

RUF Dual Mode Public Transport

by Palle R Jensen, RUF Danmark

Introduction

Cities are very different in size and structure.

In general, European cities have an old dense part with a lot of historical monuments and very narrow streets. Some US cities also have a well defined downtown while others (LA) are covering a huge area while the downtown is of limited size.

Societies are also very different. Some countries are completely dominated by the car (US) while others for historical reasons have an extensive traditional public transport system to supplement the car. A few industrialized countries have a significant amount of bicycles (Denmark).

Energy sources are also very different. Some countries (Norway) have a lot of hydro power others (France) have a lot of nuclear power while some are relying on oil.

For these and other reasons, transport systems will have to be adapted to the surrounding society which varies from country to country.

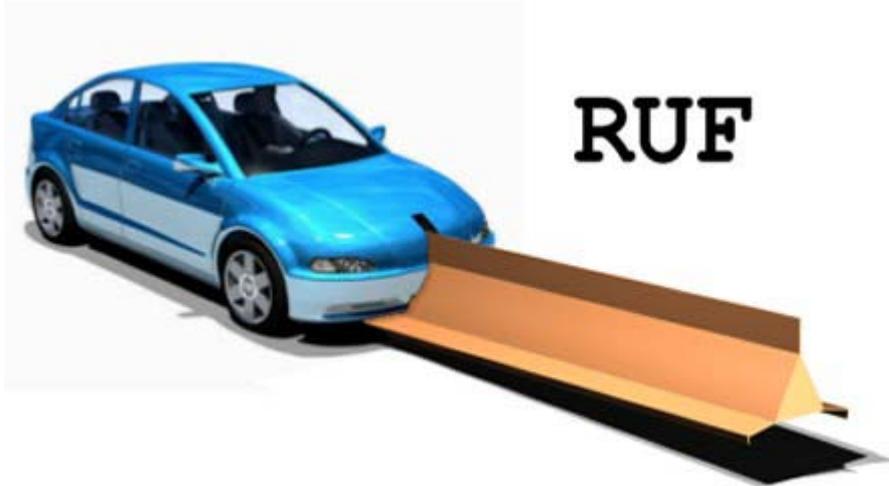
The key reason for success for a new transport system will be flexibility. One system, which is flexible enough to cover most of the varied transportation needs of modern cities will become a success.

In the following, I will describe why the RUF (Rapid Urban Flexible) system is such a system.



RUF Dual Mode (www.ruf.dk)

Dual Mode means a transport system where all vehicles can drive in two modes: either as road vehicles or using a special guideway.



On the road the vehicles are manually controlled and on the guideway system all vehicles drive automatically.

The guideway system is organized as a network of guideways connected in junctions. A typical separation of junctions will be 3 miles. Speed in junctions is 20 mph and top speed on the line is 95 mph. All stations are off-line so that most vehicles can drive through the junction without stopping.

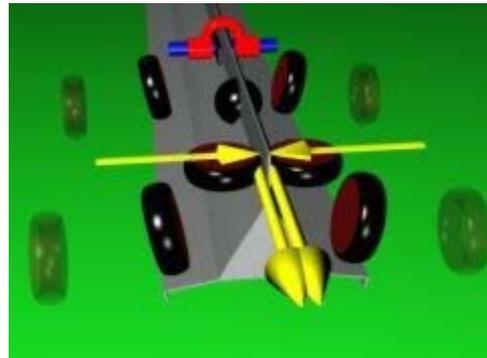
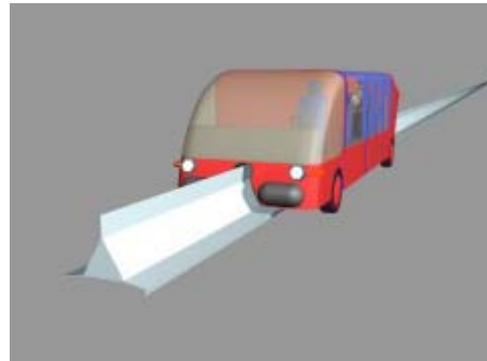


In order for such a system to work properly, the automated part has to be extremely safe and also to feel safe for the common user who is not familiar with the engineering calculations behind the concept.

