The RUF system

Questions and Answers

Palle R Jensen
Inventor of RUF

RUF International
Robert Jacobsens Vej 78.4.2
2300 Copenhagen S
Denmark

Mobile (+45) 4078 7655
E-mail PRJ@RUF.DK
Web WWW.RUF.DK

RUF

Questions and Answers

The RUF System

What is the RUF System ?

The Inventor of the RUF System

The RUF system was invented by Electronic Engineer Palle R. Jensen and has been developing since 1988. Four patents have been granted and there are more to follow. Palle R. Jensen is a professional inventor who has worked previously with electronic/mechanical inventions such as ultrasound scanners, fingerprinting readers, laser scanners, etc. The inventions have been awarded at many international competitions for inventors.

RUF = Rapid Urban Flexible

The name RUF originates from the headline of the first article on the system first published in 1999 in Ingeniøren, a magazine for engineers. The headline read "Afsted i en RUF" which in Danish means "away in a great hurry".
After 1993 RUF was introduced to an international audience via the Internet. Again and again the question was asked: "What does RUF stand for". A brainstorming determined that Rapid Urban Flexible is the best interpretation of a rapid and flexible urban traffic system.

Dual-Mode systems

Technically speaking RUF is a so-called dual-mode system meaning that the vehicles can travel in two different ways: As a car or as a train. As early as 1970 there were people at American universities who realized it would be a great idea, but no concrete plans were made. At that time computer engineering was a costly affair so that the monitoring of the automatic part would be extremely cost-heavy. The principle was therefore abandoned until the RUF was invented.

RUF International

RUF®
INTERNATIONAL

In 1994 a deal was made with the engineering company, Mogens Balslev A/S, to form a consortium known as RUF International. Its objective is to develop the system and to define a RUF standard, for which car manufacturers can take out license and produce RUF cars for the system. From 2003 RUF International is owned 100% by Palle R Jensen.

Test track for RUF

In 1998 subsidies were received from the Ministry of Energy, the Ministry of Environment and the Ministry of Education to build a test track for RUF.
A number of Danish enterprises: Siemens, NCC, Semco, NESA and many more supported the development with sponsorships.

RUF
Questions and Answers

The ruf car

How does the ruf function ?

Size

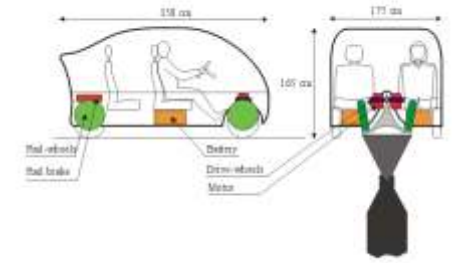
The ruf can be manufactured in different sizes.
A typical ruf will seat 4 persons. It is approx. 180 cm wide, 160 cm high and 3.5 m long. It is equipped with small batteries, which allows a range of at least 50 km on batteries. It may be equipped with a small petrol engine (hybrid car). It must be capable of driving at least 80 km/h on ordinary roads. On rail the same driving power will allow a top speed of up to 200 km/h.

The Rail Channel

Right through the ruf runs a triangular shaped channel, which is used for "riding" on the triangular shaped monorail. Inside the cabin it acts like an armrest without interfering much. During rail travel it is comforting to know that the rail with certainty keeps the ruf on the right course. Between the seats on top of the channel a child's seat can be placed.

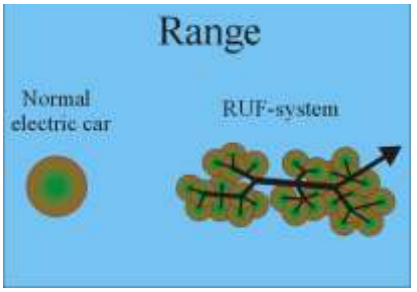
The Motive Power System

The ruf is driven forward by two electric motors, one on each side of the rail to avoid a differential. There is no gearbox. A ruf will accelerate quite evenly from standstill to top speed. An electric motor has a good tractive force even when running slowly. It does not use energy when stopping for a red light. By placing the motors directly in the driving wheel at the top of the rail the tractive force is returned to the rail without any loss of transmission.



Power Supply

The ruf normally run a few kilometres only on the ordinary road network before reaching the rail system. The built-in small batteries supply the ruf with power on the road. On the rails it is supplied with power from the rail, both for propulsion and for charging of batteries. A future expansion of the rail network with a mesh width of 5 x 5 km will result in an unlimited range of the ruf.



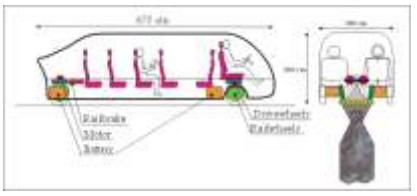
The Hybrid Unit

Until the network covers the entire area fitting it with a hybrid unit can expand the range of the ruf. The unit can be coupled to the ruf by filling the gap below the ruf when it is not riding on the rail.
In the future a fuel cell can be used.

The maxi-ruf

How does a maxi-ruf function ?

Size
The maxi-ruf is approx. 2 m wide, 2 m high and 7 m long. It seats 10 people as well as a driver. Each passenger has his own seat and there is no standing room. Up to three maxi-ruf's can be coupled together as an articulated bus and driven by one driver.



The Rail Channel
Right through the middle of the maxi-ruf runs the channel, which can accommodate the rail. Since the rail can curve corresponding to a curving radius of 26 m the central part of the channel will be a little wider than the rest. This means that the front and rear seats are wide thereby making it possible to place a wheel chair or a baby carriage between the two front seats at each side.

