PEOPLE PODS[tm]

THE HIGH SPEED PERSONAL/MASS TRANSPORTATION REVOLUTION

by
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CHAPTER 1

INTRODUCTION

Introduction

Until people can get back and forth from their home to their workplaces faster, cheaper and safer than by automobile, they will necessarily remain in their inefficient, fossil fuel consuming, polluting and dangerous automobiles. People also greatly prefer traveling on their own personal schedule and really would rather not be constrained to a train, bus or carpool schedule. In spite of the real problems that continue to grow with the use of private automobiles (congestion; pollution; stress and frustration; rising gasoline, insurance and parking costs; etc.) the mainstream of society still refuses to consider any existing form of public transportation as an attractive alternative.

The only solution is for mass transportation to become extremely efficient high speed personal transportation!

The goal of the People Pods non-stop grid system is to provide the most attractive, practical, effective, and profitable, public transportation system ever devised. To accomplish this objective, the Pods must be so capital and energy efficient that individuals would pay no more to use it than they would normally spend on gasoline. Creating a daily commuting service that is safer, faster, cheaper and less frustrating to use than personal automobiles is the essential motivating incentive that the People Pods concept addresses.

The original People Pods concept was wheel driven, and based on existing ultra light weight electric motors. The Maglev People Pod concept offers compelling advantages but requires significantly newer technologies and related unknown costs. Additional technology ingredients include lightweight streamlined composite structures, advanced power distribution control systems, and today's modern high-powered computers. Using either power system, the People Pods concept can be used to create a useful, low cost, safe public/personal transportation system.

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SOCIETY OF AUTOMOTIVE ENGINEERS
FUTURE TRANSPORTATION CONFERENCE
Portland, Oregon

MINIATURE STREAMLINED VEHICLES FOR PERSONAL NON-STOP TRANSPORTATION

The People Pods personal/mass transportation concept for commuters is based on extremely **light weight**, 200 pound, advanced composite, two passenger vehicles (600 pound gross weight capacity). Safety considerations, of course, necessitate operation on a **monorail track system** above all other heavier traffic.

Supporting such a miniscule traveling weight also means guideway **material requirements can be minimized**, even after meeting all static, dynamic and seismic structural safety requirements. The real benefit is a guideway material and labor cost of **less than $1 million per mile**, which is especially attractive when compared to the **$50 million** plus per mile currently projected for the 100,000 pound plus gross weight, 160 passenger monorail trains. Basically, supporting a 100,000 pound weight (that may come by just once every 20 minutes) takes a much more substantial structure than that required to support a continuous stream of 600 pound objects.

The light weight per foot of our track design allows us to create an in-situ automated **track forming/manufacturing robot** that enables a two shift crew to deploy one mile of two way track per day. This further reduces costs and has the added benefit of shortest possible neighborhood disturbance time.

A comfortable, semi-reclined, sports car like seating and careful attention to subsonic aerodynamic streamlining will enable the tandem seated People Pod passengers to be carried along at a **steady 100 MPH** for less than **1/2 cent** of electrical energy **per mile.** If one was buying gasoline this is the equivalent of **400 miles per gallon!**

The **personal** nature of this transportation concept **completely eliminates** the time and energy wasting need to decelerate, stop, let *some* passengers "off" and others "on" and then after some delay, finally reaccelerate away from each and every station. A People Pod user will board, then travel **non-stop** on the main track until switching off to decelerate to a stop *only* at **his preselected** destination station.

Anti-collision sensors, in conjuction with air bags and hydraulic brakes that squeeze the track itself, can provide computer controlled **emergency** "6g" decelerations (55 foot stopping distances). The result is a safe 1/2 second headway spacing (73 foot spacing) and a capacity of **14,400 vehicles** *per hour* (both directions). This represents somewhat more vehicle carrying capacity than a **six lane** freeway!

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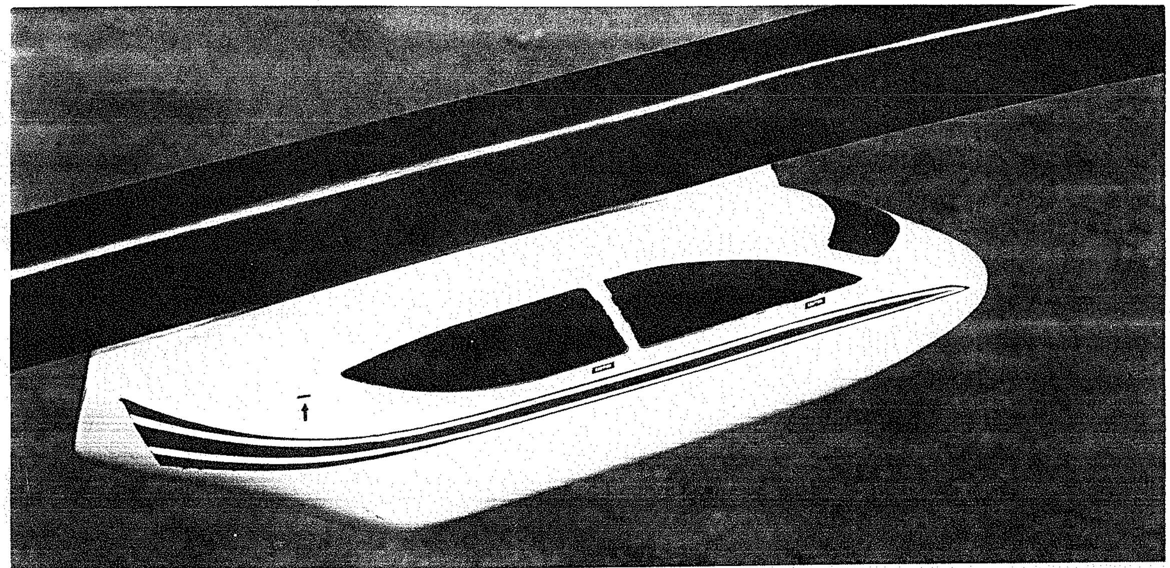
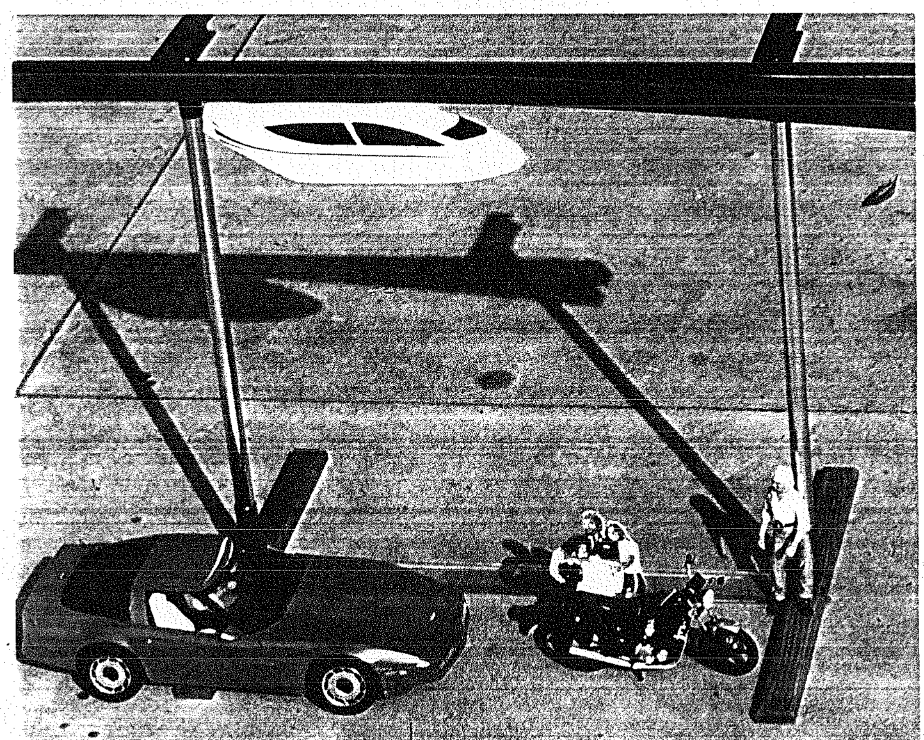
PEOPLE PODS™



100 MPH speed, non-stop point-to-point transportation on a 3 dimensional grid.



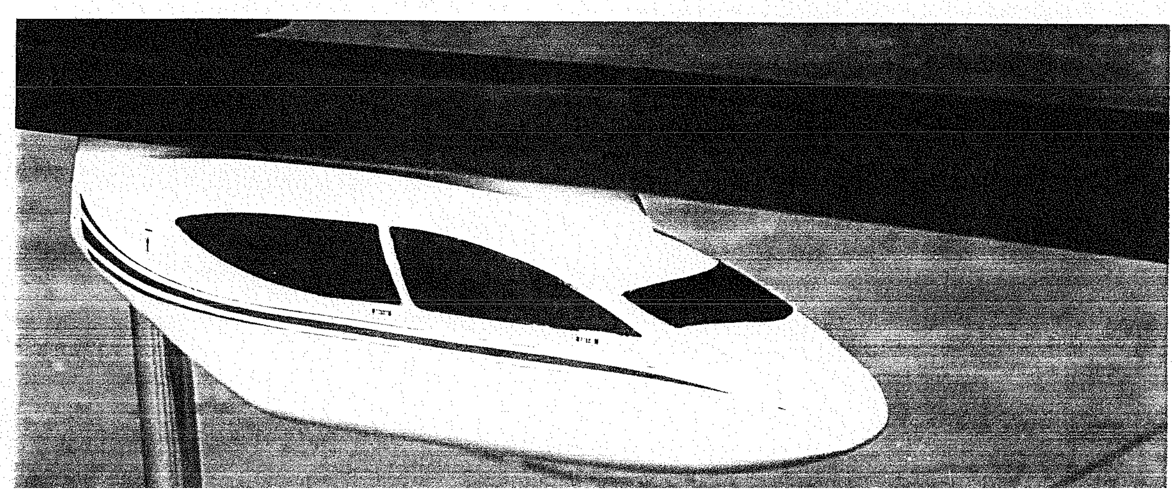
Collision proof, safe travel above all other traffic.

Non-polluting, clean electric power gives 400 MPG energy efficiency.

Faster, safer and cheaper than automobile commuting.

Lightweight, aerodynamic, two passenger capacity, advanced composite structure.

Less than $1 million per mile low cost, lightweight, robot formed guideway track.



CHAPTER 2

DEFINITION
OF THE
ULTIMATE TRANSPORTATION SYSTEM

What is "TRANSPORTATION"?

What defines a "GOOD" transportation system?

What defines the "ULTIMATE" transportation system???

The ULTIMATE TRANSPORTATION SYSTEM should:

1) move people and cargo from any point to any destination instantaneously.
2) move them on demand (without waiting for a scheduled departure).
3) move them without consuming any energy, nor making an pollution.
4) move them without any risk of danger, whatsoever.
   And finally ....
5) the system for such travel should require no capital investment.

Our PEOPLE POD concept is merely an integration of current technologies that yields an interesting transportation system that is quite a bit closer to the above ideal than anything proposed or in use today.

Daily commuting is one of our most frustrating, planet polluting, time wasting and energy wasting problems. People Pods(tm) provide a practical, fast, efficient, environmentally responsible and profitable public transportation system. Douglas J. Malewicki, the inventor, designer and engineer of ROBOSAURUS has designed and patented this personal magnetic levitation transportation system.

People Pods:

· Promote energy efficiency.
- -requires 1/20th the energy of an automobile.
- -400 MPG equivalent!!
- -reduces dependency on foreign oil.

· All electric.
- -immediate reduction in smog.
- -pod itself produces zero emissions.
- -entire process produces 1/50th to 1/100th of the pollution of an automobile.
- -extends the earth's life expectancy.

· Cruises at 100 MPH to your destination.
- -much faster commute.
- -less stressed and more productive employees.
- -no speeding or DUI tickets.

· Affordable.
- -projected user cost approximately 10 cents per mile.
- -more than competitive with today's overall auto expenses.

· Electronic sensing, computer controlled and emergency braking.
- -safer than traveling by automobile.
- -reduces insurance costs.
- -risk free of injury/death by intoxicated, incompetent or inattentive drivers.

· Moves more people per lane per hour than any paved road, train or monorail system.
- -no more 30 mile, one hour commutes.
- -consistently prompt employees.
- -no schedules, inconvenient routes or questionable stations.

· Leaves the remaining surface traffic less congested and more freely flowing.
- -reduces auto and truck energy waste and pollution.
- -decreases product "in transit" time.

· Provides non-stop operation on 3 dimensional grid.
- -no traffic lights or pedestrians.
- -no fender benders.
- -no energy wasted on acceleration / deceleration or idle.

· Lower installation costs per mile than any paved road, railroad or monorail system.
- -no additional right-of-ways
- -cheaper to build, maintain and use.
- -highly profitable.

· Can be erected faster than any paved road, railroad or monorail.
- -no more waiting for the "Construction Ahead".
- -no more dodging dangerous "cement walls".

CHAPTER 3

RELATIVE COSTS

RELATIVE COSTS

This photo illustrates the complex and very expensive THREE DIMENSIONAL overpass system required to allow automobile traffic to flow *freely* in all directions.

Unfortunately, **THREE DIMENSIONAL** overpasses cannot be implemented at ***every*** intersection because of both **huge capitol costs** ($120 million plus) and the requirement for **large areas of land.** Construction expense is gigantic because the final reinforced concrete structure must not **only** safely support the weight of a continous stream of 4,000 pound automobiles, mixed with **80,000 pound** tractor-trailor trucks, but more importantly must bear its **own massive** concrete tonnage weight.

These concrete structures have to be properly designed to carry:

1) the **static loads** (weight of cars and trucks **plus** the concrete's own weight);

2) the **dynamic loads** arising from both exceptional gusting winds and the motion of the moving vehicles (these result in a spectrum of structural forcing function frequencies that can cause long term damaging fatigue of the structure) and finally;

3) the inevitable **seismic loads.**

THE TWO DIMENSIONAL, LOW COST ALTERNATIVE

In a **two dimensional** system of surface roads, **red lights** are used to safely **hold back** one direction of flow in order to enable opposing and cross traffic flows to pass. The main penalties of two dimensional systems are:

1) commuting time lost in **waiting** at each red light;

2) commuting time lost because of the **close proximity of red light intersections** to each other - a reasonably fast cruising speed can neither be attained nor sustained;

3) pollution from all the engines **sitting at idle;**

4) pollution from all the **excess vehicle power** that must be produced to accelerate away from each stoplight and

5) physical danger and reduced human safety - **75%** of all traffic accidents **happen** at **two dimensional** intersections.

WHY A PEOPLE POD *THREE DIMENSIONAL* SYSTEM IS AFFORDABLE

First of all, the maximum traveling weight of a People Pod, including it's two passengers, will be **600 pounds** or less. This is **less than 1%** of the **80,000 pound gross weight** legally allowed for trucks - which existing roadbeds and concrete overpasses **must be** designed to structurally support for decades.

This fact alone should tell us that **the amount of structural *materials* needed** to construct a **totally safe** People Pod roadway (in our case monorail track suspended from support poles) will be **insignificant** in comparison! In reality, it turns out that our small travelling weight enables us to use very low cost, tapered steel tube **utility light poles** to support our monorail track. Thus, any street with a row of existing light poles in place **becomes a candidate** for a minimally invasive, super quiet People Pod route.

We merely have to insert extra intermediate support poles and pole foundations. Then, working in concert with human teams, our proposed selfcontained giant **track forming robots** will semi-automatically roll form and attach **one mile of track per day** to the poles. Lastly, the electrical power distribution network would be installed.

In **city skyscraper environments** it is important to note that our track can simply **be attached to the building sides directly.** Using such existing elevated structures would reduce installed per mile costs even further by eliminating most of the required poles. Also, each major building could then have it's own enclosed weather protected arrival/departure station built in at People Pod track height (ie: one would enter the building at the third story level).

The most important things to note, however, is that **no new land is ever required.** New roadways, overpasses and railroad networks all need **expensive, relatively unavailable land.** People Pods only need the use of a small amount of air **above** the **existing land.** There would be no takeover of the right-of-way of pedestrians, cars, trucks, buses or trains required!

SAFETY ADVANTAGES OF THE ABOVE GROUND MONORAIL *PEOPLE POD* SYSTEM

1) **No collisions** with automobiles, trucks, bicyclists, children at play, other pedestrians, or stray animals **is possible** - ever.

2) Unlike trains, People Pods are **trapped** to their track and **can't derail** - ever. For the same reason, **wet or icy surface roads**, which cause many an automobile to slide out of control and crash, have absolutely **no effect** on People Pod operations.

3) The People Pods passenger carrying module is suspended **below** the track and it's respective drive mechanism is trapped **inside** the hollow steel roll formed track. Thus, **loss of control** from swerving to avoid potholes or hitting other road debris **is impossible.**

4) Lastly, since the hollow track is essentially a one piece roll formed square tube with only a slotted opening at the **bottom,** short circuit electrical fires and mechanical jamming problems that could be caused by rain, ice and dirt **falling into a top groove** are **eliminated.**

A **computer controlled** monorail system means People Pod commuters will additionally be travelling **safer** than by automobile because:

1) A three dimensional grid and **locked in-line travel** means radar anti-collision avoidance systems and precision relative speed control becomes practical (there is **no cross traffic** to surprise the radar!);

2) Automatic sensing of vehicle spacing, combined with computerized acceleration control, results in super precise safe merging;

3) High "g" emergency braking capability becomes practical since the track structure itself can be used as grip surface by a fast response computer controlled powerful hydraulic brake. *No longer is emergency braking deceleration capability **limited** by the traction capabilities of **rubber tires on asphalt;***

4) Computer control of **all** vehicles **will totally eliminate** accidents, injuries and deaths **from intoxicated**, incompetent, or inattentive drivers.

5) Daily sophisticated automated maintenence checkout procedures for **all** People Pods will eliminate the congestion and resulting safety problems caused by vehicle breakdowns from irresponsible individuals with poor automobile maintenence habits.

*THE **INHERENT SAFETY** OF PEOPLE POD TRAVEL AS COMPARED TO AUTOMOBILE TRAVEL WILL HAVE A DIRECT EFFECT IN **LOWERING** OPERATING COSTS, MAINTENENCE COSTS AND INSURANCE COSTS.*

People that **still choose** to commute by car will also appreciate the People Pod system for some of the following reasons:

1) Each People Pod commuter is **not** driving an automobile on the streets below. This reduces congestion for those who do drive;

2) More destination parking spots will be vacant and thus, easier to find closer to one's final driving destination;

3) An **above ground** People Pod network system **does not require** train like right-of-way **gate** systems. Regular trains selfishly **consumes the time** of **all** automobile commuters stuck waiting at the gates, while **simultaneously** causing unneccessary pollution from idling engines and once the gates go up, from the extra power needed to accelerate up to efficient cruise speeds. Also, trains regularly kill people (especially those too impatient to wait). In 1992 - 16 in Orange County, 32 in Los Angeles County and 13 in San Diego County.

CASCADING COST BENEFITS

Admittedly, any other **overhead** Monorail system has some of the inherent safety features of the People Pod system, but none of the ***cascading cost effective benefits*** of our system. Specifically, at projected costs of $50 to $60 million per mile for the typical 100 passenger Monorail train, we could **alternatively erect 50 *parallel* miles of People Pod track spaced at say one mile intervals.**

Supposedly, the government is getting ready to spend that kind of money for several demonstration Monorail systems. Some of the inherent problems with such Monorails (or any other train or light-rail vehicles) of **large** mass passenger carrying capacity are:

1) They run on a schedule - miss one and it costs you **time** waiting for the next;

2) These systems **must stop at each and every** station to let **some** passengers **off** and new ones **on.** Besides **time** lost in just sitting at each station, additional **time** is lost in decelerating **to** and accelerating away **from** each station. This reduces potential average cruise speed.

3) Such systems are inherently so expensive that it becomes illogical to ever contemplate extending and branching the system out **all over** a city in order to make the system **useful to all** the taxpaying populace living in the city.

4) In addition to the huge initial capital, such systems are typically expensive to operate and also usually operate at less than initially projected ridership. They inevitably never pay for themselves, nor breakeven financially on an annual basis and end up subsidized by taxpayers who don't even use the system - forever!

Wouldn't the **same** intended money be better spent on developing a **complete grid** that becomes **useful to all** - no matter **where they live** in the city and no matter **where they want to go** in the city. *A system that will be used* ***because*** *their is no waiting,* ***because*** *it gets you to your desired destination* ***fast,*** *at a steady 100 MPH, and which will be used* ***because*** *it* ***costs*** *the user* ***less*** *than he would have to be paying for just the gasoline for his car!*

The only real solution is for MASS transportation to *become* PERSONAL transportation!

SUMMARY COMPARISON

For our final comparison, imagine travelling within a large city that spent the money to build parallel 6 lane freeways spaced each and every mile apart that head **North and South** along with more parallel 6 lane freeways spaced each and every mile apart that head **East and West.** Then, assume **each intersection node** of this grid had a **three dimensional overpass** system so you would never have to sit at a red light again. Such a system would be **impossible to saturate** and congestion as we know it would dissapear!!!

Furthermore, technology exists **now** that would enable every traveler's automobile to have a simple on-board computer that could keep him informed regarding road conditions along his intended path for the trip. With a total grid of North - South and connected East - West freeways, a tractor-trailor crash that slid, rolled over and blocked **all three** lanes on one side of one of the freeways completely, presents **no congestion problem** because of the myriad of alternative **continuous** speed routes that your computer would suggest to you almost instantly. No **rerouting to surface streets** would be required. AND no dreaded **red lights** to slow you down.

There are also significant pollution benefits to keeping all traffic moving along at a steady speed where the engines can operate most efficiently. The inherent safety implications should also be obvious. Such an idyllic system for automobile traffic would, unfortunately, be **totally nonaffordable.**

On the other hand a People Pod system to do the exact same job is quite affordable and *WOULD NOT* be ridiculously expensive! AND you would be paying less per day than you do for gasoline to move the 3,000 pound beast around AND you would never have to pay a parking fee again AND you would be commuting to work legally at a steady non-stop 100 MPH in complete relaxed safety!

Douglas J. Malewicki
January 12, 1993

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ECO-EXPO PRESS RELEASE

Booth 122 - New Environmental Technologies Exhibit Area

The world's *first* high speed *personal* / mass transportation system

When finished in the year 2000, the LA Red Line will have consumed **5.3 billion dollars** to create 22.7 miles of track that can move up to 40,000 commuters per hour. It is projected that daily ridership will attain 385,000 people. Maximum speed is claimed to be 70 MPH. Stops at stations, however, will reduce the commuters **average speed to 33 MPH**.

The PEOPLE POD personal/mass transportation proponents claim that the same **5.3 billion dollars** could be used to build a **5,300 mile** interlinked three-dimensional grid system (one mile spacings) that would cover the entire Los Angeles area, all of Orange County, the entire Riverside - San Bernadino area and most of the Valley. The monorail People Pods would provide highly personal, steady **non-stop 100 MPH commuting** that is super energy efficient and non-polluting. The system could carry 4,200,000 commuters **per hour** (YES - 4.2 million) at costs to the user of less than they typically pay per week for gasoline and parking fees. Anyone living in the above communities covered by the grid would have an average walk from their home of only 880 steps to get to a People Pod station and an average of another 880 steps to get to their work place.

For more information come to booth 122. Ask us the rationale behind our cost and performance analyses. Come and use our **interactive display** that will show you what ***your*** new commute time would be with People Pods. Come and see how you could travel quietly and peacefully relaxed in air conditioned comfort. Come and play with our model that actually ***floats*** along it's track by ***magnetic levitation forces!*** Decide for yourself if we are mildly sane, totally crazy OR perhaps know our engineering, math, physics and economics. Ask lots of questions and decide for yourself whether or not this unique integration of existing technologies should be implemented for the benefit of our country and our children.

People Pod creator, Doug Malewicki, is an extremely cost conscious engineer/inventor with a Masters in Aeronautical Engineering from Stanford University. His most noted recent creation is ROBOSAURUS, a 40 foot tall, 58,000 pound CAR-nivorous electrohydromechanical entertainment monster robot. At stadium shows, ROBOSAURUS lifts cars weighing up to 4,000 pounds 50 feet in the air while breathing 20 foot fingers of flame that incinerate paint and plastic. He bites them in half, rips off their roofs and hurls the mangled carcasses to the ground. ROBOSAURUS is controlled by a human pilot strapped inside the head - just like the imaginary TRANSFORMER and GOBOT toys. He also transforms himself into a legal licensed trailer for easy transport from show to show.

Malewicki also created the streamlined, ultra lightweight street and freeway legal California Commuter which got him in the Guinness Book of World Records for obtaining 157 miles per gallon on his Los Angeles to San Francisco freeway record run. He has also been published in SCIENTIFIC AMERICAN - The Aerodynamics of Human Powered Vehicles. His most recent consulting projects ranged from doubling the useful duration of hydrogen peroxide monopropellant fueled ROCKET BELT for a Texas client to redesign engineering for a Canadian based company to greatly reduce the manufacturing costs of their "Miracle Motion" electric powered BABY BASSINET in order to help them enter mass markets.

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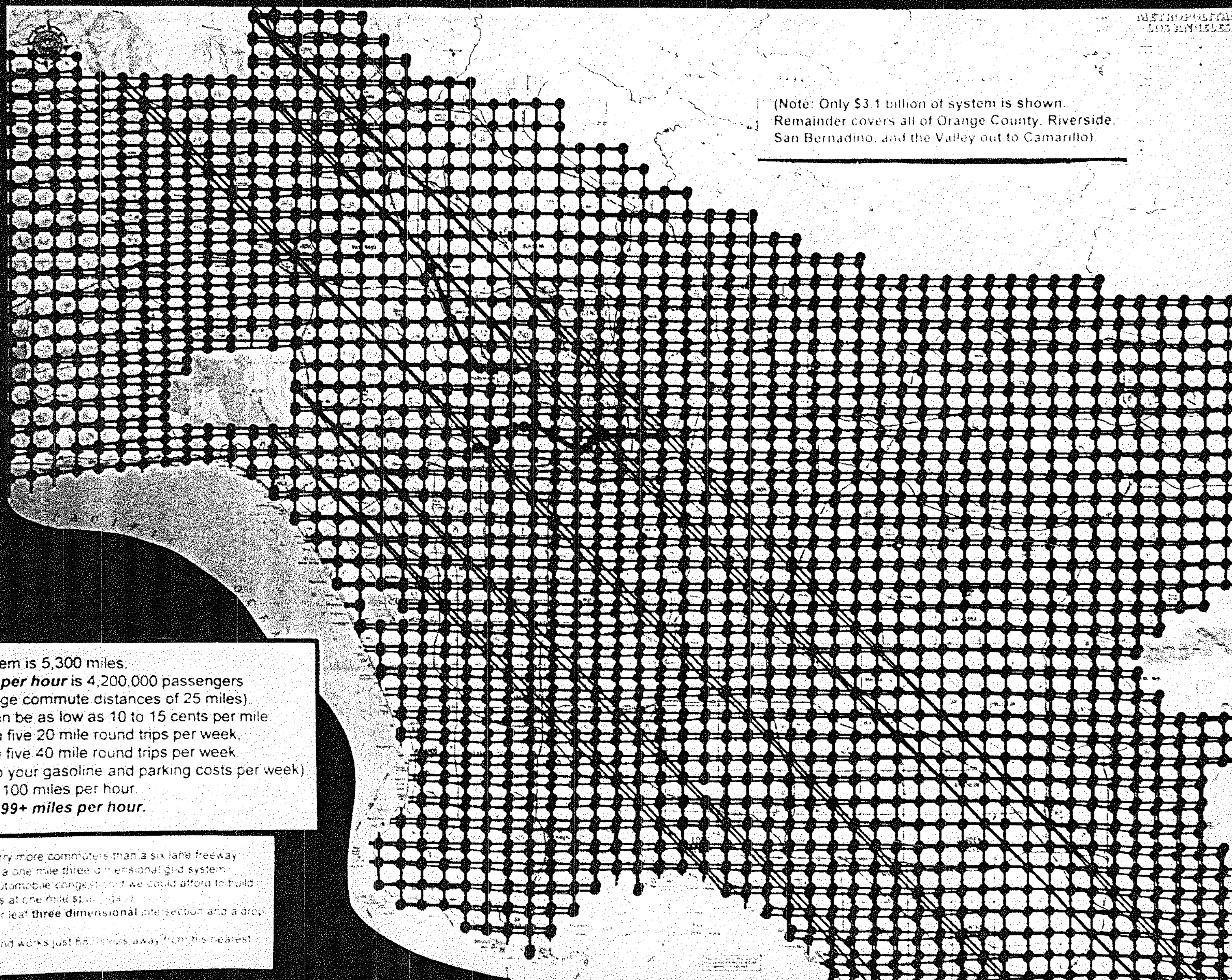
PEOPLE PODS™ - A $5.3 BILLION INVESTMENT

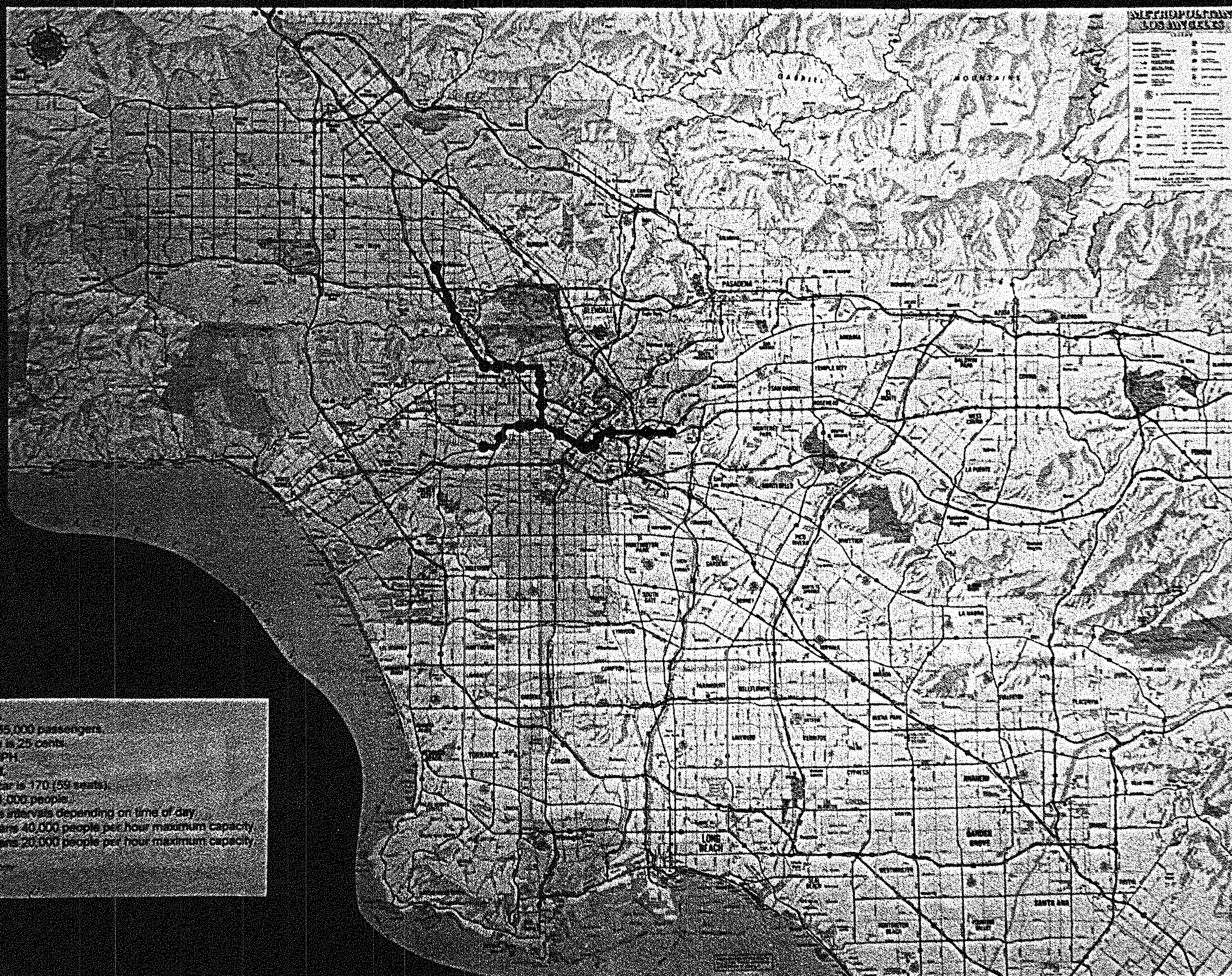


- Total length of system is 5,300 miles.
- Maximum capacity *per hour* is 4,200,000 passengers (based on average commute distances of 25 miles).
- Charge to Users can be as low as 10 to 15 cents per mile ($20 will buy you five 20 mile round trips per week. $40 will buy you five 40 mile round trips per week. Compare that to your gasoline and parking costs per week)
- Maximum speed is 100 miles per hour.
- ***Average speed is 99+ miles per hour.***

- Each **BLACK LINE** can carry more commuters than a six lane freeway
- The **BLACK LINES** are on a one mile three dimensional grid system (Imagine the effect on automobile congestion if we could afford to build parallel six lane freeways at one mile [illegible])
- Each **RED DOT** is a clover leaf **three dimensional** intersection and a drop off/boarding station
- The average person lives and works just [illegible] away from his nearest People Pod station

Paying to Park

LA RED LINE - A $5.3 BILLION INVESTMENT



- Total length is 22.7 miles.
- Expected Daily Usage 305,000 passengers.
- Charge to Users per mile is 25 cents.
- Maximum Speed is 70 MPH.
- Average Speed 33 MPH.
- Passengers carried per car is 170 (59 seats).
- A six car train can carry 1,000 people.
- Operates at 3 to 6 minute intervals depending on time of day.
  - 3 minute intervals means 40,000 people per hour maximum capacity.
  - 6 minute intervals means 20,000 people per hour maximum capacity.

ECO-EXPO DISPLAY
(These are the captions for the previous 2 charts)

CHART 1:
LA RED LINE - A $5.3 BILLION INVESTMENT

Total length is 22.7 miles.
Expected Daily Usage 385,000 passengers.
Charge to Users per mile is 25 cents.
Maximum Speed is 70 MPH.
Average Speed 33 MPH.
Passengers carried per car is 170 (59 seats).
A six car train can carry 1,000 people.
Operates at 3 to 6 minute intervals depending on time of day.
 3 minute intervals means 40,000 people per hour maximum capacity.
 6 minute intervals means 20,000 people per hour maximum capacity.

Ref: Metropolitan Transportation Authority
 Rail Construction Corporation
 (213) 620- RAIL

CHART 2:
PEOPLE PODS™ - $5.3 BILLION INVESTMENT

(Note: **Only** $3.1 billion of system is shown.
Remainder covers *all* of Orange County, Riverside,
San Bernadino, and the Valley out to Camarillo).

Total length of system is 5,300 miles.
Maximum capacity **per hour** is 4,200,000 passengers
 (based on average commute distances of 25 miles).

Charge to Users can be as low as 10 to 15 cents per mile.
 ($20 will buy you five 20 mile roundtrips per week,
 $40 will buy you five 40 mile roundtrips per week.
 Compare that to your gasoline and parking costs per week).

Maximum speed is 100 miles per hour.

Average speed is 99^+ miles per hour.

Each **BLACK LINE** can carry more commuters than a **six lane freeway.**
The **BLACK LINES** are on a one mile three dimensional grid system.
 (Imagine the effect on automobile congestion if we could afford
 to build parallel six lane freeways at one mile spacings!!)
Each **RED DOT** is a clover leaf **three dimensional** intersection
 and a drop off/boarding station.
The average person *lives and works* just 880 **steps** away from his
 nearest People Pod stations.

PEOPLE PODS™ SURVEY

We would appreciate your responses after we have satisfactorily answered any and all of your questions about the People Pods concept.

1) How far do you commute to work? ___________ miles each way.
2) How long does it usually take? ______typical time, ______best time, ______ worst time.
3) How much do you pay for gasoline each week? $____________
4) Do you pay for parking? _________$ per month (or ______$ per day).
5) Would you be willing to walk 880 steps from your house to a People Pod station and another 880 steps to get from your destination station to your workplace? _____YES, _____NO.
   If NO, would you prefer getting to the stations *POLLUTION FREE* using:
   _____a) a bicycle;
   _____b) a $4,000 simple, cheap electric car with a single automobile battery that would give you a 1 mile range at 25 MPH maximum speed;
   _____c) a $1,200 fully enclosed (body with lockable door) electric tricycle that would give you a 1 mile range at 20 MPH maximum speed;
   _____d) a $400 ten pound electric scooter with a top speed of 15 MPH and a 1/2 mile range that would fold up into a 2 foot by 4 inch by 4 inch package. This could be easily carried on the Pod and be recharged enroute for the remaining short scoot to your workplace.
6) If the entire LA area PEOPLE POD system was already built, fully safety tested and if commuting non-stop, point-to-point at 100 MPH was already proven safe, super energy efficient and non-polluting what do you think today's commuters would be **willing** to pay per mile to enjoy using the system (see table below). As much as $_______ per mile.

Notes: 1) Regular fares on the LA Red Line will be $1.10 to travel the 4.4 miles or **$.25 per mile**.
2) The IRS recognizes and allows that an automobiles true total cost is **$.28 per mile**

Thank you for your time in taking this survey.

To return your survey form, to be placed on our mailing list, or to place an order please send to:

Aerovisions, Inc., 14962 Merced Circle, Irvine, CA 92714

138 PAGE PEOPLE PODS BOOK: ***THE HIGH SPEED PERSONAL/MASS TRANSPORTATION REVOLUTION*** $19.95
(See sample book in Booth 122)

45 MINUTE VIDEO (VHS only): $19.95
Features the powered MagLev PEOPLE POD model in action; ROBOSAURUS during tests and doing stadium shows; the KITECYCLE; the JET MOTORCYCLE and the 152 MPH PEDAL BICYCLE. Note this is amateur video, rather than professionally filmed, titled, dubbed and edited video.

Please add $3.00 for shipping and handling or $5.90 for 2 day USA Priority Mail.
California residents please add 7.75% State Sales Tax.

TOTAL ENCLOSED (check or money orders only): $ _______

NAME ____________________________

ADDRESS _________________________

CITY ____________________ STATE _______ ZIP CODE ________

WHAT WE LEARNED AT THE
ECO-EXPO

1) We were surprised that **every** survey form we received indicated these potential PEOPLE POD users would be totally willing to walk an average of 880 steps to get from their homes to a boarding station and another average 880 steps to walk from their destination station to work. Obviously, the caliber of people who pay to visit such shows slants the survey.

2) Everyone was fascinated with our working Magnetic Levitation model. We let them push it up and down to see how it really was floating by magnetic repulsion forces. We also let them gently shove the vehicle back and forth along the 4 foot track in order to see how near frictionless a MagLev system could be.

3) Some people were concerned with the potential *visual pollution* of a PEOPLE POD system in spite of the vast emission reductions, energy savings, congestion elimination, high speed 100 MPH non-stop commuting potentials and personal safety features. WE had to explain that an actual in scale grid system would not dominate the aerial view of Los Angeles as our Chart 2 seems to imply. In the scale shown, the **black lines** would be about 1 block wide (instead of 1 foot wide)and the **red dots** we used to represent 3-dimensional intersections/stations would be about 5 blocks in diameter. No we do not intend to laser blast half mile diameter areas of the earth from orbit in order to install a PEOPLE POD system! The actual visual pollution exists, but it should be no worse than old time telephone poles with the wires hanging from pole to pole (but only at 1 mile apart intervals - not along every single street as was common for such wiring). It surely has to be far less ugly than constructing a new 6 lane freeway next door (which is what would be required to move as many commuters per hour). AND - even if you lived next door the **noise** pollution of PEOPLE PODS going by would be about the same as bicycles going by.

4) Magnetic Levitation in combination with a linear induction motor propulsion/normal braking system essentially means we would have a ***SOLID STATE*** transportation system. The only moving parts would be the hinged doors which open and close (to board the vehicle) and the air conditioning control knob. The seats do not even have to be adjustable - because there is **no** requirement for you to have the best possible outside vision in order to drive safely and prevent accidents. Sit back and relax!

5) **Family access.** The PEOPLE PODS original purpose was low cost, non-polluting, high speed, safe commuting. However, we always planned that **families** could travel together in our small aerodynamic pods by simply docking together and forming mini-trains. In this case, there is no *engine* pulling the trailing cars. ***All*** cars are propelling the synchronized group. Once connected, you can all talk to each other. This is also the way larger luggage could be brought along. Furthermore, *if* we charge according to the *actual energy used* the second and subsequent PODS will be running at reduced fees per mile because of the aerodynamic drag reduction due to "drafting".

6) **Access for the handicapped.** The adjacent clipping says it all. We have proposed that special stations with paid human assistance be located at every 5 mile spacings on the grid. We feel the PEOPLE POD system should be profitable enough to provide **free** door-to-door dial-a-ride service to and from these special stations. Special larger PODS would carry a single handicapped person and their manual or powered wheel chairs along with them. Obviously, energy costs from aerodynamic drag of the larger frontal area POD goes up. The idea is to provide the **absolute most convenient service** for the handicapped while not penalizing track installation costs. The cost of branching out the system **to all** goes up **according to the gross weight that is suspended.** This also means 350 pound people must ride **alone** and giant football/basketball players may also be stuck using the special PODS designed for the handicapped or even stuck driving their automobiles down below. If you design **all** PODS for the rare super large person or try to accommodate any and all kinds of handicaps all the time, you could easily drive installation costs and energy costs up so high that the system becomes economically impossible. Our goal is to create the most energy efficient transportation for 98% of the people and treat the other 2% so well that it just couldn't possibly be any more convenient for them.

Public transit is for everyone.

Last year the Americans with Disabilities Act was made law. And it said that no one can discriminate against anyone with a disability. The folks at Easter Seals worked hard for this Act, because it requires all public buses, trains and subways be accessible to everyone, including those who use wheelchairs. Easter Seals and Project ACTION thank you for supporting the Americans with Disabilities Act.

Because public transportation is for everyone.

Easter Seals

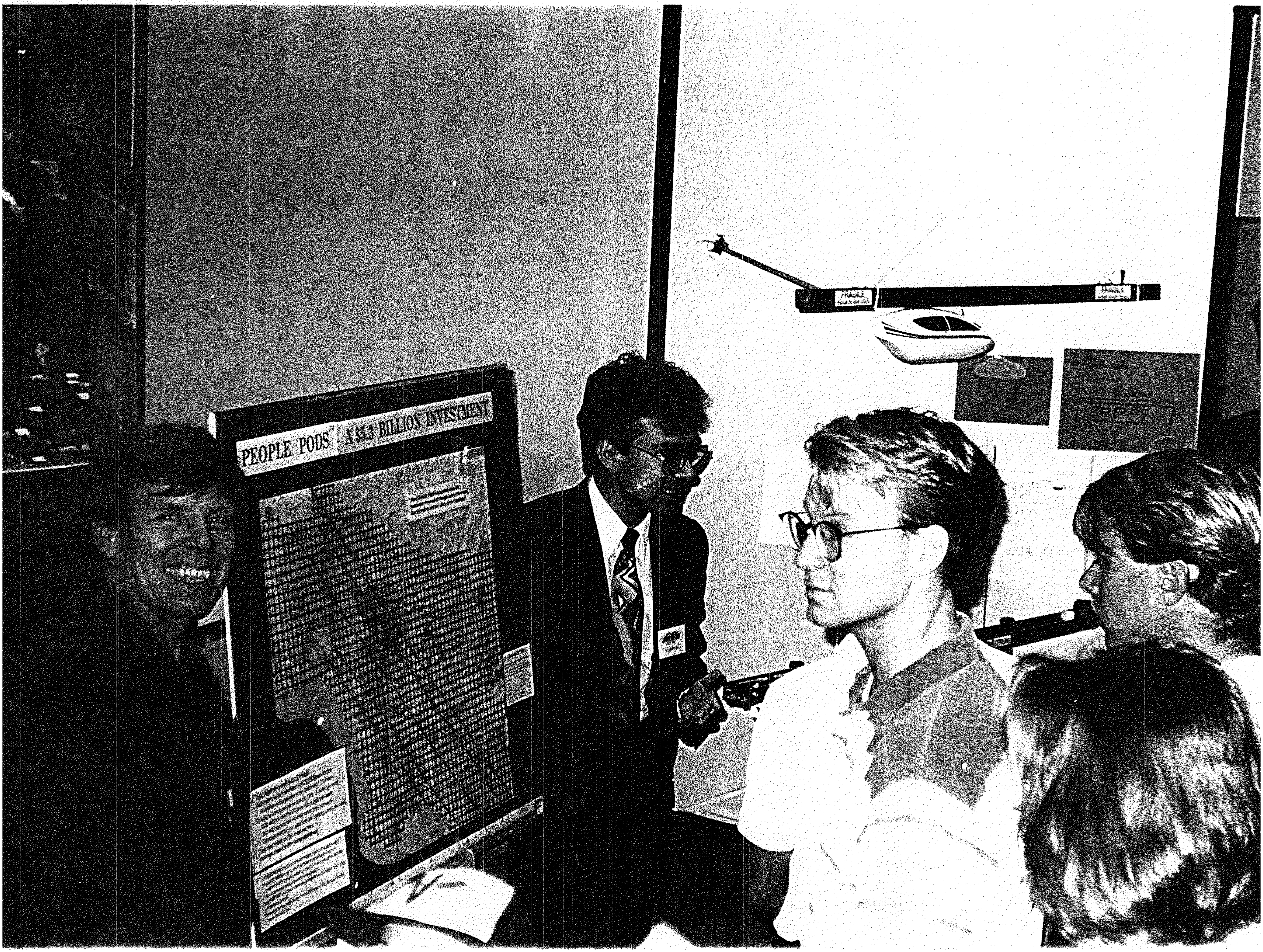
7) **Improved emergency response for Paramedic services.** We can envision PEOPLE POD routes that go directly into the emergency rooms of local hospitals or to farther away specialist hospitals. In an emergency, a mom or dad could jump in the car with a sick baby, race to the nearest POD station and then proceed at 100 MPH right to the emergency room entrance. Also, it might be quicker to haul a heart attack victim to the nearest POD station than wait for the Paramedics.

8) People don't seem to understand that what the AQMD (air quality management district) is doing by forcing people to car pool and by fining companies who don't prepare *proper* reduced car usage plans is what we engineers call "attempting to solve ***symptoms*** instead of the real ***problems***".

An example of that is *replacing* tires on a car to *fix* a weird wear out pattern on one side of the tread. The symptom is a worn tire. The real problem is suspension alignment. The PEOPLE PODS concept addresses and fixes the real PROBLEM of the major cause of pollution and congestion in the Los Angeles basin at an affordable price!

9) **The affordable price.** Our comparison to the $5.3 billion to be spent on the 23 mile LA Red Line subway is valid. It really tells us taxpayers that it's costing us a lot of money for a 1800's style, mere 33MPH average speed system that will benefit the few. That money should be spent benefiting **all** the taxpayers of the LA basin.

We were trying to educate visitors to our booth as to how much is a million dollars and how much more is a billion dollars. Our analogy is you won the **NEW** lottery where you get to stand in front of a money dispensing machine that shoots out one dollar into your bushel basket every second. The question is how long before you have a million dollars and how much longer before you have a billion dollars? It's algebra. This machine is giving you 60 dollars every minute or 3,600 dollars every hour. It takes 11.5 days to get the million and 32 years to get the billion!


PEOPLE PODS™ A $3.3 BILLION INVESTMENT

CHAPTER 4

MINIATURE MAGLEV VEHICLES FOR PERSONAL NON-STOP TRANSPORTATION

Price: $4.50

aero visions
INCORPORATED

PEOPLE PODS™

Miniature Magnetic Levitation Vehicles for Personal Non-Stop Transportation

by

Douglas J. Malewicki
Aerovisions, Inc.
Irvine, California, USA

and

Frank J. Baker
Monitoring Automation Systems
Irvine, California, USA

June 1991

INTRODUCTION

A new appreciation for the increasing value of time, along with today's environmental and energy concerns, has created a new demand for an innovative transportation solution.

The People Pods™ Maglev transportation concept (FIG 1) uses extremely light weight, 200 pound electric vehicles that are aerodynamic, non-polluting and carry two passengers. While traveling at 100 MPH on a monorail track system (safely above all other heavier traffic) a pod achieves an equivalent 400 MPG energy efficiency.

Because of this miniscule traveling weight, an elevated guideway can be built with minimum materials for less than $2 million per mile and still exceed all static, dynamic and seismic structural criteria. This can be compared with proposed 160 passenger monorail trains (weighing 100,000 pounds) which require guideways costing up to $40 million per mile .(1) *

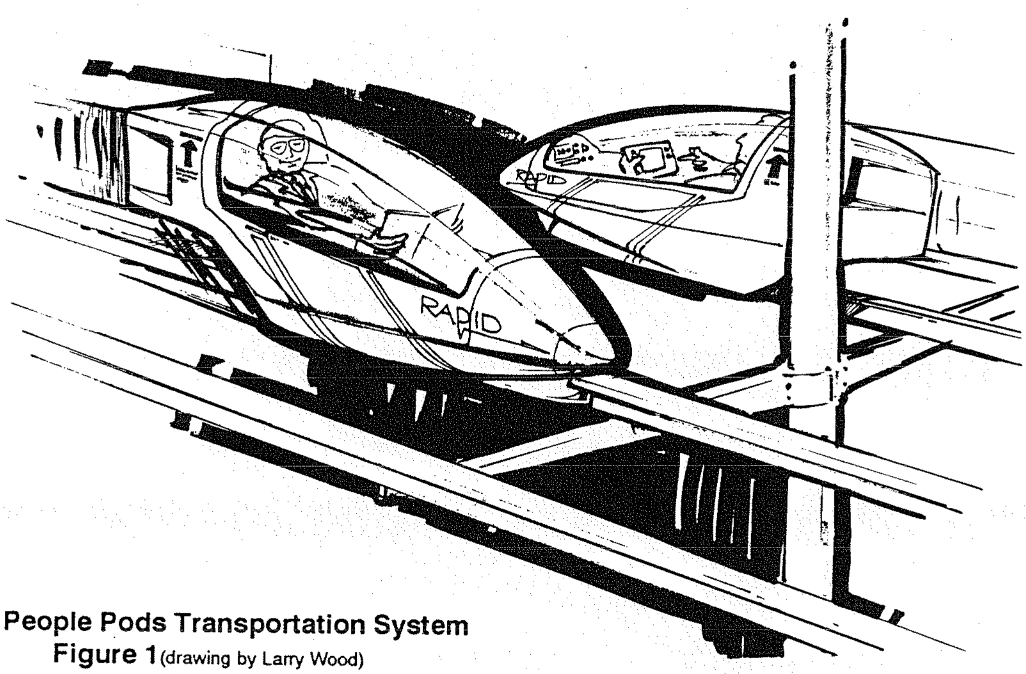
The light weight of track design allows us to create an automated track forming/manufacturing robot that enables a two shift crew to deploy one mile of two way track per day. This further reduces costs and interrupts neighborhoods for shorter periods of time.

* Numbers in parentheses designate references at end of paper.

Comfortable, semi-reclined, sports car like seating and careful attention to subsonic aerodynamic streamlining will enable the tandem seated People Pod passengers to be carried along at a steady 100 MPH for less than 1/4 cent of electrical energy per passenger mile.

The personal nature of this transportation concept completely eliminates the time wasted to decelerate, stop, let some passengers off and others on and then reaccelerate at each and every station. A People Pod user will board, then travel non-stop on the main track until switching off at his preselected destination station

Anti-collision sensors, in conjunction with air bags and hydraulic brakes that squeeze the track itself, will provide emergency computer controlled 6g decelerations (55 foot stopping distances). The result is safe, 1/2 second headway spacing (73 foot spacing) and a capacity of 14,400 passengers per hour in each direction. This can be compared with four lane freeways which carry only 12,000 vehicles per hour.



The People Pods Transportation System
Figure 1 (drawing by Larry Wood)

The goal of the People Pods non-stop grid system is to provide the most attractive, practical, effective, and profitable, public transportation system ever devised. To accomplish this objective, the Pods must be so capital and energy efficient that individuals would pay no more to use it than they would normally spend on gasoline. Creating a daily commuting service that is safer, faster, cheaper and less frustrating to use than personal automobiles is the essential motivating incentive that the People Pods concept addresses.

The original People Pods concept was wheel driven, and based on existing ultra light weight electric motors (2). The Maglev People Pod concept offers compelling advantages but requires significantly newer technologies and related unknown costs. Additional technology ingredients include lightweight streamlined composite structures, advanced power distribution control systems, and today's modern high-powered computers. Using either power system, the People Pods concept can be used to create a useful, low cost, safe public/personal transportation system.

A COMMUTING SOLUTION

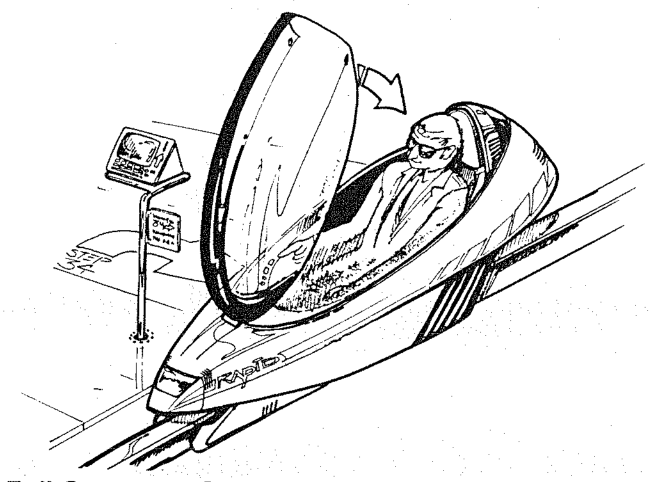
Once we understand the true objectives and problems of present day commuting, we can open our minds to create a solution utilizing the best of today's technologies.

PERSONAL TRANSPORTATION - The Popular Choice.
The goal of most commuters is to leave their home when THEY desire to leave, to go to ANY specific destination THEY desire to reach and, lastly, to progress to that destination as QUICKLY as legally possible. In our relatively affluent society, economic cost is a secondary consideration. Automobiles and the extensive road systems we humans have slowly created, have for decades been a reasonably acceptable solution to that quest -- all at a reasonable cost per week. Stress and frustration levels, however, escalate as traffic snarls and congestion continue to increase. The constant vigilance to continually avoid crashing with other cars, pedestrians and children also adds to that stress level and to the intangible, non-economic cost of personal transportation.

PUBLIC TRANSPORTATION - The Unpopular Choice.
The goal of any public transportation system is to move the maximum number of people back and forth to work each day at the lowest possible cost for capital equipment, land, daily operations and system maintenance. The intent, of course, is to reduce freeway traffic and pollution for many while providing a legitimate transportation alternative for a significant portion of the population.

PUBLIC TRANSPORTATION - Why does it fail?
Available public transportation, and prior proposals, refuse to address the intangible costs to users of such systems. These include inconvenience of schedules, inadequate routes, limited destinations, and the lost time compared with the use of a private automobile. In a nutshell, most existing public transportation cannot compete with private automobiles (for those who can afford a private automobile and have the ability to drive). Despite the mounting problems of solo driving, (including: traffic, pollution, stress, insurance costs, etc.) these intangible costs are still too high to make existing public transportation attractive to the mainstream of society.

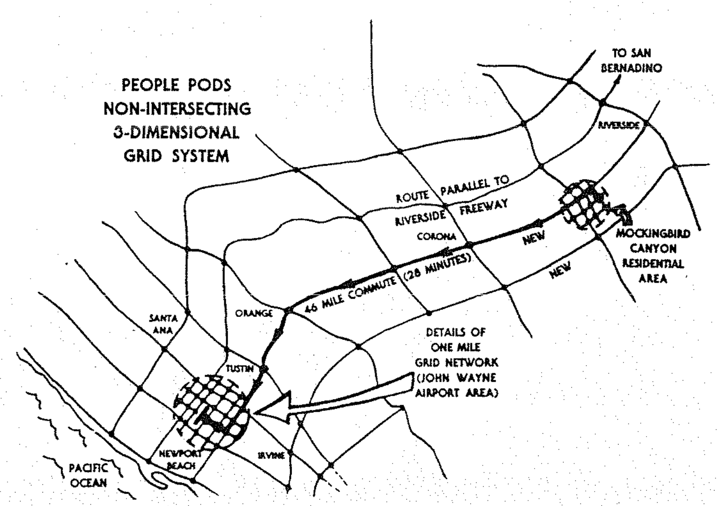
PUBLIC TRANSPORTATION - The obvious challenge.
Public transportation can succeed only if it can compete with private automobiles in terms of schedule flexibility, efficiency of operation, service to desired destinations and finally the hard economy of daily use. A transportation system that meets or exceeds this challenge can not only be successful, but profitable for all of society both economically and in terms of quality of life. The People Pods system concept has the capability to meet this challenge.



Full Computer Control for Safety and Convenience
Figure 2 (drawing by Larry Wood)

COMPUTER CONTROL
At ALL times ALL pods are under the traffic control supervision of a fully redundant master computer. Also, EACH pod operates on its own local intelligence and in fact can safely reach its destination independent of the central computer (3). Although directed by the central computer for idle Pod routing, and spacing density management, each Pod relies on its own redundant collision proof control system and again, has the ability to reach its selected destination without communication with the central computer.

It is important to note that ALL pods are traveling at a precision matched speed of 100 MPH. There, can be no passing and no tailgating. The passenger can sit back and relax, or catch up on office details during his daily commute. (FIG 2,3)



Example People Pods Commute
Figure 3

A CONGESTION SOLUTION

A single people pod lane has a potential capacity of 14,400 passengers per hour. Four lane freeways only carry 12,000 vehicles per hour.

HIGH THROUGHPUT WITH COMPUTER CONTROL People Pods do not depend on the inconsistent reaction time of human drivers, and are not subject to the same deceleration limits as today's freeway traffic. Computer control, high g braking capability, and electronic collision sensing allow closely spaced traffic density at high speeds. At 100 MPH, a half second spacing is a separation of 73.3 feet. Emergency deceleration from 100 MPH to a stop, at 6 g, permits a stopping distance of 55 feet. These limits would allow a throughput of up to 7,200 vehicles per lane, per hour. Depending on occupancy, as many as 14,400 people could be moved per hour. (FIG 4)

A COMMUTER'S DREAM. The People Pods system places track pairs in a grid, covering urban areas. The total number of lanes running in any given direction is spread out across the grid area, like small freeway systems, much closer together.

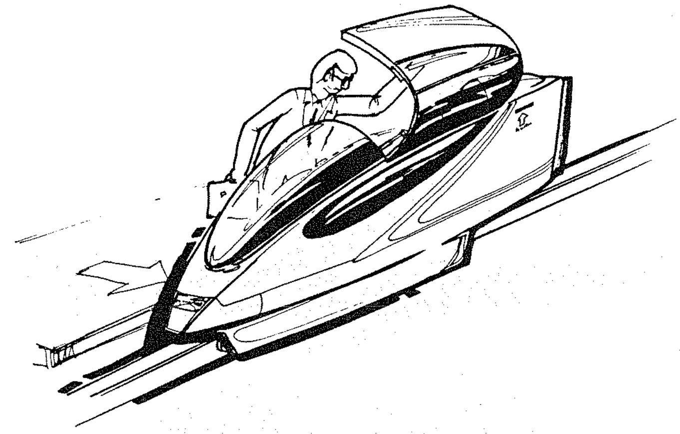
The congestion solution is derived from the total number of lanes which can be used to offload freeway traffic. Not only does the commuter save time by using a superior solution, freeways become less congested for commercial and business traffic, and those who continue to use their vehicles will not compete with commuter traffic. (TABLE 1)

If you cover a 20 by 20 mile area with one mile density grids, this grid consists of 21 two lane tracks in each direction, or 42 lanes. This is a theoretical maximum throughput of 42 x 7,200 vehicles per hour, or 302,400 vehicles per hour. Realistically, commuters are going to compete for particular segments which may become saturated at times, and other segments will never saturate. However, saturation is a measure of success, and indicates only that additional lanes should be added.

Consider the number of vehicles removed from the freeway and surface streets and the new found value of improved throughput on the existing highway system. As inexpensive as People Pods are, there are still good reasons to use our road system, and the roads will not only be available but vastly improved by having less traffic for those who will use their cars and drive commercial vehicles.

Table 1 - Travel Time Comparisons

TRAVEL METHOD	AVERAGE SPEED	TIME TO COMMUTE 25 MILES	TIME TO COMMUTE 50 MILES
BUS (many stops)	20 MPH	75 Minutes	150 Minutes
AUTO (congested freeway)	35 MPH	43 Minutes	86 Minutes
TRAIN (light rail with stops)	45 MPH	33 Minutes	67 Minutes
AUTO (max legal speed)	55 MPH	27 Minutes	55 Minutes
PEOPLE PODS (non-stop)	100 MPH	15 Minutes	30 Minutes



Commuter Entering for Departure
Figure 4 (drawing by Larry Wood)

NON COMMUTER UTILIZATION
To enhance non-commuting uses, including family travel, we envision many optional features for People Pod transportation. These features include:

> Computer controlled links of several Pods for a small "train", including inter-pod voice links. This accommodates travel with children and traveling socially with more than two persons in a group. This also permits carrying cargo or large luggage on a People Pod journey.
>
> Special telemetry and stations for cargo only use of the People Pod Grid System, for swift courier service and direct freight forwarding and expediting. Large businesses could easily accommodate their own internal stations.
>
> High speed service direct to hospital emergency rooms.

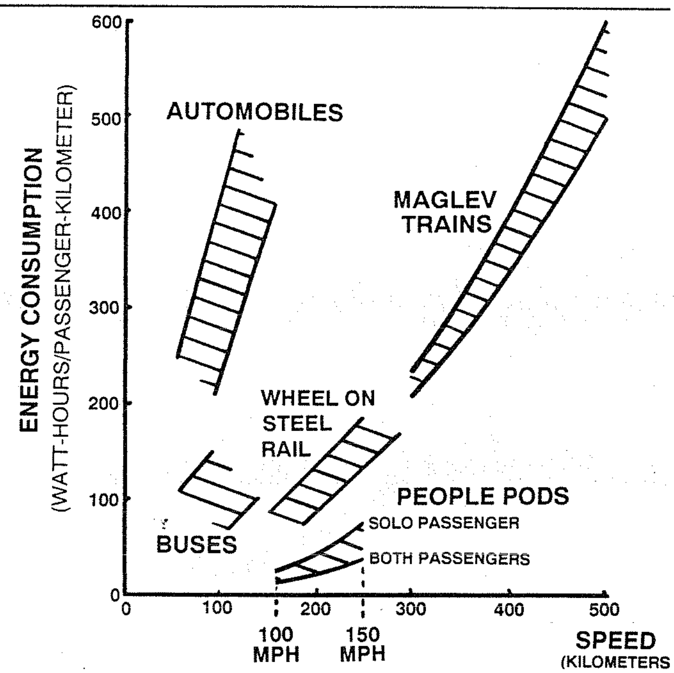
Many significant new ways of using the People Pods system can be envisioned with only a little imagination.

