RUF 2006

Rapid Urban Flexible

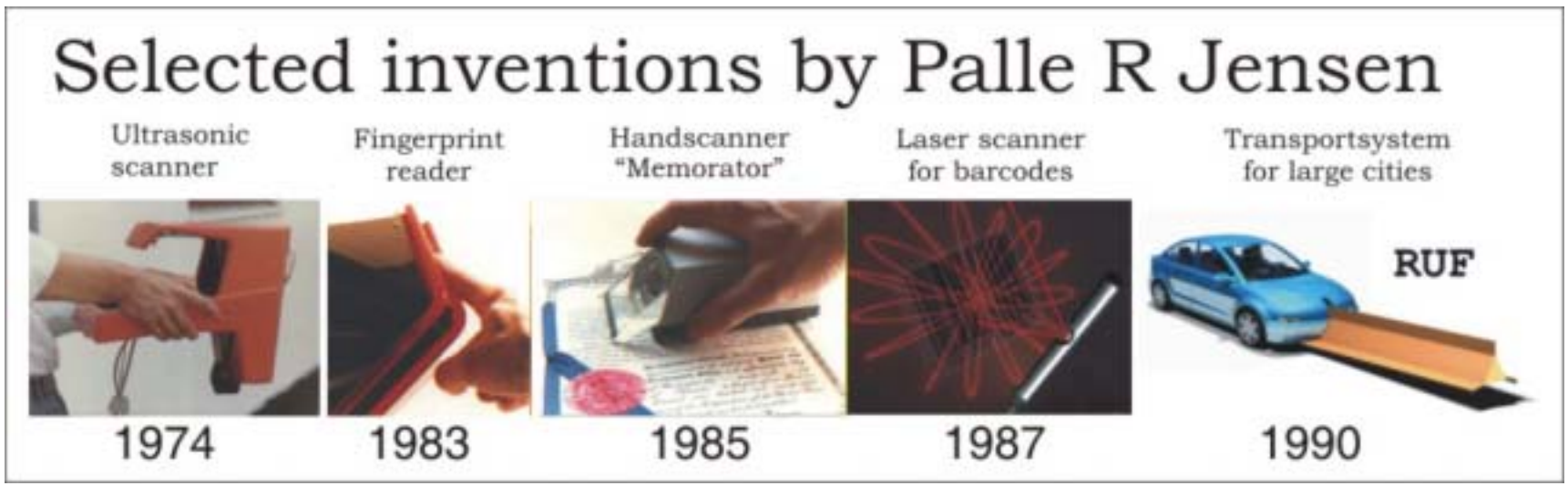
Palle R Jensen, RUF International, August 2006

RUF 2006

Overview:

RUF is an invention

An invention is defined as a surprising new combination of known elements



I have been professional inventor since 1974 and made some remarkable inventions throughout the years. Most of them have had nothing to do with traffic. Non the less I solved (partly) a problem for the Danish Railroads regarding closure of the doors of the S-trains by inventing a new way of closing the doors.

Recognitions

My inventions have been recognized by winning a series of prizes and appearing on several international media. I have shaken hands with the Swedish King 2 times in connection with invention prizes. I have also had the opportunity to appear on CNN.

Honorable membership

Dansk Selskab for Kreativitet og Innovation

udnævner herved

Palle R. Jensen

til ÆRESMEDLEM af selskabet som påskønnelse af hans utrættelige indsats som opfinder og innovatør gennem årene samt hans bidrag i ord og gerninger til realisering af selskabets formål.

Herluf Troelle
Formand

Ole Leimand
Næstformand

Danish Society for Creativity and Innovation

Inventor ← → Scientist

There is a great difference between the two roles. Inventor's work is not as systematic as a scientist. The result is that the product may be surprizing for the experts and this is exactly what is required for an idea to be an invention.

Scientists work more systematic and consistent. Both activities are important.

Inventor:

Recognition of problem

Inspiration

Creativity

Idea

Surprize among experts

Patent

Uncertain income

Scientist:

Hypothesis

Analyses

Systematic

Datacollection

Data handling

Conclusion/publication

Salary

The power of the idea

A simple idea can have great consequences.

The idea about the Hyperlink was developed into the World Wide Web, but the idea of a web browser based upon the hyperlink was conceived by an individual: the inventor Tim Berners-Lee

This proves that significant inventions **can** be made by individuals.

History has many examples of this, but many believe that this is no longer possible.

I will argue that radical inventions will often appear among individual free inventors who are not associated with any of the big corporations.

The big corporations: the car industry and the train industry are trapped within their core technologies and their development people will not usually be asked to think “outside the box”.

Motivation

My motivation for working with transport problems was the frustrating war between car lovers and train lovers. The situation was locked and unconstructive.

The lack of space in the growing cities and the emerging oil and climate problems also added to the motivation.

Solution: RUF Dualmode

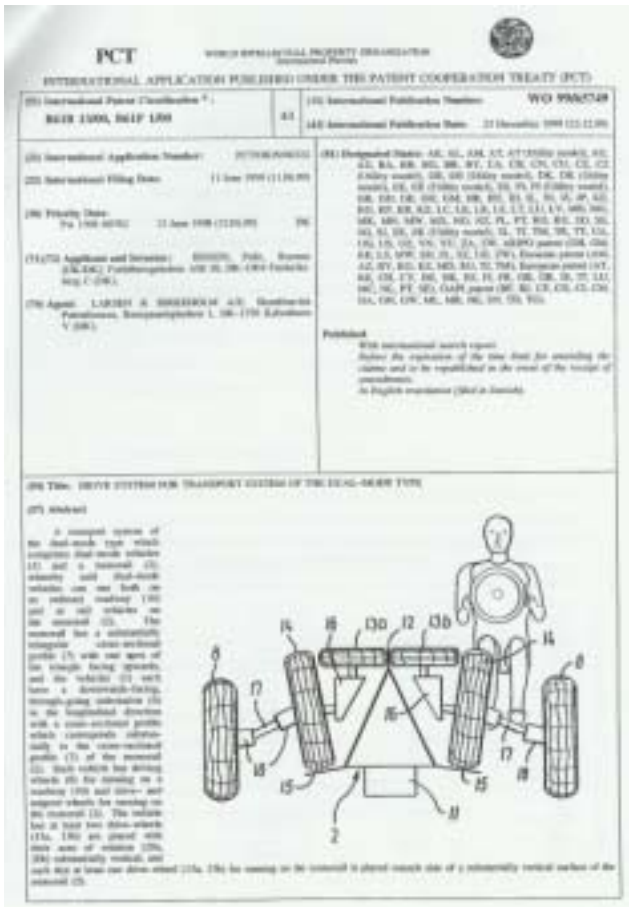
The solution to the problems was found to be the dualmode concept, i.e. the vehicles are able to drive in two different modes: on roads or on a special, exclusive monorail.

The system can serve privately-owned cars (ruf), publicly-owned cars (ruf) and small public transit buses (maxi-ruf) can also be served.

Larger units (mega-ruf) as well as freight units can be implemented.

Publication

Before publication in the magazine ”The Engineer” in 1990 a patent application was filed. Later 4 patents were granted covering important technical details.


PCT

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

WO 9965749

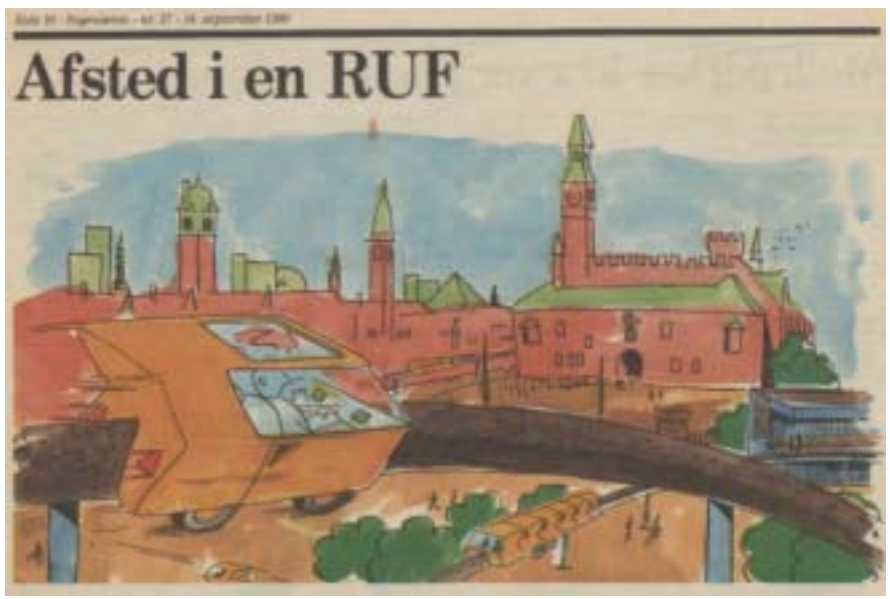

THE UNITED STATES OF AMERICA

TO ALL TO WHOSE THESE PRESENTS SHALL COME:

Whereas, THERE HAS BEEN PRESENTED TO THE Commissioner of Patents and Trademarks

Why the name RUF ?

The headline of the first article was ”Afsted i en RUF” which means ”Get along in a hurry”.
Later as the concept was discussed on the internet, Americans kept insisting that RUF had to be an acronym.
For that reason, I made 3 lists of words: R-words, U-words and F-words and found the best combination: Rapid Urban Flexible.



Immediate reaction

Copenhagen local radio contacted me and interviewed me directly

A traffic program called ”Axel” on the main Danish TV channel made a program about RUF and made the first animations. The program was very positive

The Copenhagen Traffic Authorities decided to donate 50,000.- DKr (approx. US $8,000) for an analysis of RUF.

The Laboratory for Road Data decided to donate another 50,000.- DKr

The Ministry for the Environment added 100,000.- DKr and a private consulting company COWI consult was asked to perform the analysis.

The COWI foundation gave a grant (40,000,- DKr) which made it possible for me to participate in the work.

Evaluations

The COWI report 1991

The potential for energy savings was confirmed.
The economics were not analyzed. Nevertheless, it concluded in a pessimistic tone regarding costs.

EU DG7 Reconnect 1999

AEA Technology Environment made the analysis and declared that RUF could be considered as a: ”Most promising technology” regarding congestion problems.

Citytraffic, Ministry for the Environment 2000

The evaluation was performed by the Institute for Future Research and CASA, Center for Alternativ Social Analysis

The conclusions of the evaluations:
RUF is far better than traditional public transport
RUF offers great environmental benefits

Global media interest

CNN

BBC World

Discovery Channel

German TV

Dutch TV

Belgian TV

Danish TV

Radio in Canada

RUF International

A consortium was formed in 1993. Mogens Balslev A/S Consulting Engineers was the main partner and a long row of sponsors participated in different ways. In the period 1993 – 2003 more than $ 2 million was invested.
Unfortunately Mogens Balslev A/S was forced to withdraw due to bad economy so from 2004 RUF International is 100% owned by Palle R Jensen.

Test track opened in 2000

Financed by the Ministries of Energy, Environment, Education and Culture together with Mogens Balslev A/S and several sponsors, ruf no. 1 was built and tested. Also the Industrial Designer Thomas Dickson MDD was able to create a 1:1 design model. Proof of Concept tests were performed successfully.

EU research programs

Palle R Jensen was invited to participate in 2 research consortia funded by EU. Together with 14 partners the consortia CyberCars og CyberMove worked in the period 2000-2004. They were coordinated by INRIA in Paris.
The funding was given under the programs for sustainable development (EESD) and information society technology (IST).

In total RUF received approx. 250,000 Euros.

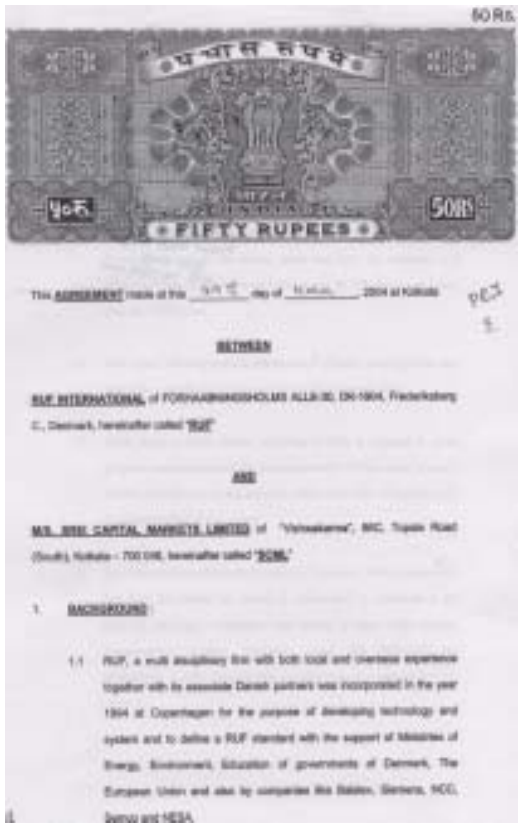
US funding

The Lounsbery Foundation has donated money to help RUF create ruf test vehicle no. 2 and has also been supportive in the process of creating a new institute at Texas A&M University with the purpose of evaluating dualmode systems. CEETI = Center for Energy, Environment and Transport Innovation was stimulated by Mr. Bruce A. McHenry (graduated from MIT).

A series of internet-based conferences have been organized by CEETI covering different aspects of dualmode technologies.

Contract in India

RUF International has signed a contract with SREI, which is the largest financing company regarding infrastructure in India. The plan is to build a RUF line in Calcutta, 100 km long and to be served by mega-ruf vehicles with room for 20 seated passengers. The West Bengal Government is interested but wants to see RUF demonstrated in Denmark on a test track with a length of at least 2 km.


50 Rs.
FIFTY RUPEES
50 Rs.

BETWEEN

RUF INTERNATIONAL

AND

1. BACKGROUND


আনন্দবাজার পত্রিকা

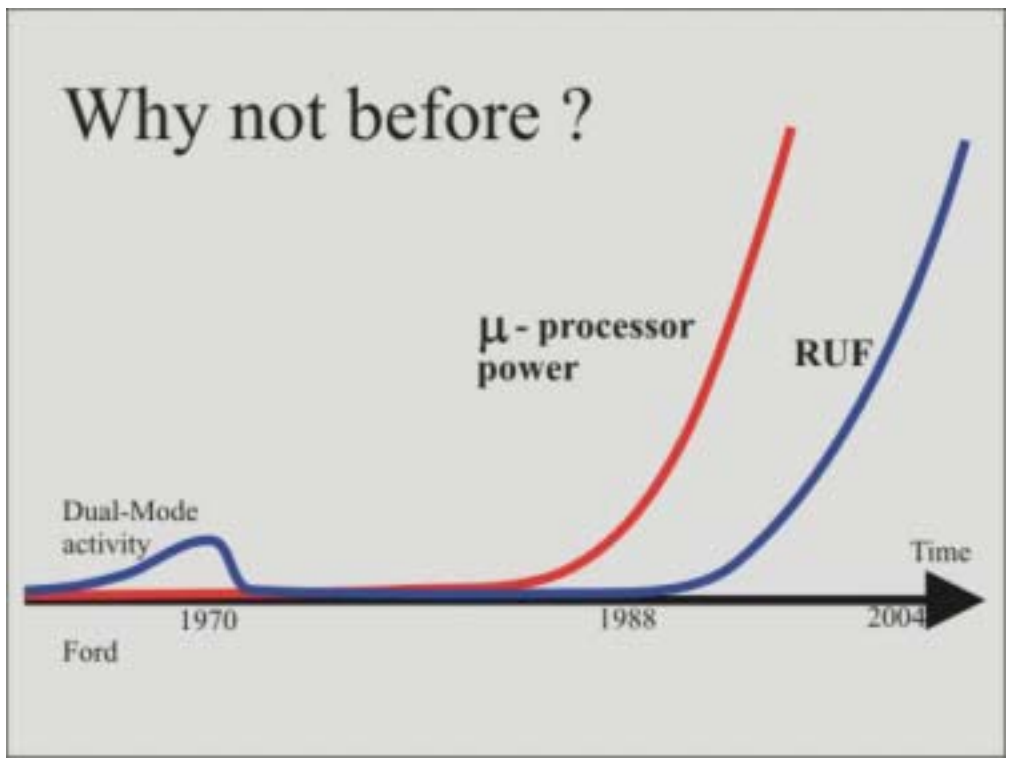
নৈহাটি-কলকাতা-নামখানা, এ বার মোনোরেল

Why dualmode ?

Combines the **flexibility** of the car with the **environmental advantages** of a train

Why not invented before ?

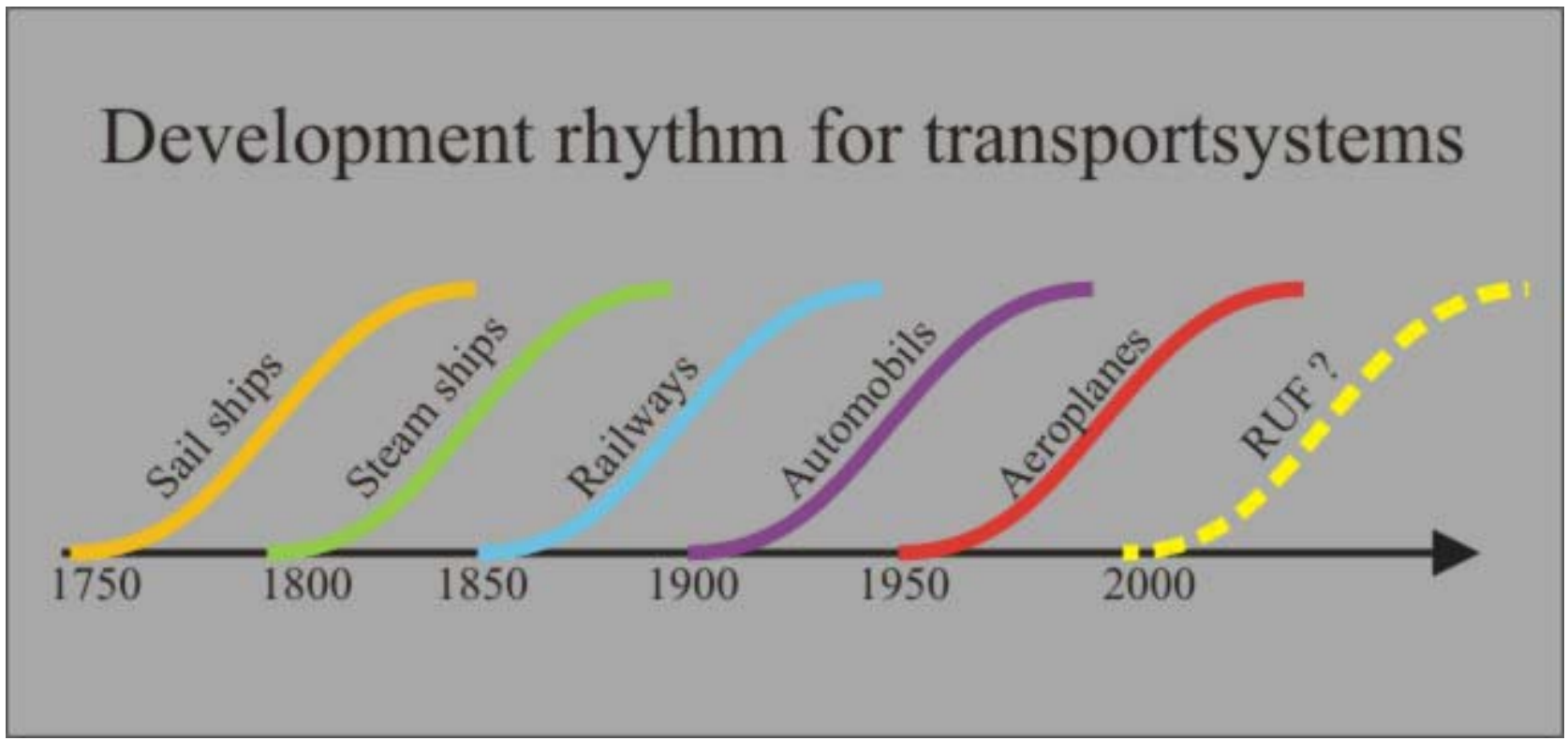
The Dualmode concept was actually discussed at US universities in the 1970's but it was never realized despite intense activity. A national dualmode conference was even held in the USA.
The reason for the lack of a breakthrough is probably that computer power at that time was very costly and slow. A network of automated vehicles simply could not be controlled. Today this is no longer a problem.



Why has the time come ?

According to a controversial theory, major transport system innovations appears following a certain rhythm. Every 50 years something new has to appear. According to this theory something new should appear around year 2000.

