Archives and Records

Executive Summary:

This study examines data regularly maintained by the AATA for evidence of AOS impact. These data include on-time performance, bus trips broken because of maintenance or other incidents, time lost due to broken trips, on-road incidents and passenger complaints. On time performance data were still being compiled at the time of this study. Other data sets did not reveal conclusive evidence of AOS impact, though declines in on-road incidents and passenger complaints were potentially suggestive of benefits.

Overview of AATA's Advanced Operating System

In the fall of 1998, the Ann Arbor (Michigan) Transportation Authority began deploying advanced public transportation systems (APTS) technologies in its fixed route and paratransit operations. The project's concept is the integration of a range of such technologies into a comprehensive system, termed the "Advanced Operating System" (AOS) to "smart buses", "smart travelers," and a "smart operation center" to benefit from timely and coordinated information on critical aspects of transit operation and maintenance. The prime contractor for the project was Rockwell, and providers of other integrated subsystems included: Digital Recorders Research of Triangle Park, North Carolina; Trapeze Software of Mississauga, Ontario; Prima Facie of King of Prussia, Pennsylvania; REI of Omaha, Nebraska; Red Pines Instruments of Denbigh, Ontario; and Multisystems, Inc. Cambridge, Massachusetts. Evaluator for the project was a team from the Urban and Regional Planning Program of the College of Architecture and Urban Planning, University of Michigan.

"The Smart Bus"

Central to the system is the deployment of automatic vehicle location (AVL) technology in order to provide continuous real time data on the location of transit vehicles. Each bus determines its location using global positioning satellite (GPS) technology; differential corrections are broadcast to the vehicles so they can calculate their locations within one or two meters. A Mobile Data Terminal (MDT) in each vehicle stores complete route schedules on an insertable memory card. The GPS system provides accurate time to the vehicles. Buses compare scheduled times and locations with actual locations to determine their schedule adherence. If a bus determines that it is running late, the driver is advised, and if necessary, the onboard computer notifies the Operation Center. The AVL also triggers an outside destination announcement and the internal next-stop signs and announcement. It also integrates location data with fare collection, electronic controlled engine data and ultimately, automated passenger counters,

The AATA network makes use of extensive timed transfers at four major transfer points. When a bus is running behind schedule, AOS enables digital bus-to-bus communications to improve the transfer between buses; the driver of the first bus can send a digital request (that includes the bus' location) to hold the second bus to ensure that a passenger will not miss a desired transfer.

Video surveillance is provided on board vehicles for security, as well as to help resolve any claims that may arise.

On the paratransit side, drivers receive their entire schedules and mark their arrival and departure times with date, time and location information as well as all the features above.

"The Smart Operation Center"

The AATA Operation Center collects and acts upon information provided by the transit vehicle and drivers. Each AATA bus has an 800 MHZ radio and onboard computer. The system minimizes voice transmissions by providing data messages that summarize vehicle status, operating condition, and location. Out-of-tolerance engine conditions such as oil pressure and temperature are reported in real time to the onboard computer, the Operations Center and the Maintenance Department.

Through the use of real time displays of vehicle location and schedule adherence reporting, dispatchers working at the Operation Center can manage the system and assist drivers by inserting overload vehicles in the system or recommending re-routing options. All changes to the route and schedule database are noted and automatically updated.

Onboard the vehicle, the driver has an onboard emergency system. When encountering a life-threatening situation, the driver covertly alerts the dispatcher, who immediately notes the vehicle's location on the system's center map and dials the appropriate agency. The system also allows the dispatcher to open up a central public address system inside the vehicle to monitor the situation. The system also supports responsive reporting of routine, non-life-threatening emergencies, such as passenger inconvenience.

For paratransit vehicles, reservations, scheduling, flexible integration with fixed-route, and after-trip information utilize Trapeze software. All of these elements are based on real-time information generated with the Rockwell TransitMasterTM software.

"The Smart Traveler"

The "smart travler" a person informed about his or her transportation options, as well as about current conditions relative to transit use. Inside the bus, next stop announcements, date, time and route are given to passengers utilizing the onboard public address system and a two line LED display. The driver also has the ability to trigger timed and periodic announcements for special events that can be made to support the system. Outside the bus, the current route information is announced to waiting passengers, and the destination signs are changed based upon the location. Kiosks will provide real-time bus location information at selected locations; ultimately this information will be provided to travelers at their home or workplace via telephone, cable television or internet.

Evaluation Data from AATA Records

A major component of the information required to evaluate AATA’s Advanced Operating System (AOS) is found in regularly collected records of the authority. This report details the current inventory of after-implementation data. These data serve as the after period to compare to the previously collected baseline data. Archive and records data are available in three areas:

- Schedule adherence
- Broken trips (i.e., trips interrupted because of mechanical or human incidents)
- Reported on-road incidents by category

Schedule adherence is potentially influenced by automatic vehicle location applications such as pacing information and real time vehicle location available to drivers and dispatchers. Broken trips and on-road incidents may be reduced through a combination of video camera recording inside buses, covert and overt alarms available to drivers, and automatic monitoring of vehicle systems (i.e. DDEC engine monitoring).

