Systems Engineering Analysis and Synthesis

The original design objective for the Ultra system was to identify the ideal system for future urban transport. A requirements analysis for such transport suggested that the optimum system should offer the features shown in the box to the right. This requirements specification formed the basis for the synthesis of an urban transport system. The system which emerged is known as Ultra, originally short for Urban Light Transport.

Ultra Features

- Available on demand
- Non Stop
- Accessible
- Environmentally Sustainable
- Low Cost
- Safe and Secure
- Integrates with other modes

Available on demand

Ultra is an automatically controlled personal taxi system of four-seat vehicles that run on their own segregated guideway network. Transport is available on demand at any of a series of stations distributed around the city like cab ranks. The empty vehicle management system ensures that a vehicle is nearly always available at the station as required. Simulations of many applications have shown that the majority of passengers would obtain immediate service from a waiting vehicle, and wait times in all applications studied to date are comfortably within the design target of 90% of all trip demands met within a minute.

Non stop

All stations are off-line, so once a passenger's journey has begun, they can sit back and relax as there are no intermediate stops, and no congestion – the vehicle takes the passenger straight to their chosen destination. As a result, maximum speeds only need to be 40 km/h (25 mile/h) for most applications, as the non-stop nature of the journey ensures a much higher average speed than

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possible on roads in urban areas (especially during peak times). This gives passengers a greatly reduced journey time when compared to other modes of transport such as car or light rail.

Accessible

Ultra provides car levels of service to non car owners, including the young and the old, and the entire Ultra system has been designed to allow for ease of use by all groups of people. In congested urban areas, Ultra provides a more accessible transport service than is available from the car, or any current form of public transport. A simple user-interface, which can incorporate electronic payment via e.g. a smart-card system, permits any user to request direct transport to any other station on the network.

In addition, the system provides significantly increased accessibility for those with a wide range of disabilities: there is no change in level between platform and vehicle floor, and the vehicle door has been designed to provide a wide opening area to facilitate entry, meeting the access requirements for both the UK (Disability Discrimination Act, DDA) and the US (Americans with Disabilities Act, ADA). Appropriate lifts are provided for high level stations, and stations can even be located inside buildings for added convenience. The vehicle design can accommodate a wheelchair and companion, and wheelchairs can be turned around inside the vehicle to ensure a comfortable journey.

Following discussions with the mobility group of the UK Department for Transport, special emphasis was put on providing a system which meets the needs of the partially disabled (e.g. those who are partially sighted or have movement difficulties). These design considerations also greatly facilitate travel by everyone whose mobility is temporarily restricted by luggage, shopping or children in pushchairs.

Environmentally sustainable

Sustainability issues are critical for 21st century transport. Analysis, shown here in the figure below suggests that most forms of transport, public or private, have similar levels of energy use and emissions output.

Because the Ultra vehicle is electrically powered, there is zero emission at the point of use, but in any case, overall energy and emissions are significantly reduced.

The average system energy usage is 0.55 MJ per passenger km. This can be compared with figures of over 1.2 MJ per passenger km shown for conventional forms of transport; the figure for LRT is even higher, at around 2.4 MJ.

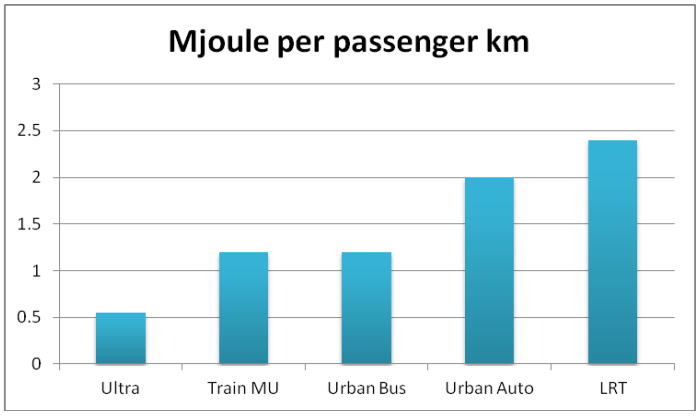

Figure 1: Energy Use for Various Types of Transport

The typical benefit compared with cars is over 70%, and in peak periods when cars (and buses) are restricted by congestion this benefit rises to nearly 90%. This energy saving translates directly into reduced carbon dioxide emissions. The system meets the Kyoto recommendations that carbon dioxide emissions should be reduced by at least 60%. The target date for these recommendations is 2050; Ultra is able to exceed this emission reduction target *now*.
Resource usage is also considerably reduced because of the small scale of the system. Vehicles are reused many times during each day, so each vehicle does the job of many heavier cars. Infrastructure costs and resource usage are reduced by a factor of between six and ten compared with roads or motorways. Because the vehicles require considerably lower power than other forms of transport, there is a significant reduction in noise. Typically the vehicles cannot be heard over background noise levels, even at a few metres.

Low cost

The lightweight infrastructure requirements and ability of the vehicles to be mass produced enables capital costs to be kept low. In addition, the automated control systems remove the need for drivers, and this translates into significantly reduced operating costs. These factors ensure fares can be kept low whilst still providing an attractive return on capital investment.

Costs for a specific application will vary significantly depending on the individual system complexity, and are particularly influenced by the ridership demand the system faces.

Safe and secure

Safety is the prime design requirement for any transport system. Ultra is designed to exceed the best safety standards of modern public transport, and has the numerous safety features described in section 1.6. The detailed concept safety paper developed by Ultra PRT has received a 'Letter of No Objection' from the UK regulator in 2000, and the prototype system was approved to carry passengers in 2003. The Heathrow system has been approved under UK regulations by an Independent Safety Verification Team.

Further, by providing an effective form of transport, which will encourage existing car users to use safer public transport, significant benefits can be projected in terms of fatalities, and serious or slight injuries.

Ultra also offers significant benefits in personal security. As noted above, waiting time is very low (or zero), as the empty vehicle management system ensures that a vehicle is nearly always available at the station waiting for the passenger. Thus, the risks associated with waiting for public transport are almost eliminated. Furthermore, all stations will be under continuous coverage by CCTV, with direct links to the controller available from all vehicles and from all stations via help buttons. In addition, in-vehicle CCTV is an option where required.

Integrates with other modes

The system is complementary to existing forms of transport. By providing a network link (with on-demand access) to major bus and rail stations or to park-and-ride sites, it will improve the attractiveness of these modes. Thus Ultra can contribute to improved transportation in multiple ways: directly, by providing an attractive mode it its own right, and indirectly, by enhancing the appeal of other modes. A stated preference study in Cardiff (UK) suggested that the proportion of people using conventional public transport such as bus and rail would be doubled if there were an Ultra distribution network at the city end of the system.