AN ENERGY SOLUTION

The lighter, the smaller, and the more streamlined the transportation machine, the less energy required to propel it along at any speed. Allowing the machine to travel non-stop eliminates energy lost to acceleration and deceleration.

THE PEOPLE POD SOLUTION.
As envisioned, the People Pods are miniature, but comfortable, 200 pound two passenger, super streamlined, electric wheel driven or maglev vehicles. Now a solo human occupant represents 50% of the gross weight. With two passengers, the occupants would represent 67% of the gross weight. The Pods take power directly from their monorail track (with a sliding wiper contact like a toy slot car or by induction (4)) so they do not have to carry the awful weight penalty of on-board batteries. Excess weight is the primary factor that limits performance and range of self-contained electric automobiles, but this limitation is overcome by the proposed People Pods System.

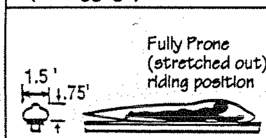
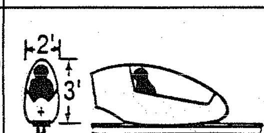
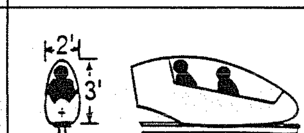
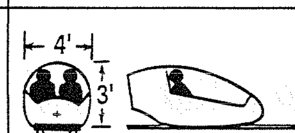
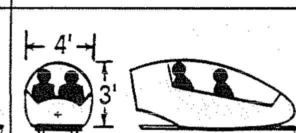
As envisioned, a single People Pod carrying two passengers would only consume 4.8 horsepower of energy while moving at a **steady 100 miles per hour**. This is 3.6 kilowatts of electricity. At 9 cents per kilowatt hour means just **32 cents to travel 100 miles**. (FIG 5, TABLE 2)



High Speed Energy Efficiency (5)
Figure 5

Table 2

Performance Comparisons of Possible People Pod Concepts (6)

Single Seater	Single Seater	Two Passenger	Two Passenger	Four Passenger
Absolute Min.Teardrop (no luggage)	Comfortable + 30lbs Luggage	Tandem	Side by Side	Two Front, Two Rear
				
Pod Weight 100	150	190	270	350
People Weight 170	200	400	400	800
Total 270	350	590	670	1150
Frontal Area .88 sq. ft.	4.7 sq. ft.	4.7 sq. ft.	10.2 sq. ft.	10.2 sq. ft.
Drag Coef. .08	.1	.11	.13	.145
C_D A .070 sq. ft.	.47 sq. ft.	.52 sq. ft.	1.326 sq. ft.	1.479 sq. ft.
Horsepower @ 100mph: Air .50 HP	3.38 HP	3.74 HP	9.53 HP	10.63 HP
Rolling .36 HP	.46 HP	.79 HP	.89 HP	1.53 HP
Total .86 HP	4.04 HP	4.77 HP	10.97 HP	12.8 HP
Kilowatts .68 KW	3.03 KW *	3.58 KW	8.23 KW	9.60 KW
Energy cost per 100 miles $ .06	$.27	$.32	$.74	$.86
MPG Equiv. 2,167 mpg	481 mpg	407 mpg	176 mpg	151 mpg
Relative Eff. 450%	100%	83%	36%	31%
Accel. Power 13.5 HP	17.5 HP	29.5HP	33.5 HP	57.5 HP
Note: Gas cost = $1.30 per Gal and Elect. cost = $ .08979 per KW-Hr			(Steady Speed of 100 mph)	D. Malewicki, 6/16/90

* This is the power of two hair dryers

A POLLUTION SOLUTION

With the use of an efficient vehicle (407 MPG equivalent), using clean electricity for all power, pollution caused by commuter transportation can be reduced to insignificant levels.

AIR and NOISE POLLUTION

Studies have shown that in Southern California alone, automobiles and trucks add an average of 842 tons of pollutants to our air each weekday. Automotive engineers have done an excellent job of controlling the visible portion of combustion by-products (air pollution) and quieting the noise of 5,000 explosions a minute in our gasoline powered vehicles.

Most of the noise you hear from a modern car traveling along at a **steady speed** is tire noise. That noise is strictly proportional to the **weight** of the vehicle. Reducing gross weight from approximately 3200 pounds to 600 pounds (with two occupants) will mean a lot less noise. Maglev will eliminate the tire noise entirely. Perfect aerodynamic shapes will also reduce secondary noise.

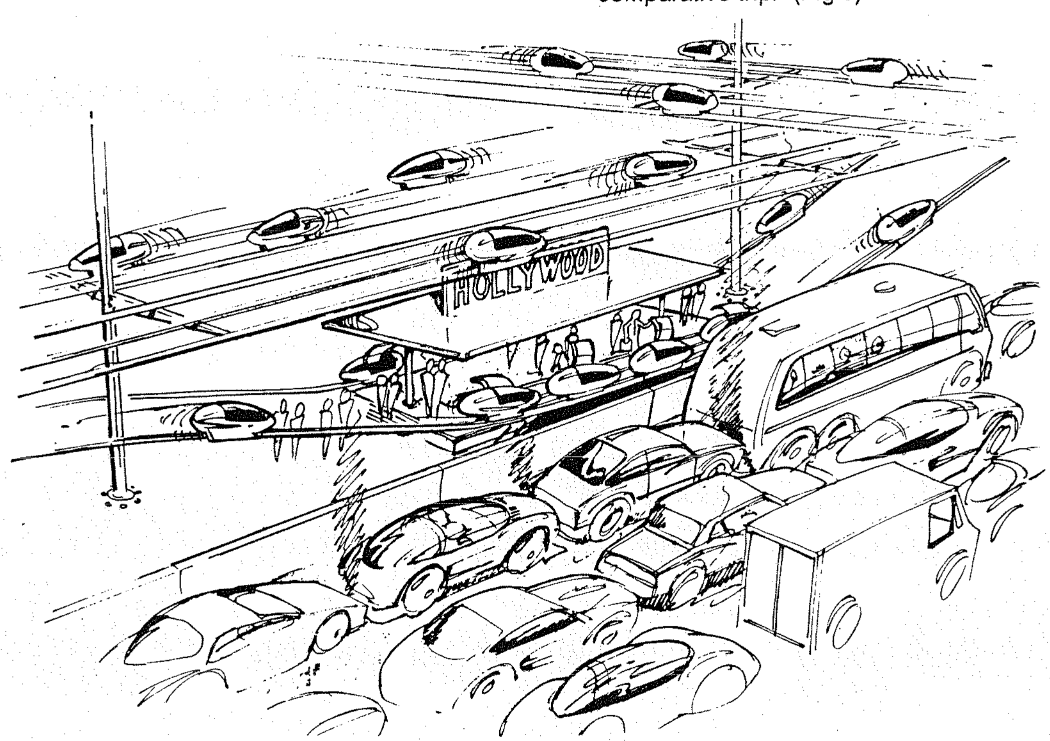
Each person using a People Pod vehicle instead of an automobile will eliminate the pollution contribution of that automobile. Opponents may argue that the generation of additional electricity for People Pods will create additional pollution. This issue must be addressed by looking at the huge amount of pollution that People Pods will eliminate.
One power plant can produce the electrical energy for hundreds of thousands of People Pods. Combustion engineers can implement sophisticated computer controlled systems which burn fuel with incredible efficiency and minimal emissions. This level of sophistication would be too complex and costly if installed on each and every automobile.

To obtain the energy efficiency of People Pods vehicles, automobiles would have to achieve more than **407 MILES PER GALLON!** Especially note that People Pods are achieving this efficiency while travelling at a steady **100 Miles Per Hour!!** Based on energy efficiency alone, People Pods caused pollution would be 11 times less than produced by a 33.3 MPG car and 18.5 times less than for a 20 MPG car.

Studies have shown that 50% to 90% of an automobiles total pollution comes from the first two minutes after the cold start of the engine.(7) Only after the engine is warmed up does the catalytic converter begin to do its job. The electrical power plant is not doing a cold start for each People Pod user and thus eliminates this major source of pollution.

Other studies have shown that an idling gasoline engine pours out 300 times as much carbon monoxide into the air as one that is running freely. Additionally, covering 10 miles in 30 minutes (slow, heavy traffic at a 20 MPH average speed) causes a car to emit 250% more hydrocarbons than traveling 10 miles at speed on a traffic free road. (8) An electric generating plant, produces power on a constant basis and is not subject to the idling or traffic constraints which cause excess pollution in automobile engines.

As you can see, there will be pollution due to the generation of electricity, but no matter what method is used, the net pollution for People Pod users appears to be 1/50th or perhaps 1/100th of that produced by an automobile for a comparative trip. (Fig 6)



Fast, Non-Polluting Commuting - Figure 6 (drawing by Larry Wood)

A RELIABILITY SOLUTION

An all solid state Maglev People Pod vehicle requires virtually no moving parts. These vehicles will demonstrate exponential improvements in reliability when compared with internal combustion engine powered commuting machines.

ADDRESSING THE RELIABILITY QUESTION

Several people introduced to the People Pods concept to are concerned about reliability and the ability to keep the system moving. Since all the Pods are single file and are locked on to the monorail track, it would appear that the **whole line** would come to a halt if just a single pod were to fail. This appears to be similar to the traffic disaster that occurs when a semi tractor trailer rig overturns blocking all lanes to a major freeway. Critical engineers further comment that with, for example 250,000 Pods being used each day, the probability of at least one machine failing may be near 100%.

FIRST - THE BUILT IN SOLUTION

The primary goal of the People Pods system requires a complete grid network so you can arrive very close to your desired final destination. this same grid system provides escape routes in the event that any one mile segment of track is totally blocked by a failed pod. Once the grid exists, vehicles would automatically be routed both left and right around a blocked section.

CLEARING A FAILED POD

The streamlined nose cone of every Pod will include a hard rubber tip and the back will have a matching structured target push area. Thus, one pod could assist a stalled pod to the next station to clear the track obstruction. Note that the sonar sensing anti-collision device, in combination with the phenomenal braking capability prevents any contact at a large speed differential (a "crash").

If a Pod electric motor quits working, it would take the trailing pod 11 seconds to catch it. Even if the anti-collision system failed, the speed differential would only be 8 MPH at impact. (9) (The failed Pod does not slow down more quickly for the same reasons it takes very little power to cruise at 100 MPH. These reasons include excellent streamlining, low frontal area, and low rolling resistance.)

The trailing Pod has plenty of excess motor horsepower available and can easily power one or more failed pods to the next station. Given that the anti-collision sensor is working, the trailing pod merely decelerates slightly, nudges up to the failed Pod, and accelerates both Pods up to the grid speed of 100 MPH. At the next station, both Pods exit, and the failed pod is directed off at the next station and into a maintenance lane. The passenger of the trailing Pod continues his commute after the insignificant delay.

In the event of a complete grid power outage, an on-board, 10 pound, bi-polar battery will yield an emergency range of 3 miles at 100 MPH or even more at reduced speed.

DISCUSSION OF ELECTROMAGNETIC RELIABILITY

Each Maglev People Pod will be driven by a linear induction motor and supported by magnetic levitation. Unlike complicated internal combustion engines, with a high part count and many hot wearing surfaces, this device has no moving parts and no friction in its normal cruising mode. There are no reciprocating parts being driven by combustion to generate a high heat and noise environment.

This kind of reliability is not possible in internal combustion engines. Internal combustion engines have surfaces that must contain explosions, and must therefore be very tight and generate significant friction and wear.

The mean time between failure for an entirely solid state propulsion and levitation system is expected to be phenomenal once developed to production levels.

DRIVER RELIABILITY

Most freeway traffic problems are caused by accidents which are caused not by mechanical failure, but by human error. People Pods do not have driver error as a potential cause for failure.

RELIABILITY CONCLUSION

Overall, the People Pods concept can not only survive the reliability question, but can make a strong case for itself based on reliability as a positive factor for implementation of People Pods Grid systems.

A SAFETY SOLUTION

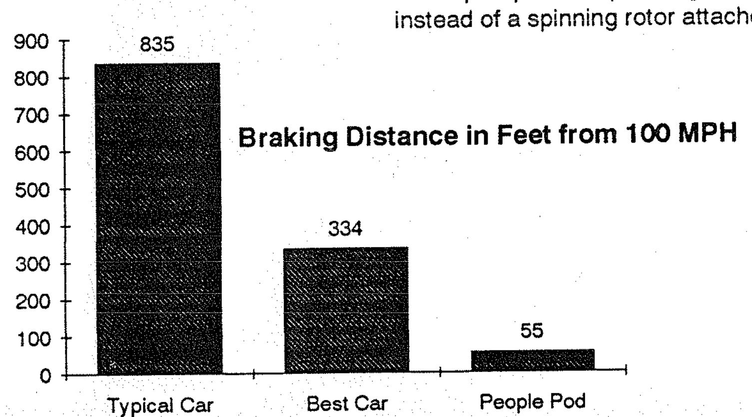
An elevated guideway reduces collision probability to a single dimension. Automated controls eliminate risk associated with driver errors. The resulting accident potential is easily managed with simple redundant computer controls.

DRIVER RELIABILITY Most freeway traffic problems are caused by accidents which are caused not by mechanical failure, but by human error. People Pods do not have driver error as a potential cause for failure. Countless deaths and waste of human life caused by intoxicated drivers can be reduced significantly.

Crashing or being involved in a crash is an inevitable expectation. As a result, the modern automobile has necessarily evolved into a 2,500 pound to 3,000 pound average weight mobile barrier of protection for its 170 pound average weight human occupant (80% who commute all alone each morning). It takes an average engine capacity of 50 to 100 horsepower to adequately propel these machines. Half of Southern California's pollution problem is caused because internal combustion powerplants have to be sized to accelerate and propel all that protective structural weight. The human occupant represents a mere 5% of gross vehicle weight!

FAR GREATER SAFETY The one dimensional aspect of this form of track travel also means the pods can successfully use simple forward looking sonar/radar sensors to automatically apply the brakes in the event of an impending collision with the rare but possible failed pod. This is not a totally useful feature for automobiles because of the ever possible cross-traffic collision.

Also note that typical automobile driver's braking is limited in its deceleration capability to about .5 g's -- a product of vehicle weight on the road surface (called the "normal" force) times the coefficient of friction between the tire and the road surface. A People Pod on the other hand, could decelerate at several g's (during a computer controlled emergency stop) because it could squeeze against the track top and bottom surfaces simultaneously with a "normal" force that is several times GREATER than the WEIGHT of the vehicle. (FIG 7) In this instance, an automobile-type, hydraulically operated brake pad pair is squeezing both sides of a section of track instead of a spinning rotor attached to a wheel and tire.



People Pod High "g" Braking Capability
Figure 7

Public transportation, including trains, which allow people to stand or walk along aisles are necessarily limited to 1/8 "g" braking/deceleration (10). This requires 2,670 feet to stop from 100 MPH.

MORE ON SAFETY - IS 100 MPH TOO FAST ?? Some people think that 100 MPH is too fast, too scary, and just too dangerous. This is because they have a fear of crashing, after all we must argue that *SPEED DOES NOT KILL - CRASHING KILLS!* No one complains that 600 MPH is too fast to fly in an airliner. After all, if its going to crash, its going to fall out of the sky. Even if it flies at 55 MPH, its still going to kill you if it falls out of the sky. So - Why do people fly? The answer is simple. People fly because commercial aircraft have been engineered for safety and the system has been proven to be safe. Even in the early days of air travel, passengers were willing to take the risks of air travel because of the tremendous benefits of high speed transportation. People Pods offer these same benefits at a different time and place. As modern society as we know it could not exist without air travel, the same will be said some day for the People Pod system.

Unlike a commercial airliner, People Pods can operate independently when other portions of the system fail. Pods can travel to their destination without instructions from the central computer. Collision avoidance systems are unique and independent within each Pod. Rare switching failures will result in some traffic redirection and commuter inconvenience, but not a total grid shutdown.

Safety is not an item to be trivialized. A substantial portion of People Pods engineering will be dedicated to the necessity for ultra-safe, reliable operation.

AN INTERCITY TRAVEL SOLUTION

The true point-to-point and non-stop nature of this system provides a total travel time solution that is superior to that of proposed high speed 125 MPH trains.

POSSIBLE LONG DISTANCE UTILITY

Originally envisioned as a point-to-point city commuter system which is faster, less expensive, safer, and cleaner than existing transportation, the People Pods system may be valuable as a long distance transportation alternative.
In a Los Angeles Times article dated May 25th, 1990 (11), it was stated that a legislative study urged the state to develop a $12.6 billion rail system to carry passengers between Los Angeles and San Francisco at speeds of 125 MPH. (This article did not estimate how many people would use the system on a daily basis.)

If the State of California wants to spend that much money, the People Pod proponents feel strongly that a far more cost effective solution can be implemented with People Pod technology. In fact, for less than the proposed **$12.6 billion could build substantial supporting grid networks in both major cities**. The following logic can illustrate the cost efficiency of the People Pods system:

> A conservative estimate for the cost of People Pods bidirectional monorail guideway for the two passenger pods, is $1.5 million per mile. Thus, 500 miles of track costs $750 million.
>
> Assume that 25,000 two passenger Pods are required at a cost of $6,000 each. These Pods will cost $150 million.

So far, this is only $900 million dollars, or only 7 % of the proposed $12.6 billion budget!

HOW MANY PEOPLE CAN BE TRANSPORTED DAILY?

Now, lets address how many people can be moved on each system. How many trains can leave a station from either end, and how often? To be generous, lets assume that one 500 passenger train leaves every half hour, completely full. If train service runs for 16 hours per day, even at full saturation, with trains running in both directions, only 32,000 people per day can be served.

The train, must stop to let people off in between. If it stops 6 times, for 10 minutes per stop, including acceleration and deceleration time, the travel time is 5 hours. Although the train travels at 125 MPH, the true average speed is only 100 MPH.

Even if the train is not full it must travel anyway, and its costs for the trip are probably the same whether it is empty or full. People Pods, on the other hand don't travel when no one wants to use them.

Now, lets consider the People Pod alternative:

> First, People Pods will travel non-stop at an average speed of 125 MPH. With 25,000 pods the system could move as many as 100,000 people per day with one passenger per pod and as many as 200,000 per day with two passengers per pod.
>
> Lets compare this with current airline traffic. If an average flight carried 300 passengers, 667 flights per day would be required to carry 200,000 people.

ENERGY EFFICIENCY

As previously explained, electric motor wheel driven People Pods would be extremely energy efficient. Increasing the previously proposed speed of 100 MPH by 25% to 125 MPH consumes twice as much energy. Now, a two seat pod, traveling 125 MPH would require $2.70 worth of electricity to travel 500 miles. This is only $1.35 per passenger when two are riding in a pod!

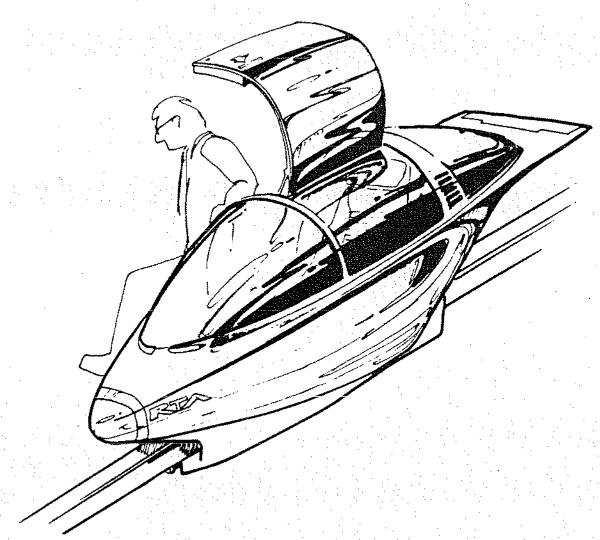
CONVENIENCE AND A FASTER TRIP

Remember that the People Pod leaves on demand, without a schedule, and stops only when you want it to, and where you want it to. You may want to stop for lunch or a rest just as you would in your own car. (FIG 8)

THE REAL REASON TO CHOOSE PEOPLE PODS

With the remaining $11.7 Billion, we could add another 200,000 People Pods, plus 7,000 miles of People Pod Grid System Track to complete the transportation system infrastructure in both Los Angeles and San Francisco.

Just how vast would the benefit to society be??



Arrival At Destination
Figure 8 (drawing by Larry Wood)

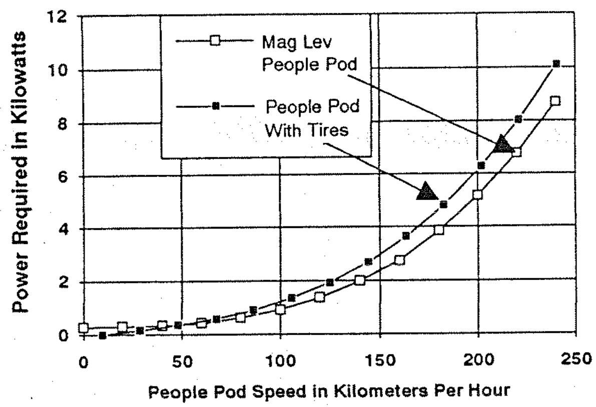
MAGLEV - THE PREFERRED SOLUTION

Although electric powered wheel driven People Pods can be delivered, Maglev technology offers advantages which justify the needed research and development investment.

MAGNETIC LEVITATION

Ten years ago, magnetic levitation principles as applied to transportation were in their technical infancy. Now, nothing has to be invented, just engineered for the specific application (12).

Maglev computer analysis program (12) for our small, lightweight, streamlined machines show that less power is consumed to support a People Pod vehicle at speed using magnetic levitation than when using high performance 50 PSI tires! (FIG 9)



Comparison of Maglev to Tire Driven People Pods
Figure 9

The computations also clearly showed that, just as with the rolling resistance of a wheeled vehicle, the power consumed for both levitation and magnetic drag is **insignificant** compared to the power used to overcome aerodynamic resistance forces **at speed.**(6,12) This fact emphasizes the importance that must be placed on optimizing the vehicles size and shape for minimum air resistance.

The magnetic levitation power of 270 watts used in the above graph may actually be less as shown in Table 3.

The entire economic premise of the Maglev People Pods System depends on 1) a low cost guideway and 2) total independent control of each vehicle. We must have on-board systems to provide lift, guidance stabilization, propulsion and electromagnetic switching. This means we must choose passive sets of conductor strips in the guideway rather than controlled coils throughout.

It was estimated that an aluminum strip just 1 foot wide and .050" thick would be required for our vehicle weight (12) at a cost of approximately $10,000 per mile. Compare this with $250,000 per mile as required for a 1.3 million pound maglev train (48 inch wide by .4 inch thick aluminum strip).

This is basically an inverted "electromagnetic river" (13) - the precursor to the superconducting, DC powered Magnetic Well Potential System.

The challenge to make a Maglev version of People Pods a reality, will require the development of small, lightweight superconducting magnets.(14,15,16)

With magnetic levitation, we no longer contact any surfaces. Wear on both the pod and the track are all but eliminated. This also translates directly to higher speed capabilities. At a steady 150 mph, a Maglev People Pod would use 11.5 kilowatts of electrical energy for combined propulsion and levitation. Energy costs for a 100 mile trip would be $1.03 (instead of $.32 at 100 MPH for the rubber tire, traction version). An automobile would use $6.50 worth of fossil fuel for the same 100 miles - and legally shouldn't be exceeding 65 MPH

Nothing mechanical moves inside the pod nor in the track. Thus, there is no friction wear on pod or track. Pod and track durability and reliability increases dramatically as maintenance requirements, cost and depreciation expenses are reduced.

Table 3
Maglev Systems Comparisons (12)

Levitation Method	Basic Levitation Power Requirement *	Levitation Power Reqd. for 600 lb People Pod	Feature Comparisons
German TransRapid Electromagnetic Attraction	1 Kilowatt per Metric Ton (2,205 lbs)	270 Watts	Active control. Expensive track.
Japanese RTRI Superconducting Electrodynamic	0.1 Kilowatt per Metric Ton	Less	Passive track. Needs wheel support until 100KM/HR speed attained.
Russian MPV Superconducting Magnetic Well Potential	0.01 Kilowatt per Metric Ton	Less Again	Levitates at zero speed. Requires no wheels.

* For large Maglev Trains. Scale down efficiency not established.
(At 100 MPH, magnetic drag + 270 watt levitation power is still less than rolling resistance of 50 PSI tires.)

AN AIRPORT GRIDLOCK SOLUTION

In 1987, 21 major airports each experienced more than 20,000 hours of flight delays (17). Costly airport expansion is not the only solution.

ONE ANSWER - Replace short haul flights with all weather People Pods. At the present time, 63% of all air operations are flights whose origins/destinations are within 600 miles. Diverting this traffic to People Pods would triple the long haul flight capacity of these airports and save hundreds of billions of dollars planned to be spent on solving these impending airport gridlock problems.

Once you create safe, reliable, extremely low energy use 125 MPH to 150 MPH People Pod capability, the implications for 100 to 600 mile trips is incredible! Once major city wide grid networks are complete, then total point-to-point trip time beats airplane service.

People Pods can also at the same time be a cost effective way to relieve the ground surface congestion in and out of airport terminals for the remaining long haul flight customers.

EXAMPLE: LA TO SAN FRANCISCO
You could travel directly from your home in Los Angeles to your destination in the Bay Area, without intermediate travel to the airport or train station, confusion and waiting for luggage or planes, wasted time waiting for departures or gates, or walking between parking lots.

If you question the validity of this product, analyze the true time required for an airline flight to San Francisco.(TABLE 4,5) By the time you leave your house and drive to the airport, allowing time for traffic, waiting in lines, and getting to the airport a bit early, you must leave your house at least an hour before your flight.

Once you get to San Francisco, you must deplane, pick up a rental car and drive into the city. This can easily take an extra hour and a half. Even though the airplane travels at 600 MPH, most of your time is spent waiting at 0 MPH making your average speed for the entire event less than impressive. Using the Maglev People Pods, you could complete the same trip in similar time, if not more quickly, in a much more productive, relaxed manner with minimum pollution and energy.(TABLE 6)

Table 4
Typical Los Angeles to San Francisco Business Trip by Aircraft

1. Drive time to airport	30 MIN
2. Park, check in, wait for flight	30 MIN
3. Board and prepare for flight	15 MIN
4. Taxi and take off	15 MIN
5. Climb out, fly, descend	60 MIN
6. Land, taxi, deplane	15 MIN
7. Walk to rental car*, check in	15 MIN
8. Get rental car	15 MIN
9. Drive to Destination	30 MIN
TYPICAL MINIMUM TOTAL TRIP TIME	**3.75 HOURS****

* Assume carry on baggage only (no 1/2 hour waiting for luggage).
** "Average Speed" for the 450 mile trip is 120 MPH!

Table 6
Energy Cost for People Pod Trips

	Speed		
Trip Distance	**100 MPH**	**125 MPH**	**150 MPH**
200 miles	$ 0.64	$ 1.25	$ 2.16
400 miles	$ 1.28	$ 2.50	$ 4.32
600 miles	$ 1.92	$ 3.75	$ 6.48

Table 5
Comparison of Point to Point Travel Times

Trip Distance	Travel Mode	People Pod Non-Stop Speed		
		100 MPH	125 MPH	150 MPH
200 Miles	Aircraft	3 Hours, 5 Minutes		
	People Pod	2 Hours	1 Hrs, 36 Min	1 Hrs 20 Min
400 Miles	Aircraft	3 Hours, 25 Minutes		
	People Pod	4 Hours	3 Hrs, 12 Min	2 Hrs, 40 Min
600 Miles	Aircraft	3 Hours, 45 Minutes		
	People Pod	6 Hours	4 Hrs, 48 Min	4 Hrs

AN ECONOMIC SOLUTION - Guideway Costs

Supporting a miniscule traveling weight means guideway material and construction costs also are minimized.

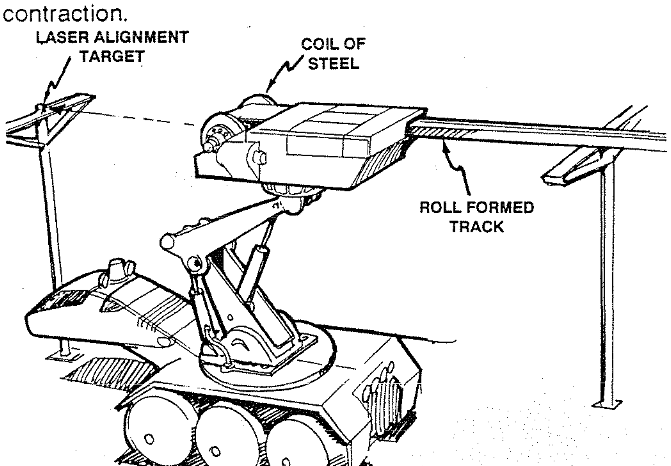
Details of the *Preliminary People Pod Monorail Track Cost Analysis Report* (18) are summarized here.

SUPPORT POLES - Due to the light weight of the People Pod system, we have selected common street lighting utility poles to provide the necessary structural support. Because of the inherent strength of steel tapered tubes, several wind mill manufacturers have used this same approach to safely support some very large bending moments.

MONORAIL TRACK - Track itself must meet severe criteria for static and dynamic structural strength, deflection and cost. In addition, provision for power transfer to the People Pods must be included, as well as pod trapping to the track and pod switching.

CONTINUOUS ROLL FORMING FROM COILS OF SHEET STEEL - People Pods track could be continuously manufactured in place by a large, mobile, computer controlled and computer stabilized roll forming machine with automatic welding of the seam.(FIG 10) In our case, however, the track stays fixed in space while the forming machine travels from pole to pole at exactly the speed the product is emerging. Thus, a very strong and stiff monorail track could be produced which is simultaneously being gently deformed to permanently turn climb and descend as necessary to follow the available terrain. The track could also be produced with a built-in precision twist to provide the banking needed to more comfortably negotiate high speed curves.

As with welded steel railroad track, we may have to allow the track to float on the poles to allow for thermal expansion and contraction.



One Mile Per Day Track Forming Machine
Figure 10 (drawing by Larry Wood)

Author Malewicki has previously invented and engineered a 56,000 pound, 40 foot tall, fully articulated hydraulic robot.(19)

SWITCHES - It is important to note that as currently envisioned, NO portion of our track MOVES. Switching is entirely done by components in the POD itself. The reasons for this are reliability, safety, and for low maintenance costs. Pod based magnetic controlled switching principals were demonstrated by the Aerospace Company in 1972 .(19)

Table 7
People Pod Monorail Guideway Pair Preliminary Total Cost Per Mile*

Item	Requirements	Total Installed Cost
Support Poles	Supports located every 20 feet (utility poles).	$396,000
Monorail Guideway	Two one mile guideways.	$174,920
Passive Switches	Two high speed "exit" switches. Four high speed "merge in" switches.	$18,000
Drop Down Stations	Two low speed "exit" switches. Two transition to descent. Two sections station track. Two acceleration segments. Two fences.	$48,350
Interchange	Four 90 deg. turns. Four crosstracks. Four low speed "exit" switches. Two low speed "merge" switches. Two 1000' decel segments. Two 1000' accel segments.	$69,530
Maglev Passive Strip	Two miles .050" aluminum conductor.	$20,000
	Grand Total	**$726,800**

*Coil steel stock was priced at $0.36 per pound in small 1000 pound quantities.(Aug 1990) To be conservative, the above guideway costs were based on steel at $1.00 per pound. The calculated beam span to deflection ratio was 3,380 to 1. This was based on maximum vehicle loading, all nose to tail, parked continuously along the guideway.

Table 8 - Relative Costs

PROJECT	PROPOSED COST	PEOPLE POD	% COST
Jamboree Road (Two Miles)	$13 Million Per Mile	$ 1 Million Per Mile (two lane)	7.7%
Typical 8 Lane Freeway	$63 Million Per Mile	$ 3 Million Per Mile (six lane)	4.8 %
Typical Concrete Fwy. Interchange	$ 100 Million + Each	$ 150,000 Each	0.15%
LA to SF 125 MPH Train	$ 12.6 Billion for 500 Miles	$ 0.9 Billion for 500 Miles	7.1%
LA Metro Rail Subway	$ 250 Million Per Mile	$ 1 Million Per Mile	0.4 %

AN ECONOMIC SOLUTION - Vehicle Costs

Large scale mass production, product uniformity, minimum materials and mechanical simplicity yields extremely low vehicle costs.

A COMPARISON WITH AUTOMOBILE MANUFACTURING COSTS

Today's automobiles are complex mechanical devices which must travel over varied surfaces using a complex mechanical control system.. People Pods do not require the following components which are essential in an automobile:

> Control mechanisms, including: steering wheel, shift levers, pedals and associated linkages.
>
> Running lights (headlights, turn signals, brake lights, etc.), mirrors, roll down windows, and spare tires.
>
> Transmission, differential, radiators, exhaust systems (mufflers, catalytic converters), engine instrumentation.
>
> 2800 lbs of processed and manufactured materials (from the typical 3000 lb car).

The power train of a People Pod vehicle is extremely simple in comparison to a modern automobile. A single electric motor powering a People Pod vehicle is not much more complex than the starter motor alone on an automobile.

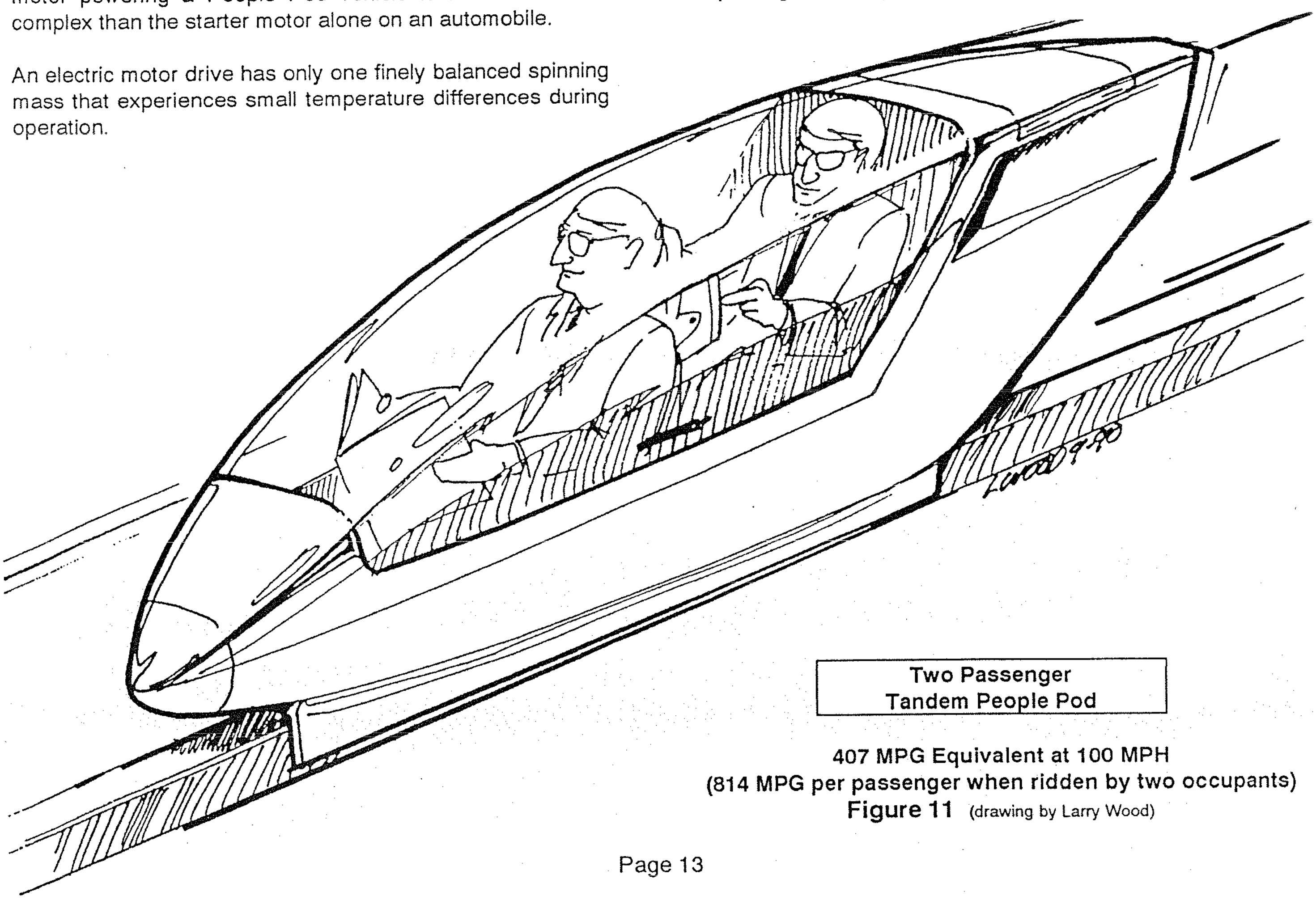
An electric motor drive has only one finely balanced spinning mass that experiences small temperature differences during operation.

Mechanically, Maglev propulsion is even simpler. A Maglev linear electric motor driven system only has one moving part - the vehicle itself. There is no contact at speed, no friction, and an almost unlimited useful life.

The People Pod vehicle (FIG 11) does contain a sophisticated electronic control system. Although development costs for electronics are not insignificant, reproduction costs of electronic components in high volume is extremely low. (Pocket Calculators, Laser Compact Disk Players and VCRs are significant examples.)

People Pods personal monorail cars can be produced in volume for far less than the cost of an inexpensive automobile. People Pod chassis and body parts are molded composite materials which can be produced with very little labor.

Again, the People Pods vehicles are used over and over again each day by many people. The cost of building each People Pod vehicle can be recovered very quickly by virtue of its high percentage of time in service. Private automobiles by comparison spend most of their economic life depreciating in parking lots and garages.



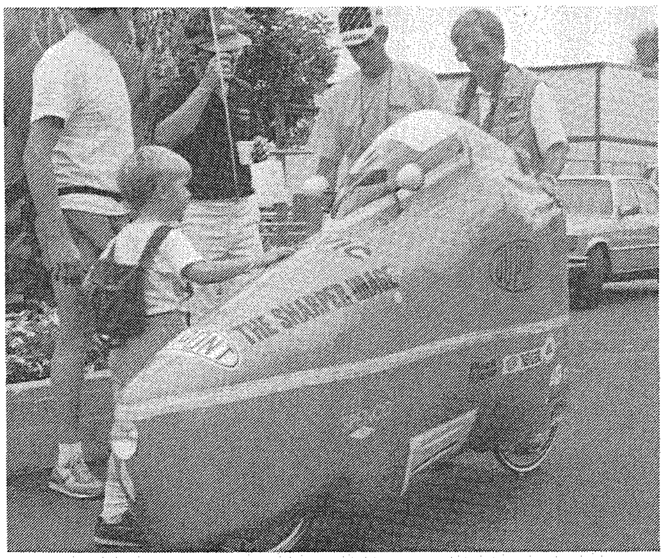
Two Passenger Tandem People Pod

407 MPG Equivalent at 100 MPH
(814 MPG per passenger when ridden by two occupants)
Figure 11 (drawing by Larry Wood)

BACKGROUND OF THE INVENTION

Streamlined bicycles and an interest in pollution free, fast, efficient human powered transportation were key influences.

This ultralight weight, high speed, personalized monorail transportation system concept was created in the proverbial flash of insight on Saturday, March 10, 1990. It led to a long night of subsequent calculations, performance analysis, cost estimates and creative excitement as the possibilities unfolded. The actual technical foundation for the People Pods, however, goes back over 10 years to involvement with the International Human Powered Vehicle Association (IHPVA). Aerodynamic refinements and engineering improvements by IHPVA enthusiasts have resulted in the development of 35 pound streamlined bicycles that powered by a single human (1 Horsepower maximum output) have set 65 MPH records(21).

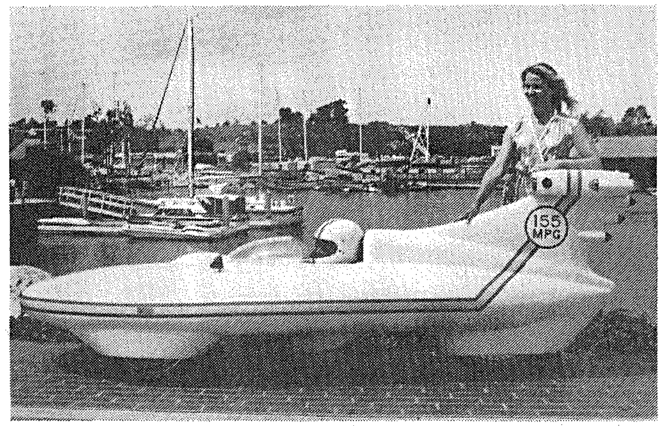


Gardner Martin's *GOLD RUSH* HPV. - 65 MPH plus world record holder and Dupont Prize winner.

Figure 12 (Photo by Lynn Tobias)

Obviously, similar machines with 1 Horsepower motors could cruise the freeways at 65 MPH and greatly reduce commuting energy requirements, congestion, pollution, etc. Unfortunately, in an accident they would be instant death traps when competing against 80,000 pound trucks, 3,000 pound cars and EVEN 600 pound motorcycles.

In 1980, financier Richard Wm. Long, DDS, and one of the authors (Malewicki) applied these IHPVA principles to create a fuel economy Guinness World Record setter, the licensed and freeway legal, 230 pound, California Commuter (22). In 1980, Malewicki set an official Los Angeles to San Francisco 157.192 MPG at 55 MPH gasoline economy record. A year later, he set a Los Angeles to Las Vegas diesel economy record of 156.33 MPG at 56.3 MPH on a route that involved total ascents of 7,993 feet (13). The California Commuter, in spite of it's efficiency, never became a viable mass market product because of these same safety issues.



The Licensed And Freeway Legal *CALIFORNIA COMMUTER* - 155 MPG at 55 MPH Fuel Economy World Record Holder.

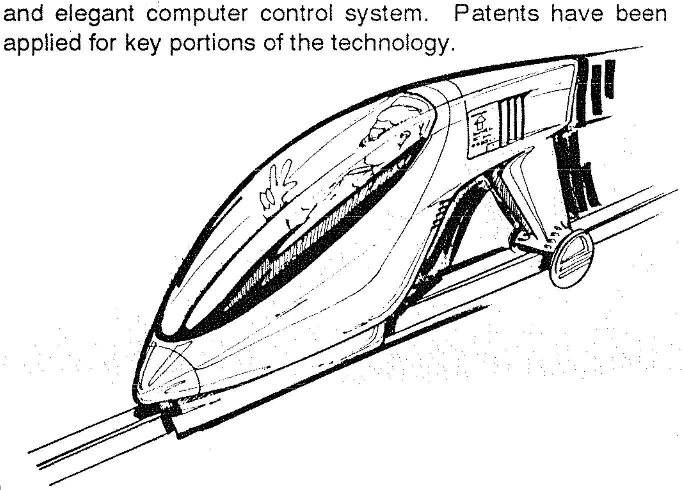
Figure 13 (Photo by David Ross)

The People Pod concept takes this super energy efficient IHPVA technology, strengthens the vehicles structure for mass production and longevity and places the Pods up on a monorail guideway system (a protected environment) to eliminate any possibility of collisions with any and all dangerous surface traffic. By placing the machines above ground, one also makes it impossible to collide with pedestrians, animals, and road debris.

Performance Analysis (23) showed that if one can achieve the streamlining goals that the energy consumed even while traveling at 100 MPH will just about be the same amount consumed by two hair dryers.

CURRENT ACTIVITY

Additional design details, of which there are many, continue to be developed. These include suspending the pods below the guideway for a number of significant advantages, including all weather operation and reduced guideway torsional loading. The authors have also developed a number of critical design details, including a sophisticated and elegant computer control system. Patents have been applied for key portions of the technology.



CONCLUSION

The irresistible potential for low capital costs, tremendous efficiency, environmental sensitivity, and true value to the consumer make the Miniature Maglev Transportation System a compelling concept for immediate attention.

PEOPLE PODS - The Next Step in the Natural Evolution of Transportation:

1. Can be erected faster than any paved road, railroad or monorail
2. Is lower in cost than any paved road, rail transit or monorail system - so a large grid network becomes affordable!
3. Can move more people per lane per hour than any paved road, train or monorail system.
4. Requires 1/20 of the energy of an automobile to travel each mile.
5. Produces 1/50 to 1/100 of the pollution of an automobile.
6. Leaves the remaining surface traffic much less congested and more freely flowing, thus, reducing auto and truck energy waste and pollution.
7. Gets you to your destination faster because it cruises at a steady 100 mph.
8. Provides non-stop operation on 3 dimensional grid - never any traffic lights which results in much faster commute times.
9. Will be far safer for users than traveling by automobile because of electronic safety sensing, in-line computer controlled travel and high "g" emergency braking capability.
10. Will allow its users to be free of risk of injury or death caused by intoxicated, incompetent or inattentive drivers.
11. Is so efficient that the service can be priced so low that commuters will use People Pods because it is essentially costs them no more than paying weekly for gasoline.
12. Will be highly profitable when charging just 10 cents per mile. Note that the cost of energy only for the typical automobile (the gasoline cost) is about 6.5 cents per mile.
13. Because of the low cost, non-stop at 100 mph features, intercity trips (up to a 300 mile range) eventually mean People Pods become the logical choice for such travel.

ADDITIONAL MAGLEV CONCLUSIONS

As we continue our research into magnetic levitation for our light weight People Pods, we anticipate large reductions in maintenance and depreciation costs along with slightly less energy per mile costs. The technologies are here today and the cost of People Pods sized Maglev track construction only goes up a few percent per mile.

If Maglev becomes a reality for People Pods, then boosting intercity speeds to 125 mph and even 150 mph incurs no hazardous wear and tear, nor resulting safety problems. Point to point travel time on non-stop 150 mph People Pods matches a jet plane on a 600 mile trip IF the departure city and arrival city have their completed People Pod grids installed.

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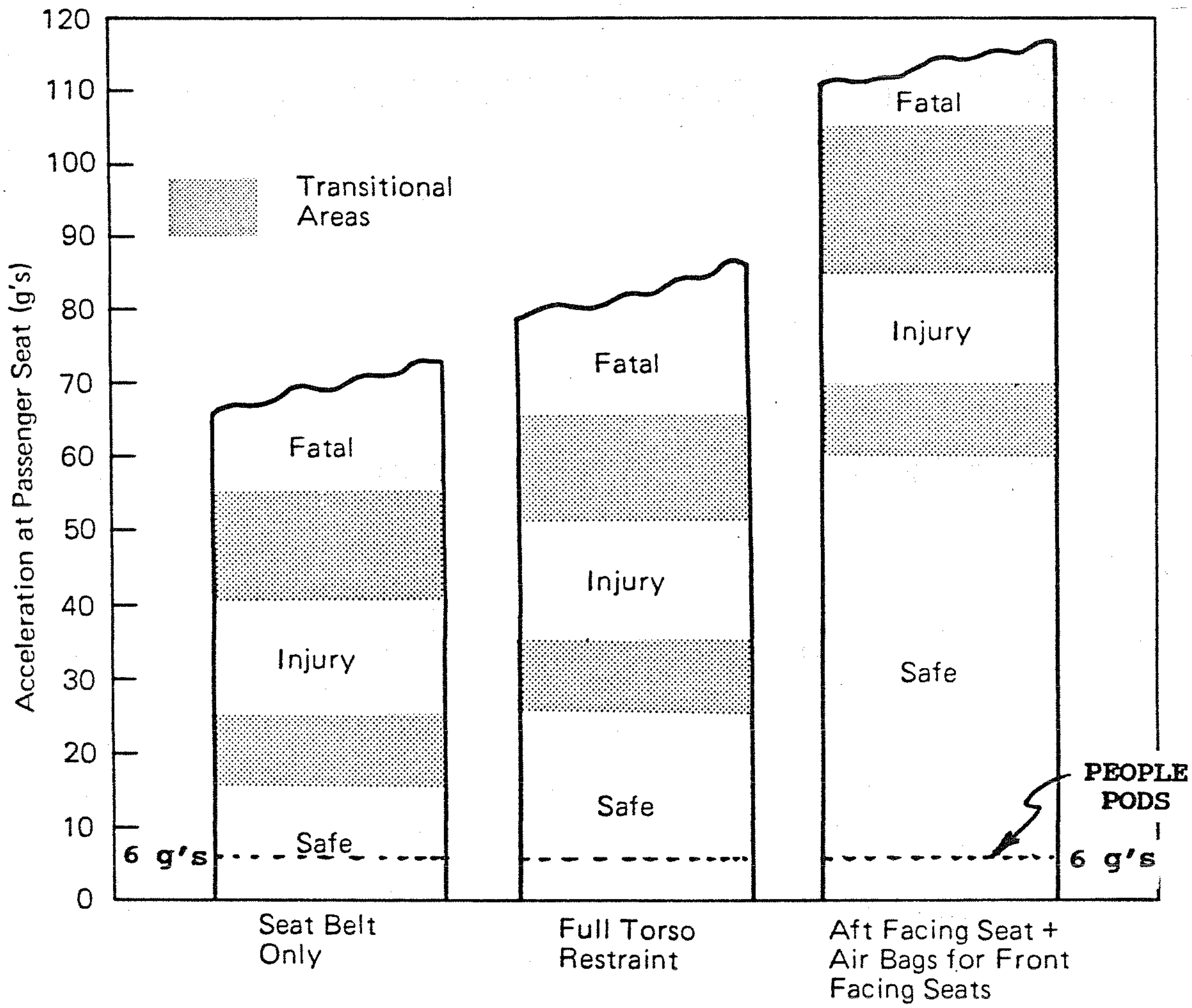


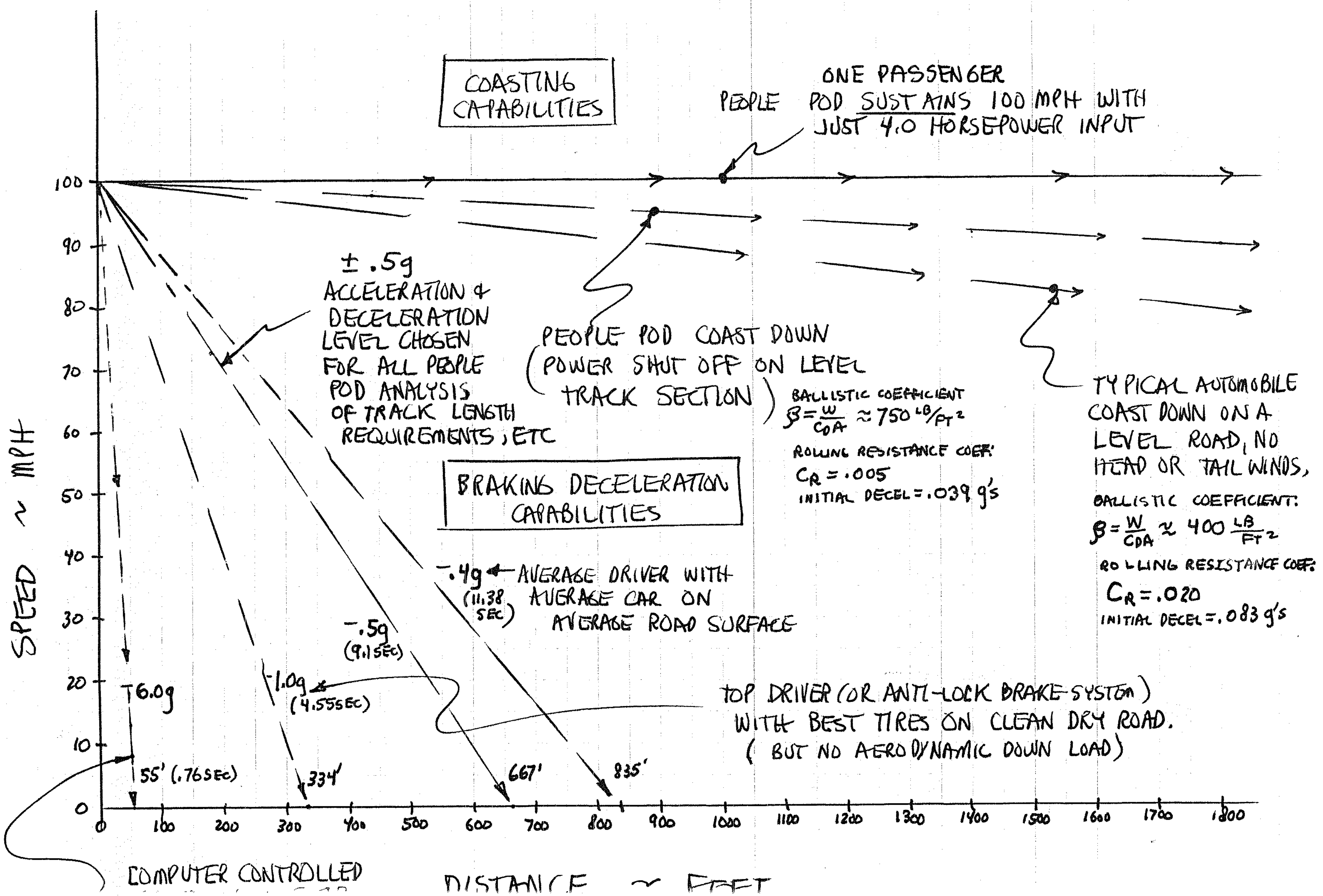
Fig. 6-12. Deceleration Tolerances for Short Duration Impulses When Using Various Body Restraint Systems

DECELERATION LEVEL in g's	VEHICLE	CONDITION	DISTANCE TO A COMPLETE STOP FROM 100 MPH	TIME TO STOP FROM 100 MPH
.125 g's	TRAINS	People standing in aisles	2,670 feet	36.4 seconds
.4 g's	CARS	Normal hard braking	835 feet	11.4 seconds
.7 g's		Skilled hard braking	477 feet	6.50 seconds
1.0 g's		Clean dry road, Best tires	333 feet	4.55 seconds
6.0 g's **	PEOPLE PODS	Grips track	55.6 feet	.759 seconds
15.0 g's	ZERO INJURY SAFETY THRESHHOLDS	Seatbelt only	22.2 feet	.303 seconds
25.0 g's		Full torso restraint	13.3 feet	.182 seconds
60.0 g's		Air bag + full torso restraint	5.6 feet	.075 seconds

** NASA data shows that the limits for humans to *sustained* 6 "g" deceleratior (eyeballs out) is **4 minutes** (240 seconds) for **performance** and 5 minutes (3(seconds) under **emergency** conditions. The extremely rare **emergency** 6 "g" stc

PEOPLE POD PERFORMANCE

D. MALEWICKI
7-19-90



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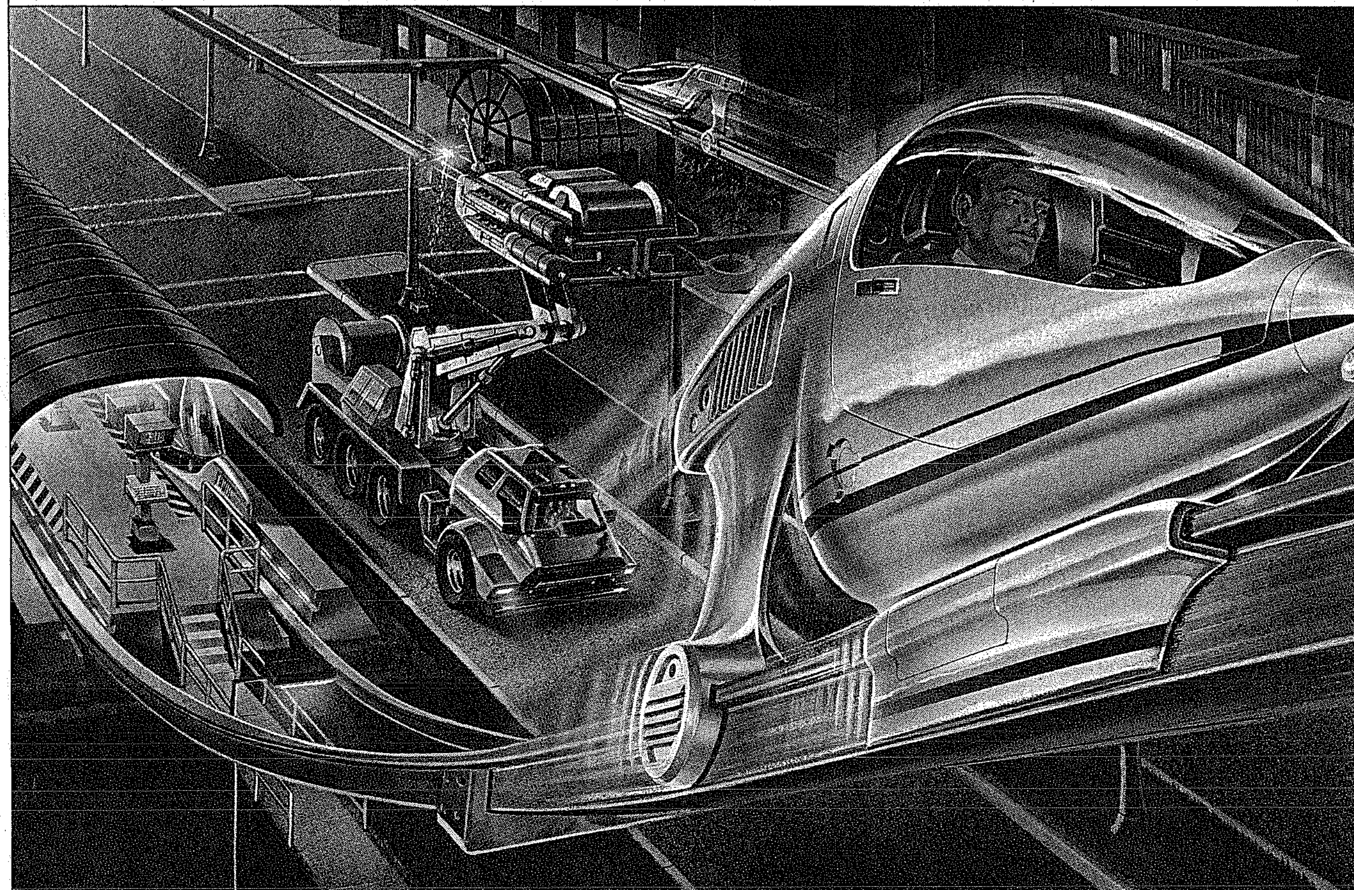

PM ILLUSTRATION BY PAUL DIMARE

Personal Maglev, Public Transportation

IRVINE, CA—How do you get Southern Californians out of their cars and into mass transit? It may take an ingenious marriage of convenience and efficiency. Prolific inventor Doug Malewicki has a solution: individual magnetic-levitation cars that run on a grid of monorails.

Each teardrop-shaped vehicle, called a People Pod, would carry one or two passengers and operate under the supervision of a master traffic-control computer. The rider would hop in a Pod at a drop-down station, key in the destination and sit back for the ride. An onboard computer ushers the vehicle around the 1-sq.-mile grid for a nonstop 100-mph ride. Meanwhile, the master computer routes idle Pods to high-traffic areas and controls Pod-spacing density.

Built of aerospace composites, a Pod would weigh only 200 pounds, including superconducting magnet. The vehicle could gain power for levitation and propulsion from the track via an induction pickup.

For safety, anticollision radar would activate hydraulic brake pads that squeeze each side of the T-shaped track. A healthy Pod could nose a failed vehicle into a maintenance track to clear congestion.

Malewicki is currently jockeying for funds to build a 1-mile test track in Orange County, California.

One key to People Pod economics: roll-forming machine, in background, lays steel track across utility poles.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Philip Chien, Mike Fillon

Highlights This Month

- **Fly Me To Mars**—Boeing's excursion vehicle flouts lunar-lander tradition.
- **Jet Packer**—Japan's magnet-drive ship is ready.
- **Weight Lifter**—C-17 takes to the skies in maiden flight.
- **Special Forces' New Horses**—Night choppers emerge from shadows.
- **Fastest Guns In The West**—Bullets fly at 27,000 miles per hour.
- **Six Of A Kind**—A half-dozen drones vie for close-range role.

(More Tech Update on page 12)

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CHEAP AND PLENTY
STRONG FOR LIGHTWEIGHT
PEOPLE POD
STRUCTURAL
SUPPORTS!
ZLJX183

There are two well known basic concepts for achieving magnetic levitation: one is based on electromagnetic attraction (EMA), which is exemplified in the German Transrapid (18) and the Japanese HSST (32); and the second method is based on electrodynamic repulsion (EDR), exemplified in the Japanese RTRI super conductive (SC) train (33)

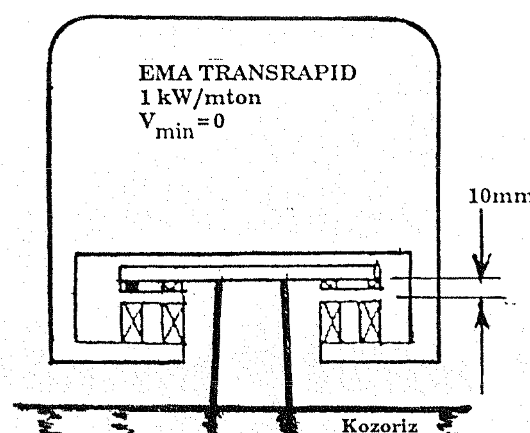
MPW is a third concept, less well known than EMA and EDR, which is an adaption of the ac Magnetic-River (39) levitation concept, but based on the SC dc circuit instead of an ac circuit, Furthermore, MPW is not EDR like the RTRI train, but it has characteristics similar to the Magnetic-River (39) effect. Also, the MPW magnetic attraction force passes through zero and changes to a repulsion force before the separating distance becomes zero. The MPW effect requires one superconductive (SC) dc circuit with a magnetic field density less than the magnetic field density of a second dc electro and/or permanent magnet, and/or two-wire hyper conductive dc line pair of infinite length (21)(22).

In a gravity field, the MPW vehicle exhibits stable levitation distances up to one-half meter at zero vehicle velocity, either above or below a guideway, with inherent vertical pitch control; and, also inherent lateral yaw control because a null-flux exists laterally also (2)(39). Further, the MPW null-flux and magnetic force reversal characteristic becomes the basis for a linear traction motor, through an efficient reversible energy transformation between the magnetic potential energy of a SC circuit and vehicle kinetic energy.

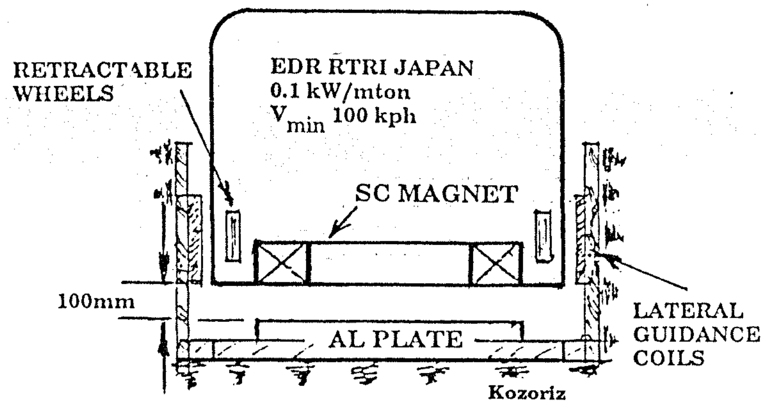
Figure 5 compares the key features of these three alternatives: EMA, EDR and MPW. As examples: EMA is typified by a 10mm levitation gap under a steel track, levitation power consumption of about 1kW/mton, and is capable of levitating at zero velocity.

