HNC Engineering Design
Assignment 1 – **Design Report**
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EzzzE *Travel*™

Customer Requirements

A questionnaire style survey took place in Rochester Town Centre where a thousand potential customers where asked about a new mode of transport in the Medway Towns. The idea of **EzzzE *Travel*™** was extremely positive, 927 people answered **YES** when asked 'would they make use of a mono rail type system that ran through the heart of the Medway Towns via popular attractions and landmarks.' The demand for the system was far greater than expected.

Questionnaire Results

From the questionnaire the following customer requirements where identified in order of priority:

1. Safety
2. Reliability
3. Cost
4. Comfort
5. Fast and Efficient
6. Environmentally friendly
7. Accessibility

Design Parameters

The **EzzzE *Travel*™** system must cover the conurbation of the Medway Towns giving transport to those areas in most demand, i.e. popular route.

The **EzzzE *Travel*™** system must be both practical and economical in terms of use and maintenance. **EzzzE *Travel*™** must be driverless but only accessible to either pre-paying customers or ticket on demand basis. Each cab/train must weigh no more than 1000kg and be powered by low power battery or a 'green' fuel. Separate drop-off and access points are required and a Maximum of 6 seated passengers per cab. **EzzzE *Travel*™** must also be logistically practical.

Design Information From Other Sources

ULTra

ATS began developing the ULTra personal rapid transit system in 1995 in association with the University of Bristol. The PRT system emerged from systematic engineering analysis as the optimum solution to urban transport problems, for both the user and non-user of the transport system.

The company has completed the initial phases of prototype development and has undertaken successful passenger trials. The prototype system has consent from the UK Regulatory Authority (HM Rail Inspectorate) to carry the public, which represents a significant milestone. The Company has financed the high-risk initial phases of development from internal sources, from in-kind support by its major partners, and

contract funding from the UK Government and potential customers. Total investment on the project to date from all sources is around £15 m.
The company operates 4 prototype vehicles:

- Demonstration vehicle for static exhibitions
- Demonstration vehicle fully equipped and approved for operation with passengers on the test track at Cardiff
- 2 engineering mule vehicles to develop control software and hardware

The company's test track facility was established in Cardiff by the end of June 2001. This facility contains all the features expected in a typical application, elevated sections, sections at-grade, various banked and unbanked curves, inclines and declines, merges and diverges and a station. The total length of the guideway is just less than 1km.

Cardiff Test Track Elevated Section View

Cardiff Test Track Aerial

In addition the company has a research test track on a six-acre site at Avonmouth Bristol.

Testing Duration

The company's first "A" vehicle started testing in May 2001, with initial testing at the companies Avonmouth Test track in Jun 2001. Testing continued on the Cardiff test track through to June 2002. This vehicle was then redesignated as an engineering test vehicle and has been used since that time for vehicle and control system development. A second "A" vehicle was also made available for Engineering test development in September 2002.

The first "B" vehicle, with a fully representative passenger compartment and automatic door system, was completed in February 2002 and has undergone extensive testing on the Cardiff test track. Total test time to date is over 1000 hours during which the vehicles have traveled a test distance of over 2000 km.

In July 2003, the ATS developed navigation software and hardware was installed in the "B" vehicle, and testing of this vehicle was carried out between that time and the end of September 2004. During this period, the "B" vehicle was tested over 294 hours and traveled the equivalent of over 3000 journeys with no equipment or operational failures being recorded.

Further vehicle system and debris testing has been carried out at Cardiff using the "A" vehicle fitted with upgraded sensors and debris deflectors. This vehicle has also been used to develop the berthing techniques, equipment settings and improved algorithms for the control software.

The track is in continuous use for development work and for demonstrations. Demonstration to a wide range of technical and customer teams has provided over 500 people with direct experience of the ULTra system, with unanimously positive response.

ULTra is an innovative form of Personal Rapid Transit ("PRT"). ULTra (Urban Light Transport) emerged from a fundamental reappraisal of the transport needs of a city. It is designed to meet the expectations of passengers – convenient, inexpensive, reliable, safe and easy to use, while also satisfying public demands for value for money, ease of construction and environmental benefit.

Conventional forms of public transit require passengers to collect in groups until a large vehicle is scheduled to travel on predetermined routes. In contrast, ULTra offers personal transport with no waiting, and takes passengers non-stop to their chosen destination. This is a transport system which is as convenient as, or in congested environments more convenient than, the car, but with minimal environmental impact.