The RUF system obtains this high and visible level of safety by means of several innovative (patented) construction details:

- The rail is a triangular monorail
- The vehicles are “riding” on top of the monorail so that the center of gravity is placed under the top of the monorail.
- A special rail brake can press against both sides of the top of the monorail. The pressure is not limited by gravity, so braking power is always available when needed.

RUF drive system



- Vehicles in the RUF system are able to be closely coupled so that no collisions can take place within a platoon.
- The system only operates with seated passengers.



RUF Public Transport Vehicles

RUF is a system which can be used both for privately owned electric cars (ruf) and for public vehicles. In this article I will not go into further detail with the privately owned vehicle. The system will probably be started as public transport in the first phase.

RUF offer a wide range of vehicle sizes which can be used for public transport in different situations. This is part of the flexibility of the system.

A short introduction to the different types of public vehicles:

Maxi-ruf

A 10 seat electric bus, 7 m long, 2 m wide and 2 m high.
5 seats in each side plus a chauffeur seat in the front part.



Midi-ruf

A 5 seat electric bus, 5 m long, 2 m wide and 2 m high.
3 seats in the right side plus 2 seats (one sometimes used by the chauffeur) in the left side.

Ruf

A 4 seat electric car, 3.5 m long, 1.75 m wide and 1.6 m high



Mini-ruf

A 2 seat electric car, 3 m long, 1.75 m wide and 1.6 m high

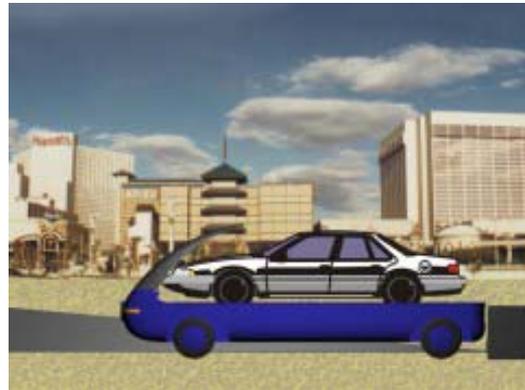
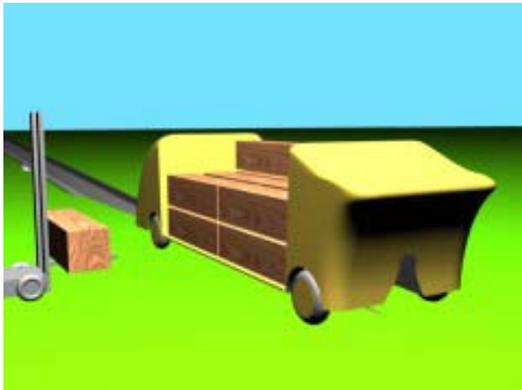
Special vehicles

Snow removing robot

RUF container for small goods

Rescue vehicle able to drive backwards along the rail to a vehicle with a problem

RUF pallet for transport of ordinary cars



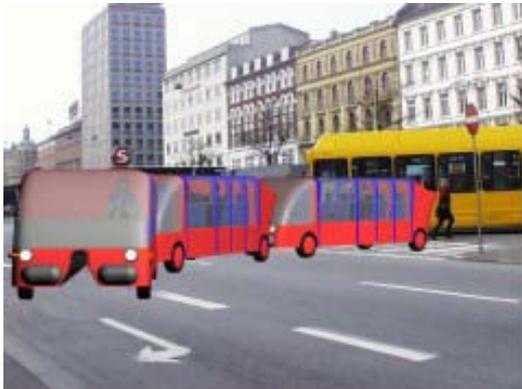
Combined vehicles:

RUF train

Variable size, max 10 units, mini-ruf / ruf or midi-ruf / maxi-ruf

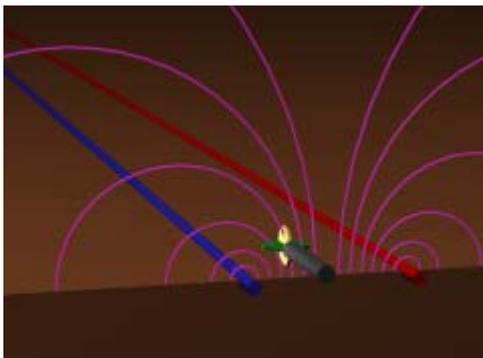
Articulated bus

Up to 3 maxi-ruf driven by one chauffeur



RUF "tram"

Up to 10 maxi-ruf coupled and driven by one chauffeur and guided around sharp corners by means of magnetic fields from wires buried in the road surface.



