

## Passenger Response to a PRT System

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### ABSTRACT

A series of evaluations of passenger response to use of the ULTra PRT system has been carried out. These include questionnaire studies using a static prototype vehicle, carried out in Bristol and Cardiff (232 responses) and two sets of passenger trials on the prototype ULTra system in Cardiff using 53 subjects. This provided a full trip experience for the users, and has given the first information based on a complete experience of a PRT system.

Major features from the studies to date are

- There have been strongly positive response to the system in essentially all respects
- In particular there has been little negative response to the overhead infrastructure.
- Responses have uniformly suggested that passengers are prepared to accept higher fare levels than buses for the trip. Per vehicle fares of around £2 (\$3) are regarded as acceptable.
- Passenger trials have shown uniformly positive results. In particular, no passengers stated that they felt insecure in the small scale automated system.

Generally results from passengers who had the full trial experience show little difference from those who only experienced the static prototype. The only major feature appears to be that passengers who have experienced a ride on the system are prepared to pay a higher fare. The results have demonstrated extremely positive response to the use of a PRT system. These results, consistent over four separate studies, are regarded as strong evidence of the acceptability of PRT systems in general to the public as a whole.

### INTRODUCTION

An important question on the potential application of PRT systems is their potential acceptance by the public. Previous work eg Rosenblad (1998) used simulated environments within a full scale cabin with a small number of subjects. The availability of a new full scale system has provided the opportunity for a series of studies of passenger response to a real situation.

The ULTra PRT system is currently under development in the UK cf Lowson (2003) and [www.atsltd.co.uk](http://www.atsltd.co.uk). The system uses four-seater battery-electric vehicles automatically steered on rubber tires on a segregated guideway. The vehicles have a maximum speed of 40 kph, (25 mph) and operate non-stop from origin station to destination station, with all stations being off-line. Vehicles are available on electronic demand as the passenger arrives at a station: for most passengers there will already be a vehicle waiting, but if there is not the nearest empty vehicle will be called up automatically, so that average waiting times are very short. The system is intended to provide transport as good, or better than, the car, without the disadvantages of congestion and pollution. A prototype system is operating on a 1 km track in Cardiff Wales.

A number of questionnaire studies and full passenger trials have been undertaken with the objective of evaluating public response to use of a PRT system. The work included:

1. Questionnaire studies using a static prototype vehicle, carried out in Bristol and Cardiff (232 responses). This was intended to provide information on overall response to the system.
2. Two sets of passenger trials on the prototype ULTra system in Cardiff. This provided a full trip experience for the users, and has given the first information based on a complete experience of the system, albeit on a modest number of subjects (53 to date).

This paper compares the results from these studies.

## **2. QUESTIONNAIRE SURVEYS**

### **2.1 Introduction**

These surveys were undertaken in Bristol and Cardiff respectively in 2001/2002. In both cases the questionnaire process was similar. A static prototype ULTra vehicle to “A” model standard was used as the focal point of a display on the ULTra system. In Bristol this was undertaken in association with the “free streets” display in Bristol, organized by Arup in conjunction with Advanced Transport Systems. In Cardiff the process was undertaken in the Capitol Shopping Center by ATS.

Respondents were self selected from those who viewed the display. This could lead to a degree of bias. Also although the respondents could get a full impression of the vehicle, their perception of the track could only be obtained from pictures and explanations. The questionnaires were completed in Bristol by 138 people of whom 44% were male and 56% female and in Cardiff by 94 people of whom 66% were male and 34% female

The only noteworthy difference between the two groups was a greater tendency of Cardiff respondents to use public transport. (18% made daily use in Cardiff compared to 10% in Bristol). In view of the minor differences between the results for Bristol and Cardiff, the results from the two studies have been combined here. The Bristol results were reported separately in Lowson (2003).

The questions put together with the answers in percentage terms and a brief discussion is given in the next section.

