph.D. (Honorary) in Science, Tuskegee University
- Projects relying on Tuskegee labs and students



*“One of the Top Inventors in  
the World”*

Time Magazine

Exciting credible new ideas (risky but near term) for US to leapfrog the world both in batteries and in more efficient heat-to-electricity for flexible cars !!!!!!!

**US inventors can leapfrog past China  
and make pure electrics affordable IF we  
give them more support.  
(Other players: ReVolt, ARPAAE.)**

|                      | Specific Energy (Wh/kg) | Energy Density (Wh/l) | Discharge Rate (C) | Specific Power (W/kg) | Cycle Life |
|----------------------|-------------------------|-----------------------|--------------------|-----------------------|------------|
| Nickel Cadmium       | 80                      | 150                   | 10                 | 500                   | 800        |
| Nickel Metal Hydride | 150                     | 250                   | 5                  | 200                   | 800        |
| Lithium ion          | 211                     | 577                   | 5                  | 300                   | 500        |
| DMFC                 | 250                     | 75                    | 5                  | 500                   | 500        |
| Johnson Lithium Air  | 2000                    | 2000                  | 5                  | 400                   | 500        |

•New: [www.excellatron.com](http://www.excellatron.com): Argonne verifies >100 cycles recharge

Through R&D fuel/gallon could be cut in half again.

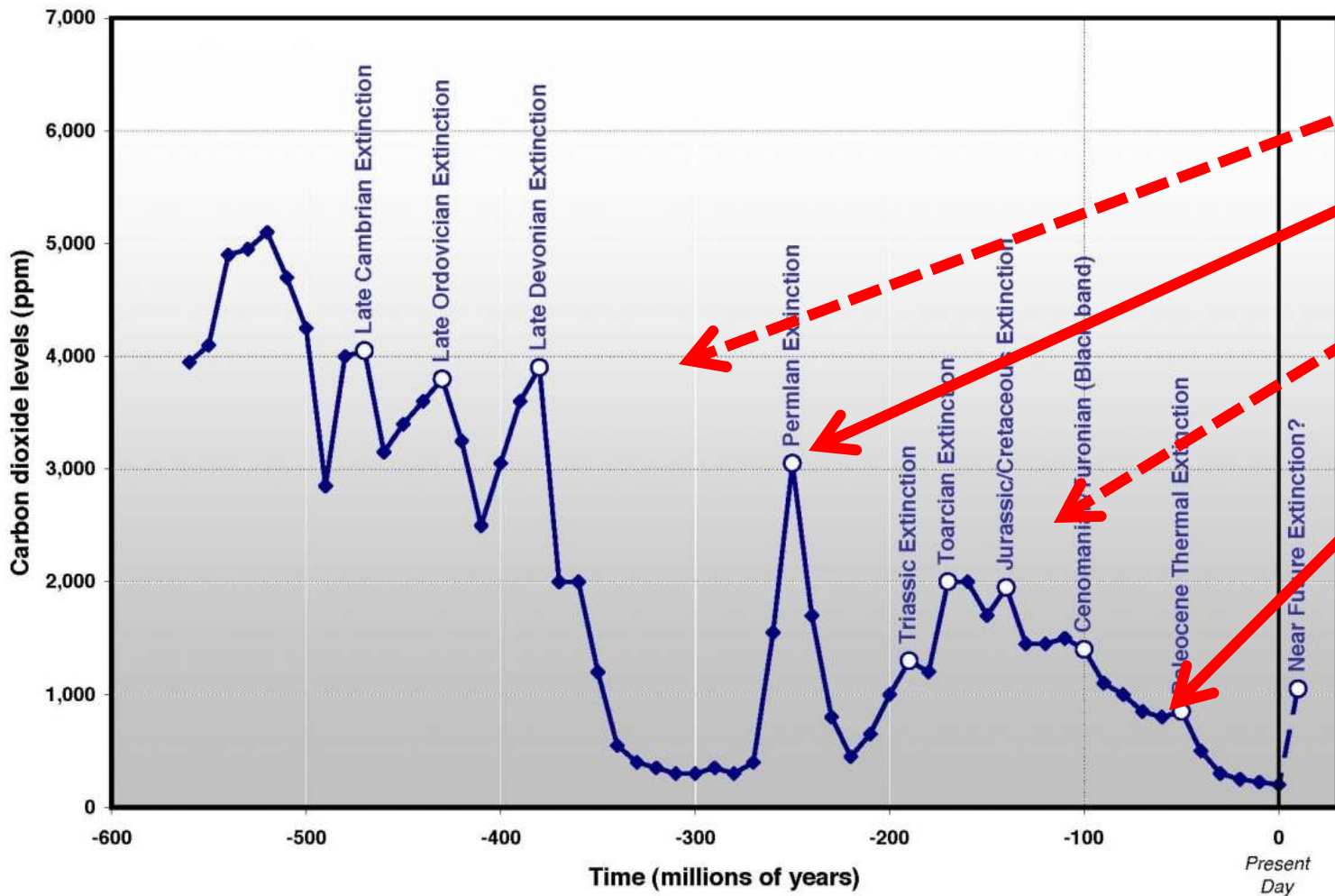
## Key unmet opportunities:

- Double kwh/gallon and kwh/\$ of solar farms:
  - Advanced 50-55% Stirling  
[www.werbos.com/Atacama.pdf](http://www.werbos.com/Atacama.pdf)
  - JTEC new advanced solid state system (NSF may...)
- Shock wave engine (U. Michigan)?

US Senate skeptics 2009: “CO2 was >2000 ppm for millions of years in earlier earth. Didn't life just go on as usual? How bad could it be?”



No one in the room knew,  
but I decided to find out



H2S in air  
And  
Radiation  
Enough  
To kill  
All humans

- NSF Geosciences sponsored best data on past:
- Graph from Peter Ward, Under a Green Sky, adapted by Englander. Ward theory half right.