EDR is characterized by a 100mm levitation gap, about 0.1 kW/mton levitation power, and lifts-off at a speed above about 100 km/h, needs retractable wheels to accelerate to lift-off and/or decelerate and land below 100 km/h, and additionally is inherently unstable in the lateral yawing and vertical pitching coordinates, and needs lateral electrical guidance coils in the guideway and vertical pitch aerodynamic design parameter selection for stability control.

MPW can be characterized by about a 100mm to 150mm suspension gap beneath a two-wire hyper dc guideway, 0.01 kW/mton levitation power, levitates at zero velocity, and furthermore exhibits inherent lateral yaw and vertical pitch stability, by judicious parameter tradeoffs.



ref: F. Wyczalek, *MagLev Transit in America and US National Energy Strategy*, SAE Future Transportation Tech-



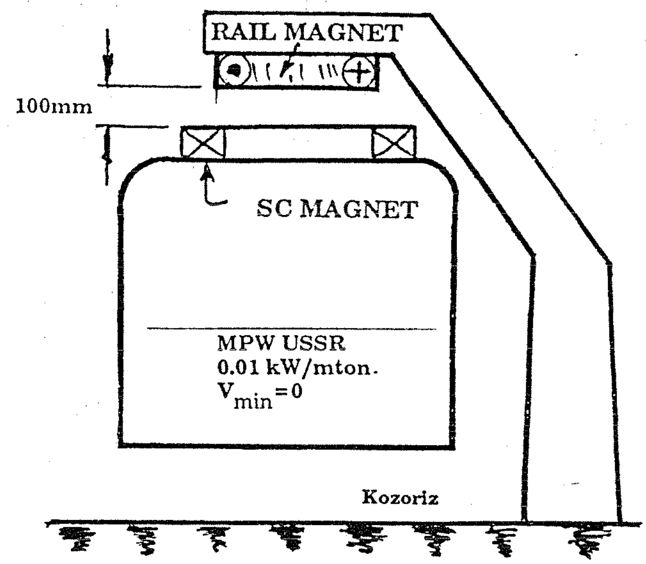
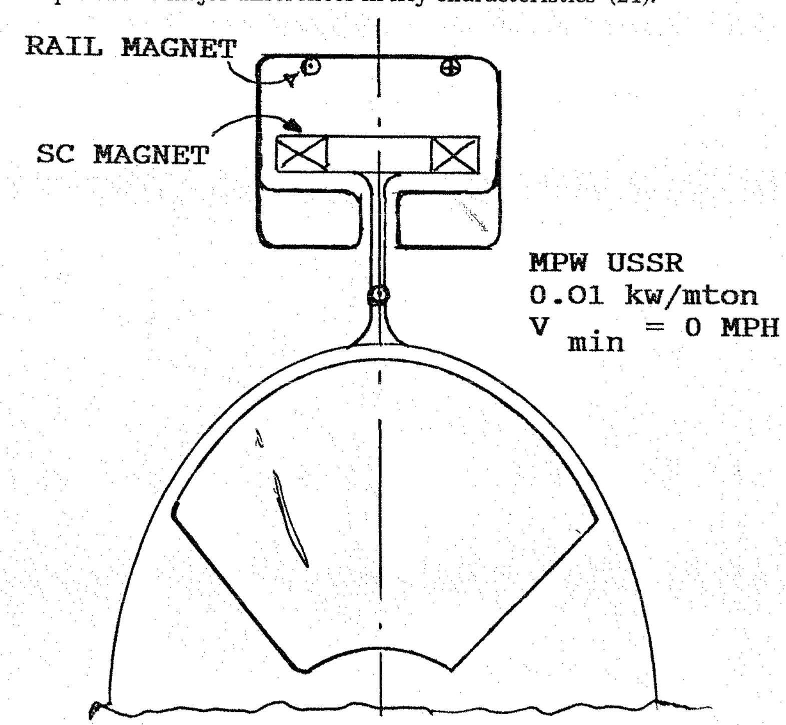
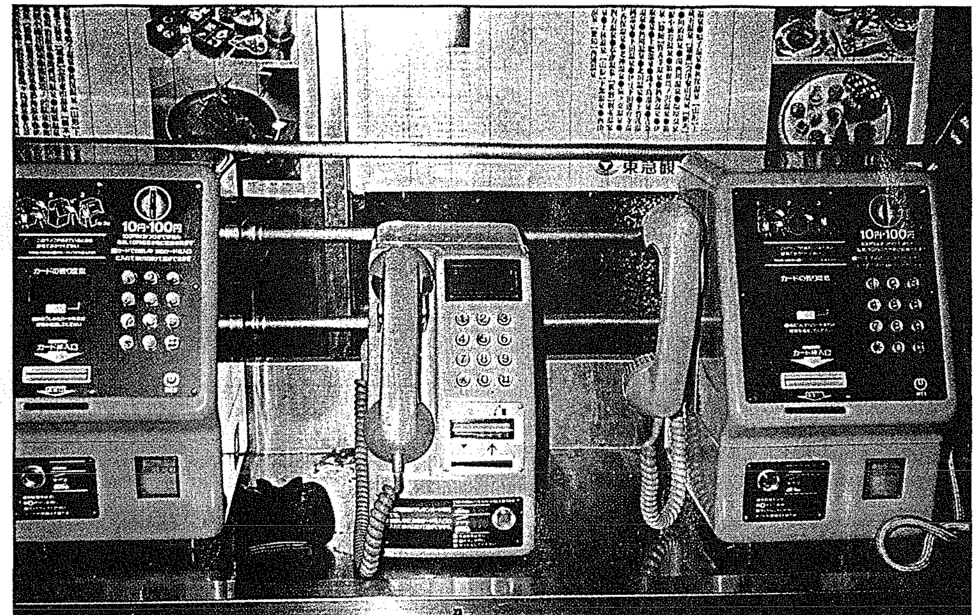


Figure 5 Comparison of EMA, EDR and MPW Maglev concepts shows major differences in key characteristics (21).



PEOPLE POD configuration

DON'T PHONE HOME WITHOUT IT



A magnetic strip on the prepaid telephone card records the amount of money remaining and tiny holes are punched in by the magnetic card reader to indicate use.

Tokyo - Coin telephones have virtually disappeared in some locations in Japan since Nippon Telegraph and Telephone Company (NTT) issued prepaid telephone cards in 1982. More than ten billion cards, measuring 5.4 x 8.6 cm have been sold since. The cards have specific denominational value magnetically imprinted on them that is erased with each use. A card reader punches a tiny hole next to a scale printed on the card's surface to indicate the remaining value. Card pay phone meters are read on site.

The cards replace coins in telephones, and are also used for subway tickets, postage stamps, movie tickets, expressway tolls, gas stations, and supermarket shopping. About half of the prepaid cards are given as gifts and many Japanese families have cards that last for a lifetime.

NTT and other issuers insist that the main reason for the card is to eliminate the inconvenience of carrying coins. In addition, phone companies do not have to collect several hundred tons of coins every week. Cards are not refundable, but NTT gives cash or phone bill discounts for the remaining units. NTT will say nothing about the internal mechanism of its telephones. U.S. companies such as AT&T and Sprint are marketing various prepaid or credit-card linked telephone cards but their value is not resident in the card. The user punches in the card number to access a prepaid service. AT&T is working on adding a function that would allow another card to cut in when one is about to run out. No one in the U.S. plans to try card-slot phones yet.

—David C. Hulme,
Asian Correspondent

MENSA BULLETIN
The Magazine of American Mensa

October 1993
No. 370

BOOKS

Looking at BOOKS

By Tom Elliott

MENSA BULLETIN • *October 1993*

People Pods: The High-Speed Personal/Mass Transportation Revolution by Douglas Malewicki (138 pp., b&w photos, charts, illustrations, appendices, pb.; publ. Aerovisions, Inc., 14962 Merced Circle, Irvine, CA 92714, no ISBN, $19.95 + $3 p&h). Also: **The People Pods** – a 45-minute video (VHS) $19.95 + $3 p&h

"Basically, super-low installation costs per mile means a city could afford to construct a system that goes everywhere and thus becomes useful to all. . . . I'm confident we have something that eventually can create tons of jobs and be an American product for export all over the world – and that sounds like something Mensa should be looking to encourage." People Pods: what an original concept! Two-person pod-shaped vehicles running to and fro on monorails at 100 mph, no traffic lights or bothersome intersections, programmed to pick us up and get us to our destination, and all for 10 cents per mile. Malewicki has obtained several patents on People Pods and has published what is actually a proposal to sell the concept. And he's no novice at marketing original ideas: Included in the book and on the video is one of his successful products, Robosaurus, a five-story-high steel robot that looks like a Tyrannosaurus rex. With its 12 tons of gripping force and a 20-foot flamethrower, it's a crowd-drawer at car shows, demolition derbies, races and similar events, where it picks up, crushes and incinerates full-sized cars. What won't Mensans think of next?

CHAPTER 5

SOFTWARE DESIGN CONSIDERATIONS FOR A PERSONAL MAGLEV TRANSPORTATION SYSTEM

SAE TECHNICAL PAPER SERIES

921585

Software Design Considerations for a Personal Maglev Transportation System

Frank J. Baker
Monitoring Automation Systems

Reprinted from: Maglev (SP-926)

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921585

Software Design Considerations for a Personal Maglev Transportation System

Frank J. Baker
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ABSTRACT

The People Pods™ transportation concept for commuters is based on extremely light weight, 200 pound, advanced composite, two passenger Maglev vehicles traveling on a monorail system above all other traffic.

To provide on demand, point to point transportation, guideways are installed in multiple directions across and between urban business and residential areas. Vehicles are to be available for immediate departure at regular stations along the guideway system.

The challenges of automating such a transportation system can be met by implementation of a vast number of processing units, including one in each vehicle. The overall architecture of automating this system can be viewed as a dynamic network of systems. Component systems in this network must also be capable of operating independently, and of still providing service given the multiple levels and potential combinations of failures which all have some probability of occurrence as part of normal operations.

INTRODUCTION

The goal of the People Pods™ non-stop grid system is to provide the most attractive, practical, effective, and profitable, public transportation system ever devised.

The ultimate transportation system would move people and cargo from any point to any destination, instantaneously, on demand (without waiting for a scheduled departure), without consuming energy, and without any risk of danger. Additionally, the system for such travel would require no capital investment. Obviously, this is not possible. However, current technology can be applied to produce a practical transportation system that is much closer to these ideals than anything we are using today.

The proposed People Pods™ transportation system plan provides an answer for the urban commuter. This segment of the transportation equipment and services market is where demand for serious solutions is most significant in terms of the number of people involved, and the growing inadequacy of currently available solutions.

The People Pods™ solution is a revolutionary concept that does not require any new fundamental technology. It can be developed **now.**

OVERVIEW OF THE PEOPLE PODS CONCEPT

The People Pods Maglev transportation concept for commuters is based on extremely light weight, 200 pound, advanced composite, two passenger vehicles. Safety considerations, of course, necessitate operation on a monorail track system above all other heavier traffic.

Supporting such a minuscule traveling weight also means guideway material requirements can be minimized, even after meeting all static, dynamic and seismic structural safety requirements. The real benefit is a guideway material and labor cost of less than $2 million per mile, which is especially attractive when compared to the $50 million plus per mile currently projected for the 100,000 pound plus gross weight, 160 passenger monorail trains.

The light weight per foot of track design allows the development of an in situ automated track forming / manufacturing robot that enables a two shift crew to deploy one mile of two way track per day. This further reduces costs and has the added benefit of shortest possible neighborhood disturbance time.

A comfortable, semi-reclined, sports car like seating and careful attention to subsonic aerodynamic streamlining will enable the tandem seated People Pod passengers to be carried along at a steady 100 MPH for less than 1/4 cent of electrical energy per passenger mile.

The personal nature of this transportation concept completely eliminates the time wasting need to decelerate, stop, let some passengers off and others on and then re accelerate at each and every station. A People Pod user will board, then travel non-stop on the main track until switching off at his pre selected destination station.

In the event of a serious emergency, anti-collision sensors, in conjunction with air bags and hydraulic brakes that squeeze the track itself, can provide computer controlled emergency 10g deceleration's (34 foot stopping distances). The result is a safe 1/2 second headway spacing (73 foot spacing) and a capacity of 14,400 passengers per hour in each direction.

Although the preferred implementation of this system includes Maglev vehicles, the concept is also valid using wheeled vehicles. The use of Maglev technology should decrease maintenance costs dramatically be eliminating the need for most friction and wear producing moving parts while maintaining the same or superior energy efficiency.

<u>The previously stated attributes of the ideal transportation system are addressed by the People Pods™ system as follows:</u>

SPEED - Instantaneous transportation is not yet possible. At the present we must be content to move matter through space as quickly as our chosen technology allows with safety. As the People Pods™ system is entirely automated, and travels non-stop on dedicated guideways, 100 miles per hour as a top speed is not only very reasonable but is also very close to the point to point average speed as well.

ENERGY EFFICIENCY - Light weight, aerodynamically efficient design, and non-stop operation allow each vehicle to travel from one point to another at an energy cost of less than 1/2 cent per passenger mile (1/4 cent with two passengers), or less than 50 cents for a 100 mile trip.

SAFETY - Multiple, redundant automated systems replace a human driver and eliminate the risk of collision from driver error. Dedicated, single direction, suspended guideways make vehicle directional control and it automation simple, and simplicity is the first ingredient to reliability and safety.

COST - Light weight vehicles in huge quantities can be mass produced at a very low cost. The vehicles are re-used by for several trips each day and do not sit idle, depreciating in a parking lot. Guideways are small, and light in weight. The guideways are elevated and can be built above existing roads, minimizing the cost of real estate acquisition.

It is entirely possible that, this concept may be so capital, labor and energy efficient that it can provide a profit from revenues that may represent no more than what an individual user would normally be paying out for gasoline.

Creating a home to work and back again daily commuting service that is safer, faster, cheaper and less frustrating to use than personal automobiles is the essential motivating incentive that the People Pods concept addresses.

THE TRANSPORTATION SYSTEM FROM THE PERSPECTIVE OF THE SOFTWARE ENGINEER

The People Pods Transportation System **is automated.**

Under normal conditions, the system must function without human pilots, drivers, engineers, traffic controllers or ticket agents. Naturally, machines can only do so much. People will be required as customer service representatives so that personal problems and exceptional situations can be handled in an appropriate manner.

The automated portions of the system perform much as would trained human operators in a non-automated system. Because the dimensions and parameters of travel on the grid system are greatly simplified, the proposed level of automation is not at all an unreasonable expectation.

ELEMENTS OF THE TRANSPORTATION SYSTEM NETWORK

An overall picture of the system is that of a vast network of processing systems (in vehicles) in constant high speed motion, plus a number of system supervisory, management, ticketing and billing systems.

Each of the major system elements is discussed in some detail in the following sections.

VEHICLE SYSTEMS

Perhaps the most critical concept of this proposed design is that any or every vehicle is capable of functioning without any external computer control or connection. To clarify, the vehicles can operate with complete independence of hard wired connections, and can rely on electronic optical sensor technology for track position sensing.

Conceptually, it is possible to implement a simplified version of this system with automation in the vehicles alone. This is important for several reasons. When designed to work in this way, the transportation system and individual or multiple vehicles can continue to provide service (at least to the current occupants) under conditions of multiple systems failure external to an individual vehicle. Second, this provides for simplicity and flexibility in the remaining non-vehicle systems improving reliability and lowering overall system costs.

<u>The functions of the on board automated vehicle systems include:</u>

1. Verification of proper operation of vehicle system, sensor, propulsion, braking and switching components, and switches to backup components as required.
2. Acceptance of periodic download of track grid information and preferred routes from external system(s).
3. Reading encoded ticket media for passenger travel instructions.
4. Verification of passenger(s) ready status through physical restraint and seat sensors, and passenger activated "ready to travel" control (a button or switch).
5. Execution of a program to take the vehicle to the ticketed destination, based on the stored track grid and preferred route information. This includes control of vehicle acceleration, deceleration and switching the required number of times to reach the desired destination.
6. Optionally, acceptance of re-route commands from central system, station module or track module units on an exception basis.
7. Execution of special procedures upon sensor indication of an exceptional condition, including emergency stops, switching, and acceleration.
8. Execution of commands downloaded from external control systems when idle, so that idle vehicles at low demand stations can be moved to high demand stations.

COMPONENT CONSIDERATIONS - Each set of components in the vehicle will be hardware redundant, or "duplexed". When a single component fails, the vehicle can complete its current journey before taking itself out of service for repair.

Using "finite state" design, program execution paths will be designed for each combination of component failure, including failure of both the primary and secondary units of a pair of duplexed components. Design of "deadman switch" logic should be applied at each final level, such that components perform a default "maximum safety" preferred action in the event of the most critical failures.

VEHICLE SYSTEMS GENERAL DISCUSSION - Vehicle systems include an optically based track position sensing device similar to bar code scanning ("auto id") equipment widely used in many industries. In its simplest implementation, directional control is maintained by accelerating, braking, and switching as the proper track markings are scanned.

Emergency sensors detect failures in the propulsion units (either Maglev or wheel), a slow or stopped vehicle blocking the desired track path, or guideway defects requiring exceptional control actions to be taken.

Conceptually, collision sensors could be radar or optically based, but would need to be sophisticated enough to detect blockage of only the area associated with the vehicle's guideway, and not be confused with guideway variations, close structures, or simply oncoming or slower vehicles on an adjacent guideway.

Because of the quantity of vehicles, it is conceived that at-station data communication would be through an optical data link with no hard wire requirement, and no radio (emission and interference concerns). For exceptional situations, such as real time re-routing requirements and failure reporting, a low-power "cellular type" radio network is envisioned.

When a vehicle fails totally and becomes dead on the guideway, a trailing vehicle will execute a program to decelerate and push both vehicles off at the next opportunity.

GUIDEWAY SYSTEMS

A minimal amount of equipment is needed for the guideway system modules.

Vehicle identification scanners are required to record the scanned id number of each passing of vehicle into temporary storage. Should a vehicle fail to report at a destination station, the central control system (or intermediate station module) can poll the appropriate track scanning units to determine the last reported location of a vehicle.

Another guideway automation function is for sensors to record and report exceptional track conditions (as detectable) back to the central control computer so that re-routing can be performed.

Much like the independence of the vehicle, a guideway segment should be capable of transmitting re-route or exceptional information directly to vehicles given a failure to communicate with the central system. Ordinarily, such information would be confirmed and/or initiated by the central traffic control system(s).

STATION SYSTEMS

AUTOMATED TICKETING MACHINES - are required at each People Pods™ station. There is nothing revolutionary or extraordinary about these machines, they exist today in many transportation systems and for various modes of transportation. A number of enhancements could be easily provided however. These enhancements include:

Travel Assistance Terminals: An interactive, multiple language terminal for consumers to select the best destination station based on only the knowledge of an address or landmark name.

Variable Fares: To encourage use of vehicles which might otherwise require idle re-routing to high demand departure stations from high demand arrival stations, fares could be variable at certain times of the day. These fares could even be recalculated and offered on a real time basis with connection to the central traffic routing system.

The main function of the ATM would is to create an encoded ticket which will enable the vehicle to take the passenger(s) to their destination and to provide for payment. Several features are envisioned to make the system easy to use, including the ability to purchase a multiple use ticket with pre-coded destination information.

VEHICLE LINK MODULES - The central system downloads map and preferred routing information to these modules for subsequent vehicle downloading. Additionally, these modules record individual vehicle departure and arrival transactions for future transmission to the central system. As important components, these systems are also backup component protected, however, a failure of one of these modules simply means that a given set of vehicles must rely on information already on board, while some station capabilities are limited. These modules also could be an utilized as an intermediate network link for the guideway system modules.

CENTRAL CONTROL SYSTEMS

The purpose of the transportation system central control is to provide tools for effective management of the transportation system as a whole, as follows:

SYSTEM NETWORK MONITORING - Serving as the central intelligence of the transportation system, the central control systems must verify communication with other system modules and report failures to initiate maintenance activity as required.

VEHICLE CONTROL - As previously mentioned, the vehicle does not depend on constant contact with the central system for nominal operation.

Periodically, the central systems (by way of station modules) will download each vehicle with a "map" of the guideway grid system and preferred routing algorithm for each possible point to point trip. This would not happen directly. The new maps are to be downloaded to modules at the stations, and from there to individual vehicles at appropriate link time. Based on traffic patterns and demand, this is expected to be somewhat dynamic.

Given that the central system has knowledge of traffic and demand patterns, it can be used to analyze optimal routing patterns to maximize and balance usage of vehicles and guideway assets.

VEHICLE TRACKING - The central system, in conjunction with guideway sensors, will monitor the progress of vehicles to expected destinations. When deviations occur, problem solving programs or processes are initiated, which in turn may result in combinations of maintenance personnel and/or robotic equipment deployment, and vehicle re-routing. Again, with the philosophy of failure tolerance, the design allows continued operation without constantly ready central systems.

As each vehicle leaves its departure station, under normal conditions, a report of its expected destination can be uploaded to the central system (or stored at local equipment for update if the central system is not queued up or able to receive data). Periodically, the central system can poll remote sensing and data storage equipment to verify expected locations of vehicles. On an exception basis, backtrack the expected route (checking for last known location) if expectations are not verified. Although a vehicle in some kind of failed mode would be expected to report this failure itself, some failure conditions would in fact prevent that from occurring.

VEHICLE AVAILABILITY - The central system will monitor demand and vehicle availability, re-routing idle vehicles as required from low departure demand stations to high departure demand stations. On a long term basis, data is available to be analyzed for recommendation of changes in track or station capacity, numbers of lanes, and vehicles. Resulting analysis will produce recommendations for optimal use of assets (vehicles and guideways) and improved customer service.

MAINTENANCE and EXCEPTION HANDLING - As vehicles report maintenance needs, they can be routed to appropriate facilities. Also, maintenance personnel can be automatically dispatched to traced locations of radically failed vehicles.

ACCOUNTING AND BILLING - Nothing is particularly unique about the accounting and billing requirements for this system, except that it is likely for the transaction volume to be very large. Additionally, the system will need to deal with both cash and credit, and direct interface to credit and bank systems. An audit of ticket sales against reported vehicle movements is one of the obvious functions.

Central System Throughput and Performance Considerations: The central systems need not be interrupted in real time by reporting from each active vehicle. Although this could be done, other design alternatives must be considered that are more tolerant of failure and system load and growth potential. Given the potential throughput of location movement transactions for thousands (perhaps hundreds of thousands) of vehicles, it would seem better to involve the central systems in vehicle movement tracking only on an exceptional or periodic polling basis. In addition, note that central system has been made plural, for multiple systems. Multiple processing units are envisioned, using either multiple systems for dedicated functions or multiple systems for multiple regions, with common functions. On the other hand, high speed processor technology is progressing at such a rapid rate, that any specific hardware and systems architecture imagined truly remains to be seen. Using state-of-the-art object oriented design and development tools, the resulting software will be reasonably portable to the best technology as it becomes available.

SUMMARY

The People Pods™ transportation concept provides the optimal solution for personalized, on-demand, mass transportation using the best of today's technology. To perform at its best as an effective, efficient system, sophisticated automated systems are required.

The most important considerations in automating this transportation system are reliability and flexibility in response to changes in real time transportation conditions and demand.

Each of the design requirements for automation can be met by careful consideration of readily available technology and the predictable interaction of system components in normal and failed modes. The probability of failure combinations that cannot be predicted will always exist. By designing components that are capable of performing independently, the impact of failures on the system as a whole can be minimized.

Today's transportation problems cannot be solved by improving today's existing transportation modes incrementally to their theoretical level of perfection.

Innovative concepts that break existing paradigms are required to approach the ideal of instantaneous, on demand, zero cost mobility.

REFERENCES AND RECOMMENDED READING

D. Malewicki, F. Baker, People Pods - *Miniature Magnetic Levitation Vehicles for Personal Non-Stop Transportation* , Aerovisions, Inc., June 1991.

Note: Considerable detail and many additional technical references which validate and expand on the People Pods™ Transportation Concept can be found in the above document.

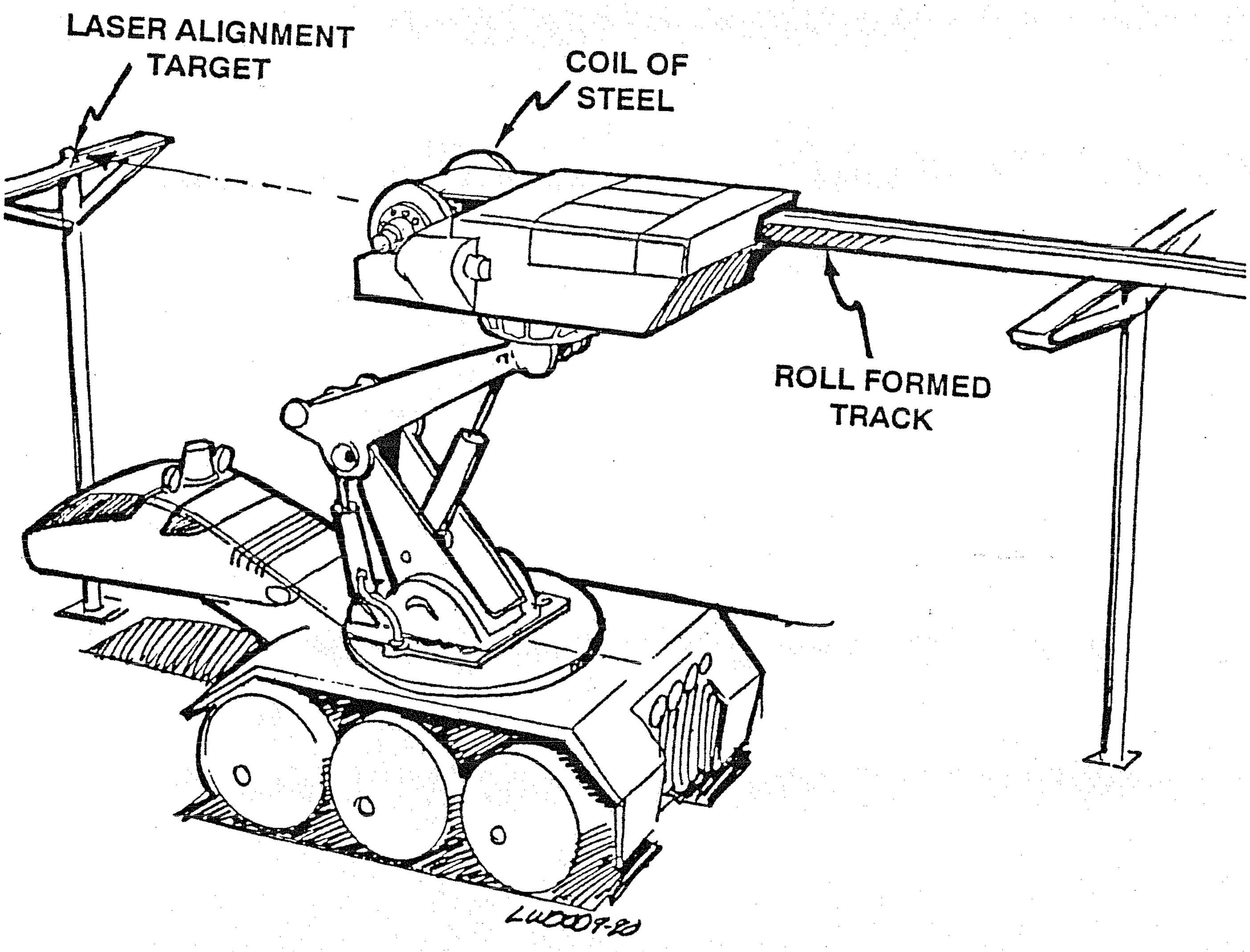
D. Malewicki, F. Baker, US. Patent # 5,108,052 - *Passenger Transportation System for Self-Guided Vehicles*, Issue Date Apr. 28, 1992

CHAPTER 6

ONE MILE PER DAY
ROBOTIC TRACK FORMING MACHINE

aero visions
INCORPORATED

ONE MILE PER DAY ROBOTIC TRACK FORMING MACHINE



Douglas Malewicki

October 19,1991

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aero visions

INCORPORATED

ROBOTIC TRACK FORMING MACHINE

The drawing on the previous page is from the Aerovisions, Inc. People Pod Society of Automotive Engineering (SAE) report (page 12). At first glance, the reader may be quite skeptical regarding both technical feasibility **and** our ability to successfully create such a machine. Since the People Pod prime directive is to **reduce** total installed per mile capital costs to 1/10th to 1/20th (and ideally even to 1/50th) of present mass transportation systems **per mile** costs, it **absolutely demands** such innovative concepts. We **must** design, build and **make** the robot work as intended.

In order to put such a design/engineering task into proper perspective we have attached some photos and material on ROBOSAURUS. This 58,000 pound, 40 foot tall, fully mobile machine was created by Aerovisions president, Doug Malewicki and his team. The proposed track forming machine is in reality **a much less complicated** machine with a lot less functions than ROBOSAURUS. Aerovisions has both the technical qualifications and a proven, respected track record for this type of **inventing to order.**

CONTINUOUS ROLL FORMING OF MONORAIL TRACK FROM COILS OF SHEET STEEL

Hopefully, the reader is familiar with the seamless rain gutter roll forming equipment carried entirely in a single van. Easily stored rolls of thin gage pre-painted coil stock are used to produce any desired precise lengths of rain gutter segments for homes.

It would be an easy engineering design task to add built-in shrink and stretch post forming hydraulic rollers/grippers. The reader should now be able to envision a rain gutter that as it comes out of the machine, actually gently skews the formed structural shape left or right or up or down **as desired.**

In a similar manner, the PEOPLE PODS track could be continuously manufactured in place by a large, mobile, computer controlled and computer stabilized version of a rain gutter making, roll forming machine with automatic welding of the seam. In our case, however, the track stays fixed in space while the forming machine travels from pole to pole at exactly the speed the product is emerging. Thus, a very **strong and stiff** monorail track could be produced which is simultaneously being gently deformed to permanently turn left and right and climb and descend as necessary to follow the available terrain. The track could also be produced with a built-in precision twist to provide the banking needed to more comfortably negotiate high speed curves.

PS: A better understanding of the more complex nature of our ROBOSAURUS beast and it's capabilities can be obtained by watching "STEEL JUSTICE", a two hour Universal Studios Television live action pilot featuring ROBOSAURUS that will air nationally on NBC, Sunday April 5, 1992 from 9 to 11pm.

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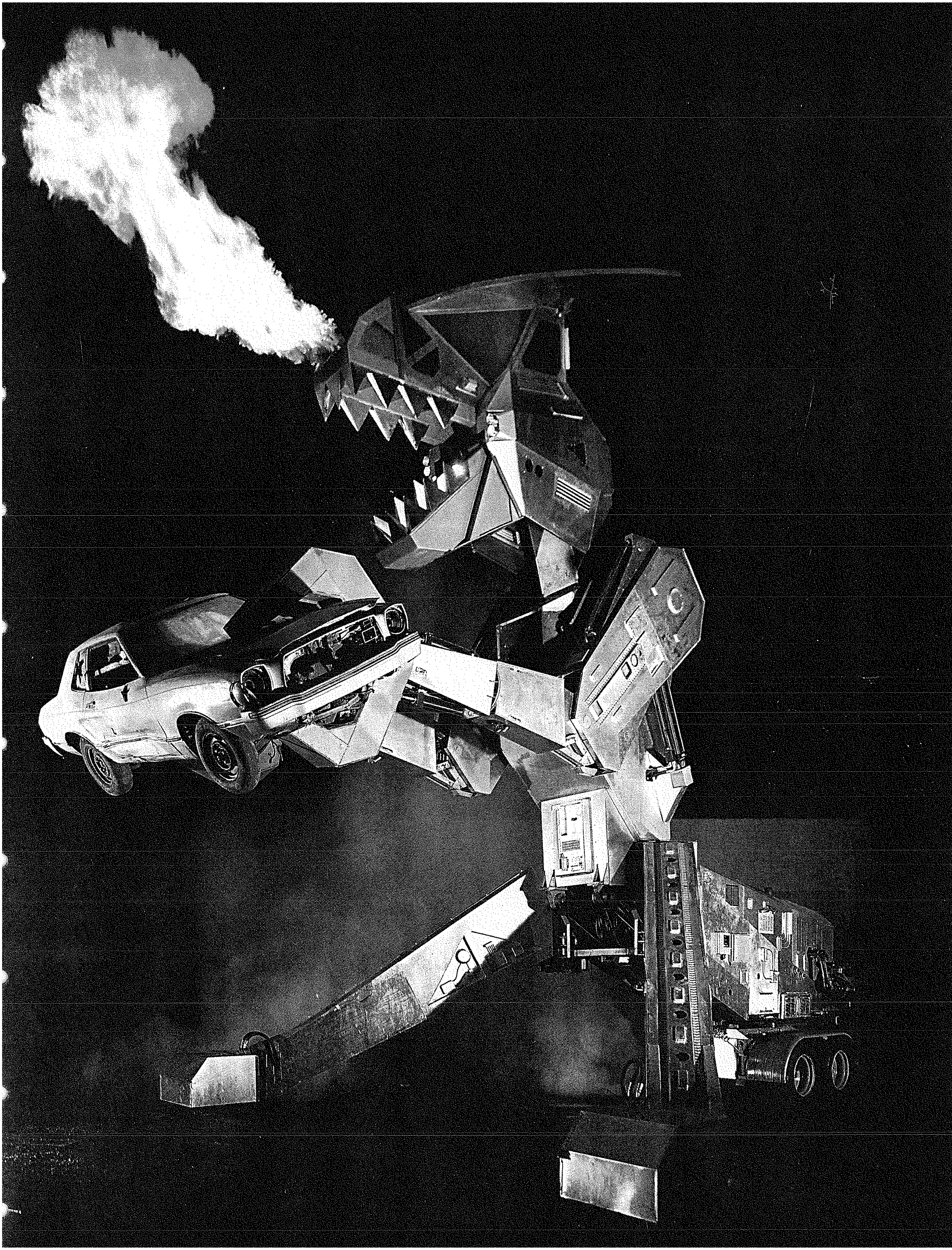

Step aside GODZILLA and KING KONG. Enough mere fantasy...

NOW it's time for REALITY!!!

MONSTER ROBOTS, INC.

presents

ROBOSAURUS™

THE WORLD'S FIRST CAR-NIVOROUS MONSTER

- ☐ An electrohydromechanical creature of prehistoric proportions.
- ☐ Stands 40 feet tall (twice as tall as Tyrannosaurus Rex).
- ☐ Weighs 56,000 pounds.
- ☐ Lifts 4,000 pound cars up higher than a 5 story building.
- ☐ Breathes 20 feet fingers of flame that incinerate paint and plastic.
- ☐ Crushes cars with 24,000 lbs. of gripping force.
- ☐ Bites and rips out roofs and doors using menacing razor sharp stainless steel teeth.
- ☐ Hydraulically transforms into a legal, licensed trailer for travel across the nation's highways.

Built at a cost of $1.5 million, ROBOSAURUS is the most incredible man made monster ever conceived. He grips, lifts, crushes, burns, bites, pounds and throws his victims - full size cars around with ease! ROBOSAURUS, the largest fully articulated robot ever built, is controlled by a human pilot strapped inside the monster's cranium - just like the imaginary TRANSFORMER and GOBOT toys.

Monster Robots, Inc. worked closely with P-Q Controls, Inc. of Bristol, Connecticut to develop a sophisticated fly-by-wire electronic system that enables a single operator to have full independent control of 18 hydraulic functions simultaneously. This is essential for smooth lifelike coordinated motion during a show.

Each of the 18 motions has it's own devoted P-Q Control, Inc. solid state computer brick. These P-Q "valve drive boards" take the pilot's simple "up and down" microswitch keyboard commands, converts them to the simulated (and totally tunable) proportional pulse width modulated signals which operate the hydraulic valves. All this and the ears wiggle, too!

For enhanced safety of both the pilot and the spectators, a ground crew is in constant communication with ROBOSAURUS'S pilot. In the event of any danger or malfunction, the ground crew can take over control of the monster at any time using a compact hand held P-Q Controls, Inc. INFRARED REMOTE CONTROL unit.

P-Q has earned an international reputation for excellence in engineering, sturdiness and adaptability for electronic controls AND only P-Q Controls, Inc. offers MULTI-LINK choices:

- ☐ WIRE (multiplexing via twisted pairs)
- ☐ FIBER OPTICS (electrically isolated)
- ☐ INFRARED (tetherless)
- ☐ RADIO REMOTE (for long range)

"I have had tremendous success with P-Q Controls ... not one failure of any kind ... the very best technical support and product education ... without P-Q, a single pilot could not even begin to operate my toy properly."

Doug Malewicki

Inventor, Designer and Engineer of Robosaurus

Monster Robots, Inc.
11110 Tuxford Ave.
Sun Valley, CA 91352
(818) 767-0758, (714) 559-7113

P-Q Controls, Inc.
95 Dolphin Road
Bristol, CT 06010
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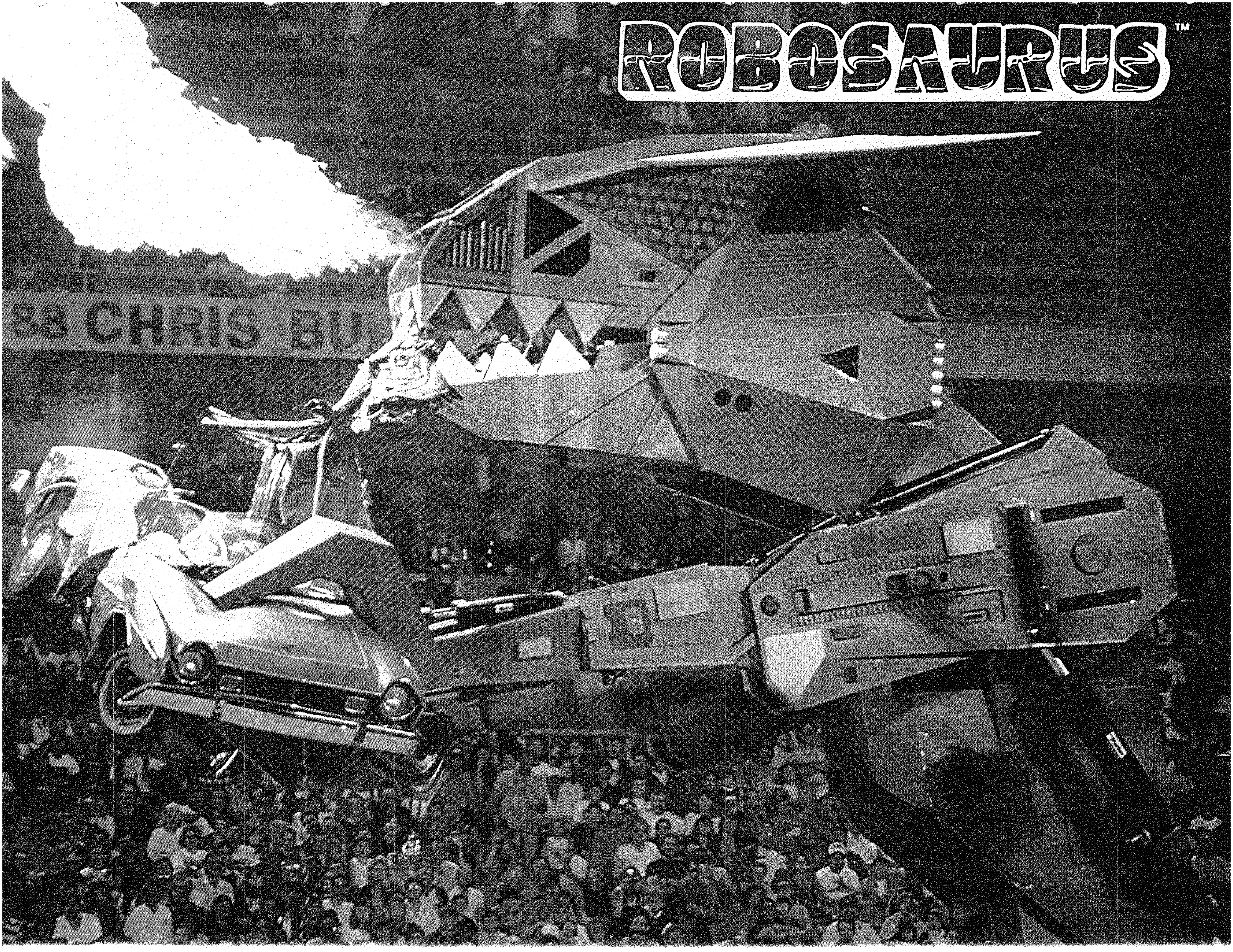

ROBOSAURUS™
88 CHRIS BU

CHAPTER 7

PRELIMINARY PEOPLE POD MONORAIL TRACK COST ANALYSIS

PRELIMINARY
PEOPLE POD
MONORAIL TRACK COST ANALYSIS

Douglas J. Malewicki
President
Aerovisions, Inc.
August 28, 1990

PRELIMINARY COST ANALYSIS
Table of Contents

1. SUPPORT POLES

Due to the light weight of the PEOPLE POD system, we have selected common street lighting utility poles to provide the necessary structural support. Because of the inherent strength of steel tapered tubes, several wind mill manufacturers have used this same approach to safely support some very large bending moments. Also, since the poles are already produced in reasonable quantities they are fairly inexpensive. The current cost is known to be approximately $2000 per complete installation in Orange County, California.

Because of the large quantity of pole installations required, we envision bringing that cost down thru the use of large hydraulic pole handling machines and a moving assembly line semi-automated process. By reducing the labor component and by using a high degree of automation, in conjuction with significant material quantity discounts we expect we could reduce the installed cost to less than $1,500 per support pole and have used that figure in our cost analysis summary.

2. MONORAIL TRACK

The track itself must meet severe criteria for static and dynamic structural strength, deflection and cost. In addition, provision for power transfer to the PEOPLE PODS must be included, as well as a wear surface, a traction surface, POD trapping to the track and POD switching.

MATERIAL COMPARISONS

A. ADVANCED STRUCTURAL COMPOSITES

A zero thermal expansion, high modulus Graphite composite structure (as proposed for the space station) would be wonderful, exciting, high-tech, etc. A 20 foot section of such track would only weigh 40 pounds and have excellent long term corrosion properties. Unfortunately, at a processed price of about $50 per pound would mean a cost of $2 million per mile for the two lanes of track alone.

B. ALUMINUM

Aluminum is 35 percent the weight of steel and can have yield and ultimate structure properties somewhat higher than basic steels. Unfortunately, aluminum also has one third the stiffness of steel, much more cost and double the thermal coefficient of expansion.

C. STEEL

The embodiment that presently intrigues our team is the use of corrosion proof weldable steels. Early analysis is showing strength with more than adequate safety factors along with suitable stiffness for minimum deflection (track sag) at very low per mile costs when steel is selected.

CONTINUOUS ROLL FORMING FROM COILS OF SHEET STEEL

Hopefully, the reader is familiar with the seamless rain gutter roll forming equipment carried entirely in a single van. Easily stored rolls of thin gage pre-painted coil stock are used to produce any desired precise lengths of rain gutter segments for homes.

It would be an easy engineering design task to add built-in shrink and stretch post forming hydraulic rollers/grippers. The reader should now be able to envision a rain gutter that as it comes out of the machine, actually gently skews the formed structural shape left or right or up or down as desired.

In a similar manner, the PEOPLE PODS track could be continuously manufactured in place by a large, mobile, computer controlled and computer stabilized version of a rain gutter making, roll forming machine with automatic welding of the seam. In our case, however, the track stays fixed in space while the forming machine travels from pole to pole at exactly the speed the product is emerging. Thus, a very strong and stiff monorail track could be produced which is simultaneously being gently deformed to permanently turn left and right and climb and descend as necessary to follow the available terrain. The track could also be produced with a built-in precision twist to provide the banking needed to more comfortably negotiate high speed curves.

As with welded steel railroad track, we may have to allow the track to float on the poles to allow for thermal expansion and contraction. Alternatively, expansion joints may have to be located every so often. Those joints, if any, should be multiple slip fingers to maintain a perfectly smooth track surface (as far as the contact patch width of the pneumatic tires is concerned).

ROLL FORMED TRACK COST ESTIMATES

For simplified analysis purposes, let's assume the track structure is a continuously formed and auto-seam welded elementary round hollow tube. Cold rolled sheet stock currently sells at 36 cents per pound in small 1000 pound quantities. Galvanized currently sells at 47 cents per pound (no we wouldn't be welding galvanized - it's just an example of the extra cost for obtaining basic corrosion protection) .

Note that our crossection shape needs to be optimized for maximum stiffness per dollar and must necessarily be the POD trap, traction/ wear surfaces and conductor supports. As an alternative, two channel-like formed segments separated by a bonded insulator may well be a more optimum cost effective selection.

Final design will take serious brainstorming along with iterative structural analysis and cost analysis to come up with the very best possible trade off and standard for all future track. Aerovisions, Inc. already has $50,000 plus of time invested in this project and we will only get into all those detail designs and manufacturing optimization details once funding to continue the project is obtained.

For preliminary cost analysis purposes, we will be conservative and assume the basic track metal will cost as much as $1.00 per pound (rather than the $.36 quoted for a small 1,000 pound purchase). Even with the $1/lb figure, the calculations of Table I still shows low cost possibilities.

INSTALLATION TEAM LABOR COSTS AND SPECIALIZED MACHINE COSTS

Again the goal is to completely build one mile of track per day. We envision that two shifts will be required.

Table II gives the rationale for both total labor costs per mile and specialized machine costs (amortization, spare parts, maintenance). An artists drawing detailing this moving assembly line concept should be ready by mid September. This perspective drawing should help ones understanding of the possible robot-like automation machine concepts.

It must be emphasized that the roll forming machine is just a concept at this stage. No analysis has been completed for the hydraulic horsepower required for forming the three foot wide 12 gage steel, nor has any design details or size or weight calculations even been begun. Also, it would be desireable if the machine could legally be trailered on the highways without permits - meaning it should be less than 60,000 pounds in weight and not more than 48 feet long, 8 1/2 feet wide and 13 1/2 feet tall when retracted for transport.

The in-place roll forming machine concept may seem a complex method to produce PEOPLE POD track initially, but the benefits once developed should be obvious. Also, a lot depends on if such a machine would take $4 million vs $40 million to perfect.

Other methods of producing track obviously will be explored. As an example, simple truss work structures, while not as aesthetic nor futuristic in appearance, could be designed to reduce material costs even further. The trade off here would be against possible higher installation labor costs.

PREPARED BY
D. J. MALEWICKI
AUG 26, 1990

TABLE I — TRACK MATERIAL COST

PRELIMINARY MONORAIL TRACK — COST VERSUS STRENGTH MATRIX

ASSUMPTIONS : 1) COLD ROLLED STEEL SHEEL, $\sigma_{YIELD} = 27,500$ PSI, $\sigma_{ULT\ TENSION} = 50,000$ PSI
$E = 30 \times 10^6$ LB/IN², $\rho = .283$ LB/IN³.

2) ON A 20 FOOT SPAN, TWO 10 FT LONG PODS (TWO PASSENGER TYPE) GROSS WEIGHT OF 600 LBS EACH IS DISTRIBUTED UNIFORMLY FOR ADDITIONAL 60 LB/FT LOAD.

3) MONORAIL TUBE IS FORMED FROM 3 FT WIDE SHEET STOCK, THUS FINAL OD = 11.46" = 36"/π

4). TOTAL WEIGHT SUPPORT BETWEEN 20 FT POLES IS $wl = w \times 240"$

PREPARED BY:
D. J. MALEWICKI
8-25-90

MATERIAL THICKNESS (t)	18 GAGE (.048")			12 GAGE (.105")		
WEIGHT / FT²	2.00 LBS/FT²			4.375 LB/FT²		
WEIGHT PER FT OF TRACK	6.00 LBS/FT			13.125 LB/FT		
PODS + TRACK (w) WEIGHT PER FT	66.00 LBS/FT = 5.5 LB/IN			73.125 LB/FT = 6.0937 LB/IN		
$/FOOT @ $1/LB MTL COST.	$6.00/FT			$13.125/FT		
$/MILE (2 TRACKS = 10,560 FT)	$63,360/MILE			$138,600/MILE		
TUBE MOMENT OF INERTIA $I = \frac{\pi}{8} D^3 t$	28.133 IN⁴			61.822 IN⁴		
DISTANCE TO OUTER FIBER C=R=	5.73"			5.73"		
BEAM LOADING CONDITION	SIMPLE SUPPORT*	CONTINUOUS**	FIXED ENDS*	SIMPLE SUPPORT	CONTINUOUS	FIXED ENDS
MAXIMUM BENDING MOMENT M_{MAX}	$= \frac{1}{8} wl^2$ = 39,600 INLBS	$= .1071\, wl^2$ = 33,929 INLBS	$= \frac{1}{12} wl^2$ = 26,400 INLBS	43,875 INLB	37,592 INLB	29,250 INLB
MAXIMUM BENDING STRESS $\sigma = M_{MAX} \frac{C}{I}$	8,065 PSI	6,912 PST	5,377 PST	4,066 PSI	3,484 PSI	2,711 PSI
SAFETY FACTOR = $\frac{27,500 \text{ PSI } \sigma_y}{\text{ACTUAL BENDING } \sigma}$	3.41	3.97	5.11	6.76	7.89	10.14
MAXIMUM BEAM DEFLECTION δ	$= \frac{5}{384} \frac{wl^4}{EI}$ = .228"	$= .0065 \frac{wl^4}{EI}$ = .141"	$\frac{1}{384} \frac{wl^4}{EI}$ = .056"	.141"	.071"	.028"

* REFERENCE — ROARK — FORMULAS FOR STRESS AND STRAIN

MAST

PREPARED BY
D.J. MALEWICKI
AUGUST 27, 1990

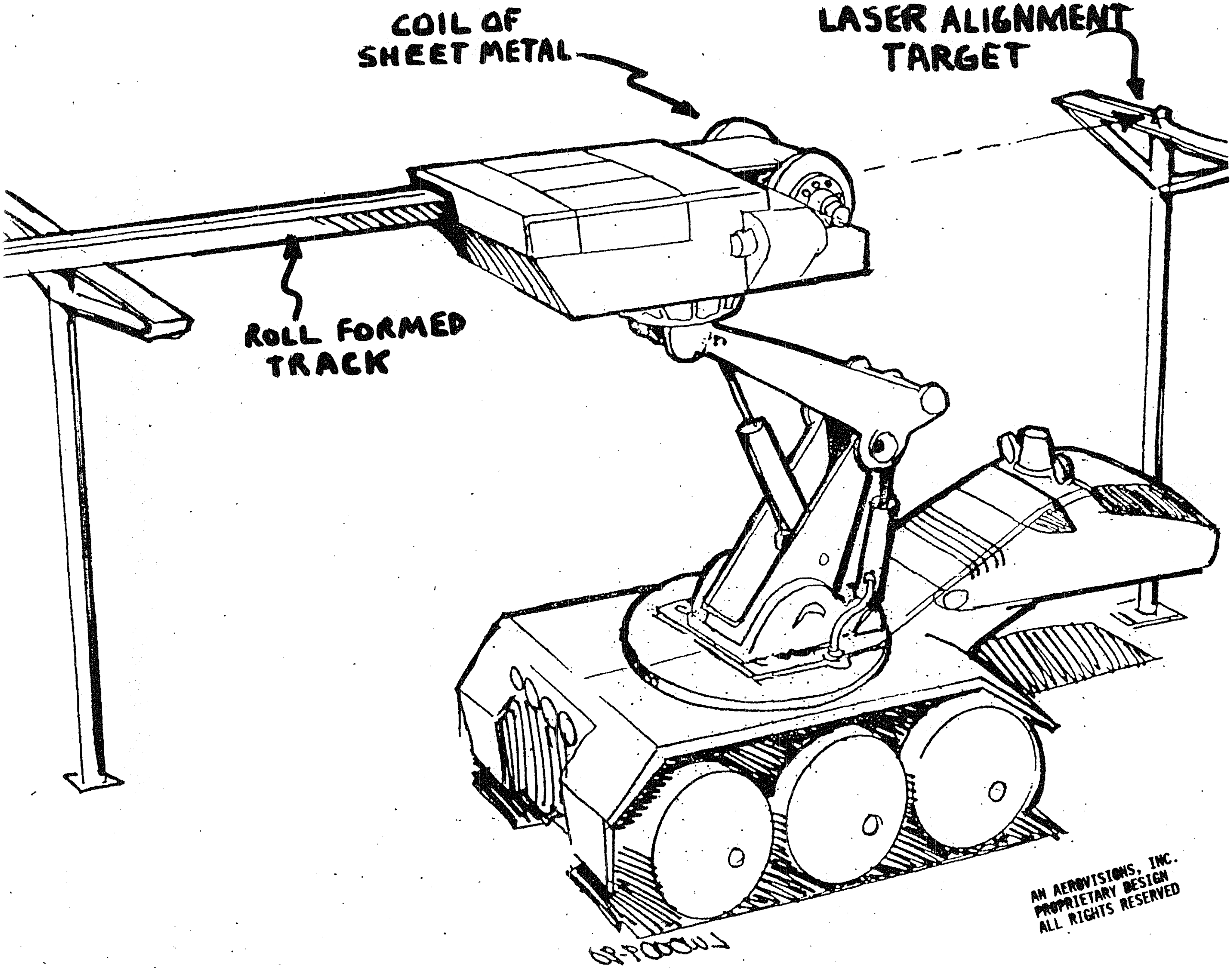
TABLE II

PRELIMINARY MONORAIL TRACK INSTALLATION TEAM LABOR COSTS AND AUTOMATION MACHINE COSTS

ASSUMES:
1) 6 HOURS EFFECTIVE RATE OUTPUT PRODUCED ON EACH 8 HOUR SHIFT.
2) 2 SHIFTS PER DAY PRODUCING TRACK
3) POSSIBLE 3RD SHIFT FOR AUTOMATION MACHINE MAINTENANCE.

ITEM	WORK RATE PER TEAM	NO. OF TEAMS REQUIRED	NUMBER OF MEN ON A TEAM	TOTAL DAILY TEAM LABOR COST	AUTOMATION MACHINE COST/HR.	TOTAL DAILY MACHINE COSTS
MONORAIL TRACK FORMING TEAM	1,000 FT/HR (= 3"/SEC) = 6,000 FT/SHIFT	4 (2/SHIFT)	TRUCK DRIVER (MORE COILS) \$25 \$40 2 ROBOT OPERATORS \$40 \$105	\$6,720	\$400/HR EACH (2 REQUIRED) = \$800/HR	\$12,800
FINAL ALIGNMENT TEAM	1,000 FT/HR = 50 POLES/HR	4 (2/SHIFT)	2 INSPECTOR \$40 LASER OPERATORS \$40 2 WELDERS \$25 \$25 \$105	\$6,720	\$100/HR EACH (4 REQUIRED) ≃ \$400/HR	\$6,400
MAINTENANCE TEAM	—	1	MAINTENANCE ENGINEER \$40 + HELPER \$25 SPARE PARTS TRUCK DRIVER \$25 \$90	\$2,880	\$50/HR	\$800
				\$16,320		\$20,000

THUS TOTAL TRACK COST (10,560 FT) INCLUDING MATERIAL WOULD BE:
\$138,600 + \$16,320 + \$20,000 = \$174,920
WHICH IS \$15.56/FT INSTALLED


COIL OF
SHEET METAL
LASER ALIGNMENT
TARGET
ROLL FORMED
TRACK
AN AEROVISIONS, INC.
PROPRIETARY DESIGN
ALL RIGHTS RESERVED

3. SWITCHES

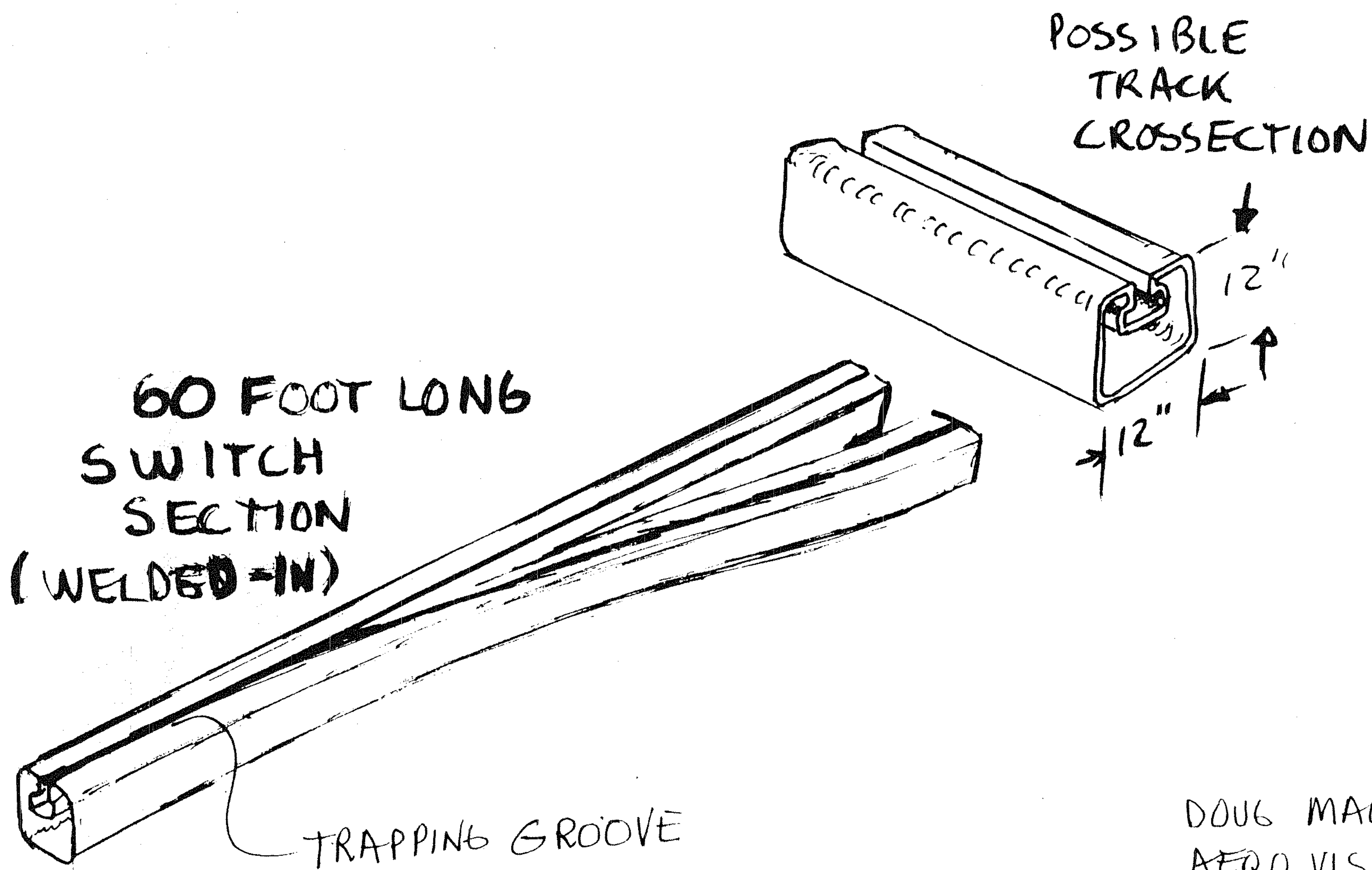
Only two high speed "decision-to exit" switches are required per mile of track (four total including both lanes of track). The first switch is for leaving the track and dropping down to a station and the second is to leave the current straight-thru track to slow down to prepare to turn right or left at a grid interchange.

There also will be two high speed "merge-in" passive switches required per mile. One for PODS climbing up onto the system from a station and another for PODS merging in from the perpendicular grid interchange location (four total for both lanes).

It is important to note that as currently envisioned, NO portion of our switches MOVE. Switching is entirely done by moving components in the POD itself. Of course, for safety and to prevent any possibility of derailment, the POD remains trapped by the track at all times, whether or not the POD goes straight or exits the main track at a switch point.

Moving switch components were eliminated to make the track as maintenance free as possible. Mechanical switching would have to be absolutely positive, especially when the pods are spaced at only 1/2 second intervals. This would incur computer hookups to each and every switch, positive switch open/close sensing, very fast acting hydraulic powered structural components, large inertial loads, and immense resultant wear and tear. ie: zero long term reliability, repeatability and safety.

With the present passive switch concept, cost is reduced to just two special sections of track namely: A) "decision-to-exit" or B) "merge-in". These would be modular 60 foot long truckable assemblies (estimated 1,300 pounds each) that could be built in jigs and fixtures at a remote plant, transported to the site, manipulated off the truck and up into proper position with special robot machines and then welded up in place.

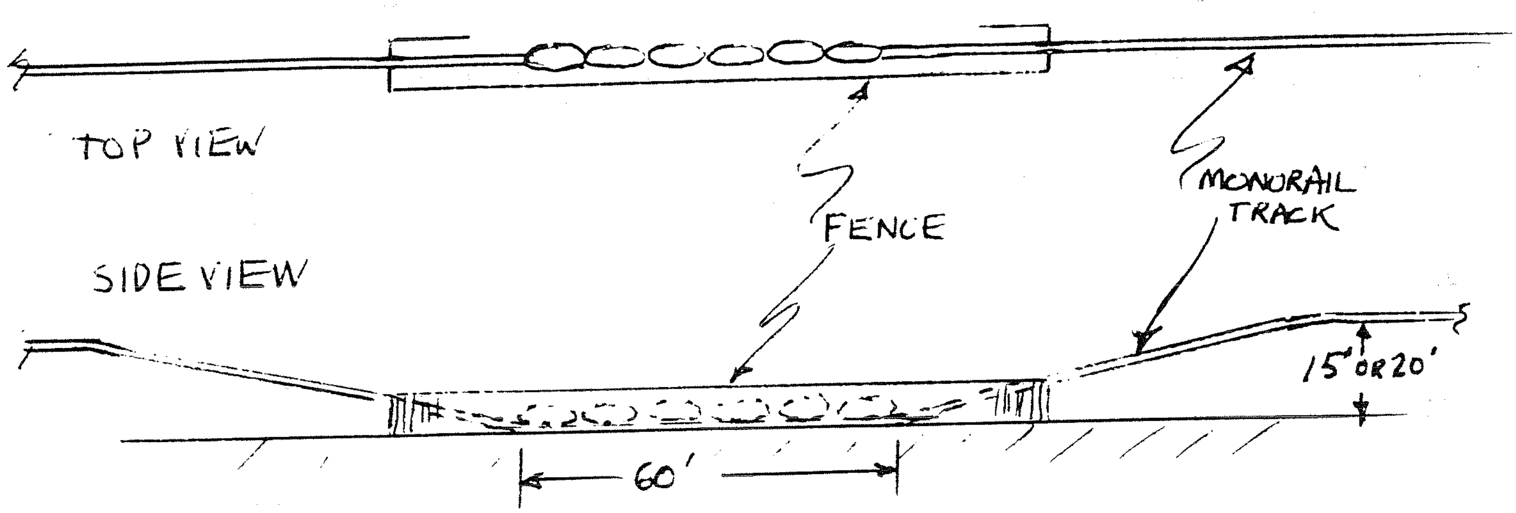


DOUG MALEWICKI
AERO VISIONS, INC
9/14/90

4. STATIONS

There will be one drop off station for each lane once each mile. A simple station with an availability of six two passenger pods (10 feet long each) would take up the same ground distance as one bus. With track branches or longer ground track to increase the number of PODS available for departure, costs would go up proportionately. We also would want a simple barrier wall once the pod is below the 6 foot above the ground level to prevent anyone from walking across or onto the track and being hit. Besides the expense for track segments, the fence should be the only additional expense and should cost no more than $5,000. Figure 1 shown below should convey the idea:

FIGURE 1 - STATION WITH FENCE



The largest cost component in building a drop off station is in the extra track length used to decelerate from 100 MPH to zero MPH and then later on to reaccelerate back up to grid speed from zero MPH. Each station would require an extra 993 foot of parallel track for deceleration at 1/3 g (or 662 feet at 1/2 g). Thus, after switching off the main lane - approximately 1,000 feet of extra track is needed to slow down, plus 70 foot to transition and descend to the 60 feet long horizontal ground level transfer station track. 70 feet more are needed to climb up and lastly another 1,000 feet to accelerate up to speed before merging on to the main lane (2,200 feet total).