### **2.2 Response and Discussion**

#### *Acceptability as transport*

The answer to the first question suggests that PRT would find ready acceptance as a transport mode. Comparing the answers to the first and last questions, it can be seen that the figures for the potential usage of PRT are typically double the current usage of public transport in each of the first three categories. It appears that PRT does offer a significantly more attractive form of public transport.

#### *Appearance*

The responses to questions 2 to 4 relate to the appearance of the system. No respondent felt that the vehicle appearance was poor, indeed the majority thought the vehicles would look excellent. Response to the interior arrangements was also very positive although not as strongly positive as the external appearance. Several forms commented on the need for bicycle carriage, although note that the “free streets” display in Bristol attracted a disproportionate number of bicycle users. The visual appearance of the elevated structure was regarded generally as good, with 29% rating it excellent.

It is especially noteworthy that the response to the elevated track gave a notably positive response, with no definitely negative responses and only 2.6% feeling that it could be difficult.

1. If an ULTra system were available I would probably use it	Several times a day	A few times a week	Several times a month	Very occasionally	Never
	18.5%	45.3%	23.7%	11.6%	0.9%
2. How do you feel the ULTra vehicles would look in the City?	excellent	good	average	poor	awful
	59.0%	35.7%	5.3%	0.0%	0.0%
3. How do you rate the internal arrangements of the ULTra vehicle?	excellent	good	average	poor	awful
	44.2%	50.9%	4.4%	0.4%	0.0%
4. How do you rate the visual appearance of the elevated track?	excellent	good	average	poor	awful
	40.4%	40.8%	17.5%	1.3%	0.0%
5. How do you feel about an ULTra elevated track in the City?	No problem	Probably OK	Not sure	Could be difficult	Definitely negative
	58.3%	28.3%	10.9%	2.6%	0.0%
6. Would you be prepared to pay more or less to use Ultra than a Bus?	More	Equal	Less		
	71.2%	11.0%	17.8%		
7. Would you be prepared to pay more or less to use Ultra than a Train?	More	Equal	Less		
	22.4%	17.6%	60.0%		
8. Would you be prepared to pay more or less to use Ultra than a Taxi?	More	Equal	Less		
	10.8%	16.5%	72.6%		
9. What per vehicle fare are you prepared to pay for a 2-3 mile ULTra trip?	50p-£1	£1-£2	£2-£3	£3-£5	More than £5
	19.7%	50.9%	24.3%	4.1%	0.9%
10. Would you use and be happy with a smart card payment system - no cash?	Yes	Not sure	No		
	82.2%	14.3%	3.5%		
11. Would you want to be able to pre-book your trip by computer?	Very important	Useful	Don't care	No benefit	
	10.5%	58.3%	19.3%	11.8%	
12. Would you want to be able to pre-book your trip by telephone?	Very important	Useful	Don't care	No benefit	
	14.2%	61.3%	15.1%	9.3%	
13. How close to your house would you wish an ULTra station to be?	Less than 100 yds	Less than ¼ Mile	Less than ½ mile	Less than 1 mile	More than 1 mile OK
	11.5%	45.6%	18.9%	14.7%	9.2%
14. Could you tell us your age?	Under 15	16-24	25-49	50-64	Over 65
	4.8%	14.0%	54.8%	16.7%	9.6%
15. I travel into the City	Every Day	Twice a week	One a week	Very occasionally	Never
	44.4%	21.1%	17.0%	15.2%	2.2%
16. I use public transport in the City	Every Day	Twice a week	One a week	Very occasionally	Never
	13.6%	15.8%	13.6%	40.8%	16.2%

Table 1 Response to Initial Questionnaire Studies

### *Fares*

The question about fares compared to bus/train or taxi gave overall results which seem reasonable. It is striking that 71% of people appear willing to pay a higher fare than the bus to use ULTra. 11% stated that they were prepared to pay higher than current taxi fares.

This result is consistent with the results for acceptable fare levels, question 9. The mean acceptable fare taking mid points of the fares distribution, weighted by the number of replies, is £1.74 (\$2.88).

Several comments on the forms suggested that the system should have a subsidized fare.