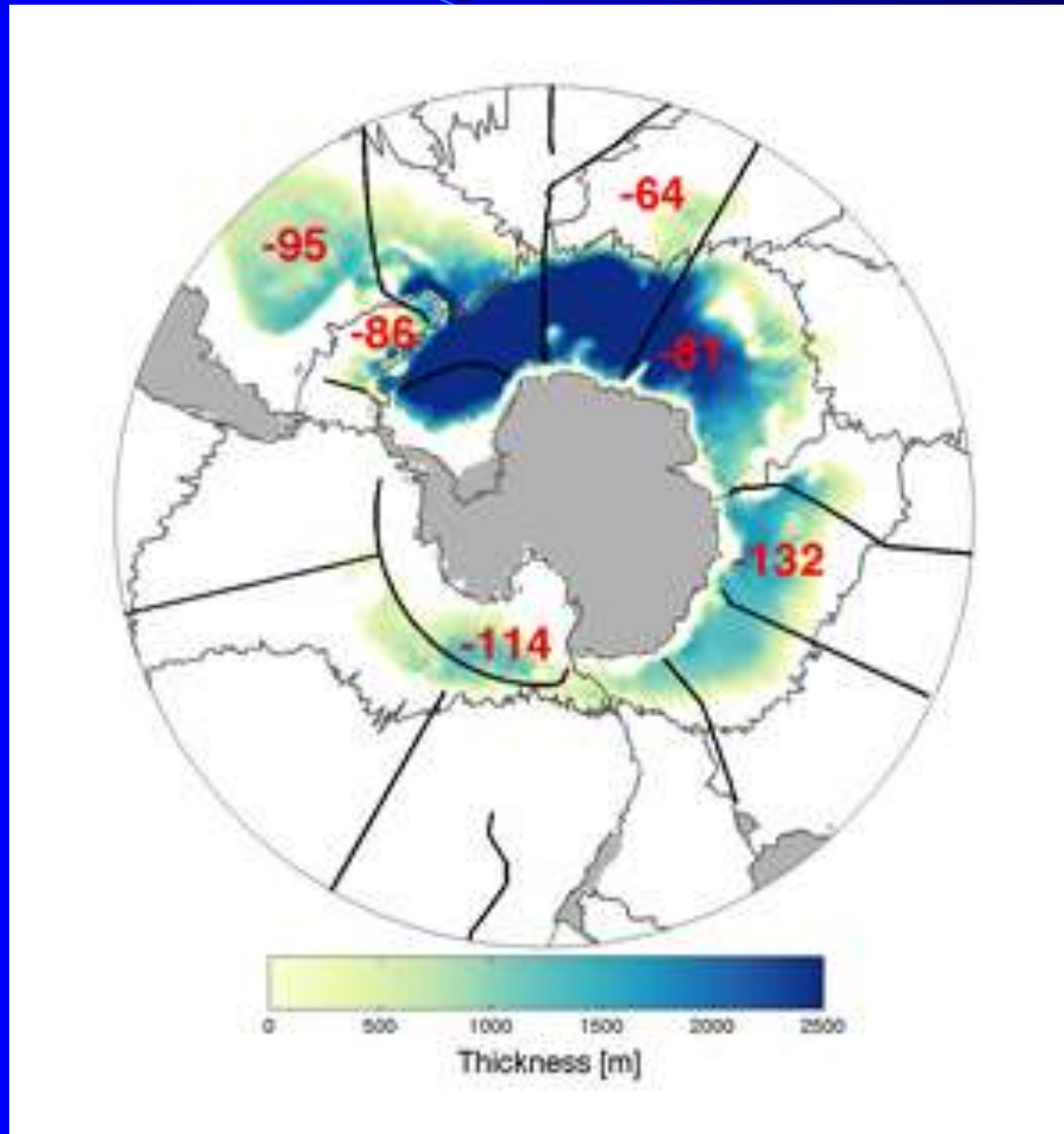
But we already know what the two factors are which cause H<sub>2</sub>S archaea to proliferate (google “stinky aquarium” and see paper by Kump



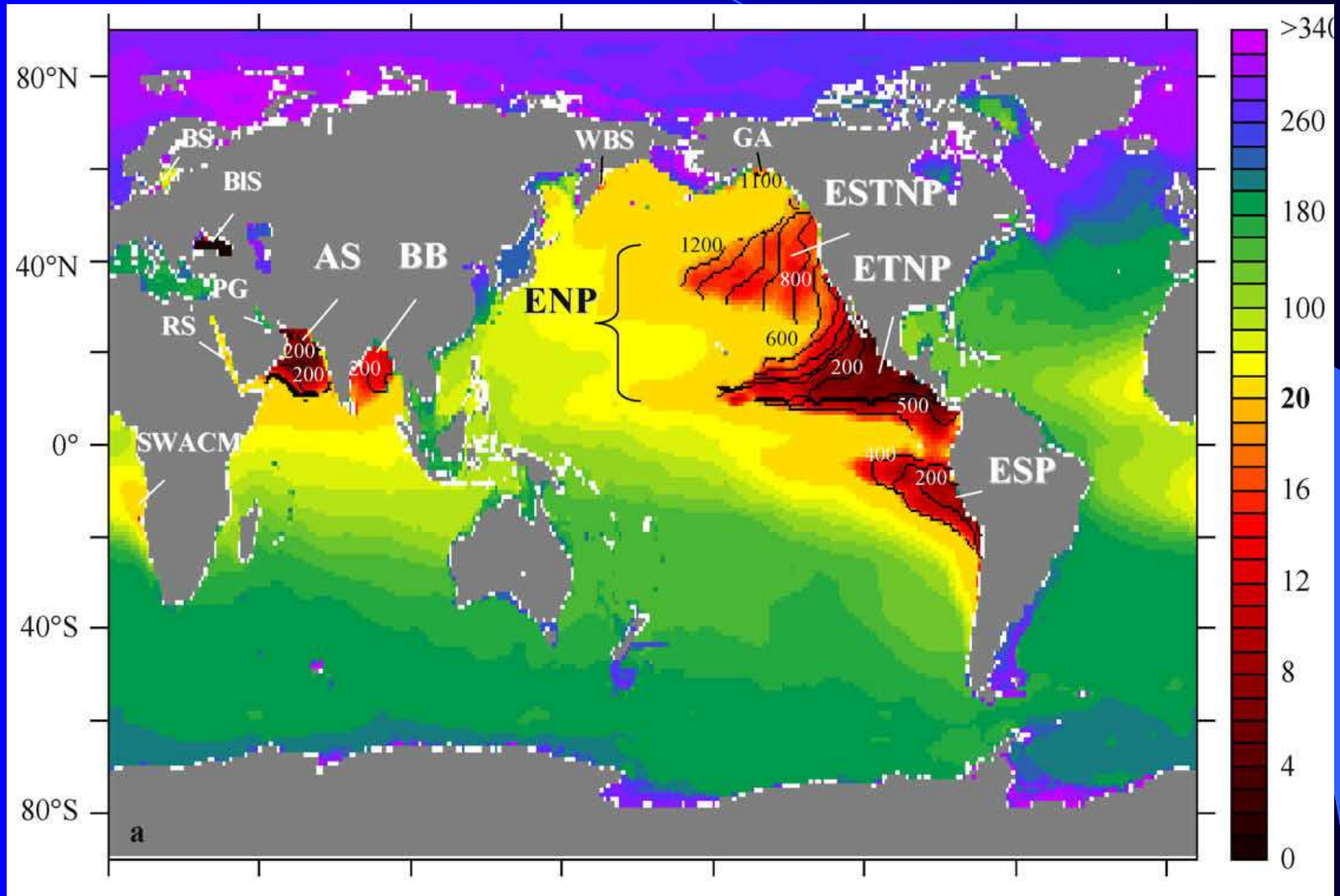
- Low oxygen in water: exactly Ward’s concern about “stratified ocean,” blocking the “lungs of the planet” (THC). How far are we?
- NUTRIENT supply already hugely plentiful today thanks to agriculture!