5. GRID INTERCHANGE

First we must note that the cost of the straight-thru track sections for our grid interchange have previously been accounted for. Also, the cost of the high speed "decision-to-exit" switch segments (for a possible left or right turn) have been accounted for, as well as the respective "merge-in" switch.

What remains then is some additional track and a 15 MPH LOW SPEED "exit" switch and "merge-in" switch.

The enclosed very preliminary three dimensional modular non-stop interchange sketch of Figure 2, can be used to calculate the extra track (final artwork for this concept to be available mid September).

1. The length of a 90 degree turn of 45 foot radius is 70 feet (4 required).
2. The length of straight cross track portion is 15 feet (4 required).
3. The slow speed exit switch is equivalent to 10 feet of parallel track (2 required).
4. The slow speed merge-in switch is also equivalent to 10 feet of parallel track (2 required).

Thus, each 1 mile segment of track bears a portion of its respective interchange cost at each end and this can be represented by the cost of an additional 320 feet of track (ie: 4 x70 + 4 x 15 + 2 x 2 x 10 + 2 x 2 x 10).

Also note that if we are clever, we can eliminate 2000 feet of the track cost involved in decelerating to a mid-mile station location (1000 feet used for each of PEOPLE POD flow). By locating stations just past a grid intersection, we can utilize the same switch and deceleration track used in preparing to turn. Another cost benefit is that a long high speed switch segment is replaced by a short low speed switch segment (which is necessarily located just before the low speed left hand turn is made).

Obviously, a three dimensional working model would clarify this cost saving element. We intend to build such an architectural model as well as computer animate a typical use of the system when funding permits.

Table III summarizes all the component costs for a complete one mile of track with respective portions of an interchange and with drop down unloading/boarding stations for both lanes.

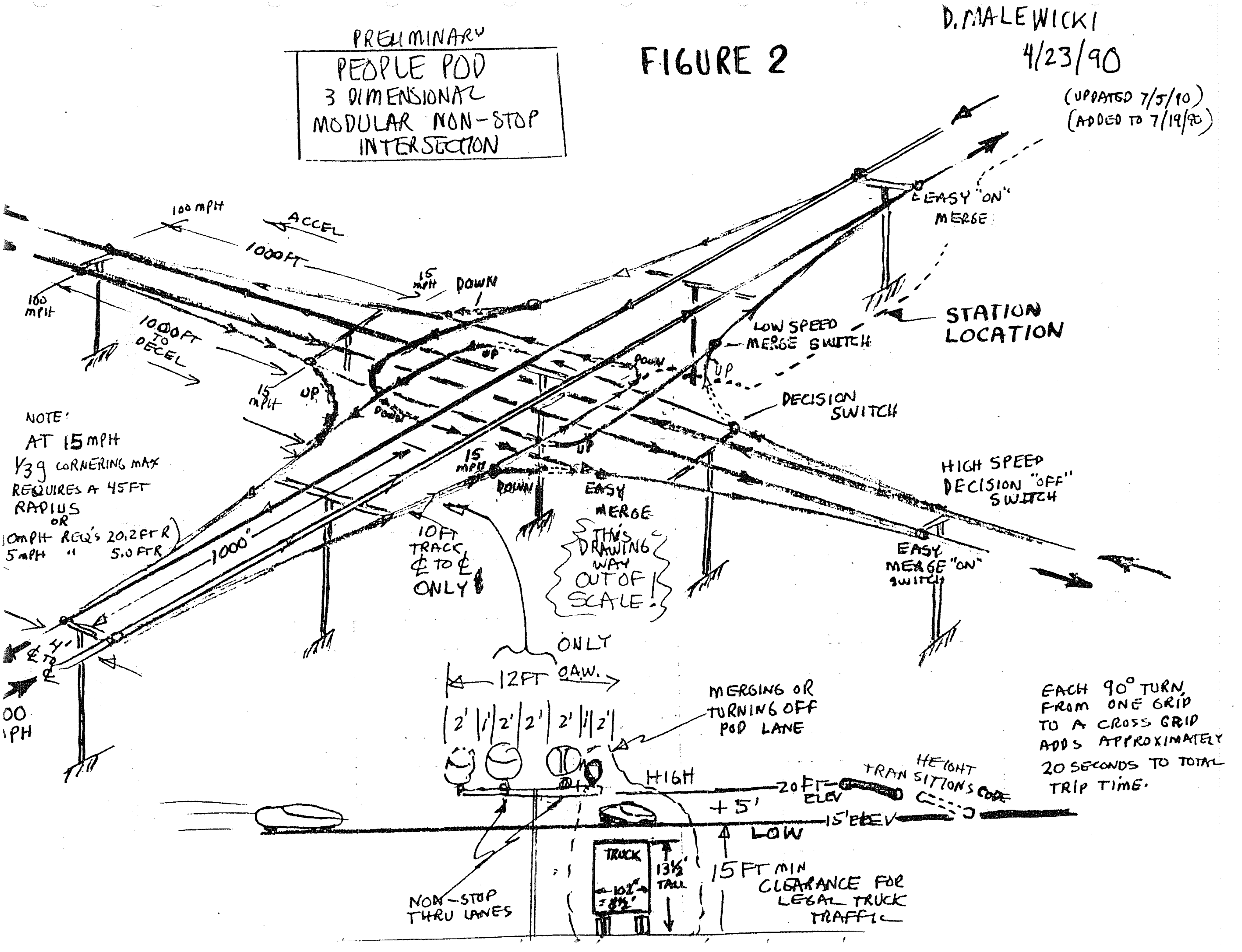

PRELIMINARY
PEOPLE POD
3 DIMENSIONAL
MODULAR NON-STOP
INTERSECTION
FIGURE 2
D. MALEWICKI
4/23/90
(UPDATED 7/5/90)
(ADDED TO 7/19/90)
100 mPH
ACCEL
1000 FT
100 mPH
1000 FT TO DECEL
15 mPH
DOWN
UP
EASY "ON" MERGE
STATION LOCATION
LOW SPEED MERGE SWITCH
DECISION SWITCH
HIGH SPEED DECISION "OFF" SWITCH
EASY MERGE
EASY MERGE "ON" SWITCH
THIS DRAWING WAY OUT OF SCALE!
NOTE:
AT 15 mPH
1/3 g CORNERING MAX
REQUIRES A 45 FT RADIUS
OR
10mPH REQ'S 20.2 FT R
5 mPH " 5.0 FT R
1000'
10 FT TRACK ℄ TO ℄ ONLY
ONLY
12 FT OAW.
2' 1' 2' 2' 2' 1' 2'
MERGING OR TURNING OFF POD LANE
HIGH
20 FT ELEV
+5'
15' ELEV
LOW
TRAN SITIONS HEIGHT
15 FT MIN CLEARANCE FOR LEGAL TRUCK TRAFFIC
TRUCK
13½' TALL
102" 8½'
NON-STOP THRU LANES
EACH 90° TURN FROM ONE GRID TO A CROSS GRID ADDS APPROXIMATELY 20 SECONDS TO TOTAL TRIP TIME.

TABLE III

PEOPLE POD MONORAIL TRACK

SUMMARY OF TOTAL COST PER MILE

ITEM	REQUIREMENTS	TOTAL INSTALLED COST	% OF GRAND TOTAL
1. SUPPORT POLES	SUPPORTS LOCATED EVERY 20 FEET $\frac{5{,}280 \text{ FEET}}{20 \text{ FEET}}$ = 264 POLES AT $1,500 COST EACH INSTALLED	$396,000	56.0%
2. MONORAIL TRACK	TWO STRAIGHT ONE MILE LANES 5,280 FEET X 2 X $15.56/FT INSTALLED COST	$174,920	24.7%
3. SWITCHES	TWO HIGH SPEED "EXIT" SWITCHES FOUR " " "MERGE-IN" SWITCHES } 6 X $3000 INSTALLED = 18,000	$18,000	2.5%
4. STATIONS	TWO LOW SPEED "EXIT" SWITCHES 2x500 = 1000 TWO 70' TRANSITION TO DESCENT TWO 60' OF STATION TRACK TWO 70' TRANSITION TO ASCEND TWO 1,000' ACCEL SEGMENT } 2,400 FT X $15.56/FT INSTALLED = $37,344 TWO FENCES @ $5,000 EACH $10,000	$48,350	6.8%
5. INTER-CHANGE	FOUR 90° TURNS @ 70' EACH FOUR CROSS TRACKS @ 15' EACH } 340 FT X $15.56/FT INSTALLED = $5,290 FOUR LOW SPEED "EXIT" SWITCHES TWO LOW SPEED "MERGE" SWITCHES } 4 X 500 = 2000 TWO 1000' DECEL SEGMENT TWO 1000' ACCEL SEGMENT } 4,000 FT X 15.56 = 62,240	$69,530	9.8%
		$706,800	

NOTE: TOTAL COSTING BASED ON STATIONS ADJACENT TO GRID INTERCHANGE TO ELIMINATE COST OF TWO HIGH SPEED SWITCHES AND TWO 1,000 FEET SEGMENTS OF DECELERATION TRACK

PREPARED BY
D. J. MALEWICKI
AUG 29, 1990

CHAPTER 8

MONORAIL PEOPLE PODS

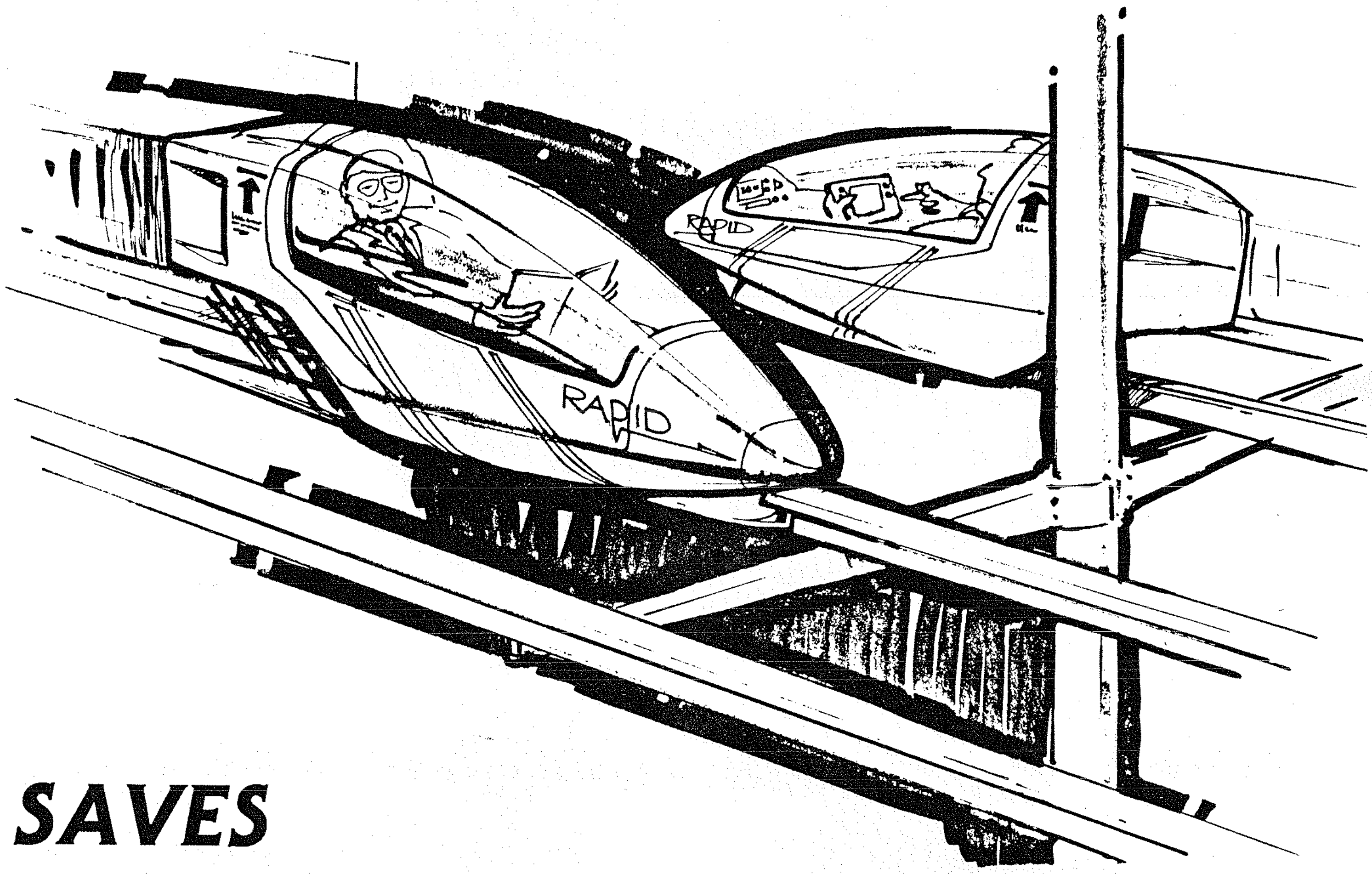
MONORAIL

PEOPLE PODS™

HIGH SPEED ❑ LOW COST

SUPER ENERGY EFFICIENT ❑ ENVIRONMENTALLY RESPONSIBLE

PERSONAL/PUBLIC TRANSPORTATION



SAVES

- ❑ TRAVEL TIME
- ❑ ENERGY
- ❑ LIVES
- ❑ COSTS

MINIMIZES

- ❑ STRESS
- ❑ TENSION
- ❑ POLLUTION

14962 Merced Circle, Irvine, California 92714 (714) 559-7113,4 Fax: 289-0216

SAVES TRAVEL TIME

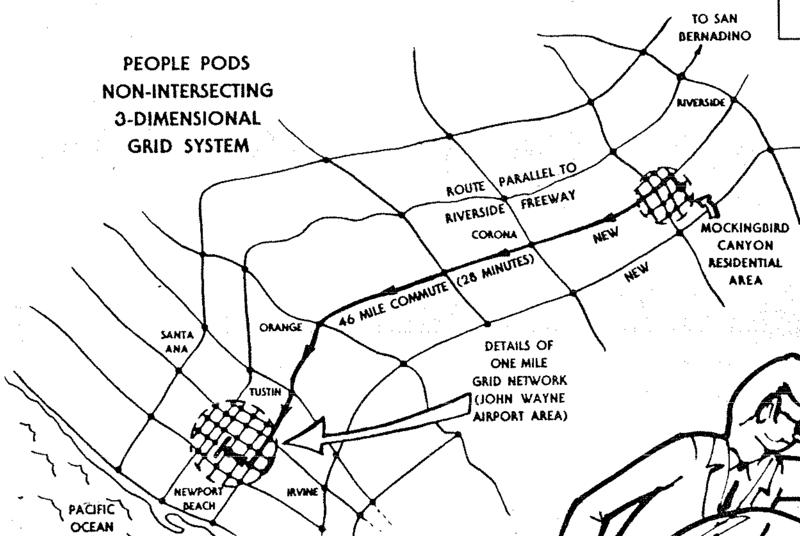
High Speed Steady **100 MPH cruise speed.**

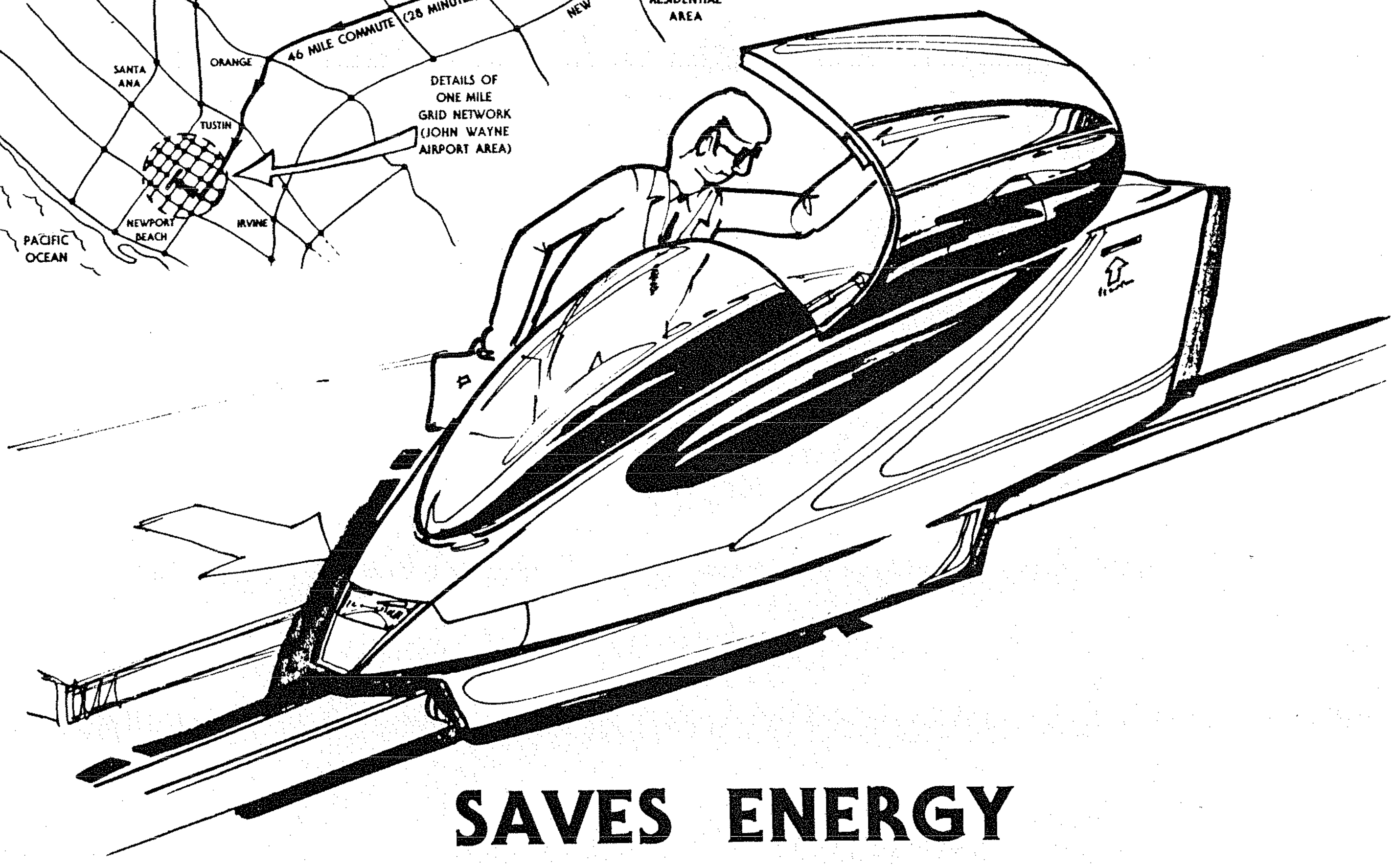
NO WAITING for a scheduled bus or train to arrive.

Go **NON-STOP** to your destination.

Travels directly from your pickup station on the grid network to **any other** grid station <u>**you**</u> **select.**

TRAVEL METHOD	AVERAGE SPEED	TIME TO COMMUTE 25 MILES	TIME TO COMMUTE 50 MILES
BUS (many stops)	20 MPH	75 Minutes	150 Minutes
AUTO (congested freeway)	35 MPH	43 Minutes	86 Minutes
TRAIN (light rail with stops)	45 MPH	33 Minutes	67 Minutes
AUTO (max legal speed)	55 MPH	27 Minutes	55 Minutes
PEOPLE PODS (non-stop)	100 MPH	15 Minutes	30 Minutes





SAVES ENERGY

Inherent safety of self guided vehicles and **collision proof**, three dimensional grid system, permits extremely **light weight** vehicle design.

Light weight and streamlined **aero design** yields **phenomenal 370 MPG energy efficiency at 100 MPH.**

NON-STOP operation **eliminates energy waste** of idling, and the constant acceleration and deceleration required in traditional surface transportation.

PEOPLE PODS travel **safely** at **100 MPH** (versus 55 MPH for cars) and use **95% less energy!**

VEHICLE TYPE	FUEL EFFICIENCY	FUEL COST	ENERGY COST PER 100 MILES	DAILY PARKING COST
Typical Car	20 MPG	$1.15 Per Gallon	$5.75	Zero to $5.00
Economy Car	33 1/3 MPG	$1.00 Per Gallon	$3.00	Zero to $5.00
Non-Stop People Pod	370 MPG* at 100 MPH	$.069 Per Kilowatt Hour	$0.27	Always Zero

* Gasoline Equivalent

SAVES LIVES

Eliminates any possibility of **collisions** due to driver error.

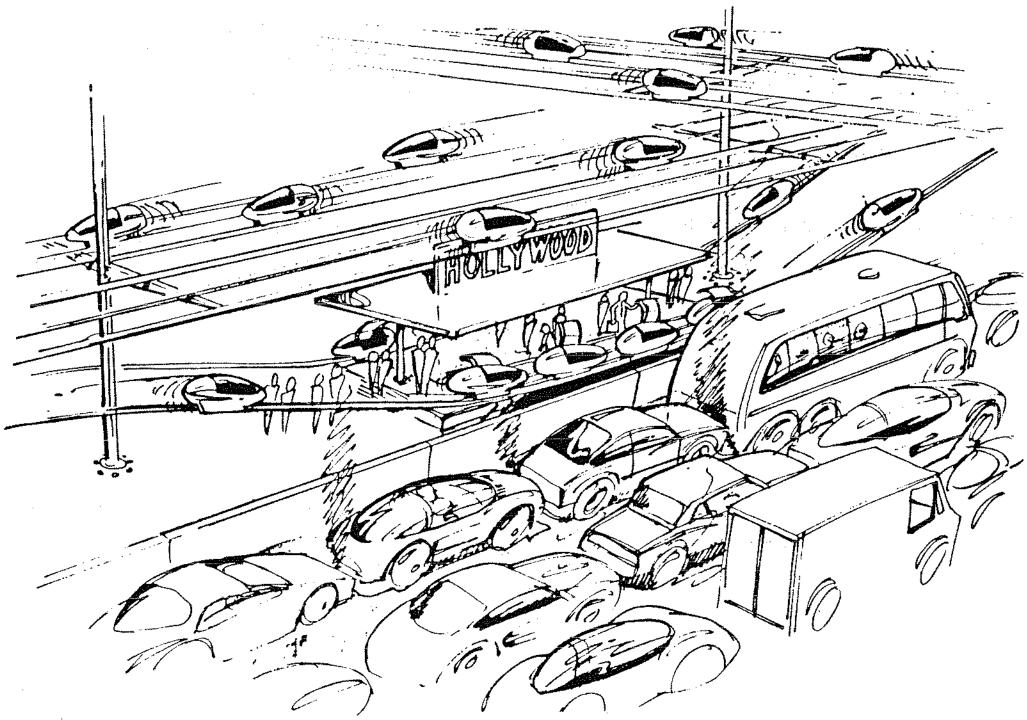
No more accidents caused by **intoxicated, incompetent, or inattentive drivers**.

Computer control reaction time is **virtually instantaneous** in an emergency situation, permitting **safe, high speed operation.**

The **elevated grid** track system is **up above ordinary traffic.** Also, **North / South** tracks and **East / West** tracks are at different elevations and **do not intersect.** Therefore, any possibility of **collision is eliminated.**

PEOPLE PODS engineering **eliminates fore and aft collisions** by:

- **Computer controlled** acceleration and braking.
- Fully redundant, self contained, on-board local **emergency control intelligence** uses sonar sensors to detect potential collisions and **safely stop any pod independent of external cause.**
- T shaped track can be **gripped** with tremendous pressure, to **stop** a Pod **without skidding.** This is far more effective than any conventional wheel to road braking technology.



SAVES COSTS

PEOPLE PODS can be **developed on existing real estate**, eliminating additional land acquisition costs.

Light weight track and support materials are extraordinarily **inexpensive** when compared with steel reinforced concrete roads, massive overpass structures, monorail tracks, railway track and station structures.

PEOPLE PODS have very **few** complex **mechanical parts**, and are **inexpensive to build.**

Pods are **only 150 pounds** of processed materials compared to 2500 to 3000 pounds for an automobile.

Large **robotic equipment is proposed** for erecting support poles and track. This could **deploy** the grid system at a rate of **one mile per day** for each installation team.

Installing the People Pods grid is more like installing power line systems than the grading, layering, and paving that is required for highway construction.

PROJECT	PROPOSED COST	PEOPLE POD	% COST
Jamboree Road (Two Miles)	$13 Million Per Mile	$ 1 Million Per Mile (two lane)	7.7%
Typical 8 Lane Freeway	$63 Million Per Mile	$ 3 Million Per Mile (six lane)	4.8 %
Typical Concrete Fwy. Interchange	$ 100 Million + Each	$ 150,000 Each	0.15%
LA to SF 125 MPH Train	$ 12.6 Billion for 500 Miles	$ 0.825 Billion for 500 Miles	6.5%
LA Metro Rail Subway	$ 250 Million Per Mile	$ 1 Million Per Mile	0.4 %

Depreciation and **maintenance expense** on private automobiles is **eliminated** except for pleasure use.

Lower Insurance Rates are always applied for low mileage drivers.

No parking expense, or traffic citations.

Goal is to have commuters **pay no more** for PEOPLE POD trips **then** what they now pay **for gasoline alone.**

MINIMIZES STRESS AND TENSION

PEOPLE POD **riders can relax** and read, or catch up on office details **without** the constant vigilance required for **driving in rush hour traffic.**

Every PEOPLE POD has its own **computer controlled chauffeur.**

Predictable high speed performance **eliminates** the stress of **arriving late.**

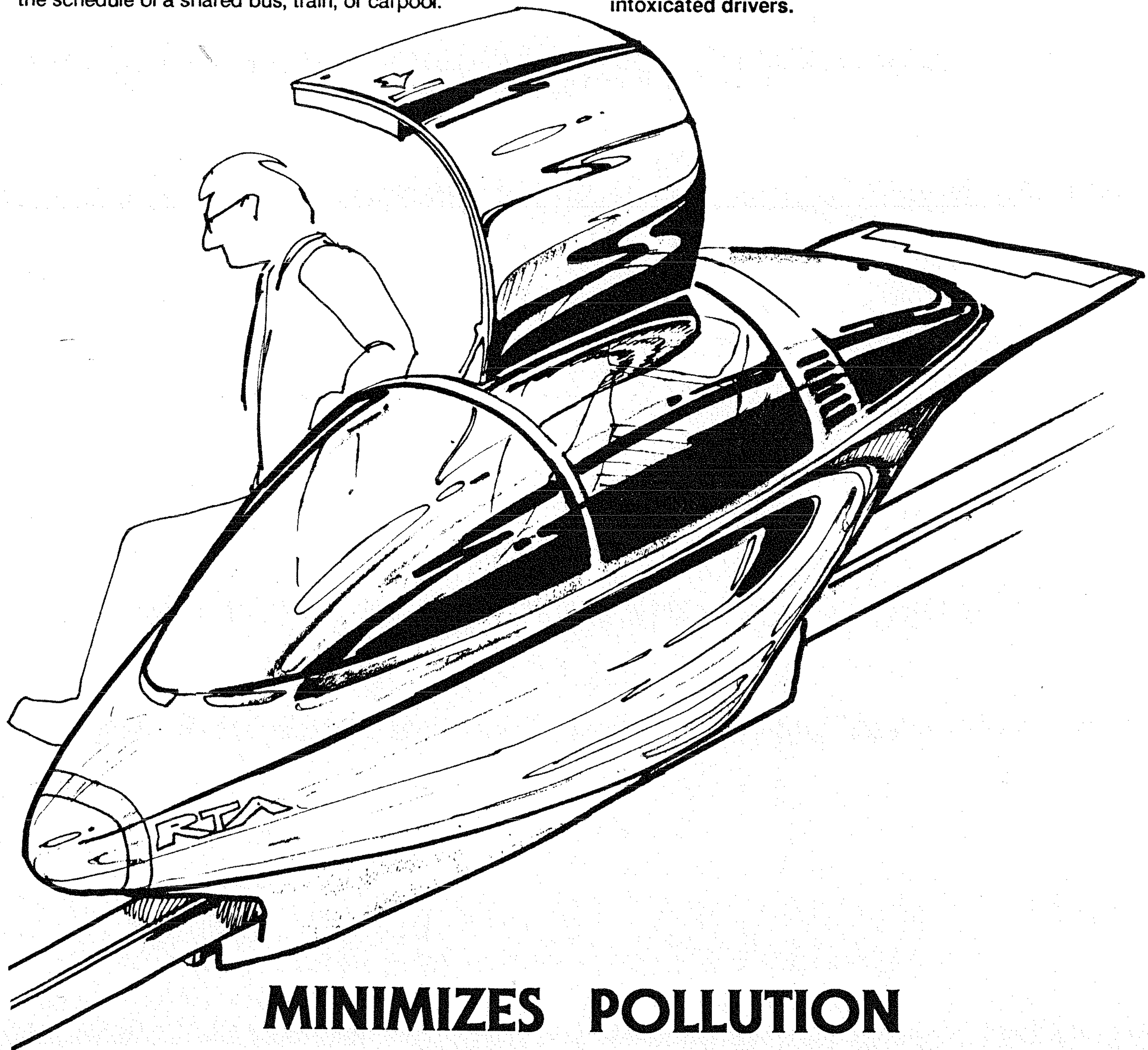
On demand availablility eliminates the stress in meeting the schedule of a shared bus, train, or carpool.

No searching for, squeezing into or paying for **daily parking.**

No fear of **leaving a major investment** as you park it **in the urban concrete jungle.**

No caution required to ride, **no paranoia of traffic citations** and rising insurance rates.

Teenage **children** travelling on the PEOPLE PODS **are safe from** the tragedy caused by irresponsible **intoxicated drivers.**



MINIMIZES POLLUTION

Equivalent 370 MPG energy efficiency.

A single 100 MPH People Pod replaces as many as 16 polluting automobiles in daily commuting service.

Safe, Clean, Electric Power

Electrical Generating Stations can be located miles from urban areas.

CHAPTER 9

COST COMPARISONS
TO THE
FLORIDA MAGLEV PROJECT

COST, TRAVEL TIME AND CAPACITY COMPARISONS BETWEEN THE 250 MPH FLORIDA MAGLEV DEMONSTRATION PROJECT AND THE PROPOSED 100 MPH PEOPLE POD SYSTEM

Florida Maglev reference data from William W. Dickart III's paper, *The Transrapid Maglev System - An Update*, Society of Automotive Engineers Report 921583, presented at the Future Transportation Technology Conference, Costa Mesa, California, August 1992.

COST COMPARISON ANALYSIS

	FLORIDA MAGLEV	PEOPLE PODS
TRACK (16 miles)	$20M/mile = $320M	$1M/mile = $16M
VEHICLES	2 X $30M = $60M	2,300 X $10,000 = $23M
STATIONS	2 X $10M = $20M	2 X $5M = $10M
RIGHT OF WAYS	$100M	$0M
TOTAL	**$500M***	**$49M**

*Only the total $500 million figure was specified in the reference. The components yielding that total are estimates.

The Florida Maglev will take people 14 miles from the ***Orlando Airport*** to the proposed ***International Station*** close to Disneyworld where they would disembark and then take taxi's or shuttles to their respective hotels. We would propose an additional total 30 miles of People Pod track (at a cost of plus $30 million) to route passengers directly into the second story mini-station located at any of 150 local hotels.

These small stations could be built in for $50,000 to $75,000 each. That cost would be a burden of **each** interested hotel which eliminates the fancy larger $5 million International station. Thus, the new total cost for a **much more useful** People Pod system becomes:

$49M + $30M -$5M = $74 million.

Obviously, it now becomes logical to enable people to check their baggage in **at their** departure **directly** to their **specific** hotel. They should not have to be burdened with waiting for their luggage at the airport. Airport baggage handlers could easily load People Pods with baggage that has proper hotel ID's (with secondary bar code info for fast automatic routing). Hotel personnel would receive, then deliver this baggage right to one's room.

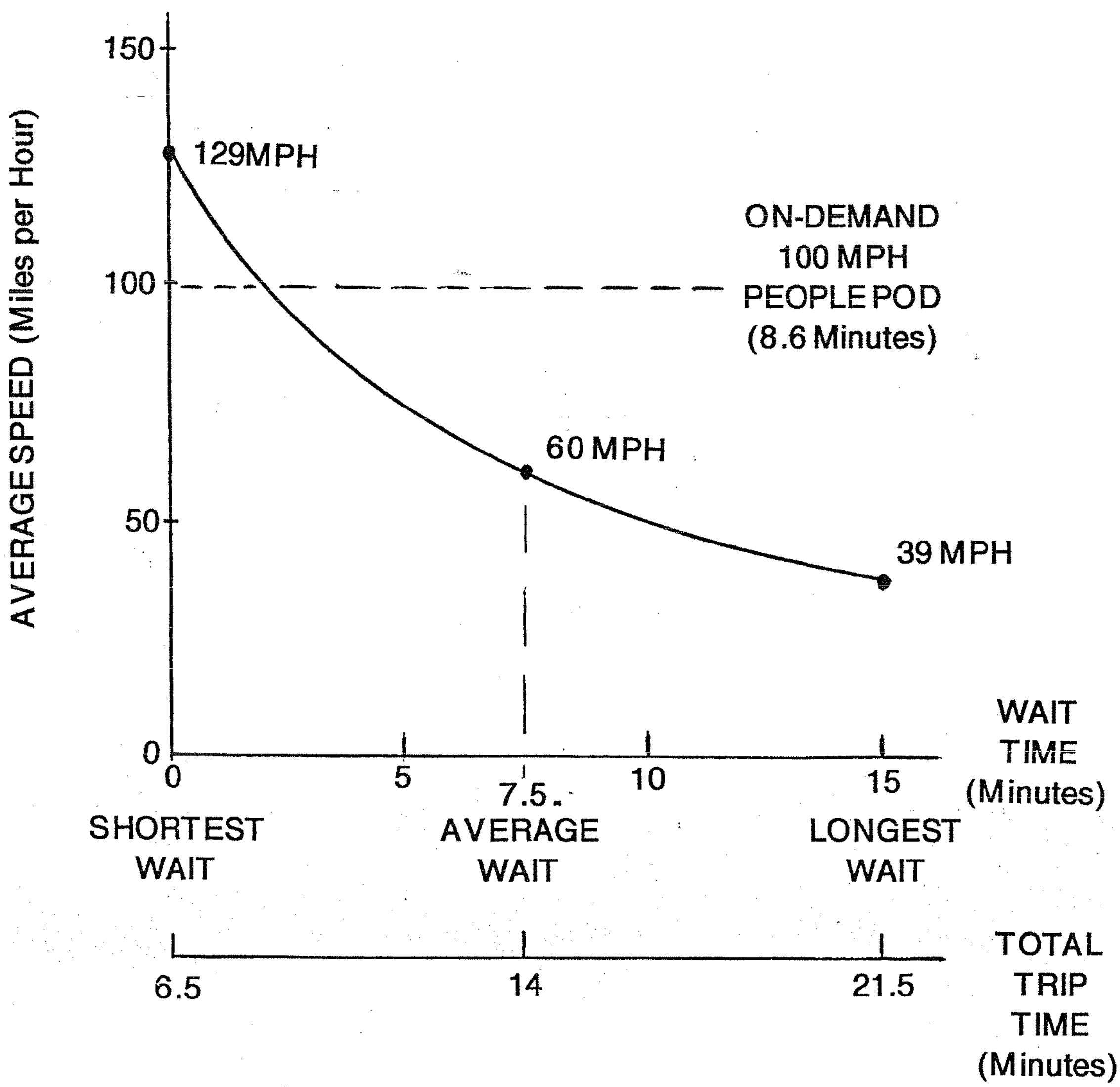
TRAVEL TIME COMPARISON ANALYSIS

The Florida Maglev will take people 14 miles from the *Orlando Airport* to the proposed *International Station* in 6.5 minutes. Thus, even though the Maglev will attain a claimed peak speed of 250 MPH, it's *average* speed for the trip is only 129 MPH!

A 100 MPH People Pod would average 97.4 MPH for the same trip (including time lost accelerating up to 100 MPH and later decelerating to a stop). The same 14 mile trip would take 8.6 minutes which is only 2.1 minutes longer than the "250 MPH" Maglev).

We must note that the People Pod system is a **personalized on-demand** system (meaning there is never any waiting for the train to arrive), whereas the Florida Maglev departs only once every 15 minutes. A person who just catches the Maglev **will** average 129 MPH for the trip. On the other hand, a person who **just misses** the Maglev and who now **must wait** the 15 minutes to catch the next Maglev spends 15 minutes **waiting at zero speed** and **another** 6.5 minutes covering the 14 mile distance for a total of 21.5 minutes. This fact yields a rather poor average of just 39 **MPH** for the trip!

The following graph illustrates this very real average speed for the 14 mile trip:



PASSENGER CAPACITY COMPARISON ANALYSIS

	FLORIDA MAGLEV	PEOPLE PODS
MAXIMUM CAPACITY PER HOUR	4 trips/hour x 400 passengers/train = 1,600 per hour.	7,200 trips/hour x 2 passengers/pod = 14,400 per hour.

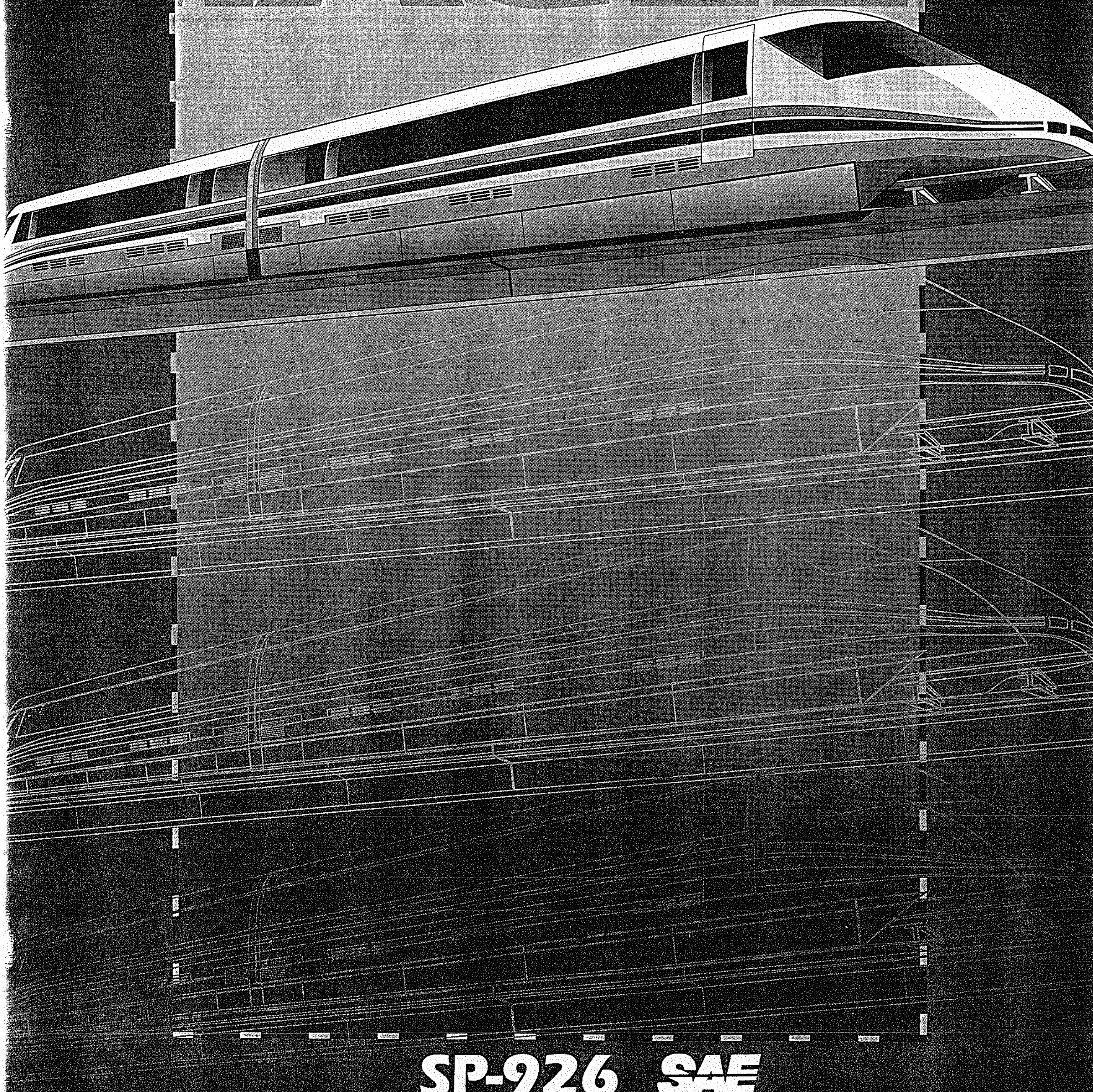
Even if all passenger's baggage was carried automatically in separate People Pods, a capacity for 7,200 passengers per hour still exists which is 4.5 times as much as the Florida Maglev.

REVENUE AND PAYBACK ANALYSIS

This analysis compares the fare structures. Currently, the Florida Maglev project is **projecting** 5,000,000 riders annually at an $18.00 fare (this is a daily average of 21,918 passengers or 13.7 hours a day at maximum capacity - which may be quite optimistic). In view of this optimism, we will ignore supply and demand relations and will **assume** that the much lower People Pod fares **would not** increase annual ridership. Of course, this simplified breakeven analysis does not include any annual maintenance costs, energy usage costs, administrative costs or promotion costs.

SYSTEM INSTALLATION COSTS	Revenue per mile	One way ticket price	Annual gross	Years to breakeven
$500M Maglev	$1.285	$18.00	$90M	5.6
$74M People Pod	$.20	$2.80	$14M	5.3
	$.30	$4.20	$21M	3.5
	$.40	$5.60	$28M	2.6
	$.50	$7.00	$35M	2.1

MAGLEV



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The Transrapid Maglev System - An Update

William W. Dickhart III
Consultant to Transrapid International

ABSTRACT

This paper presents the status of the Transrapid Maglev System and the first commercial super-speed maglev application in the world planned for Orlando, Florida. It includes a brief summary of SAE paper No. 89 1714 which was presented in August 1989 and covers subsequent developments. It also includes some discussion of institutional factors to be considered when planning the implementation of a new system.

The purpose of this paper is to provide an update on the status of the 500 km/hr super-speed magnetically levitated ground transportation system that was developed in Germany. This maglev system features contactless electromagnetic suspension and long stator three-phase propulsion. This transportation mode has little effect on the environment, is safe and cost effective.

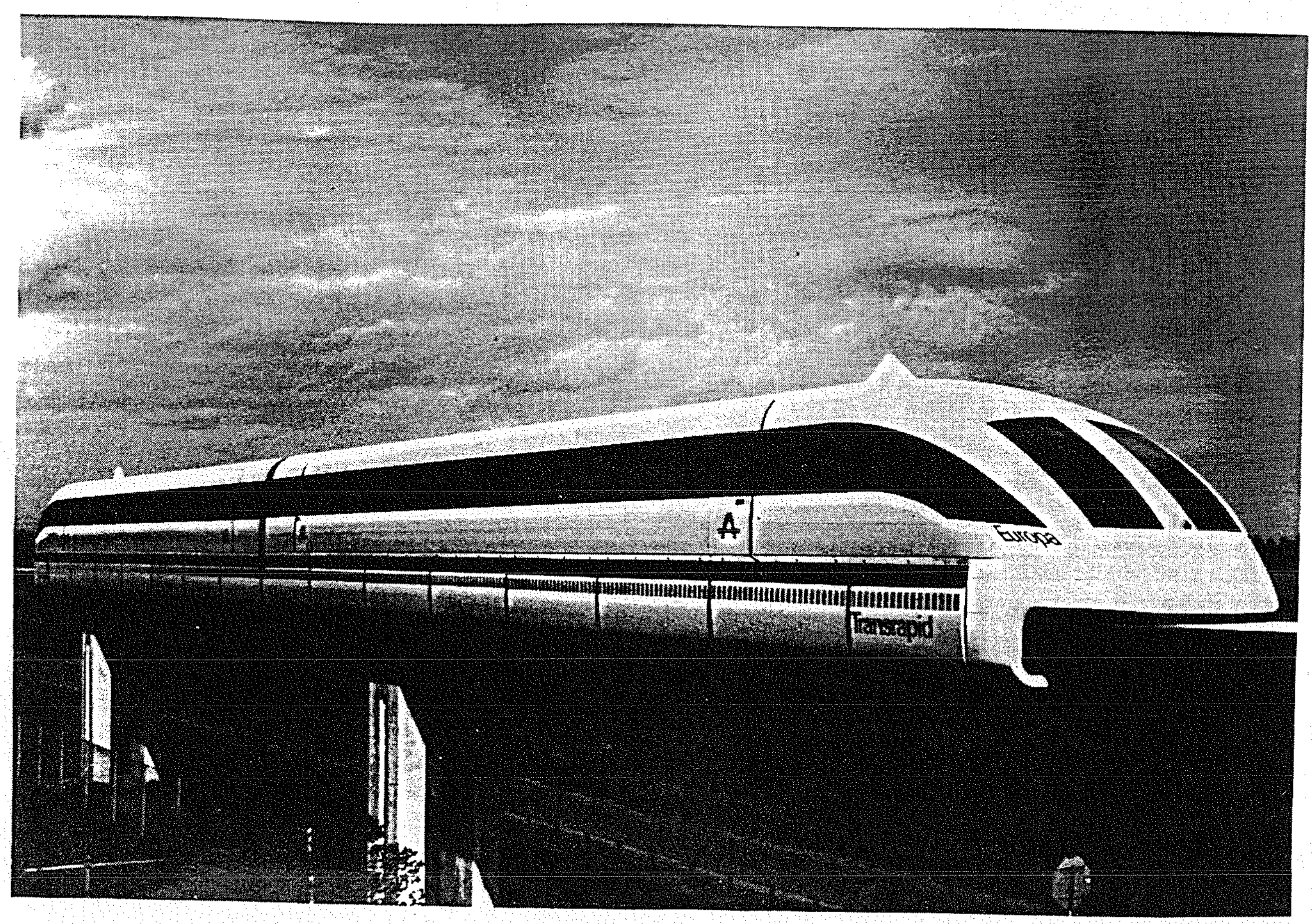


Figure 1 Transrapid 07

SUMMARY OF 1989 PAPER

The previous paper[1]* presented in Vancouver, Canada in August 1989 covered the history of the Tranrapid Maglev development up to that time, the system description, the full-scale test site, environmental safety and cost considerations, and potential revenue systems.

In brief, Hermann Kemper began research on maglev systems in Germany and conducted successful tests in the 1930's (receiving a patent in 1934).

In the late 1960's the German government began a study of traffic and modes which led to the development of very high speed maglev systems by the German Ministry of Research and Technology. The development included short stator, long stator, EDS and EMS technology and system studies. The long stator EMS system was selected for full scale development based on performance, cost and magnetic field considerations.

In 1979 TR05, the first maglev system licensed to carry passengers, was demonstrated at the International Traffic and Transport Exhibition in Hamburg.

In 1988 TR06 set a speed record of 257 mph (412 km/hr) and participated in a month-long high-speed public demonstration at the Emsland test facility with 8 to 10 minute transits of the 25 mile (40 km) circuit at speeds up to 250 mph (400 km/hr).

TR07, the prototype revenue service vehicle, began testing in 1989.

Transrapid vehicles are magnetically levitated and guided and propelled by synchronous linear induction along a guideway. Levitation magnets are mounted on the vehicle undercarriage below the guideway beam. When the levitation magnets are energized, the vehicle is lifted and a fixed gap of about 3/8 in. (10 mm) is maintained between the magnets and the propulsion coils mounted on the underside of the guideway. Linear generators charge batteries on the vehicle and provide power for magnets, emergency brakes and hotel services.

The long-stator motor provides propulsion and braking. Only short sections of the guideway are energized as the train passes.

The guideway structures are steel or concrete beams mounted on piers generally elevated about 16 ft. (5m). Switches are bending steel beams which are aligned by actuators.

The system is operated automatically from a control center with data transmission with the vehicle, wayside locations, wayside equipment and switches.

* Numbers in parentheses designate references at end of paper.

The Emsland test track is in N.W. Germany. Full scale high speed tests and continuous operation over the 25 mile (40 km) two loop circuit serves to qualify the system for revenue application.

Transrapid maglev is electrically propelled. There are negligible magnetic fields in the vehicle or in the vicinity. There is no rolling noise, gear noise or wayside vibration. The noise level at 25 meters was calculated to be 92 db(A) at 250 mph (400 km/hr).

Transrapid maglev wraps around the guideway and is automatically controlled so derailment and "pilot error" are virtually eliminated. The interiors are designed to meet Air Transport Standard 1988. Emergency egress is provided at predetermined locations along the guideway.

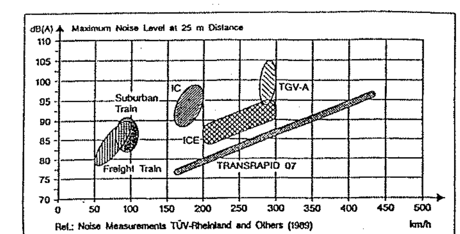
Production costs of the Transrapid guideway have been reduced through the application of automation and computer-aided techniques, i.e., an automated line to produce stator packs, robot welding of beams, computer-aided machining of beams (steel and concrete) and installation of stator packs, computer-aided surveying, automated production and application of cable winding and software to reduce the need for blueprints.

Capital costs for the Transrapid system, especially in hilly terrain, may be comparable to the costs of a high speed rail system because of the 10% climbing ability and 12 degree banking in curves. Operating costs are expected to be less than for a rail system.

A number of routes were being considered for application in Germany and in the United States including a demonstration project in Florida.

RECENT TECHNICAL PROGRESS

In December 1989 TR07 established a speed record of 271 mph (436 km/hr). Measurements taken during high speed runs confirmed that Transrapid emits the lowest noise level compared to other transportation systems with a peak level of about 93 db(A) at 250 mph (400 km/hr) at 25 meters. (See Figure 2.) Of course, wayside vibration is negligible when compared to rail systems.



Noise Measurements Transrapid 07/Railroad Vehicles

Figure 2

Measurements of magnetic flux density both inside the TR07 and outside confirmed that like TR06, the levels are low, 100 to 1000 m Gauss at the floor (the same order as the earth's field) and 10 to 30 m. Gauss at the seat level. (See Figure 3.)

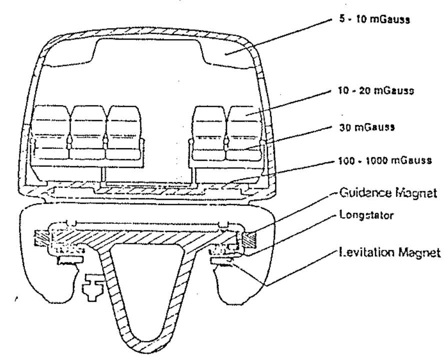


Figure 3 Magnetic Flux Density

During the summer of 1990, intensive testing operations resulted in the accumulation of more than 100,000 km (62,500 miles), a bench mark necessary for official consideration of the readiness of the system. During continuous rides a regular speed between 186 mph (300 km/hr) and 250 mph (400 km/hr) and more was reached. Testing included non-stop rides of more than 1000 km (625 miles) and 2500 km (1600 miles) per day.

January 1992, at a joint conference held by the German Federal Minister of Transport, the German Federal Minister for Research and Technology and the President of the Board of German Federal Railroads, it was announced that, in an opinion submitted by the joint study group of experts, the magnetic levitation train Transrapid had reached[2] technical readiness for revenue service.

The expert opinion on the readiness for revenue service covers: the vehicle; the support and guidance system; the propulsion and energy supply; the operation control system and the communication system; the guideway and switches; and the system engineering (safety, sound emission and aerodynamics).

Each of these components was assessed according to the following criteria: operability; reliability; availability; safety; maneuverability; flexibility; failure tolerance; maintainability; ecological safety; compatibility; and comfort.

With the certification of technical readiness for revenue service a Transrapid route may now be included in the German Federal Transport Master Plan and the conditions for opening legal planning proceedings for building an application route in Germany have been met.

SAFETY

The Transrapid maglev system has been undergoing a safet certification process during the development for both use i Germany and for export. TUeV Rheinland, a safet certification group in Germany, has been responsible fo certifying the safety of the unique technology aspects of th system. Much of this certification has been conducted at th Emsland test site.

The Emsland test site is operated by an independent tes organization IABG for the maglev test and plannin organization MVP. MVP was founded in 1984 by the Germa National airline, Lufthansa, the German Federal Railway, an IABG in order to operate the site and evaluate the syste independent of the developers.

In the United States, the Federal Railroad Administratio has the responsibility for maglev safety under the Railroa Safety Act of 1970 and the Rail Safety Improvement Act of 198 which defined the term railroad to include maglev systems.

At the time of the selection of Transrapid for application in Florida under the Florida Maglev Demonstration Act by the High Speed Rail Transportation Commission in 1989, no safety standards for maglev systems existed. The U.S. and German governments quickly established a program under a technology exchange agreement to provide all relevant information (including proprietary data) on the Transrapid system to the FRA in their role of evaluating the suitability and safety of applying the system in the U.S.

The Federal Task Force, which began work in 1989, consists of a team of experts and specialists from FRA, Volpe National Transportation Systems and consultants. The team has expressed appreciation for the cooperation of the Federal Ministry for Research and Technology, TUeV Rheinland, the Transrapid Consortium and MVP for providing information, documentation and access to testing. To date, four reports have been issued, "The Preliminary Safety Review of the Transrapid Maglev System" November 1990[3] and Executive Summary April 1991[4], "High-Speed Maglev Trains; German Safety Requirements RW-MSB" January 1992[5] and "German High-Speed Maglev Train Safety Requirements - Potential for Application in the United States" February 1992[6]. A report is planned on the Readiness for Application.

It is understood that FRA plans to develop a Rule of Particular Applicability for the Florida Maglev Demonstration Project. Ultimately, a Rule of General Applicability may be developed for all maglev systems. However, this may require some years of experience with operating maglev systems.

REVENUE SYSTEMS

In Germany there have been tremendous changes since 1989 with the unification of the East German states, the ensuing financial burden, the plan to move part of the government to Berlin, the desperate need to upgrade infrastructure in the eastern states and the need for transportation to and within the eastern states. There have been a number of studies of candidate links for Transrapid as a result. A Hamburg-Berlin line has been recommended and is currently being considered for inclusion in the Federal Transport Master Plan. A decision is expected in 1992.

In the United States, a number of application studies have been conducted. However, the ability to finance mega-projects has changed dramatically since 1989. The situation will probably remain restricted until there is some financially successful experience in one or more maglev systems or public monies to cover the high risk capital portion of new systems.

From both financial and technical viewpoints, it would be very beneficial to establish a short high-speed revenue system, such as, the Florida Maglev Demonstration Project.

The State of Florida passed Maglev Demonstration Act in 1988. In 1989 Maglev Transit Inc. (MTI) was the only bidder in response to a request for proposal. MTI was formed, under the guidance of the Forum for Urban Development, to bring together Transrapid technology with leading U.S. and Japanese financial, engineering and construction firms to build and operate the world's first commercial application of a super-speed maglev system.

In the spring of 1990 the plan was amended to offer service between Orlando International Airport and International Drive near the tourist attractions and hotels.[7] In the fall of 1990 exhaustive administrative hearings were held on the plan with the resulting recommendation that the plan be certified.

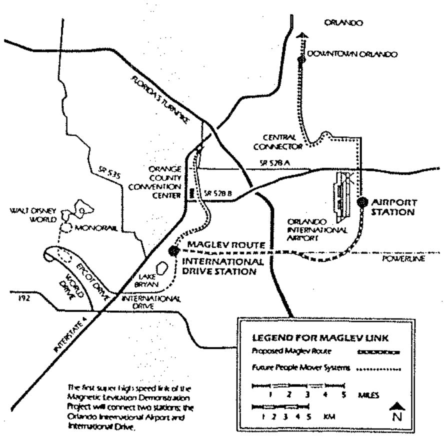


Figure 4 Orlando Maglev Demonstration Route

On June 12, 1991 the Governor and the Cabinet of the State of Florida took a historic step and certified MTI to construct and operate the Maglev Demonstration Project. This $1/2 billion system will provide rapid access (6-1/2 minutes) from Orlando Airport to the center of the tourism district on International Drive. The track has a length of 14 miles (22 km). Speeds of 250 mph (400 km/hr) will be reached and over 8 million passengers per year will be carried in the opening years.

Maglev trains will consist of 4 passenger cars and 1 baggage car with seats for 400 passengers. Peak service will provide approximately 4 trips per hour each direction (10 hours), off-peak 2 trips per hour each direction (10 hours) and with fringe service 1 every 90 minutes if required (4 hours). The system will be operated as a single track shuttle.

It is planned that airline baggage will be "through-checked" directly to the Grand Terminal at International Drive. The Grand Terminal will be intermodal with easy access to buses, vans, taxis, rental cars, autos and the surface transit system being proposed to run on International Drive.

The Florida Maglev Demonstration Project will be the world's first and the success of this project will lead to the opening of a new era of maglev in the United States for the 21st century.

INSTITUTIONAL CONSIDERATIONS

Technology may be only a small part of the task of implementing a new high-speed rail or super-speed maglev system. Financial and institutional considerations may require the major effort. Institutional considerations can have a major effect on financing as they can result in delays and stretch outs with attendant costs.

It is almost universally recognized that implementation of one of the high-speed or super-speed systems results in environmental benefits when compared to the competing highway or air modes in pollution, noise and energy consumption. However, there is no mechanism by which these benefits can be used to offset minor environmental costs needed to implement a system. In Florida, for example, it is necessary to purchase and set aside 30 acres for every acre touched in wetlands even though the wetlands will be protected during installation and restored after the elevated system is installed and the construction bridge is removed. There is even the possibility of having conflicting mitigation requirements from different agencies for the same parcel of land. There is also the possibility that citizens or groups opposed to the project can find an environmental, growth management or other basis to demand a hearing to contest the compliance of the project.

A system that has been franchised by the state may still find local opposition along the route, or that local governments want their price for any route that passes through their jurisdiction.

Competition, public and private, may be able to impede the process and add time and costs. In Florida, for example, the local toll road will receive funds to mitigate for auto toll revenue directed to maglev.

In 1989 the Transportation Research Board Committee on Intercity Rail Passenger Systems AIG06 (now AIE13) recognized the need to study institutional and financial requirements for High Speed Ground Transportation Systems and to develop a methodology to compare modes and explore investment strategies to meet national objectives. The Committee recommended a Research Project which was conducted and a report issued. Unfortunately, these needs were not addressed.[8] Let up hope they will be in the near future.

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8 Committee For the Study of High Speed Surface Transportation in the U.S.
Transportation Research Board
Special Report 233, 1991

PEOPLE PODS™ VS FLORIDA MAG LEV TRAIN

PREPARED BY D. MALEWICKI SEPT 11, 1990

	TGV	FHSRC FLORIDA FASTRAIN FLORIDA HIGH SPEED RAIL	PEOPLE PODS
COST OF TRACK PER MILE (2 WAY)	$15M	$12M	$1M
TOTAL TRACK COST FOR 230 MILES (MIAMI TO TAMPA)	$3.45 BILLION	$2.76 BILLION	$.23 BILLION (ONLY 8.3%)
MAXIMUM CRUISING SPEED (MPH)	185 MPH	150+ MPH	100 MPH (66%)
TIME TO COVER THE 230 MILES	160 MINUTES (=2.66 HOURS) (7 PLANNED STOPS)	160 TO 175 MINUTES (=2.66 HOURS) (13 STATIONS)	138 MINUTES (=2.3 HOURS) (NO STOPS)
RESULTING AVERAGE SPEED (MPH)*	86.25 MPH	86.25 MPH	100 MPH (+16% FASTER)
ENERGY COSTS BTU/PASSENGER MILE**	803. BTU (=1,147 BTU AT 70% CAPACITY)	972. BTU (=1,388 BTU AT 70% CAPACITY	61. BTU (ONLY 6.2%) (=122 BTU AT 50% CAPACITY)
EXPECTED USAGE PASSENGERS PER DAY	19,600 /DAY	5,674 /DAY	86,400 FOR 6 HOURS USAGE ↑ 14,400/HOUR (+1,500% !!)
ANNUAL USAGE	5,262,000	1,702,300	25,000,000 CAPACITY AT 6HRS/DAY
FARE REQUIRED	$76.60 (33¢/MILE)	← SAME	$23.00 (10¢/MILE) (30% OF COST)
ENERGY COST/TRIP	$8.16	$9.89	$.62

* PLUS ADDITIONAL TIME WOULD ACTUALLY BE LOST DUE TO HAVING TO ARRIVE EARLY TO MEET THE SCHEDULE TIMES OF THE MAG LEV

** AUTOS 3,125 BTU/PASSENGER MILE AT 55MPH AVE.
AIRPLANES 6,220 BTU/PASSENGER MILE AT 450MPH AVE.

CHAPTER 10

ORANGE COUNTY GRID
PRELIMINARY PROFIT ANALYSIS

COMPLETE ORANGE COUNTY GRID
PRELIMINARY PROFIT ANALYSIS

I. CAPITAL COSTS

Assume a 20 by 20 mile complete grid featuring one by one mile spacing would be needed. This requires 420 miles of two way track (we will use 500 miles of track for this analysis).