The Doors
The maxi-ruf has a door for each seat, which facilitates entry and exit. The doors are divided into two parts and hinged at the top.

Door-to-door Public Transport
A maxi-ruf can be used in a manner, which enables door-to-door public transport. By means of dynamic route planning the maxi-ruf operates as a dial-a-bus in an area defined by the mesh of the rail network. There is no timetable. Travel is organized by request; ordering and payment take place electronically. The fare depends on the quality of the journey. If you pay for it you can be picked up at your home address and taken directly to your destination without having to change on the way.

Automated People Mover, APM
When the maxi-ruf arrives at the rail network the driver gets off. The maxi-ruf proceeds as an APM and the long sections are driven with great speed on the rail.

Streetcar Without Rails and Overhead Wires
In the heart of the city there are no rails. Here a maxi-ruf can travel on with a driver as a kind of streetcar. Since it can run on batteries that have just been recharged on the rail there is no need for establishing overhead wires. As it runs on rubber wheels there is no need for placing rails in the roadway. It provides better driving comfort than an old-fashioned streetcar and it is much cheaper to establish.

Dual-mode

What is the dual-mode principle ?

Definition

A dual-mode system is a traffic system where vehicles can run in two ways, either manually controlled on ordinary roads or automatically on a special rail. The purpose of the dual-mode system is to combine the best feature of car driving with the best of travelling by rail.

The Road System

Travelling by road has the advantage of being very flexible. In a modern society the road network is what connects all destinations. A good traffic system must therefore be able to exploit the road system.
Individual driving on the road network, however, is not particularly efficient At high speeds large distance to other vehicles is required. This limits the capacity and leads to large energy consumption. An extension of the road network in an existing big city is very costly due to the necessity of removing many houses to make room for new roads.

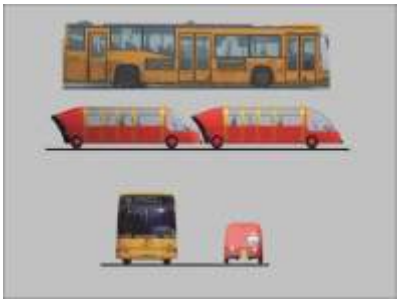
The Rail System

Traditional rail systems are very efficient and safe when it comes to moving a lot of people from one station to another. However, rail travel will never become as flexible as road travel, and will therefore never be able to stand alone. Traditional railway technology with steel wheels against steel rails has a very low rolling resistance. It gives low energy consumption, but also poor braking properties.

Automated People Movers

Experience with APM is now so good that it must be considered as a technology safer than driver-operated trains.

The RUF System



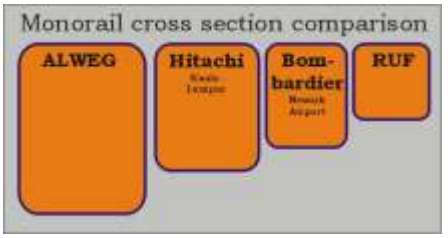
A dual-mode system as the RUF system is capable of solving a vast number of traffic problems associated with modern living in big cities.
The rufs are just as flexible as the cars in the neighbourhood and more efficient on the sections where rails replace the highway. They provide assurance against queues, low energy consumption and great safety.
The maxi-rufs can provide public transport in a way, which is far better than traditional bus/train solutions. It is possible to provide door-to-door transport and shorter travelling times. Integration with IT is possible, since all units are small and flexible.

Location

Where can the rails of the RUF system be placed ?

Space Requirements

The maxi-ruf, which is the system's largest vehicle, is 2 m wide and 2 m high. Since it is steered with sideways precision on top of the triangular rail it does not need more than 2,5 x 2,5 m free space. The rail does not need to be placed in a high position. It can be placed on the ground, below the ground or above the ground in various heights. The curves on the rail should have a curving radius of at least 26 m corresponding to the idea that it should feel comfortable to turn at 30 km/h. Higher speeds require less curving.



In the Middle of an Existing Highway

If a six-laned highway such as Lyngbyvejen should have a higher capacity this could be achieved by placing a ruf rail instead of the fastest lane in each direction. This would also be the cheapest location, since no masts are required.

Next to the Metropolitan Railway Line

In many places next to the Metropolitan Railway Line there is room for a ruf rail, which can be located at a low level on top of the ground and supported by low masts. The rail may be placed on top of a noise screen, which will reduce the level of noise from the train rails. The ruf train runs on rubber wheels and therefore does not contribute much to the level of noise.

As an Elevated Railway in a Wide Road

The median strip of a wide road can be used for location of rails at a minimum height of 4 m. Such an elevated railway will be better in coping with poor weather conditions than the ordinary road. In other cases a busy street can be converted to an environmentally friendly street plus a ruf elevated railway. As a result the barrier effect is reduced and social life can flourish.

As an Underground Railway

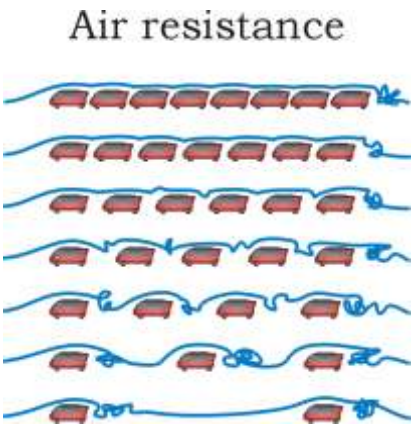
A particularly attractive alignment in densely populated areas is to place three ruf rails in one tunnel tube. It is much cheaper than leading trains through two separate tunnel tubes. Safety is at a premium, since a ruf cannot derail. The third rail can be used for adjusting the capacity according to demands. It can also be used for evacuation of passengers in the event of an emergency.

