knowing less...

...failing more
...when conventional wisdom makes no sense

in a 2005 study of 80 critically ill patients, “there were seven deaths in people getting standard treatment and only one in those allowed to have fever…”

...at which point the study was halted due to ethical concerns

...when 5B people live like 500M do today

Source: EIA
...worldwide car sales: 2000

- USA: 8,800,000
- Japan: 4,090,000
- China + India: 2,690,000
- UK: 2,200,000

Source: various reports – no’s are approximate
...worldwide car sales: 2009

Source: various reports – no’s are approximate
...but still plenty of room to grow!

Number of cars per 1000 people (2008)

- US: 458
- UK: 511
- Japan: 490
- Germany: 499
- Brazil: 102
- Russia: 212

(source: Deloitte Consulting, Economist Intelligence Unit)
...the chindia test

only scalable if competitive unsubsidized
Volt or Nano?

Tata Nano: 203,000 pre-orders
or
Chevy Volt: 45,000 by 2012

Source: BBC, GM
... liquid fuel vs. battery

% of power from liquid fuel vs. % of power from electric sources over time.
...traditional views?
...green: batteries vs. ICE
...electric cars aren’t an easy “fix-it”
... coal in China
... the BP oil spill
... coal mining
... the sources of petroleum
...What are the real issues?


Source: Foreign Policy, citing Roger Stern, Princeton
...electric does not solve anything by itself

“China's dirty and dangerous coal mining industry cost the country a hidden $250 billion last year in lost and damaged lives, wasted energy and environmental devastation.”

Source: Reuters – research initiated by WWF, Greenpeace, and the Energy Foundation
Impact on CO2 & oil use: ICE or EV?

U.S. New Vehicle Sales by Technology (millions)

Source: Energy Information Administration
If China’s per capita oil use = South Korea, its share of global use goes from 10% to 70%!

Source: Council of Foreign Relations/Paul Swartz, citing OECD / BP / IMF / US Census / BLS
Technology Choices

Source: Estimates from discussions and the working committee of Academy of Science
Technology Choices

Source: Estimates from discussions and the working committee of Academy of Science
incremental gains continue over time

- Cam phasing
- PDA w/high EGR
- 2-step VVA w/phaser
- Cylinder deactivation
- Boosted, Downsized
- Flexible VVA
- Fully flexible valve actuation
- DI stratified charged w/NOx Trap
- Advanced DI/HCCI concepts

Regen braking
Stop-start
Reduced friction, thermal management
...unconventional
“The fine line separating the delusional from the visionaries amongst us is often not foresight, but rather hindsight.”

Ben Semel
...our approach: crazy risks

Projects/plans or “shots on goal”

Safe or Likely to fail

Fiduciary investing or Non-fiduciary
Ready...

Fire!

...Aim
Ecomotors
...the Ecomotors story

re-examination of a 100 year old idea ...

...an entrepreneur with a track record of defying the naysayers
...everyone told me:

1. It is not possible to convert a gasoline engine to a Diesel, using the same transfer line. I did it and it is the most successful Diesel in the world and it was copied by everybody.

2. The combustion for a high speed Diesel is not possible. I started production with a 5000 rpm Diesel with 2000 engines/day on the gasoline engine transfer line.

3. You cannot use a rubber toothed belt to drive the camshaft and the injection pump. I did it and it is the standard solution today.

4. It is not possible to use an aluminum radiator because the corrosion will destroy the engine. I did it and it is the standard solution today.

5. It is not possible to create an “emission free” natural gas burner. I did it. It is in mass production at VIESSMANN. BUDERUS sued VIESSMANN about “emission free” and lost.

Dr. Peter Hofbauer, Chairman and CTO
OPOC Engine

OPOC Fuel Efficiency (+50-60%)
- Single Module: +15%
- Dual Module: +30%
- Trivid: +10%
- Application Opportunity: +5%

Fully Balanced Module
- Enables Stackable Power Modules
- Enables Hybridization and Tribrids
- Enables module shut off
EcoMotors’ Technology Targets

Target Efficiency:
- Single Module  +15%
- Dual Module    +45%
- Tribrid        +55%

50+% More Efficient
-no change in “energy/distribution” infrastructure

1 / 2 the Weight & Size
~1 hp/lb

Clean Emissions with the Lowest Carbon Footprint

Lowest Cost...
- Easy to mfg
- Uses existing suppliers

1/2 the parts
Source: Estimates from discussions and the working committee of Academy of Science
Smallest Carbon Footprint

Assumptions
- 5 yrs of operation
- 12K miles/yr
- US base electricity (50% coal)

IC Gasoline Engine
IC Diesel Engine
HEV
PHEV-40
EV100
opoc® MDH Flex-Fuel Engine
opoc® MDH Diesel Engine

OPOC ADVANTAGE!
Lowest Cost...Initial Cost & Operating Cost

Assumptions
- 5 yrs of operation
- 12K miles/yr
- $3.00/gal – gasoline cost
- $2.75/gal – diesel cost
- $0.10/kW-hr
- 3% cost of capital

* Source: McKinsey Quarterly #3
Transonic
...the Transonic idea

SUPERCritical FUEL INJECTION

Source: Transonic
TSCI™ FUEL INJECTION

Supercritical Injection
400°C
Catalyzed
Low Octane Gasoline
Optimized Combustion

GASOLINE DIRECT INJECTION (GDI)

Liquid Injection
100°C (uncontrolled)
Non-Catalyzed
High Octane Gasoline
Combustion before TDC