1. TRACK	(500 miles x $1M per mile)		= $500M
2. PODS	(50,000 only x $5,000 each - see note 1)		= $250M
3. R&D		mechanical	= $25M
		electrical	= $25M
		software	= $25M
4. MANUFACTURING FACILITIES		pods	= $25M
		track robots	= $25M
5. MAJOR MAINTENENCE STATIONS	(10 at $5M each)		= $50M
		TOTAL	= $925M

Note 1: POD QUANTITY - Initially a computer controlled operational spacing between pods of 1/2 second at 100 MPH will be used. This means 73.3 feet between the 10 foot long pods (83.3 feet total tail to tail). Thus, if all pods are on the track and none are sitting at a station, then the maximum number of pods the 420 miles of two way track could handle would be:

$$\frac{\text{(2 way tracks) x (420 miles) x (5,280 feet/mile)}}{\text{83.3 feet/pod}}$$

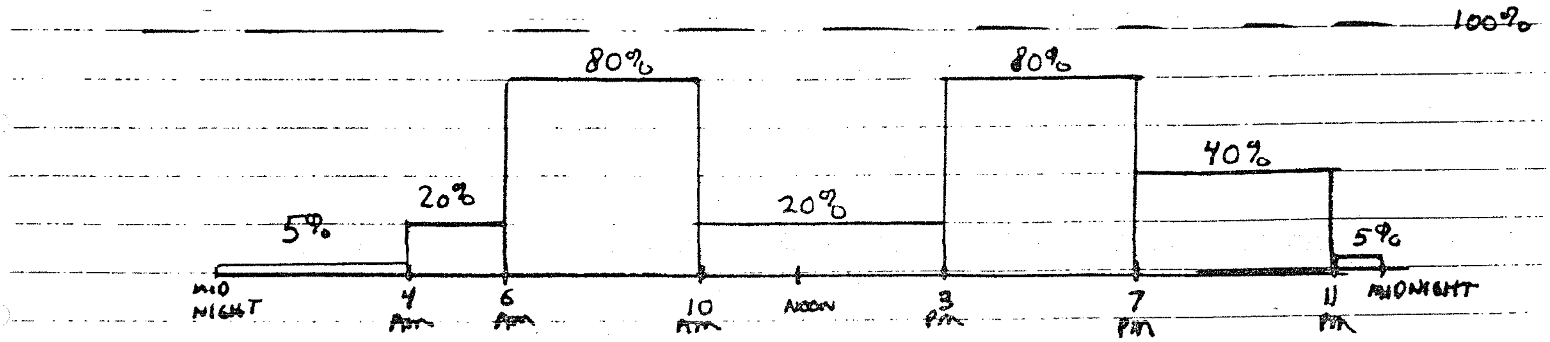
or 53,243 maximum total. Obviously, this density can be increased once safety is proven and the required spacing is reduced.

POD COST - In small 50,000 quantities we expect each pod should cost no more than $5,000. Once they are being produced in 250,000 to 500,000 and above quantities, a pod should cost no more than $2,000.

II. POD DAILY UTILIZATION ESTIMATES

Assume all trips average 10 miles in length. Thus, at 100 MPH (no stops, no turns, no acceleration or deceleration time lost) each pod could do a maximum of <u>ten</u> such 10 mile trips each hour. For analysis purposes, we will use a more realistic approximation for maximum capacity of just <u>six</u> 10 mile trips each hour. Also, we shall assume all riders are travelling solo (or alternatively that we charge for the trip - not for how many people are in the pod making that trip).

24 HOUR UTILIZATION CHART



From the above graph we can can calculate that in one 24 hour period each pod should complete 57.9 ten mile trips (out of a maximum assumed capacity of 6 per hour x 24 hours = 144 ten mile trips).

PERCENT UTILIZATION *	TOTAL TIME *	MAX RATE =	NUMBER OF 10 MILE TRIPS
5%	5 hours	6/hr	1.5 trips
20%	7 hours	6/hr	8.4 trips
40%	4 hours	6/hr	9.6 trips
80%	8 hours	6/hr	38.4 trips
			57.9 trips/24 hours

This means each pod replaces and removes from the surface traffic more than 25 cars used just for commuting each day for a total of 1,250,000 cars! Also note that each pod travels 579 miles each day and the 50,000 pods travel a total of 28,950,000 miles. People pods moves the commuters to their destinations faster, safer and with less than 5% of the energy now required. Furthermore, the energy source is much cleaner electricity - meaning significantly less pollution!

III. DAILY GROSS INCOME

At a current price of $1.30 per gallon of gasoline, driving a 20 mile per gallon car means a cost $.065/mile for gasoline expense alone (people pod energy cost is only $.0032/mile). If the user is charged $.20/mile or $2.00 for a ten mile trip we would gross $5,790,000 each day which is $2.113 billion per year. Alternatively, charging just $.10/mile we would gross $2,895,000 each day which is $1.057 billion per year.

PER MILE CHARGE *	TOTAL DAILY MILES =	DAILY GROSS	ANNUAL GROSS
$.10	28,950,000	$2,895,000	$1.057 BILLION
$.20	28,950,000	$5,790,000	$2.113 BILLION

IV. DAILY EXPENSES

ITEM	BASIS	DAILY COST	ANNUAL COST
1. ENERGY	$.0032/mile * 28,950,000 miles per day	$92,640	$33.8 MILLION
2. POD MAINTENENCE	$.005/mile * 28,950,000 miles per day	$144,750	$52.8 MILLION
3. POD DEPRECIATION	$5,000/500,000 mile life * 28,950,000 miles per day	$289,500	$105.6 MILLION
4. TRACK MAINTENENCE		$200,000	$73.0 MILLION
5. TRACK DEPRECIATION	$500M/(20 year life * 365 days per year)	$68,443	$25.0 MILLION
6. ADMINISTRATION		$100,000	$36.5 MILLION
	TOTALS	$895,333	$.327 BILLION

V. DAILY PROFIT

PER MILE CHARGE	DAILY GROSS -	DAILY EXPENSES =	DAILY PROFIT
$.10	$2,895,000	$895,333	$1,999,667
$.20	$5,790,000	$895,333	$4,894,667

PER MILE CHARGE	ANNUAL PROFIT	PERCENT RETURN ON $.925 BILLION INVESTMENT
$.10	$.730 BILLION/YR	78.9% PER YEAR
$.20	$1.786 BILLION/YR	193.1% PER YEAR

CHAPTER 11

PEOPLE POD
SIX MONTH PROGRESS REPORT

PEOPLE PODS

SIX MONTH
PROGRESS REPORT

prepared by

DOUGLAS J. MALEWICKI

People Pod inventor
and
Co-founder of Transport Innovations, Inc.

October 31,1990

This package contains a summary of findings and decisions and conclusions regarding the first six months of PEOPLE POD development.

I. FINDINGS

We have created a system concept that:
1. Can be erected faster than any paved road, railroad or monorail.
2. Is lower in cost than any paved road, rail transit or monorail system - so a large grid network becomes affordable!
3. Can move more people per lane per hour than any paved road, train or monorail system.
4. Requires 1/20 of the energy of an automobile to travel each mile.
5. Produces 1/50 to 1/100 of the pollution of an automobile.
6. Since each PEOPLE POD zipping back and forth across town eliminates 25 automobile roundtrips daily - leaves the down below remaining traffic much less congested and more freely flowing, thus, reducing auto and truck energy waste and pollution.
7. Gets you to your destination faster because it cruises at a steady 100 mph.
8. Because of non-stop operation on 3 dimensional grid means never any traffic lights which results in much faster commute times.
9. Will be far safer for users than traveling by automobile because of electronic safety sensing, in-line computer controlled travel and high "g" emergency braking capability.
10. Will eliminate drunk driver caused deaths.
11. Is so efficient that the service can be priced so low that commuters will use PEOPLE PODS because it is essentially costs them no more than paying weekly for gasoline.
12. Will be highly profitable when charging just 10 cents per mile. Note that the cost of energy only for the typical automobile (the gasoline cost) is about 6.5 cents per mile.
13. Because of the low cost non-stop at 100 mph features, intercity trips (up to a 300 mile range) eventually means PEOPLE PODS becomes the logical choice for such travel.
14. As we delve more and more into magnetic levitation for our light weight PEOPLE PODS, we see large reductions in maintenance and depreciation costs along with slightly less energy per mile costs. The technologies are here today and the cost of people pod sized MAG LEV track construction only goes up a few percent per mile.
15. If MAG LEV becomes a reality for PEOPLE PODS, then boosting intercity speeds to 125 mph and even 150 mph incurs no hazardous wear and tear, nor resulting safety problems. A non-stop 150 mph PEOPLE POD beats a jet plane on a 500 mile trip IF the departure city and arrival city have their completed PEOPLE POD grids installed.
16. We have learned that some of the elements of our on-demand non-stop elevated form of transportation have been proposed as far back as 30 and 40 years ago and is still being worked on. We are acquiring quite a library on PRT (personal rapid transit). "Rapid" to them, however, seems to mean 30 to 40 mph. If I personally can't beat my borderline legal 70 MPH Porsche commuter times, I'm not interested. These same people also can't seem to break out of the $7 million to $15 million per mile mold. With such cost to contend with no wonder the politicians have been hesitant all these years.

II. DECISIONS MADE

1. We have abandoned the original single seat PEOPLE POD concept in favor of the still very aerodynamic tandem two seater. You absolutely cannot make them bigger for more people because you lose the energy savings, create more pollution and track goes up to support the extra weight. It ruins everything - Especially potential profit!
2. We envision families or couples desiring to travel to the same destination will be able to link up and form short PEOPLE POD trains with voice communication capability between pods.
3. The pods will be heated and cooled for comfort. We are thinking we would like to charge in proportion to the extra energy being used. Also a pod carrying a 60 pound child won't demand as much power as one carrying two 200 pound adults. It again seems charges should be according to power consumed for the trip.

III. DECISIONS TO BE MADE

1. Magnetic Levitation will be explored thoroughly. Experts the field have me convinced PEOPLE PODS can exploit MAG LEV technology in a surprisingly cost effective and reliable manner.

2. Linear Drive (80% probable)
Still learning about what is essentially unwrapped motor shell cases that became the track. Weighing pros and cons of synchronous versus induction linear motors.

3. Induction Power Pickup versus sliding wiper contacts. (99% probable) The cost per mile of track, overall power transmission efficiency and weight penalty per pod have not been properly explored yet.

4. Hanging the pods below a monorail track. (70% probable) We have finally come up with a simple, logical way to easily and gracefully get in and out of a reclined (aerodynamic) seat that is hanging from above. The real benefits are eliminating dirt, rain, ice and snow problems. The monorail track is totally sealed on the top and sides. Also, electrical contacts are inside the hollow track structure away from prying curious little hands (let alone feet). Lastly, the top of the track should not be flat, but should come to a point so no crazy teenagers could possibly walk along it.

IV. CONCLUSIONS (85% probable)

All the technologies necessary to implement the PEOPLE PODS system exist. No star wars, fusion or superconductivity type breakthroughs are required. The United States Space Program gave us the essential ingredient - high powered teeny solid state computers. PEOPLE PODS is all off-the-shelf THIS and off-the-shelf THAT used in a unique combination that will accomplish great savings in both travel time and energy - while greatly reducing pollution. Also, extremely low capital and operating costs compared to any competing systems make it a worthwhile investment for the private sector.

D. MALEWICKI
10-23-90

**PEOPLE PODS
ENERGY REQUIREMENTS**

A TWO SEAT POD AT A GROSS WEIGHT OF 600 LBS WILL CONSUME 3.8 KILLOWATT TO TRAVEL ~~EACH~~ 100 MILES (100 MPH FOR 1 HOUR).

$$\frac{3{,}800 \text{ WATTS}}{2 \text{ PASSENGERS}} = \frac{1{,}900 \text{ WATTS}}{\text{PASSENGER}}$$

TO TRAVEL 100 MILES

100 MILES = 160.9 KILOMETERS

THUS ENERGY

$$\frac{1{,}900 \text{ WATTS}}{(1 \text{ PASSENGER})(160.9 \text{ KILOMETERS})} = \frac{11.80 \text{ WATTS}}{\text{PASS KM}}$$

WHICH FROM THE GRAPH IS ABOUT 1/20 OF AN AUTO (AT ONLY 55MPH) AS PREVIOUSLY DISCUSSED AND STILL 6 TIMES ~~BETTER~~ THAN THE BUS (WHEN ITS FULL).

A second approach to magnetic levitation makes use of cryogenically cooled magnets on the vehicle and a sheet of conducting material (or coils), such as aluminum, on the guideway. When the magnet is moved over the conducting plane, electric currents are produced in the material. These currents, in turn, produce a magnetic field that reacts with the field of the primary magnets in such a way as to repel the magnets and hence the vehicle to which they are attached. Since motion is required to produce the field, this system will not levitate at zero speed but must rely on wheels until a speed of 25 mph or so is reached, at which time the vehicle will levitate. This system is sometimes referred to as the "repulsive" system because of the manner in which it repels the vehicle from the guideway.

Two considerations of any transportation system are energy consumption and noise. Figure 3–7 compares energy consumption among several transport modes. MAGLEV is seen as almost a continuation of the wheel-on-rail curve to higher speeds. Figure 3–8 compares the noise characteristics of wheel-on-rail and MAGLEV. Up to about 300 to 350 km/h, MAGLEV is quieter than conventional trains. In fact, the primary noise source at high speeds is aerodynamic noise.

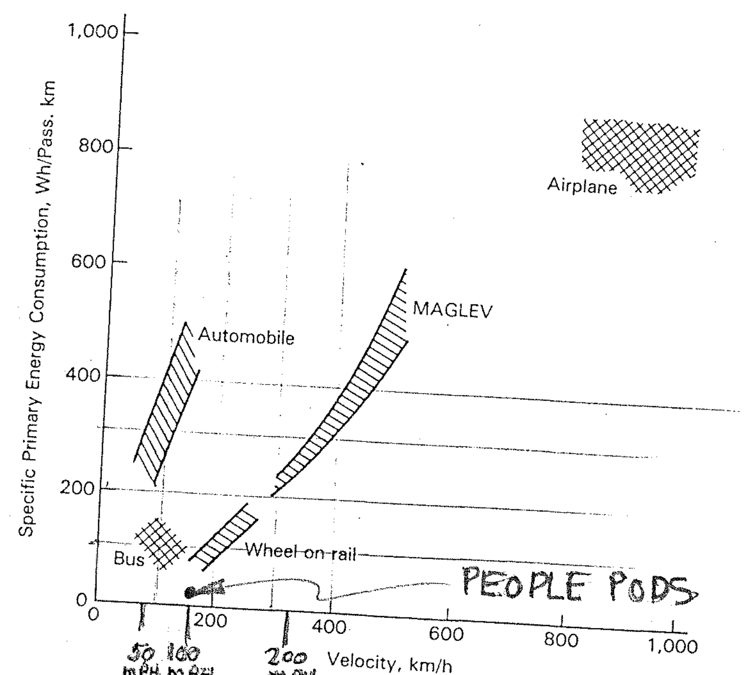


Figure 3–7 Primary energy consumption (*Source:* Federal Republic of Germany, Ministry for Research and Technology)

MAGNETIC LEVITATION

Ten years ago, magnetic levitation principals as applied to transportation were in their technical infancy. Now, nothing has to be invented - it is merely expensive! Preliminary investigation and the results of discussions with mag-lev experts indicates that our extremely light weight PEOPLE POD concept may be the needed key to successfully introduce this technology and actually enhance our profit structure.

1. Magnetic levitition of our 600 pound gross weight two passenger people pod should only require .27 kilowatts of energy (1 kw per metric ton - 2,205 lbs). The typical 1.3 million pound proposed mag-lev train would take 589 kw of power to levitate. The typical high speed train weighs 2,700 pounds for each passenger it carries. Peoples pods should only weigh 100 pounds per person carried!

2. Initial calculations indicate that magnetic drag as speed is increased is slight. In fact, it appears that supporting the vehicle using magnetic levitation consumes less power at all speeds than our proposed high pressure tire concept! The result is no tire wear, no flat tires, no drive systems, no gears, no cog belts, no bearings, no moving parts, etc. The effect on reducing maintenence costs should truly be impressive!

3. The 1.3 million pound train will require the unwound shell of the linear induction (or synchronous) electric motor to be made from an aluminum strip 0.4 inch thick by 4 feet wide (approximately $250,000 per mile cost). First estimates for the 600 pound gross weight people pod is an aluminum strip only .050 inches thick by 1 foot wide (approximately $10,000 per mile extra)!

4. It should only require 1 to 2 foot of on board coils to propel our people pod vehicle.

5. Since we no longer contact any surfaces, wear on both the pod and the track are all but eliminated. This in turn means safe higher speed capabilities. At a steady 150 mph, a mag-lev people pod would use 11.5 kilowatts of electrical energy for combined propulsion and levitation. Energy costs for a 100 mile trip would be $1.03 (instead of $.32 at 100 MPH for the rubber tire, traction version). An automobile would use $6.50 worth of fossil fuel energy for the same 100 miles - and legally shouldn't be exceeding 65 MPH.

6. Nothing mechanical moves inside the pod nor in the track. Thus, there is no friction wear on pod or track. Pod life goes way up and pod maintenence goes way down. Also, track life goes way up and track maintenence costs go way down. We have confidence our ideas for pod based magnetic controlled switching will prove invaluable.

7. Once you create safe, reliable, extremely low energy use 125MPH to 150MPH people pod capability the implications for 100 to 500 mile trips is incredible! Once major city grid networks are complete, then total trip time in this range beats any airplane service.

IV. MAG-LEV PEOPLE POD DAILY EXPENSES

ITEM	BASIS	DAILY COST	ANNUAL COST
1. ENERGY	$.0032/mile * 28,950,000 miles per day	$92,640	$33.8 MILLION
2. POD MAINTENENCE	$.001/mile * 28,950,000 miles per day	$28,950	$10.6 MILLION
3. POD DEPRECIATION	$5,000/1,500,000 mile life *28,950,000 miles per day	$96,500	$35.2 MILLION
4. TRACK MAINTENENCE		$40,000	$14.8 MILLION
5. TRACK DEPRECIATION	$500M/(50 year life * 365 days per year)	$27,377	$10.0 MILLION
6. ADMINISTRATION		$100,000	$36.5 MILLION
	TOTALS	$385,467	$.140 BILLION

V. DAILY PROFIT

PER MILE CHARGE	DAILY GROSS	-	DAILY EXPENSES	=	DAILY PROFIT
$.10	$2,895,000		$385,467		$2,509,533
$.20	$5,790,000		$385,467		$5,404,533

PER MILE CHARGE	ANNUAL PROFIT	PERCENT RETURN ON $.925 BILLION INVESTMENT
$.10	$.916 BILLION/YR	99.0% PER YEAR
$.20	$1.973 BILLION/YR	213.2% PER YEAR

Study says airlines face gridlock in the sky by early in next century

REGISTER 10/14/90

By Lawrence L. Knutson
The Associated Press

WASHINGTON — Air traffic likely will double early in the next century and billions of dollars in airport expansion and thousand-seat planes may be needed to prevent gridlock in the sky, a report released Saturday said.

"Delays in air travel have been mounting and could reach staggering proportions in the coming years," the National Research Council concluded in its report on a one-year study conducted for the Federal Aviation Administration.

In 1987, each of 21 major airports experienced more than 20,000 hours of flight delays. But by 1997, the report said, 39 airports could reach that level. Delays could reach 100,000 hours a year at such major hubs as Chicago, Atlanta and Denver.

The nation's air-transport system is expected to carry about 1.3 million domestic and international passengers a day in 1990.

But shortly after the year 2000, the number is expected to reach 2.5 million a day or nearly 1 billion passengers a year, the report said.

"If this growth continues, the system could be carrying 4 million to 5 million passengers daily by 2040, more than triple the present volume of traffic," the report said.

Recommendations

- The FAA should establish a strategic-planning process through the year 2040 with shorter-range goals in each 10-year period.
- Increase capacity at up to 50 existing airports at a cost of $40 million to $65 million each, with runway changes and improvements in air-traffic control.
- Develop new secondary hubs for connecting flights at some or all of the 28 underused airports in the nation at a cost of $250 million to $500 million each.
- Study ways to improve airport design, manage resources, reduce airport noise and integrate air and land transportation.
- Create an expanded, centrally organized airport system by giving the federal government authority to oversee improvements in airport capacity, possibly including construction of 10 new major airports. This could involve federal costs of $50 billion to $90 billion over the next 40 years.
- Seek market-based solutions to capacity problems. This strategy also involves the construction of 10 new airports but would give state and local authorities responsibility for increasing airport capacity. Estimated federal financing: $38 billion to $75 billion.
- Develop larger subsonic jets of up to 1,000 seats for heavily traveled routes, supersonic commercial transports for international routes, and short-haul aircraft and miniports at suburban locations for transfer purposes. Develop new surface-transport systems to absorb some of the 200-to-500 mile intercity traffic now handled by aircraft. The estimated price tag in federal, local and private funding: between $50 billion and $100 billion by 2020 and perhaps $125 billion to $165 billion more by 2040.

— From Register news services

If plans are not made now to handle such vastly increased levels of air travel, "congestion and delay ... will be a constraint on growth that will profoundly affect the society in the 21st century."

10/3/90

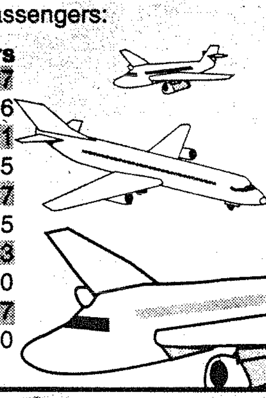
Top 10 airports

Here are the 10 busiest US airports in 1989 based on the number of arriving and departing passengers:

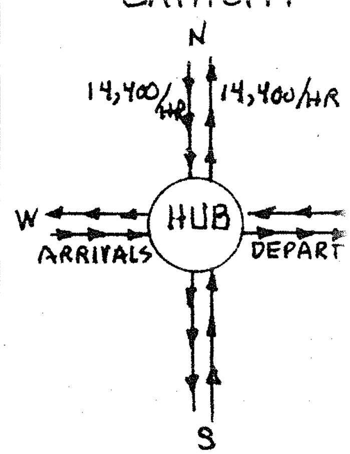
Rank	Airport	Total passengers
1.	Chicago O'Hare	59,130,007
2.	Dallas/Ft. Worth	47,579,046
3.	Los Angeles International	44,967,221
4.	Atlanta	43,312,285
5.	New York (JFK)	30,323,077
6.	San Francisco	29,939,835
7.	Denver	27,568,033
8.	Miami	23,385,010
9.	New York (LaGuardia)	23,158,317
10.	Honolulu	22,617,340

Source: Airport Operators Council International

= 162,000/DAY
= 6,750/HOUR (→ 1. Chicago O'Hare)



PEOPLE PODS CAPACITY

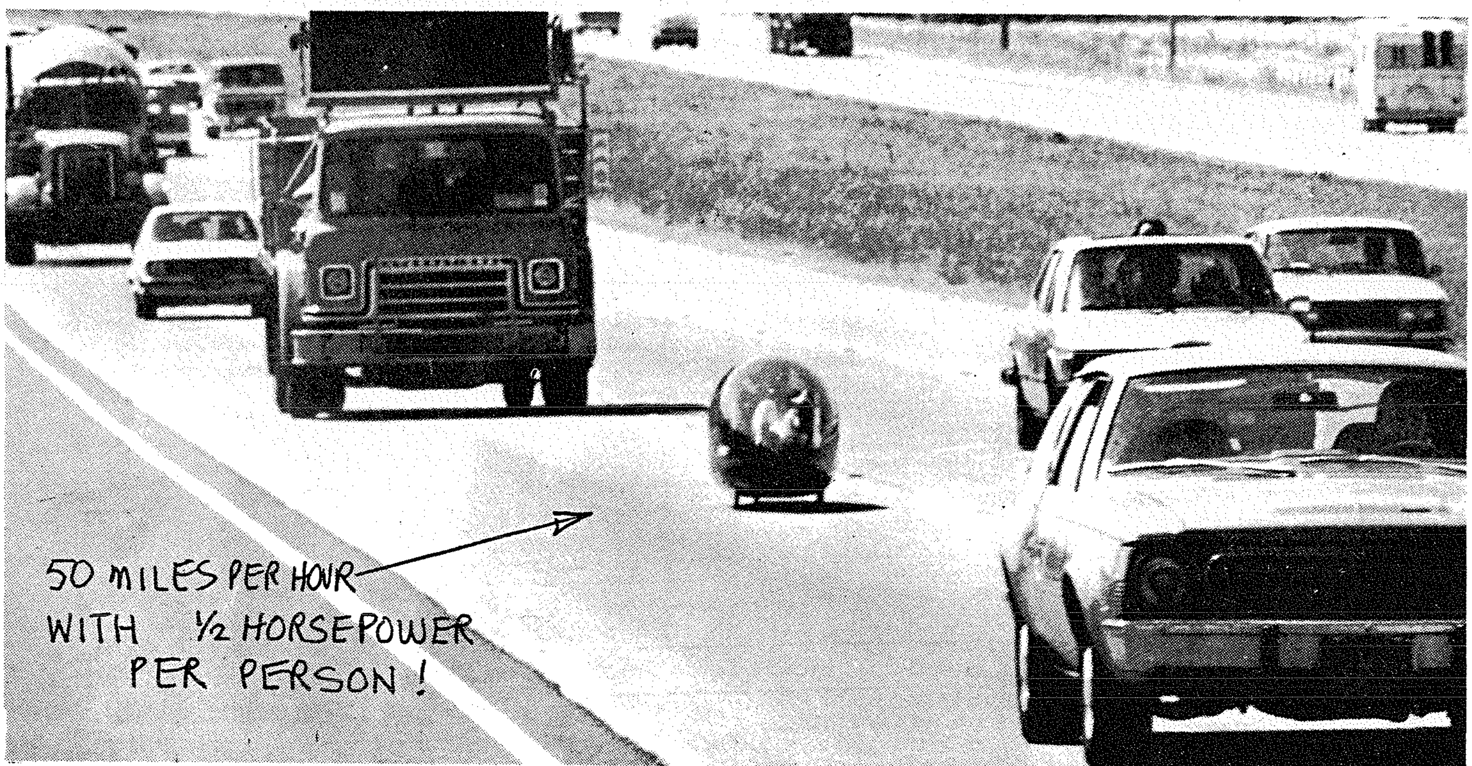


FULL CAPACITY = 115,200/
SOLO CAPACITY = 57,600/

HUMAN POWER

Official IHPVA Newsletter

Winter, 1981



Nice shot of VECTOR tandem at Stockton, sandwiched between Caltrans truck and Ct Gremlin. Rich Turner, Stockton Record.

HUMAN POWER ON THE FREEWAY

On Friday morning, May 30, 1980, Fred Markham and Chris Springer peddled the Vector Tandem on California Interstate 5 from Stockton to Sacramento, a distance of 41.8 miles. The trip took just under 50 minutes, giving an average speed of 50.5 miles per hour. This is the story of how it happened.

By F. Dan Fernandes, Vector Design Team

It was to be California's first Energy and Transportation Fair in Sacramento, and the Caltrans sponsors were searching for ideas to draw public attention to their event. Why not demonstrate a human powered vehicle on the freeway, suggested Will White, Caltrans employee and IHPVA member. Doug Unkrey and I were requested to supply the Vector Tandem vehicle and to support the demonstration, which was to be 42 miles from Stockton to Sacramento on Interstate 5.

Why not indeed; well, here are some reasons: there are fast cars and big trucks out there, and nasty little lane markers to fracture high speed bicycle tires. There could be a headwind or a crosswind, and it could be very hot in Sacramento in May. And what if we got stuck going uphill very slowly, or going downhill very fast?

Still, the Vector Tandem holds the current endurance record of 46+ miles in one hour and could maintain the legal minimum freeway speed (45) for that distance if the riders were of top quality. We could have a CHP escort, which would make it as safe as possible, and we could make the run early on Saturday morning, so it wouldn't be so hot or windy, and the traffic wouldn't be very heavy.

It all sounds almost conceivable, and what a great chance to show the world what human power can do! We'll do it! Now to find two brave, strong riders. Will White volunteered to ride with me, but he and I being bicycle commuters, the world was not going to be impressed. With some recruiting effort by Will White we obtained Fred Markham and Norman Gall to be our champion riders. Now things were getting exciting!.

It soon developed that some concessions had to be made in the planning. The ride was to be made mid-Friday morning instead of early Saturday morning, to improve media coverage for the energy fair. The CHP refused to escort us, saying a Caltrans escort would be sufficient. Then the CHP, having second thoughts, tried to move the ride off the freeway onto a county road. But they backed down when Frank Lonza, Caltrans coordinator, informed them it was going to be the freeway or nothing.

Norman Gall suffered a minor injury in training just a few days before the ride and would be unable to participate. Fortunately,

DOUG MALEWI...

Busiest freeway intersections

These are the ten busiest freeway intersections in Orange County, by number of vehicles per day:

1	Santa Ana (I-5) Fwy. at the Orange (57) Fwy.	470,000
2	Riverside (91) Fwy. at the Orange Fwy.	427,000
3	Santa Ana Fwy. at the Costa Mesa (55) Fwy.	400,000
4	Garden Grove (22) Fwy. at the San Diego (I-405) Fwy and the San Gabriel River (I-605) Fwy.	387,000
5	Costa Mesa Fwy. at the San Diego Fwy.	377,000
6	Santa Ana Fwy. at the Riverside Fwy.	367,000
7	Garden Grove Fwy. at the San Diego Fwy.	313,000
8	Riverside Fwy. at the Costa Mesa Fwy.	288,000
9	San Diego Fwy. at the Corona del Mar (73) Fwy.	287,000
10	Santa Ana Fwy. at the San Diego Fwy.	284,000

Source: California Department of Transportation

The Orange County Register

A (mostly) smooth ride: Despite a few fits and starts, ridership on the Orange County-Los Angeles commuter train continues to grow, averaging more than 200 a day on the morning inbound train alone.

The train, which began operation April 30, provides service from **San Juan Capistrano** to Los Angeles' Union Station with stops in **Irvine, Santa Ana, Anaheim** and **Fullerton.**

Adrienne Brooks, rail projects manager for the Orange County Transportation Commission, said there have been a few glitches. Trains failed to get to San Juan Capistrano for the regular 6 a.m. departure on at least three occasions because of various unexpected problems, ranging from an overturned car on the tracks to thieves stealing the copper wiring for the switching system.

She said the train was late twice last month, but never more than eight minutes beyond its scheduled 7:25 a.m. arrival time.

On most days, it arrived early, sometimes by as much by as 15 minutes, she said.

Brooks thinks that's a pretty good record.

"If you were driving on the freeway and there was an accident, how late would you be?" Brooks asked.

She said the train got a big boost in ridership in July after the explosion in the Metro Rail tunnel in Los Angeles forced the closure of a portion of the Santa Ana (I-5) Freeway for five days. Officials hope to encourage additional ridership with a new discount ticket program, Brooks said.

Dana Reed

Long-distance commitment: Anyone aspiring to become the California Department of Transportation's district director in Orange County is advised to take the long view.

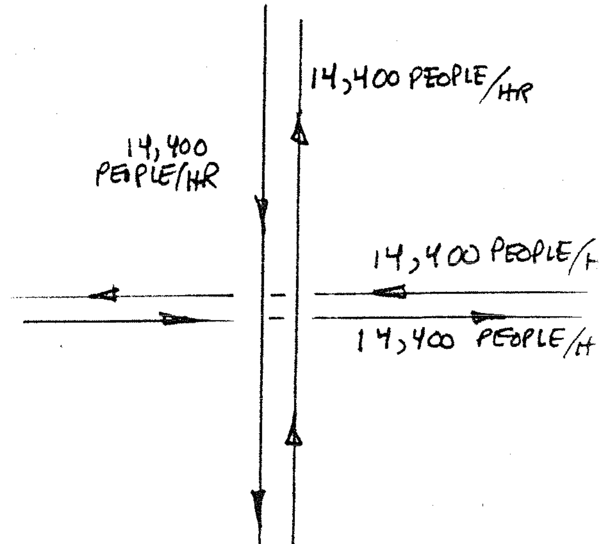
Dana Reed, chairman of the Orange County Transportation Commission, noted that District Director **Keith McKean** retired from Caltrans last week after 39 years and that his replacement, **Russell Lightcap**, has been with the agency 44 years.

"The way I see it, someone starting with Caltrans today would be eligible to become district director in 2045," Reed joked.

FROM ORANGE CO REGISTER

PEOPLE POD
SINGLE LANE INTERSECTION
MAXIMUM CAPACITY
CALCULATIONS

2 PASSENGERS / POD
1/2 SECOND SPACING AT 100M
100 MPH TO ZERO MPH 6 g
EMERGENCY STOPPING DISTANCE
= 55 FEET ∴ OK
(ACTUAL SPACING = 76.6 FT − 10 FT LENGTH = 66...

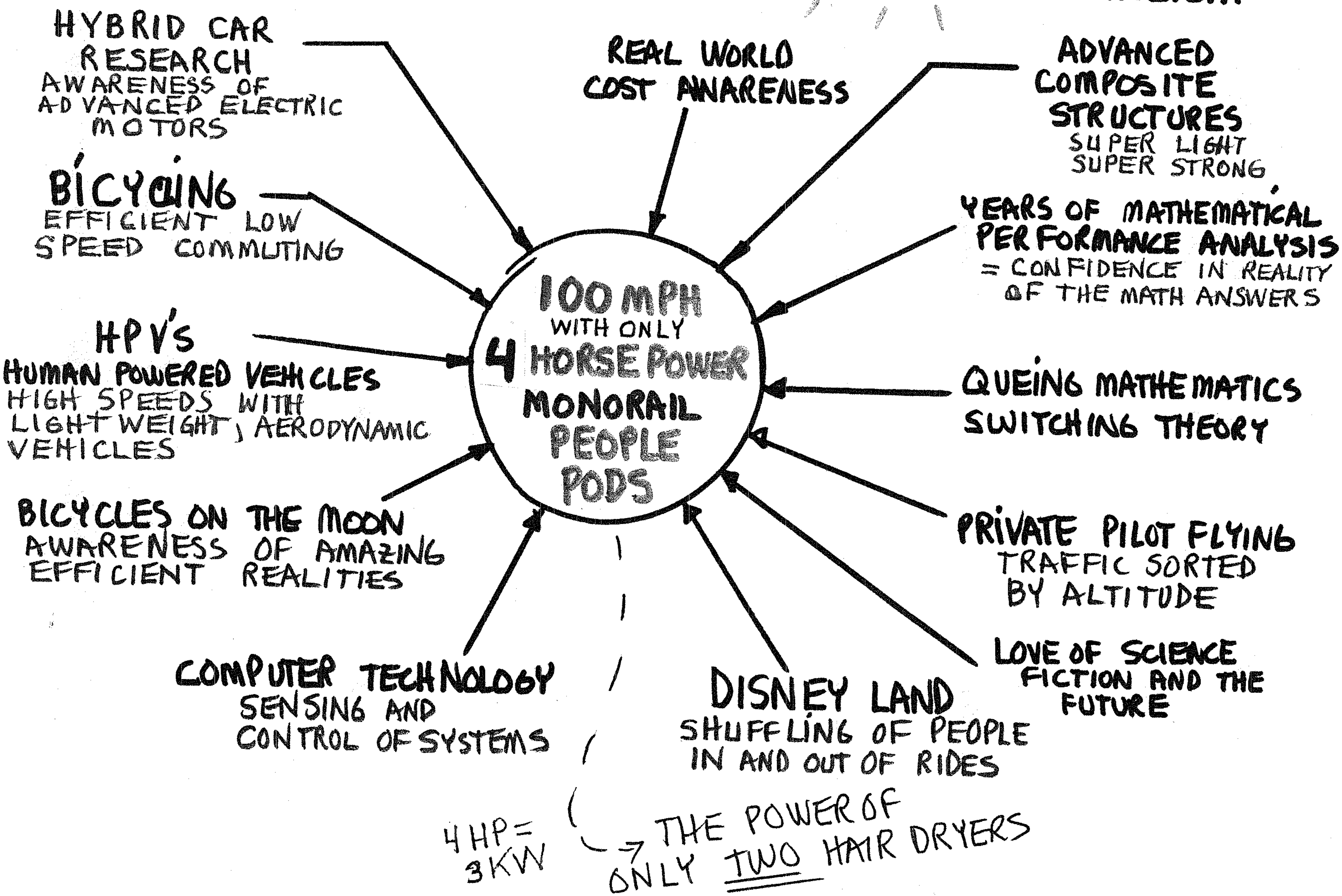


THUS,
TOTAL INTERSECTION MAXIMUM
CAPACITY PER HOUR
= 4 X 14,400 = 57,600 PASSENG...
= 1,382,400 " /...

LOOKING AT ITEM 1 — SANTA ANA
ORANGE FWY (57)
ASSUME 20% IS TRUCK + LARGE VEHICLE TRAFFIC
LEAVES 376,000 PEOPLE/DAY

A PEOPLE PODS SINGLE GRID INTERSECTION WOULD MOVE TH... MANY PEOPLE IN 3 1/4 HOURS IN THE MORNING PLUS ANOTHER 3 1/2 HOURS IN AFTERNOON!!!

BASIS FOR THE PROVERBIAL FLASH OF INSIGHT



The Orange County Register Thursday, August 2, 1990

Metro

DIANA GRIEGO ERWIN

People Pods are idea; Has time come?

A thick packet that arrived in the mail was a strange one.

The top page looked like an advertisement straight out of "The Jetsons" with drawings of single-passenger vehicles called "People Pods."

I set it aside, but looked closer days later when a cover letter implored me to believe the authors weren't "science-fiction crazies."

Fooled me, I thought.

Two transportation stories this week pressed me to call the People Pod promotors.

The first was paying 5 cents more per gallon at the gas pump. The second was an Environmental Protection Agency plan saying we could face no-drive days if we fail to reduce smog substantially.

So I chatted Wednesday with Victor Vurpillat, 58, a futurist from Laguna Niguel.

The brainchild of designer-inventor Doug Malewicki of Irvine, People Pods are 150-pound, bullet-shaped vehicles that would dramatically alter — and improve, Vurpillat says — the way Southern Californians commute.

This is his dream: Driven by a small electric motor, the computer-controlled pods would cruise on a non-stop grid system running above street and freeway traffic.

Vurpillat says the cost for building this is minuscule compared with freeway and light-rail construction.

The small design team that includes an aerospace-materials specialist, engineers and an automation expert, says robotics could build one mile of the system daily for about $1 million per mile — about 1/50th of the cost of freeways.

Traveling 100 mph, the pods would propel travelers 25 miles in 15 minutes. A car averaging 35 mph in commuter traffic would cover the distance in 43 minutes; a light-rail train with several stops, 33 minutes.

Eventually, the network would be so complete, it could deliver commuters within 2,000 feet of their desired destination.

The best part: The pods allow commuters to leave home when they want and travel to any destination without stops in between.

The system exists only in their minds, but supporters push it because they believe only innovation will free us from gridlock.

Malewicki's next step is getting a grant to build a prototype.

But the greatest obstacle, Vurpillat says, is public acceptance.

An industrialist he knows loves the idea but simply said: "It doesn't look enough like a car."

He thinks private industry, not government, should build it because "new ways of thinking are not the government's forte."

The question is, would you use something that costs less, cuts pollution, is safer and could virtually rule out the need to use your private automobile daily?

Or are we too set in our ways?

The Orange County Register Saturday, September 8, 1990

Business

Protecting your invention

·rom an idea to reality

Kathi Kent Riley/The Orange County Registe
)ug Malewicki, left, talks with Victor Vurpillat, one of his partners and a company start-up specialist, about their People Pod project.

Protecting invention key to success

People Pod creator left a paper trail

JAN NORMAN

It's Your Business

After you've invented solar socks is no time to play I've Got A Secret.

Sure, you don't want some reprobate to rip off your idea, reaping huge profits to live the high life like some savings and loan executive. But the invention biz has a saying: "No tell; no sell."

So how does an inventor safeguard an idea and still get it to market, It's Your Business wanted to know in Problem 122.

Here's how Irvine inventor Doug Malewicki goes about it. One Saturday last April, he read in The Orange County Register, no doubt, about a proposal to spend $125 million to build a monorail transit system. He figured something better could be done for less.

Malewicki looked at the utility poles along Culver Boulevard and it clicked. One- or two-passenger vehicles running on tracks held up by the poles. Cover the region with these tracks like a net, so travelers can catch a ride within yards of their homes and arrive within yards of their office door. One-hundred miles an hour. The equivalent of 370 miles per gallon.

Wow! Travel from San Clemente to Santa Ana in 15 minutes. Cut your commute bill 95 percent. And the cost of constructing the tracks is $1 million a mile. Compare that to the $250 million a mile being spent on the Los Angeles Metro Rail.

Lest you think he ate anchovy pizza before bed, you ought to know that Malewicki, with a Stanford University aeronautical engineering degree, has a bit of a track record with super fuel-saving vehicles. He invented the California Commuter, which set fuel-efficiency records in 1980 for traveling from Los Angeles to San Francisco on less than three gallons of gasoline.

A three-seat production model of that baby is on hold while Malewicki works on this invention, which he calls People Pods.

Is he working in a locked vault? Nah. In five months People Pods already has a 14-member team of engineering, manufacturing and business start-up experts. Malewicki freely gives stacks of information to news reporters and explains People Pods to Inventors Workshop. He's even called his congressman, but hasn't gotten a reply.

Shouldn't he be more secretive?

"I have so many ideas, if you want to steal one and go through all the hassle (of making it reality), go ahead," Malewicki says.

Victor Vurpillat, one of Malewicki's partners and a company start-up specialist, says, "You can explain these things in detail for two reasons: Most people are honest, and the courts are siding with inventors against corporations that have taken ideas. It's gotten to the place that most big companies won't let you tell them your ideas."

But don't think that People Pods is up for grabs. As soon as the idea clicked that April Saturday, Malewicki started a journal to establish his date of conception.

Two weeks later, he presented People Pods to a closed session of Inventors Workshop. Only members who have signed non-disclosure agreements sit in on those sessions and offer advice on each other's work. Again, he was establishing his date of conception.

He reserved a trademark on the name. He had a patent search done to determine no one else had officially protected the idea.

He has applied for design and utility patents.

These actions are second nature to Malewicki, who first broke into the marketplace in 1965 with a card game called Nuclear War. After selling several thousand, he abandoned the project. But years later a game manufacturer revived it as Nuclear Escalation.

He also invented a jet engine motorcycle and kitecycle. His latest invention to hit the market is the 54,000-pound Robosaurus, a fire-breathing car crusher that entertains at car shows.

That track record is important as Malewicki tries to move People Pods toward reality.

"I have a lot of credibility because I have said I was going to do a lot of crazy things and actually did them."

Obviously, Malewicki has developed inventions so many times that such protections are routine, but novices need to learn the ropes, says Joseph J. Todd, president of MarketMed Inc., an invention marketing firm in Tustin.

Too many fall prey to invention protection companies that have the inventor file a disclosure document with the US Patent Office, which Todd equates to mailing yourself a stamped self-addressed envelop. Then these firms send the inventor's idea off to dozens of companies without getting a non-disclosure agreement signed first.

But even inventors who obtain a patent sometimes have to spend a fortune fighting the ripoff artists, Todd says.

He recommends that inventors get signatures on confidential non-disclosure documents from every person and company that participates in the enhancement of the product, file for a patent, make a prototype (known in the invention biz as reducing the invention to practice) and get counsel they can trust.

Gene Scott, president of the Orange County chapter of Inventors Workshop, agrees with Todd, not just because these actions build a shield around an idea, but because they also give the inventor an air of professionalism. Inventors who appear to be amateurs about protecting themselves are more likely to get ripped off.

Although Scott acknowledges that inventions are stolen sometimes, he adds, "inventors don't need to be as paranoid as they are and it really hurts them. They have to tell people or they won't get their invention on the market."

CHAPTER 12

PEOPLE PODS:
THE SOLUTION FOR
CONGESTION, AIR POLLUTION
AND
ENERGY CONSERVATION PROBLEMS

The Solution for:

Personal Transportation
Smog and Air Pollution
Energy Conservation

Executive Summary

Transportation Innovations Inc.

People Pods ™

Research and Development Capitalization

Ten Million Dollars

TRANSPORTATION INNOVATIONS, INC.

Mission Statement

Transportation Innovations, Inc. has developed a solution to the pollution, energy and congestion problems created by personal transportation without trading for the inconvenience and time constraints of traditional public mass transit. The on-demand monorail People Pods system is the solution. People Pods provides 100 MPH non-stop transportation that is a cost effective and safe alternative for commuters while consuming 1/20th of the energy and creating 1/50th of the pollution of an automobile.

The Transportation Solution

Public transportation can succeed on a significant scale only if it can compete with private automobiles in terms of schedule flexibility, efficiency of operation, service to desired destinations and finally the hard economics of daily use. The goal of all commuters is to leave when they desire and to travel to any specific destination as fast as legally possible. Automobiles and the extensive road systems we humans have slowly created, have for decades been a reasonably acceptable solution to that quest - but at an extreme cost in energy, pollution and lives.

The People Pods non-stop grid system provides the most attractive, practical, effective and profitable public transportation system ever devised. The Pods will be so capital and energy efficient that they can provide a profit from revenues which represent no more than what an individual user would normally be paying for gasoline. Creating a home to work and back again daily commuting service that is safer, faster, more cost effective and less frustrating to use than personal automobiles is the essential motivating incentive that the People Pods concept addresses.

The Peoples Pods concept utilizes proven technological developments in light weight streamlined composite structures, high efficiency ultra light weight electric motors, advanced power distribution control systems and today's modern high powered computers to create a low cost, safe personal/public transportation system.

Transportation Innovations, Inc. has created a system concept that:

- Is lower in cost than any paved road, rail transit or monorail system.
- Requires 1/20th of the energy of an automobile to travel each mile.
- Produces only 1/50th to 1/100th of the pollution of an automobile.
- Cruises at a steady 100 miles per hour.
- Can be erected faster than any paved road, railroad or monorail.
- Once completed, has a potential return on investment capital of 80% per year!
- Is safer than traveling by automobile.
- Will achieve public acceptance due to its inherent appeal and practicality.

Low user costs, combined with the time saving aspects of using the People Pods system will be the driving motivation for the acceptance of this innovative transportation system.

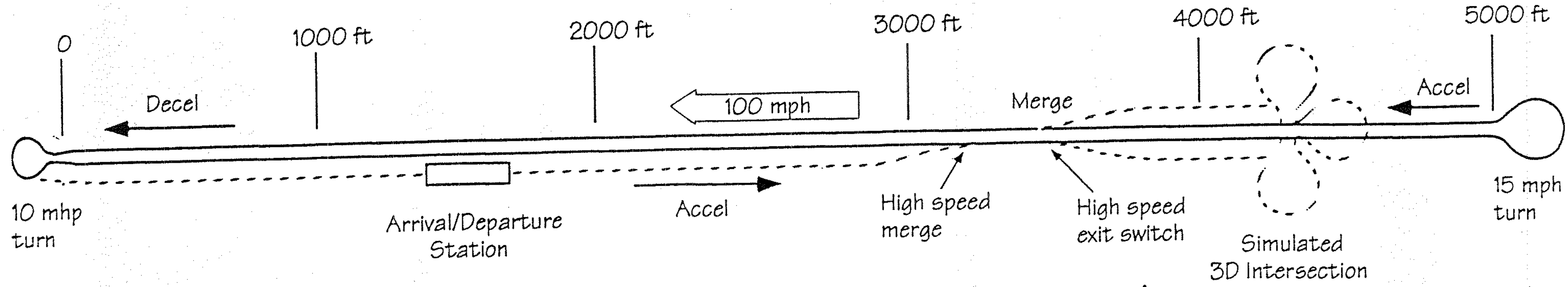
As currently envisioned, the People Pods are comfortable, 200 pound, two passenger, aerodynamic, electric vehicles. The Pods take power directly from the monorail track so they do not have to carry the excess weight penalty of on-board batteries. Excess weight is the primary factor that limits performance and range of self-contained electric automobiles. This limitation is overcome by the People Pods System.

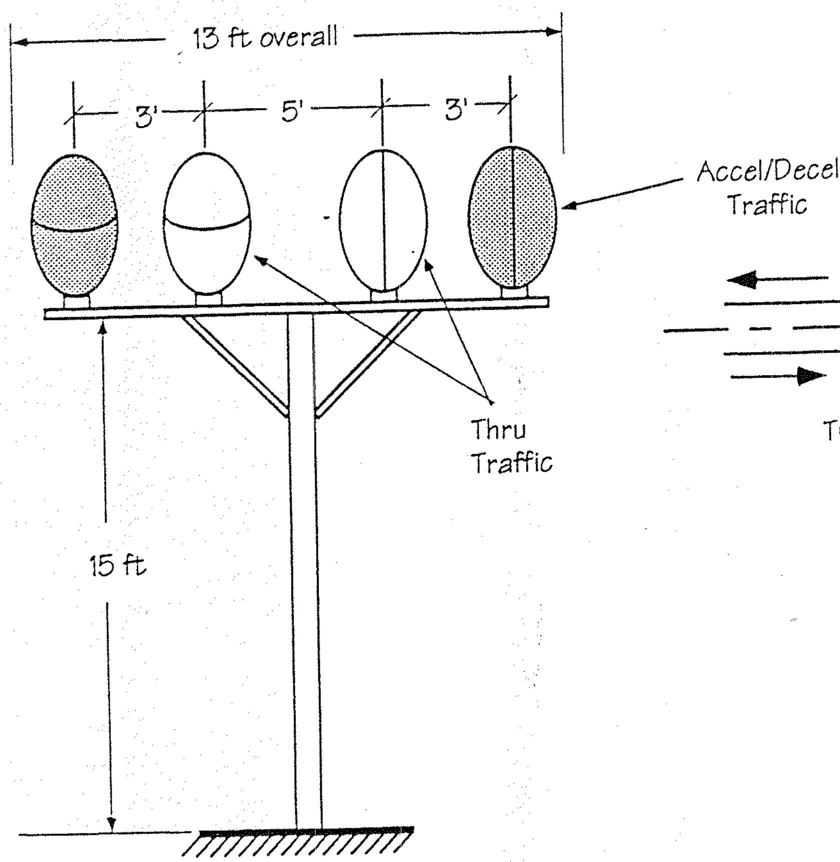
A single two passenger People Pod will require less than 5 horsepower while cruising at a steady 100 miles per hour. This is 3.6 kilowatts of electricity (a bit more electrical power than consumed by two hair dryers) and at 9 cents per kilowatt hour, the energy cost for a 100 mile trip will be 32 cents. Thus, for $l.30 of energy - the price one pays for just one gallon of gasoline energy - a People Pod will travel 407 miles!

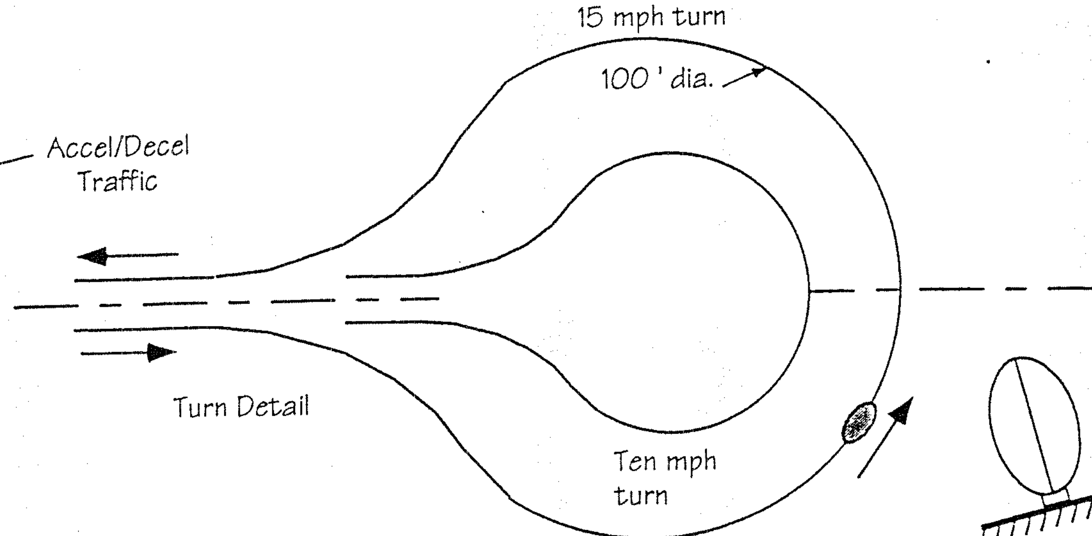
People Pod ™

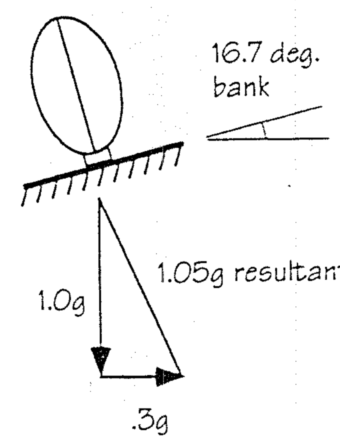
System Demonstration Test Track

Phase II









10 mph turn requires
22.3 ft radius for .3g.

15 mph turn requires
50 ft radius for .3g.

Douglas Malewicki
Dec. 2, 1990

FOUNDERS

Frank Baker, 35 - MBA, University of Southern California. Frank is Vice-President of Monitoring Automation Systems, world's leading supplier of non-stop computer systems for continuous monitoring of commercial and residential burglar and fire alarms. At MAS, Frank is currently responsible for R & D and special projects. He has directed software development, product design, operations and support for MAS at various times in the past 10 years. At USC, Baker specialized in Entrepreneurship and Venture Management, and performed Fellowship work in the area of Probability and Statistics.

Douglas Malewicki, 51 - MS Aeronautical and Astronautical Engineering, Stanford University. Doug is the inventor of the PEOPLE PODS concept. He has been involved in the International Human Powered Vehicle Association movement and has written papers on the performance of aerodynamic light weight vehicles, including Scientific American. Malewicki is a Guinness World Record holder for his street and freeway legal 155 MPG (at 55 MPH) California Commuter. Doug is the creator of ROBOSAURUS, and Co-Founder and CFO of Monster Robots, Inc.

BUSINESS ADVISORS AND ENGINEERING CONSULTANTS

Paul Bartlau 39, BS Business Administration, Oklahoma State University. President, VP of Marketing and Co-founder of publicly traded C.I.S. Inc., a 300 employee computer software firm specializing in the health care industry. Paul also has an extensive background in finance and commercial real estate.

Craig Ellis 31, BS Mechanical Engineering Rensselaer Polytechnic Institute. Director of Composite Manufacturing Engineering for the B-2 Stealth Bomber at Northrop's Advanced Systems Division. Craig has an extensive background in all aspects of development, tooling and fabrication of aerospace composites.

Allen Goody 57, BS Mechanical Engineering, University of Colorado, MBA California State University,Long Beach. President, Transportation Concepts Group, Newport Beach CA. Successful field directory on the winning 1990 Measure M campaign representing the Orange County Transportation Coalition. Previous experience includes: VP, Ordnance and Missile Control Operations for Ford Aerospace - Aeronutronic Division, General Dynamics - Reliability Engineer, General Motors - Vehicle Design Engineer.

Robert Kubinski, 30 - Vice President of Prototype Development for Aerovisions, Inc. Bob is co-inventor and co-designer of the ROBOSAURUS Monster Robot. He supervised, and is heavily involved in fabrication, producibility and quality assurance.

Jim Potts, 30 - BS Mechanical Engineering, Texas Tech University. Jim is a specialist in limited production design and technology for highly stressed advanced composite parts for medical, aerospace and other commercial applications.

Kevin Pracon, 33 - BS Mechanical Engineering, Rochester Institute of Technology. Kevin is an automation design and implementation specialist. He has been awarded patents for Robotic End Effectors used in automobile manufacturing, aerospace, and cruise missile surface preparation. Pracon also has significant experience in strategic planning and business startups.

Art Rosene, 53, is a pioneer in composites and non-metallics manufacturing. He has proven expertise in taking new theories and concepts and turning them into tangible products. Art is a specialist in designing for low cost fabrication, factory production problem solving, and improving assembly line procedures. Rosene is one of the few Northrop B-2 Division Representatives allowed to give public presentations and TV interviews on the Stealth Bomber project and was featured on the January 1990 cover of Plastics World.

Bruce Sargent, 38 - BS Electrical Engineering, Long Beach State University. Bruce is the founder of two successful companies, Ocean Scientific, Inc., which manufactures computer controlled automated medical laboratory instruments and Frontline Technology, Inc., a division of Schwinn which manufactures the Velodyne, a bicycle training simulator and fitness measurement sports product.

Steve Schlanger, 30 - President and founder of Unison Technologies. Unison is a leading manufacturer for microcomputer Uninterruptable Power Supply (UPS) systems. Steve pioneered innovative digital high powered switching mode power supply designs and holds patents in these fields.

Doug Schumann, 45 - BS Mechanical Engineering, University of New Haven. President and founder of P/Q Controls, Inc., designer and manufacturer of electronic controls for mobile machinery. Doug holds patents for inductively coupled joysticks, level sensor positioning systems, and non contact level sensors.

Lynn Tobias, 42 - BS Aeronautical and Astronautical Engineering, University of Washington. Past President of the International Human Powered Vehicle Association (IHPVA), Lynn has designed and built notable streamlined human powered vehicles which evolved to become the present world's fastest. Tobias is currently a System Effectiveness Engineer at Mc Donnell Douglas Space Systems Co.

Victor Vurpillat, 56 - PhD Human Behavior, MBA Pepperdine, BS Mathematics Cal Poly. Victor has been instrumental in the startup of ten companies over the past 25 years - resulting in their total market value of over $ 1 Billion. Dr. Vurpillat became Vice-President of Research and Development for Safeguard Scientific, Inc. in 1976. He is also currently Vice-Chairman of Unison Technologies, Inc., another Safeguard company.

Larry Wood, 48 - LA Art Center College of Design. Larry has 25 years experience in transportation and industrial design specializing in automotive (Ford Motor Co.) and aircraft (Lockheed) areas. From his prolific creative talent, thousands of concepts have been developed into commercial products ranging from refrigerators and toy cars to wide body commercial aircraft.

PRELIMINARY BUDGET PLAN FOR PEOPLE PODS PROJECT

PHASE I – $125,000 CONCEPT DEVELOPMENT (Complete)

Invention
Analysis of tradeoffs
Integration of engineering benefits
Integration of cost benefits
Initiate basic patent protection

PHASE II – $1 1/2 Million DEVELOP TECHNOLOGY (In Progress)

Thorough marketing research
Develop political infrastructure
Obtain commitments for right of ways
Detail design and engineering analysis
Vendor sourcing
Detail costing for design tradeoffs
Procure additional patent protection
Software development
Models
Full size mockup

PHASE III – $17 Million PROTOTYPE DEVELOPMENT (no revenue)

Construct one mile test track
Test -- controls
acceleration
steady cruise speed operation
braking
automatic emergency braking
switching
merging
ingress / egress
Quantify -- energy savings
pollution reduction values
safety

PHASE IV – $100 Million INITAL IMPLEMENTATION (First revenue generation)

Track roll forming machine perfected
Install first 20 to 30 miles of track
Basic pod factory in operation

PEOPLE PODS DEVELOPMENT PLANS FOR THE FUTURE

PHASE II – Research and Development

Formal design details for the People Pods Personal/Public Transportation System need to be completed so that accurate cost projections and schedules will be reliable. During this initial phase, the following objectives are slated for accomplishment.

Completion of Research for Validation of the People Pods Concept:

- A formal marketing research project will be commissioned to prove that consumer demand for the People Pods product exists, and to determine the required price points for various levels of demand. This will result in a demand curve which can then be used to target cost limitations in the formal design stage.
- Through additional research, prove that the system can be truly profitable for development with minimal or no additional investment of public funds.
- Other detailed analysis of saturation and queueing is required to determine optimum routing and computer control algorithms.

Develop Design Details and Material Specifications:

- Central computer control systems specifications, including functionality for: traffic management; idle pod routing; scheduled and remedial maintenance management; power usage analysis; and end user billing.
- Central system / Pod Vehicle telemetry and control hardware and software.
- Track system details. including: supports, mounting, interchange and switching details, power distribution.
- People Pods stations.
- People Pods vehicle chassis, power system and electronic control systems.
- People Pods vehicle manufacturing and tooling design, component and subcontract item specifications, manufacturing and maintenance facility design.
- Develop Reliable Cost Figures Based on Design Details.
- Build Mockups and Working Prototypes.
- Negotiate With Select Entity for Installation of Phase II Pilot System.

PHASE III – Prototype Development

Construction of a one mile test track, preferably in the Orange County, CA area.

- Test the controls, acceleration, cruise speed, braking, automatic emergency braking system, switching, merging and ingress / egress
- Quantify the energy savings, pollution reduction values and safety

PHASE IV – Initial Implementation

Installation of Pilot System to develop real world experience and refine design for large scale implementation of People Pods Transportation Systems.

- Construct main People Pod storage and maintenance facility.
- Construct and debug track and pole installation robot machines.
- Set up assembly line to build initial run of Pods.
- Install 10 mile straight pilot section with drop down boarding stations at each one mile increment (11 stations).

CHAPTER 13

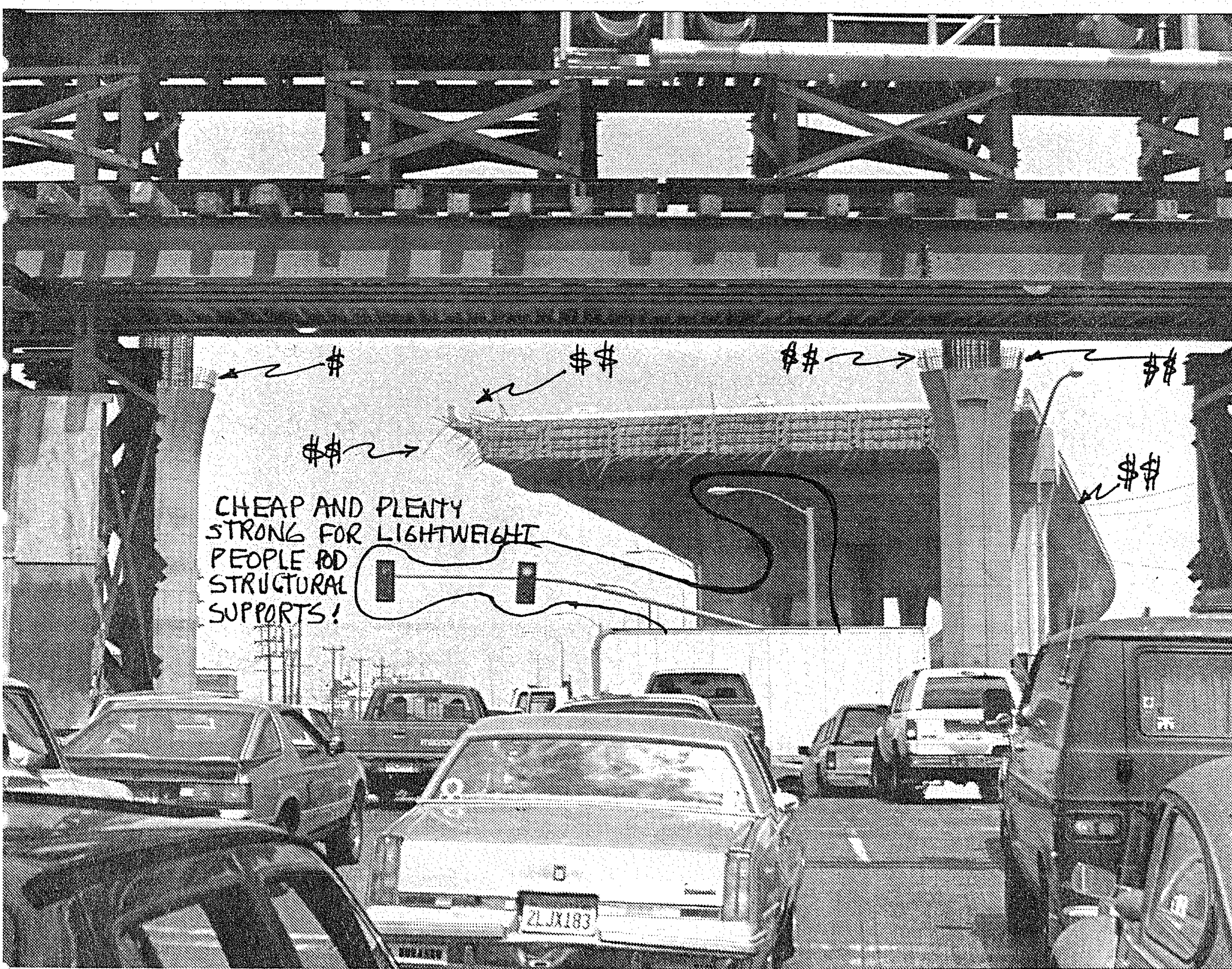
POSSIBLE
LONG DISTANCE UTILITY

Los Angeles Times, May 25, 1990

SACRAMENTO

S.F.-L.A. Rail Link Urged by Year 2000

A legislative study urges the state to construct a $12.6-billion rail system by the year 2000 that would carry passengers between San Francisco and Los Angeles at speeds of 125 m.p.h. or more. The study, which the Legislature will consider when it sets funding priorities for improving rail service in the San Joaquin Valley, calls for building a route over the Tehachapi Mountains along Interstate 5 to link Bakersfield and Los Angeles.