Environment

Which consequences does a RUF system have for the environment ?

The CO_2 Problem

Electric cars are somewhat better than ordinary cars when it comes to CO_2 emission. Owing to the close coupling of the rufs, the energy consumption per km will fall dramatically. Thus all emissions will fall compared to other cars.

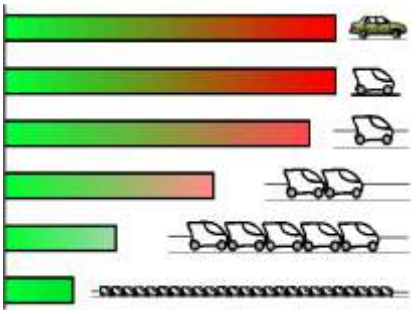


Pollution

In the neighbourhood there is no pollution from the RUF system. All emissions arise from distant power plants or renewable energy sources. The emission control is far better centrally than de-centrally (cars).

Resources

Power for the system can increasingly be collected from renewable energy sources as wind, sun and wave energy.

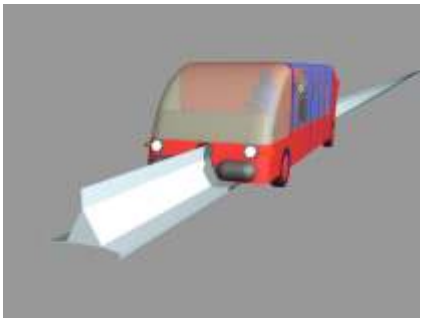


Noise

On roads the ruf makes as little noise as other electric cars. The only noise source when travelling on roads is by and large wheel noise. On the rail the wheel noise is reduced because the carrying wheels do not require brake linings.

The City Environment

The inner city will be a peaceful place when the only vehicles in the city are bicycles, rufs and maxi-rufs. Many people will feel tempted to the new kind of public transport provided by maxi-rufs (door-to-door, guaranteed seats, single seats, no timetable, flexible fares).



Visual Pollution

The rails will only be located in places where they do not obstruct. The rail is extremely slender (85 cm wide) and can be placed as a network with a mesh width of 3-5 km. In the city there are no rails. Maxi-ruf can operate as a kind of streetcar on batteries. No hampering overhead wires are necessary.

Barrier Effect

A wide street with much traffic can be converted into a silent street with an elevated RUF guideway.
The residents will recover the street area and be able to pass the area without any danger. The traffic capacity of the street will be increased at the same time.
It is really outrageous to allow fast traffic at street level where children should be able to move freely.

Comfort

How comfortable is it to use the RUF system ?

Road Driving

All ruf vehicles are electrically operated. This means that driving on ordinary roads is very comfortable. There are no engine noise and no gear change. Driving is more even that for cars with automatic gears. The wheel noise from a ruf is less than for other electric cars, since ruf batteries weigh less, typically only 1/3 of other batteries.

Rail Travel

Travelling on rail is even more comfortable. The wheel noise is reduced significantly due to the smooth rail wheels, which have been made possible by the efficient rail brake. The lateral guidance is perfect in relation to the top rail situated in the middle of the vehicle. The drive wheels, which grip tightly against the top of the rail, prevent the vehicle from swaying like a train.

Seats

Even in the public part of the system (maxi-ruf) there are seats for everybody. There is no standing room. All passengers have single seats. There is room for a wheelchair or a baby carriage between the two opposite front seats in each side.

Entry and Exit

It is easy to enter and leave a ruf. The ruf is a little taller than normal cars. Cars are normally low to enable them to drive with great speed on highways. Since the ruf only travels fast when it is coupled to other rufs in a small train, the height is not so important. Entering is very easy. The maxi-rufs are designed with one door to each seat. This provides an extremely easy entry directly from street to seat. Passengers who enter or leave at street level of a busy street are primarily seated in the right side of the maxi-ruf.

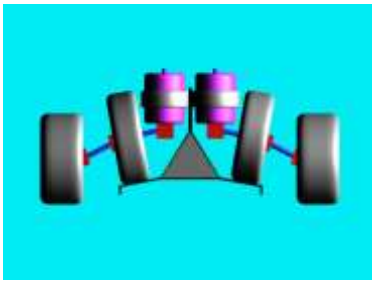
The View

A special attraction of the ruf system is the part of the journey, which takes place as elevated railway. It gives a feeling of safety to ride on the triangular rail and a joy to watch the scenery from 5 m above the ground. Passengers of the RUF system will have a good conscience knowing that they do not contribute to pollution and noise.

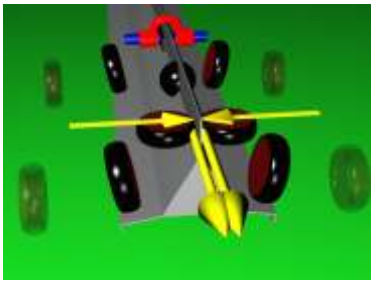
Speed

Which rates of speed can the RUF system provide ?

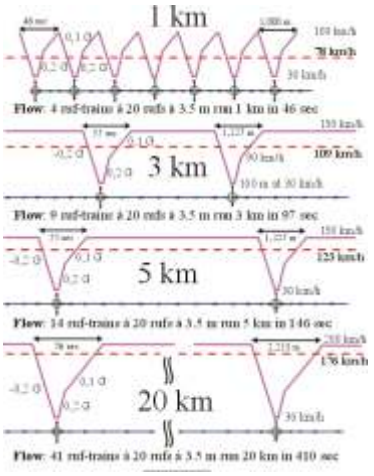
Stability
Ruf vehicles "ride" astride a triangular rail. The centre of gravity of the vehicles lies below the top of the rail, so the stability is very high. Rates of speed up to 200 km/h should be possible without risk of safety.