Modes of Operation:

Public ruf rental car

The user has a rental agreement with the RUF operator.

The user has the ruf or mini-ruf parked at his residence outside working hours. He can use it as a car and he doesn't have to worry about noise or cold start emissions.

Electric cars don't make noise and they don't emit anything in the near environment.

The small battery will allow the ruf to drive at least 30 miles at full charge.



In the morning he will drive the ruf a few km to the rail access point. Normally he will get access to the rail without waiting and once on the rail system, the average speed is more than 70 mph. While on the rail, the user can have access to the Internet and open e-mail in order to prepare for work. He can earn money while driving and at no safety risk.

Just before the egress ramp he will be tested if he is ready to take over control. If not (sleep, illness etc.) he will be parked automatically close to the egress ramp but away from the traffic flow. The system will try to wake him up and he will have to pay extra for the use of this facility.



The egress ramp is placed as far away from freeway ramps as possible in order to avoid road congestion problems. If possible it will end close to a parking facility which can function as a buffer in case of problems. If an egress ramp get blocked, the ruf will be redirected to the next exit and will have to drive back from there (3 miles max.).

He now takes over control and drives to his destination where he leaves the ruf at a special parking rail where 5-10 rufs can be parked. They recharge batteries via the parking rail and maintain an attractive temperature while waiting for a new customer.



During the working day, many small trips are made using the public rufs from parking rail to parking rail (spread all over the city). The users identify themselves via a personal smart card and pay for the trip. The identification is erased as soon as a new user has seen that the vehicle seems OK. The trip is cheaper than taking a taxi but since there is no chauffeur, the operator can gain a considerable profit from this mode.

At the end of working hours, the user finds a new public ruf and drives back the same way as he arrived in the morning.

He will save time and earn money compared to car driving, but it is public transport. He will experience less stress and the rail part of the trip will be much safer than driving on a highway.

The operator will be able to offer a cheap rental rate and still earn money because the vehicle is used during the day for other profit creating purposes.



Intelligent devices combining cell phone, smart card, GPS, PDA and other future devices can be used in connection with this type of public transport. It is only possible because all units in the RUF system are small, unlike traditional public transport.

PRT mode

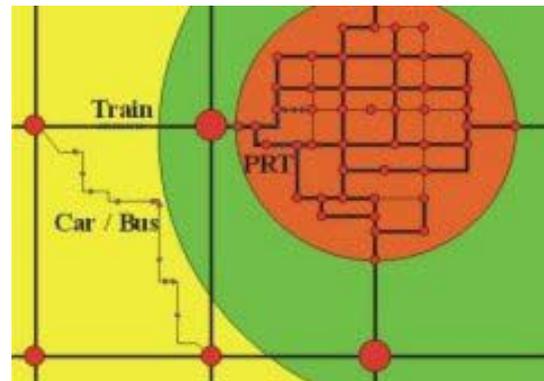
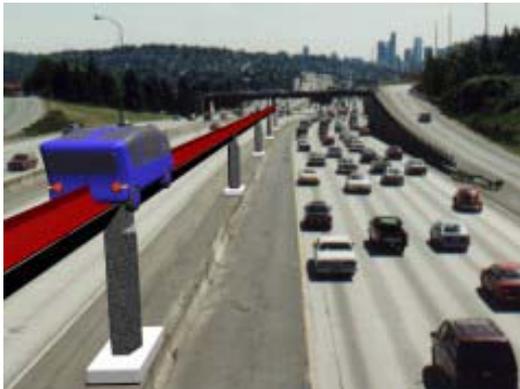
Personal Rapid Transit uses small vehicles running automated on-demand on a network of guideways. This function has been demonstrated successfully for many years in Morgantown, West Virginia.

RUF can offer a similar service where it is relevant.

RUF PRT is relevant when at least one of the endpoints of a trip is placed in a dense part of a town where walking to the final destination from a PRT station would be acceptable (400 m max, fair weather and no luggage).

RUF PRT can be performed with any of the smaller RUF vehicles: mini-ruf, ruf or midi-ruf. A wheelchair user would require a midi-ruf for this service.

RUF PRT normally operates without train formation since the distance between stations are much shorter (0.5 mile) than in normal operation (3 miles). A trip can start with rufs driving in a train but end with the same rufs driving in PRT mode.