### *Payment and Booking*

82% of respondents are happy with a smart card payment system, no cash. Only 3% are opposed. Perhaps surprisingly, there is no correlation of reluctance to pay by smart card with desire for low fares. No respondent wishing to pay the lowest fare insisted on paying by cash. About 70% of those surveyed stated they would find computer or telephone booking useful.

Analysis of the comments suggests that several of the respondents had not fully appreciated the on-demand nature of the system. However, the good level of support for computer/telephone booking remains a valid conclusion.

### *Station Location*

57% of respondents would wish the station to be within ¼ mile or less of their home, although 24% appear happy to walk up to a mile or more. There is no apparent correlation of this response with age or with responses to other issues such as visual intrusion.

### *Current Non Public Transport Users*

It will be seen from Question 16 in that 57% of the respondents either never or very occasionally (ie rarely) use public transport. An analysis of the replies to Question 1 "If an ULTra system were available I would probably use it" gave the following results.

several times a day	a few times a week	several times a month	very occasionally	Never
25.6%	37.8%	24.4%	12.2%	0.0%

Table 2 Projected use by non public transport user

It is clear that users who are unwilling to use existing public transport would be very prepared to use PRT.

### 3. PASSENGER TRIALS

#### 3.1 Introduction

The objectives of the passenger trials were to obtain views, comments and reactions from members of the public to a number of aspects of the ULTra system including:

- Ease of use (for both able-bodied and disabled passengers), including:
  - entering a station, selecting a journey and entering a vehicle
  - giving the start command and riding in a vehicle to a set destination
  - disembarking from a vehicle and leaving a station
- Sense of security
- Comfort (seating and ride) and ambience (including colours and styling)
- The overall ULTra experience

Two sets of passenger trials were undertaken on the ULTra prototype test track in Cardiff. The first trials took place in Jan 2003, and were based on a set of 18 volunteer subjects. These were managed by ATS. The second set of trials, undertaken under the EDICT project, were undertaken in May 2003 and designed to be as free from bias as possible. These trials were conducted by Transport and Travel Research Ltd. Professional recruiters were deployed to ensure that, in addition to the targeting of socio-economic groupings, groups represented an equal gender distribution, a wide distribution of age, and a variety of car ownership and travel behavior. Some of the groups were targeted at sections of the population who might be excluded from other public consultation exercises. These include people who are elderly, or who have a disability. Such groups comprise a significant proportion of the potential users of any public transport system as well as of other public services. The approach ensured a wide variety of responses from a variety of socio-economic groupings

Both trials followed the same format including use of a simple station, a functioning representation of the destination request panel, the “B” model vehicle and a typical journey comprising a number of circuits of the test track. The general appearance of the Cardiff test track for the passenger trials is shown below.



Figure 1 General View of Cardiff Test Track Showing Station

The station used was of a type that would be suitable for a 'Park and Ride' situation where small stations need to be distributed around a large car park. A typical city center station would be considerably larger with better access facilities, including lifts where the station is elevated.

Within the station a 'gate' allowed access to the vehicle for able bodied and those in a wheelchair, at which was situated a simplified demonstration model of an ULTra journey selection system, or 'Destination Panel'. Passengers could select from a choice of destinations displayed on a computer-generated map. As a passenger changed their choice of destination it updated the map display and the name was spoken automatically (to assist blind and partially sighted passengers).

Upon confirmation of a passenger's destination, the vehicle doors would open to admit them. Once the passengers had embarked and the vehicle doors were closed, the journey would commence under automatic control.

The journey comprised two circuits of the test track giving a total trip length of 1.4km. The test track is in a figure of eight arrangement and contains all the major features that are likely used in city center applications including:

- guideway at grade and elevation
- gradients (10% inclines and 6% declines)
- merges and diverges
- station



Figure 2 Photographs of the ULTra Prototype System as used in the Trials

**Safety**

Prior to the commencement of the trials HM Rail Inspectorate reviewed the ‘Safety Case for the Passenger Trials’, inspected the test track, traveled in the test vehicle and had the safety systems demonstrated. HMRI then issued a ‘consent letter’ that allowed the trials involving the public to go ahead, saying that they considered the Safety Case to be robust.