Basic Characteristics of ULTra

The ULTra system exploits modern computing and information technologies to provide a new approach to transport. Off-the-shelf technology, mostly from the automotive industry, provides mature, well proven and reliable systems and components.

Principal vehicle characteristics:

- Four seats
- 500 kg payload
- 40 kph (25 mph)

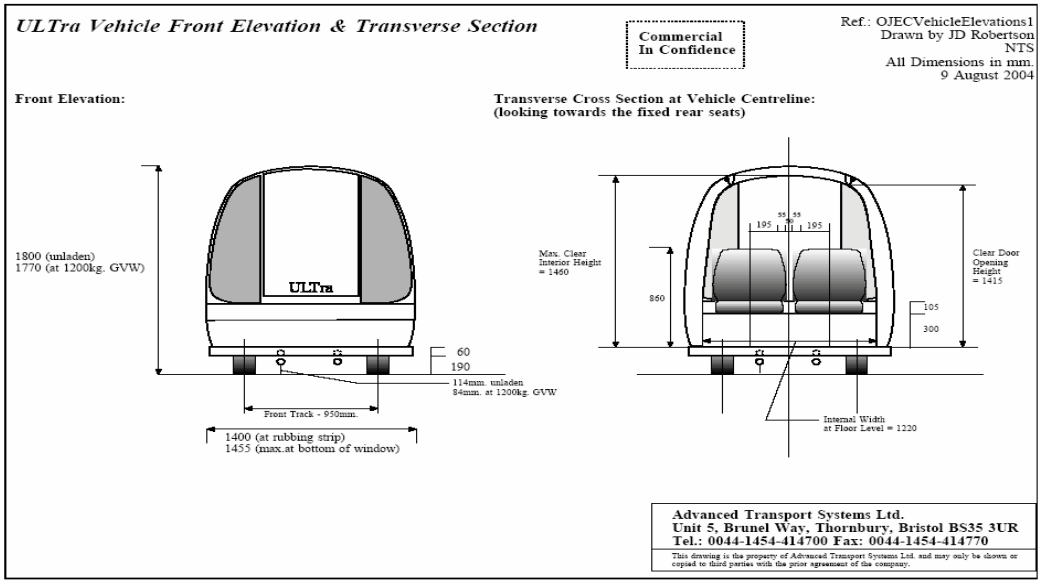
The ULTra system uses a fleet of low power, electrically driven vehicles on a dedicated guideway network of routes. The operation of the system and movement of the vehicles on the network is managed by software and systems developed by ATS.

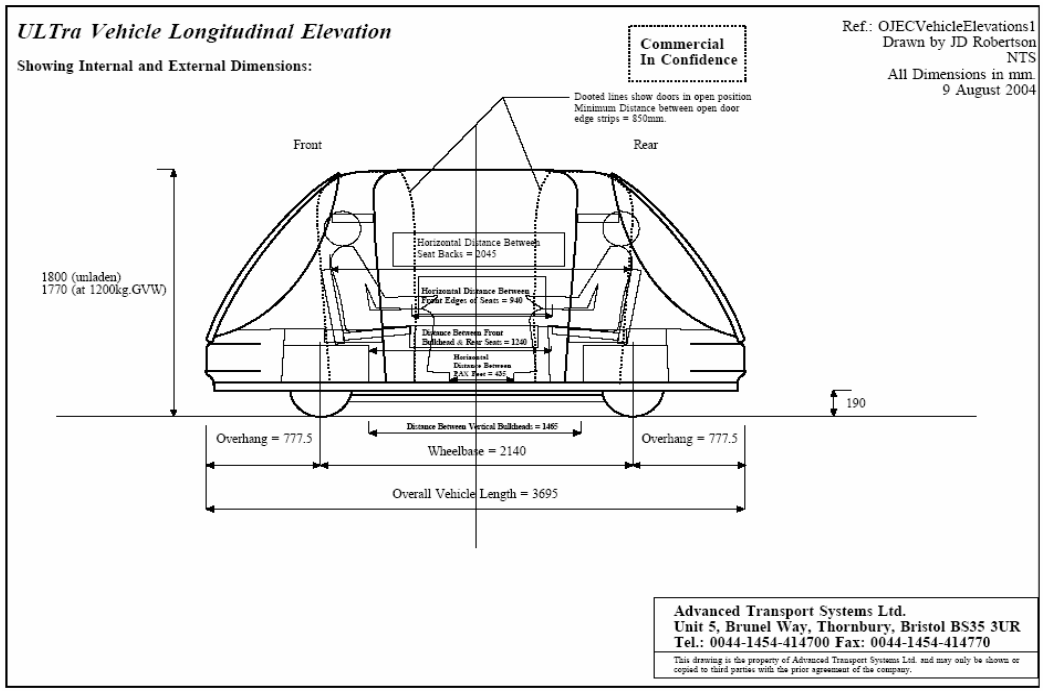
The innovative design of the ULTra system provides unique advantages, notably considerable flexibility in application
ULTra can operate at-grade or elevated either within or external to buildings, offering the opportunity for significant benefits to the passenger. Low loading footprint means that the system can be carried by conventional building structure with no need for structural strengthening.