Traction Power
The motors shall allow the ruf a speed of 80 km/h when driving on roads, but faster if possible. When the rufs are closely coupled on the rail the air resistance is reduced to such an extent that the rufs can obtain a speed of 200 km/h over long distances. Adjusting the pressure on the rail can vary the friction between drive wheel and rail. That provides good driving power up hill and low friction with normal driving.



Rhythm of Speed
All vehicles follow a certain rhythm. The top speed is 100-200 km/h dependent of the distance between the junctions. In the very junction the rate of speed is as low as 30 km/h. The acceleration starts with 0.2G, but is reduced to 0.1G at higher speeds in order to save on the demands of motor power. In a typical situation with 5 km between the junctions a top speed of 150 km/h will give an average speed of 122 km/h.



Travel Times
A highway has its maximum capacity at a speed, which is considerably below top speed. The reason is that the braking length increases with the square of the rate of speed. In the RUF system the rufs are clustered together in small trains and the braking ability is at a premium. As a result maximum capacity can be obtained at top speeds.

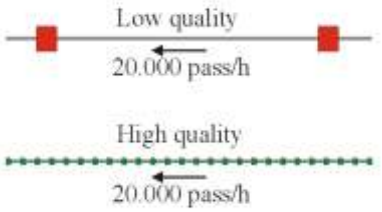
Examples
According to the travel planner website (www.rejseplanen.dk) it takes 44 minutes to go from Værløse outside Copenhagen to Jarmers Plads near the center of Copenhagen by public transport, as we know it today.
With the RUF system it will take 11 minutes from the time of entering the rail outside Værløse until the driver leaves the rail at Jarmers Plads.
The RUF system is faster, and more comfortable and the time on the rail can be used constructively, since a ruf can be connected to the Internet during the whole journey into town.

Capacity

Which capacity has a RUF system ?

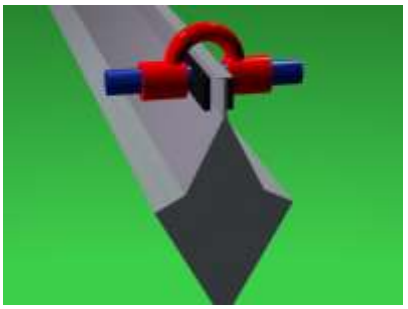
The Rail

Owing to the very efficient rail brake the ruf trains can travel relatively close to each other. It gives high capacity and good quality, since many departures for few passengers are preferably to fewer departures for many passengers.



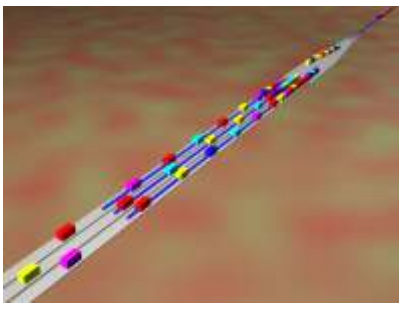
The Rail Brake

Ordinary braking takes place by using the drive wheels as generator and returning power to the power rails. In an emergency the special rail brake, which is placed behind the center of gravity of the ruf, is used. It gives a very stable and efficient braking power in all conditions. The pressure against the rail can be adjusted so that the necessary braking is obtained. Emergency braking of 1G is always within reach.



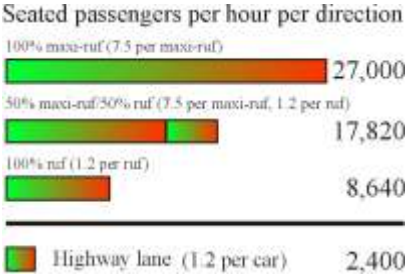
Safety Distance

At a speed of 30 km/h the ruf can brake down to 0 below 4 m. The fenders can absorb 10 km/h without being damaged.
In the interchange sections the roadway is always ideal, since it is covered and under surveillance.
If the rufs are allowed to drive individually on to the rail at the speed of 30 km/h and afterwards cluster together like trains comprising 10 rufs, the distance between the trains will be 45 m at 30 km/h and 385 m at 150 km/h.
A 1G braking only requires 88 m to get from 150 km/h to 0, thus allowing an ample safety margin.



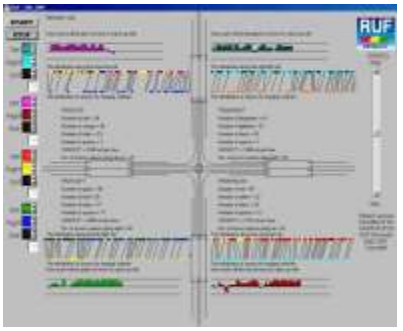
Line Capacity

By interweaving trains from two or more feeder rails the capacity of the line can reach one 20-ruf train every 10 seconds. This is the equivalent of 7,200 ruf/h or more than two highway lanes. If half of the trains are 10 maxi-ruf-trains the passenger capacity at an occupancy rate of 75% and 1.2 person per ruf corresponds to 17,820 seated passengers per hour per direction.