RUF taxi

The RUF taxi (normally midi-ruf) is ordered exactly like any other taxi. The difference is, that the chauffeur leaves the car before it enters the guideway. The chauffeur is now ready for another trip on the road while the user continues on the rail network automatically. At the egress ramp another chauffeur is ready to continue the trip while the user remains seated in the vehicle. This service is available 24 hours a day and especially for long trips, it is much cheaper than a normal taxi trip.

APM mode

Automated People Movers are normally large vehicles running on a special rail without driver. The rail is normally structured as a simple line with on-line stations. This means that all passengers have to wait at every station even if they don't want to stop at the station.

RUF APM mode is more flexible. Automated vehicles run automatically between off-line stations. This means that when a train arrives at a "station", the train will split and most of the train will continue without stopping (20 mph) while some of the cars in

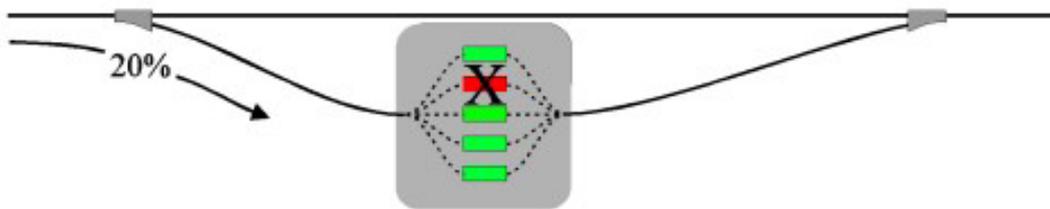
the train will be separated from the train and directed to a rail parallel with the main line. Here the passengers can leave the vehicle without delaying the others.

Off-line stations also means that the system is much more reliable than an normal train station.

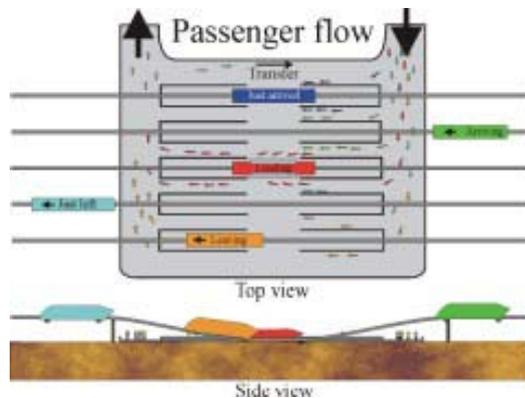
TRAIN: Problem at X => System breakdown



RUF: Problem at X => 96% functionality



Station layout can be designed in a way which both allows for off-line operation and easy transfer between parallel platforms.

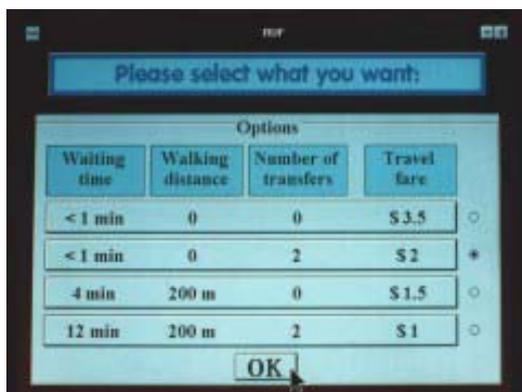


Dial-a-bus mode

Small electric busses like maxi-ruf and midi-ruf are perfectly suited to perform Dial-a-Bus service.

The operator can make an agreement in advance with different types of customers:

Commuters can tell the operator at which time they want to arrive at their destination. Since this type of trip is almost the same every day, it is possible to organize it so that the busses will be used almost 100 % upon arrival at the rail network. The users pay once a month, so there is no money transfer in a normal trip. The loading time will be very short and the chauffeur is not afraid of being robbed because he has no money from fare collection.



School children normally only need local transport but like commuters their arrival time is important. They can use the dial-a-bus in the same way as the commuters.

Retired citizens often want transport during the day without having a critical arrival time. This means that the operator can call them when it is convenient for the system to collect them. When they are collected, they will enjoy the very easy access to the seat made possible by the individual doors.