It could be RUF.



RUF main features

The RUF system is built using a range of key technologies:

Dual mode electric vehicles (could be hybrid)

Ruf is a car, maxi-ruf is a bus

The vehicles drive automatically on a network of monorails or manually on the roads

Power is supplied from the monorail. Only small batteries are needed.

Drivesystem allows for adjustable friction against the monorail

A hybrid unit can be used for longer trips using the roads

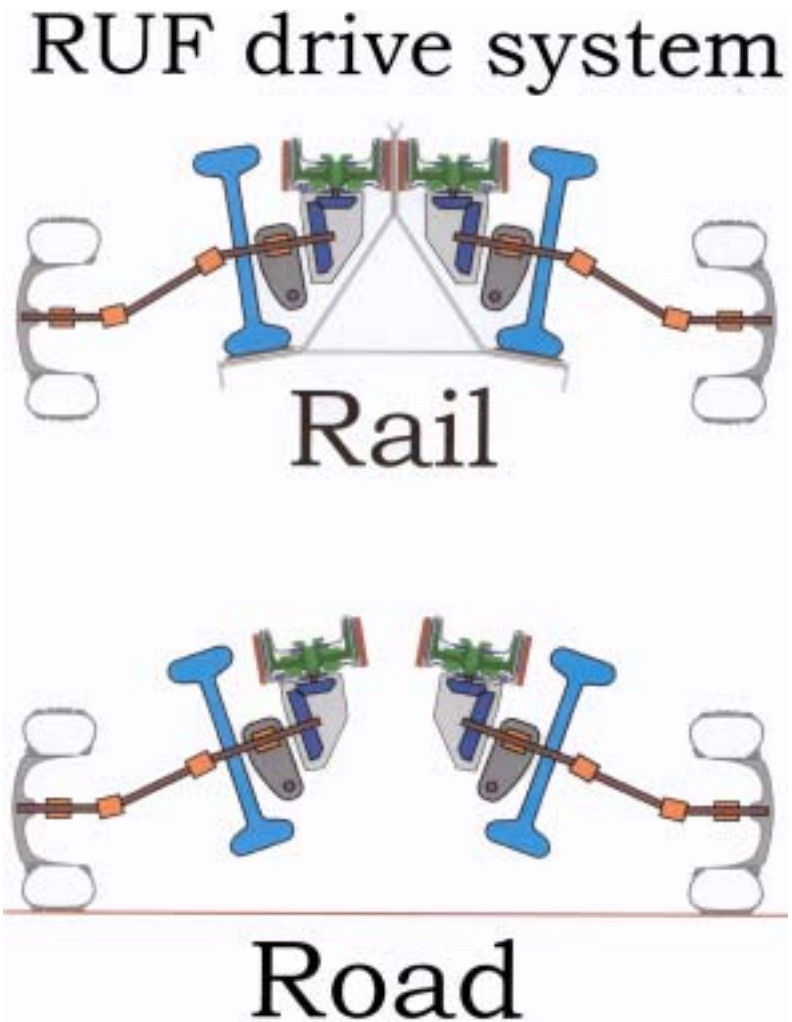
Switching is done using magnetic fields of different frequencies

Electric bus with one door for every seat. Very easy access for elderly people.

Triangular monorail, ensures against derailing and requires minimum space.

Rail brake for emergency braking (1G)

RUF drivesystem, patented



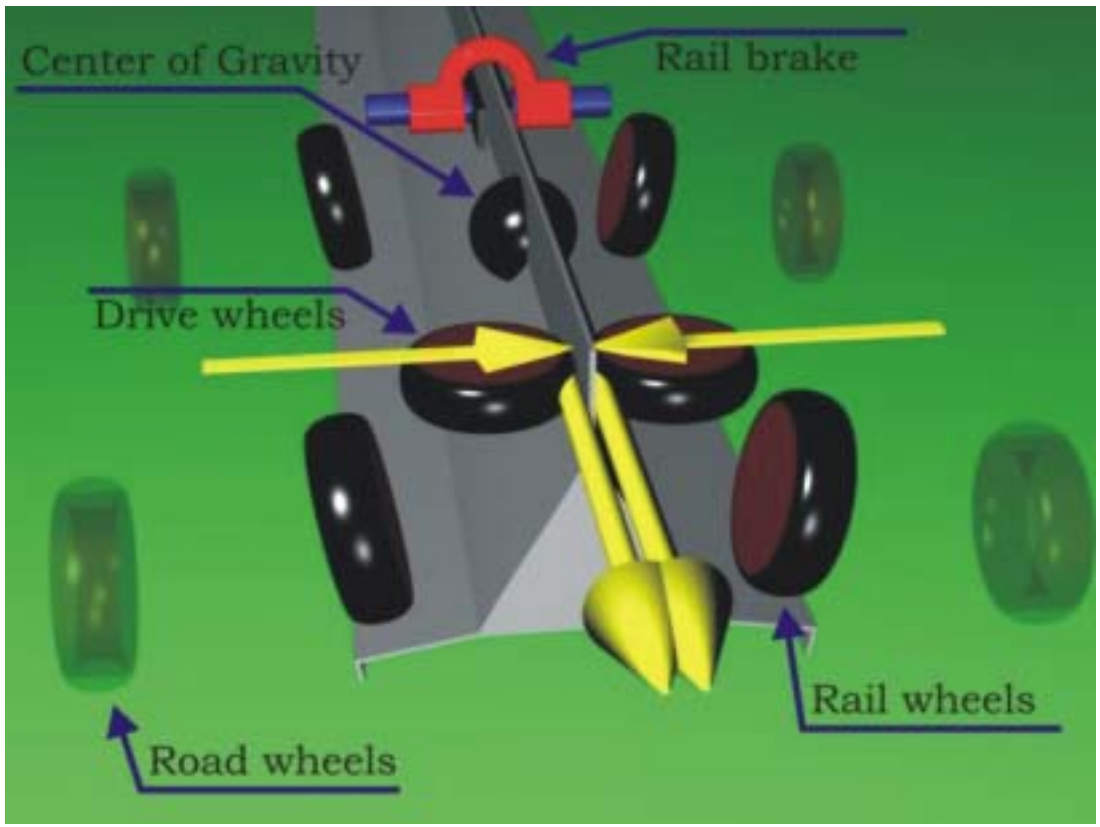
The drivesystem is built around 2 electric wheel motors which can be pressed against the top of the triangular monorail.

The motors are used both for driving on the monorail and for road driving.

On the monorail the vehicles are locked to the monorail which means that derailings are impossible.

The support wheels on the monorail are smooth. Normal braking uses the motors in reverse. Emergency braking uses a special rail brake. This allows for low rolling resistance and low noise.

RUF drivesystem

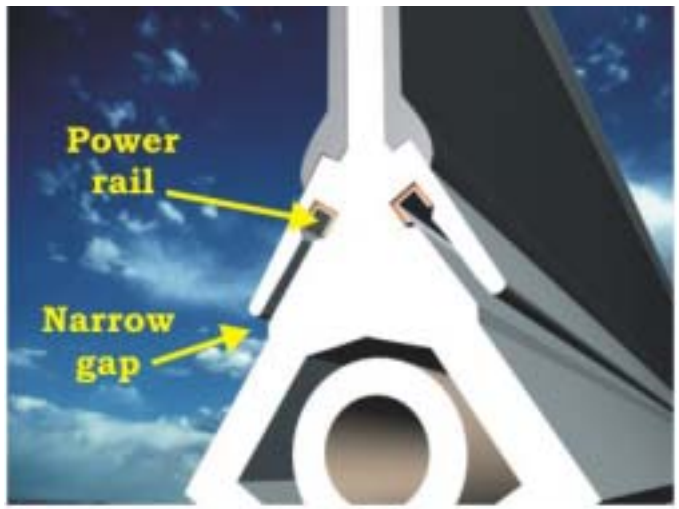


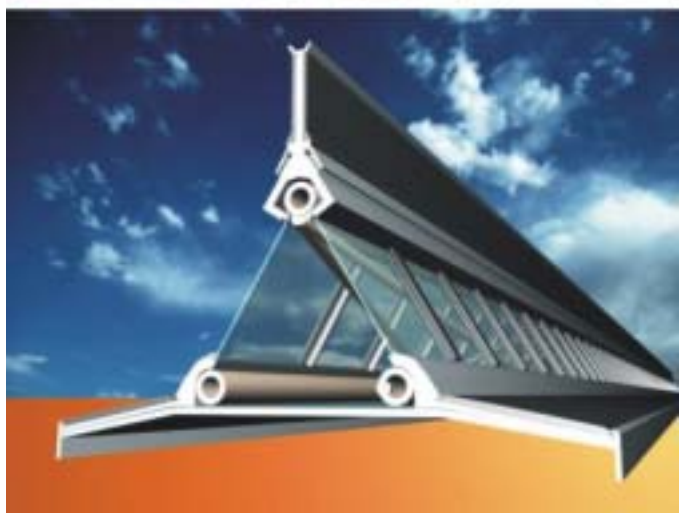
The drive system allows adjustment of the pressure against the monorail. This means that friction can be increased when it is needed i.e. when the vehicle accelerates or climbs a hill.

The rail brake is placed in the rear of the vehicle. It is only used for emergency braking.

The center of gravity is placed below the top of the monorail. This way the stability of the vehicle is very high.

RUF gets power from the rail

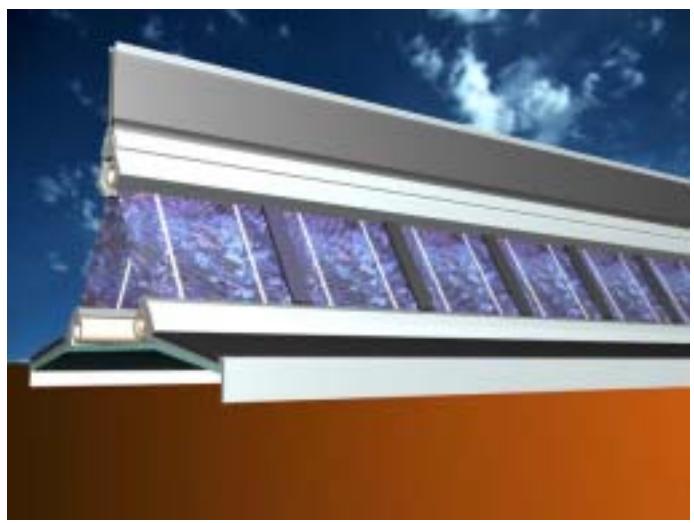




The RUF system only needs small batteries because it can recharge the batteries with power from the monorail.

The power rail also makes it possible to regain the braking energy very efficiently.

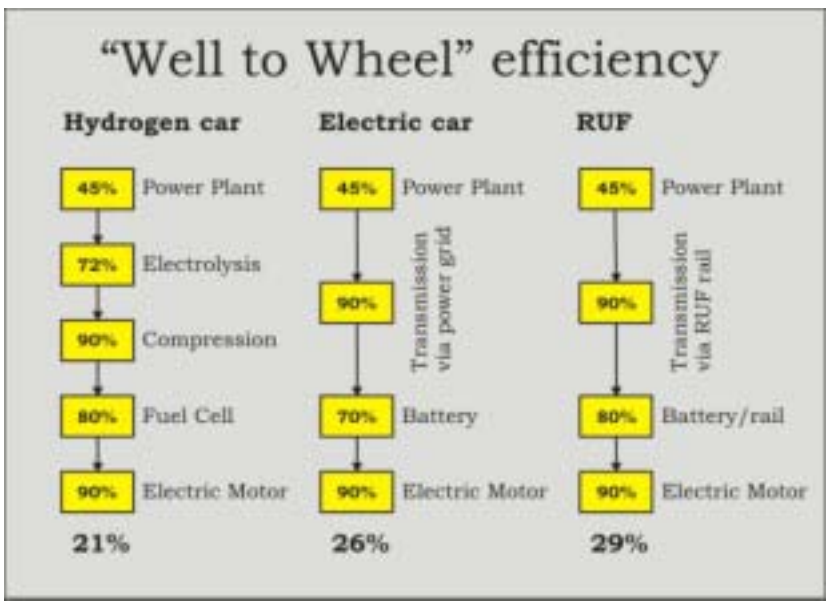
Solar cells at the side of the triangular monorail can add to the power supply.

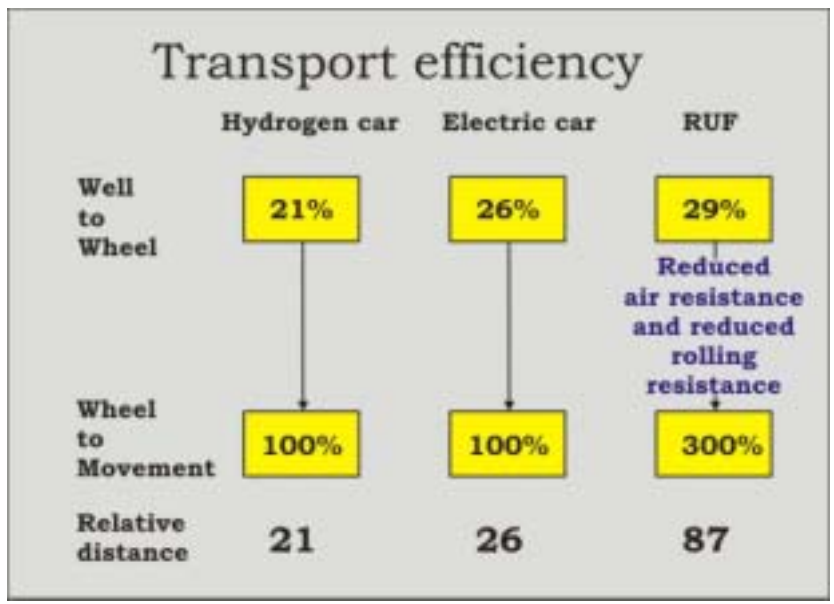


RUF is better than hydrogen

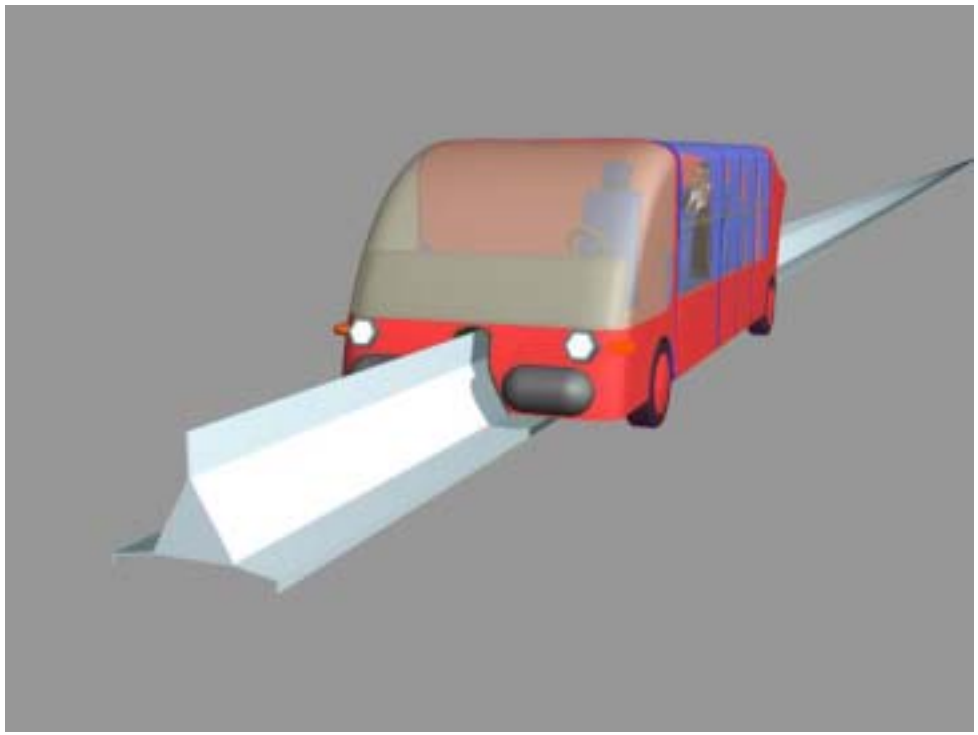
Hydrogen production is costly and energy consuming.
Storage of hydrogen is very difficult
A battery is needed in order to have enough peak power

RUF is powered directly from the monorail over long distances
RUF does not need nearly as much energy when moving along the rail as part of a train. The distance a ruf can move on a given amount of energy is far longer than a normal car (4 times). The transport efficiency of RUF is superior.





RUF monorail is very slender



The triangular monorail is very simple and takes up minimum space. It’s visibility is minimized.

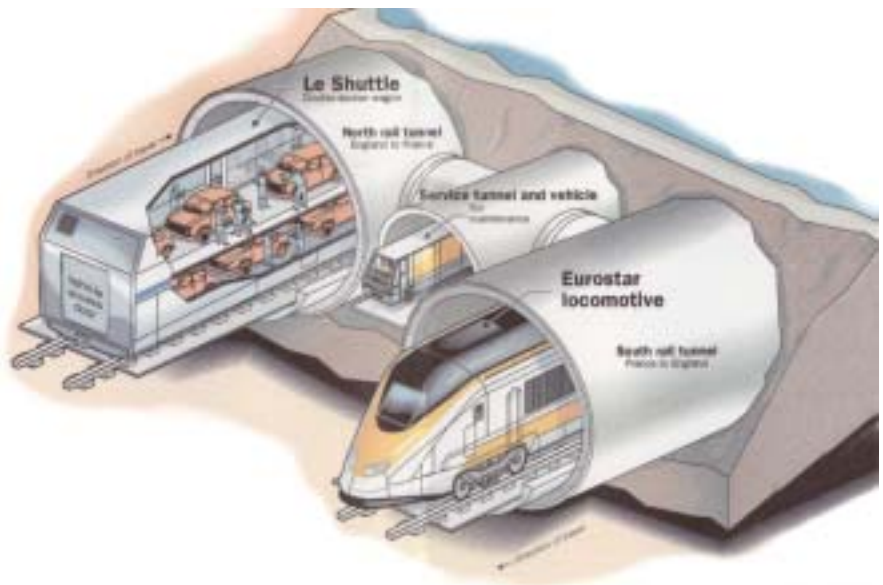
The cross section is optimized regarding supportive strength and torsional stiffness.

The modules are 20 m long. They can be mass produced in a factory under optimal conditions. This will ensure a low price and it is possible to use the finished rail itself to transport the modules.

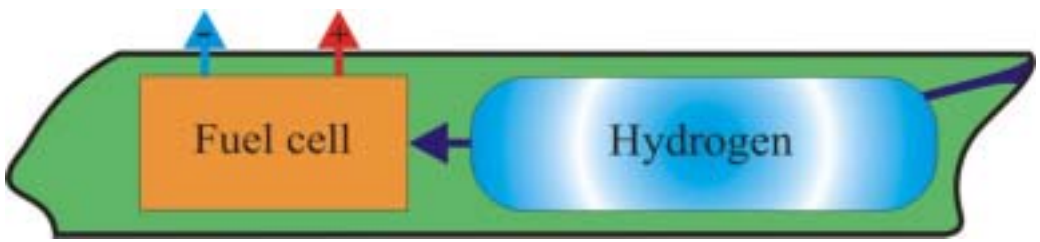
The empty space inside the monorail can be used as a container for all kind of important cables.

RUF switch is magnetic

The switch in RUF uses the dualmode principle. The vehicles leave the monorail at 20 mph and drive along a short road section guided by magnetic fields with different frequencies. Vehicles tuned in on a certain frequency will follow the corresponding track. A very flexible and safe function is obtained.
Magnetic guidance is used today in the tunnel under the English channel. Service vehicles have been running more than 1 million km at much higher speed than RUF without any problems.