POSSIBLE LONG DISTANCE UTILITY

Originally envisioned as a point-to-point city commuter system which is faster, less expensive, safer, and cleaner than existing transportation, the PEOPLE PODS system may be valuable as a long distance transportation alternative.

In a recent Los Angeles Times article dated May 25th, 1990, it was stated that a legislative study urged the state to develop a $12.6 billion rail system to carry passengers between Los Angeles and San Francisco at speeds of only 125 MPH. This article did not estimate how many people would use the system on a daily basis.

If the State of California wants to throw that much money on the table, the PEOPLE POD developers feel strongly that a far more cost effective solution can be implemented with PEOPLE POD technology. In fact, the proposed $12.6 billion could build substantial supporting grid networks in both major cities with change to spare.

The following logic can illustrate the cost efficiency of the PEOPLE PODS system:

- A conservative estimate for the cost of PEOPLE PODS bidirectional monorail track pair for the heavier two passenger Pods, is $1.5 million per mile. Thus, 500 miles of track costs $750 million.

- Assume that 25,000 two passenger Pods are required at a cost of $3,000 each. These Pods will cost $75 million.

So far, we have only spent $825 million dollars, or only 6 1/2 % of the proposed $12.6 billion budget!!

How many people can be transported daily?

Now, lets address how many people can be moved on each system. How many trains can leave a station from either end, and how often? To be generous, lets assume that one 500 passenger train leaves every half hour, completely full. If train service runs for 16 hours per day, even at full saturation, with trains running in both directions, only 32,000 people per day can be served.

The train, must stop to let people off in between. If it stops 6 times, for 10 minutes per stop, the travel time is 5 hours. Although the train travels at 125 MPH, the true average speed is only 100 MPH.

Even if the train is not full it must travel anyway, and its costs for the trip are probably the same whether it is empty or full. PEOPLE PODS, on the other hand don't travel when no one wants to use them.

Now, lets consider the PEOPLE POD alternative:

First, the PEOPLE POD will travel non-stop at an average speed of 125 MPH. With 25,000 pods the system could move as many as 100,000 people per day with one passenger per pod and as many as 200,000 per day with two passengers per pod.

Lets compare this with current airline traffic. If an average flight carried 300 passengers, 667 flights per day would be required to carry 200,000 people.

Energy Efficiency

As previously explained, PEOPLE PODS are extremely energy efficient. Increasing the previously proposed speed of 100 MPH by 25% to 125 MPH consumes twice as much energy. Now, a two seat pod, traveling 125 MPH would require $2.70 worth of electricity to travel 500 miles. This is only $1.35 per passenger when two are riding in a pod!

Convenience and a Faster Trip

Remember that the PEOPLE POD leaves on demand, without a schedule, and stops only when you want it to, and where you want it to. You may want to stop for lunch or a rest just as you would in your own car.

What to do with the rest of the $12.6 Billion:

With the remaining $11.78 Billion, we could add another 250,000 PEOPLE PODS, plus 7,000 miles of PEOPLE POD Grid System Track to complete the transportation system infrastructure in both Los Angeles and San Francisco.

Just how vast would the benefit to society be??

Commuting problems as we know them in the city, could well be on their way to extinction.

You could travel directly from your home in Los Angeles to your destination in the Bay Area, without: Intermediate travel to the airport or train station, Confusion and waiting for luggage or planes, Wasted time waiting for departures or gates, Walking between parking lots. Life as we know it could be free of "hurry up and wait".

If you question the validity of this product, analyze the true time required for an airline flight to San Francisco. By the time you leave your house and drive to the airport, allowing time for traffic, waiting in lines, and getting to the airport a bit early, you must leave your house at least an hour before your flight. Once you get to San Francisco, you must deplane, pick up a rental car and drive into the city. This has got to take an extra hour and a half even on the best of days. Even though the airplane travels at 600 MPH, most of your time is spent waiting at 0 MPH making your average trip time for the entire event less than impressive. Using the PEOPLE PODS, you could complete the same trip in similar time, if not more quickly, in a much more productive, relaxed manner.

LOS ANGELES TO SAN FRANCISCO
HIGH SPEED TRAIN

	PROPOSED TRAIN	PEOPLE PODS	JET AIRPLANE	PRIVATE AUTOMOBILE
TOTAL COST	$12.6B	$.825B	$.40B/plane	$.000012B (1)
PASSENGERS PER DAY	32,000 (2)	200,000 (3)	200,000 (4)	?
CRUISE SPEED	125MPH	125 MPH	500MPH	70 MPH
AVERAGE SPEED	100 MPH (5)	125 MPH (6)	125 MPH (7)	58 MPH (8)
ENERGY COST/ TRIP/PERSON	?	$1.35	?	$33.75
TICKET COST	?	$20.00	$30.00	$33.75

(1) People drive their $12,000 automobiles on roads that they and their parents have and continue to pay taxes for.
(2) Assumes one train carrying 500 people leaves each end, once every half hour for 16 hours every day. 8,000 people per day is probably more realistic.
(3) Assumes 25,000 pods carrying 2 people each, make 2 round trips each day. A steady flow of on demand users for 16 hours a day.
(4) Assumes 300 people on each plane, 667 flights each day initiated at one of the three major airports at each end. For a 16 hour operational day this requires 7 flights out of each of the airports every hour. With a 3 hour turn around time this would require a combined fleet of 125 planes - a total capital cost of $5 billion.
(5) Assumes 6 ten minute stops for intermediary passengers or 5 hours to travel the 500 miles.
(6) No intermediate stops required for the convenience of other travelers you have never even met. A 125 MPH PEOPLE POD is YOUR computer chauffered personal vehicle for the entire trip. The remaining $11 billion should be used to construct complete people pod networks in LA and SF. That's enough capital for 3,500 miles of grid in each area, another 250,000 PEOPLE PODS and obvious non-stop point to point travel!
(7) Assumes a 30 minute drive to Los Angeles Airport; 15 minutes to park, check in and walk to the gate; 30 minutes to wait for the plane to start boarding; 30 minutes to load all passengers, taxi to the runway and take off; 1 hour to fly to San Francisco, 15 minutes to land ,taxi in and deplane; 30 minutes to get to the car rental booth and then to the rental car; and a half hour to drive to your final destination. That is 4 hours total or 125 MPH average door to door!
(8) Assumes one cruises at 70 MPH (just over the legal speed limit), spends the first and last 40 miles of the trip in some congestion averaging 50 MPG, and spends 1 hour for lunch and a gas fillup. That's 8.6 hours.

7/17/90

MORE LONG DISTANCE ANALYSIS

ANAHEIM TO LAS VEGAS

$4 BILLION TO GO 265 MILES IN 75 MINUTES ON A 300 MPH MAX SPEED MAG LEV TRAIN.

ACTUAL AVERAGE SPEED:

$$V = \frac{265 \text{ MILES}}{75 \text{ MINUTES}} = \frac{265 \text{ MILES}}{1\tfrac{1}{4} \text{ HOURS}} = 212 \text{ MPH}$$ FOR THE EXPRESS—NON STOP

WITH 6 TEN MINUTE STOPS (CORONA, ONTARIO, RIVERSIDE, GEORGE AFB & BARSTOW)

$$V = \frac{265 \text{ MILES}}{1\tfrac{1}{4} \text{ HRS} + (6 \times 10 \text{ MIN})} = \frac{265}{1\tfrac{1}{4} + 1} = \frac{265 \text{ MILES}}{2\tfrac{1}{4} \text{ HRS}} = 117 \text{ MPH}$$

THUS FOR THE NON-EXPRESS RUNS..... OUR LA→SF 125 MPH 2 PASSENGER PODS ACCOMPLISH A FASTER ANH TO VEGAS TIME BECAUSE OF THE "NEVER STOP" TILL YOU WANT TO STOP FEATURE.
(AT 125 MPH THE 265 MILE TRIP TAKES 2 HRS 7 MINUTES)

EST COSTS:

265 MILES OF TRACK AT 1.5 MILLION/MILE	=	$397.5 MILLION
10,000 PODS AT $3,000 EACH	=	$30 MILLION
		$427.5 MILLION

OR 10.7% OF THE PROPOSED $4 BILLION

THE JULY 17, 1990 REGISTER ARTICLE PROJECTED 5 MILLION ROUND TRIP PASSENGERS PER YEAR BY THE YEAR 2000

$$\text{THATS } \frac{10 \text{ MILLION TRIPS/YEAR}}{365 \text{ DAYS/YEAR}} = 27{,}397 \text{ TRIPS/DAY}$$

THATS 2.7 TRIPS EACH DAY FOR EACH POD IF RIDDEN SOLO.
OR 1.4 TRIPS " " " " " " " TWO UP.

IN AN 8 HOUR WORK DAY THE 10,000 PODS COULD MAKE 3.8 TRIPS EACH
A 6 AM TO 10 PM (16 HR WORK DAY) " " " " 7.5
A 24 HR WORK DAY " " " " 11.3

... EASILY COVER THE 5 MILLION ROUND TRIPS/YEAR!

THE JULY 17, 1990 REGISTER ARTICLE STATED THE ROUND TRIP TICKET COST WAS ESTIMATED AT $110 (OR $55 EACH WAY).

2 SEATER POD ENERGY ONLY COST AT 125 MPH IS:

$\frac{\$.64}{100\ \text{MILES}}$ OR $\frac{\$1.70}{265\ \text{MILES}}$ TWO PEOPLE OR $.85 EACH PERSON

IF WE CHARGE THEM GAS COST FOR THE TRIP IN THEIR 20 MPG, $1.15/GALLON AUTOMOBILE EQUIVALENT, THEN

$\frac{\$5.75}{100\ \text{MILES}} = \frac{\$15.24}{265\ \text{MILES}}$ — 28% OF THE $55 FARE!

ONE: RIDERSHIP WOULD PROBABLY GO UP SIGNIFICANTLY

TWO: GROSS FROM 10 MILLION TRIPS WOULD BE $152.4 MILLION

THREE: TOTAL ENERGY BILL WOULD BE $.85 X 10 MILLION PEOPLE = 8.5 MILLION

LEAVES $143.9 MILLION

IF 50% WAS CONSUMED BY MAINTAINENCE ETC

WE WOULD HAVE $72 MILLION LEFT AND WOULD PAY FOR THE ENTIRE SYSTEM IN 5.9 YEARS WITH $72 MILLION PROFIT /YEAR THEREAFTER

A 16.8% RETURN ON INVESTMENT

AT $110 ROUND TRIP ($55 EACH WAY)

GROSS FROM 10 MILLION TRIPS WOULD BE $550 MILLION
- 8.5 MILLION ENERGY

LEAVES 541.5

LESS −72 MGMNT/MAINTAINCE ADVERTISING ETC

$469.5

THUS PAYED OFF IN < 1 YEAR!!!

(I PREFER THE $15 TRIP COST)

LASTLY TAKE $4 BILLION − $427.5 MILLION COST = $3.572 BILLION LEFT

AND BUILD 1900 MILES OF PEOPLE POD TRACK = 2.850 BILLION

AND ADD 250,000 PODS TO COVER VEGAS + ORANGE CO = $.750 BILLION

3.600 BILLION TOTAL

AND HAVE 100 MPH NON STOP ACCESS TO 125 MPH LINK FROM ALL OVER ORANGE COUNTY OR LAS VEGAS. DOOR TO DOOR IS NOW FASTER THAN

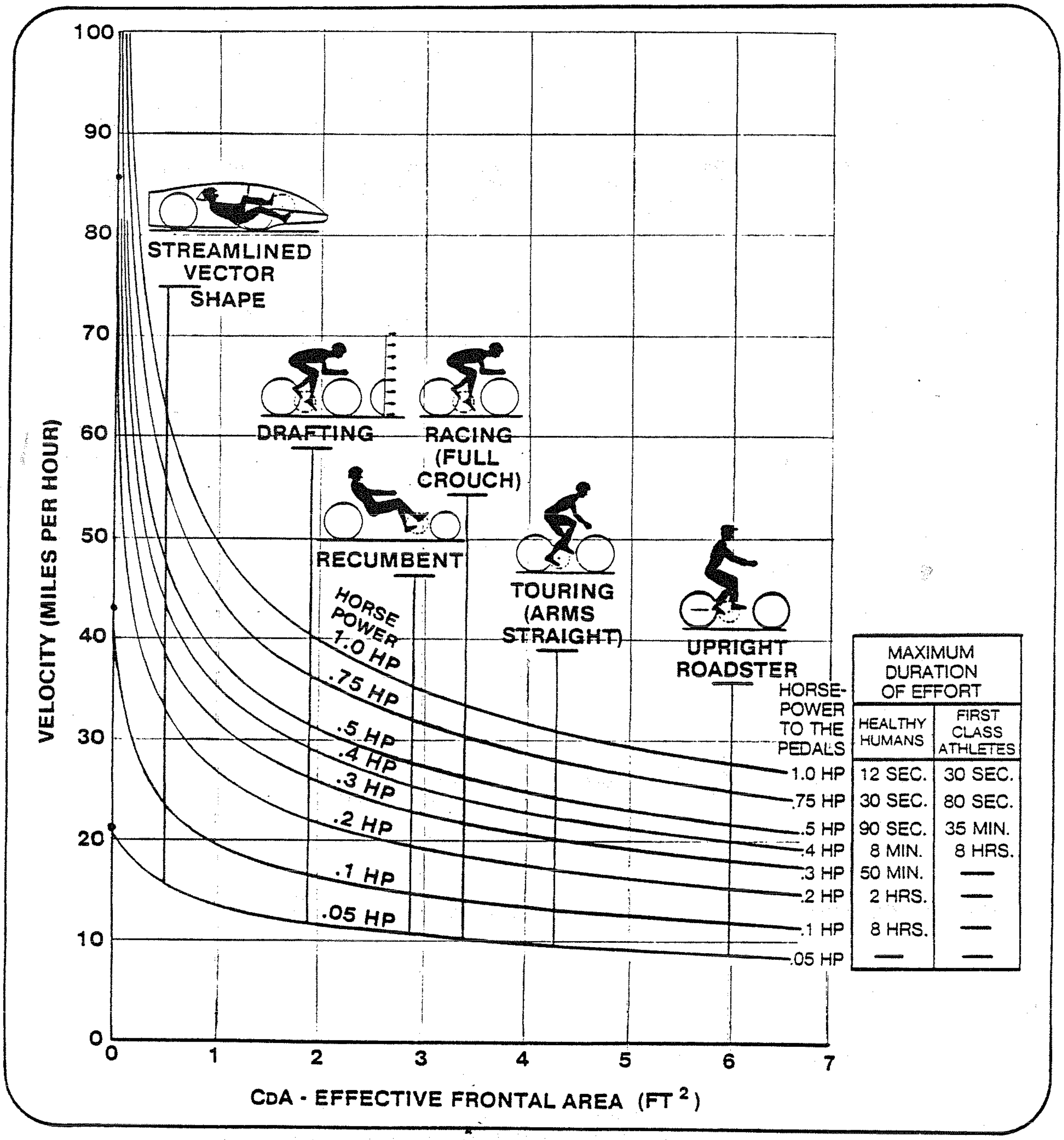
CHAPTER 14

AERODYNAMIC REFERENCE: NEW UNIFIED GRAPHS AND COMPARISONS FOR STREAMLINED HUMAN POWERED VEHICLES

Price $4.50

NEW UNIFIED PERFORMANCE GRAPHS AND COMPARISONS FOR STREAMLINED HUMAN POWERED VEHICLES

BY
DOUGLAS J. MALEWICKI



PRESENTED AT THE SECOND HUMAN POWERED VEHICLE SCIENTIFIC SYMPOSIUM

Long Beach Convention Center, Long Beach, California, October 22, 1983

14962 Merced Circle, Irvine, CA 92714
Second Edition/Revision October 1989

INTRODUCTION

This paper explores the limits of human powered vehicle performance. New graphs unify the interrelations between aerodynamic drag, available human power and resulting speed performance. Detailed charts compare standard bicycles, improved production bicycles, record HPV'S and ultimate theoretical machines in a coherent format that will give the reader additional insight into the importance of aerodynamic drag. Segments of this material will appear in the December 1983 issue of SCIENTIFIC AMERICAN's article, "The Aerodynamics of Human-Power Vehicles by Al Gross, Dr. Chet Kyle and Douglas Malewicki.

COMMENTS:

The SCIENTIFIC AMERICAN ARTICLE was a lot of hard and sometimes frustrating work. Our reward was not splitting $1,000 three ways (that's probably a mere 20 cents an hour for our time), but in seeing streamlined HPV'S even being considered as suitable subject matter in such a prestigious scientific publication. We did feel confident that our final draft was both technically competent and interesting, and were quite happy when the editors subsequently notified us that our article would be the feature of the month and that a streamlined HPV would be their cover art.

From the beginning, my personal goal was to attempt to bring existing information together into more unified and coherent graphical presentations. I have always had severe hang ups concerning good graphs! Graphs are just not suitable until they are clear enough to explain technical concepts to 10 year olds. I also happen to hate graphs that are distorted or chopped in scale because it makes mental interpolations and extrapolations difficult.

The "COMMENTS' section of each page will be used as my SOAP BOX to help the reader understand why each graph looks like it does. Some of the alterations to previous graphs are quite subtle (and maybe irrelevent) while other graphs are totally innovative.

Douglas Malewicki

DOUGLAS MALEWICKI
DIRECTOR

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CONTENTS

SPEED RECORDS

HUMAN POWERED VEHICLE SPEED RECORDS. In 1938 the Union Cycliste Internationale (UCI) banned streamlined vehicles from sanctioned bicycle competition. Thus, from 1938 to 1973, in all categories, the speed records for human powered vehicles (HPV's) remained nearly constant.

Aeronautical engineers and bicycle enthusiasts founded the International Human Powered Vehicle Association (IHPVA) in 1973 to encourage innovation in efficient bicycle design. Since 1974 the one-hour speed record has increased substantially (dotted curve). Likewise the 200 meter flying start records for single rider HPV's (dashed curve) and tandem HPV's (solid curve) have increased dramatically.

COMMENTS:

The small graph here in the "comments" section is the very familiar IHPVA speed records graph popularized by Dr. Kyle. In order to get a lot of information packed onto one sheet of paper, Chet started the vertical scale (speed) at 30 MPH. He also segmented the horizontal scale (years) and finally linearized this scale starting in 1970.

For the SCIENTIFIC AMERICAN article we replotted the data on a 0 to 65 MPH linear vertical scale, and a 1930 to present day linear horizontal scale.

Several facts now become a bit clearer at first glance which saves having to read and interpret individual numbers.

1. Top speed potential really did stagnate for at least a generation.

2. The creation of the IHPVA to encourage previously restricted basic aerodynamic innovations, increased top speed capability almost 50% in just 6 years - a veritable jump when seen on the true linear time scale. (Personally I'd like to see a 1880 to 1983 linear scale. The efforts of the IHPVA would then appear like a burst into hyperspace from the UCI controlled norm.)

3. After the demise of Ontario motor speedway, IHPVA records have not continued their spectacular increases. In fact, there have been no increases whatsoever - Progress has flattened out! What gives? Are we in for another 40 years with no progress?

4. Without taking a careful look at numbers in the earlier chopped scale graph, it appears that 200 meter top speeds might be about 5 times faster than the 1 hour records. After all, a human can generate a whole lot more power for 30 seconds than he can for 1 hour. On the linear scale graph, however, one visualizes true percentages directly and can see that in the past, 200 meter speed records were really only one third higher than one hour records. Obviously, some other factor is robbing power input at very large rates. (An excellent opportunity to remind the uninitiated that power consumed by aerodynamic resistance varies with the cube of speed!)

5. Nowadays, the single rider 200 meter record (58.89 MPH)is almost 60% higher than the 1 hour record (36.94 MPH). Why isn't the single rider one hour record closer to 45 MPH? (Especially when one considers the VECTOR tandem's feats on the California freeway). I suspect that the 200 meter speeds should still only be 30% more than the 1 hour record speeds. Let's call it simply a lack of interest.

6. You'll note, I just took specific data points from Dr. Kyle's original graph that just don't exist on the linearized graph! It seems one really needs both graphs to obtain maximum insight. Such dilemas should dissappear in a few years when there are no more printed books, just laser disks or all digital storage. You'll read an article on your color graphics computer terminal and can zoom back at will to take in the overall graph or can zoom in and see details of specific data points. (Color picture of the machine,the rider,complete vital statistics, etc.).

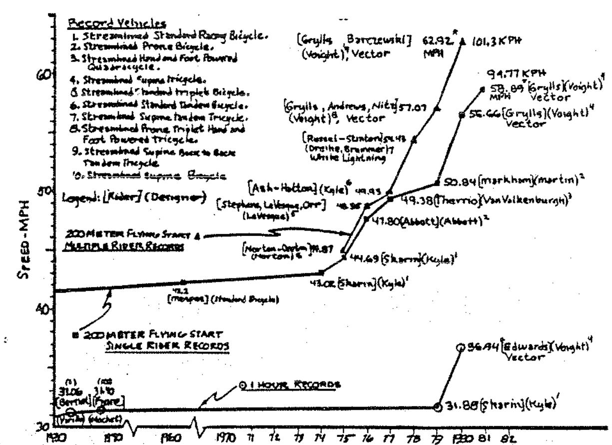
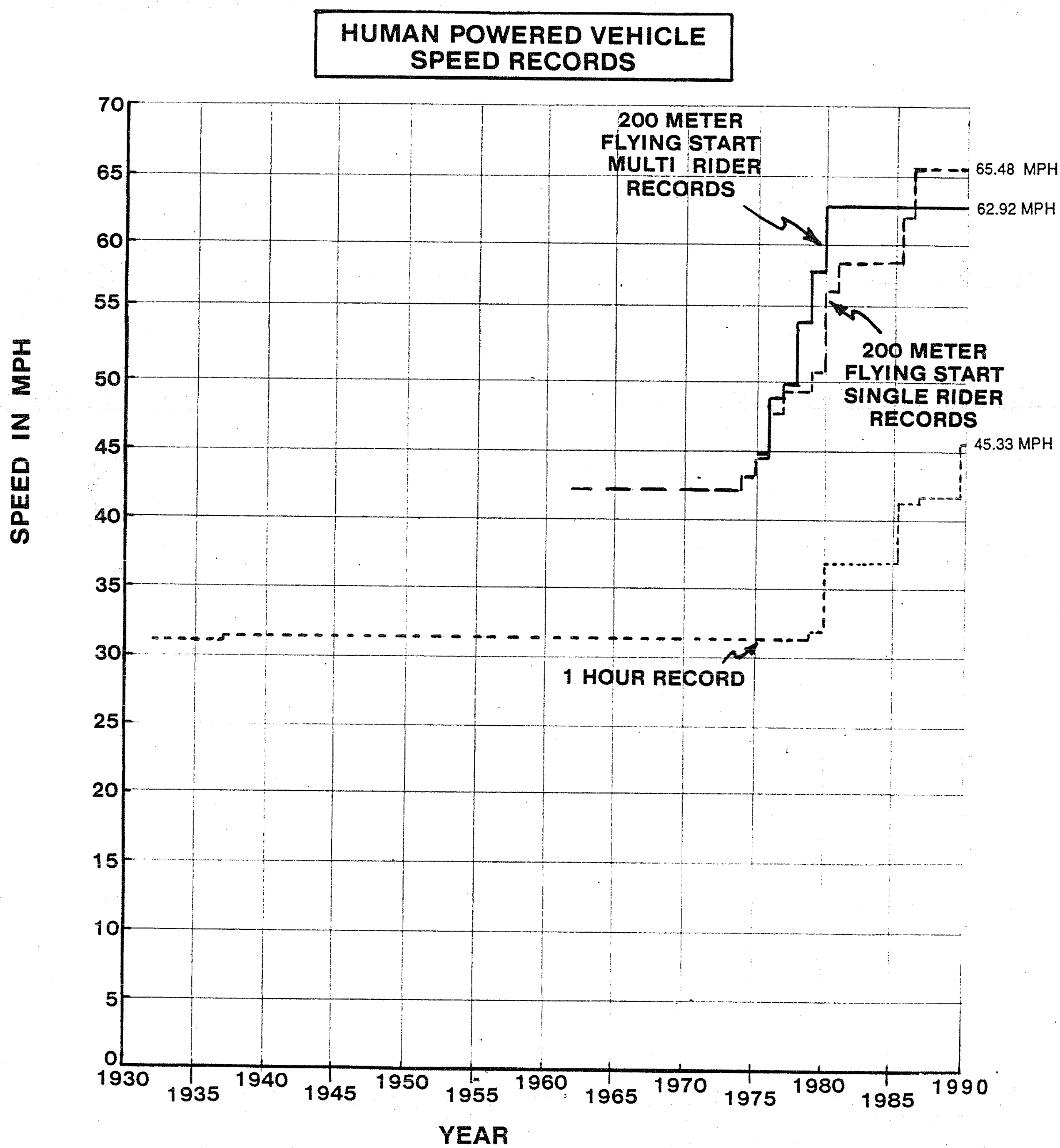


FIGURE 1 - HUMAN POWERED VEHICLE SPEED RECORDS

* Present Records as of 4/81 Generated C.R.Kyle

7. Last bit of knitpicking! Official records were broken at each annual speed championship. The graph should be a series of jumps since the speed records did not increase gradually (on a straight line) between years.



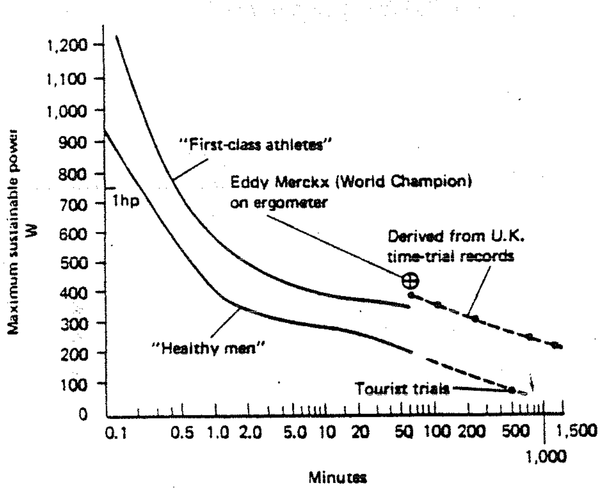
HUMAN POWERED VEHICLE SPEED RECORDS
SPEED IN MPH
YEAR
200 METER FLYING START MULTI RIDER RECORDS
200 METER FLYING START SINGLE RIDER RECORDS
1 HOUR RECORD
65.48 MPH
62.92 MPH
45.33 MPH
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990

6 HUMAN POWER CAPABILITY

COMMENTS:

The small graph here in the Human Power "comments" section should be another familiar plot to all. Namely, Human Power output as a function of time. By plotting such results on a semi-log scale, a whole range of useful data can be presented simultaneously. However, several factors in this familiar graph bothered me and required additional clarification by Dr. Kyle in order to make complete sense.

Figure 2.13
Long-duration human power output. Curves from reference 26.



REFERENCE: BICYCLING SCIENCE page 51
Second Edition 1982
Written by: Frank Rowland Whitt and
Dr. David Gordon Wilson
Published by: The Massachusetts
Institute of Technology
Available from: The IHPVA
PO BOX 2068
SEAL BEACH, CA 90740

1. All the graphs I've ever seen are plotted so that "Y"-the variable (vertical axis) is a function of "X"-the input (horizontal axis). When one conducts ergometer measurements, the power level is set (the "input") and the subject sees how long (the output variable) he can generate that level of power. It is not the other way around! I do not know know why in this instance "X" has been plotted as function of "Y", but it has become the standard.

2. The familiar plot also confused me, as it appears that the test specimen can generate; 1 horsepower for 12 seconds; then can continue to generate .75 horsepower for 30 seconds; a half horsepower for the next one and one half minutes; and then can continue on down to .1 horsepower all day long. (I wondered if the situation could also be reversed?) This was quite misleading. I did eventually find out that each data point that makes up the line indeed represents an exhausted human. No more power is available without some rest.

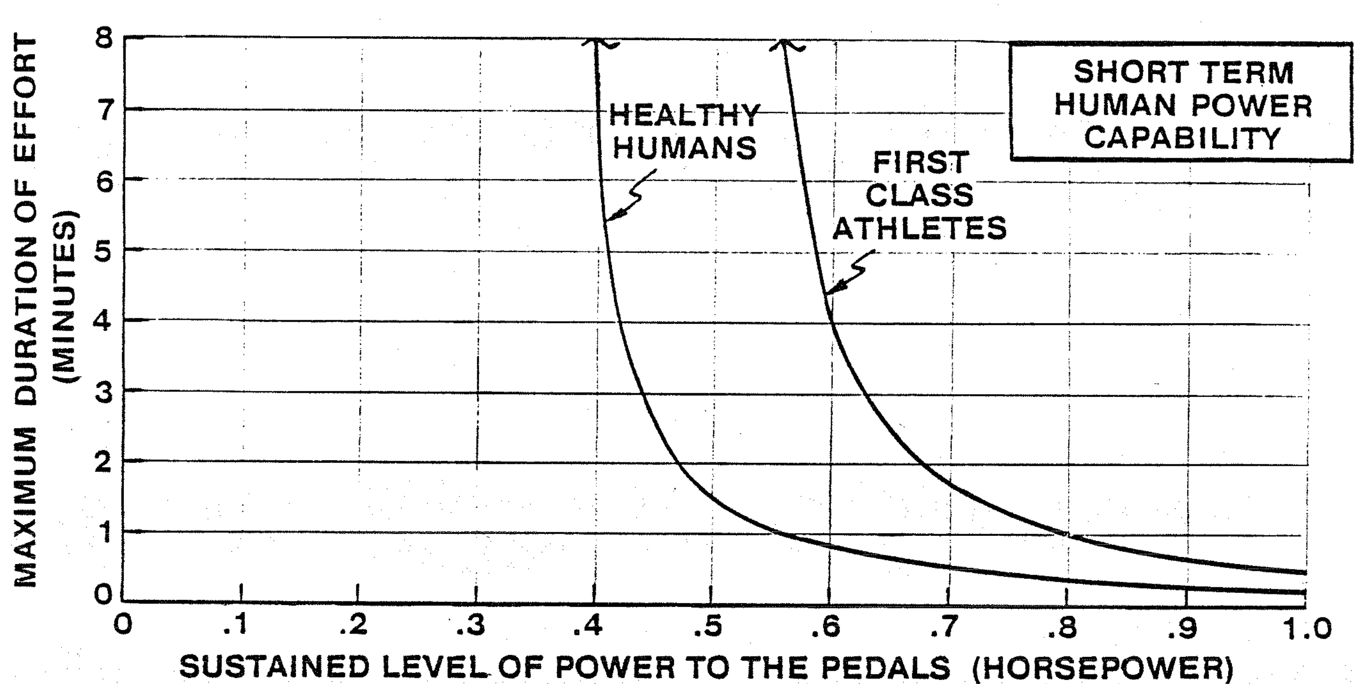
3. The familiar graph is semi-log which packs a lot of data onto one sheet of paper. Unfortunately, I have difficulty in mentally interpreting high horsepower data in proper time perspective because of this semi-log scale.

4. I hate Watts as the dimension for power units! I understand how much light a 100 watt light bulb puts out but have no intuitive feel for watts as a unit of measure of power. When I was a kid no one ever told me how many watts his Corvette developed! (Also our article was for SCIENTIFIC <u>AMERICAN</u> not some international journal). I still have to divide by 746 to get any feel for what power in watts means.

I would like to see an all metric world, but at least give me a break in the meantime by dual dimensioning all axes.

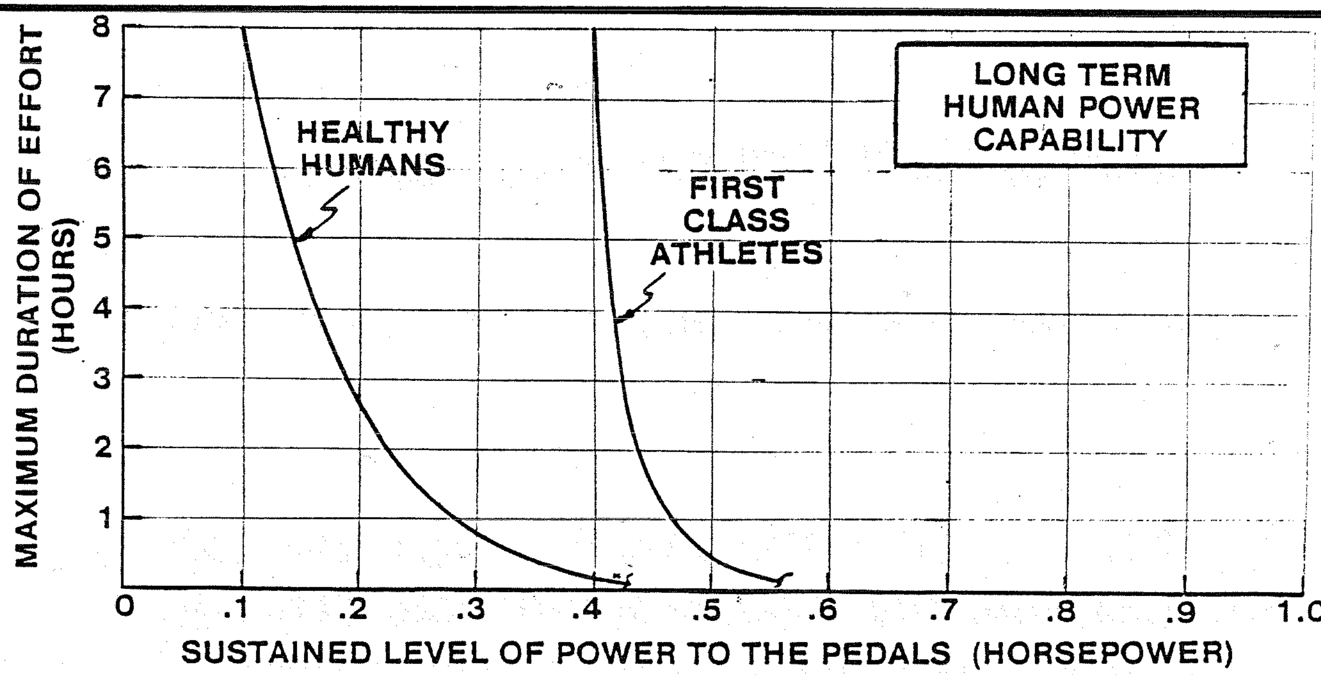
5. Lack of grid lines on the familiar graphs also made it difficult for me to read off specific data points. However, as I researched human power literature, I came to see why grids were left off - the data is scattered all over the place! A one inch wide graph line instead of a pencil width line would be appropriate! For purposes of theoretical performance calculations, one has to select some power capability numbers so it wouldn't hurt to standardize an official "Healthy Human". (You can't just say "Healthy Man" anymore. It's too chauvinistic.) I'd also like to note that to date the available human power graphs don't even consider human weight. If you check Bryan Allen's English Channel Flight power output and his duration to exhaustion, you'll see he wouldn't even be considered a "First Class Athlete". But, boy was he light (141 lbs.). His power to weight ratio was the best of Dr. MacCready's available engines. (Ref - IHPVA First Scientific Symposium).

6. My Human Power Capability Graphs are linear. Without the benefit of the time compression effect of log scales, I had to make two separate graphs (obviously a disadvantage). I also put the "maximum duration until exhaustion" where it belongs, <u>as a function</u> of the preselected horsepower level. This linear presentation should help visually clarify the severe limitations of organic engines. What I find especially interesting is that a "First Class Athlete" can produce 1.0 horsepower for only some 30 seconds, but he can produce 50% of that value for a whole 30 minutes and 40% all day long!



SHORT TERM HUMAN POWER CAPABILITY is quite small and varies widely among individuals. A "first-class athlete" can produce 1.0 horsepower for some 30 seconds while "healthy humans" can sustain this power level for a mere 12 seconds. Prediction of the top speed of various streamlined human-powered vehicles usually has been based on the assumption that the rider can contribute 1.0 horsepower. Agreement between top speed predictions and actual observed speeds at the IHPVA annual speed championships has been quite good.

The power data presented here combine independent ergometer measurements contributed by Harrison, Kyle, Wilkie, and NASA that have been corrected for gear train losses, so that true horsepower input to the pedals, rather than to the wheel, is shown. To obtain these data, experimenters asked the subjects to maintain preselected horsepower levels on an ergometer for as long as possible, and their endurance was recorded. An ergometer is a stationary bicycle configured as an instrument to measure human power output.



LONG TERM HUMAN POWER CAPABILITY data are used to predict the average cruise speed of various human-powered vehicles on an all day tour or non-strenuous commute. An average "healthy human" can produce a steady 0.1 horsepower for a full eight-hour period, while a "first class athlete" can produce 0.4 horsepower for a similar period. Some rare "champions" can produce 0.5 horsepower all day long. Scatter of actual ergometer measurements is quite large, due to variability of motivation, age, general health, how long the subject has acclimated to the ergometer device, and the temperature and humidity during the tests. None of the observations even attempt to relate human power to human weight.

BASIC AERODYNAMIC DRAG

AERODYNAMIC DRAG FORCE is affected by atmospheric density and the vehicle's shape, size, and velocity. To compare the aerodynamic efficiency of two vehicles it is only necessary to compare effective frontal area (CdA), which is the product of the aerodynamic drag coefficient (Cd) and the frontal area (A). When comparing the aerodynamic drag of two vehicles traveling at the same speed, the dynamic pressure (q) on the vehicles is identical and can be ignored for the comparison. While enclosing a human-powered vehicle in a streamlined fairing increases its frontal area, the aerodynamic drag forces on the vehicle at any speed will be decreased if the streamlining also reduces the effective frontal area (CdA).

COMMENTS:

Air is an invisible (except in Los Angeles), odorless, tasteless combination of gases, water vapor and suspended dust particles that weighs only one thirteenth of a pound per cubic foot at sea level. This invisible gas extends upwards from the planet's surface for about 500 miles. It is most dense at the earth's surface and rapidly gets less dense as altitude increases.

At 100 miles elevation, the air is already so thin that it barely retards space ships orbiting at 17,000 miles per hour. The weight of a 500 mile tall column of air above any single square inch of the planet's surface is 14.7 pounds. The weight of all the air surrounding our planet is 5.8 quadrillion tons, which is quite impressive for something you can't see!

One can only see and feel the results of moving air (the wind bending trees). When an object moves thru still air, it must necessarily disturb, displace, and push aside the individual particles and gas molecules in its path. A bicyclist can feel these forces but they hardly seem significant. A bicyclist traveling at 20 MPH feels a dynamic pressure from his motion thru the still air of only 0.007 PSI! (This works out to conveniently be just about one pound per square foot - a useful number to remember). Our bike tires at 100 PSI represent 14,000 times as much pressure. We humans and our machines move through this invisible tenuous atmosphere, hardly aware that resistance by the air has such effects as absorbing fully half of all the fuel energy used to propel our automobiles and trucks along at 55 mph.

Our senses do convey some information about air, even tho we can't see the gas that causes the resistance: Our skin feels the small pressures even at bicycle speeds; our ears hear air generated noises that grow louder the faster we go, and our eyes water if we ride down a long, fast downhill.

A bicyclist travelling at 20 miles per hour typically displaces 1000 pounds of air per minute, while a diesel tractor trailer truck will displace 34,000 pounds of air per minute while travelling at 55 MPH. The bicyclist's continuous interaction with the invisible gas results in a continuous resistance force of about 4.4 pounds at 20 MPH. The rider must develop this force continuously or he will not be able to maintain this selected speed.

The aerodynamic drag formula on the following page was used to calculate the 4.4 pound value. One should ask why does the retarding force vary with velocity squared? To answer that, we can look at what happens when you double speed. The bicyclist: 1) hits twice as many molecules of air each second he travels and 2) hits them twice as hard because he's travelling twice as fast. Similarly, a tripling of speed increases drag force by nine.

How does one measure Cd's (the dimensionless drag coefficient)? You can't! It's like the invisible air. You measure all the other items in the drag formula and calculate.

$$C_D = \frac{D}{A\left(\frac{1}{2}\rho V^2\right)}$$

Over the years, aeronautical engineers have measured drag forces on countless shapes under all forms of conditions, and calculated the Cd's for those shapes. After you study all the Cd's in the literature, you gain some insight into what the Cd for the next "new" shape might be.

Such data even exists for assorted bicycles with riders, bicycles alone, and riders alone!

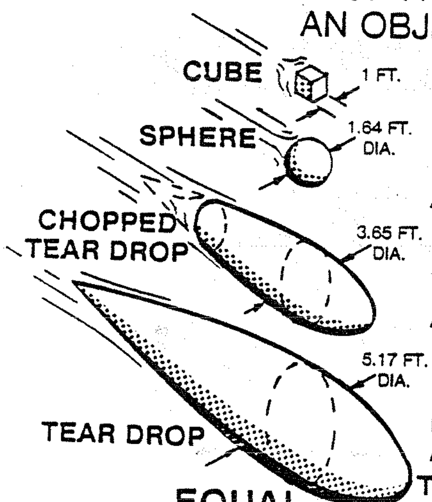
AERODYNAMIC DRAG

$$D = C_D \times A \times q$$

D	C_D	A	q
AERODYNAMIC DRAG FORCE (POUNDS)	AERODYNAMIC DRAG COEFFICIENT (DIMENSIONLESS)	PROJECTED FRONTAL AREA (SQUARE FEET)	DYNAMIC PRESSURE (POUNDS PER SQUARE FOOT

THE SHAPE EFFECT

A MEASURE OF HOW STREAMLINED AN OBJECT IS



CUBE	$C_D = 1.05$, $A = 1.0\ FT^2$	$C_DA = 1.05\ FT^2$
SPHERE	$C_D = .47$, $A = 2.13\ FT^2$	$C_DA = 1.05\ FT^2$
CHOPPED TEAR DROP	$C_D = .10$, $A = 10.5\ FT^2$	$C_DA = 1.05\ FT^2$
TEAR DROP	$C_D = .05$, $A = 21\ FT^2$	$C_DA = 1.05\ FT^2$

EQUAL DRAG BODIES

THE PRODUCT $C_D \times A$ IS CALLED THE EFFECTIVE FRONTAL AREA.

THE SIZE EFFECT

"A" 16 FT^2 (4' x 4')

"B" 9 FT^2 (3' x 3') — FLAT PLATE "B" HAS 56% OF THE DRAG OF FLAT PLATE "A"

"C" 4 (2' x 2') — "C" HAS 25% OF THE DRAG OF "A"

"D" 1 (1' x 1') — "D" HAS 6% OF THE DRAG OF "A"

HOW SPEED (V) AND ATMOSPHERIC DENSITY (ρ) ARE TAKEN INTO ACCOUN

$$q = \tfrac{1}{2}\rho V^2$$

$$= \frac{(V_{MPH})^2}{391}$$

(AT SEA LEVEL, 59°

SPEED	DYNAMIC PRESSURE
0	0
10 MPH	.25 LB/FT^2
20 MPH	1.02 LB/FT^2
30 MPH	2.30 LB/FT^2
40 MPH	4.09 LB/FT^2
50 MPH	6.39 LB/FT^2
60 MPH	9.20 LB/FT^2

	BICYCLES	RECUMBENTS	TRICYCLES
BARE	$C_D = .88$, $A = 3.9\ FT^2$, $C_DA = 3.4\ FT^2$	$C_D = .77$, $A = 3.8\ FT^2$, $C_DA = 2.9\ FT^2$	$C_D = .77$, $A = 3.5\ FT^2$, $C_DA = 2.7\ FT^2$
BOXED IN	$C_D = 1.2$, $A = 7.36\ FT^2$, $C_DA = 8.8\ FT^2$	$C_D = 1.2$, $A = 6.68\ FT^2$, $C_DA = 8.0\ FT^2$	$C_D = 1.2$, $A = 5.38\ FT^2$, $C_DA = 6.5\ FT^2$
CORNERS ROUNDED	$C_D = 1.0$, $A = 7.36\ FT^2$, $C_DA = 7.4\ FT^2$	$C_D = 1.0$, $A = 6.68\ FT^2$, $C_DA = 6.7\ FT^2$	$C_D = 1.0$, $A = 5.38\ FT^2$, $C_DA = 5.4\ FT^2$
HALF ROUND FRONT & REAR	$C_D = .7$, $A = 7.36\ FT^2$, $C_DA = 5.2\ FT^2$	$C_D = .7$, $A = 6.68\ FT^2$, $C_DA = 4.7\ FT^2$	$C_D = .7$, $A = 5.38\ FT^2$, $C_DA = 3.8\ FT^2$
ELLIPSE FRONT AND REAR	$C_D = .3$, $A = 7.36\ FT^2$, $C_DA = 2.2\ FT^2$	$C_D = .3$, $A = 6.68\ FT^2$, $C_DA = 2.0\ FT^2$	$C_D = .3$, $A = 5.38\ FT^2$, $C_DA = 1.6\ FT^2$
TOP ROUNDED	$C_D = .2$, $A = 7.10\ FT^2$, $C_DA = 1.4\ FT^2$	$C_D = .2$, $A = 6.41\ FT^2$, $C_DA = 1.3\ FT^2$	$C_D = .2$, $A = 4.84\ FT^2$, $C_DA = 1.0\ FT^2$
FULLY STREAM-LINED	$C_D = .12$, $A = 7.0\ FT^2$, $C_DA = 8\ FT^2$	$C_D = .12$, $A = 5.0\ FT^2$, $C_DA = .6\ FT^2$	$C_D = .11$, $A = 4.56\ FT^2$, $C_DA = .5\ FT^2$

BASIC BICYCLE POWER REQUIREMENTS

AIR RESISTANCE AND POWER REQUIREMENTS. Aerodynamic drag consumes the majority of a bicyclist's energy. At a speed of just under 10 miles per hour, aerodynamic drag of a bicycle and rider becomes equal to all other resistance forces combined. At 20 miles per hour, aerodynamic drag is five times greater than the rolling resistance, and at 30 miles per hour the air resistance is almost twelve times greater than rolling resistance.

If a rider doubles speed from 15 to 30 miles per hour, aerodynamic drag force increases four times (the velocity squared relationship) from 2.47 pounds to 9.89 pounds (left graph). Similarly , the power curve (center graph) shows that doubling the speed from 15 miles per hour to 30 miles per hour increases the horsepower consumed by aerodynamic resistance eight times (the velocity cubed relationship), from .104 horsepower to .833 horsepower. At the same time, doubling the speed increases the total requirement for power input to pedals 6.5 times from .14 horsepower to .90 horsepower. This same graph shows that a "healthy human" generating 0.1 horsepower will travel at 12.5 miles per hour. A rider traveling at 20 miles per hour who doubles power input will only increase speed 30 percent to 26 miles per hour.

If a rider assumes the fully crouched racer's position instead of the straight arm touring position, the effective frontal area (CdA) of the rider and bicycle is reduced about 20 percent. At 20 miles per hour, aerodynamic drag consumes a much greater proportion of the power than does rolling resistance. Consequently, reducing air resistance by assuming the fully crouched racing position reduces the overall power demand on the cyclist by 17 percent, a substantial amount.

In other words, a "healthy human" would be exhausted in three quarters of an hour if asked to sustain the 0.3 horsepower input required to maintain 20 miles per hour in the upright touring position. However, the same human in the crouched position would need to develop slightly less than 0.25 horsepower to maintain 20 miles per hour. At 0.25 horsepower the rider could extend the effort to 1.5 hours before reaching exhaustion. Alternatively, a cyclist who maintained a 0.3 horsepower input in the crouched positon could travel 1.5 miles per hour faster than a cyclist contributing the same power in the upright position. Measuring the horizontal and vertical distances from the right panel's dotted curve to its solid curve permits assessment of the possible tradeoffs between speed and power requirements, when a cyclist crouches to reduce air resistance.

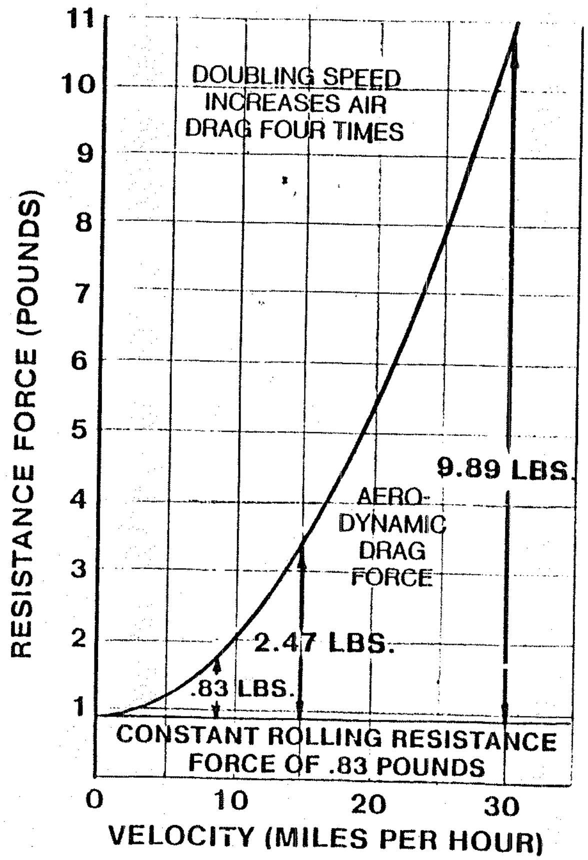
COMMENTS:

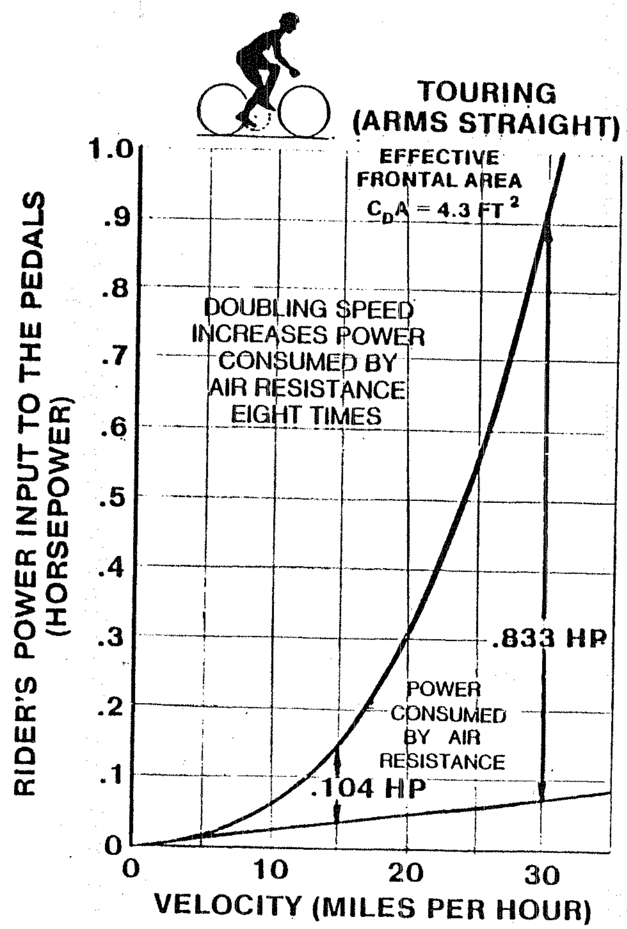
Power is the measure for the time rate at which the bicyclists work effort is being consumed. The term horsepower was originated by Boulton and Watt to state the power of their steam engines to prospective customers. They found that an average horse could work continuously at the rate of 22,000 foot pounds per minute. Apparently they decided to rate mechanical horsepower 50% greater than live horsepower, so they used 33,000 foot pounds istead of 22,000 foot pounds per minute. This amount of power has become the universal standard for horsepower. This unit of one HP is equal to the amount of work done in lifting 33,000 pounds one foot in one minute which is equal to lifting 550 pounds one foot in one second.

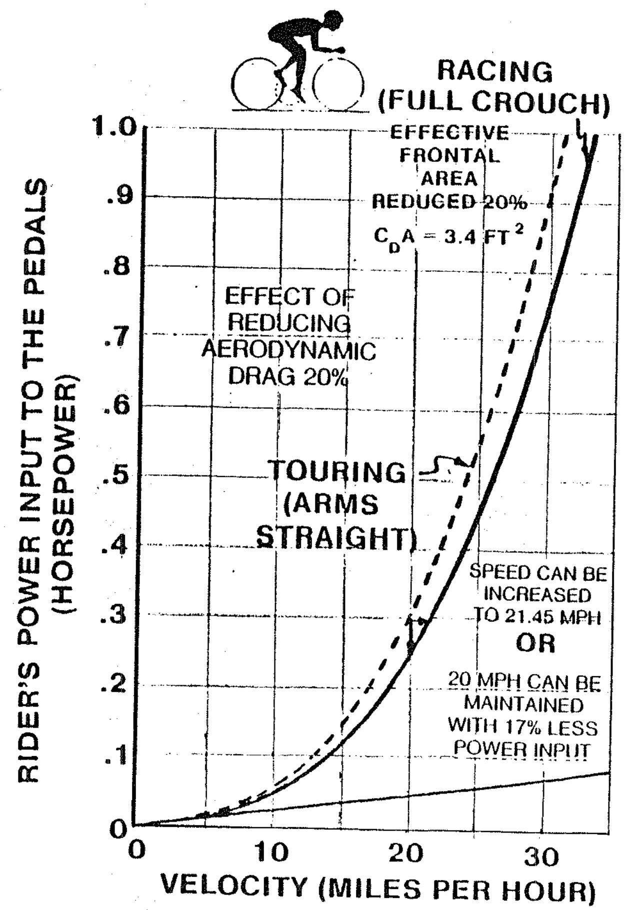
The power consumed by aerodynamic drag varies with the cube of velocity. Why? Let's compare a streamlined bicycle that has a low aerodynamic drag of only 4 pounds while traveling at 40 MPH to a standard bicycle which already has 4 pound of aerodynamic drag resistance which traveling at 20 MPH. The POWER required to overcome the SAME aerodynamic drag FORCE is not the SAME! Power is a rate of consumption of energy.

Moving along twice as fast against an IDENTICAL resistive force takes twice the power, and moving three times as fast takes 3 times the power. FORCE acting on an object over a specified DISTANCE is work. When you cover TWICE as much DISTANCE in the SAME period of time, the work output has DOUBLED during that period of time even if the retarding force did not vary with speed. In our case, the aerodynamic drag force on a specific bicycle will be already increasing with the square of velocity. Power calculations require one more multiplication by velocity and thus, the cubic relation.

BASIC BICYCLE POWER REQUIREMENTS







12 PERFORMANCE COMPARISONS

THE HUMAN POWER VEHICLE PERFORMANCE COMPARISON TABLE summarizes the relationships between aerodynamic drag forces and rolling forces for an assortment of human-powered vehicles. Comparisons of different vehicles at both 0.1 and 1.0 horsepower clearly show the benefit of improved streamlining.

The limitations of the human engine mean that speeds are fairly low while climbing steep hills. This table provides data for 5 percent grades. For hills that steep, a streamlined fairing's weight can somewhat negate its aerodynamic speed benefits. Coasting down the other side of the same steep hill on a streamlined machine, at a very high and dangerous speed, may or may not make up the time lost during the climb. On more gentle 2.5 percent grades, streamlined machines will both climb and descend at faster speeds than conventional bicycles, despite their weight penalty.

Notice that the numerical data presented here substantiate that tandem bicyclists perform better per rider than woudl solo cyclists. The aerodynamic drag on a pair of tandem cyclists is less than the total drag on two independent cyclists.

Considering this table's hypothetical projections for "perfect" bicycles (zero aerodynamic drag and zero rolling resistance for the machine), one can conclude that air drag on the cyclist's body will greatly limit the potential opportunities to improve standard bicycle performance. Even riders of "perfect" bicycles, lying absolutely flat in either prone or supine position, and not even bending their knees to pedal, will perform better if they are enclosed by a fairing.

The table also shows that motorpacers can achieve phenomenal speeds. Note: at low speeds, the effects for motorpacing would not be much greater than those for drafting, and that the motorpacing predictions of this table are invalid at other than high speeds.

If appropriate bicycles, roads and life support systems could be developed, bicyclists on the moon could achieve truly amazing speeds, because lunar gravity is one-sixth the earth's gravity, and the air resistance is zero. (See bottom row of table.)

COMMENTS

Everyone likes the Human Powered vehicle performance table! It is merely a more detailed and expanded version of what Dr. Chet Kyle has been presenting for a few years. Chet and I deliberated at length over all the strange Cd's, A's and Cr's. I had the further fun of drawing all the machines to scale and doing all the calculation's on my all powerful 16K Sinclair ZX-81 (Super cheap, but with the $99 printer it's definitely a useful tool).

In addition to the usual HPV,s I added a few standard production bikes to the comparison list and also enlarged upon Al Voigt's concept of the "perfect" bicycle which he introduced at the first IHPVA Scientific Symposium. Namely no aerodynamic drag on the bicycle whatsoever (The ultimate aero component bike?) and no rolling resistance whatsoever (but I presume great traction and great conrnering capabilities - the very best tires in the Universe).

More ridiculous, impossible, "perfect" bikes give us an idea of where performance may ultimately lead. The "perfect recumbent"and "perfect prone" assume no leg motion whatsoever which greatly reduces frontal area. Imagine the human body as a chemical storage battery of some sort. Then assume someday some clever fiend will figure out how to attach the leads to this organic (12 Volt?) battery. Of course, it is logical(?) to assume that the amp-hours until exhaustion for any preselected amperage drain rate will identically match today's human power curves. Anyway, it all gives one an idea of ultimate human power performance (on this planet only-it gets much more interesting cruising on the surface our low "g", no atmosphere sister planet).

By the way, the 0.5 CdA of the 109 pound prone rider was actually measured this past summer by Dr. Kyle in the Austin, Texas wind tunnel. The frontal area of the prone superman style lady is one third of the single rider Vector, but, alas, the Vector is much better streamlined, so the effective frontal area's (CdA's) are identical.

HUMAN POWERED VEHICLE PERFORMANCE

	DESCRIPTION		FORCES AT 20 MPH (POUNDS) Aerodynamic Pressure is about 1 LB/FT² (AIR / rolling)	AERODYNAMIC DATA: DRAG COEFFICIENT C_D	AERODYNAMIC DATA: FRONTAL AREA (FT²) A	AERODYNAMIC DATA: EFFECTIVE FRONTAL AREA (FT²) C_DA	ROLLING RESISTANCE COEFFICIENT C_R	LEVEL GROUND, NO WINDS: HORSEPOWER REQUIRED AT 20 MPH AS A PERCENTAGE OF THE TOURING (ARMS STRAIGHT) BICYCLIST	LEVEL GROUND, NO WINDS: ALL DAY TOURING SPEED AT 0.1 HORSE-POWER OUTPUT (MPH)	LEVEL GROUND, NO WINDS: MAXIMUM SPEED WITH 1.0 HORSE-POWER OUTPUT (MPH)	EFFECT OF HILLS: STEADY SPEED UP A 5% GRADE AT 0.4 HORSE POWER OUTPUT (MPH)	EFFECT OF HILLS: STEADY SPEED COASTING DOWN A 5% GRADE (MPH)
STANDARD BICYCLES	BMX (YOUTH OFF ROAD RACER)	30 LB BIKE, 120 LB RIDER, 20" DIA. 40PSI KNOBBY TIRES	5.52 / 2.10	1.1	4.9	5.4	.014	146%	10.1	27.8	12.2	19.8
STANDARD BICYCLES	EUROPEAN UPRIGHT COMMUTER	40 LB BIKE, 160 LB RIDER, 27" DIA. 40 PSI TIRES	6.14 / 1.20	1.1	5.5	6.0	.006	140%	11.3	27.6	10.9	24.0
STANDARD BICYCLES	TOURING (ARMS STRAIGHT)	25 LB BIKE, 160 LB RIDER, 27" DIA. 90 PSI CLINCHER TIRES	4.40 / .83	1.0	4.3	4.3	.0045	100%	13.1	31.1	12.2	27.7
STANDARD BICYCLES	RACING (FULLY CROUCHED)	20 LB BIKE, 160 LB RIDER, 27" DIA. 105 PSI SEWUP TIRES	3.48 / .54	.88	3.9	3.4	.003	77%	14.7	33.9	13.0	31.2
IMPROVED PRODUCTION	AEROCOMPONENT (FULLY CROUCHED)	20 LB BIKE, 160 LB RIDER, 27" DIA. 105 PSI SEWUP TIRES	3.27 / .54	.83	3.9	3.2	.003	73%	15.0	34.6	13.0	32.2
IMPROVED PRODUCTION	PARTIAL FAIRING (ZZIPPER) CROUCHED	21 LB BIKE, 160 LB RIDER, 27" DIA. 105 PSI SEWUP TIRES	2.97 / .54	.70	4.1	2.9	.003	67%	15.4	35.7	13.1	33.9
IMPROVED PRODUCTION	RECUMBENT (EASY RACER)	27 LB BIKE, 160 LB RIDER, 27" REAR, 20" FRONT, 90 PSI CLINCHERS	2.97 / .94	.77	3.8	2.9	.005	75%	14.4	35.2	12.5	33.7
IMPROVED PRODUCTION	TANDEM	42 LB BIKE, TWO 160 LB RIDERS, 27" DIA. 90 PSI CLINCHERS (181 LBS PER PERSON)	5.32 (2.66) / 1.62 (.81)	1.0	5.2	5.2 (2.6 per person)	.0045	66%	15.2	36.6	13.0	35.2
	DRAFTING (CLOSELY FOLLOWING ANOTHER BICYCLIST)	20 LB BIKE, 160 LB RIDER, 27" DIA. 105 PSI SEWUP TIRES	1.94 / .54	.50	3.9	1.9	.003	47%	17.5	41.0	13.6	41.7
RECORD HPV'S	BLUE BELL 2 WHEELED SINGLE RIDER	40 LB BIKE, 160 LB RIDER, 27" REAR, 20" FRONT, 105 PSI SEWUPS	.61 / .80	.12	5.0	.6	.004	27%	22.5	58.6	12.9	77.4
RECORD HPV'S	KYLE 2 WHEELED TWO RIDERS	52 LB BIKE, TWO 160 LB RIDERS, 105 PSI SEWUPS (186 LBS PER PERSON)	1.44 (.72) / 1.12 (.56)	.2	7.0	1.4 (.7 per person)	.003	24%	23.3	56.6	14.0	69.9
RECORD HPV'S	VECTOR SINGLE TRIKE	68 LB BIKE, 160 LB RIDER, SEWUPS 27" REAR, 24" FRONT	.51 / 1.02	.11	4.56	.5	.0045	29%	21.8	61.2	11.3	90.1
RECORD HPV'S	VECTOR TANDEM TRIKE	75 LB BIKE, TWO 160 LB RIDERS, 24" SEWUPS (198 LBS PER PERSON)	.62 (.31) / 1.78 (.89)	.13	4.7	.6 (.3 per person)	.0045	23%	25.6	72.5	13.0	108.4
THEORETICAL LIMITS	PERFECT BIKE	NO ROLLING RESISTANCE. ZERO DRAG ON ENTIRE BIKE. DRAG OF HUMAN ONLY IN TOURING POSITION.	3.07 / 0	.8	3.8	3.0	0	59%	16.7	35.9	13.4	34.7
THEORETICAL LIMITS	DRAGLESS HUMAN	ZERO DRAG ON HUMAN. DRAG OF BIKE ONLY. ROLLING RESISTANCE INCLUDES HUMANS WEIGHT.	1.33 / .81	1.1	1.2	1.3	.0045	41%	18.4	45.8	13.3	50.3
THEORETICAL LIMITS	PERFECT RECUMBENT	DRAG ON FLAT ON BACK HUMAN ONLY.	.72 / 0	.6	1.2	.7	0	14%	27.1	58.3	16.8	66.9
THEORETICAL LIMITS	PERFECT PRONE BIKE	DRAG ON 109 LB SMALL BUT POWERFUL HUMAN ONLY	.51 / 0	.6	.8	.5	0	10%	30.4	65.3	23.2	65.3
THEORETICAL LIMITS	PERFECT PRONE STREAMLINER		.07 / 0	.05	1.4	.07	0	1%	58.3	125.9	25.6	174.5
THEORETICAL LIMITS	MOTOR PACED	42 LB BIKE, 160 LB RIDER (VEHICLE BREAKS AIR FOR RIDER), 70 PSI MOTORCYCLE ROAD RACING TIRES	0 / 1.21	—	—	VARIES WITH SPEED (MINUS OVER 100 MPH)	.006	23%	29.4	294.0	12.6	∞
THEORETICAL LIMITS	MOON BIKE 1/6 g ENVIRONMENT	25 LB BIKE, 160 LB RIDER, 15 LB SPACE SUIT, 27" DIA 90 PSI CLINCHERS	0 / .15	—	—	0	.0045	3%	237.5	2,375.	78.4	∞

STREAMLINING COMPARISONS

STREAMLINING human-powered vehicles improves performance at all power input levels. Here again, effective frontal area (CdA) is used as a direct measure to compare the streamlining objects. (Effective frontal area is merely the product of the aerodynamic drag coefficient Cd, a measure of the efficiency of a shape, and the projected frontal area of the object, A.) An upright rider on a roadster bicycle (CdA = 6.0 square feet) has about the same effective frontal area as the 1984 Corvette automobile (CdA = 6.5 square feet). This means that at identical speeds the aerodynamic drag forces and the power required to overcome aerodynamic drag resistance for the two vehicles are the same. Notice from the curve that the speed performance of a 25 pound human-powered vehicle, having the same shape and size as the record-holding VECTOR (CdA = 0.5 square feet) can be quite impressive. If vehicles can be created that reduce effective frontal area even more than the Vector, one can see readily that quite reasonable horsepower levels could produce remarkable speeds. Conceivably, human-powered vehicles could commute at speeds comparable to automobiles.