Some users (from O to D) will be able to obtain door-to-door transport. Using a midi-ruf it is even possible to obtain a trip without other stops than at the access station (A) and the egress station (B). The operator hopes that there are more passengers from O to A and from A to B and from B to D at this time. If not, the midi-ruf will continue with only one paying passenger. He pays for the luxury of having a very fast and comfortable trip from door to door almost as fast as the privately owned ruf.

“Tram” mode

Trams are normally very popular among the users because of the ride comfort (dedicated lanes and electric propulsion).

The traffic authorities are reluctant because it cost a lot of money to implement tram lines in streets where new rails have to be positioned on top of all kind of installations already placed under the street surface.

It is also very inflexible to make a normal tram line. It cannot easily be moved if the demand changes.

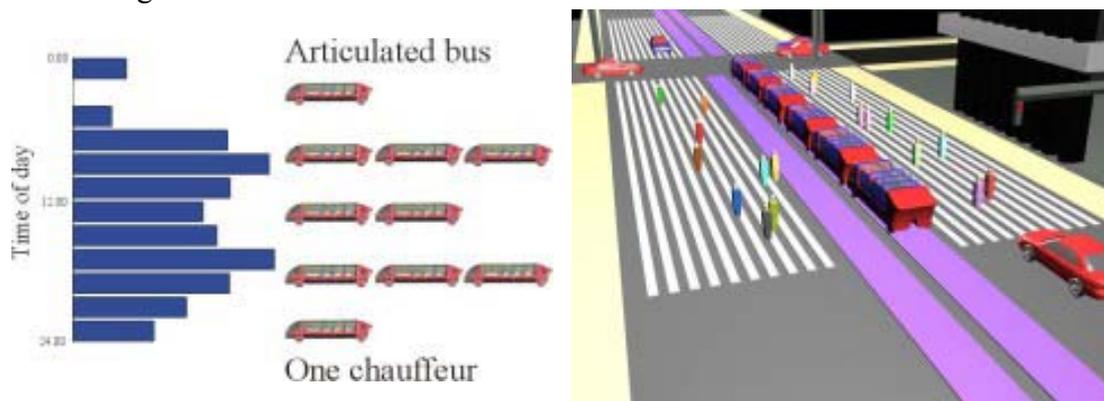


A RUF “tram” solution is much more attractive. It consists of a “train” of maxi-rufs and/or midi-rufs coupled together to form a “tram”. No rails are needed because it runs on rubber wheels. No overhead wires are needed because it runs on battery power. This is possible because the vehicles makes use of the rail network in order to recharge the batteries in between the tram trips.

The users will experience the same high level of service as in traditional trams. The establishing cost of a RUF “tram” system will be much lower and the lines can be changed easily. The only fixed structure is the magnetic guidance wires needed for sharp turns of the “tram”.

Special exit places may have to be organized because unlike traditional trams, a RUF “tram” loads and unloads passengers to both sides. It is possible to organize this in most cases using extra stoplights at street crossings.

The tram can be considered as a kind of articulated bus where the length can be varied in accordance with the demand. The bus is much lighter than a traditional bus and the road damage is much smaller.



Conclusion

Using RUF technology it is possible to arrange public transport in a flexible way which will appeal to many groups in society. Experiences with traditional train technology indicates that it will never be possible to finance a traditional system attractive enough to pay for itself.

Since any society needs public transport it will be advantageous to implement a RUF public transport system in stead of traditional systems. The rail network has a lot of capacity and can later be used for individual electric cars well prepared for the situation when the oil becomes much more expensive.

The solutions using RUF will vary from city to city and from country to country. The many possibilities in a RUF system makes it possible to create a huge market for RUF technology where the standard is the same world wide, but the mix of vehicles differ from country to country.

The future needs more efficient transport solutions. RUF can offer these solutions without limiting mobility and comfort.

Status of RUF

The RUF concept has been developed in Denmark since 1990 with support from Danish Government sources (Ministries of Energy, Environment, Education and Culture). From 2001 RUF has support from the EU program for Sustainable Development and the program for Information System Technology.

A test track with a prototype ruf is operational in Copenhagen and a 1:1 mock up of the maxi-ruf has been built. RUF is supported by several industrial sponsors including Siemens and the political climate for RUF in Denmark is very positive.

The media has shown great interest in RUF. CNN has made a very positive program covering RUF. See:

www.ruf.dk/cnn.doc