RUF can drive anywhere

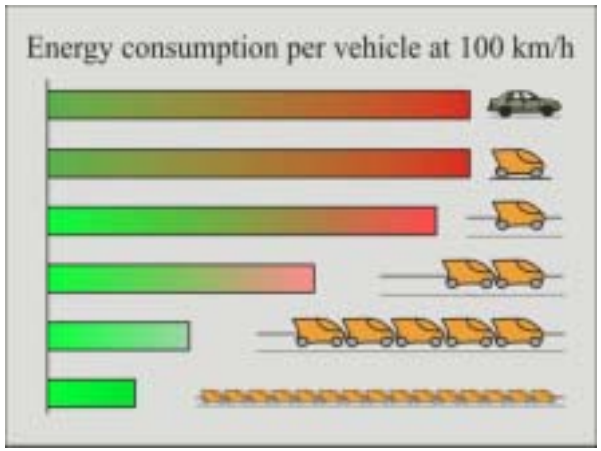


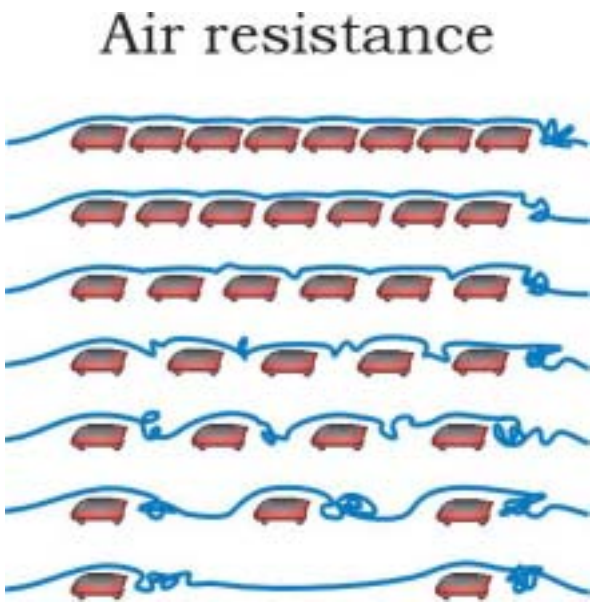
RUF uses the very extensive road network just as normal cars and busses do today. The vehicles can drive at least 35 miles on fully charged batteries. Normally only less than 2 miles range is needed in order to get to the rail network.

A hybrid unit can be mounted in the empty space under the vehicle when it is not on the monorail. This way the range can be extended to be equivalent to a normal car.

When the monorail network becomes widespread, the range becomes very large.

RUF uses very little energy





Electric motors are far more efficient than gasoline engines.

When using the monorail, the electric power goes directly from the rail to the motor.

Close coupling of vehicles on the monorail will lower the air resistance per vehicle significantly at high speed.

The rolling resistance on the monorail is very low since the vehicles do not need friction for braking via the support wheels.

Regaining energy by normal braking using the motors in reverse is very efficient since the power goes back into the monorail and doesn't overload the batteries.

The motors are mounted in the drive wheels which are in direct contact with the monorail.
Transmission losses are very low.

RUF can use wind energy

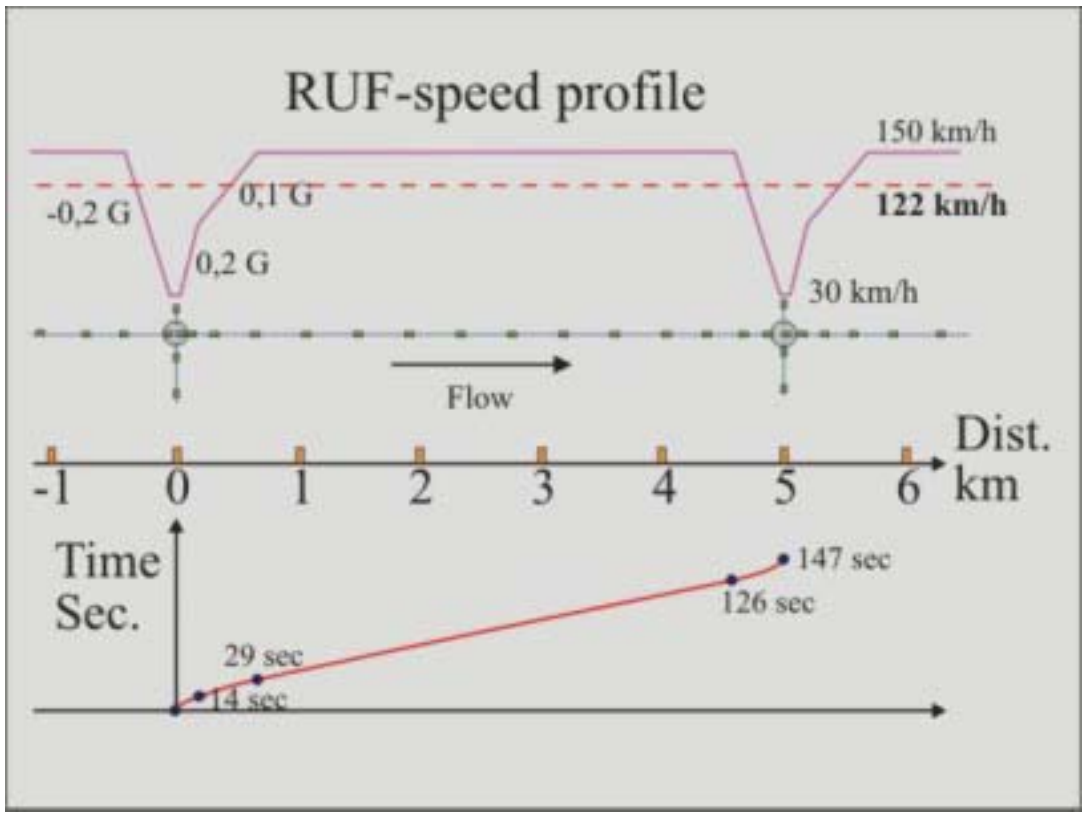
RUF can use windmill towers to carry the monorails across the sea.

The power is generated close to the place where it is used. In this way, transmission losses are minimized.

Electric cables for the RUF system and other services can be placed inside the triangular monorail

The RUF system’s energy needs are highest when it is windy, since the air resistance depends on the square of the relative wind velocity.

RUF is faster than the car



RUF has a fixed rhythm in the network of monorails. Access and egress is at a speed of 30 km/h. The top speed is 150 km/h and at every junction the speed is lowered to 30 km/h so that RUF can switch between monorails or leave the system.

At a typical distance between junctions of 5 km, the average speed becomes 120 km/h.

All vehicles follow the same speed rythm and it is not possible to overtake.

RUF is safer than the car

Many highway accidents are caused by driver failures. These accidents can be avoided when using the monorail instead of the highway. Automated driving is safer than manual driving. Especially in fog, rain, snow and darkness the monorail is a big advantage since the vehicles are perfectly guided sideways.

The creation of small trains makes it impossible to have collisions within the train itself.

RUF can handle snow

The RUF vehicles are ”locked” to the monorail by means of the drive wheels which can be pressed against the top of the rail in order to increase the friction if needed.

Snow piles will not disturb the monorail at 4 m height.

The shape of the triangular rail prevents rain from being collected on the rail. No ice will be created on the rail during cold weather.

RUF is comfortable

Driving on the monorail is very smooth. Unlike in a train there is no sideways jerk.

Noise level is very low.

The cabin can be equipped with facilities to create a ”rolling office”. It is possible to concentrate on work while commuting.

The economic consequences are very positive since riding time can be used in beneficial ways.

RUF can avoid congestion

RUF is separated from the rest of the traffic when using the monorail.

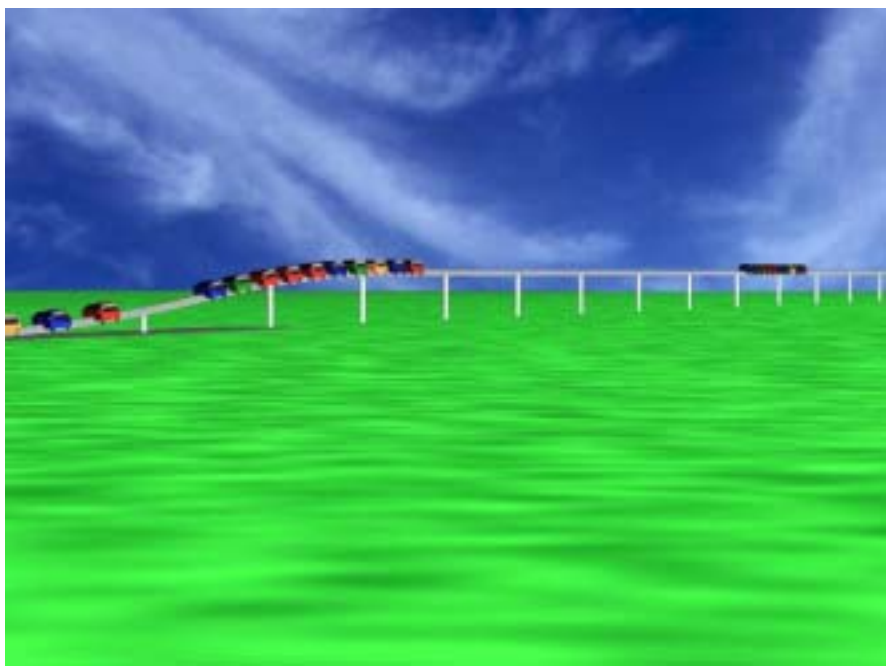
Traffic flow on the rail is system controlled, so no frustrating congestion will appear.

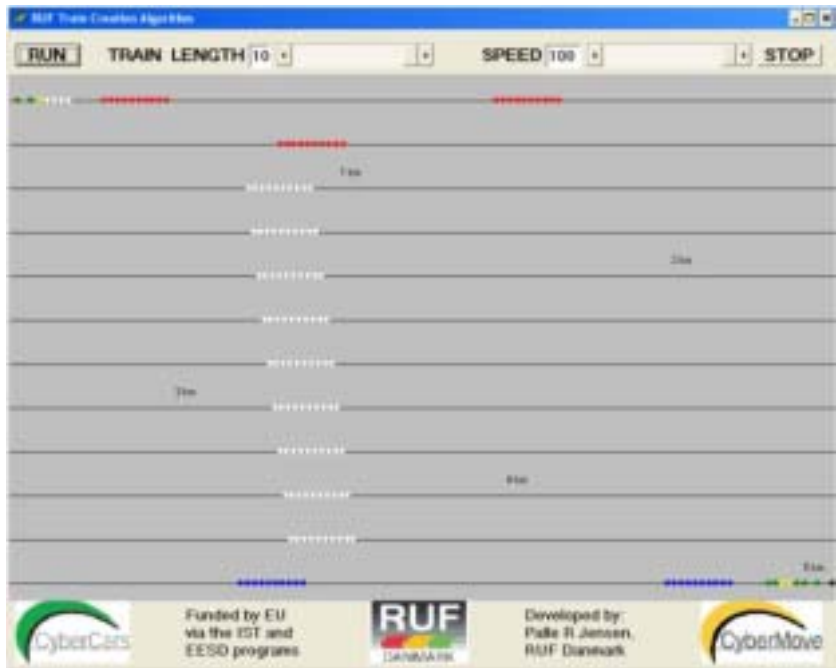
Egress ramps can be placed in such a way that the traffic flow on the system is unaffected by adjacent road congestion.

It is far less expensive to create an elevated RUF system on top of an existing highway than to expand the highway.

RUF train creation

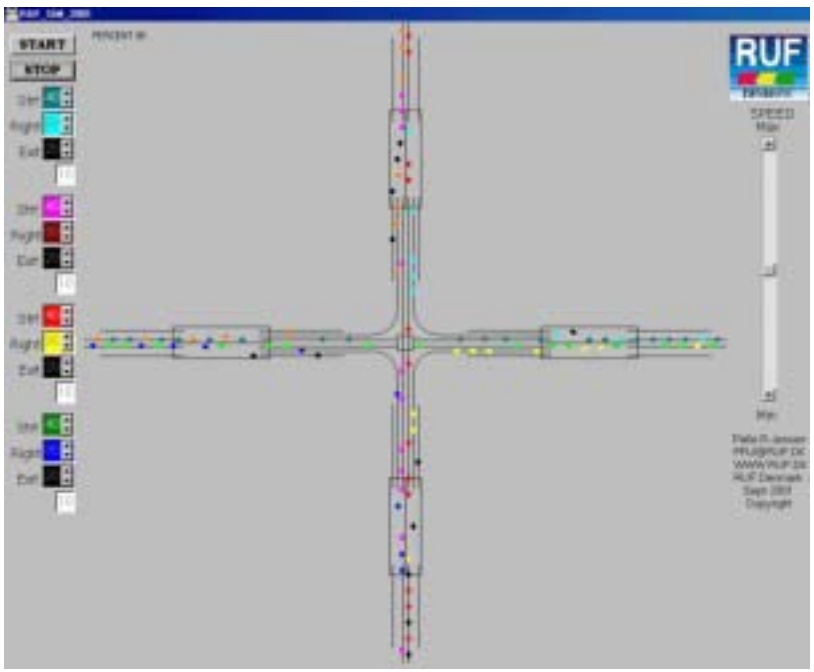
At maximum capacity, 1 ruf will enter the monorail every second at 20 mph. The coupling of vehicles is performed by slowing down the speed to 3.5 m/sec. It takes approximately 10 sec to create a train of 10 rufs.
First the train is accelerated at 0.2 G and then at 0.1 G until the top speed of 95 mph is reached. A typical distance between junctions is 3 miles.
See: www.ruf.dk/ruftrain.exe which simulates the train creation process.
This simulator was created by Palle R Jensen and funded by EU

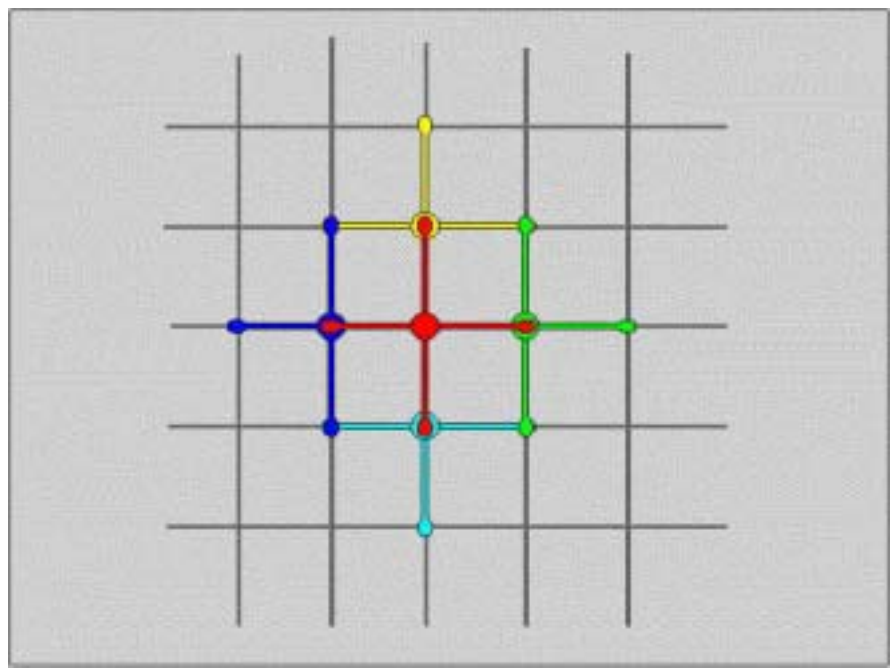




RUF control system

The control system ensures a fail-safe operation. This means that it is only possible to drive if everything is OK. Every vehicle on the section between junctions follows the same speed profile. If everything is OK it operates at 100%. A minor error can slow down the section to a lower percentage. A serious error will force every vehicle on the section to perform a 1 G emergency brake at once. The system is redundant which means that any of the neighbor junctions can take over control if needed.
See: www.ruf.dk/rufsim.doc and www.ruf.dk/rufsim.exe





RUF can park itself

A ruf need not enter street level inside the town. You can leave it at a station and let it drive by itself to a parking facility outside town. While it is parked, the batteries are recharged so it is ready when you need to get home from work. You can summon it via cell phone or internet.
This way you never need to worry about charging the batteries.

Door-to-door public transport

RUF public transport is very attractive.

Light weight electric busses can drive anywhere in the inner city. The access to the seats is extremely easy and there are seats for everybody.

No noise and no pollution.
Car drivers would like it.

RUF has been tested

Copenhagen University College of Engineering

Why has RUF not been realized ?

RUF

The chicken and egg problem:

The car cannot be sold until the rail has been built.

The rail cannot be financed before a lot of people have bought the car

Solution:

Start RUF as public transport

RUF public transport 1/9

Train = bus => revolution:

The passengers need not transfer from bus to train if they are willing to pay for a door-to-door trip with public transport which is faster than by car today and just as comfortable.

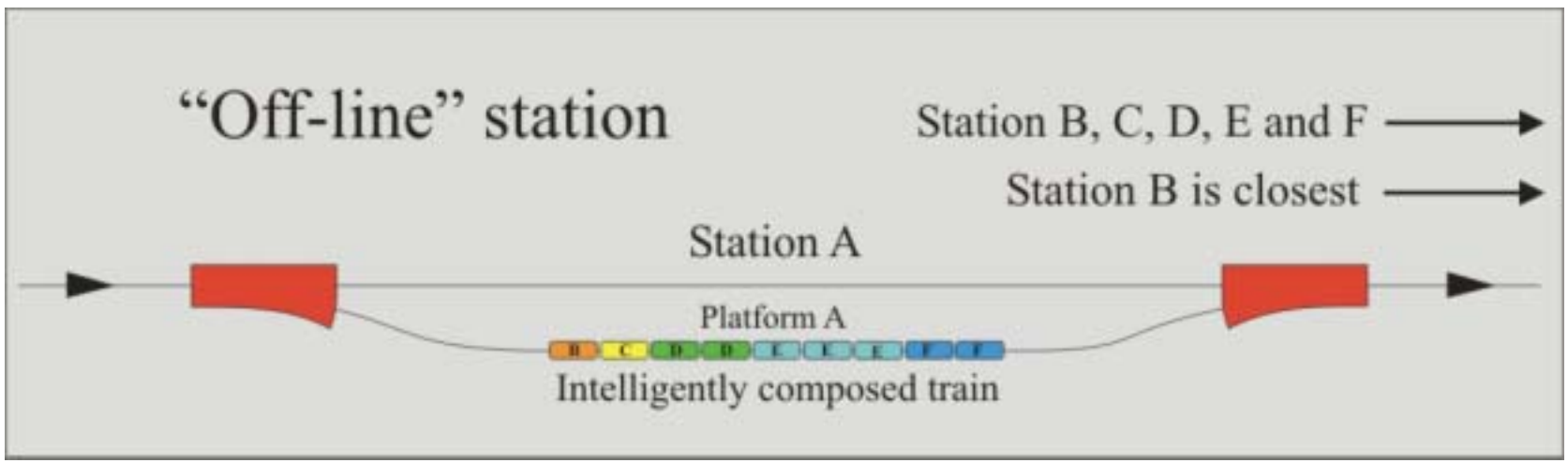
They can also choose a less expensive trip where they will need to change along the route and they might have to wait at a bus stop nearby.

RUF public transport 2/9

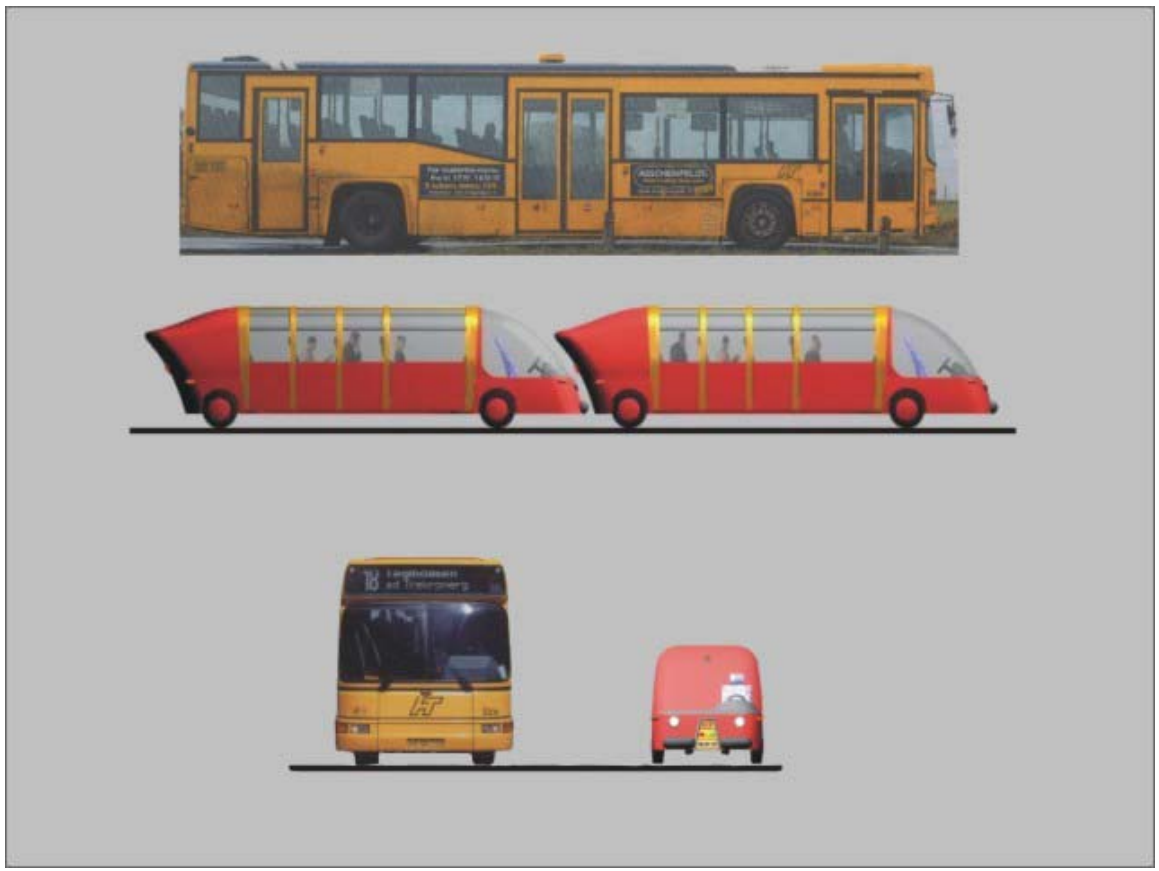
Stations are off-line

RUF can be organized so that all trains are through trains. No passengers are forced to sit in a train which stops at stations in between.