# NOAA data: 40 years for Pacific O<sub>2</sub>?



# In $\approx 40$ years, who gets poisoned first?



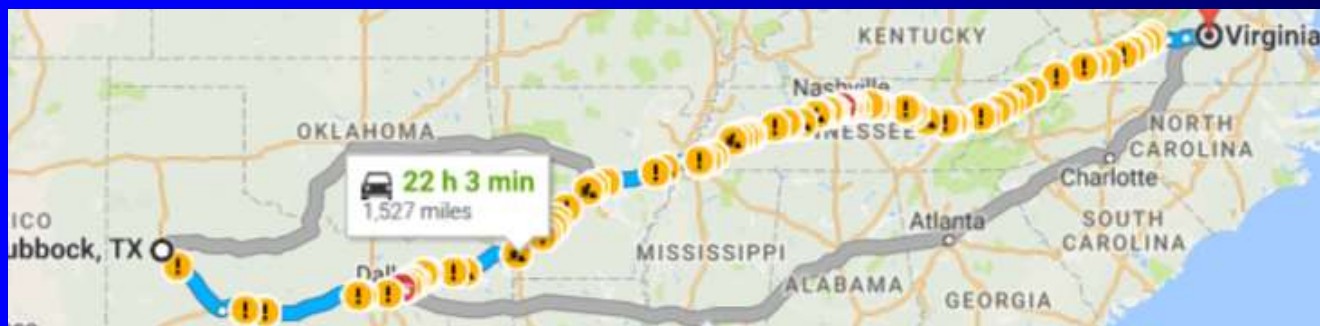
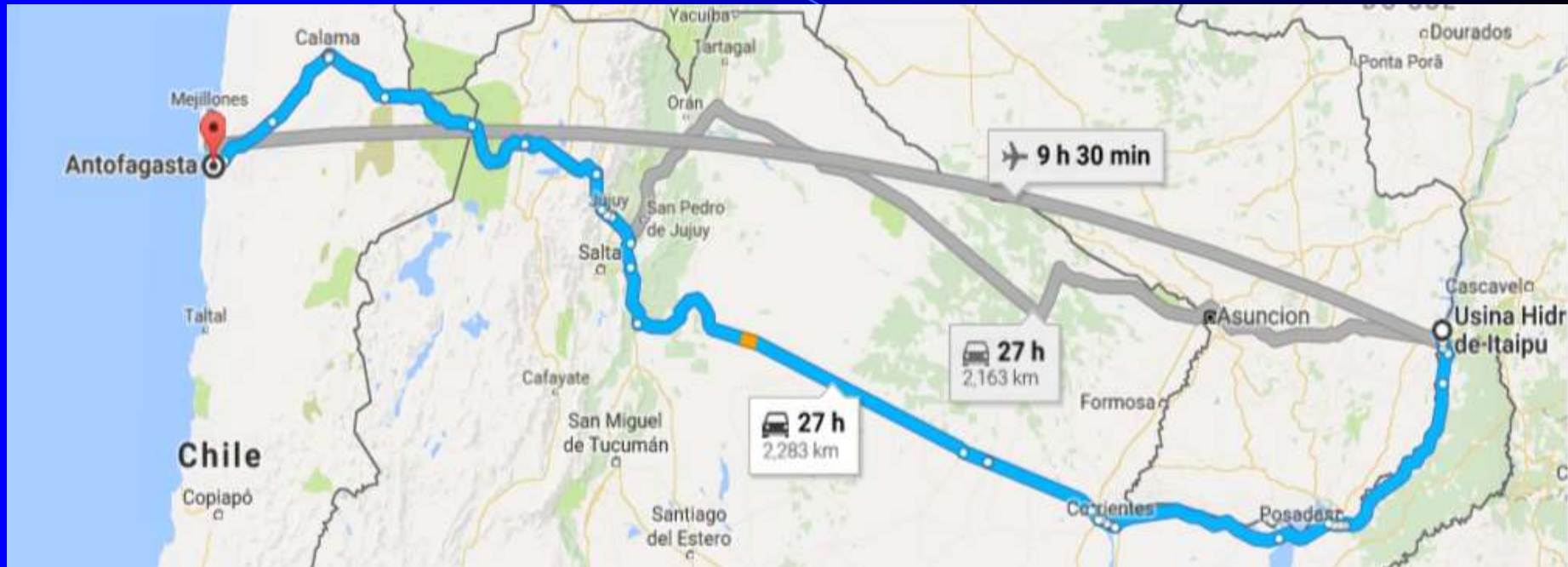
# In Addition to CO<sub>2</sub> Reduction, Global Efforts Needed In:

- Geoengineering technology. Caldeira estimates only \$1b/year needed globally... but will it work for Antarctic? Sulfates may feed archaea. Alternatives? Space mirrors (India, Russia)?
- Aquarium-level research: what are exact chemical conditions for proliferation of H<sub>2</sub>S-producing archaea? Wood's Hole neural net assay needed?
- Cyanobacteria did not save the day with past extinctions, limited by chemistry. But quantify?

# Three key Themes in [www.werbos.com/Atacama.pdf](http://www.werbos.com/Atacama.pdf)

- **Upside Export Revenue Potential:** Why it really is \$100 billion per year, to export to nonOECD South America, by 2025 or so, requiring two hedges to reduce risk in the initial business plan: (1) agreement for transmission right-of-way and purchase partners (above all Brazil) at 10¢/kwh delivered; (2) low-cost technology demos in case PV PPAs saturate.
- Basic numbers for **10 gigawatt start** requiring new discussions, hedge, real business plan
- Without faster renewables, climate risks to Chile and Peru far worse than you read, **maybe fatal**

# Proposed Start: 10 gigawatts on new line as long as TX→PJM 2¢/kwh



1gw→2.8TWH/year. With  $(10¢-3¢-2¢)*28TWH$ ,  
\$1.5 billion/year extra profit on \$3b investment



- **Links from [nss.org/EU](http://nss.org/EU):**

- **NIAC Report:** New Design for 9¢/kwh if launch costs down to \$500/kg-LEO
- **DARPA XS-1** Technology could get us to  $\leq$ \$500/kg-LEO

# Plasma Hypersonics: ANSER/Chase NSF\$

REDUCED DRAG: AAC 1st; Ganguly (APS00) shows it should work  $>$ Mach 4, 100K feet; allows Boeing RAS/V



Ebeam  
or ....

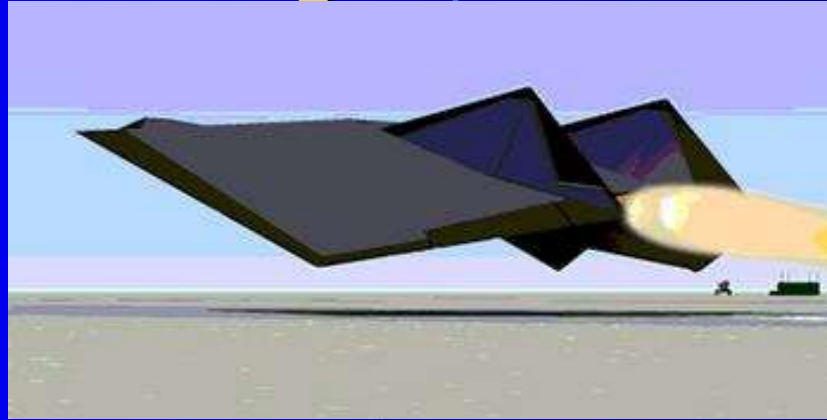


MHD Energy  
Extraction

MHD  
Acceleration

Best plasma theory predicts new Princeton design will allow ramjets to reach Mach 12, scram much more... Ames and Chase (ANSER) whole-system SSTO designs..

# Unexpected Outcome: Near-Term Design Has Passed Tough Peer Review, Scrutiny



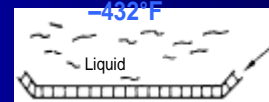
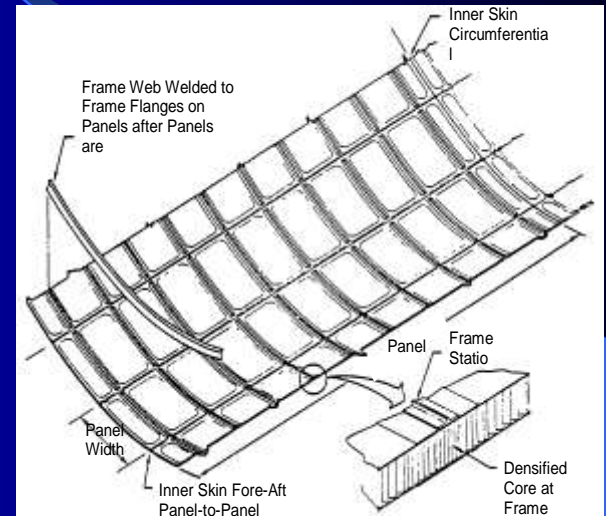
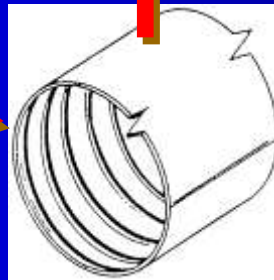
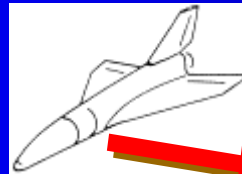
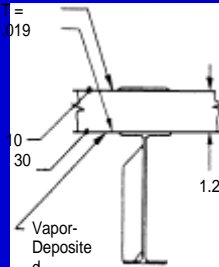
- **Rocketplane** RLV can be built **now** for near-term use, **essential** to use/enhancement of **endangered** off-the-shelf legacy technology needed for more advanced high-efficiency concepts
- Need Big vehicle to minimize \$/lb (initial \$200/lb **REAL**)
  - 1.2 million pounds, \$10-15 billion, **not a small business**
- **Horizontal takeoff essential** for aircraft operations (see also Mueller 60' s) and for big-wing lower heat load on re-entry
- Design allows use of formerly black **hot structures technology** instead of flaky tiles, ablative structures, hard-to-control slush
- Project chart **4 years**, AF mission model enough for profit



# Validated Hot Structures and Thermal Protection System



Top Panels  
(Titanium)



1,500°F

RENE' 41  
Panel

- Existing Material Technology
- Multifunction Metallic Surface

Checked with the unique test lab at WPAFB



AI



BCI



H2S, Climate



WMD+

**Lifeboat Foundation Studies:  
Extinction of Human Species  
Quite Possible if Top Decision  
Makers Unconsciously  
Assume and Implement  
Obsolete Paradigms for IT!!!**



The new AI based on deep learning is remaking the world here and now. We need to jump to CNN and RNN, the next big thing.