It is interesting to note the effects that drafting would have on bicyclists racing at 30 miles per hour. Solo bicyclists or lead cyclists in "pace" lines must continuously produce almost 0.75 horsepower to sustain this speed. First-class bicyclists can produce 0.75 horsepower for approximately 80 seconds before they approach exhaustion and must drop back in the pack to take advantage of the drafting effect. However, drafting closely at 30 miles per hour, bicyclists need only produce about 0.45 horsepower, a power input that fresh first-class bicyclists can maintain over 40 times longer, approximately 90 minutes. Victorious bicycle racers almost always owe their success to strategic use of aerodynamics.

COMMENTS:

This is my favorite graph of the Scientific American article. It unifies shapes, sizes, horsepowers, and human power capability nicely into one package. Dr. Kyle, in jest, calls it "the Unified Field Theory" for bicycles!

1. I added the 1984 Corvette in the same drawing scale merely to emphasize just how poorly streamlined standard bicycles are. It's difficult to comprehend that the 71 inch wide automobile has just slightly higher aerodynamic drag than the upright roadster bicycle configuration!

2. It should be pointed out that the graph is not really universal -- both weight and rolling resistance are fixed (180 pounds-bicycle plus rider; rolling resistance coefficient = .0045). At higher speeds and sustained horsepower levels, however, small variations in weight and rolling resistance coefficient will not shift the values even a pencil width because of the overwhelming predominance of aerodynamic drag forces.

3. The Corvette, of course, it not a small variation and invalidates the data line shown. Nonetheless, it does indeed show that a 180 pound (including driver) Corvette SHAPED and SIZED object with the equivalent rolling resistance of bicycle clincher tires would travel along at 30 MPH with a 2 horsepower moped engine!

4. How was the data for the graph generated? The usual horsepower required formula is a function of velocity (rolling resistance term) and a function of velocity cubed (aerodynamic resistance term). There is no velocity squared term. This form of cubic equation can be solved for velocity directly. It fortunately has one real root (and two imaginary roots) and the result is a complicated formula that lets you select a horsepower level of interest as an input and then lets you solve directly for the resulting velocity.

When doing sample hand calculations with the new formula, one soon notices that differences of large numbers are involved. This means that many decimal places must be carried thruout the calculations. When I wrote the computer program to generate all the points for the streamlining comparison graph, I also recalculated the horsepower each and every time (the standard formula) using the just calculated velocity as an input. A sample of the print out below shows some numerical roundoff errors being introduced, but nothing of any serious consequence.

HORSEPOWER LEVEL IS 0.75

CDA	VMPH	HPTOTAL
8	22.976	0.75000268
7	23.9944	0.75000368
6	25.2246	0.75000103
5	26.7587	0.75000153
4	28.7594	0.75000283
3	31.5527	0.75000424
2	35.9355	0.75000417
1	44.8015	0.75000235
0.5	55.6942	0.7500028
0.2	73.8255	0.75000227
0.1	90.83	0.75000218
.05	110.9934	0.75000199

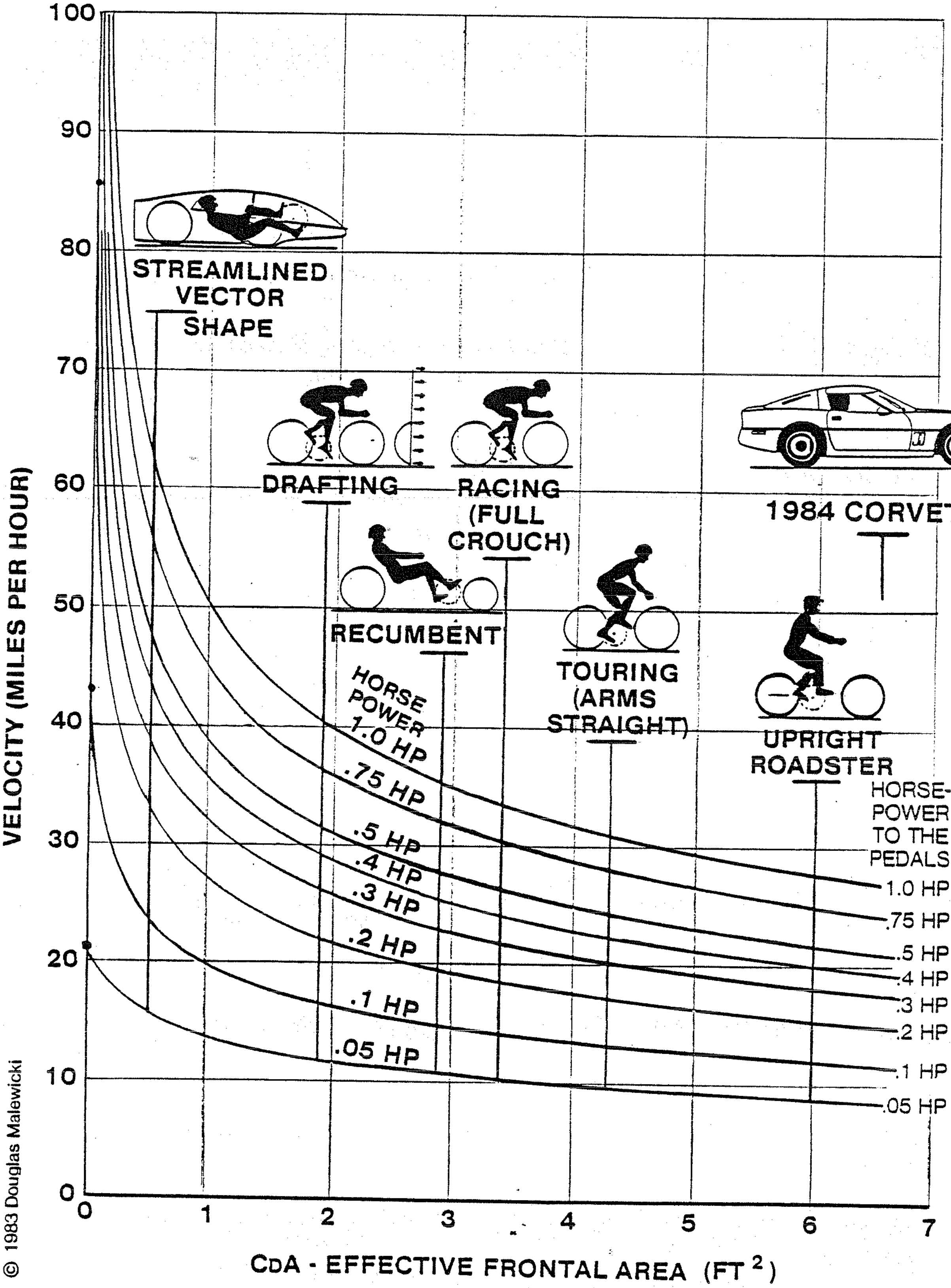
HORSEPOWER LEVEL IS 1

CDA	VMPH	HPTOTAL
8	25.3969	1.0000004
7	26.5301	1.0000012
6	27.8972	0.99999964
5	29.603	1.0000052
4	31.8294	1.0000061
3	34.9408	1.0000057
2	39.8306	1.0000014
1	49.7521	1.0000032
0.5	61.9996	1.0000036
0.2	82.5414	1.000003
0.1	102.0044	1.0000031
.05	125.3698	1.0000023

HORSEPOWER LEVEL IS 1.5

CDA	VMPH	HPTOTAL
8	29.2164	1.4999981
7	30.5245	1.5000145
6	32.1062	1.5000057
5	34.0811	1.5000079
4	36.6607	1.5000111
3	40.27	1.5000065
2	45.952	1.5000022
1	57.5169	1.5000056
0.5	71.871	1.5000037
0.2	96.1395	1.5000043

STREAMLINING COMPARISONS



HORSE-POWER TO THE PEDALS	MAXIMUM DURATION OF EFFORT	
	HEALTHY HUMANS	FIRST CLASS ATHLETES
1.0 HP	12 SEC.	30 SEC.
.75 HP	30 SEC.	80 SEC.
.5 HP	90 SEC.	35 MIN.
.4 HP	8 MIN.	8 HRS.
.3 HP	50 MIN.	—
.2 HP	2 HRS.	—
.1 HP	8 HRS.	—
.05 HP	—	—

BICYCLES ON THE MOON

In my attempt to create better graphs and better ways to explain the severe limitations imposed by aerodynamic resistance on human powered vehicles, I carried some theoretical calculations out to extreme limits. One of the surprising results was the discovery of an unbelievably cheap and reliable form of fast, efficient, personal transportation between future colonies on the moon -- namely bicycles! On the moon's surface there is no atmosphere and therefore no aerodynamic drag. Also the rolling resistance forces are one sixth of earth's values because of the reduced gravitational attraction. A 0.1 horsepower input would have a bicyclist cruising along at 237 MPH, while 0.4 horsepower input would yield a steady 950 MPH!

To hell with expensive, fancy rocket ships with precious, exotic fuels and complicated computerized gyro controlled stabilization for fast transportation between moon cities -- use bicycles instead!

The 2020 moon bicyclist will don his 7 pound Calvin Klein OPTO - COOLED MKIII exercise space suit made of Dupont double knit IMPERVIUM (which of course is available in his choice of favorite designer colors). Lightweight, puncture proof, efficiently cooled, abrasive resistant space suits will have to be evolved anyway to make utilization of men on the moon's surface practical. So why not enjoy the end results of this improved technology at the same time for bicycle recreation.

Hills? All earthbound bicycle enthusisasts loathe hills because even while generating .4 horsepower, one slows down to 12.2 MPH while climbing a 5% grade. On the moon, however, a long enough 5% grade would eventually slow the rider down to only a steady 95 MPH! The 15 minute long sweaty steep hill on earth will in reality barely be noticed on the moon because of the momentum of approach.

By now you're probably thinking that the moon is nothing but a layer of soft dust, and the above hypothesis depends on smooth paved roads with very gentle turns to handle the potential high speeds. One might also logically think it would be prohibitive to build such roads. Well, how about reprogramming the focus on the giant solar mirror (which will already be in stationary orbit) a bit tighter and fusing the soft powdery surface into smooth, smooth 5 foot diameter hard silica surface? Then program the tilt angle of the mirror so the path of the concentrated rays tracks slowly between moon bases. We suspect that melting in a vacuum will mean no bubbling nor boiling of the molten liquids. Thus a smooth final cooled surface should result.

Maintenance? Hourly cost of maintenance of moon bicycles will be insignificant compared to that of maintaining a rocket transporter and furthermore should be even less than for bicycles on earth. Forget dust and grit in the chain and derailleur. Forget flats from broken beer bottles, thorns and nails. One could leave his bicycle "outside" for decades with no rust or corrosion problems whatsoever. Also the roads themselves should not "weather" for centuries.

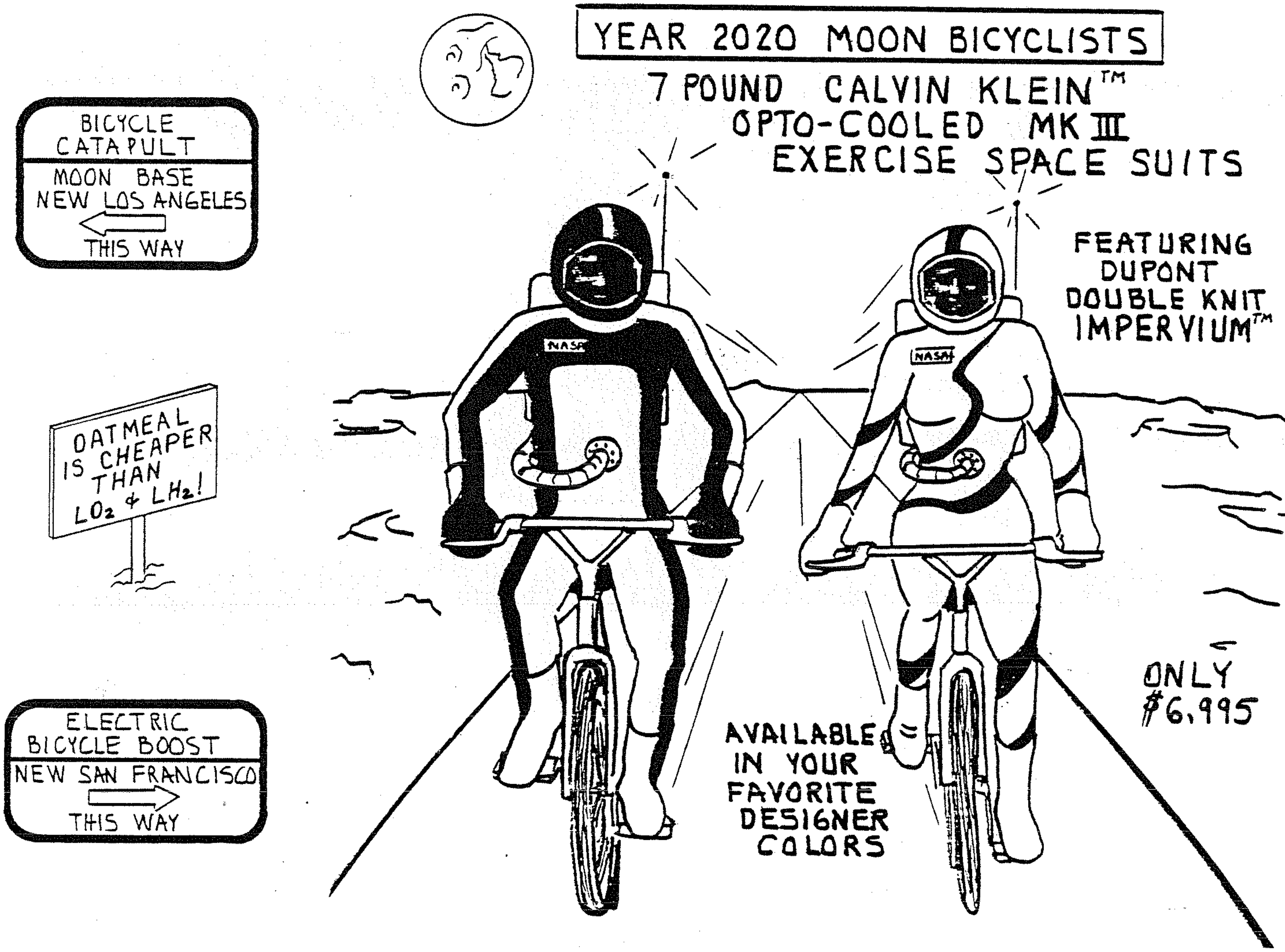
Fuel costs? Oatmeal has to be less expensive than liquid hydrogen and liquid oxygen-even on the moon. Obviously there are a lot of technical problems with a 2000 MPH bicycle such as tires and getting to high-high gearing. I do know that at least one sustained 150 MPH pedal machine exists today which at least demonstrates feasibility right now for nice and easy Sunday cruise speeds on the moon. This machine is John Howard's 150 MPH record attempt pedal bicycle for which I am Systems Engineer. (Early 124.2 MPH test runs done in Mexico this past January are to be featured on "That's Incredible" this season. The Mexican Highway was too rough to attempt any higher speeds. The Bonneville Salt Flats in Utah which were too wet in 1982 are even wetter this year, and September's SPEED WEEK was cancelled again. Meanwhile, Dr. Allan Abbott's 1973 record of 138.674 MPH average speed thru the mile timing traps still reigns supreme!)

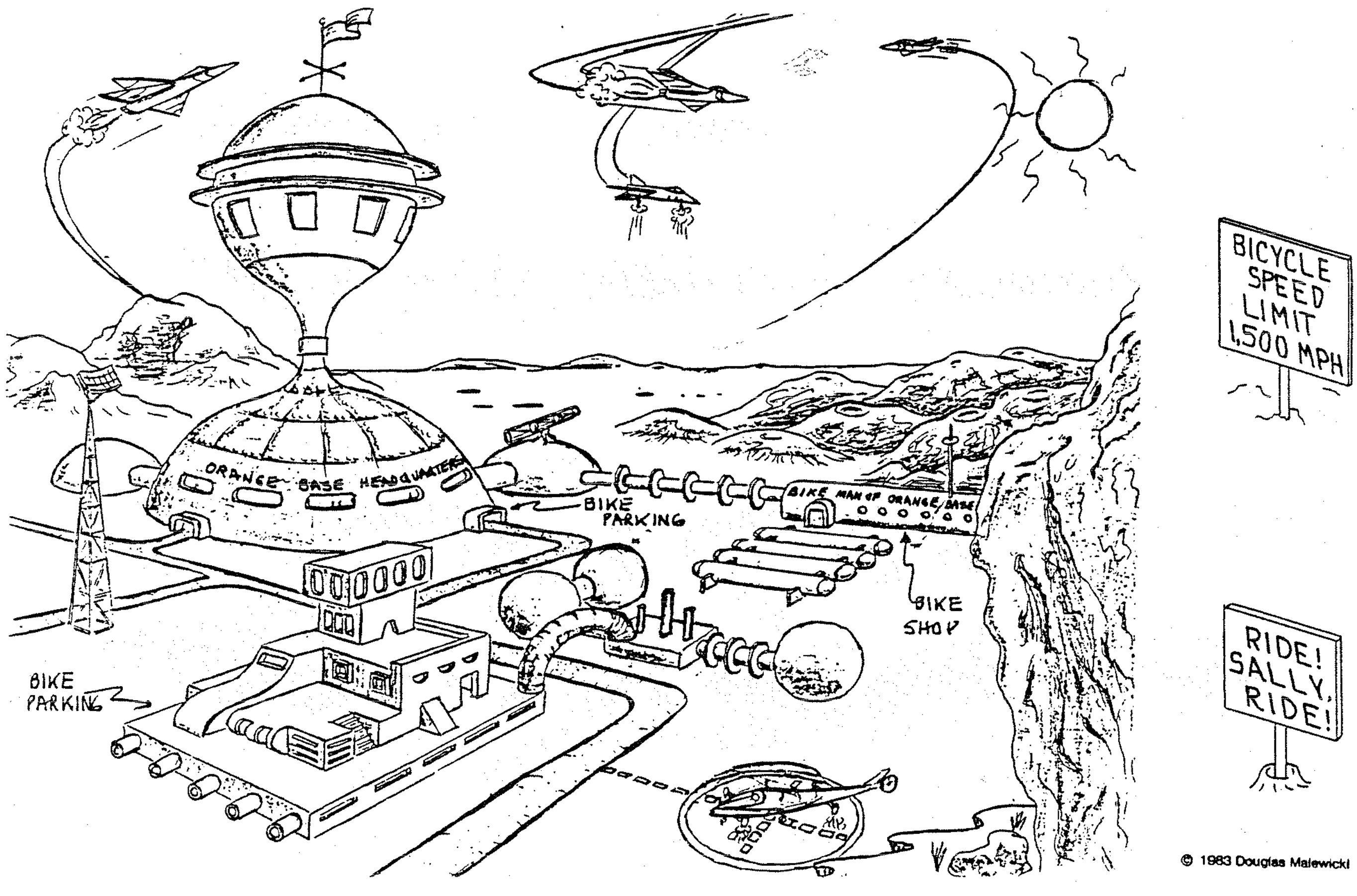
I should also point out that the technology for sustained high speeds, excellent handling and radical cornering capability exists with modern 200 MPH road racing motorcycles. These could also be converted to human power machines. Perhaps some form of enclosed and more crash resistant tricycle HPV's would be more logical, since the kinetic energy at moon cruising speeds is tremendous.

It is interesting to note that if the human is the sole source of power accelerating the rider/machine system that it takes a surprisingly long time to achieve those delightful moon cruising speeds. Analysing the problem by conservation of energy (total energy in equals resulting kinetic energy) tells us that with a steady 0.1 horsepower input it will take 1.9 hours to achieve the 238 MPH cruising speeds. This analysis accounts for no losses whatsoever (due to either air or rolling resistance).

Dr. Kyle ran some more accurate time-integration numbers for me on his computer that accurately account for rolling resistance. It would really take 8.73 hours to reach 238 MPH with a 0.1 horsepower input. The distance covered in this time would be 1,703 miles which yields an average speed of 195 MPH which isn't all that bad. Rather than spending all the time accelerating, it would seem worthwhile to build city based catupult devices or linear drive electric systems to accelerate one rapidly for a short distance in order to acquire the desired cruise velocity.

"New L.A." to "New S.F." in 15 minutes -- the speed of the Concorde for the price of a bowl of oatmeal!


YEAR 2020 MOON BICYCLISTS
7 POUND CALVIN KLEIN™
OPTO-COOLED MK III
EXERCISE SPACE SUITS
FEATURING
DUPONT
DOUBLE KNIT
IMPERVIUM™
ONLY
$6,995
AVAILABLE
IN YOUR
FAVORITE
DESIGNER
COLORS
BICYCLE
CATAPULT
MOON BASE
NEW LOS ANGELES
THIS WAY
OATMEAL
IS CHEAPER
THAN
LO₂ & LH₂!
ELECTRIC
BICYCLE BOOST
NEW SAN FRANCISCO
THIS WAY
NASA
NASA

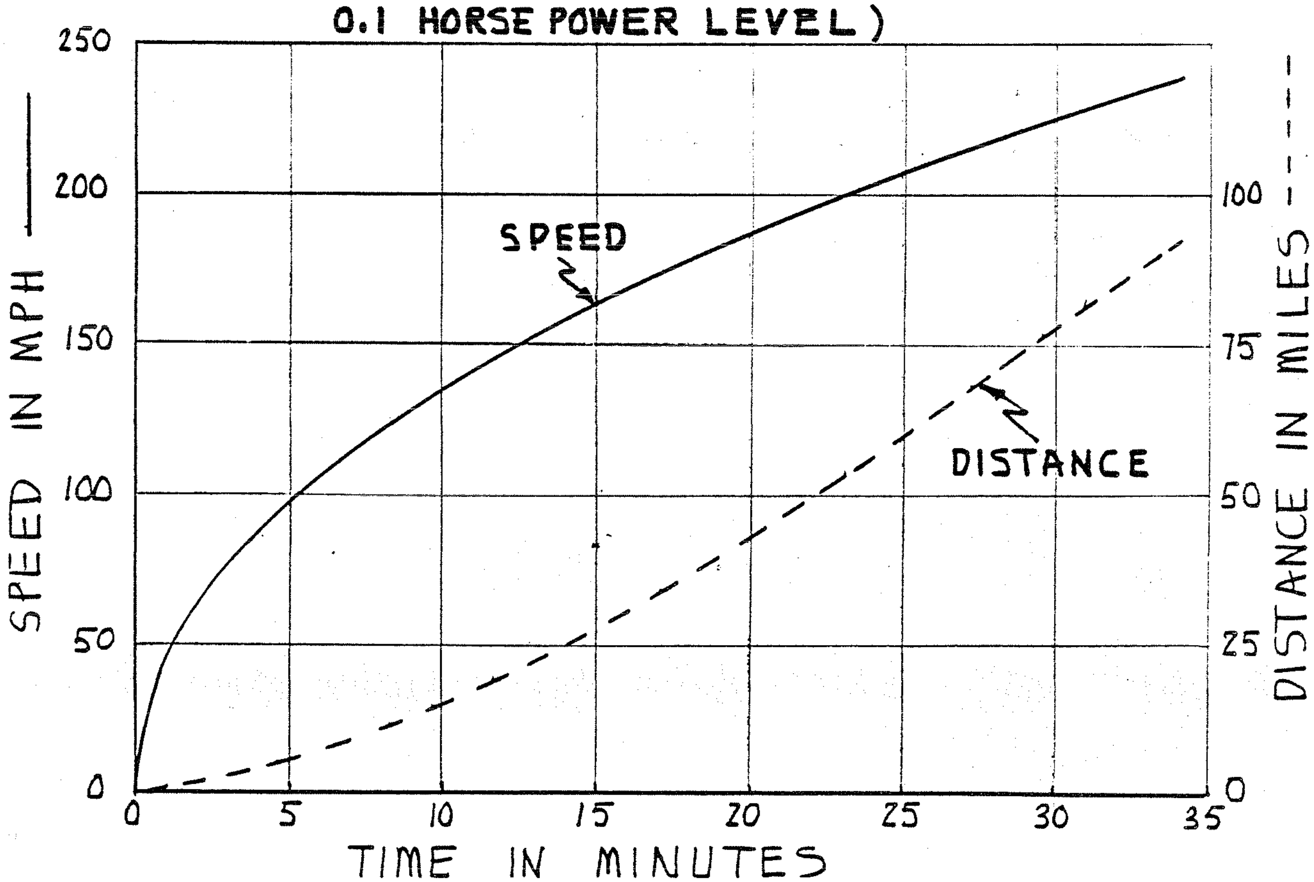

ORANGE BASE HEADQUARTERS
BIKE
PARKING
BIKE
SHOP
BIKE
PARKING
BICYCLE
SPEED
LIMIT
1,500 MPH
RIDE!
SALLY,
RIDE!

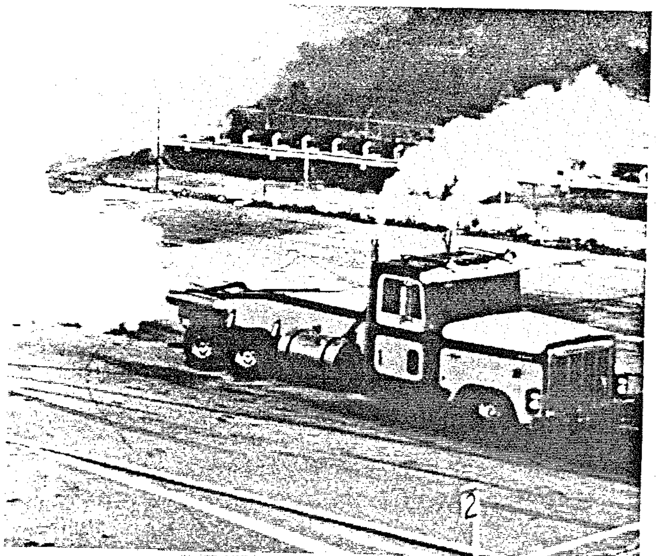
MOON BIKE PERFORMANCE

HORSEPOWER INPUT TO THE PEDALS	MAXIMUM POSSIBLE DURATION OF EFFORT		LEVEL CRUISE SPEED	
	HEALTHY HUMANS	FIRST CLASS ATHLETES	ON PLANET EARTH	ON SURFACE OF THE MOON
.1 HP	8 HOURS	(> 8 HRS)	13.1 MPH	237.5 MPH
.2 HP	2 HOURS	(> 8 HRS)	17.2 MPH	475 MPH
.3 HP	50 MIN	(> 8 HRS)	20.2 MPH	712 MPH
.4 HP	8 MIN	8 HOURS	22.3 MPH	950 MPH
.5 HP	90 SEC	35 MIN	24.3 MPH	1188 MPH
.75 HP	30 SEC	80 SEC	28.0 MPH	1,781 MPH
1.0 HP	12 SEC	30 SEC	31.1 MPH	2,375 MPH

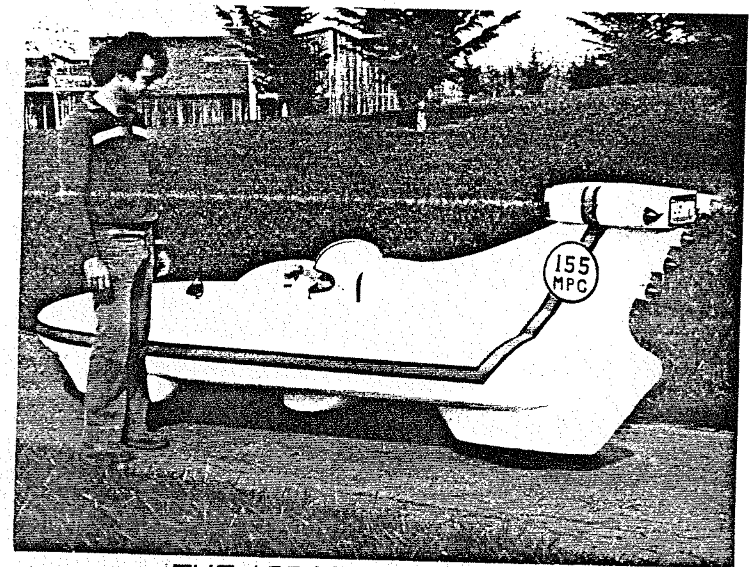
SPEED AND DISTANCE FOR MOON BICYCLIST GENERATING 0.4 HORSEPOWER

(AT 238 MPH THE BICYCLIST REDUCES EFFORT TO THE STEADY CRUISE 0.1 HORSE POWER LEVEL)

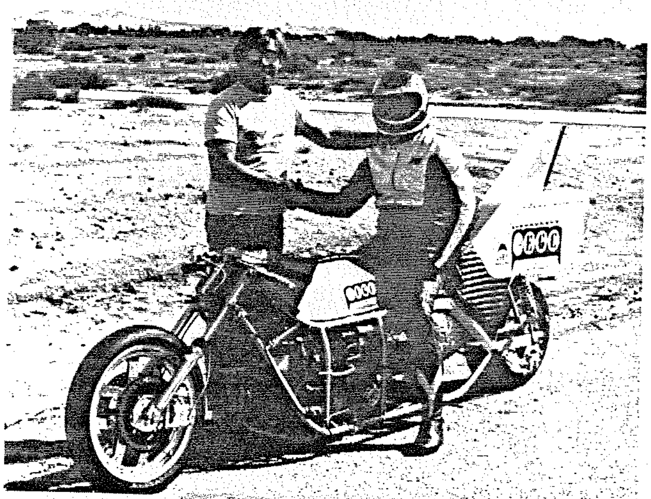




GARY CERVENY'S
JET TRUCK



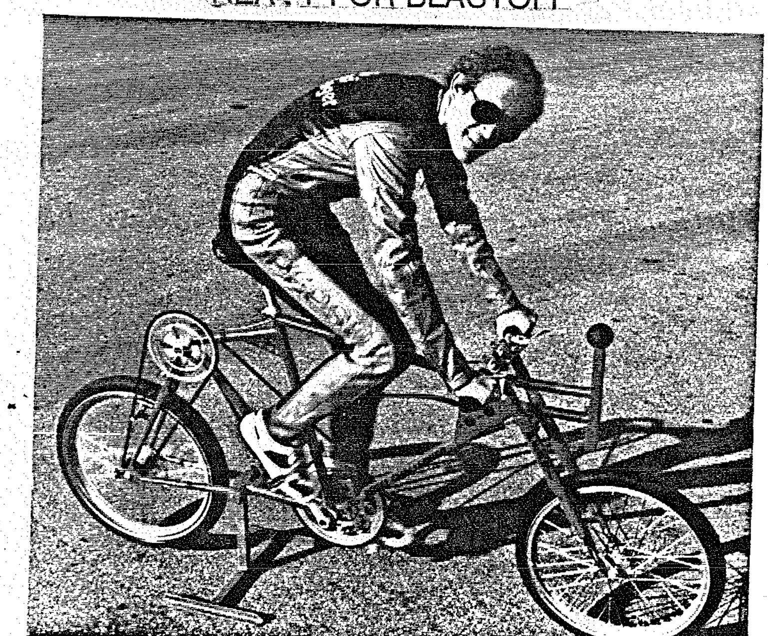
THE 155 MPG AT 55 MPH
CALIFORNIA COMMUTER



BOB CORRELL'S
JET BIKE

FLAME ON
READY FOR BLASTOFF

THE "VENTURI EFFECT"
NEWSPAPER LOG BURNER



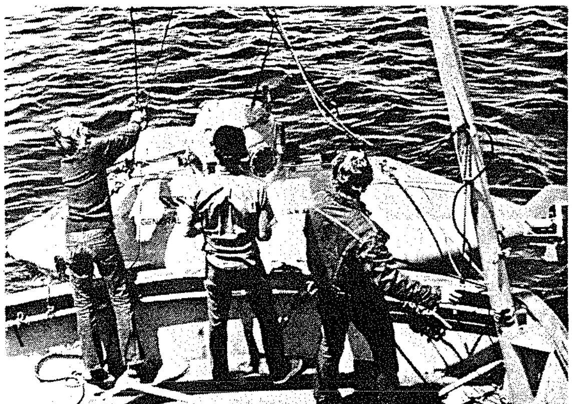
JOHN HOWARD'S 124.2 MPH
MOTOR PACED BICYCLE

AEROVISIONS, INC.

Aerovisions, Inc. is a research and development company which was formed to promote creative innovation and energy conciousness. Aerovisions, Inc's. three founders are inventor, engineering consultant and craftsman, Douglas Malewicki (MS, aeronautical and astronautical engineering, Stanford, 1963); Successful dentist, construction company entrepeneur and accomplished underwater cinematographer, Richard William Long (DDS, University of California at San Francisco, 1968); and business entrepeneur, adventurist, and balloonist, Gary Cerveny (BS, economics and business administration, University of Southern California, 1970).

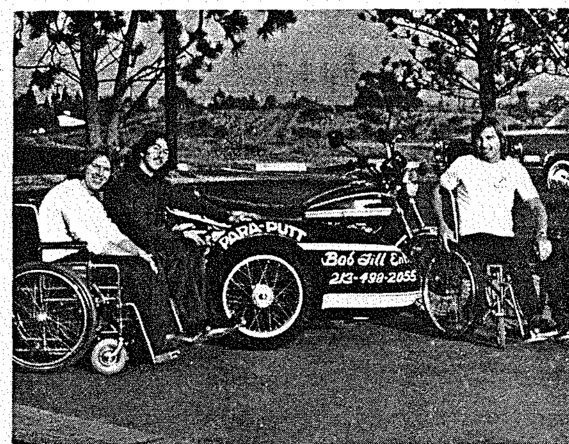
Previous and current projects that the founders have independently been involved in range from engineering stress analysis and design work for two man submarines that operate at 1,250 foot ocean depths, to setting hot air balloon - hang glider drop world records at 32,200 foot altitudes. In between, you find a motorcycle with wings (the Kitecycle), that routinely performs "jumps" over three trucks; sports cars that really fly; motorcycles for paraplegics; underwater biomass research filming contracts from General Electric and Cal Tech; underwater TV specials on the sea for USA and Japanese stations; advanced truck streamlining fairings; and even a streamlined bicycle that an 8 year old pedalled along at moped speeds (29.62 MPH) at Ontario Motor Speedway's International Human Powered Speed Championships.

Aerovisions, Inc. knows that the future belongs to the efficient.



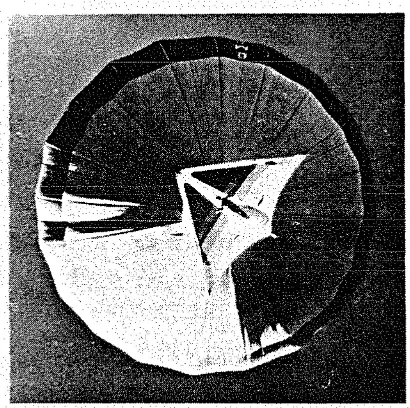
Two Man Submarine

The Flying MGB



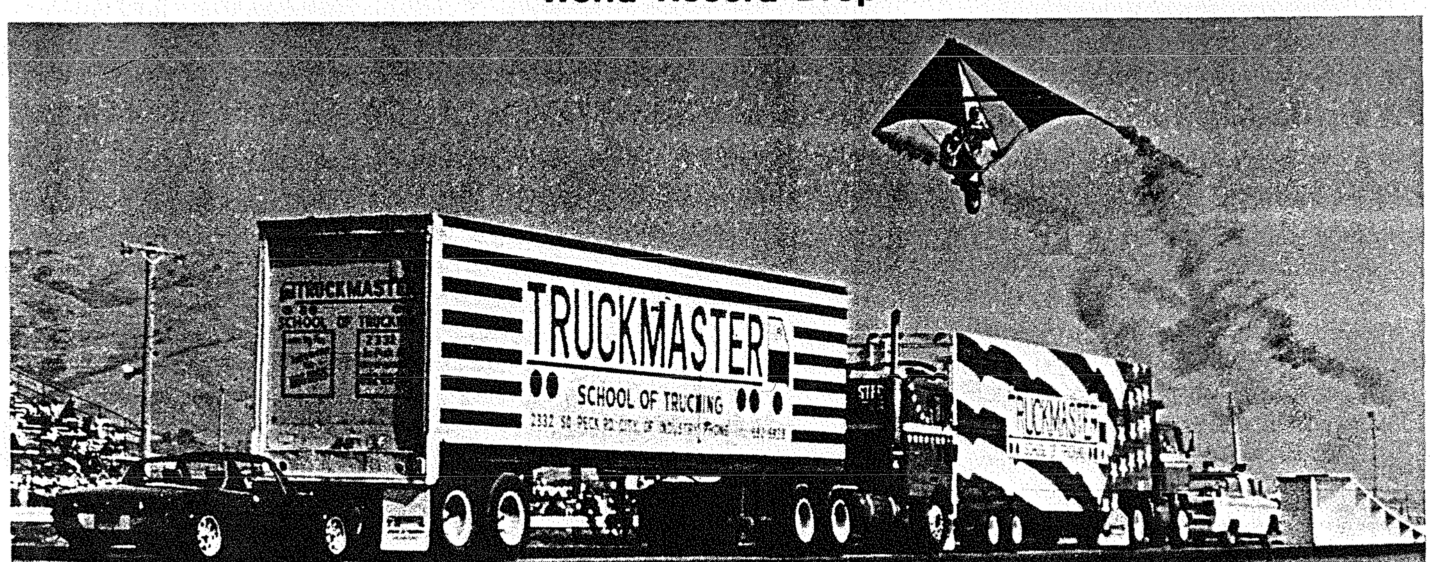
Paraplegic Motorcycle

Underwater Cinematography



32,200 Foot Altitude World Record Drop

Michelle Marie Malewicki World's Fastest Kid



Bob Correll's World Record Kitecycle Jump

1992 FACT SHEET - DOUGLAS J. MALEWICKI

INVENTOR, ENGINEERING CONSULTANT, AUTHOR, SPEAKER, CRAFTSMAN
FOUNDED AEROVISIONS IN 1974 (INCORPORATED IN 1980)

EDUCATION: Master of Science Degree, Stanford University.
Aeronautical and Astronautical Engineering.

Bachelor of Science Degree, University of Illinios.
Aerospace Engineering, High Honors

MEMBER: AIAA (American Inst. of Aeronautics and Astronautics) Snr. Member
1985/1986 AIAA Distinguished Lecturer.
1986/1987 AIAA Council - Orange County Section.
TAU BETA PI (National Engineering Honor Society).
MENSA (Top 2% IQ Society)
SAE (Society of Automotive Engineers).
SAMPE (Society for Advanced Materials and Process Engineers).
ASME (American Society of Mechanical Engineers)
IHPVA (International Human Power Vehicle Assoc.) Event Coordinator
ATRA (Advanced Transportation Assoc.)
Licensed Pilot.

LISTED IN: Guinness Book of World Records 1982, 1983, 1984 and 1985
Gasoline fuel consumption World Record.
Los Angeles to San Francisco.
157.192 miles per gallon at 55 miles per hour
(less than 3 gallons of gas to cover 450 miles).

Diesel World Record. Los Angeles to Las Vegas.
156.53 miles per gallon at an average speed of 56.3 miles per hour (this route involved total ascents of 7,993 feet).

Who's Who in Technology.
Who's Who in the West.
Who's Who in Aviation and Aerospace.

PATENTS: Holds US patents in the fields of aviation, toys, medicine, mass transportation and robotics.

PUBLICATIONS: Three books. Numerous technical papers and articles.
Samples:

Robosaurus Lives!, INTERNATIONAL FLUID POWER ASSOC. CONFERENCE, Chicago, Illinois, March 1992.

Miniature Maglev Vehicles for Personal Non-Stop Transportation, SOCIETY OF AUTOMOTIVE ENGINEERS - FUTURE TRANSPORTATION TECHNOLOGY CONFERENCE, Portland, Oregon, August 1991.

The Aerodynamics of Human-Powered Land Vehicles, SCIENTIFIC AMERICAN, December 1983 cover feature, (with Albert Gross and Dr. Chester Kyle).

New Unified Performance Graphs and Comparisons for Streamlined Human Powered Vehicles, SECOND HUMAN POWERED VEHICLE SCIENTIFIC SYMPOSIUM PROCEEDINGS, October 1983.

INVENTIONS:

1989 - **ROBOSAURUS - 40 FOOT TALL, *CAR*-NIVOROUS, FIRE BREATHING MONSTER ROBOT**
A human pilot (up inside the head) controls this giant 58,200 pound electrohydromechanical car eating entertainment robot. Hydraulically transforms itself into a legal licensed trailer for highway transport.

1983 - **BOB CORRELL'S JET ENGINE POWERED DRAGSTER MOTORCYCLE**
This IHRA licensed high tech exhibition dragster is powered by a 1350 shaft horsepower General Electric T58-GE-8E turbine used to drive helicopter rotors. We converted the engine to a pure thrust power plant **with** afterburner. It is the most powerful motorcycle ever built.

1980 - **THE CALIFORNIA COMMUTER**
An aerodynamic single passenger, street and freeway legal, three wheeled commuter of the future. Held official Guinness world records for gasoline and diesel fuel consumption at freeway speeds.

1979 - **MINI MICRO MISSILE**
Streamlined prone recumbent bicycle that Michelle Marie Malewicki at age 8 pedalled along at moped speeds (29.62 MPH) at Ontario Motor Speedway's International Human Powered Speed Championships to become the world's fastest self propelled kid.

1975 - **PARAPUTT**
Parapalegic Motorcycle built for ex-motorcycle jumper Bob Gill. In 1976 Bob drove it across country for Easter Seals and National Parapalegic Foundation fund raising.

1973 - **KITECYCLE**
Internationally famous daredevil, Bob Correll, regularily performs jumps over two trucks with the patented Kitecycle. Bob has been seen on THAT'S INCREDIBILE, CHIPS and the GUINNESS BOOK OF WORLD RECORDS national TV shows.

1968 - **X1 SKYCYCLE**
Canyon Jumping Steam powered rocket motorcycle designed and built for Evel Knievel.

1965 - **NUCLEAR WAR CARD GAME**
After 27 years, still the best selling game of licensee Flying Buffalo, Inc of Tempe, Arizona. "Nuclear Proliferation" a second enhancement was released in August of 1992. A computer version of the game was sublicensed to New World Computing, Inc. in 1990.

OTHER PROJECTS:

MARFAB, TORRANCE, CA
Stress analysis. Two man submarine with 1250 foot depth capability. The DELTA has spent the last two summers doing residual radioactivity research down in the 30 year old A-bomb and H-bomb craters of Eniwetok Island in the Pacific.

DRAGON BALLOONS, GLENDALE, CA
Stress analysis, design work, and FAA coordination for the seven hot air balloons used in the Walt Disney film, NIGHT CROSSING.

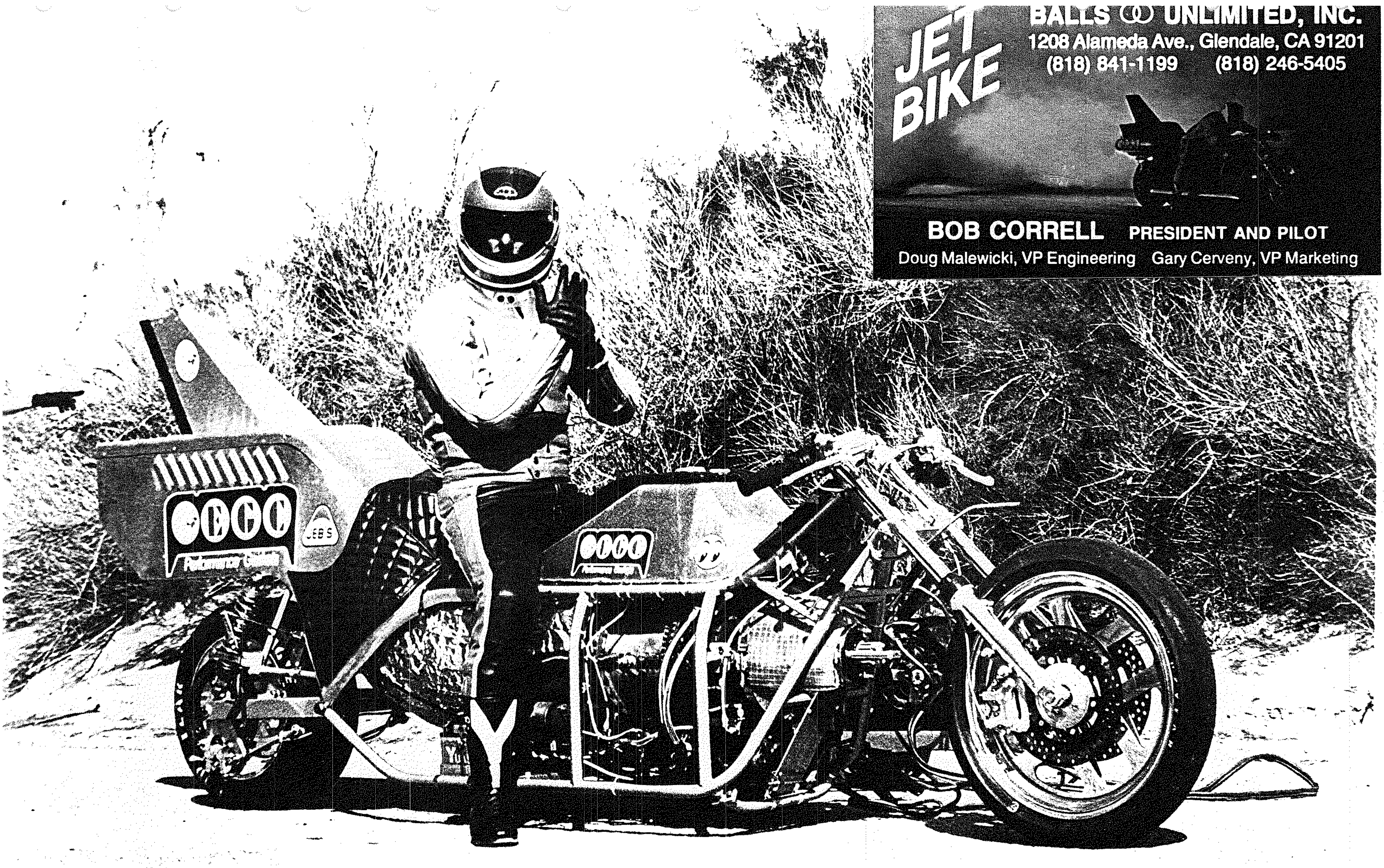
152 MPH BICYCLE FOR JOHN HOWARD, ENCINITAS, CA
John, who won the 1981 Hawaii IRONMAN TRIATHLON (Swim 2.2 miles, bicycle 112 miles and run 26.2 miles) became the world's fastest human by pedalling a bicycle at 152.284 MPH in the slipstream of a race car at the Bonneville Salt Flats on July 20, 1985. Systems engineer for entire project. Seen on "THAT'S INCREDIBLE"and on the Johnny Carson "TONIGHT" show.

HOBBIES: Inventing, designing, prototyping, computers, backpacking, running (3 hour 44 minute best marathon time), skiing, bicycling (rode 3600 miles in 1991).

MY PORSCHE — HAVE CONFIDENCE IN BOB !

THE KITECYCLE - HIGHEST FLYING MOTORCYCLE IN THE WORLD!

Internationally famous daredevil, Bob Correll, regularly performs jumps over two trucks on the Kitecycle - another patented invention of Doug Malewicki. For booking and/or press information contact Cerveny Enterprises, 1459 N. Irving Ave., Glendale CA 91201 (213) 246-5405.

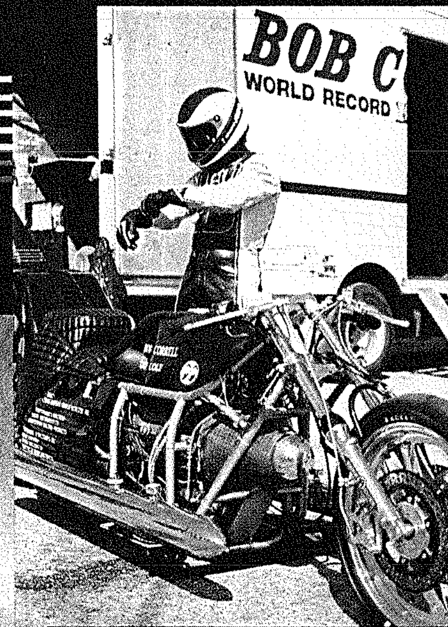


BOB CORRELL'S JET BIKE

Ball's Unlimited introduces the world's first jet engine powered motorcycle. This EGC Enterprises Inc. sponsored machine is also the world's most powerful drag racing motorcycle. 1350 thunderous, screaming horsepower in a 550 pound machine!!!

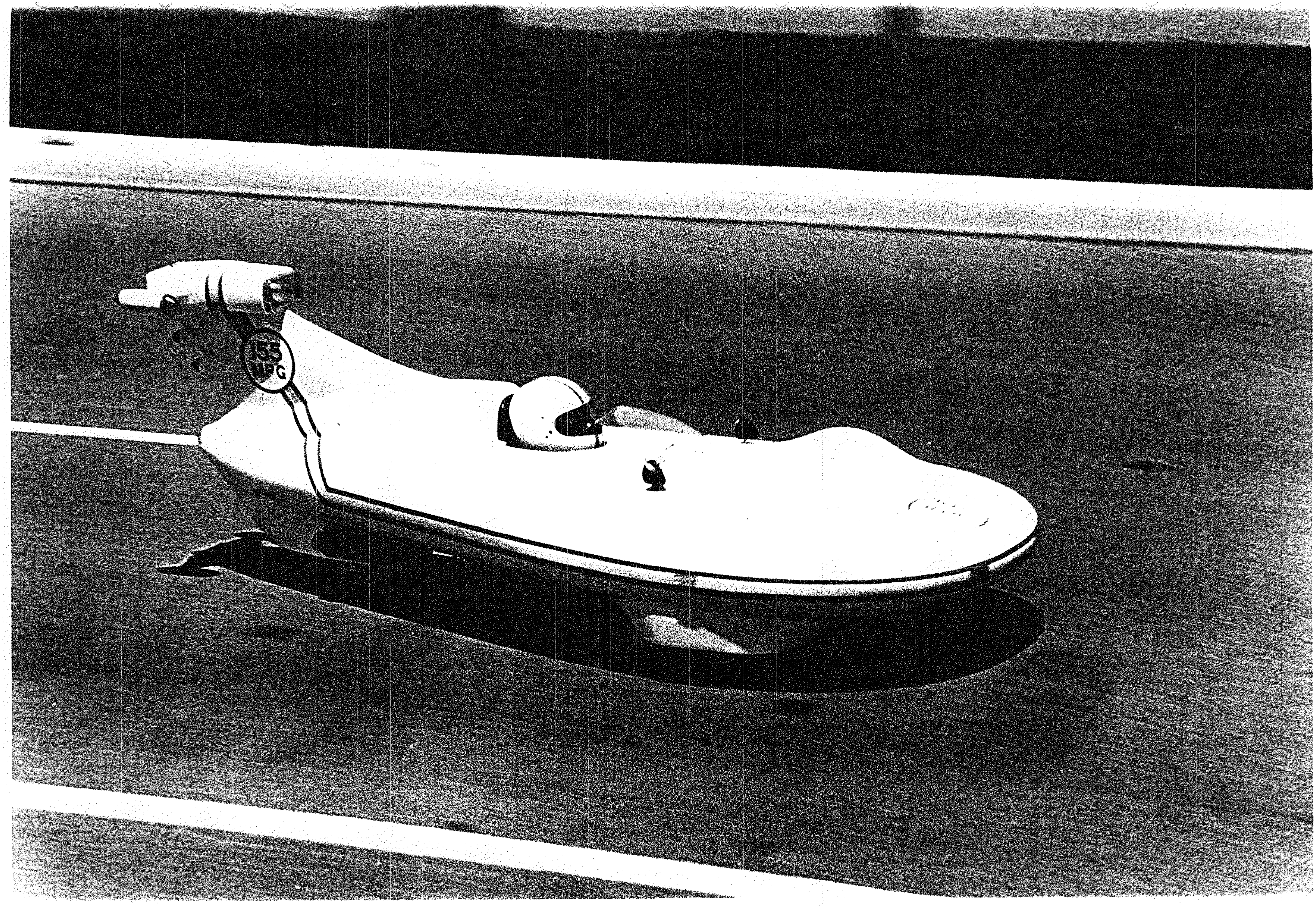
BALLS UNLIMITED
DIRECTORS
GARY CERVENY • BOB CORRELL
DOUG MALEWICKI
1208 Alameda, Glendale, CA 91201 • (818)

JET BIKE



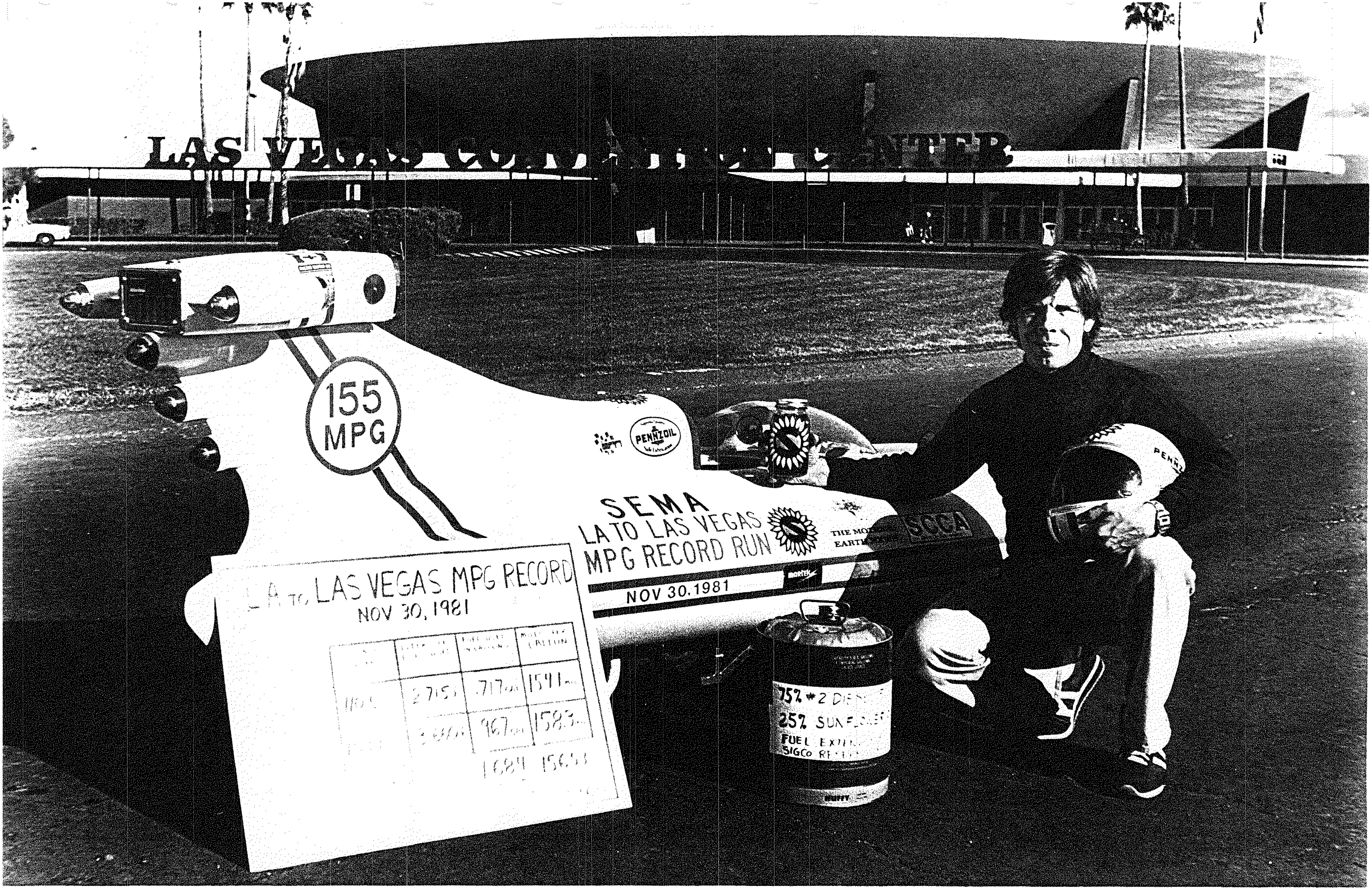
PHOTOS COURTESY DEAN MOON

Jet Powered Motorcycle
Bob Correll
Long Beach, CA



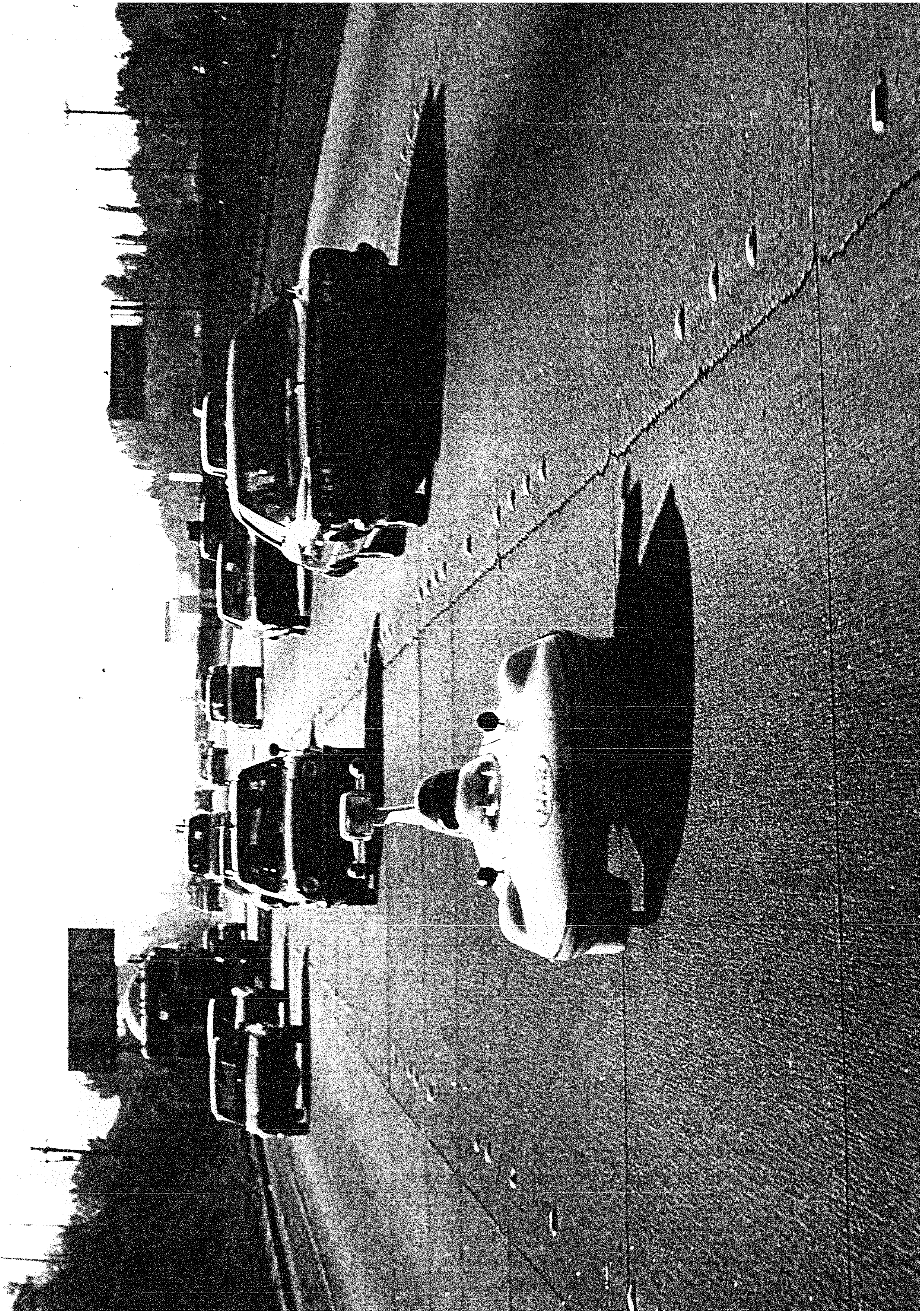
LOS ANGELES TO SAN FRANCISCO - ECONOMY RECORD RUN - NOVEMBER 20, 1980

Holding a steady speed of 55 MPH on U.S. Route 101, inventor, Doug Malewicki, set a 157.19 miles per gallon world record by driving his single passenger "California Commuter"



LOS ANGELES TO LAS VEGAS - ECONOMY RECORD RUN - NOVEMBER 30, 1981

Powered by a mixture of 25% SUNFLOWER OIL and 75% diesel fuel, inventor, Doug Malewicki, set a 156.53 miles per gallon world record for diesels while holding an average speed of 56.3 MPH over a mountainous route.