The vehicle has a small (3.8 m) turning radius and readily copes with grades of 20%, although operating routes are limited to 10% to ensure passenger comfort.

The ULTra system is highly adaptable. Modular design and construction techniques makes addition of further routes straightforward.

Vehicle design of ULTra



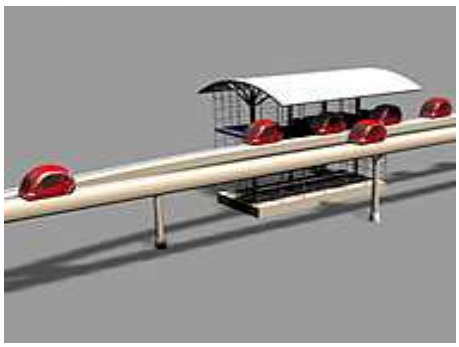


SkyWeb Express

SkyWeb Express is a system of three-passenger vehicles that travel on a network of elevated guideways.

Computer-automated vehicles wait for passengers at each station. Passengers select a destination, purchase a ticket, and enter a vehicle.

A network of rugged, low-cost guideways and stations can be expanded over time. With each grid encompassing half a mile, each station will be within a quarter-mile walk. Substantial traffic can be carried using a tiny fraction of the land required for a freeway and without creating barriers to cross traffic.



Each station is offline, allowing vehicles to travel directly to their destinations without stopping. Of the system's many unique features, this is the most important.

EzzzE *Travel*™ Design specification

EzzzE *Travel*™ Basic Operation

The passenger uses the system by going to the nearest station on the network. Stations are distributed around the Medway area served like bus stops or cab ranks. At each station there are a series of berths at each of which the passenger can select their desired destination. This is done via a smart card process. Because each passenger can be identified by their smart card the service can be personalised to respond to any special requirements of the passenger. The passenger destination selection is passed to central control which provides movement instructions to the vehicle assigned to the berth.

The passenger boards the programmed vehicle which takes them to their desired destination automatically, non-stop and by the best available route. At the destination the passenger leaves the vehicle, which may either wait there for the next fare or, alternatively, be redirected by central control to places with known demand.

The central control system responds to the passengers request by allocating a vehicle for the journey and instructing the vehicle on the required path and timing for that journey. The central control system also controls the empty vehicle management process which ensures that vehicles are sent to where they are needed.

The vehicles are controlled autonomously. Once the vehicle has received its instructions from central control it will continue to its destination without any need for further central control input. Extensive tests have been done of various forms of vehicle control. **EzzzE *Travel*™** has undergone full scale system evaluations tests on various test sites to examine control methods based on wire guidance, optical and radar sensing, embedded track magnets and local sensors based on ultrasonics or lasers. The last two of these approaches were found to be significantly more reliable and robust. A combination of these approaches will be used in the final system.

The ultimate protection on the **EzzzE *Travel*™** system is provided by an independent Automatic vehicle Protection (AVP) system. This is based on a fixed block signalling system parallel to that used on railways. The fixed blocks are defined by inductive loops set into the track which interact with sensing circuits on the vehicle. The overall approach to automatic vehicle control has been approved by HM Rail Inspectorate, who have provided their consent to the carriage of passengers on the prototype system. This followed on a full hazard analysis and failure modes and effect analysis undertaken in conjunction with industry safety specialists. The documentation resulting from these analyses provided the basis for the HMRI evaluation and consent.

Benefits of EzzzE *Travel*™ to the consumer

- **EzzzE *Travel*™** offers immediate service, Passengers rarely need to wait for a vehicle, since the empty vehicle management system ensures that one will already be at the station. Simulations demonstrate that average waiting times, even in peak periods, average around 10 seconds.