- **Deep learning** = backprop + convolutional neural network (+bottleneck nets) + tricks
- CNN = cellular neural network (Chua/Roska)
- RNN: huge symposium in Barcelona December 2016
- New evidence that the brain is an “artificial neural network” (Frontiers in Systems Neuroscience)
- Huge choices here and now in where humanity goes next -- huge new risks, new technology options

[www.weforum.org](http://www.weforum.org)

WORLD  
ECONOMIC  
FORUM

WORLD  
ECONOM  
FORUM



- Sergey Brin, the co-founder of Google and one of the most successful Silicon Valley entrepreneurs, says he did not foresee the artificial intelligence revolution that has transformed the tech industry.
- “I didn’t pay attention to it at all, to be perfectly honest,” he said [in a session](#) at the World Economic Forum’s Annual Meeting in Davos. “Having been trained as a computer scientist in the 90s, everybody knew that AI didn’t work. People tried it, they tried neural nets and none of it worked. (Deep Mind like D-Wave known, not enough.)”

# 5 Grand Challenges for Adaptive and Intelligent Systems

– General-purpose massively parallel designs to learn...



$$\frac{\Pr(A|B)}{\Pr(A)} = \frac{\Pr(B|A)}{\Pr(B)}$$

# COPN

Important future applications



Space



Sustainability



Human Potential



Prediction

Memory

...

Clustering

Optimization

$$J(t) = \text{Max} \langle J(t+1) + U \rangle$$

$$\frac{\partial^+ z_n}{\partial z_i} = \frac{\partial z_n}{\partial z_i} + \sum_{j=i+1}^{n-1} \frac{\partial^+ z_n}{\partial z_j} \frac{\partial z_j}{\partial z_i}$$



# New Performance Breakthroughs in Prediction/Recognition by Ng&LeCun

## Audio

| TIMIT Phone classification        | Accuracy     |
|-----------------------------------|--------------|
| Prior art (Clarkson et al., 1999) | 79.6%        |
| Stanford Feature learning         | <b>80.3%</b> |

| TIMIT Speaker identification | Accuracy      |
|------------------------------|---------------|
| Prior art (Reynolds, 1995)   | 99.7%         |
| Stanford Feature learning    | <b>100.0%</b> |

## Images

| CIFAR Object classification    | Accuracy     |
|--------------------------------|--------------|
| Prior art (Yu and Zhang, 2010) | 74.5%        |
| Stanford Feature learning      | <b>75.5%</b> |

| NORB Object classification       | Accuracy     |
|----------------------------------|--------------|
| Prior art (Ranzato et al., 2009) | 94.4%        |
| Stanford Feature learning        | <b>96.2%</b> |

## Video

| UCF activity classification     | Accuracy   |
|---------------------------------|------------|
| Prior art (Kaiser et al., 2008) | 86%        |
| Stanford Feature learning       | <b>87%</b> |

| Hollywood2 classification | Accuracy   |
|---------------------------|------------|
| Prior art (Laptev, 2004)  | 47%        |
| Stanford Feature learning | <b>52%</b> |

## Multimodal (audio/video)

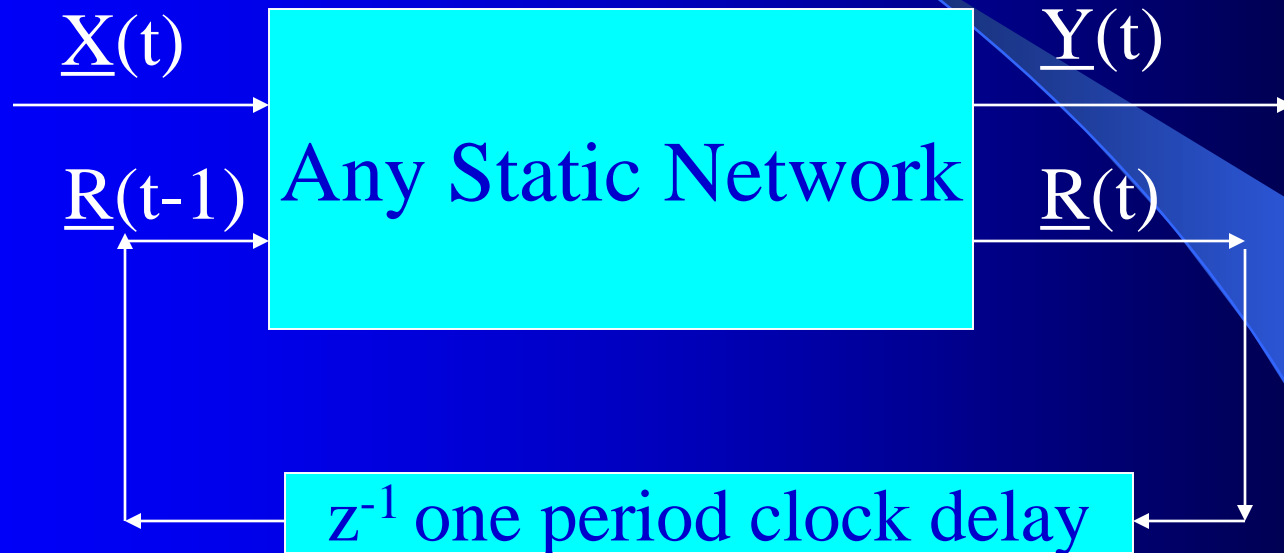
| AVLetters Lip reading         | Accuracy     |
|-------------------------------|--------------|
| Prior art (Zhao et al., 2009) | 58.9%        |
| Stanford Feature learning     | <b>63.1%</b> |

Other unsupervised feature learning records:  
Different phone recognition (Geoff Hinton)  
PASCAL VOC object detection (Kai Yu)

Andrew Ng

New world records (under NSF COPN) using relatively simple neural networks with a symmetry addition...