Stations are safe since the vehicles only drive slowly at the place where people are standing. No elevators are needed.



RUF public transport 3/9



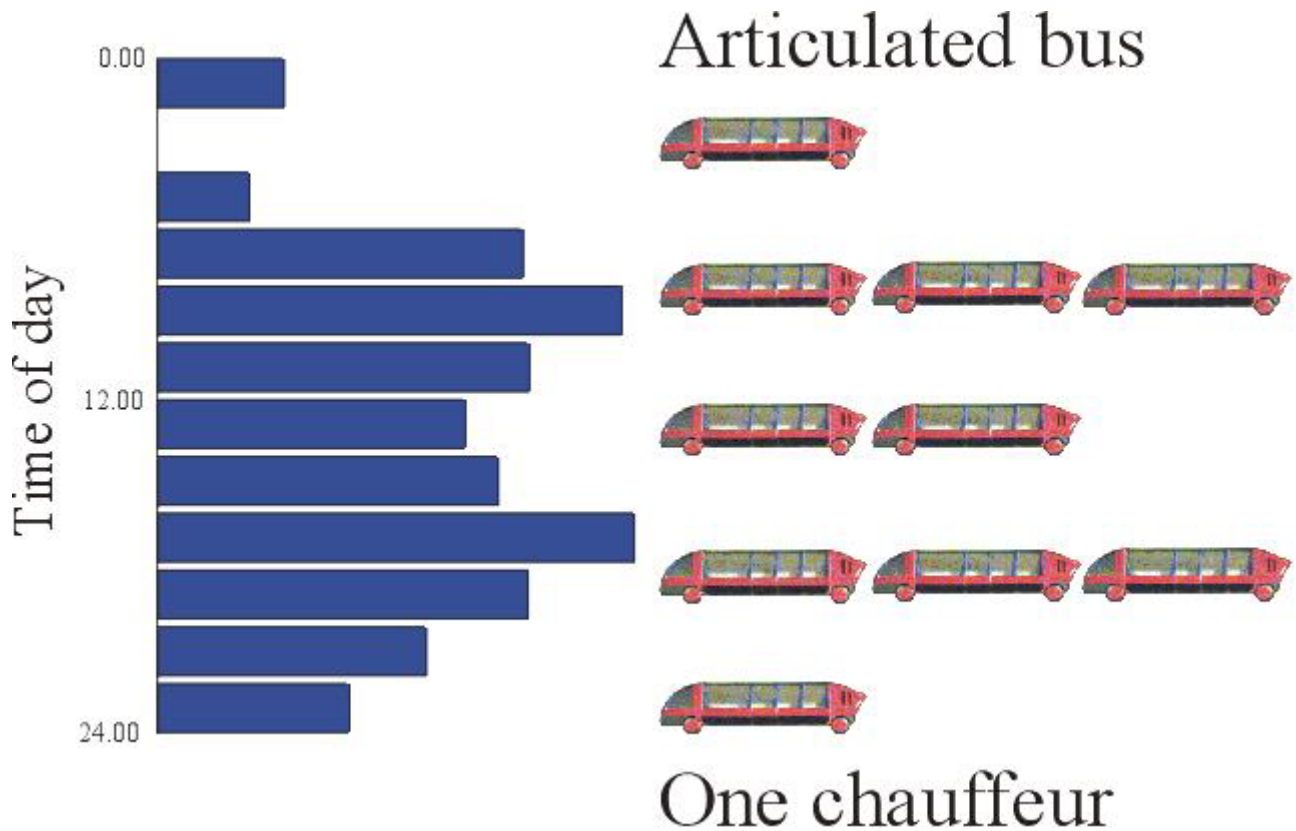
The RUF system uses many small units in stead of few large units. This means mass production and lower prices.

Since there are no standing passengers, the dimensions of the cross section can be far smaller than for a traditional bus.

You can consider the maxi-ruf as the limousine of public transport.

RUF public transport 4/9

Maxi-rufs can be coupled to form an articulated bus consisting of up to 3 units. This way the number of seats can be adjusted to match the demand during the day. The result will be less empty driving. The other vehicles can be used for other purposes: food delivery, post delivery, small goods etc.



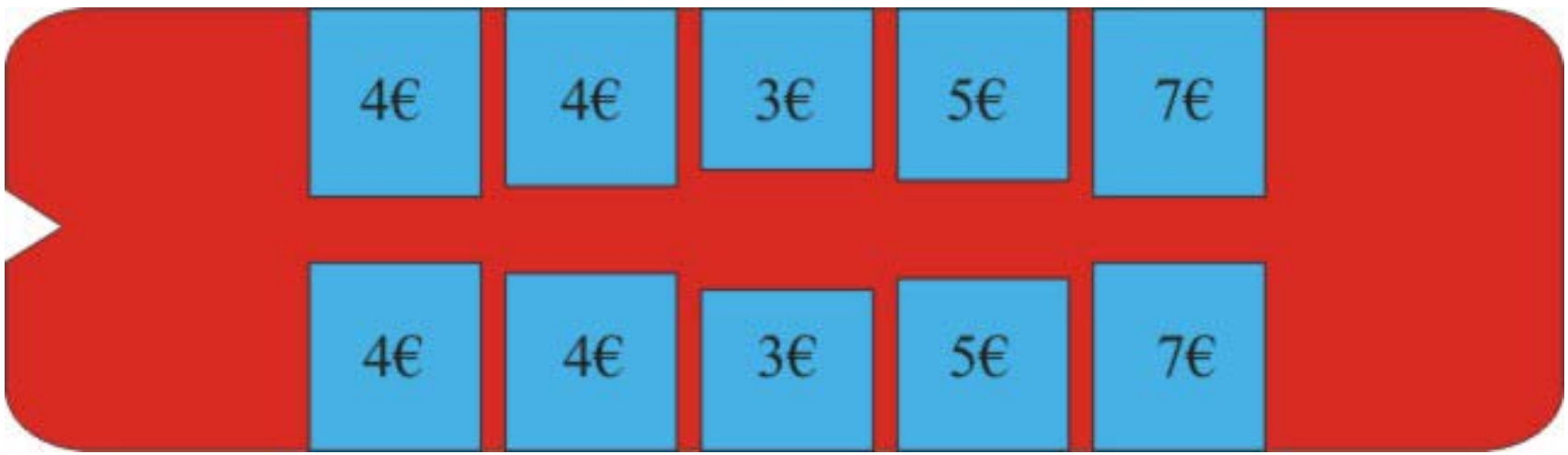
RUF public transport 5/9

Very comfortable bus/train.
The seats have car comfort. No unpleasant adjacent passengers since all seats are single seats. Access to the seats is very easy since the doors open directly to the street or platform. No problem with climbing a steep stair and keep your balance when walking in a moving bus.
No standing so nobody gets hurt during emergency braking.

RUF public transport 6/9

The Operator can charge the seats individually due to the special door system. Some seats can be more luxurious than others. The fare depends on the quality of the trip. The most expensive option is door-to-door transport with fast pick up at the doorstep and delivery directly to the desired destination. No parking problems and no parking fee.

The maxi-ruf can attract customers who would normally never consider using traditional public transport. Savings in time and parking costs can justify a higher fare for the trip.



RUF public transport 7/9

Very low weight due to small dimensions and light materials (aluminium). Minimum road wear. The amount of wear rises very quickly as vehicle weight rises. Maxi-ruf only weighs less than 3.5 tons including passengers/goods. A traditional bus can weigh 20 tons with passengers. One of the large operating expenses for a normal bus is the cost of changing brake shoes. In a maxi-ruf the brakes last longer partly because the motor is used for normal braking and partly because the weight is lower.

RUF public transport 8/9

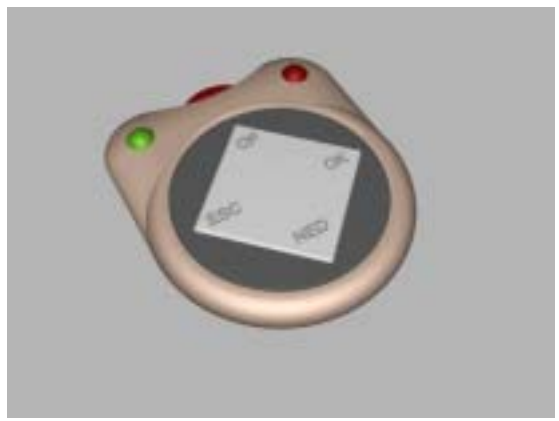
In contrast to normal public transport, the RUF system can offer a seamless trip. It can start as a dial-a-bus, continue as an automated people mover and end as a kind of ”tram”.

The ”tram” can be implemented without having to put rails in the street and mount overhead wires. This means that the cost of establishing a tram-line with RUF is extremely low.

The reason for this possibility can be found in the fact that the batteries of the maxi-ruf can be recharged on the monorail leading to the central area as well as the opposite way. This kind of ”pendulum” mode makes it possible to run purely on batteries in the sensitive parts of the inner city. No noise, no pollution.

RUF public transport 9/9

Public RUF cars on a parking rail many places throughout the city can also be considered as an advanced form of public transport.
The RUF cars are charged while parked and the temperature is kept at a pleasant level inside the isolated climate screen.
Smart cards or Bluetooth devices are used for payment and ordering.



Why is innovation needed ?

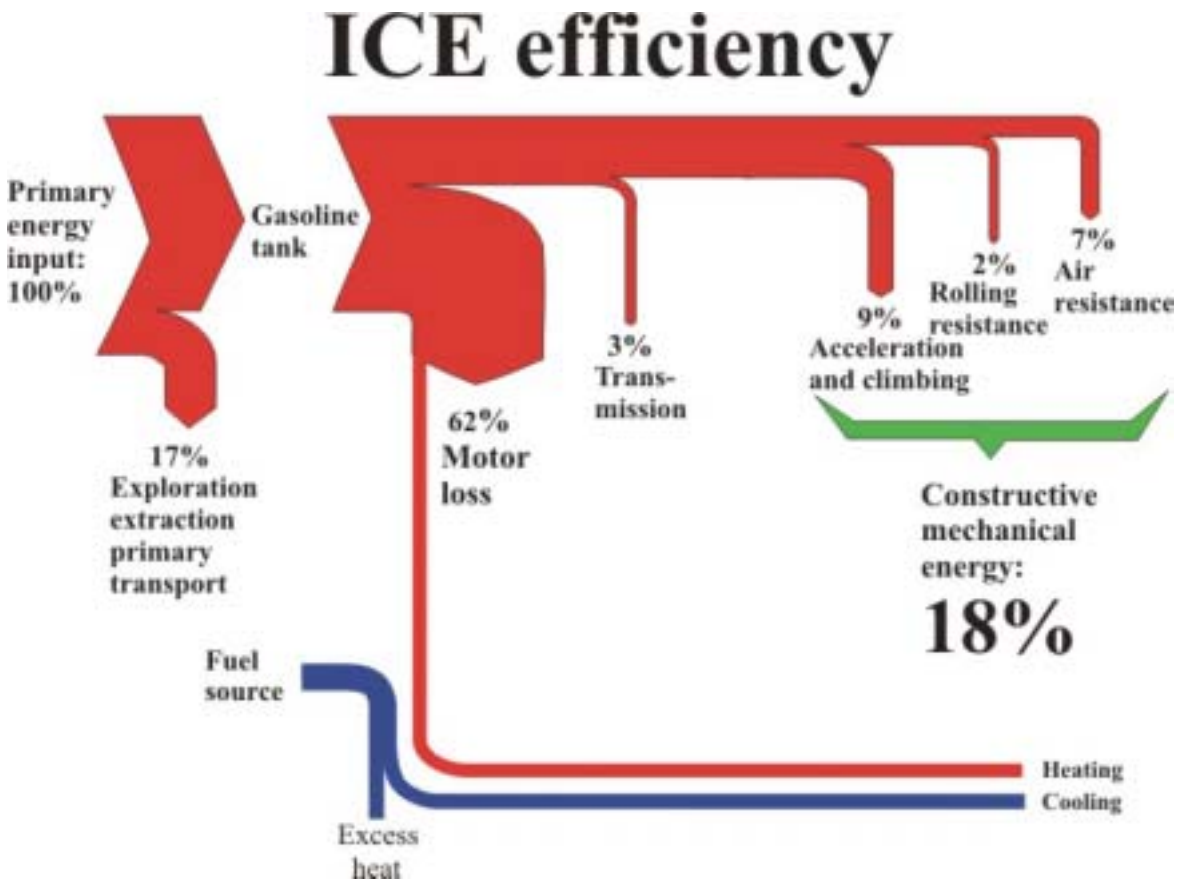
RUF

Currently, autos are quite frequently strangled in its own success. Even so, none of the traditional alternatives can compete effectively with it.

Traditional public transport is 2-3 times slower and uncomfortable and once you have bought a car it is cheaper to use it than to use public transport. There is a great need for a kind of public transport (RUF) which can compete with the car.

Why innovation 2/16

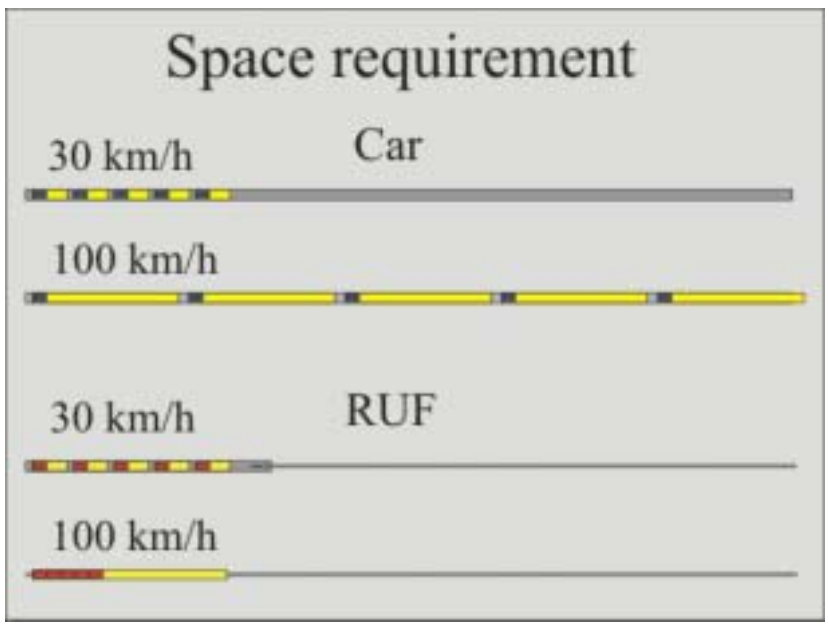
The car uses and wastes too much energy. Partly because the normal gasoline engine is very inefficient, partly because the car needs to fight a large rolling resistance and air resistance. The normal car cannot reuse its braking energy. It is lost as excess heat during braking.

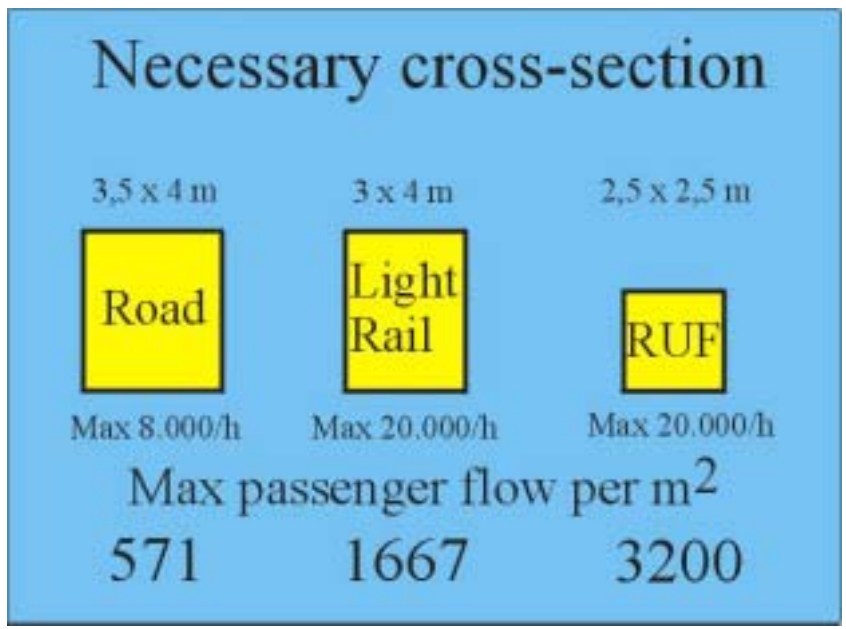


Why innovation 3/16

The car occupies too much space. The roads will have to be dimensioned to make room for the heaviest and widest vehicles (trucks).
Braking distance increases with the square of the speed. This means that capacity is reduced at high speed.

A system (RUF) with a smaller cross section and which couples the vehicles in trains can use the limited space in cities much better.





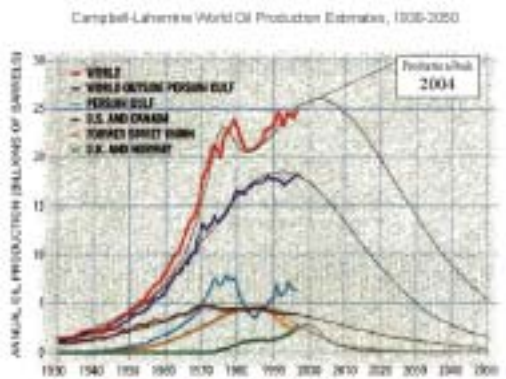
Why innovation 4/16

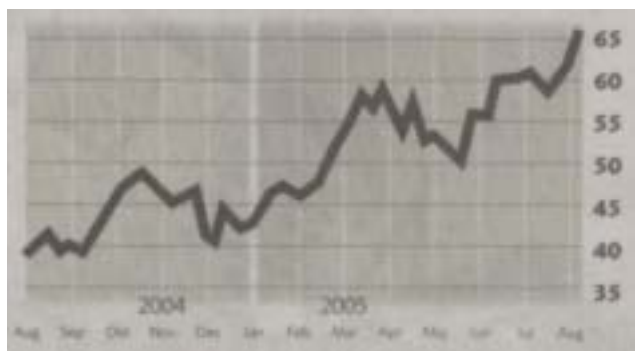
The car is dependent on oil from unstable countries. This is not the case for electric vehicles which can be supplied with energy from all kind of renewable sources. Within long the oil production can not be sustained at the present level. The price will sky rocket.
The Chinese people desire high levels of mobility and will consume huge quantities of gasoline in the future.

Ethanol requires too much land area and it represents no improvement regarding noise and pollution (except for some CO2 reductions).

Hydrogen is a very ineffecient energy carrier. Batteries are far better.

Traditional electric cars have a range problem. RUF is superior.