Source: Transonic
NRG Dynamix
NanoStellar
Fuels
...fresh approach to fuels

Sources
- Natural Oils
- Sugars/Starch
- Algae
- Biomass
- Waste

Pathways
- Fermentation
- Microbial cultures
- Gasification
- Microbes
- Gasification
- F-T catalysis
- Mixalco Process
- Catalytic Conversion
- Transesterification
- Thermo-catalytic conversion
- Pyrolysis

Outputs
- Specific alcohols/chemicals/alkanes
- Mixed alcohols
- Biodiesel (FAME/FAEE), Glycerin
- Re-crude
- Pyrolysis oil & black liquor

Decreasing cost/increasing scale
Amyris
Gevo
Coskata
Kior
Batteries
Sakti3
Advanced modeling drives Li-ion leaps

**Computation**
- Finite element
- Multi-physics
- Surrogate-based analysis

**Manufacturing**
- Reduced experimentation
- High throughput
- Low cost
Seeo
Pellion
ReCapping
...batteries

Next Generation Li-ion?

Different ions?

Quantum thingamajig?
And the weirdest ones we have not heard about...

...unlikely but not unimportant
...redefine the future
breakthrough ideas

1) Hydraulic and hydro-static hybrid drives
2) Low cost high efficiency engines (OPOC)
3) Ultra-high compression engines
4) Advanced injectors for improved combustion (TSCI)
5) Very cheap energy storage
6) Massive weight reduction (nanosteel, carbon fiber)
7) Digital fuel processing
8) 
9) ....today's unimaginable!
...the wave-disc engine?

5X efficiency in electricity production, 20% lighter, and 30% cheaper?

Source: GreenCar Congress, ARPA-E
...the crankless engine?
...the hypercar?
...imagine the possible
... the “Rosenfeld” effect

refrigerator costs AND energy use continued to decline!

Source: Amory Lovins, Rocky Mountain Institute citing David Goldstein
the father of the Green Revolution thought these soils were never going to be productive. They seemed too acidic and too poor in nutrients...
More arable land has been *created* in Brazil than is under cultivation in the US and India combined.
...knowing too much
the folly of experts: tetlock study

hundred’s of experts.
80,000+ “expert” forecasts & 20+ years

Results: Experts are about as good forecasters as dart-throwing monkeys

Source: New Yorker, Phillip Tetlock
even more?

...using data from a test used to diagnose brain damage

... The clinical psychologists’ diagnoses were no better than the secretaries
...the sources of innovation

- Google, Facebook, Twitter: Fox, NBC, CBS
- Amazon: Walmart
- First Solar: Shell & BP Solar
- Cree: GE
- DNA Sequencing
redefining swans
“black swan”

...rarity, extreme impact, and retrospective (though not prospective) predictability

Source: Nassim Nicholas Taleb, author of “The Black Swan”
takeaways

• Bang for the Buck prevails
• Economic gravity always wins
• Unconventional thinking drives disruptive change
• Technology not politics drive long-term trends
• Black Swans are likely
• Imagine the possible, don’t focus on the probable
• Invent the future
...let’s avoid silliness

...and focus on the issues

Source: EPA
Safe or Not?

Extinctions System Losses
Hurricanes Fires, Floods
Flooding NY Flooded
600 M Displaced
Catastrophe Planet Crash

Source: IPCC
khosla ventures green portfolio

- WATER / OTHER
  - Water Desalination
  - Plasticizers
  - Waste Water
  - Agronomy
  - PVC
  - Polyurethane
  - Polyethylene
  - Glass
  - Cement

- BUILDING MATERIALS
  - Feedstock Processing
  - Feedstocks
  - Cellulosic Ethanol
  - Diesel
  - Gasoline
  - Mascoma
  - Other Hydrocarbons
  - Cement

- PLASTICS & CHEMICALS
  - Plasticizers
  - Polyurethane
  - Polyethylene
  - PVC
  - Glass
  - Cement

- BUILDING MATERIALS
  - Feedstock Processing
  - Feedstocks
  - Cellulosic Ethanol
  - Diesel
  - Gasoline
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  - Cement

- OTHER
  - Nuclear
  - Synthetic Natural Gas
  - Distributed Solar
  - Smart grid
  - Generators
  - Storage

- CELLULOSIC ALCOHOL
  - Cellulosic Ethanol
  - Diesel
  - Gasoline
  - Mascoma
  - Other Hydrocarbons
  - Cement

- OTHER
  - Nuclear
  - Synthetic Natural Gas
  - Distributed Solar
  - Smart grid
  - Generators
  - Storage

- OIL
  - Cellulosic Ethanol
  - Diesel
  - Gasoline
  - Mascoma
  - Other Hydrocarbons
  - Cement

- OIL
  - Cellulosic Ethanol
  - Diesel
  - Gasoline
  - Mascoma
  - Other Hydrocarbons
  - Cement

- EFFICIENCY
  - Lighting
  - Motors
  - Other
  - Engines
  - Appliances
  - Homes
  - Drivetrains
  - Storage

- EFFICIENCY
  - Lighting
  - Motors
  - Other
  - Engines
  - Appliances
  - Homes
  - Drivetrains
  - Storage

- ELECTRICAL EFFICIENCY
  - Lighting
  - Motors
  - Other
  - Engines
  - Appliances
  - Homes
  - Drivetrains
  - Storage

- MECHANICAL EFFICIENCY
  - Lighting
  - Motors
  - Other
  - Engines
  - Appliances
  - Homes
  - Drivetrains
  - Storage

- BATTERIES / OTHER
  - Batteries
  - Storage
  - Others

- BATTERIES / OTHER
  - Batteries
  - Storage
  - Others
Comments?

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