# Time-Lagged Recurrent Network (TLRN): 50% of coal generators, Neuco Siemens.... Schmidhuber, Ford, Siemens...



$$\underline{Y}(t) = \underline{f}(\underline{X}(t), \underline{R}(t-1)); \underline{R}(t) = \underline{g}(\underline{X}(t), \underline{R}(t-1))$$

$\underline{f}$  and  $\underline{g}$  represent 2 outputs of one network

All-encompassing, NARMAX(1  $\equiv$  n)

FOR REAL TIME: Error Critic Equations in HIC Chapter 13

# Roadmap for Cognitive Prediction

Reward direct  
simplicity

Reward symmetry

1. AT&T winning ZIP code recognizer and new COPN work

3. Mouse



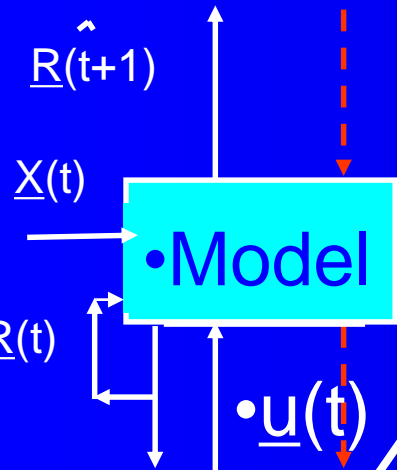
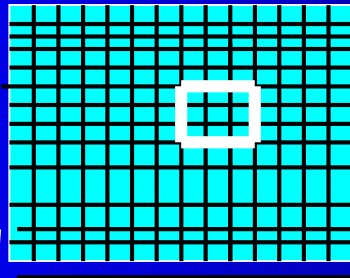
Space-like cognitive map  
of the space of **Possibilities**,  
to support higher creativity

2. reptile



Predicts What  
**Will Happen**  
Over Multiple  
Time Intervals  
Harmonized

Networks for inputs  
with more spatial  
complexity using  
symmetry – CSRN,  
ObjectNets, ....



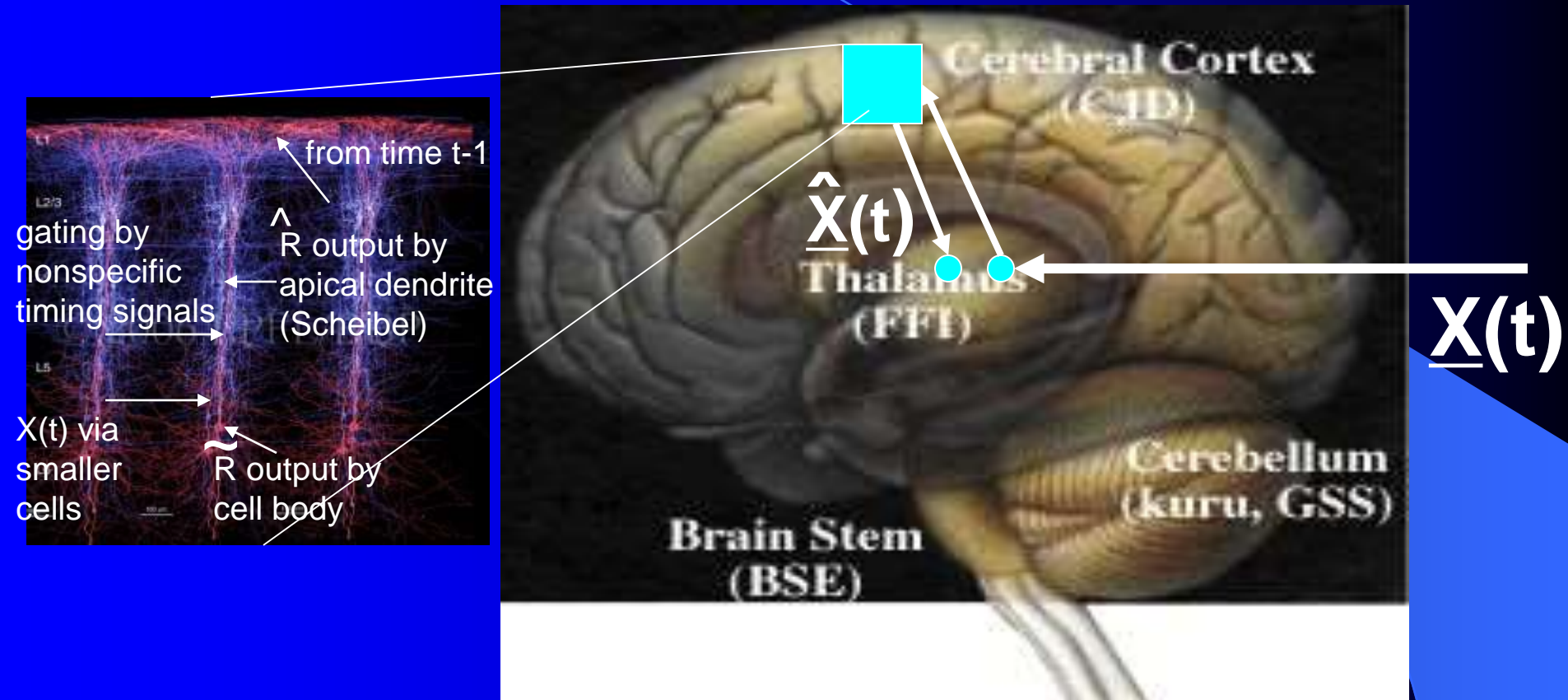
0. Vector Prediction  
(robustified  
SRN/TLRN)  
HIC Chapter 10 on web.