**Trial Procedure**

A total of 18 passengers took part in the first trials, including both disabled and able-bodied persons, and 35 passengers in the EDICT trials, which included a specific group representing those with disabilities. For the first trials the experience was limited to the ride around the track. For the EDICT groups a focus group discussion also took place and a questionnaire modeled on that described earlier was also completed. This provides the opportunity to establish any difference between answers based on a “theoretical” experience based on a static vehicle and the complete experience including the ride.

Each group of passengers made two trips on the ULTra vehicle:

- The first trip was accompanied by a member of the ATS staff, allowing the passengers to become familiarised with the ULTra system
- The second trip was unaccompanied (i.e. without an ATS staff member), allowing a realistic impression of the ULTra system to be obtained.

A short briefing was given to each group of passengers between the two trips, indicating the characteristics of the ULTra system that they were being asked to assess.

**3.2 Results**

Upon completion of their second trip, each passenger was invited to fill out the passenger trials' questionnaire by putting an ‘x’ against the characteristics that best described their view. The questions and each passenger’s response to the questions have been analyzed and the overall results are summarized in the figure below and accompanying table. The figure shows overall results against a rating from “Excellent” to “Very Poor”. The questions posed differed slightly from attribute to attribute and the precise response is shown in the table.

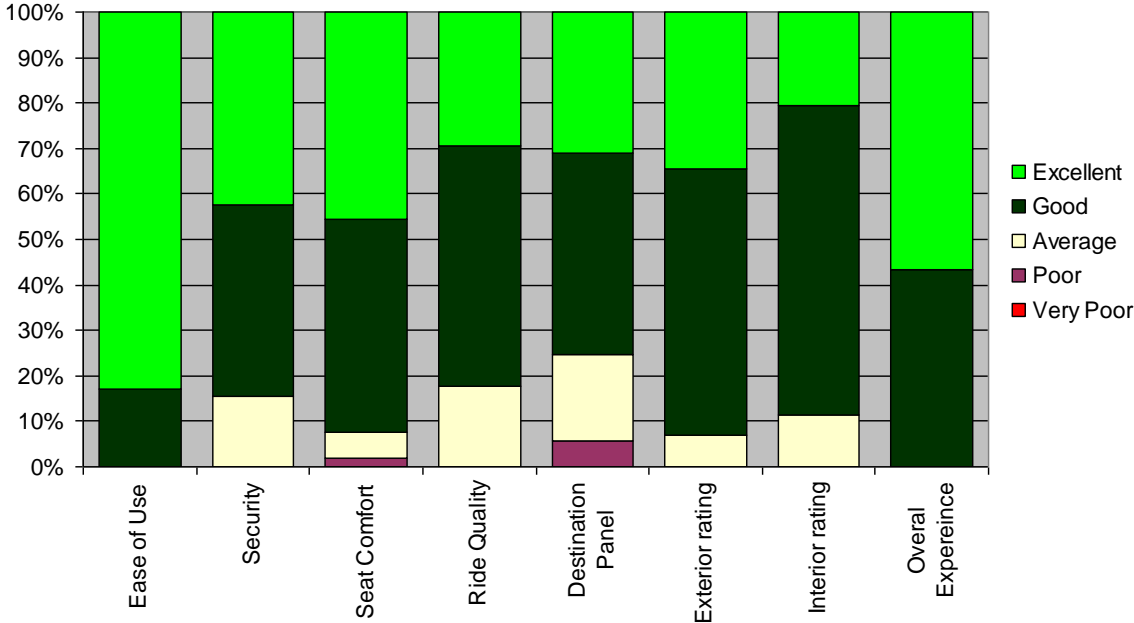


Figure 3 Summary of Results of Passenger Trials

<i>How easy did you find the ULTra System to use?</i>	Very Easy	Easy	OK	Difficult	Very Difficult
Response	83%	17%	-	-	-
<i>Did you feel secure using the ULTra System?</i>	Very Secure	Secure	OK	Insecure	Very Insecure
Response	42%	42%	15%-	-	-
<i>How comfortable was the seating arrangement in the ULTra vehicle?</i>	Excellent	Good	Average	Poor	Very Poor
Response	46%	47%	6%	-	-
<i>How would you rate the quality of the ride (bumpiness/jerkiness)</i>	Excellent	Good	Average	Poor	Very Poor
Response	29%	55%	18%	-	-
<i>How easy do you rate the destination panel to use?</i>	Excellent	Good	Average	Poor	Very Poor
Response	31%	44%	19%	6%	-
<i>How do you rate the colours and styling of the vehicle exterior?</i>	Excellent	Good	Average	Poor	Very Poor
Response	34%	59%	7%	-	-
<i>How do you rate the colours and styling of the vehicle interior?</i>	Excellent	Good	Average	Poor	Very Poor
Response	21%	68%	11%	-	-
<i>How did you rate your experience using the ULTra System?</i>	Very pleasant	Pleasant	OK	Unpleasant	Very Unpleasant
Response	57%	43%	-	-	-

Table 3 Summary of Responses from Passenger Trials

Evaluation has indicated essentially no difference in response between the first and EDICT trial groups so that the results of the two trials have been combined.