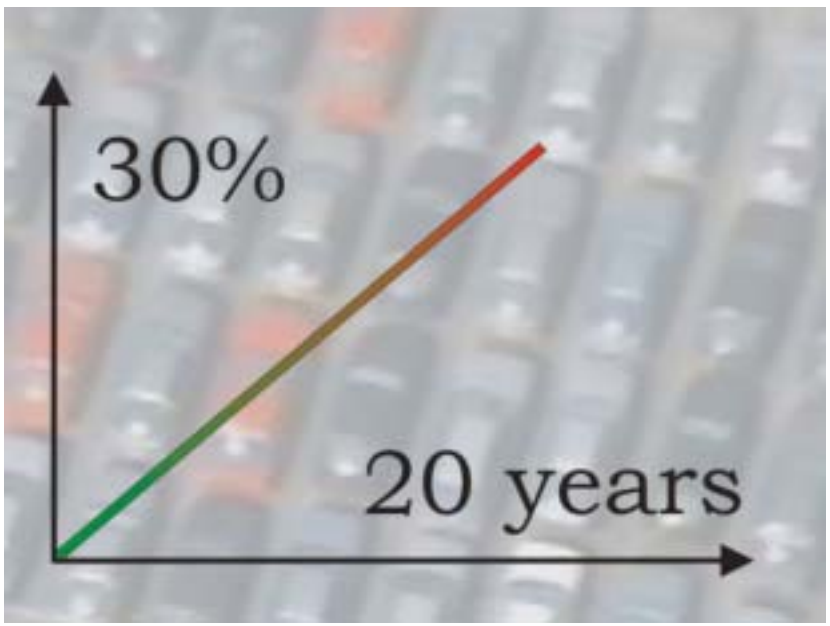


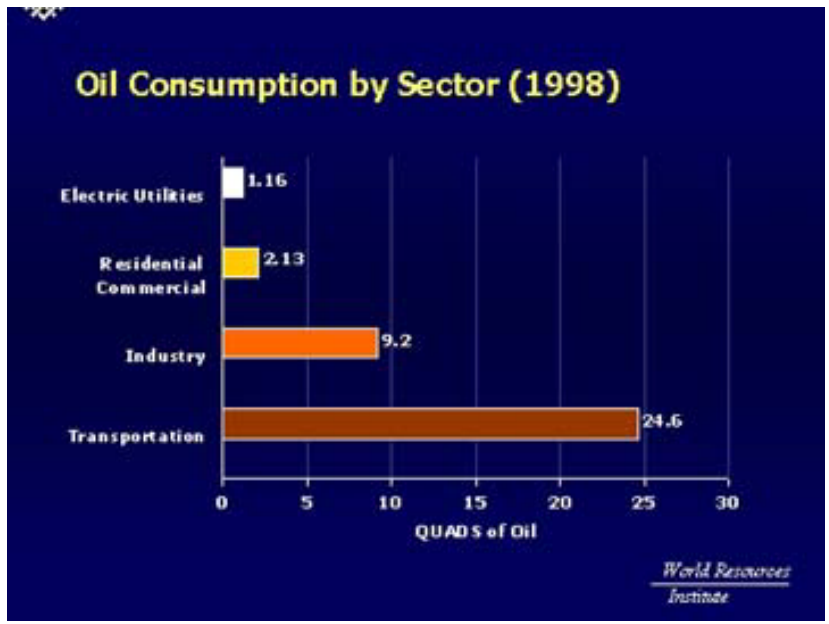


Why innovation 5/16

The share of oil consumption by the transportation sector is large and increasing.
Changes made to traditional engines take a long time to penetrate the market. It is only possible to improve the situation marginally. In the meantime the need for mobility increases very significantly.

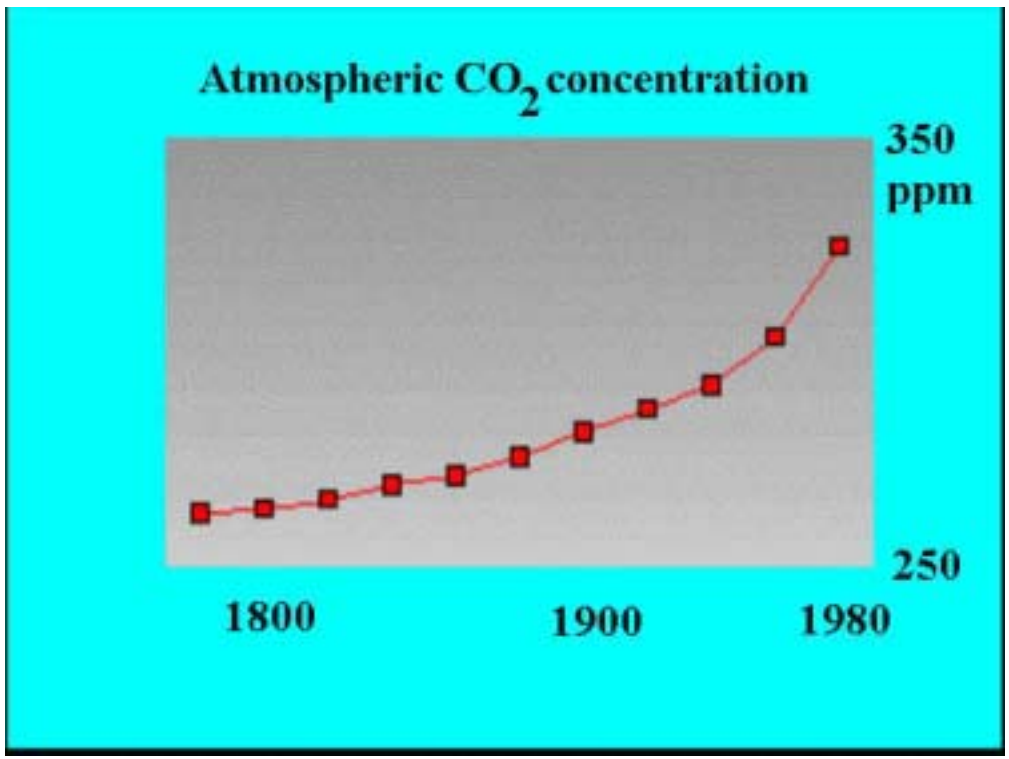
Transport ought to be driven by electricity because any improvement in the power production will have an immediate impact and benefit the environment.





Why innovation 6/16

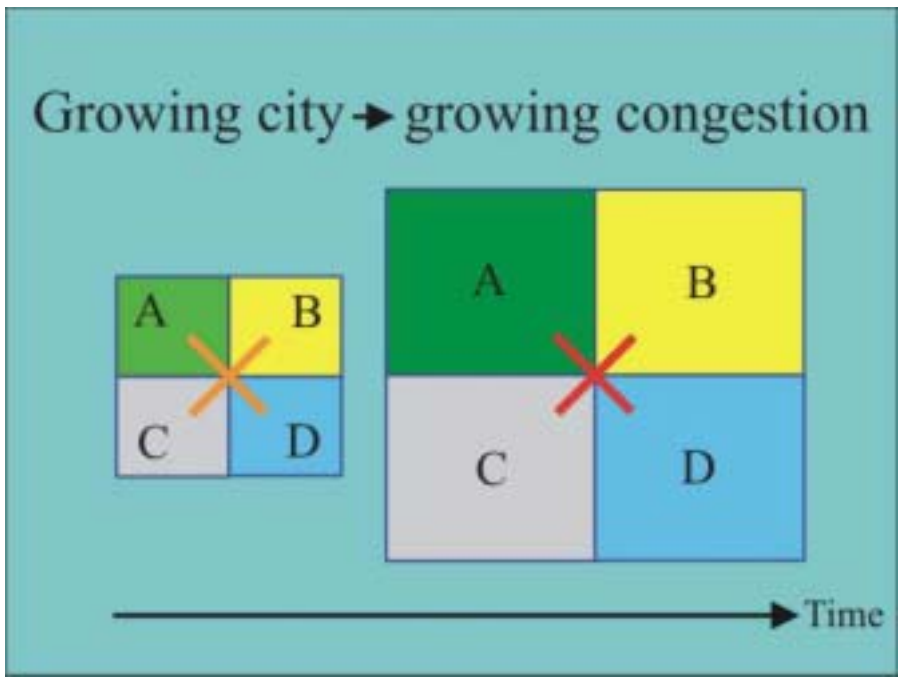
The climate problems cannot be ignored any longer. The transport sector is one of the worst polluters regarding greenhous gasses.
Electric transport can use renewable sources of all kinds and can be the core of a sustainable transport system.



Why innovation 7/16

Growing cities generate growing problems, but the trends are the same everywhere – the cities are growing. This means that the need for transport across of the city will increase. It is very difficult to expand the road network in a city since buildings cannot easily be moved.

It is far cheaper to expand the street space upwards than to go under ground. It is possible to create aesthetically acceptable solutions to elevated systems and they are popular many places around the world.



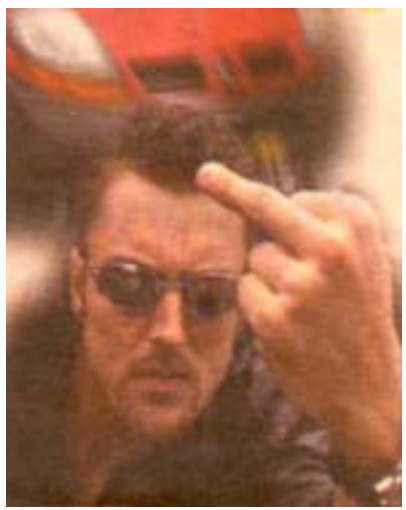
Why innovation 8/16

Traffic often destroys the social life in the city. Parked cars take away pedestrian space. The barrier effect is a big problem. Noise is unbearable.

We use too much mental energy to avoid collisions => STRESS

Automated driving should be used as much as possible. The easiest way to do this is using an elevated rail that separates the traffic from the rest of city life.

It is a big mistake to allow very heavy vehicles to move at high speed at ground level across the city. Fast moving traffic should be moved away from ground level. Elevating traffic is the cheapest solution.



Why innovation 9/16

It is very expensive to move traffic under ground.

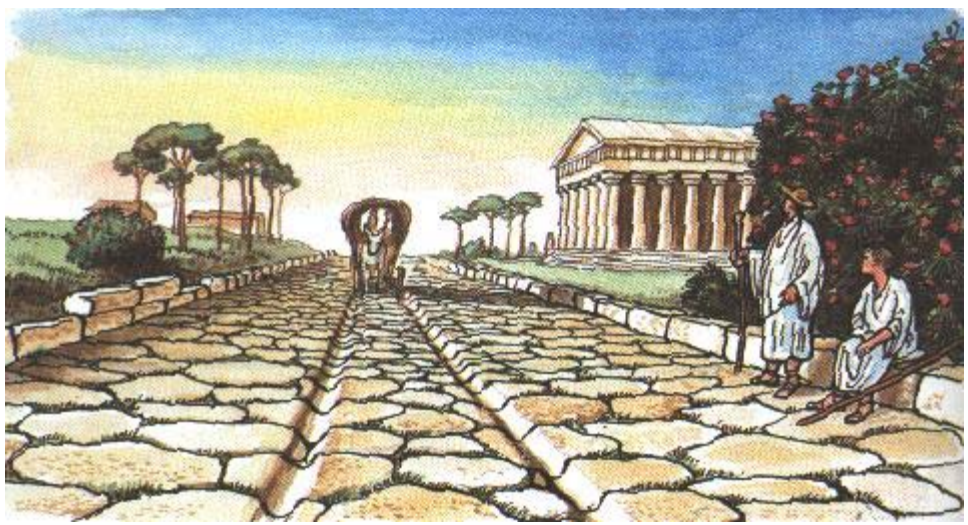
A planned new metro for Copenhagen will cost about $2 billion - a huge amount. For the same amount RUF can solve far more current and future mobility problems.

Underground stations are vulnerable to terrorist attacks especially if trains are used. Terrorists are looking for places with large concentration of people.

Elevated systems are far less expensive and less vulnerable. When they are used by many small units they are not the obvious targets for terror.

Why innovation 10/16

Basic train technology has not changed in 150 years. The track width corresponds to the width of two horses since it was the Roman chariots which defined the width of the tracks. The tracks were created when the chariot made two tracks in the muddy roads. Everybody then made vehicles with the same wheel distance. Bogie technology and switches have further limited the development of the train.
This adherence to the past has made an efficient rail technology difficult. This was not a problem when only few trains existed but today it is a very big problem. The rail concept needs to be revised fundamentally. RUF has done that.



Why innovation 11/16

The train industry still fights to improve a fundamentally flawed concept. It is amazing how far it has been possible for the engineers to push forward the technology despite a problematic starting point.

Derailments, rail breakdowns and sun kinks show that the system is under extreme pressure.

Part of the reason is due to bad maintenance but the main reason can be found in the fundamentally flawed train concept.

A new system (RUF) can avoid these errors by creating a better rail configuration with much better properties.

Why innovation 12/16

In Denmark, two human beings try to commit suicide every week by jumping in front of a train. Desperate people know that a train cannot brake fast so it is a ”safe” way to take one’s life to jump in front of a train. The speed of a normal train approaching a normal platform is high.

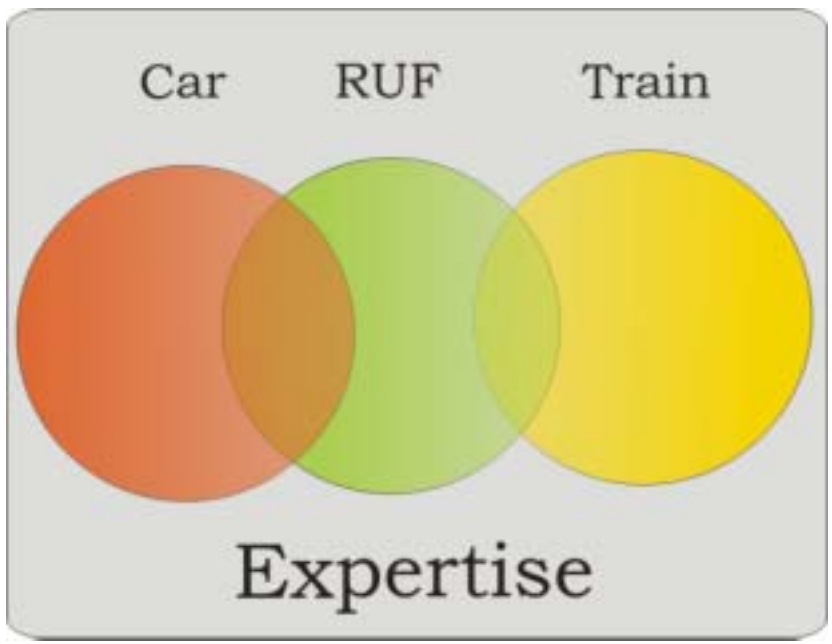
RUF stations are off-line.
This makes suicide improbable since the speed at a platform is very low.

Why innovation 13/16

In the world of traffic there are two sharply separated cultures: the car culture and the train culture. A lot of expertise has been accumulated within each culture and deviations from the basic concepts are actively supressed.

This situation makes it very difficult for anything new to emerge unless the political decision makers actively stimulate new developments.

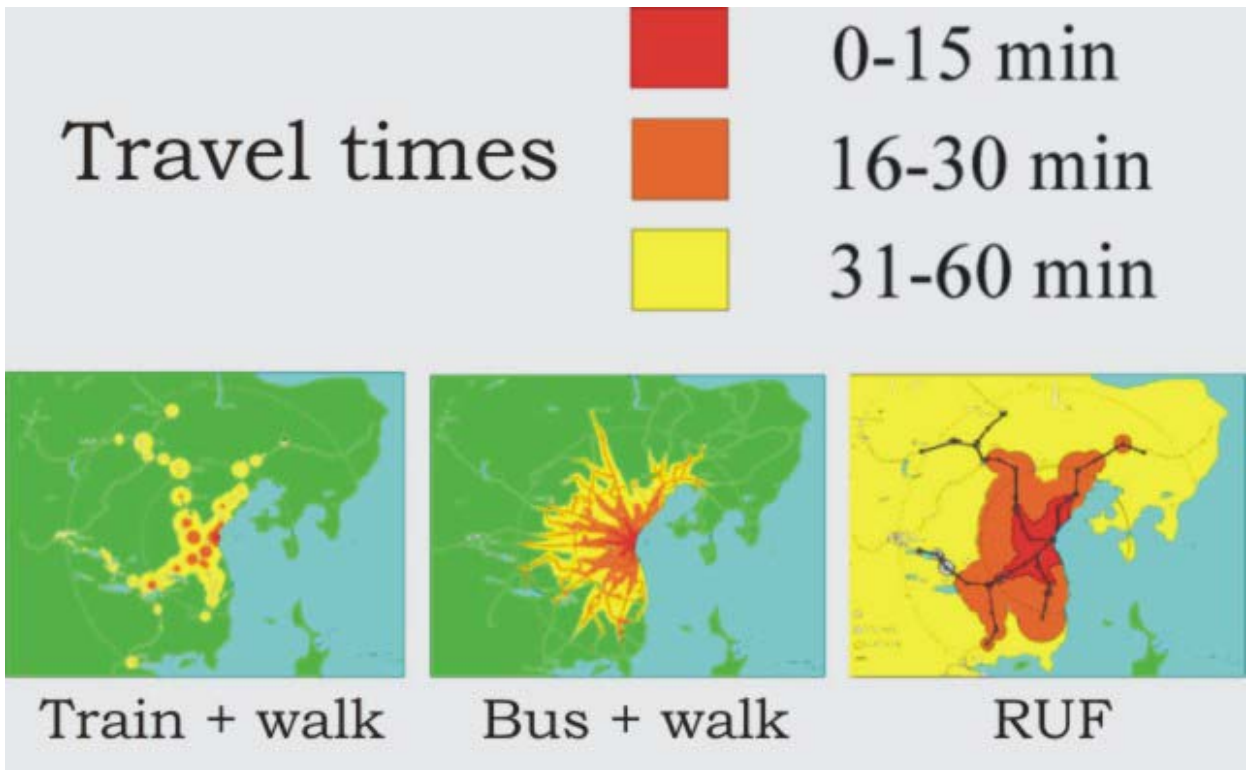
Unfortunately there is a tendency among politicians to always listen to experts in the old concepts even if these concepts have failed to solve current problems.



Why innovation 14/16

Trains and busses will always deliver long travel times since a trip includes walking to a bus stop or a station and waiting for a bus or a train which may not be on-time.

RUF has no time table and is dualmode. Consequently a door-to-door trip with RUF is much faster and attractive.

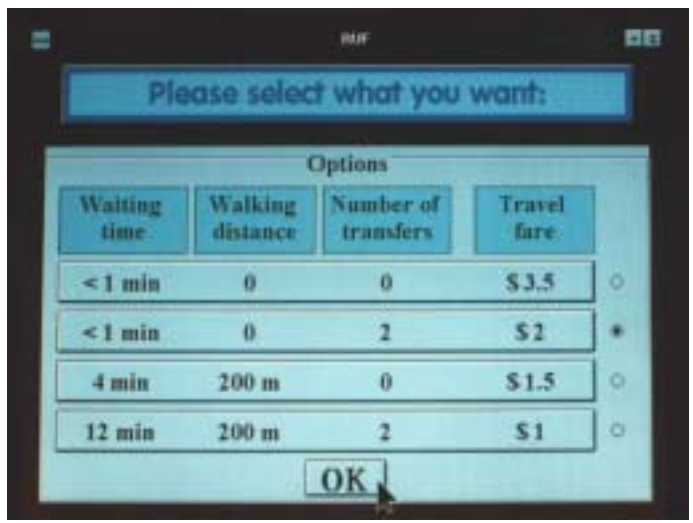


Why innovation 15/16

IT can not be used efficiently in the bus/train system.

A large bus cannot be used in a dial-a-bus service where passengers are collected at their doorstep. It is only suited for line service along wide streets.

Small units (maxi-ruf) can solve the problem efficiently. The economy is excellent since the rail part of the trip is very fast.
HotSpots and Bluetooth units can be used for ordering and payment of trips. The internet makes it possible to select between different options from your home. As a commuter you can subscribe to a pick-up service where you will be collected at the same time every day. It is easy for the operator to organize it.



Why innovation 16/16

Road pricing is widely discussed but the consequence of this tool is to limit mobility in the city. More people are forced to use alternatives which are less comfortable and slower.

The cost of driving a car has to be very high in order to convince car owners to choose traditional public transport.