To see how you could do better than even them, and break the world records again... or to see the research needs to fulfill this roadmap... see

[www.werbos.com/Erdos.pdf](http://www.werbos.com/Erdos.pdf)



# Ability to learn to “Predict Anything” Found in the Brain (Nicolelis, Chapin)



Goldman-Rakic, Baars: Consciousness, working memory due to recurrent nets!!

Richmond: “ $t+1$ ” –  $t$  is .12 seconds. Each cycle has a forwards pass to predict, and a backwards pass to adapt, from multichannel unit data. NEW PAPER VERIFIES !

But Nicolelis statement also needs verification beyond rat whiskers, few words.

(Bliss, Spruston): found “reverse nMDA” synapse and backpropagation along dendrites

# Regular Cycles of Forward and Backward Signal Propagation in Prefrontal Cortex and in Consciousness

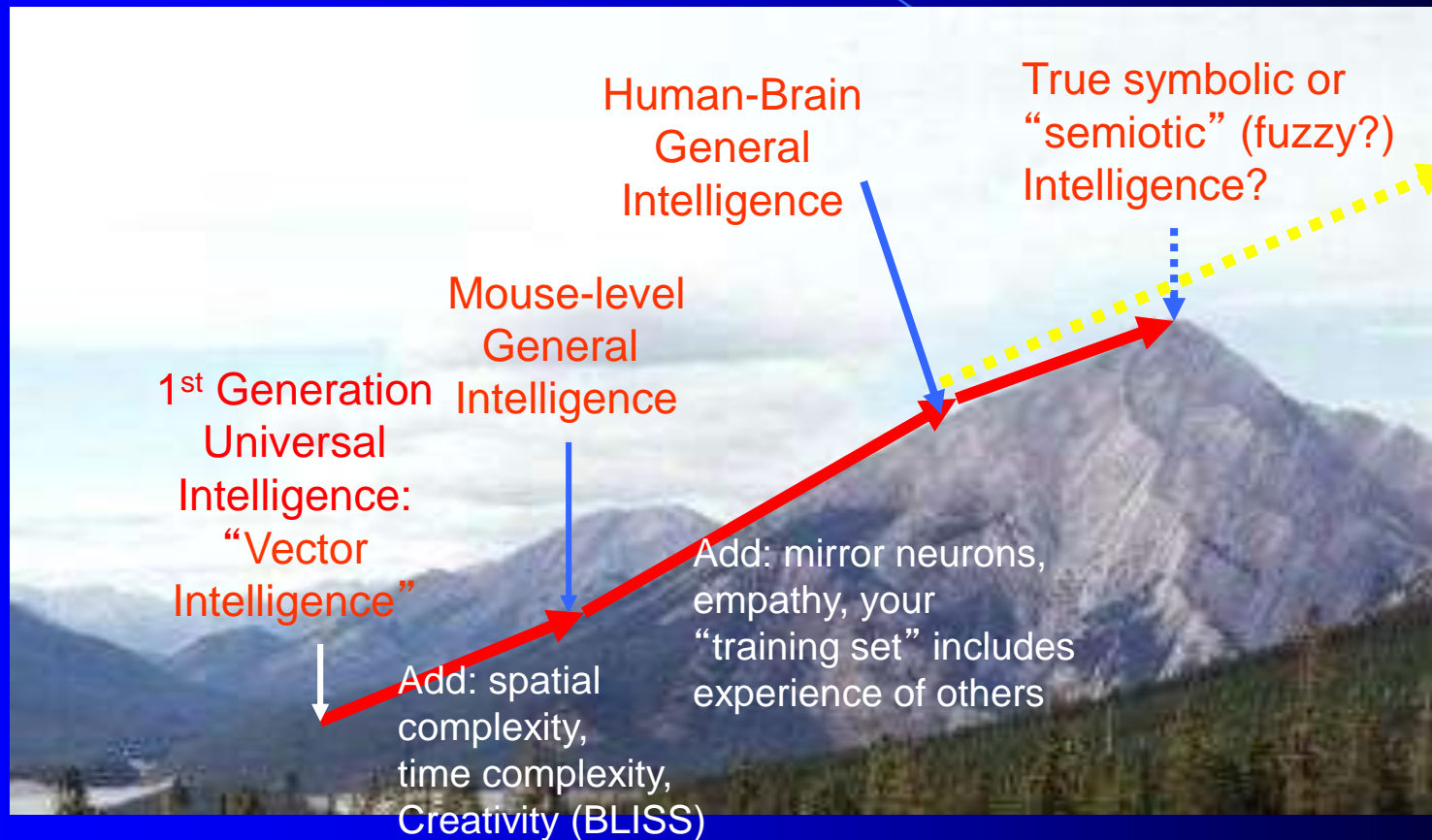
Paul Werbos and Joshua Davis

*Frontiers in Systems Neuroscience*

November 28, 2016

Open access, link posted at  
[www.werbos.com/Mind.htm](http://www.werbos.com/Mind.htm)