The exception to this is on ride comfort. The first set of trials revealed an unacceptable standard of ride with 22% of the passengers rating the ride either poor or very poor. This led to a redevelopment program for the suspensions and control systems. The improved system was used for the EDICT trials. The results for the ride quality shown in the table refer to the second trial set only, which had the upgraded and more representative suspension system. In the operational system it is expected that track surface and thus ride quality would be further improved over the prototype surface which is predominantly of poured concrete.

The responses were extremely positive, indicated by the high proportion of responses in the two left hand columns. The results speak for themselves. All passengers found the system either easy or very easy to use. All passengers rated their overall experience of the system either pleasant or very pleasant. Rosenblad (1998) also found that all subjects were in favor of PRT.



Figure 4 The Initial Passenger Trials

In the EDICT trials a proportion of the subjects did voice concerns about claustrophobia, security, overall system viability etc before the trials. In every case these concerns were allayed by the actual trip experience. Personal security whilst waiting at the station and getting into the vehicle was also an issue of concern, but respondents indicated that they would feel safer knowing that CCTV is in-vehicle, at station, and monitored 24/7. The key concerns expressed in the Focus Groups concerned vandalism and the potential problems of installing a track in a historic part of the city. The focus groups highlighted the following features they liked most:

- *“modern technology”*
- *“very quick, direct, no waiting”*
- *“lack of queues”*
- *“own space, can choose to travel alone”*
- *“no frustration, no road rage”*
- *“good for the environment”*
- *“you haven’t got to argue with drivers”*
- *“not worrying about who else is in the carriage”*
- *“easy to switch on.”*
- *“no driver”*
- *“more accessible than current public transport modes”*

#### 4 COMPARISON OF RESULTS

It is of interest to compare the results of the full passenger trials with the questionnaire results from people who had no opportunity to have a complete experience of the system. Analysis revealed little change between the results from the two groups. There was a slightly less positive response to the internal arrangements and external appearance of “B” vehicle used on the test track trials than to the “A” vehicle used for the first questionnaires. Most other issues showed minimal difference. A comparison for the two most significant issues is given below.

An important issue is the possible concern about overhead track. Rosenblad (1998) found this was a significant negative issue. However those subjects and the present questionnaire group only had the opportunity to examine pictures of the track. The trials group had the opportunity to see the actual overhead track that would be employed in practice. In both cases the response is very positive, although there is a slightly less positive set of results from people who have seen the track. On the other hand the only negative response came from those who had not seen the track.