Junction Capacity

For every distance of 5 km's rail travel there will typically be a junction, where it is possible to enter and leave at 30 km/h. A junction, which can handle trains every 10 seconds, can be designed, but it would be rather complex. Every junction will therefore be designed so that it corresponds to the expected rush-hour flow at the location in question. No more rufs will be allowed on to the system than the system can handle. The control of the flow is vested in the junctions supplemented by a certain amount of overall control. See: www.ruf.dk/rufsim.doc



www.ruf.dk/rufsim.exe

Cost

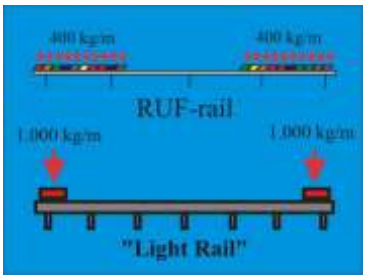
What does it cost to establish and operate a RUF system ?

Rail Network

Contrary to a train system, which primarily is used by customers living within a radius of 400 m from a station, a RUF system will attract customers many kilometres away from "the stations". This is the result of the dual-mode principle whereby customers transport themselves in their own vehicle (ruf) to the rail. This way a metropolitan area can be covered by a relatively low number of rails. A typical network will have a mesh size of some 5 x 5 km.

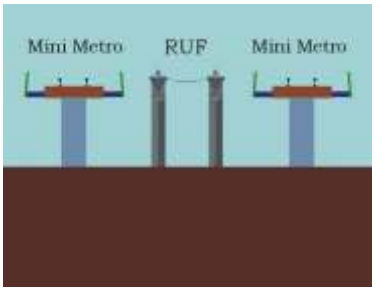
Rail Modules

The RUF rails are built as modules of a length of 20 m. This means that the modules can be made in a factory during optimum production conditions and hence forwarded via the completed rail. The rail modules only need to be able to carry 4-500 kg/m because the load is spread out more evenly than the very heavy peak load of a normal train.



Masts

The rail modules are supported by masts, the height of which is adjusted to the level. Therefore there is no need for large excavations and levelling of the ground.

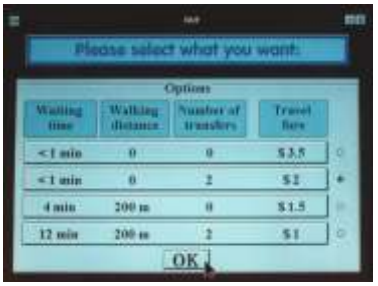


Expropriation

A ruf rail only requires free space of 2,5 x 2,5 m. It can therefore be built in many places along existing railways or in the median strip of some highways. The demand for expropriation in connection with the establishment is therefore negligible. The estimated cost of a double rail is $7 million/mile.

The Vehicles

For starting up the system it will be necessary to have a number of public vehicles (maxi-ruf) to operate the system on a public basis, until people begin to buy rufs themselves. A maxi-ruf costs less than a large bus (per seat), since large numbers are required during manufacturing, and since conventional automobile technology can be used during the start-up phase.



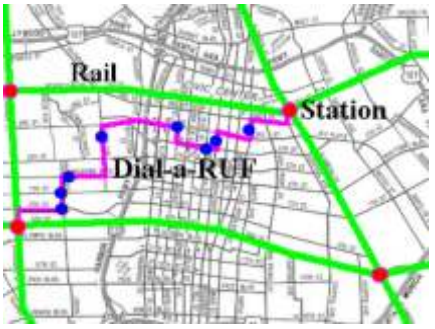
Operation

The rail part of the RUF system is automatic. There is no need for drivers on the rail network. Experience gained from automatic operation shows that it is safer than manual operation. Drivers are used for operation of dial-a-ruf service; however, this part will justify a higher fare. IT is used in the operation to a large extent. Electronic payment and a flexible fare structure provide a better economy.

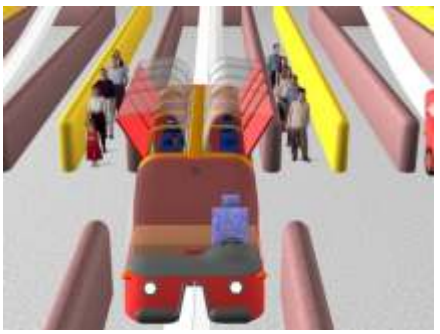
Stations

How does a RUF station function ?

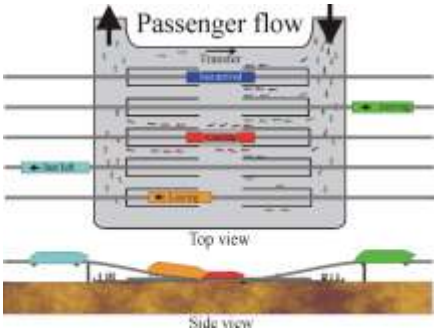
Demand
Some of the users of the RUF system can use it by getting on a maxi-ruf or another public ruf at a station. This will typically be in the densely populated part of the city. In this way the journey becomes cheaper for the user, and there is a choice between different destinations when entering the vehicle.



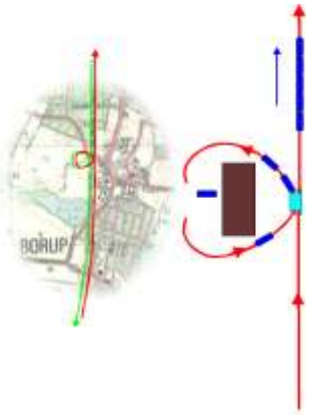
Network
A typical RUF network will be laid out with a mesh size of 5 x 5 km. Stations can be located in each junction, but they can also be placed at the end of a RUF rail. This will often be most appropriate; since the demand is often greatest where the city is most dense. In return it is difficult to find suitable alignments to and from this area. A ruf "connection line" will be able to connect an activity centre with the nearest junction of the network.