The typical situation in Copenhagen today:

Public transport: 60 min 4 zones 12 kr/trip using flexcard
Car: 30 min and 2 l of gasoline at 12 km/l

The price is comparable at 6 kr/l gasoline

Travel time is counted as 50 kr/h = + 25 kr

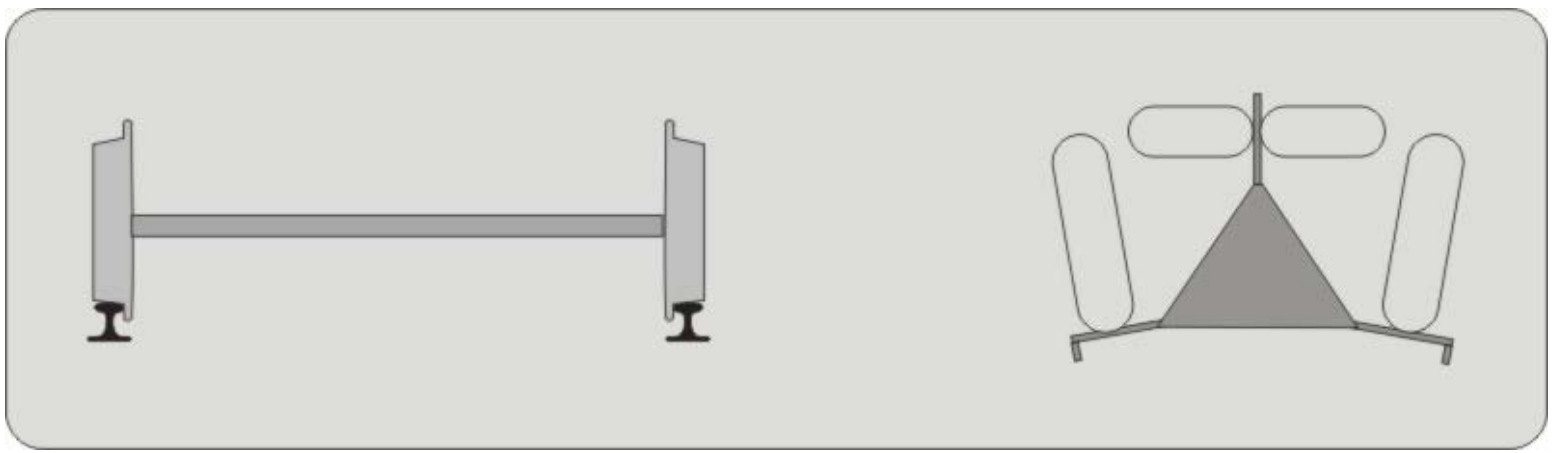
If the comfort level was equal the comparison would balance at at **18,- kr/l** gasoline or a **fee of 50 kr.** per visit to the town. (1 US$ = 6 DKr)

A system (RUF) which can make public transport as fast as the car and just as comfortable has an excellent economy.

Comparisons 1/15

Trains can derail. RUF cannot. The train is only held on the rails by a couple of small flanges on the wheels. A stone placed on the rail is enough to make the train derail. Since the center of gravity of the train is placed high above the rails, the train configuration is basically unstable.

RUF has its center of gravity placed below the top of the monorail and the drive wheels ”lock” the vehicle to the triangular monorail. A vehicle in the RUF system will not make lateral movements like the train. These movements will be prevented by the drive wheels.

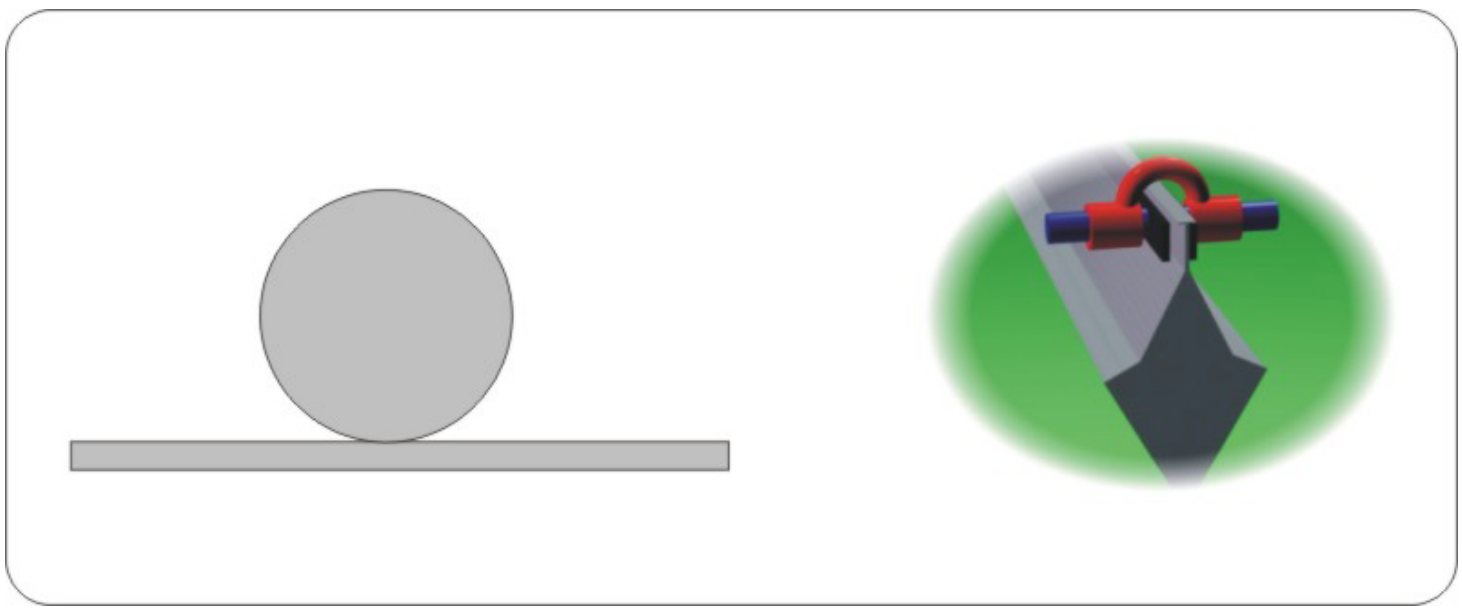


Comparisons 2/15

Trains have very poor brakes since they roll on a smooth steel rail using smooth steel wheels. Normally it is not possible to increase the friction between wheels and rail so the braking distance will be more than **500 m** from 100 km/h to 0. The friction is defined by the pressure against the rail and it cannot be adjusted.

RUF has a very efficient rail brake for emergency braking. It will press against the top of the rail until the necessary friction is obtained.

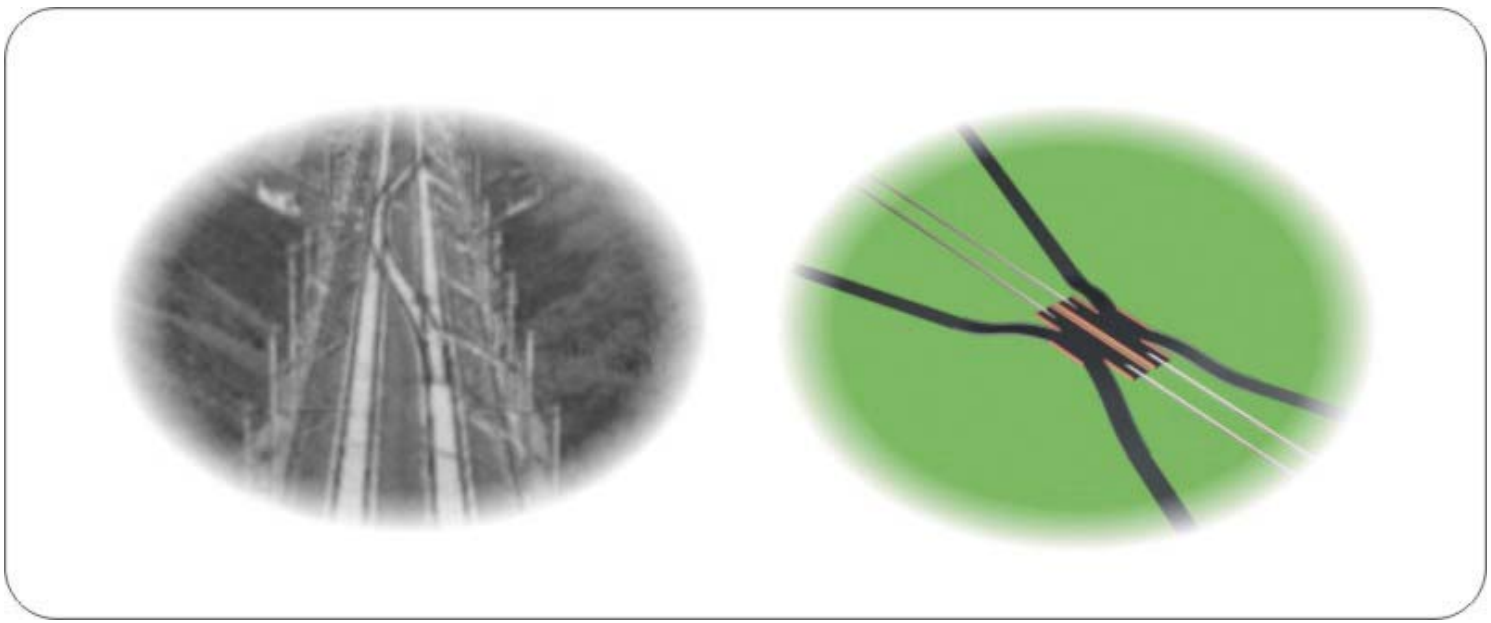
RUF can make an emergency braking from 100 km/h to 0 in **40 m** at 1 G.



Comparisons 3/15

Trains can drive in the ”wrong” direction. The structure of the network has been defined in such a way that a train can temporary switch to the opposite track in order to overtake a slower train. This possibility increases the flexibility of the train system, but it will also make the control system much more critical in order to prevent frontal collisions.

RUF, from the start, is defined as 2 completely isolated directions. It is impossible to have frontal collisions.



Comparisons 4/15

The RUF system has a lot of redundancy. This means that more than one error has to happen at the same time in order to make the system break down.

A Light Rail system is blocked if there is a power failure. The vehicles stand still as long as the power is gone. RUF can continue on battery power.

If there is a problem in a Light Rail car at a station, the whole line is blocked. A problem in a RUF vehicle at an off-line station will only affect this station.

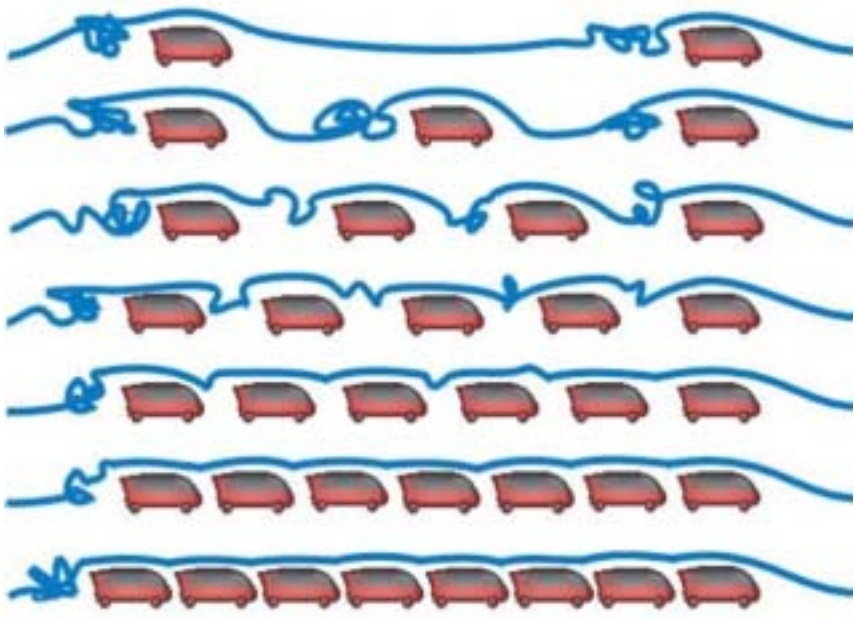
If a rail has a problem, the line is blocked.

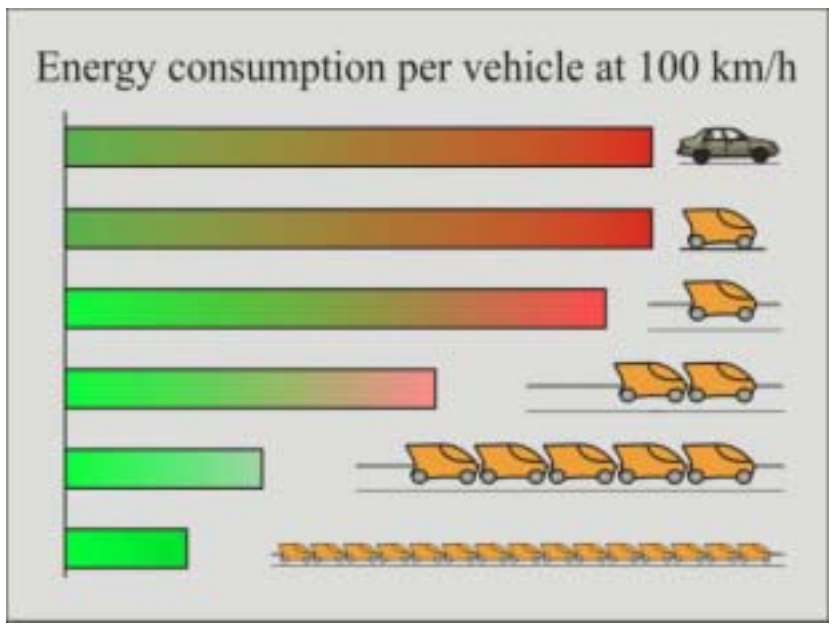
A problem on a RUF rail segment (typically 3 miles long) will prevent the vehicles on this segment to continue unaffected, but all others can continue by using the road system instead of this rail segment.
When the control system is aware of the problem, new routes will be planned to circumvent this section using the network topology.
It will cause a delay, but not stop the system.

Comparisons 5/15

Cars have to fight a large air resistance because of the turbulence created behind every vehicle at high speed.

RUF creates small trains which will minimize turbulence. The air resistance per vehicle can be lowered very much depending on the design chosen. According to calculations from the Danish Laboratory for Energy Technology at the Danish Technical University a resistance reduction to **below 1/3** can be expected in a train consisting of 10 closely coupled vehicles.



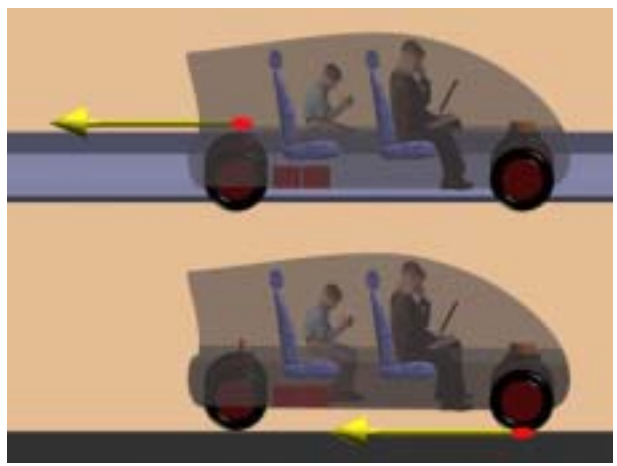


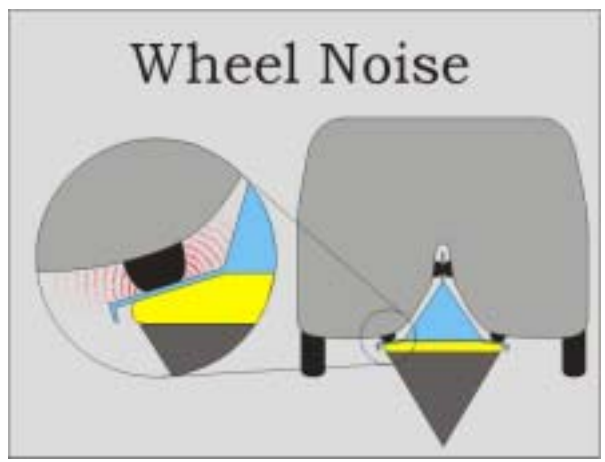
Comparisons 6/15

Cars have a large rolling resistance. It is needed all the time because steering and braking depend on it. If the friction disappears due to snow, the car might land in the ditch.

When the RUF vehicles use the monorail, rolling resistance will be reduced since braking no longer depends on the wheels carrying the vehicle and the lateral guidance is perfect via the drive wheels. The friction at the drive wheels is only large when needed for acceleration/deceleration or climbing a steep slope. Normally it is quite low.

Because of this configuration wheel noise will also be very low.





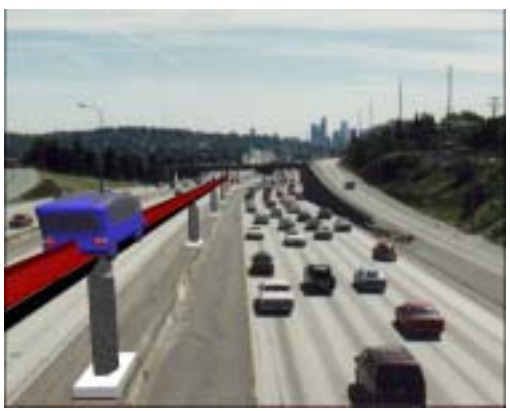
Comparisons 7/15

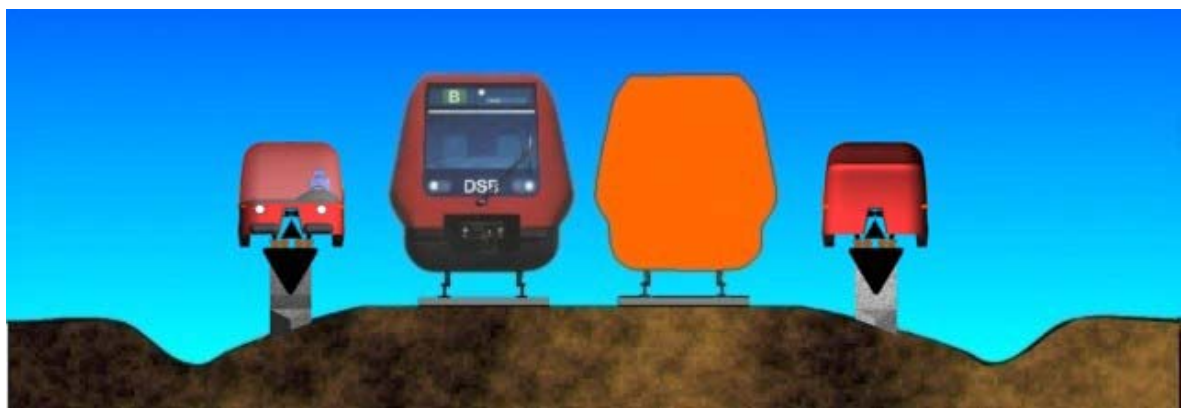
Railroad lines are very expensive to build since it is necessary to level out the ground and prepare for extreme loads. The width of the vehicles is large and they require a large amount of free height (>4 m).

As a consequence building new railroads and roads is very problematic for the surrounding society where a number of houses might have to be torn down.

RUF needs no levelling and it requires only a cross section of 2.5 x 2.5 m.

RUF can utilize existing traffic corridors better by using the space above a highway or the ditch along a railroad line. Construction time is short and easy (just holes in the ground). The normal traffic can often continue unaffected while the RUF system is built.





Comparisons 8/15

Highway junctions take up huge areas.

A RUF junction is very compact and it can be placed above a major road crossing as seen below in central Copenhagen (Jarmers plads).

An even more efficient way to implement a junction is to combine it with a major parking facility which will function as a buffer between the rail system and the road system.

The difference in height between layers in the RUF system is only 2.5 m.
In a highway system 4.5 m is required.