# From Brain to Mind: What Can We Learn Of Use Beyond the Level of the Mouse Brain?



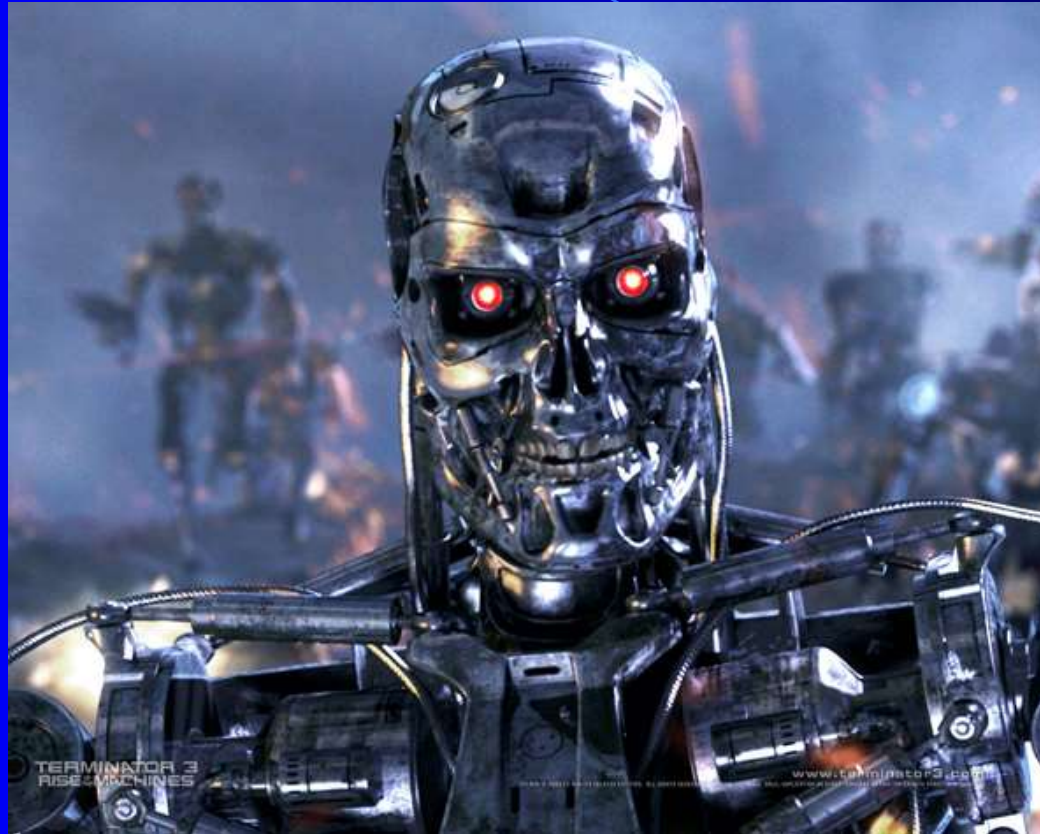
[www.werbos.com/pi/Confucius\\_talk.pdf](http://www.werbos.com/pi/Confucius_talk.pdf)

And Neural Networks 2012; arxiv MLCI

# The Biggest Picture

- Is the dark cosmos a dark forest or an ocean of life?
- Is the primitive village earth surrounded only by hungry tigers or by an ancient civilization like China 1500AD?
- Who of us will respect our true ancestors and pass the serious examinations?

ANNs, IOT etc tomorrow: risks and opportunities  
both **much bigger** than people realize!



See [www.werbos.com/NATO\\_terrorism.pdf](http://www.werbos.com/NATO_terrorism.pdf) for current overview of both in detail with links to more detail.

Current attempts at oversight like Musk very feeble, urgent issues exist

# Learning Pains as Humanity Adapts to 1 or 2 New Central Organizing Systems

Most of Earth History

Learning Pains and Unfinished Struggle 2000 BC to 2000AD

New Global Controlling Systems as Important as DNA and \$\$

DNA Evolution: Biology (Including Brains, Families) Rule Life

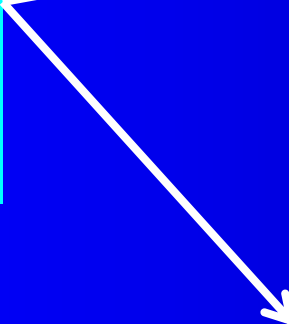
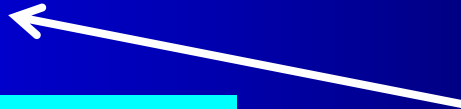
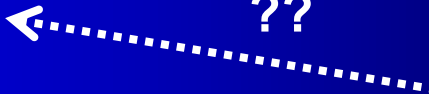
DNA, Biology

\$\$\$\$\$: Struggle for Effective Market Systems versus Dystopic Problems

?? Enable More, Deeper, More Effective Human Collective Consciousness?

Global Information Technology Systems Big Choices Being Made Here and Now

??



# New Tech Has Led to Dramatic Choices In The Past

**Personal PC:  
The Liberator**



**IBM WYLBUR:  
Rule by Power 1960 -...**



Oppression by  
Priest Kings, enabled  
by agriculture,  
Sumeria ++++



**AI can go either  
Way, depending  
on what paradigm  
we tacitly assume  
& build upon**

- **WHAT COULD  $\geq$  70% UNEMPLOYMENT IN 10-20 YEARS DO TO US?**
- Will the average villager in Iowa and Punjab set up a successful small business to fill in? (What percentage of small businesses succeed?)
- We are at a huge crossroads where IT plays a central role either way:
  - Do we help create an oppressive world where most humans become more disconnected, rightly mistrustful, squashed and more violent? Where markets are rigged?
  - Or can we find a path more like Germany and Sweden, more actively fostering human empowerment and potential, honorable competition, resting on more solid privacy, openness, distributed power, worldwide?



# Paradigms for IT: From Old and Dangerous to Emerging Hope

Expert Systems  
(no values)  
And Fixed  
Point Control  
(no freedom,  
growth)

Watson plan  
for global IOT,  
fortunately  
toned down

Today's Deep  
Learning:  
Prediction  
And Analytics  
But No Values,  
Decision

RLADP with  
Deep Learning  
Lewis, Liu '13:  
Foresight,  
Stochastic  
Optimum,  
But one value

See story of  
Stafford Beer  
In Chile

MARKETS: Multiplayer  
Generalization of  
RLADP, Like improved  
Intelligent grid DSOPF



Human Potential

Teleautonomy Biden  
Words But Also...

Radical New Hardware  
Quantum, Heat, Energy

Unbreakable Transparent  
Open OS and Comm and Top Level