Station Layout
A requirement to a good station layout is the ability of the users to find their way round. In the RUF system it is possible to make the station in a particularly appropriate manner as a result of the special design of the rail. By gripping the top of the rail it is possible to achieve enough friction for climbing relatively steeply. This means that the users can move around freely at ground level, while the vehicles are rising above the platform.



Passenger Flow
It is easy to change from one maxi-ruf to another by following the stream from exit to entrance. Having found the right platform all you have to do is to wait in line for the arrival of the next maxi-ruf.



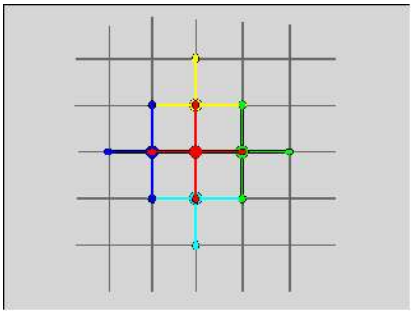
Off-line
In a dual-mode system it is easy to realise off-line stations, that is stations where the platform is situated, not on the main line, but next to. As a result of this the through-going vehicles do not get close to the waiting passengers, and the passengers can feel safer. It also means that the size of the station can be adjusted to the demand contrary to ordinary train systems, where the length of the station necessarily must be adjusted to the longest train running on the section.

Switch

How can a ruf change from one rail to another ?

Background

A RUF system is as a rule made up as a network. This means it should be possible to change from one rail to another in the network. A traditional solution with a rail that moves physically would be very difficult, since triangular rails do not curve easily. It also would not be appropriate, since it takes a relatively long time to move the rail. The flexibility of the system would be very low. Flexibility is very important in urban traffic, when the user's demands are very individual both in time and space.

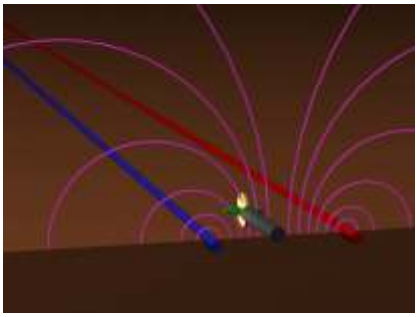


Dual-Mode Switch

The RUF system exploits the vehicle's ability to drive on a rail and on the road. An interchange in a RUF system is a piece of roadway, where the rail stops and the vehicles travel a short distance on road wheel at a low speed (30 km/h). On this section direction can be changed, so that the vehicle enters another rail. The system ensures a safe and pleasant change. After changing the ruf accelerates to top speed again.

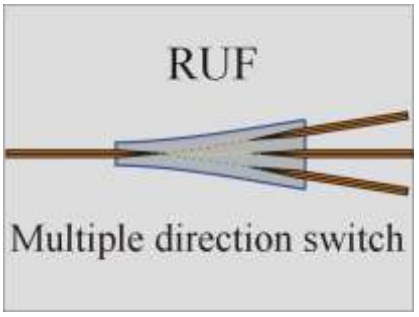
Magnetic Field

A ruf is controlled by magnetic fields, while driving automatically on the road sections. The magnetic field is fed by current from two wires situated just below the surface of the roadway. The current is an alternating current with a frequency around 10 kHz. The magnetic field is completely harmless. The magnetic detector measures the field in two planes perpendicular to each other. The two field strengths are used for calculating the exact position in relation to the field. If the deviation is too great, the front wheels will be turned so that the ruf once again land in the middle of the field. This technology is thoroughly tested. In the English Channel tunnel service vehicles are constantly running in the 3rd tunnel section. They are controlled by magnetic fields and have driven more than 1.5 million km without a single accident.



Multiple Directions

The magnetic field from two wires can function even if there are other fields present at the same location. As a result of placing several pairs of wire in the roadway and transmitting current with different frequencies through them, the ruf can choose which direction it wants to follow. On the ruf is a simple magnetic detector, which gathers the field. It works just like a radio. It can tune in on different channels. Thus it is only sensitive to the field of one of the wire pairs and will follow their course.



Parking

How to solve parking problems

Privately Owned Ruf

A ruf owner will often use his ruf to get quickly from his home in the suburbs to his workplace, which often also lies in the suburbs. He uses the rail to replace driving on the highway and therefore avoids having to queue. Parking facilities are usually provided where he works; therefore he has no parking problems during the day.

Ruf in the City

A ruf entering a city may find it hard to find a parking space, since the authorities try to keep the city centre free of cars because of the city environment. Since a ruf can drive automatically an interesting option for solving parking problems arises. The ruf user leaves his ruf at a station and lets it continue to an automatic parking facility placed in a location where real-estate prices are low. Here the ruf can park itself very efficiently, since no room is needed for exit. When the user needs his ruf again, he calls it and the ruf runs automatically to the station and is ready for him getting in.

Park and Ride

An interesting option in the RUF system is Park and Ride. The car driver parks in a parking space and remains seated in his cosy car, until a maxi-ruf arrives and picks him up. The maxi-ruf picks up car drivers and the driver then takes the full maxi-ruf to the nearest rail junction. Here the driver leaves the maxi-ruf, which continues up on the rail and without noticeable delays reaches the city. Here the user may remain seated, until a new driver will take him directly to his destination.