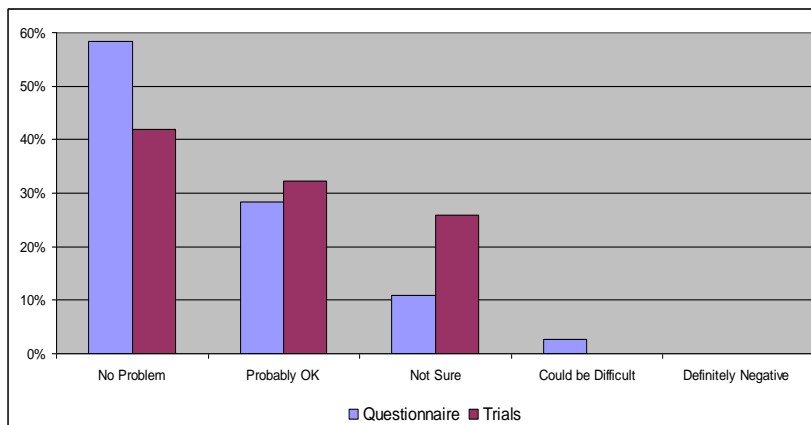


Figure 5 How do you feel about an elevated track?

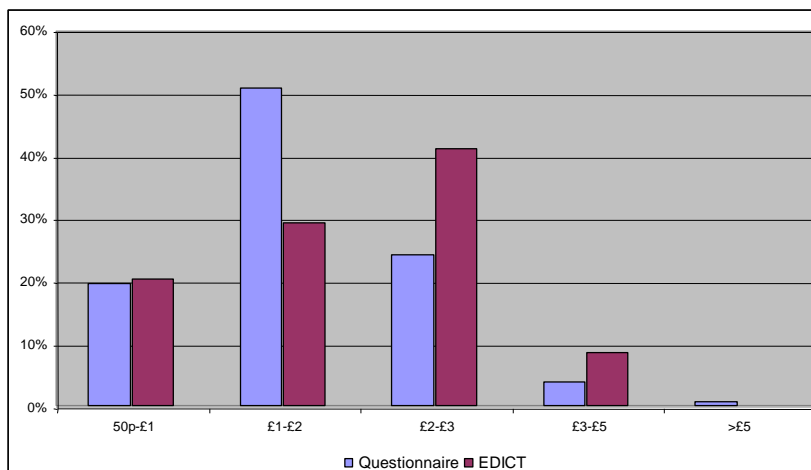


Figure 6 What per-vehicle fare are you prepared to pay for a 2-3 mile ULTra trip?

A surprising result was on the fare which was regarded as reasonable. Commercial evaluations of the ULTra system have generally used a financial case based on a fare of £1 per vehicle. (£1 UK = \$1.6 US) As already noted, the original questionnaire results demonstrated a willingness to pay a higher fare. It was of special interest to find that the fare level regarded by reasonable by persons who had experienced the ULTra system was even higher. This is shown in the EDICT results of Figure 6 above.

The average fare regarded as reasonable increased from £1.74 from the questionnaire results to £1.98 (ie over \$3) for those who had actual experience of the system.

The discussions in the focus groups provided an interesting explanation of these responses. Most evaluations of PRT against public transport use the bus as the basis of their fare comparisons. It was clear from the focus group discussions that bus transport was regarded as second rate, with participants being unhappy with the standard of service provided. The focus groups comprising elderly and disabled respondents avoided bus travel where possible as they found it inaccessible, inconvenient and/or uncomfortable.” Many people without access to a car often preferred to use a taxi even though they had access to bus routes. The ULTra system was regarded as filling a gap in the existing transport network and as offering equivalent service to a taxi. Potential passengers therefore made their fare comparisons against taxis and regarded the fares of £2-£3, (\$3-\$5) half of equivalent taxi fares, as very good value.

It is very encouraging from the point of view of PRT developers that the result of providing a fuller experience of the system is a willingness to pay a higher fare. This can also be regarded as a measure of the level of satisfaction with the overall experience.

## 5 OTHER ISSUES

### 5.1 Use by Those with Disabilities

The initial trials had some passengers with disabilities, who responded very positively to the capabilities offered by the system. For the EDICT trials one focus group concentrated on an evaluation of the suitability of the system for those with disabilities. Again an extremely positive response was found. The general view amongst those surveyed was that an ULTra was excellently matched to their personal needs. They particularly appreciated being in full control of the trip, and that they could make their trip without interfering with, or with interference from, other people.