- Non stop travel due to off-line stations, the journey is non stop from start to destination, anywhere on the network. No need to plan trips, consider schedules, or transfer between vehicles.

- **EzzzE *Travel*™** is faster than other urban transport, typically by a factor of two or three. Although maximum speeds are modest (25 mph), non-stop service ensures short trip times.

- **EzzzE *Travel*™** is reliable, predictable and congestion free affording passengers greater certainty in their journeys.

- **EzzzE *Travel*™** is safe: **EzzzE *Travels*™** target is safety levels at least as good as trains, approximately 10 times higher than automotive safety. Also segregation implies less conflict with non-users.

- Accessibility: The **EzzzE *Travel*™** system is available to all, including the young, the old, and those with disabilities.

Benefits of EzzzE *Travel*™ for the Environment and Community

- **EzzzE *Travel*™** is energy efficient: Light, small, efficient vehicles traveling non-stop and only on demand result in significant energy savings. **EzzzE *Travel*™** saves 2/3rds of automotive energy requirements, and is substantially more energy efficient than conventional public transport.

- **EzzzE *Travel*™** meets Kyoto sustainability targets; providing the required 60% reduction in carbon emissions over the car now, rather than by the 2050 target date of the Kyoto agreement – 35 years ahead.

- **EzzzE *Travel*™** is exceptionally quiet: measurements on the prototype vehicle running at 6m/s give 35dBA at 10 m, around 30 dB less than cars.

- Lightweight vehicles permit ultra-light infrastructure: Automated control allows high utilization. Small vehicles and guideways imply less land take and less visual intrusion.

- **EzzzE *Travel*™** reduces congestion: Studies indicate significant modal shifts away from the car, freeing up both road capacity and parking space.

EzzzE *Travel*™ Track Dimensions

Overall Steel/Concrete Elevated Track Width (m.)	2.1
Overall Concrete At-Grade Track Width (m.)	1.75
Internal Track Width (m.)	1.6
Internal Track Height (m.)	0.25
Typical Elevated Track Headroom for main road crossings (m.)	5.7
Typical Elevated Track Headroom for pedestrian crossings (m.)	2.5

Approaches to ice and snow control have also been prepared for applications in cold climates.

The Route

The proposed route for **EzzzE *Travel*™** is quite simple and includes all the main attractions and popular 'stop-offs' in the Medway Towns for example Dockside Outlet, Rochester Castle, Gillingham football ground, the Historic Dockyard and museums, Fort Amherst, Royal Enginners Museum and of course the high streets of Rochester, Chatham and Gillingham. The new housing development that is taking place alongside the river Medway in Rochester will also be included. This will be ideal, as part of the route can run alongside the river Medway from Strood (Medway City Estate).

The map on the next page shows the proposed route.

EzzzE *Travel*™ will begin and end at the Medway City Estate in Strood, it will follow the river Medway until it reaches the Parallel road and train bridges that pass over the river Medway between Strood and Rochester it will run alongside these bridges through Rochester following the route of the train line, then up towards the City Way College campus. **EzzzE *Travel*™** will then journey towards Chatham alongside New Road (A2) and around Chatham High Street, on towards Dockside Outlet via Fort Amherst. **EzzzE *Travel*™** will pass behind the new mid-kent college and Kent Police Department and towards Gillingham where **EzzzE *Travel*™** will loop round and begin to ascend via Luton up towards Horstead Retail Park, ASDA and the Horstead College campus, it will then run parallel with the M2 towards the Medway Bridge it will run alongside the bridge across the River Medway and descend to the original start point at Medway City Estate.

Proposed 'Stations'

EzzzE *Travel*™ 'Stations' are to be developed at the following sites:

Medway City Estate	Strood	Main Terminal Station. Access to Amadeus Nightclub, Cinemas and Health Spa.
Knight Road	Strood	Access to Strood High St and Town.
Corporation Street (opposite Library)	Rochester	Access to Rochester Town, new housing estate, Museum and Castle.
New Road (opposite KIAD)	Rochester	Access to KIAD Mid-Kent College (City Way) and Fort Pitt Grammar School.
Globe Lane (opposite Library)	Chatham	Access to Chatham High St Fort Amherst and Kitchener Army Barracks.
Maritime Way	Chatham	Access to Historic Dockyard, Dockside Outlet and New Mid-Kent College
Medway Road (Behind New Kent Police)	Gillingham	Access to New Kent Police Station.