Public Ruf

If the user has taken the opportunity of renting a ruf instead of owning it, the parking problem will be minimized. The ruf user keeps his rented ruf at home outside working hours. In the morning he drives the ruf into town and leaves it at one of the many parking rails for public rufs. Here others may rent it during the day by means of a personal smart card or a BlueTooth device which can communicate with a “HotSpot” and manage payments etc. When the commuter wants to go home, he simply picks up a new ruf and drives home via the rail. The protected parking rail makes sure that the ruf has the right temperature and that it is not damaged during parking.

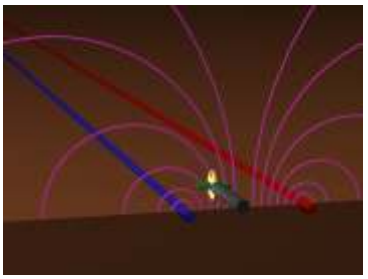
RUF "Streetcar"

How can a RUF "streetcar" function ?

Qualities of the Streetcar

An old-fashioned streetcar was popular for various reasons. Partly because the driving was smooth due to the electrical traction and partly because the alignment did not have so many turns as a bus has to make. The noise from the motors was low and there were no pollution at street level.
The disadvantages were that the rails bothered cyclists and the overhead wires disfigured the urban environment.

Ruf "Streetcar"



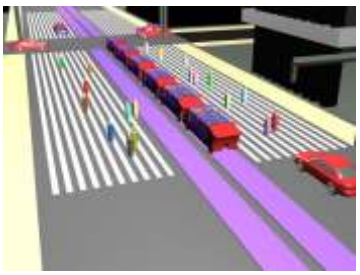
A maxi-ruf can be coupled with others so that they form a kind of articulated bus. If it consists of 3 units only, then one driver can drive it in the streets as an articulated bus. By fitting the sharp street corners with the magnetic field, which is part of the concept, one driver can drive a long column of maxi-rufs even through relatively narrow streets in the inner city. It is not a real streetcar, since there is no rail, however, its function will be just as attractive.

Battery Operation

An old-fashioned streetcar must get power from overhead wires suspended across the street. It would not be possible to run a whole day through on batteries. They would be too heavy and costly. In a dual-mode system, however, it is possible to organize oneself out of the problem. By composing the "streetcar" of maxi-rufs that have been running on the rail network into town the effect gained is that the batteries will have sufficient time to be recharged. Therefore the streetcar can manage a journey through the city on battery operation. This makes the solution more attractive and cheaper than traditional streetcars. Another advantage is the greater flexibility. The route can be deviated from in case of obstructions, etc.

Rubber Wheels

The old streetcars were not noiseless. The rail wheels squealed when turning corners and the interchanges were not noiseless either. A maxi-ruf runs on rubber wheels, so the noise will be negligible.



Getting On

It is possible to get on a maxi-ruf from both sides. That makes it appropriate to place stops in connection with traffic lights. By letting cars hold in front of a pedestrian crossing with a width corresponding to the longest streetcar people can get on and off fast and securely.

RUF and IT

How is IT used in the RUF system

Ruf Commuter

A ruf commuter will be able to use his time on the rail by doing all that will be possible to do in the future via the Internet. The commuter will be able to begin his work as soon as he enters the rail. That means he can make money while he is commuting in contrast to the commuters trapped in a queue on the highway. Since the Internet cables are placed in the rail itself a very attractive high-speed connection will be provided via the rufs internal computer.

Electronic Commerce

On the way home from work the ruf commuter will be able to order goods from the local supermarket. The goods can be ready for pick-up when he arrives in the neighbourhood. A ruf can drive directly into the supermarket, since it does not make any noise or pollution locally.

Public Transport on Demand

By means of IT and the small public units of the RUF system it is possible to provide a public journey, which is adapted to the individual's demand and purse. The journey can be ordered via PC or telephone. It is also possible to get on the maxi-ruf directly from street level. Ordering via the Internet makes it easy to choose the level of service one needs and can afford. A door-to-door transportation with departures within 5 minutes is possible, but relatively expensive. It is cheaper though than going by taxi. The cheapest journey includes waiting time, having to walk to a pick-up place and willingness to change on the way.

Dynamic Route Planning

By means of modern computers and GPS systems it is possible to organize maxi-ruf routes so that a good occupancy rate is achieved. It is not possible with big busses used nowadays. It requires small units. The GPS system monitors constantly the position of the maxi-ruf, which is transmitted via the UMTS system to the local RUF centre.

Electronic Payment

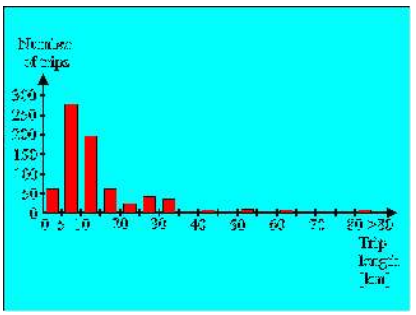
In order to put as little strain as possible on the driver, electronic payment is used to the widest extent. BlueTooth devices can communicate with the system. The display shows the fare of the journey and pushing a button makes payment.

Ruf variations

How can the users employ the ruf ?

Ruf as a Private Car

A ruf can fully replace a normal car in urban traffic. With a range of at least 50 km on batteries and access to a rail network covering the city area, all places in the city can be reached without worrying about range. Since 1 km rail travel can recharge the battery corresponding to approx. 1 km road travel, it means that a typical ruf owner will never have to worry about recharging. The rail journey will typically be many times longer than the road journey. All small journeys can be managed on the road network without burdening the environment, since the ruf has no cold-start problems and does not run idle.