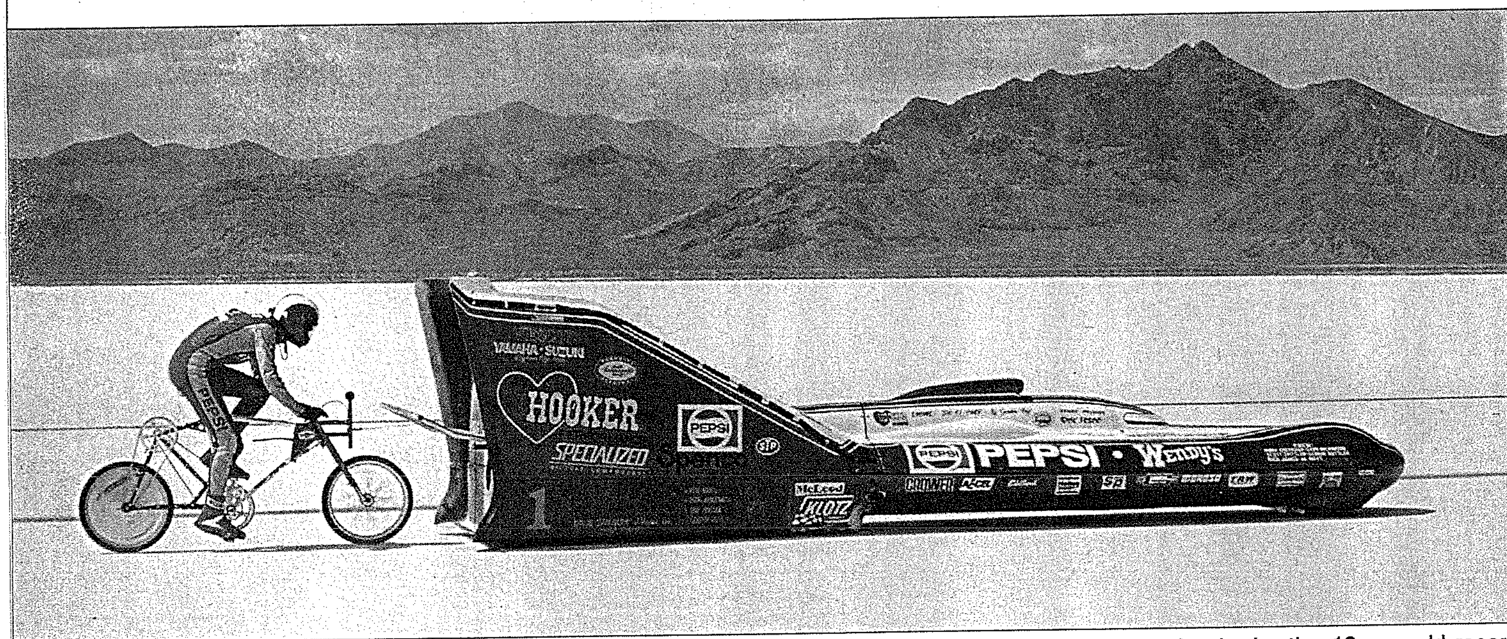
Sports Illustrated

JULY 29, 1985 Volume 63, No. 5

CYCLING

by Bob Ottum

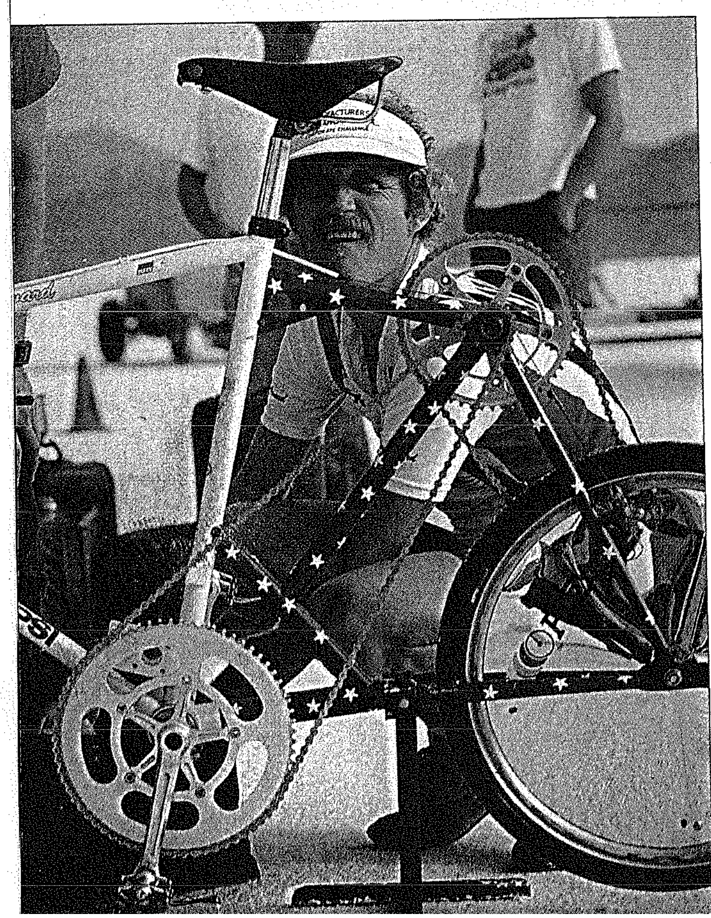
There were times last Saturday afternoon when John Howard was setting all the wrong records. Try this one: the world's fastest flat tire on a bicycle,



Howard released himself from the tow, then settled nicely into Vesco's slipstream on the run that broke the 12-year-old record.

Behold, the 150-mph bicycle

Pedaling behind a pace car, John Howard streaked to an awesome land speed record



CARL IWASAKI

The bike starred an eye-catching double-reduction gear setup.

causing the bike to careen sideways at about 150 mph. Or how about the one for the most salt ever caked to a man's handlebar mustache? But Howard, 37, a seven-time national champ, three-time U.S. Olympian and all-around cycling madman, is not one to pedal off into the sunset leaving an intact record behind him. He would give it another try.

And in one shining moment on Utah's Bonneville Salt Flats, it all came together. His 6′ 2″, 170-pound frame hunched over a strange-looking two-wheeled contraption, his legs pumping out a smooth 130 rpm, Howard set a new world land speed record for bicycles of 152.284 mph.

Howard's triumph marked the climax of a $100,000 campaign to break a recorc that hardly anybody had heard of in the first place, and now he holds the worlc mark at both wonderfully obscure ends of cycling's spectrum. In 1982 he se the 24-hour bicycling distance record covering 514 miles in that time whil pedaling around New York City's Central Park.

"A lot of people seem to think I'm cra zy," he said Saturday. Well, being craz works just fine for John Howard. He pul verized the old speed record, a 138.671 mph run at Bonneville on Aug. 25, 197 by Allan V. Abbott, who rode out in th slipstream of a 1955 Chevy.

The operative word here is slipstrean No cyclist, no matter how mighty c thigh, could achieve such dizzying speec pedaling alone; he needs the pocket c relatively thin, smooth air that a larg fast-moving object creates behind it.

Start with physics, and then ac magic—Howard's bike. "It was years the making," he says. "Doug Malewicl the guy who did Evel Knievel's Sky C cle, designed it. It grew one piece at time as we figured out how to make it faster."

Even in repose, Howard's bike seer

contin

ready to pounce: It's just 32 inches high and weighs 46 pounds, and features 18-inch wheels; 150-mph-rated tires, each carrying 70 pounds of air; and a fearsome-looking double-reduction gear system with three sprockets and two chains.

"It's a little squirrelly at times," Howard says. "Sometimes I have no idea what's going to happen when I'm riding it at speed."

Even more squirrelly stuff goes on out in front. Howard's pace car is a low-slung, long-nosed torpedo powered by a 350-cubic-inch Chevy engine, a race car with an official top speed of 300.300 mph. Its rear end swoops up smartly to create a boxlike chamber behind which the bike rides. The upper part of the aerodynamic structure has a Plexiglas windshield through which Howard can see the road ahead. Just below the windshield is a rear-facing speedometer and a small sign that says FASTER, YOU FOOL!

Perhaps it's a good thing that world land speed bicycle record runs aren't attempted all that often. Consider the routine: Howard hooks the bike up to the car with a three-foot cable. The car's driver, Rick Vesco, accelerates smoothly, up to 55 mph or so, and then Howard releases the cable. Now comes the crazy part. Howard takes over the car's speed, adjusting it with a radio-controlled throttle on his right handgrip. Vesco merely steers the car—and the two casually discuss their progress by means of their crash-helmet headsets.

The most delicate aspect of the run is staying within the slipstream. "It gets *weird*," says Howard. "If I wobble or fade too far behind the car, I lose the vortex and crash sideways in the wind. So I gradually advance the throttle, and I can feel myself being sucked in. I'm trying to pedal steadily, and that doggone windshield seems to get smaller and smaller. There's no side vision; my focus narrows, and my thoughts turn to just one thing. Life preservation."

From off to one side on the Bonneville flats, the visual effect was stunning: The teardrop-shaped race car flashed past in a blur, and pedaling along behind it, well clear of the car but still in its draft, came Howard on the cycle. At that speed, one bobble would send him sliding off the horizon.

For two days Howard and Vesco played this dangerous game, riding the six-mile course on the vast salt desert—a crystalline wonderland 100 miles west of Salt Lake City so hard-packed that it crunches loudly underfoot. On Friday afternoon, Vesco hit 137.614, but he was all alone—Howard had dropped out of the slipstream. "The salt was swirling up," he said. "It was like riding through a storm."

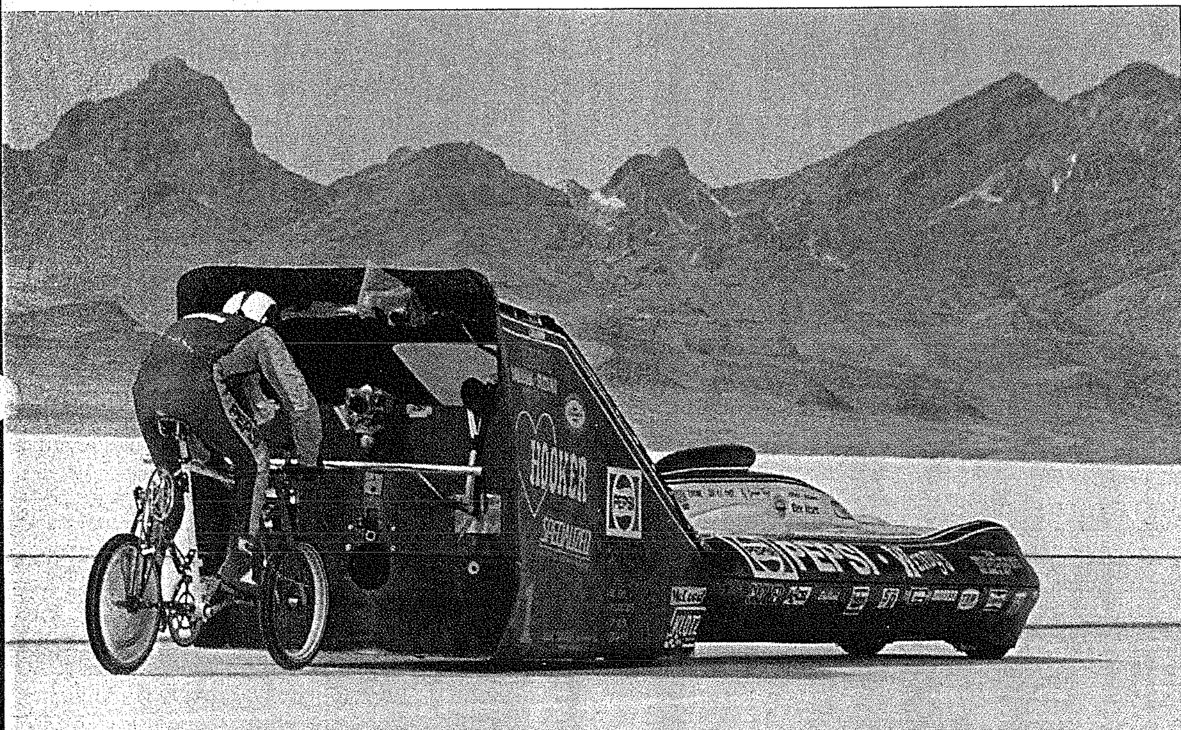
But then, relentlessly, they began to dial it in. On Saturday's first run, which started at 8:40 a.m., they reached a smooth 134.308 mph, with both the car and the bike kicking up high-arching plumes of salt behind them. "The record," said Howard, "is ours."

Not quite. On the fourth run, around noon, Howard was thrown skidding and veering out of control with a flat rear tire. "What was it, a blowout?" his crew asked Howard when they caught up with him stranded in the middle of that vast whiteness.

What happened was this: The centrifugal force at that high speed had driven the air inside the tire against the tire's wall, and the pressure was great enough to push the air out through the valve. What was needed, Howard and his crew decided, was a metal valve cap like the one on the front tire.

At four o'clock, on the sixth run of the day, the record crumbled. At the finish line there was great whooping when the official time came in over the radio, and in the blistering afternoon heat a victorious Howard was bathed by a fizzy spray of champagne that had been stored in Styrofoam ice chests for the occasion.

Howard combed the salt out of his 'stache and allowed that this was one more mission accomplished in his madcap life of cycling. Already, another wonderful new idea was taking shape inside his curly head. What if the magic bike, with a few modifications, were turned into a John Howard signature-model touring bike on which riders could barrel across the country at fantastic speeds? Well, why not? "Imagery is important to me," Howard said. "I try to picture what will happen—and then make it happen." END



CARL IWASAKI

Howard controlled the pace car from his bicycle and viewed the terrain ahead through a window.

BICYCLE guide

Volume 3, Number 1

FEBRUARY 1986

152 MPH

The Bicycle Land Speed Record:

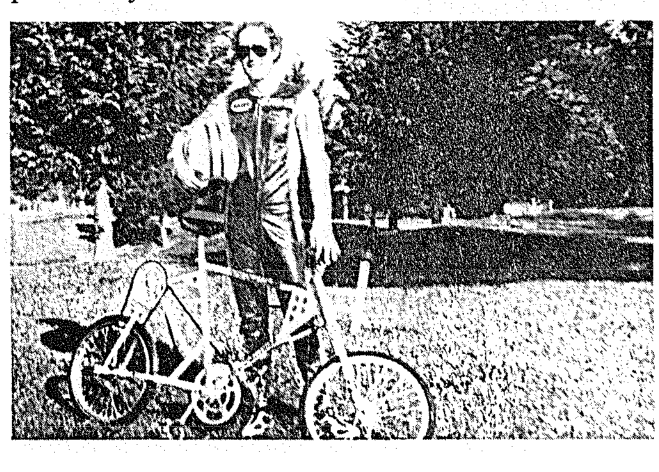
Through mutual business acquaint-ances I met Douglas Malewicki, an aero-pace engineer and odd-ball inventor. Besides creating Evel Knieval's jet-powered Skycycle and solar-powered mopeds, Doug can also lay claim to the most fuel-efficient freeway legal car on the planet, the California Commuter. It once drove from Anaheim, California to Las Vegas, Nevada on 1.684 gallons of diesel fuel. Malewicki even came up with his own board game, "Nuclear War." This was the engineer for me; we hit it off immediately.

We both agreed that our bike should use as much of the technology from Abbott's bike as possible. It helped that Doug already knew Abbott. Both are members of the International Human Powered Vehicle Association, the organization that sanctions records by streamlined bikes. Abbott graciously gave us his blessing and encouraged us to take a look at his bike.

Although it was a fine machine, we found that there was room for some improvement. Abbott's huge chainring and tiny rear cog meant that his chain could not work very efficiently. It also meant that his bottom bracket had to be placed high to provide sufficient ground clearance. That made the bike's center of gravity too high to be stable, and the bike itself too tall to duck behind the Streamliner's fairing. Doug came up with an innovative solution. He recommended that we use two normal-size chainrings and two chains—a double-reduction gear system that would give us the same mechanical advantage as Abbott, without the need for a custom made chainring. This allowed us to use off-the-shelf parts from Campagnolo, and let us place the bike much lower to the ground.

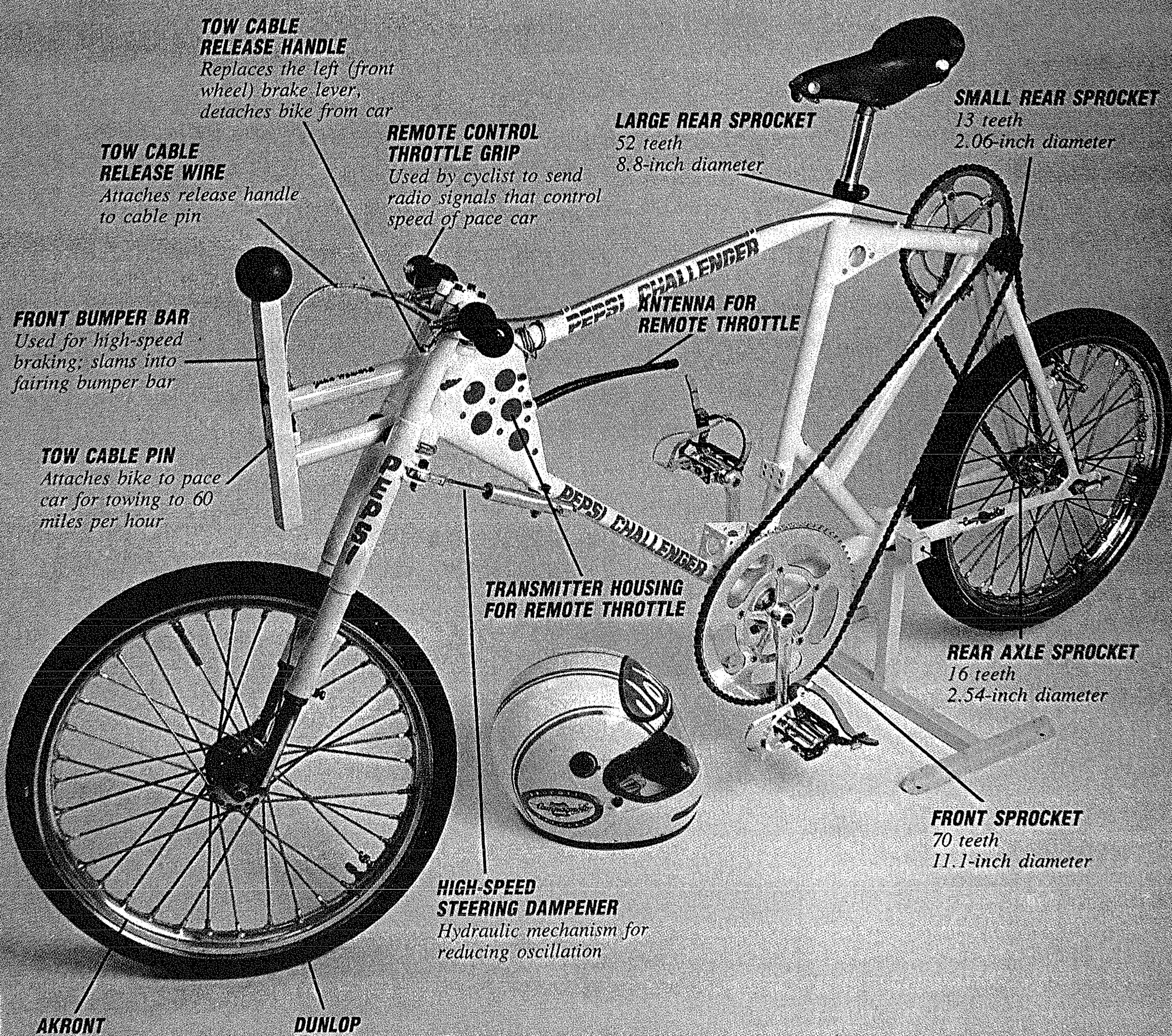
In most other respects, my bike was similar to Abbott's. It weighs about 46 pounds. It has straight motorcycle forks with shock absorbers. The handlebar goes straight across like motorcycle bars. The right handlebar lever controls an oversized brake, and my left lever releases the tow wire that is used to overcome inertia and get me up to about 55 miles per hour. Steering dampers prevent any dangerous, radical turns or violent wheel oscillations. The wheels use the same Akront alloy rims that small French motorcycles use for grand-prix racing. Later, we covered the spokes of the rear wheel with Mylar discs that I now sell through my company, Howard Performance. The discs substantially reduce the aerodynamic drag otherwise caused by the eggbeater-like flailing of uncovered spokes. With the help of Specialized, we located some custom made V-rated tires that can sustain speeds of 135 mph for an hour.

THE WORLD'S FASTEST BICYCLE—Doug Malewicki, designer of the 155 MPG California Commuter, has teamed up with John Howard, three-time Olympic bicyclist, to attempt a world record with the fastest human-powered vehicle. Using the double-reduction bike shown in the photo, John hopes to pedal over 150 MPH on the Bonneville salt flats. Bike and rider will be drafting behind Rick Vesco's low-profile 340 MPH salt flats machine with a special 5′ X 4′ fairing. To maintain proper vehicle speed, the bicycle has been fitted with a radio control twist grip, which activates the car's servo drive carburetor. Although the original run (scheduled for last September) was cancelled because of rain, things look promising for the two speedsters. During a recent unofficial test in Mexico, John clocked 124 MPH before the rough road surface damaged the car's fairing. That speed is only 15 MPH slower than the current paced-bicycle record!



THE MEAN MACHINE

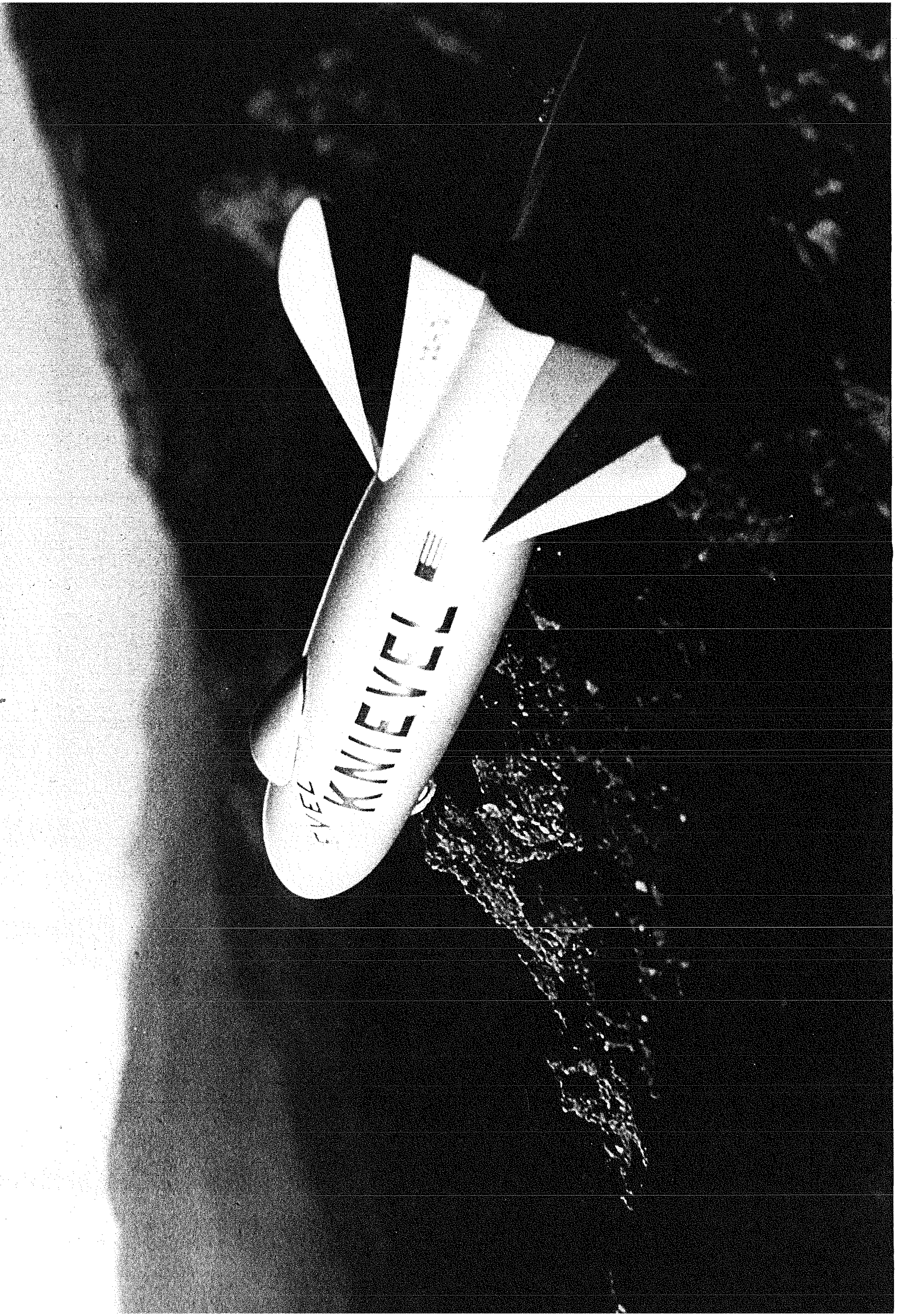
This bike was built for nothing but speed.

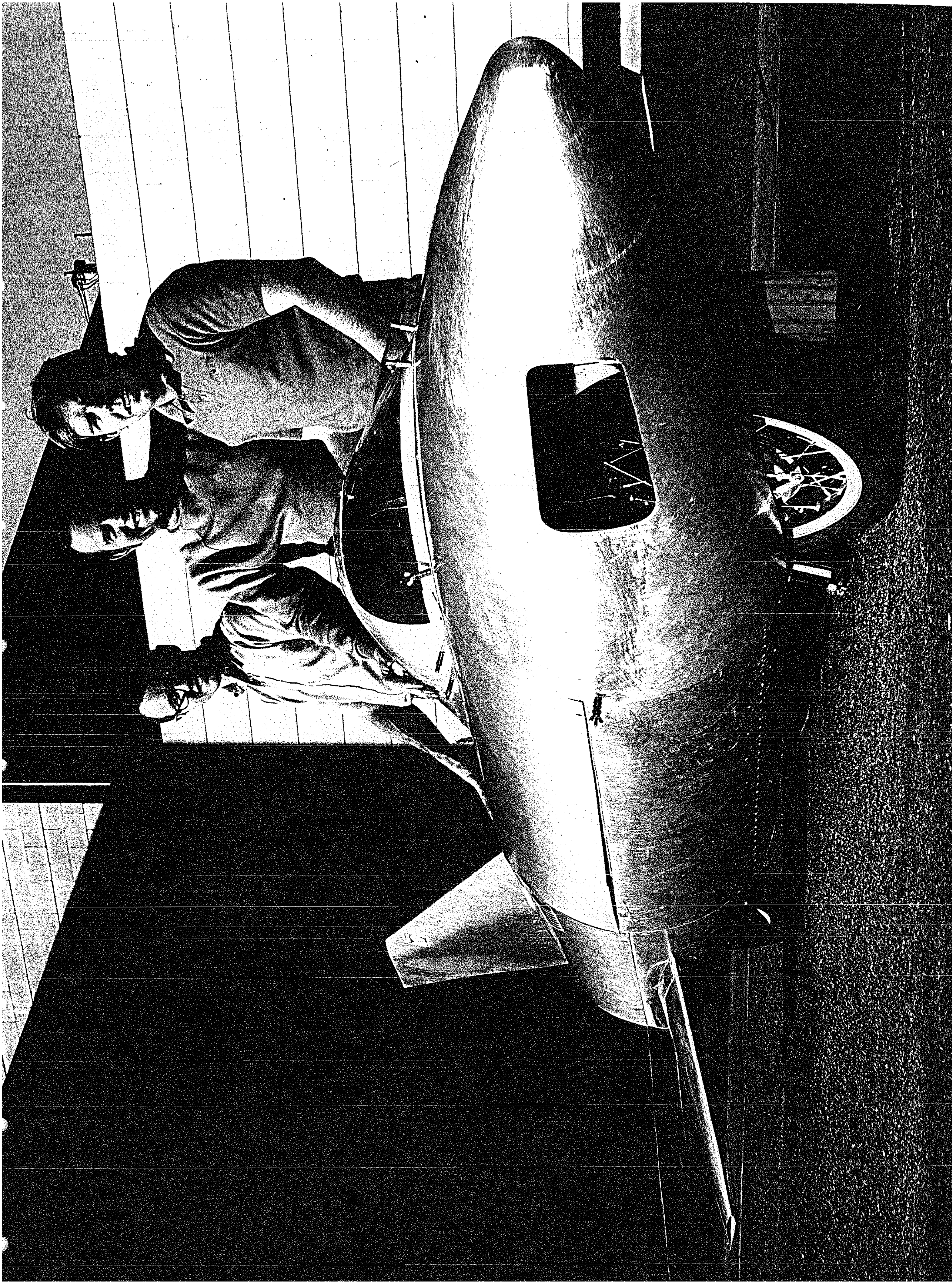


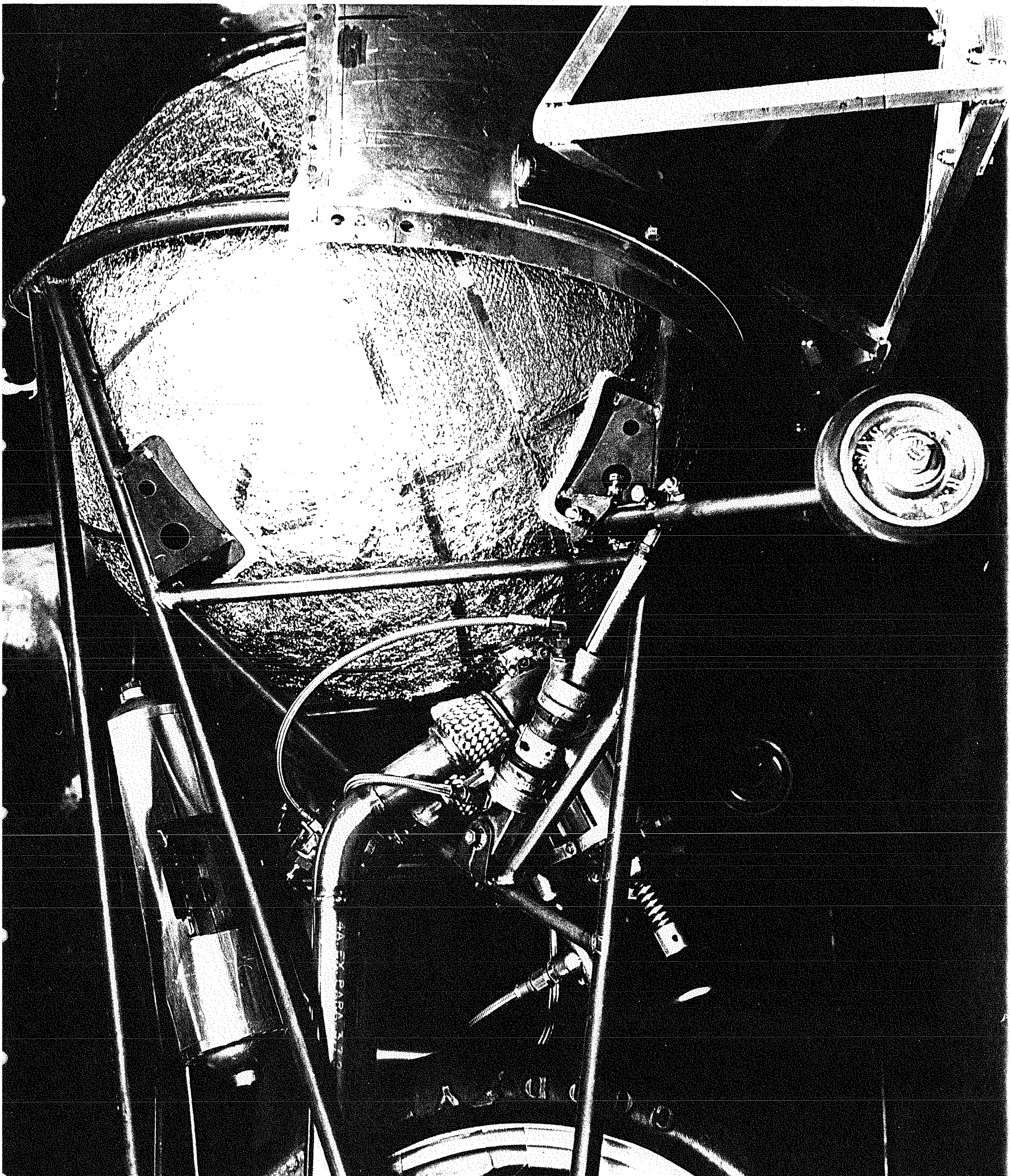
SPECIFICATIONS

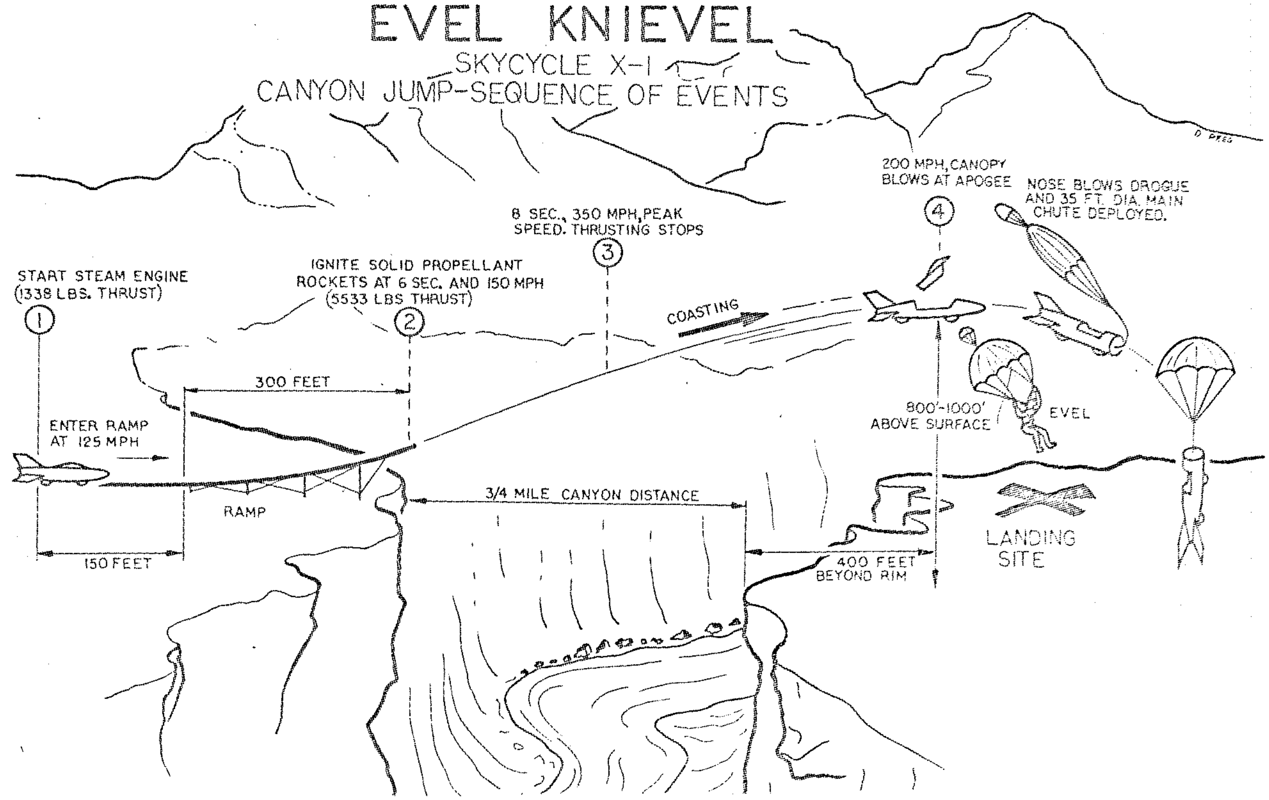
WEIGHT: *46 pounds*
HEIGHT: *32 inches*
WHEELBASE: *45 inches*
DRIVE RATIO: *One revolution of pedals equals 104 inches of forward motion for this gear arrangement. The design permits fourteen other ratios with different sprocket combinations.*

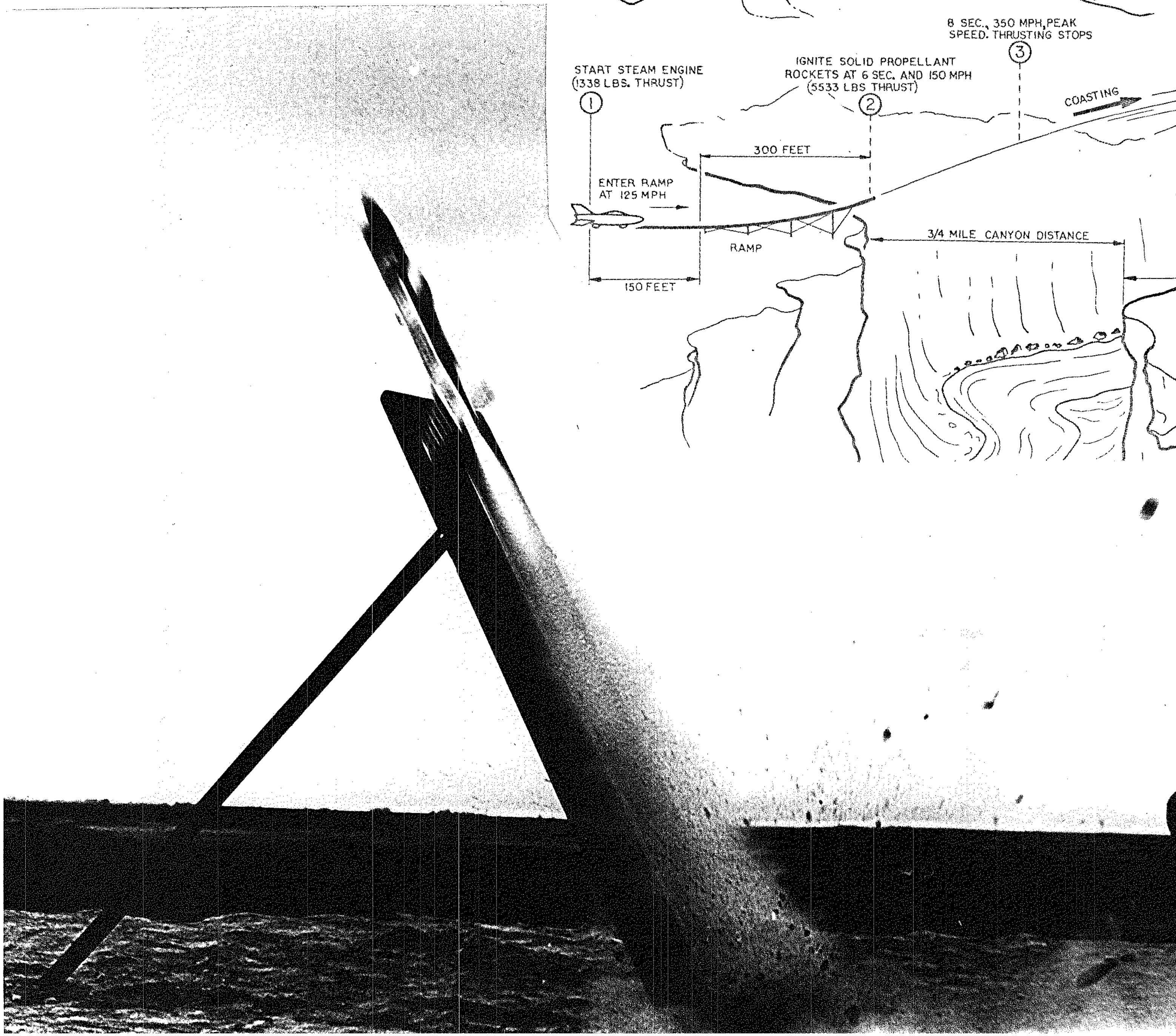
COST: *$10,000*
FRAME: *Standard chrome-molybdenum tubes*
DESIGN: *Angle and geometry of front fork adapted from high-speed motorcycles*
DESIGNER AND BUILDER: *Skip Hujsak*
SYSTEMS ENGINEER: *Doug Malewicki*

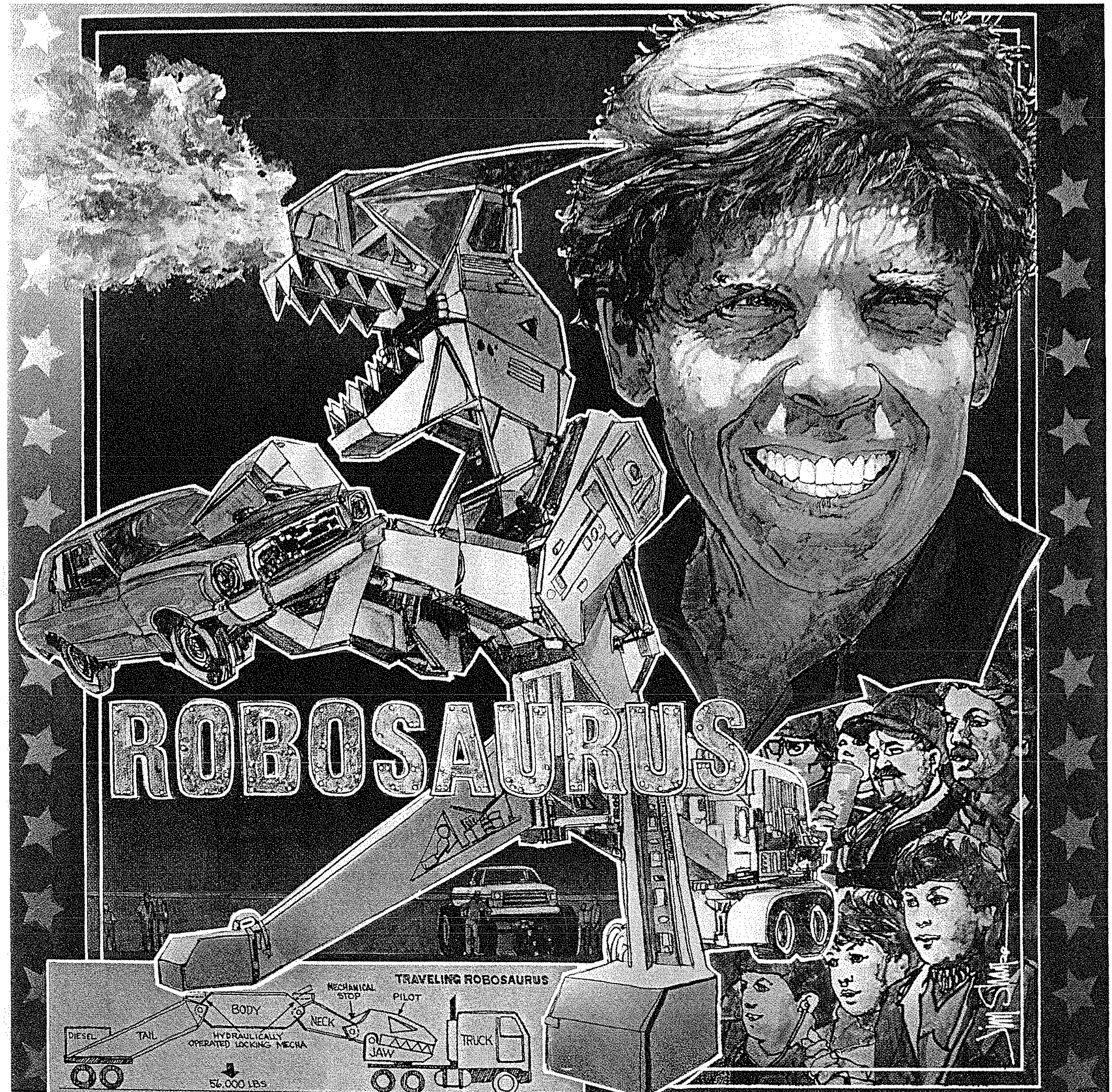

KNIEVEL






EVEL KNIEVEL
SKYCYCLE X-1
CANYON JUMP-SEQUENCE OF EVENTS
START STEAM ENGINE (1338 LBS. THRUST)
1
ENTER RAMP AT 125 MPH
150 FEET
300 FEET
RAMP
IGNITE SOLID PROPELLANT ROCKETS AT 6 SEC. AND 150 MPH (5533 LBS THRUST)
2
8 SEC., 350 MPH, PEAK SPEED. THRUSTING STOPS
3
COASTING
3/4 MILE CANYON DISTANCE
200 MPH, CANOPY BLOWS AT APOGEE
4
800'-1000' ABOVE SURFACE
400 FEET BEYOND RIM
NOSE BLOWS DROGUE AND 35 FT. DIA. MAIN CHUTE DEPLOYED.
EVEL
LANDING SITE





Some engineering challenges are real monsters

Innovative engineer Doug Malewicki envisioned a unique and challenging assignment. With Parker's cooperation, he created a monster – an electrohydro-mechanical monster named Robosaurus.

Robosaurus demolishes cars and thrills auto extravaganza crowds. He raises them 50 feet from the ground. He bites them in half, rips off their roofs, and crushes them in his monster-sized hands before hurling the mangled carcasses to the ground.

Getting this fire-breathing, fully-movable, car-crushing monster operational called for the contributions of eight Parker divisions.

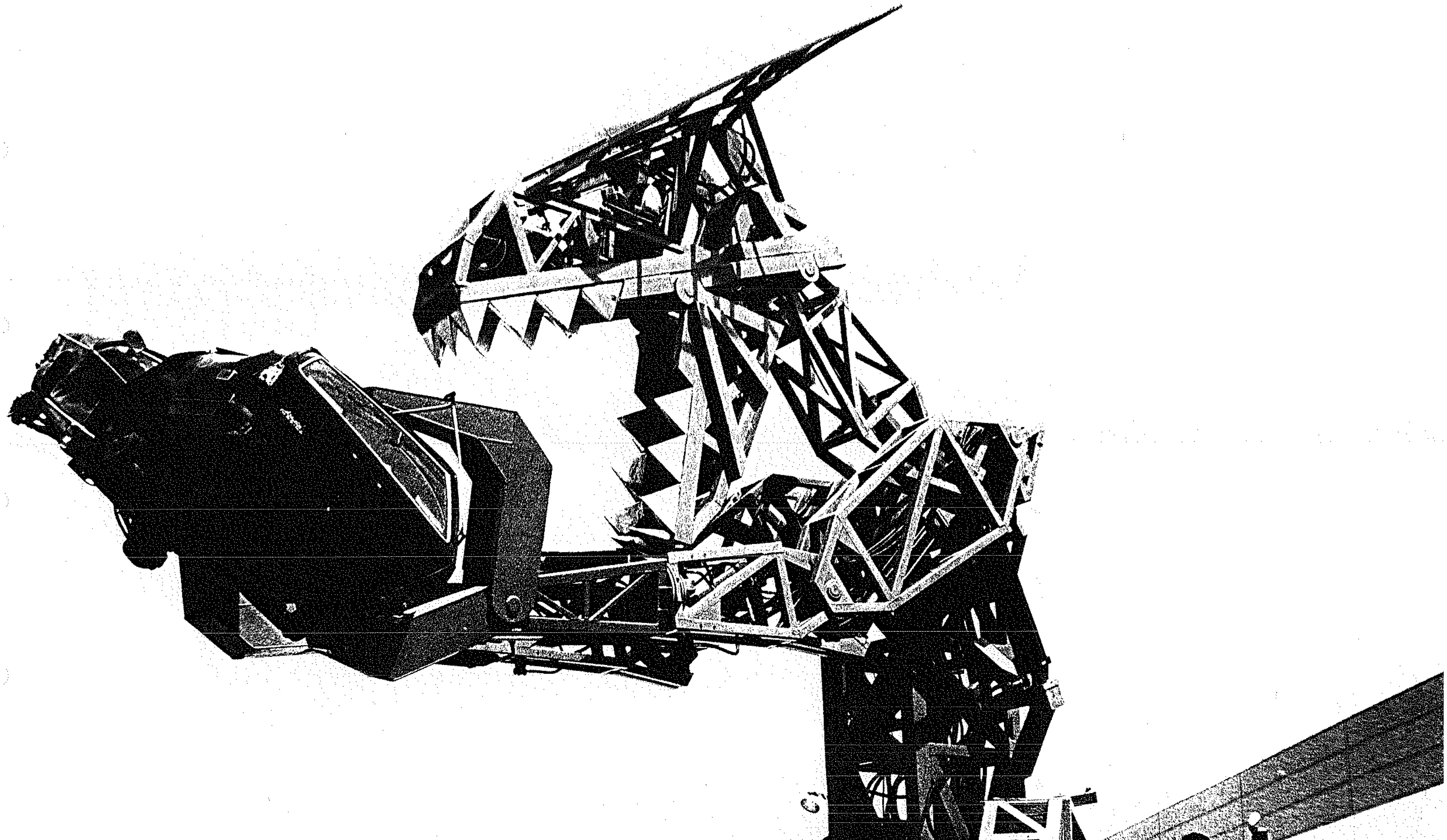
Parker engineers assisted Malewicki and his team in designing a unique turnkey system of cylinders, valves, pumps, motors, filters, seals, hoses, and fittings. And Parker's support system keeps Robosaurus in shape as he tours the world.

This type of hands-on involvement exemplifies the Company's partnerships with industrial, automotive, and aerospace manufacturers the world over – partnerships which have helped make Parker a $2.45 billion-per-year leader in the motion-control industry.

For Parker's fiscal 1990 annual report, write: Parker Hannifin Corporation, Dept. FB-16A, 17325 Euclid Avenue, Cleveland, Ohio 44112-1290. For product information, customers may call 1-800-C-PARKER.

(PH-NYSE)

A partnership in vital technologies Parker



BOYS' LIFE®

BOYS' LIFE ✦ SEPTEMBER 1992

Robosaurus:
Car-nivorous Monster

IMAGINE a monster robot with glowing eyes, jagged teeth and flaming breath.

Imagine it grabbing cars and crunching them in iron claws. It chews them up. It throws them down. It roars for more.

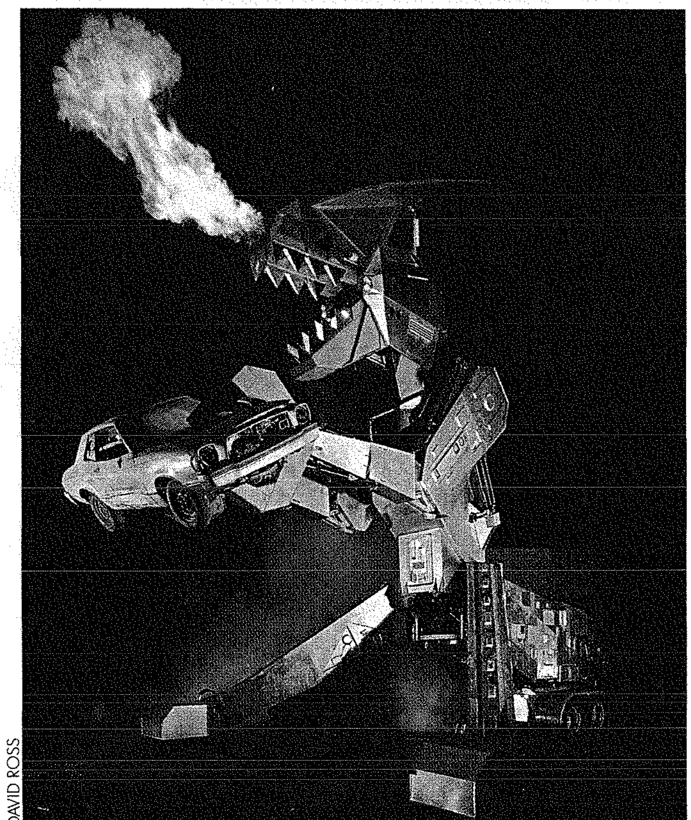
Stop imagining. Robosaurus is real! But don't run for cover. Robosaurus is just a toy. A big, BIG toy.

This 40-foot-tall steel robot looks like the dinosaur *Tyrannosaurus rex*. But it chomps on metal, not meat. It tears up cars to entertain people at car shows and races. And Robosaurus is always firmly under the control of human pilots who sit hidden in its head.

Robosaurus, or "Robo" for short, was created by Doug Malewicki, an inventor from Irvine, Calif. Mr. Malewicki says he got the idea from the Transformers toys that change from cars to robots. He wondered if he could build a life-size one. He and some friends decided to try.

They set some rules for the design. Robo had to be strong. It had to be tough. It had to be safe for its operators and the audience. Most of all, Robo had to be fun!

Malewicki gave Robo flamethrower breath using a burner from a hot-air balloon. He gave it awesome sound by adding giant speakers.


DAVID ROSS

From trailer to monster: Robo gets ready to CHOMP!

Robo is made mostly of welded steel—56,000 pounds of it. A 500-horsepower, turbocharged diesel engine in its tail provides the horrible power.

Robo has wheels in its feet and tail so it can roll up to its prey. A pilot and co-pilot are strapped into seats behind the monster's eyes. They guide Robo with computerized controls. They monitor the monster's every move by watching it on a video screen inside the tiny cockpit.

Robo transforms just like a toy. It starts the show folded up like a trailer. A truck pulls it into the arena. As the crowd watches, Robo comes to life.

Slowly, it unfolds. It stretches and roars. Then it looks for something to crunch.

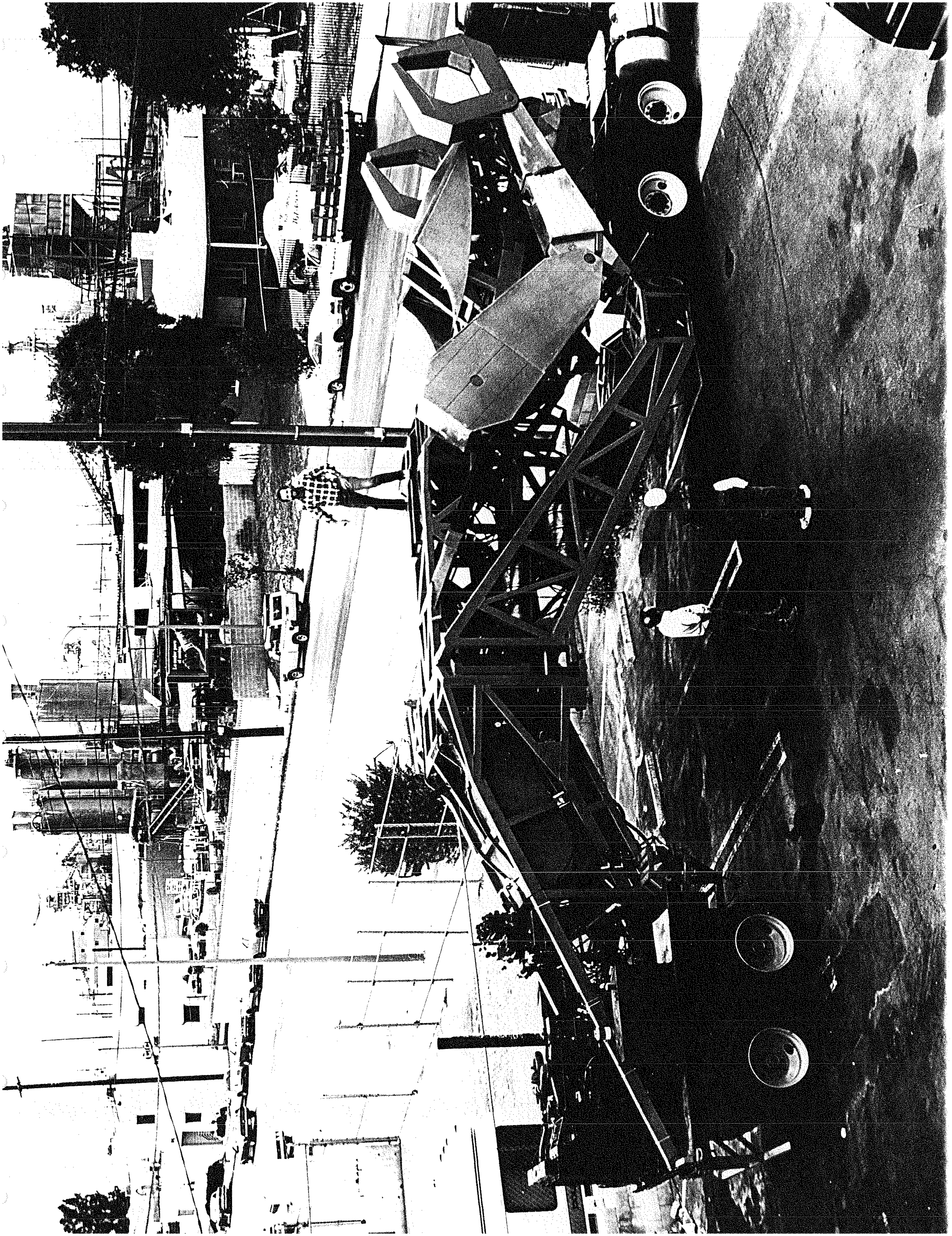
Robo's best trick is lifting a car 50 feet off the ground. It crushes it with 24,000 pounds of gripping force. Then Robo bites off the car's roof.

Flames shoot 20 feet out of its nose, frying paint and plastic. Finally, the beast drops the mangled car to the ground.

Robo cost $1.5 million to build. Malewicki and his partners are earning that money back by charging people admission to watch the robot do its stuff.

You might be able to see Robo in a television movie or in its own television series. After that may come Robo toy robots and games.

At that rate, Robosaurus may conquer the world after all.

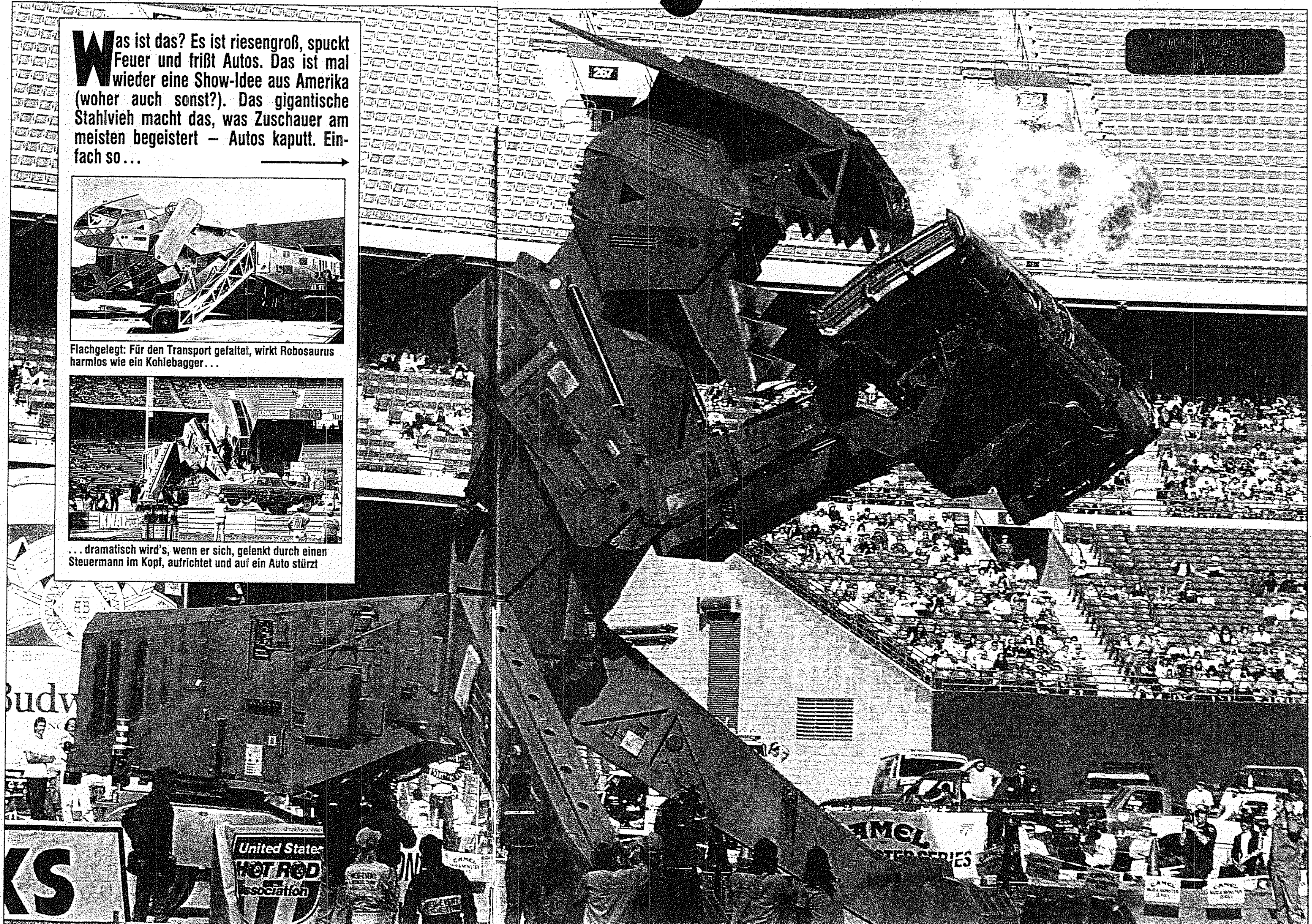



C444
C444

Kindersitz

Werbung

Autos zum Fressen gern: Robosaurus



Was ist das? Es ist riesengroß, spuckt Feuer und frißt Autos. Das ist mal wieder eine Show-Idee aus Amerika (woher auch sonst?). Das gigantische Stahlvieh macht das, was Zuschauer am meisten begeistert – Autos kaputt. Einfach so . . . →

Flachgelegt: Für den Transport gefaltet, wirkt Robosaurus harmlos wie ein Kohlebagger . . .

. . . dramatisch wird's, wenn er sich, gelenkt durch einen Steuermann im Kopf, aufrichtet und auf ein Auto stürzt

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Performance
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