Connection to a park and ride was regarded as especially valuable

*“It would be totally independent for us [disabled travelers], because we could just drive there and get on... and I don't have to find someone who is willing to help.”*

A fuller evaluation of the value of the system for those with disabilities is provided in a report by Oxley (2003). This report points out that although the present vehicle is well laid out for wheelchairs and exceeds statutory requirements in this regard, detail aspects, for example color contrasting and related aspects to aid the visually impaired, still require to be improved.

### 5.2 Station separations

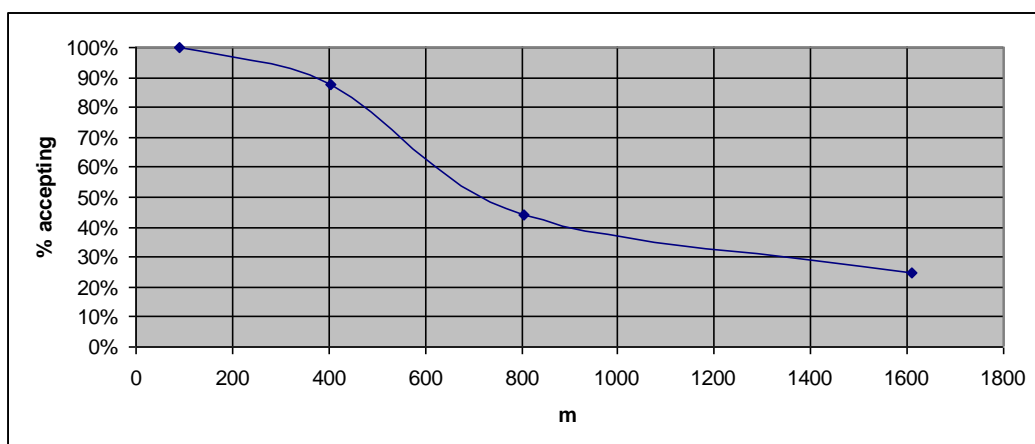


Figure 7 Acceptable walking distances

One issue of special interest to PRT developers is the distance to the station. There was little systematic difference between the groups in their response to this question. An overall figure from the 248 people who responded to this question is shown in Figure 7. In this chart it assumed that, for example, people who replied <1/4mile were prepared to accept distances up to ¼ mile. Figure 7 is integrated from these results. It will be observed that approx 90% of all respondents are prepared to accept walk distances up to ¼ mile (ie ~400m), while walks up to ½ mile (~800m) will be unattractive to more than 50% of the population. These results are consistent with the accepted recommendation that walk distances up to 400m are very acceptable.

## 6 CONCLUSIONS

1. All responses are strongly in favour of the PRT system
2. There is little difference in response between those who examined a static vehicle and those who had a complete ride experience.
3. All the passengers found the system 'easy' or 'very easy' to use.
4. No passengers (including those with disabilities) found the system, which included running on an elevated bridge section, to be insecure.
5. 90% of the passengers found the seating arrangement and interior styling to be 'good' or 'excellent'.
6. 82% of the passengers found the quality of the ride to be 'excellent' or 'good'. This followed a development program specifically aimed at improving ride quality
7. Over 90% of the passengers considered the vehicle exterior colour and styling to be 'good' or 'excellent'.
8. Passengers with disabilities responded very positively to the new opportunities available to them with a PRT system.
9. Passengers who had experienced the ride were prepared to pay a higher fare for the trip.
10. All passengers considered the overall ULTra experience to be 'pleasant' or 'very pleasant'.

With any public transport questionnaire study there will be a question as to the correlation of the responses provided with actual change of behavior given a real system. In the present case the focus group studies, in particular, are believed to have given robust results, which show little difference to the results from the other work. Thus it is believed that the results are representative of likely response to a PRT system which was publicly available.

## ACKNOWLEDGEMENTS

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