Ruf as a Rented Car

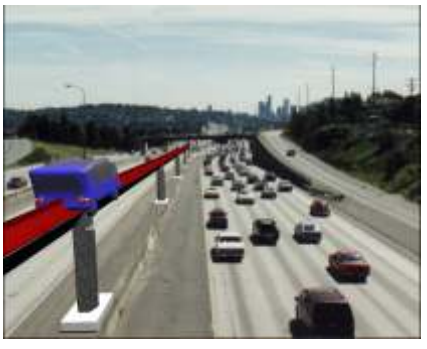
A cheaper way of having a ruf is to hire one. The user has full right of use outside working hours and can use it for commuting to and from work. During working hours others use it, since it is available to owners of a personal ruf smart card. They can borrow a public ruf for driving around in the city. The smart card is used as a personal identification and as a means of payment. In this way vandalism is avoided, since the ruf remembers who rented the ruf last, until a new user has approved it. Hence the previous owner's identity is erased.
A public ruf can be parked in one of the numerous parking rails or in a parking facility for private and public rufs.

Ruf as a Taxi

A special use of the ruf is as a taxi. A driver runs the ruf in the street network and takes the customer to the rail. From here the customer continues alone in the ruf via the rail until a new driver takes over at one of the junctions. He then takes the customer all the way to his destination. In this way journeys by taxi become much cheaper and faster. The environmental strain is far lower from a ruf taxi than from an ordinary taxi.

Ruf as Personal Rapid Transit (PRT)

A ruf can be used with advantage for individual automatic transport in a network or on a line outside rush hours. Here it works like a kind of horizontal elevator. The user pushes a button at the station and is taken to the station he wants in the network. Contrary to an elevator there is no risk of stopping on the way to invite others. Each user has his own vehicle (which can, if necessary, accommodate a whole group).



Maxi variations

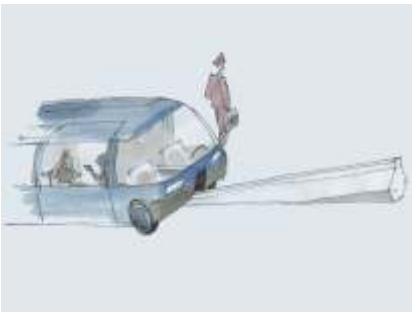
How can the users employ the maxi-ruf ?

Maxi-ruf as a Train

A traffic corridor could be serviced advantageously by maxi-rufs running as a train. Owing to the rufs efficient rail brakes safety distances can be made relatively short. This means more frequent departures. Since the RUF system is automatic, staff costs are minimal. The stations of the system are "off-line" meaning that only vehicles bound for a particular station will stop there. All other vehicles continue without stopping. As a result travel times are very short.

Maxi-ruf as a Dial-a-bus

A maxi-ruf can pick up people from their home. The maxi-rufs route is planned according to demand by means of dynamic route planning. Getting on is extremely easy, since each seat has its own door. Every passenger has his own seat; so unpleasant fellow passengers disturb no one. Contrary to traditional bus/train public transport the user can remain seated the whole way, since it is the driver who changes vehicle, and the maxi-ruf, which changes transport mode from a bus to a train.



Maxi-ruf as a "Streetcar"

One driver can drive a number of maxi-rufs through the city. The function resembles a streetcar, but there are neither rails, nor overhead wires. It runs on batteries in the city. The batteries are recharged when the maxi-ruf runs as a train to and from the city. While it is on the rail the batteries are recharged by means of power from the rail.

Maxi-ruf as an Underground Railway

An underground railway can be realized very elegantly in the RUF system. Three rails can be placed in one tube. Stations can be placed on the surface, since a maxi-ruf can manage to drive steeply uphill in contrast to traditional trains. By exploiting the gravity for acceleration and braking energy is saved.

Maxi-ruf as a Container

A very attractive way of transporting small goods can be obtained by means of the maxi-ruf. Its passenger cabin can be replaced, so that it can be converted to a container for small goods. In this way the rail network can be used during the night when passenger transportation needs are low for a fully automatic distribution of goods within the entire network.

How is the RUF system introduced ?

Test Track

A ruf and a test track has been built near the Engineering College of Copenhagen at Ballerup with subsidies from the Ministry of Education and a number of national agencies related to Environment, Energy and Design, and private sponsors (Balslev, Siemens, CWO, Semco, NCC Danmark a.o.) The test track was officially opened June 2000.

Extended Test Track

An extension of the test track up to the length of 200 m has been planned, as well as the construction of another two vehicles, one of which is a maxi-ruf. Driving at higher speeds and testing of the real rail modules will take place.

First Project

The first real ruf project will typically be a project aiming at improving the existing public transport system by means of a local RUF system based on maxi-rufs. A good location could be Lautropparken at Ballerup. Here an elevated railway based on maxi-rufs could service the high-tech industrial area by creating a good connection to the metropolitan train station of Malmparken.

Next Projects

A connection between the metropolitan railway lines via Ring 3 could easily be established by means of APM based on maxi-rufs and public rufs. The construction costs from a RUF rail will be relatively less than a traditional Light Rail solution. Customers using the RUF system will receive a better service, since the frequency is much higher and the comfort will be higher, as there are seats for everybody.

The Network

Gradually a network of RUF rails will be established covering the Copenhagen metropolitan area with a mesh width between 3 and 7 km. As a result it will be very attractive to own a ruf and use the network for day-to-day commuting. Car manufacturers will begin a production of ruf cars, and people will discover they can make money by using the rail logging on to the Internet from the ruf. It means that they without endangering themselves or others can work electronically on the way to their physical work. The operator of the system will make a lot of money and the system will be expanded by and by in step with political pressure from users to be connected to the system. The demonstration effect of the system will spread like a wild fire across the entire world.