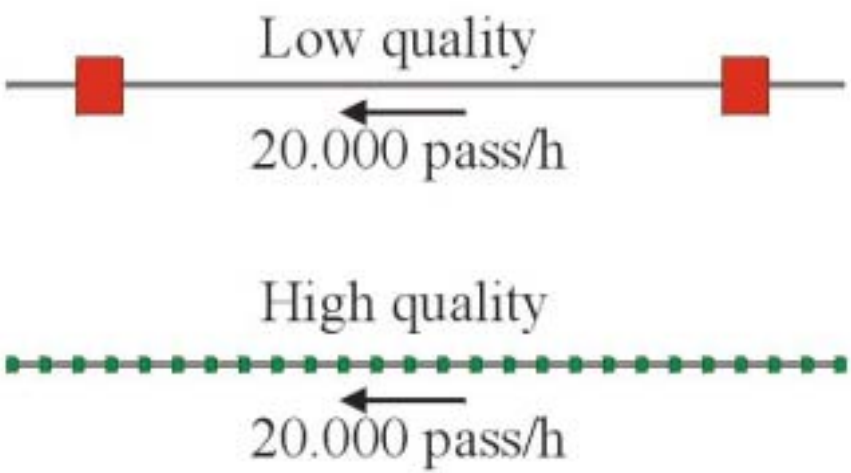


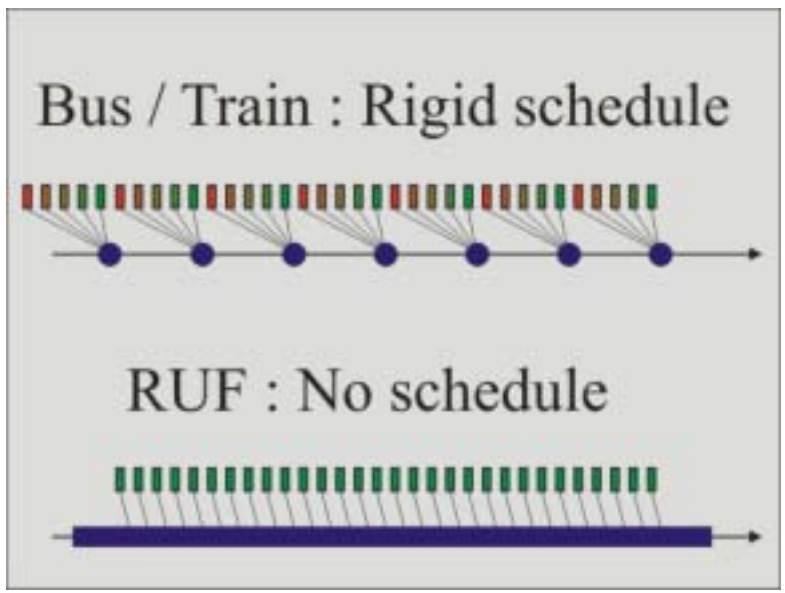
Comparisons 9/15

High capacity can be obtained in two ways:

1) Large units with few departures
2) Small units with frequent departures

The passengers prefer frequent departures since most want to be able to depart quickly when the need suddenly appears. They do not want to be limited by a time table which often does not correspond to reality.





Comparisons 10/15

The metro in Copenhagen has a high frequency (3 min) as compared with many other public transport systems.

A car driver would never accept a sign telling him that his car is going to start in two minutes !

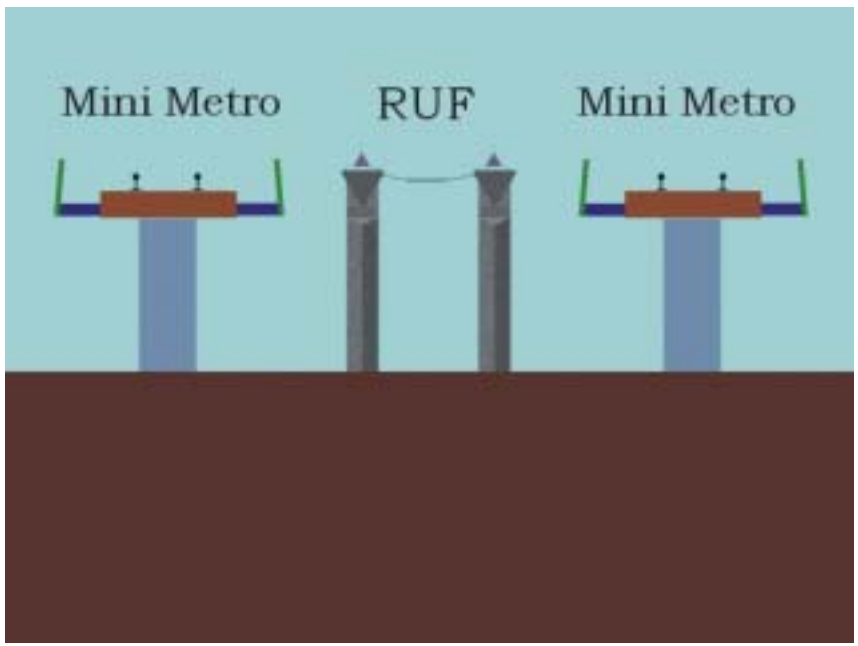
Car drivers are used to zero waiting time. In order to compete with the car a public transport system must have a similar ability.

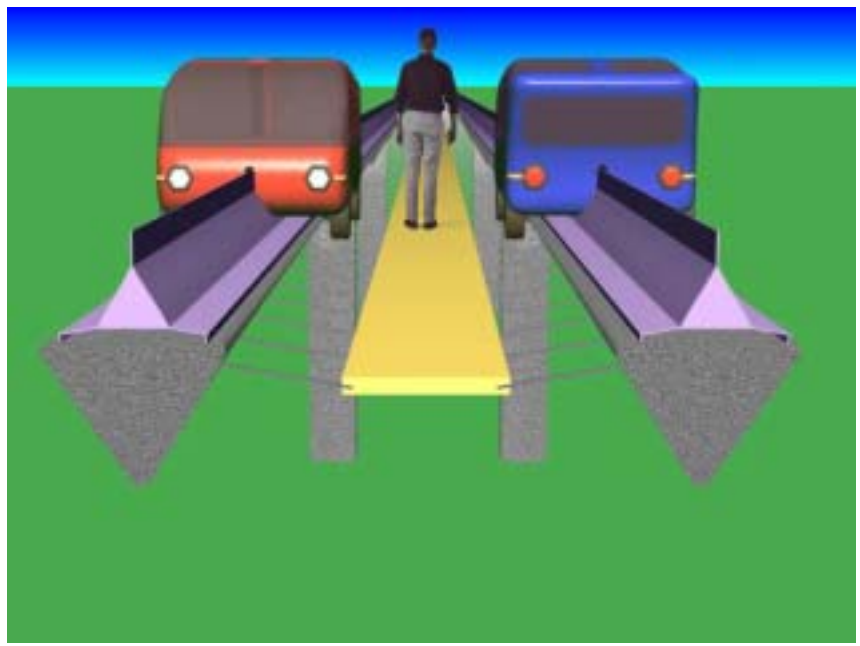
Comparisons 11/15

The so-called mini-metro in Copenhagen is running elevated part of the time. This requires a very heavy concrete structure.

In train systems and so-called Light Rail systems the vehicles normally weigh approx. 1,000 kg per meter.

RUF is far more slender since the vehicles are much lighter (500 kg/m).

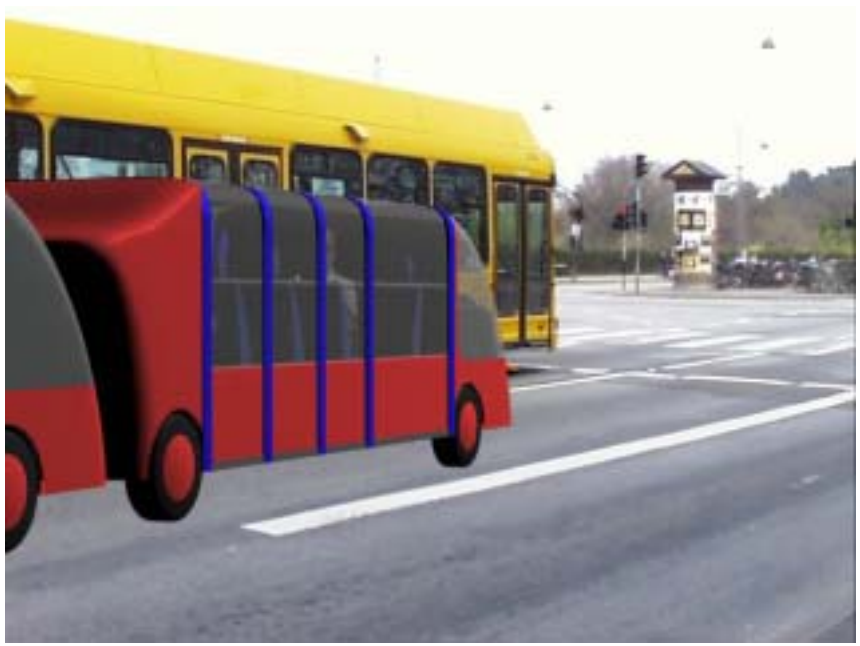




Comparisons 12/15

A traditional bus is big, heavy, noisy and polluting. It is large in part because it has room for standing passengers and there is a central gangway in order to distribute the passengers to fill up empty seats.

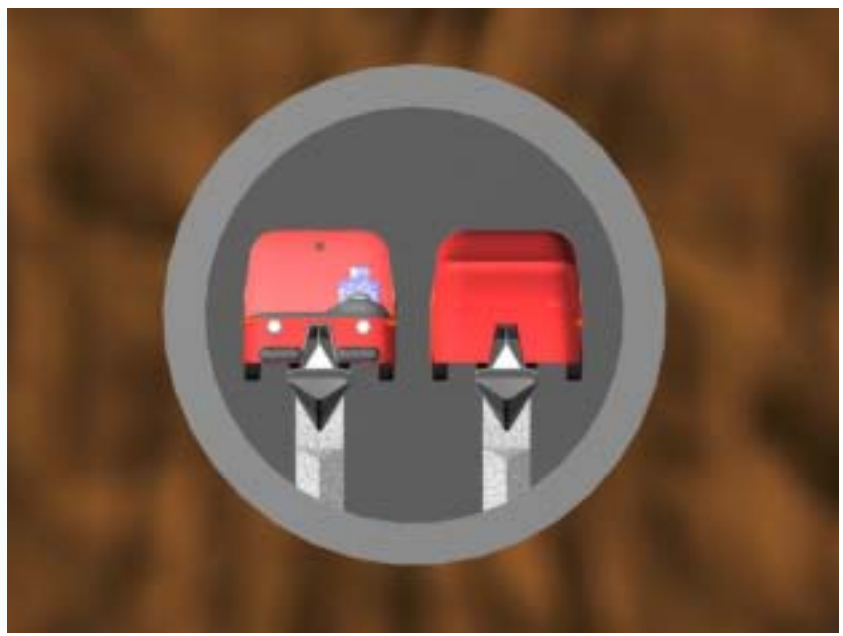
A maxi-ruf is a small, light weight, quiet and pollution free vehicle. The doors open sideways and there is a door for every seat. This way the space is used very efficiently and the weight is low. Up to 3 maxi-rufs can be coupled together and driven by one chauffeur.



Comparisons 13/15

The metro takes up a lot of space because passengers can stand up inside it. It is a traditional train concept.

A maxi-ruf is small since all passengers are seated. This means that one tunnel tube can contain 2 or 3 lines so only one tunnel is required. If 3 lines are used, the third rail can be used to supply more capacity in one direction. This is often relevant for rush hour traffic.



Comparisons 14/15

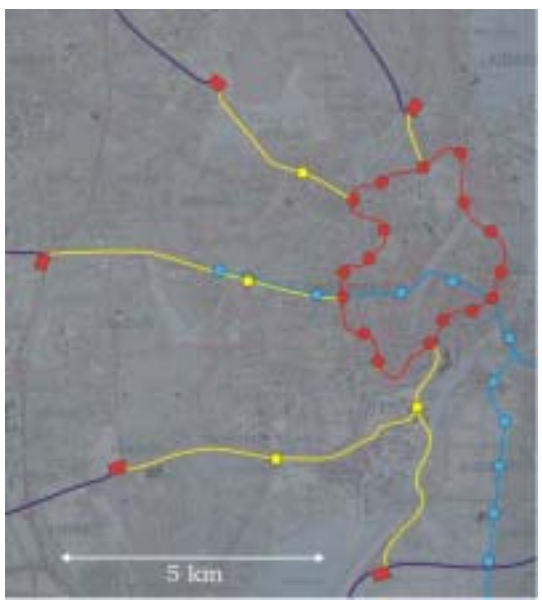
The mini-metro stations are spectacular but deep, inconvenient and vulnerable to terrorist threats. It takes long time for elderly passengers to get down to the platform. For a short trip a bus would be faster.

RUF-metro stations can be placed at the surface. This is possible because of the special drive system in RUF.
It is possible to create a perfect connection to the traditional train system since a RUF metro can share the platform with the train system.

Comparisons 15/15

The proposed ring metro will cost a lot of money but it does not address the real traffic problems in Copenhagen. Many car commuters cannot make use of the ring metro.

A RUF ring metro could, for the same amount of money, solve far more traffic problems via attractive Park and Ride facilities at the end of the highways.
The car drivers can remain seated in their car while they wait a short time for the maxi-ruf to arrive. They only need to walk 2-3 m to their seat. The parking lot need not be placed adjacent to a station where the land is expensive. It can be placed many places at a distance from the rail system since RUF is dualmode capable.



RUF problems

RUF has been developed through 16 years of intense communication between the inventor (PRJ) and experts from all over the world.

RUF has been presented at a large number of international conferences and the reception has been positive but mostly passive.

PRJ has experienced active resistance from Light Rail supporters and the train industry in USA. The resistance has not shown itself via arguments but by framing the discussion so that RUF was precluded from consideration.

PRJ has met with a number of important players in the transportation field: General Motors in Detroit, National Automated Highway System Consortium, Metropolitan Transportation Authorities in Los Angeles, NedCar in Holland, Parsons & Brinckerhoff in Los Angeles, Orange County Business Council, and more.

Transport is a very complex issue and one should expect problems when trying to redefine the transport system.

Next, I have identified some problems and their possible solutions.

RUF problems 1/7

RUF is unproven.
But:
”Proof of concept” has been performed at the Copenhagen University College of Engineering. More than 200 students have participated with solutions to technical details in the concept.

Many experts support RUF.

Several politicians want to see a demonstration of RUF.

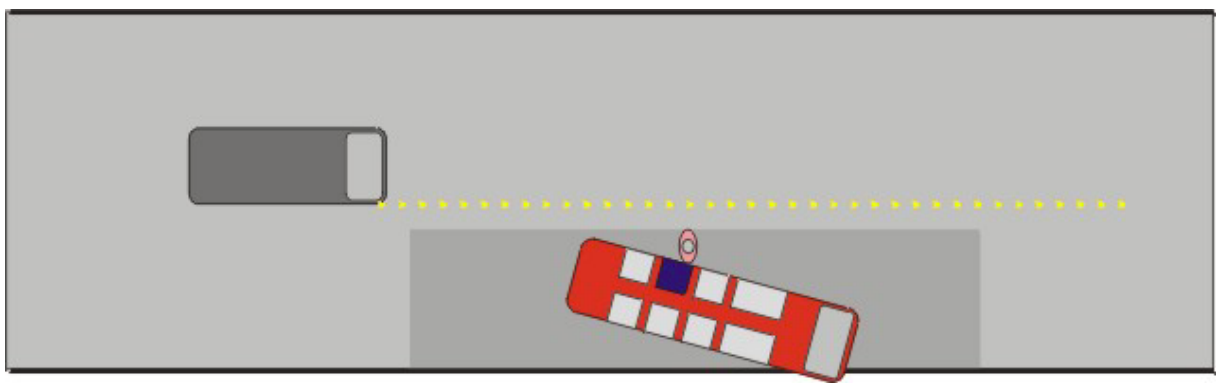
RUF problems 2/7

The RUF bus (maxi-ruf) has doors on both sides

But:
It can be solved by parking at an angle. Since a maxi-ruf is only 2 m wide it will be able to make a large angle at a normal bus stop.

Part of the problem can also be solved by the operator. Passengers can be given a seat dependent on where they are entering and leaving the maxi-ruf.
It is no problem at a station, in narrow streets or on a quiet street in the suburbs.

Cars have always had doors in both sides. The door of the maxi-ruf takes up far less space than a car door and it isn't dangerous for bicyclists.

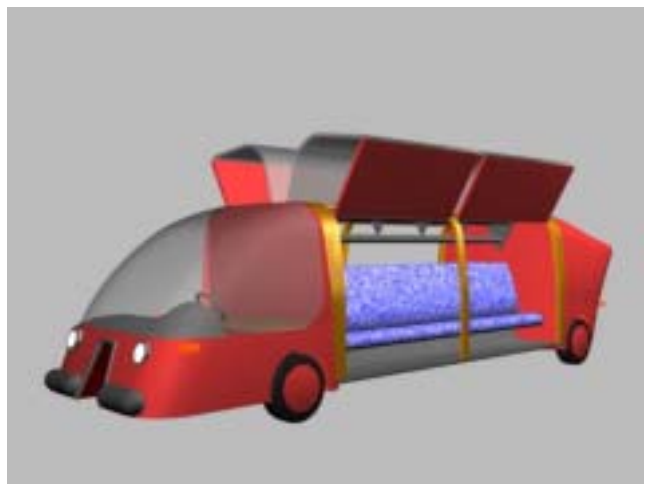


RUF problems 3/7

RUF has only a small peak capacity per vehicle

But:
It isn't useful to have a large peak capacity if the comfort level is low. It is all about attracting car drivers to public transport and they are used to a high comfort level. Maxi-ruf has room for 10 seated passengers. Up to 3 maxi-rufs can be coupled together too form an articulated bus driven in the streets by one chauffeur. On the rail network more vehicles can be coupled together.

A Mega-ruf has room for 20 seated passengers sitting on a bench.
Frequent departures can produce an amazingly high capacity.



RUF problems 4/7

Elevated rail will disturb the neighbors living on second floor.

But:
RUF lines are **not** placed in the small streets. Only major traffic corridors are used.

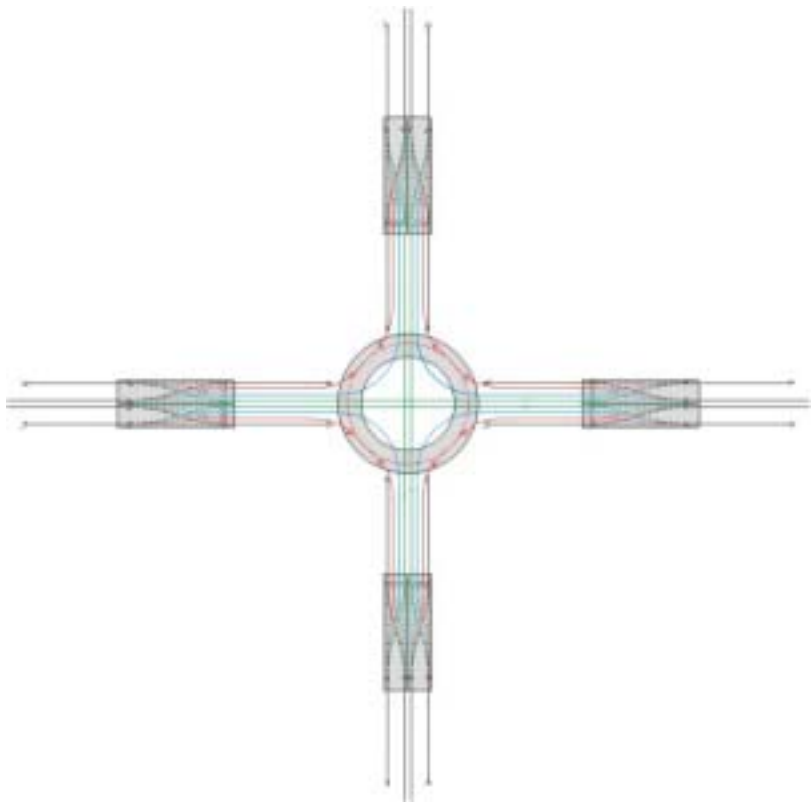
In cities like Copenhagen many people live in such a way that their sitting rooms are placed very close to the sidewalk so that people can stand still and look directly into the rooms. RUF vehicles pass by at a typical distance of 10 m and at high speed.

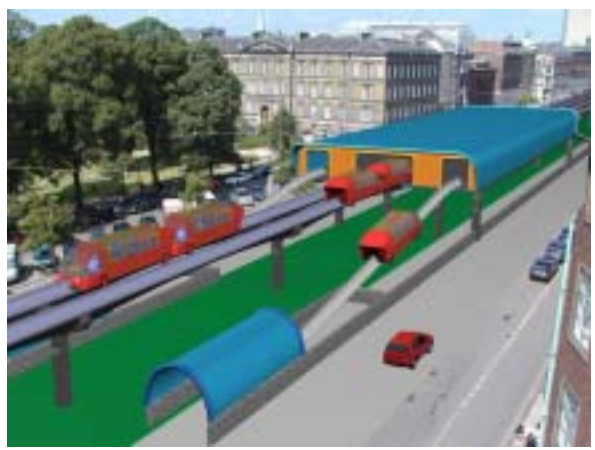
The view from a double-decker bus is more intrusive.

RUF problems 5/7

The junctions take up space in the city

But:
A central roundabout and 4 ”satellites” takes up minimum space and can be placed above existing wide streets.



