THE FUTURE OF THE AUTOMOBILE
for Personal Transportation
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Sorry, but this is not the future of the automobile!
Today!

Very few changes in fuel economy over the past 20 years

Revolution

Evolution (?)

What Kind of HELL is this?
The Aptera approach is based on "first principles".

No, not Angus MacKenzie... This is Sir Isaac Newton!

It’s back to Newtonian physics...
A vision for all vehicles in the future – must consider all of the forces on a vehicle...

The automobile and Physics 101

Aerodynamic Lift

Motive Force

Aerodynamic down force
Weight & Grade
(effects of gravity)

The Auto Union Type C-16 “Silver Arrow”

Aero drag
Braking forces
Rolling resistance
Other friction related
The automobile and Physics 201

The power required for a vehicle to overcome the force of aerodynamic drag is ...

\[
\text{Power}_{\text{Drag}} = \frac{1}{2} \rho v^3 C_D A
\]

Since energy used is a function of the cube of velocity times the form of the drag area. The faster we go, the power required also goes up by the cube of the velocity...

aerodynamics become mission critical, esp. in freeway driving

Where \( \rho \) is the density of air – so we aren’t going to impact that one too much...
The automobile and Physics 301

The power required to accelerate a vehicle ...

\[ \text{Power}_{\text{accelerate}} = \left( \frac{1}{2} m v^2 \right) / t \]

Where \( m \) = mass; \( v \) = final speed; \( t \) = time

Energy to accelerate is a function of the mass of the vehicle and how anxious the driver is to get where he’s going.

The faster we go is a squared function of the power that must be used.

Therefore, Low Mass is critical, especially in City based start and stop driving and that is most of the driving that most Americans do...
Reduce the FRICTIONAL LOSSES and there are many...
There are 4 essential ‘building blocks’ that must be considered critical in the design of future, more efficient passenger vehicles.
A Physics Lesson for all OEMs

APTERA believes these factors are absolutely critical to consider when designing the next generation of ultra fuel efficient vehicles:

1. Low mass materials

2. Aerodynamic forms

3. Regenerative braking
   (true power train efficiency)

4. Lower rolling resistance

**Aptera’s Engineering Approach**

Fully composite, monocoque body (not CF) which is 3X stronger than steel

Coefficient of drag roughly ½ of all existing vehicles on the road today

Recapturing “energy” during deceleration using electric drive!!! instead of an ICE drive train.

To reduce frictional losses everywhere (electric motor is 94% efficient, 1 speed direct drive transaxle with electric park pawl, high efficiency wheel bearings, brake pads with spring back function, low RR tires, electric steering, electric compressor vs serpentine belts, etc.)
The Aptera Formula

- **Aerodynamics** - Drives energy consumption at high speeds
- **Weight** - Drives energy consumption at low speeds
- **Safety** - A requirement in the vehicle purchase decision
Aptera’s Mission

To design, manufacture and sell vehicles that set a new benchmark in “energy efficiency”!

– Argonne National Labs certified this level of “fuel efficiency” in our “proof of concept” vehicle in September of 2010.

– On the same basis:
  • Nissan Leaf achieves - 99 MPG-e (as an electric)
  • Chevy Volt achieves - 93 MPG-e (electric only) but only 37 MPG (in gas mode)

All Aptera vehicles > 200 MPG-e (EPA)
Where must we look for fuel economy as the CAFÉ standards rise significantly?

Market penetration of new technologies for light-duty vehicles, 2008 and 2035 per EIA

- Drag reduction
- Material substitution
- Aggressive shift logic
- Turbocharging
- Advanced transmission
- Camless valve activation
- Accessory improvements

Source: Annual Energy Outlook 2010
“One thing is clear: the era of easy oil is over. What we all do next will determine how well we meet the energy needs of the entire world in this century and beyond.”

– David J O’Reilly, Chairman & CEO, Chevron Corp, July 2005

“The Stone Age ended before the world ran out of stone and the oil age will end before the world runs out of oil!”

- Paul Wilbur, CEO Aptera, July, 2009
The Automobile Company of the Future