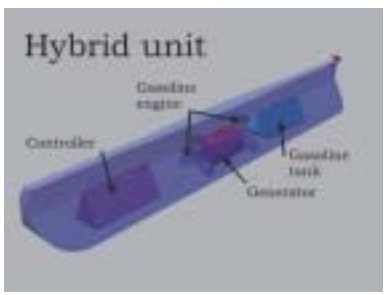


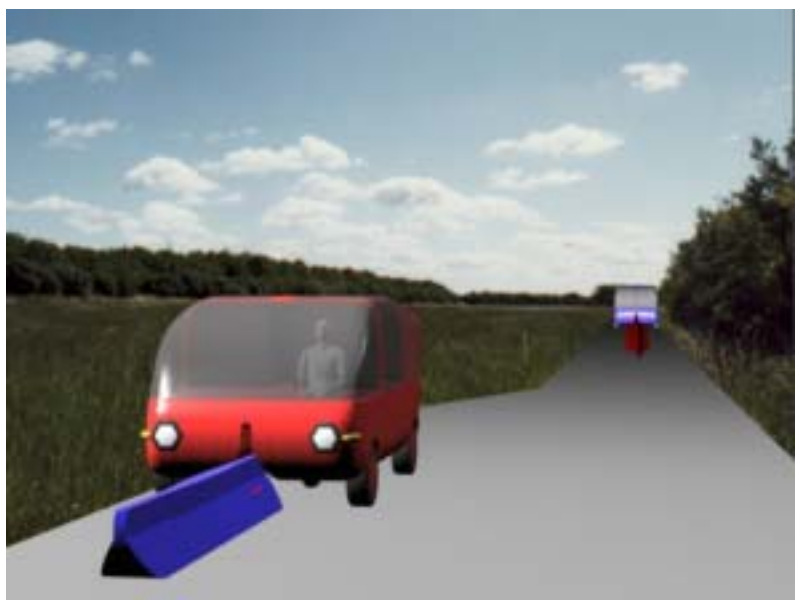
RUF problems 6/7

The range of the ruf (50 km) is too small

But:
The hybrid unit can extend this range so the ruf will function as any other car.

Nothing prevents the car manufacturers from producing rufs which have hybrid capabilities.





RUF problems 7/7

The ruf design is limited by the RUF standard

But:

The RUF standard still allows a lot of variations in the vehicle’s exterior.

Inside, the ruf the designers can place all kind of electronic ”gadgets” which can be used safely on the rail network.



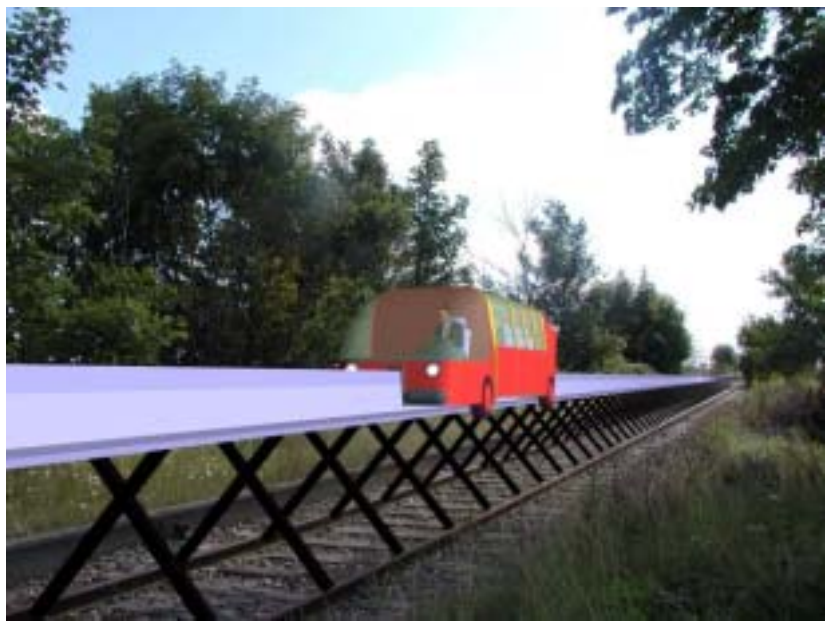


RUF strategy 1/8

Test track placed close to Naestved (Denmark)

2 km RUF rail + maxi-ruf has been planned.
Cost $3-7million. It has local political backing.

Mega-ruf demo for the Minister of Transport in India is necessary to initiate a 100 km line in Calcutta.

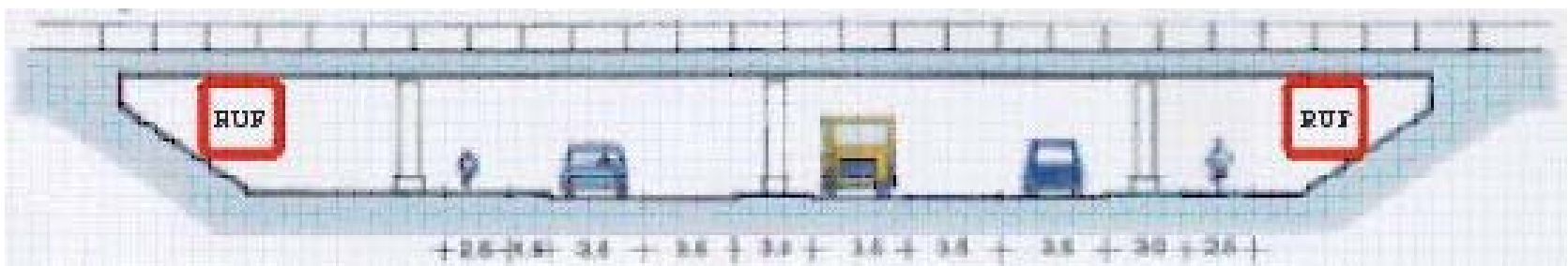


RUF strategy 2/8

Ring 3 (Lyngby to Glostrup in Copenhagen)

NIRAS + RUF International has calculated an estimated cost of the line to be **1.5 billion. DKr.** (the cheapest traditional solution = 1.7 billion.).

There is a political decision that some kind of rail connection has to be established as a connector line between train stations.



RUF strategy 3/8

Copenhagen – Ringsted (65 km)

The transport of people between Copenhagen and Ringsted can be offered at a far lower price than using a traditional train line.

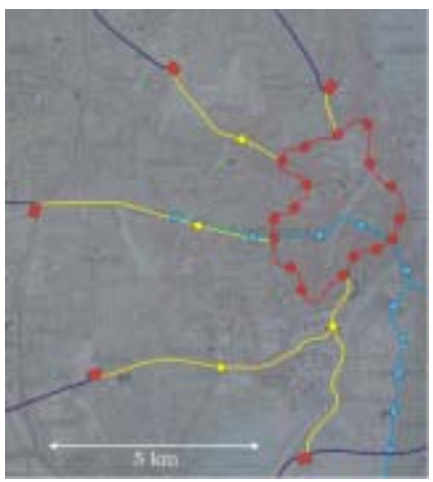
It will be an advantage for the rail transport of heavy goods to remove some of the passenger trains from the rail line. This is possible if a RUF system takes care of the commuters between Ringsted and Copenhagen.

Commuters can be collected at their home and be brought very fast to the center of Copenhagen or, if they pay for it, directly to the front door of their office. No parking problems, no transfer and faster than by car today.

RUF strategy 4/8

Ringmetro by RUF

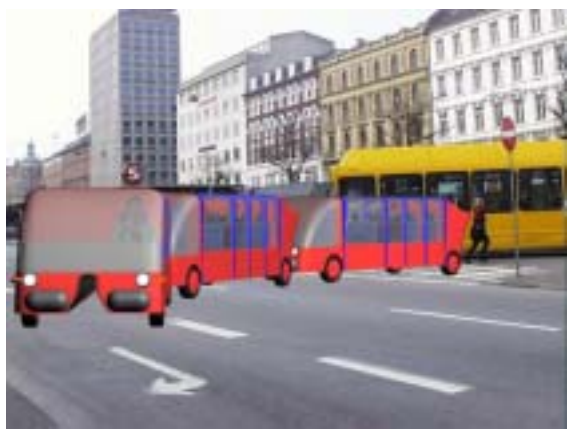
Only one tube is needed. Connection from Park and Ride facilities directly to the central part of the city. Stations at the surface are possible.



RUF strategy 5/8

The new development area at Holmen can be served by RUF

Using the ability for RUF vehicles to climb steep grades (20%) it is possible via a bridge to connect Holmen and the central Copenhagen at Nyhavn. The new opera would get an attractive connection via public transport.



RUF strategy 6/8

The Greater Copenhagen area can be covered by a RUF network.
320 km double monorail at 24 million kr/km
57 junctions at 100 million kr
5,000 maxi-ruf at 500,000.- kr
25,000 public ruf at 200,000.- kr
5,000 P-rails at 200,000.- kr
250,000 Bluetooth at 500.- kr

Total cost = 22 billion DKr
(approx. $3.5 billion)

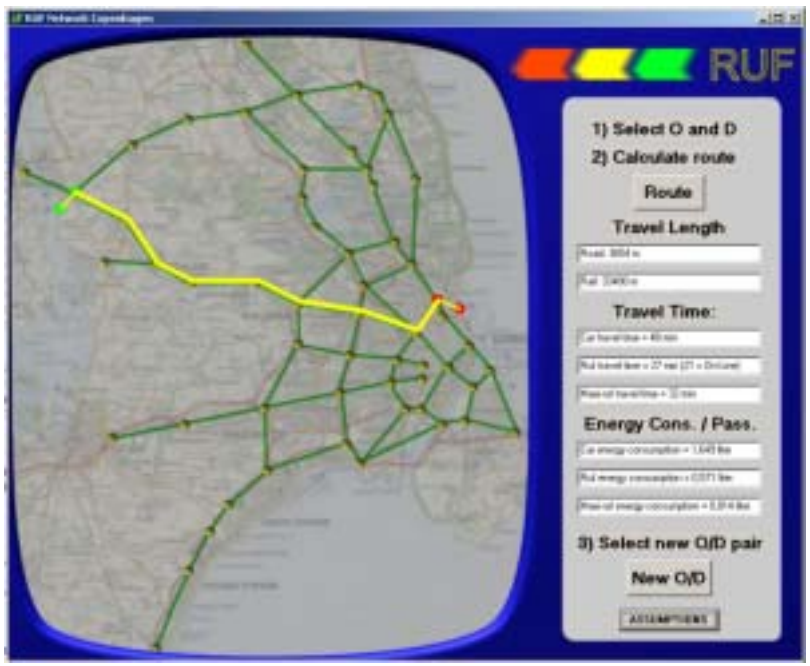
EU CyberMove CBA calculation:
Socioeconomic:
IRR(30) = 29%

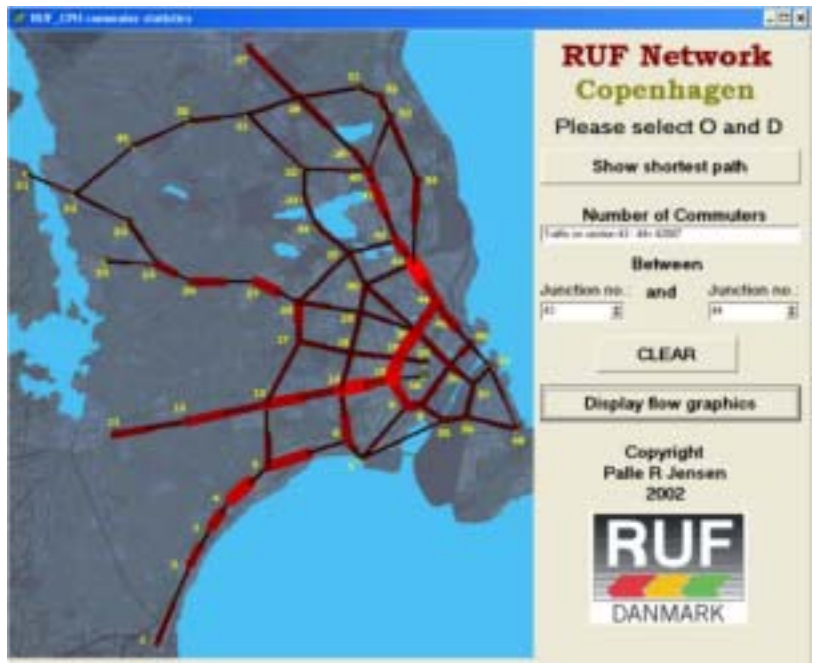
See: www.ruf.dk/rufcba.doc
and www.ruf.dk/rufcba.xls

RUF strategy 7/8

RUF network properties:

Travel time typically reduced by 25% (car vs. ruf)
Energy consumption typically reduced to 1/3 (car vs. ruf)
Energy consumption typically reduced to 1/6 (car vs. maxi-ruf)
Maxi-ruf is faster than by car when using the door-to-door option
The number of people killed in highway traffic would be reduced (from 18 per year)

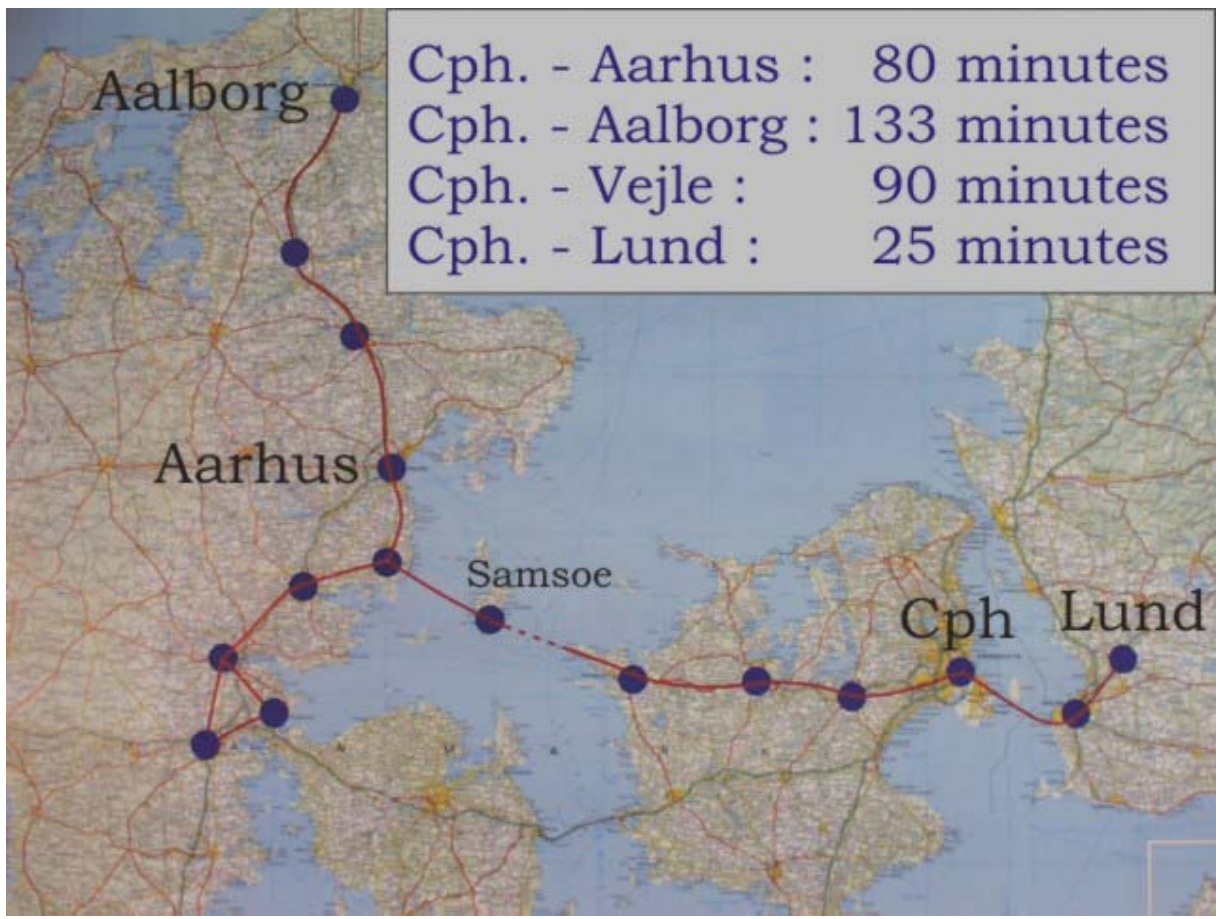


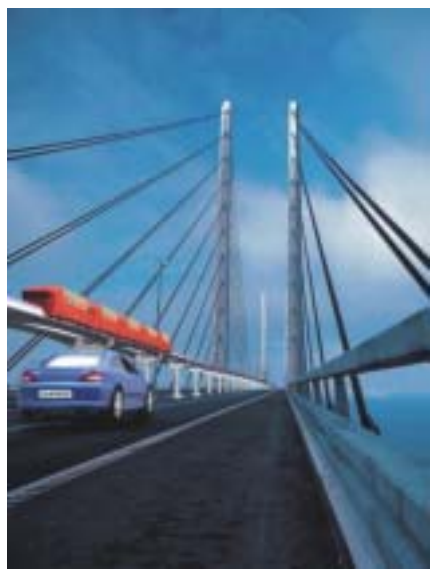


RUF strategy 8/8

RUF cross country connection via the island of Samsoe

Samsoe would be a very attractive area since it would be possible to commute to both sides.





RUF future plans

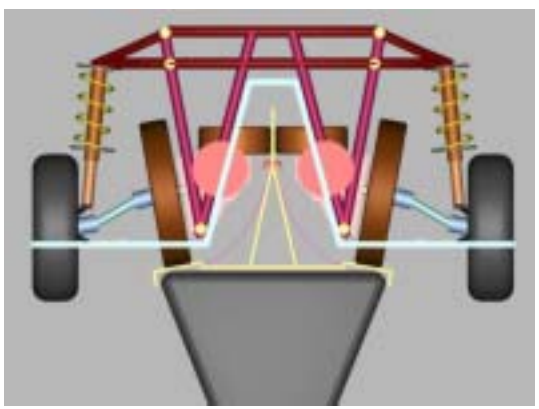
Platform for ruf no. 2 is under construction with funding from USA

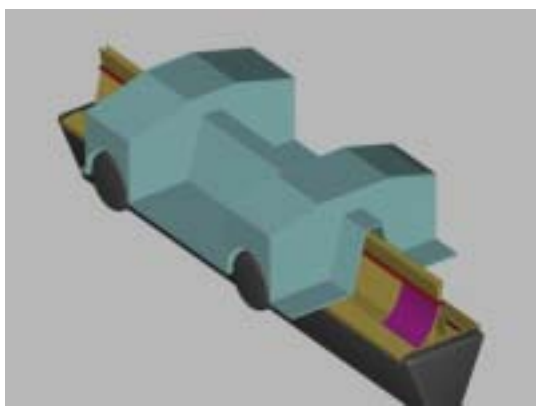
A 2 km long test track at Naestved will be realized. The funding could come from the Danish State 2007 budget.

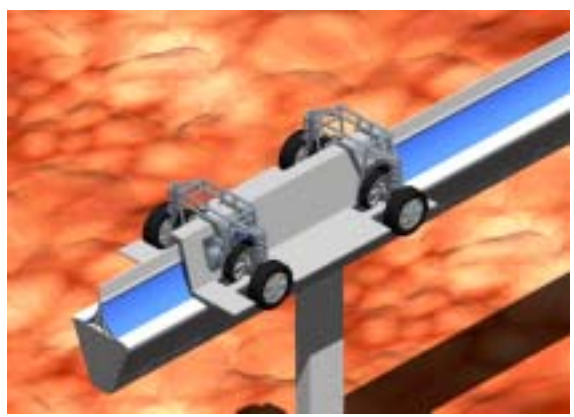
The $500 mill. RUF project in India (Calcutta) will be activated.
It will create a license income to RUF of 1% per year for 30 years.

Cooperation with Institute for Sustainable Transportation in Sweden is expanded. It relates to the Swedish oil commission.

Cooperation with CEETI, Center for Energy, Environment and Transportation Innovation in Texas is expanded.







RUF political backing

Flemming Damgaard Larsen (V)
Chairman of the Traffic Committee in the Danish Parliament:

”RUF has the potential to become a solution to many of the traffic problems: Capacity problems, Oil dependence, Climate problems, Safety problems plus the problem of creating attractive Public Transport.”

”I therefore fully support the efforts to perform a comprehensive testing of RUF.”

Martin Lidegaard (RV)
Member of the Traffic Committee in the Danish Parliament :

”I will try to get RUF funded from the Danish State budget in 2007”

Other supporters:

Walter Christophersen (DF), Søren Pind (V), Poul Andersen (S) all members of the Traffic Committee in the Danish Parliament

Conclusions:

RUF is relevant to global transport problems.

Denmark has a very strong position regarding dualmode

RUF can be tested at minimum cost

RUF is built from modules which means that costs can be relatively well-defined (so long as materials costs are stable).

RUF can both solve capacity, energy, climate, safety and environmental problems.

Follow the development via www.ruf.dk

Palle R Jensen, prj@ruf.dk

RUF International