Schedule Adherence

Schedule adherence data collected by hand before AOS implementation will be compared to data collected automatically after implementation. Due to data limitations, he latter data were still being compiled at the time this report was written.

AATA Broken Trip Data

AATA route incidents are recorded by on-duty supervisors. One set of recorded information includes data about broken trips, i.e. trips that were interrupted because of vehicle or passenger related event. The following data was recorded from supervisors' hand data ranging from January to June during 1997 and 1998, with the latter period representing the period after AOS implementation.

The frequency of broken trips are sorted by month, route number, minutes late and bus number. Table 1 demonstrates no positive impact of AOS on broken trips overall; the frequency of trips grew from 46 to 65 between the two periods.

Table 1. Frequency of AATA Broken Trips, January through June

Month	1997	1998
January	7	6
February	6	13
March	10	14
April	8	6
May	6	14
June	9	12
Total	46	65

Despite the lack of success in reducing the numbers of broken it is hoped that AOS would improve the response time to each incident. This phenomenon would show up as a reduction in the minutes of delay incurred per incident, without regard to the sheer number of broken trips. This is examined in Table 2; unfortunately, no improvement is noted, and response time deteriorated somewhat between the two periods.

Table 2 . Percent of AATA Broken Trips by Minutes of Delay Incurred

Minutes Late	Percent 1997	Percent 1998
0 to < 10 minutes	19.7	16.9
10 to < 20 minutes	50.0	38.5
20 to < 30 minutes	17.4	27.7
> 30 minutes	13.0	16.9
Total	100	100

Another potential effect of AOS is on the nature of the faults causing a broken trip. Table 3 examines this phenomenon, with the AATA's recorded reasons for the interruption of the trip including engine, brakes, tires, doors, air pressure, fuel and others. As shown in the table, there is no statistically significant difference between the distribution of reasons for trip breakage between 1997 and 1998.

Table 3: Reasons for Broken Trips

Category	1998 Percent	1997 Percent
Engine	67.7	52.2
Brakes	3.1	8.7
Tires	6.2	4.3
Doors	4.6	10.9
Air Pressure	6.2	8.7
Fuel	1.5	6.5
Others	10.8	8.7

Chi-squre=2.10 with 6 degrees of freedom, p=.9 (no statistically significant difference between 1998 and 1997).

AATA Reported Incidents

AATA incidents (January to June 1998) were recorded by on-duty supervisors. In this time period there was a significant drop in the number of incidents reported from the previous year. With the implementation of the new AOS system, it was decided to place less emphasis on recording incidents as the bugs were worked out of the system. For this reason, comparability of the data between 1997 and 1998 cannot be assumed. During this time period, only 10 incidents were reported, compared with 44 during the same period the year before. One can speculate that the fact that the biggest drop in reported incidents in problems with unruly passengers is a function of the presence of on board video cameras, but given the change in reporting procedures, this cannot be established definitively.

Table 4. Types of Reported Incidents

Type	Frequency 1997	Frequency 1998
Unruly Passengers	19	1
Other Passenger-Related Events	12	3
Vehicle-Related Incidents	7	4
Others	6	2
Total	44	10

Supplemental Information

Because of the systematic underreporting of incidents, other sources of complaint information were sought. AATA gathers data for complaints for each quarter. These

data were tabulated for the before period (January to June 1997) and the after period (same period 1998). Please note that valid complaints by category are only available for the after period, so the comparison in Table 5 is made on the basis of total complaints. Overall, a reduction of complaints was evident between the two periods; the magnitude of the drop suggests that unidentified factors apart from AOS' implementation were at work. It is important to note that passenger complaint data are highly variable, so it is difficult to interpret a year's drop. In fact, passenger complaints and passenger compliments regarding AATA seem to run together; thus it appears that other factors may be driving these data.

Nonetheless, the largest magnitude of reduction in complaints was in categories likely to be affected by AOS: "Bus off schedule" and "Passenger Missed/Passed Up." It may be that unified timekeeping throughout the system, in conjunction with the pacing information provided to drivers, may have led to improvements in these areas.

Table 5. Tabulation of Investigated Complaints between January and June

	Complaints 1997	Complaints 1998	Percent Reduction in Category
System (Policies, routes, etc.)	2	0	100.0%
Bus off Schedule	32	10 (4 validated)	68.8%
Passenger Missed/Passed Up	35	13 (2 validated)	62.9%
Rudeness/Lack of Courtesy	28	13 (2 validated)	53.6%
Other	10	5 (0 validated)	50.0%
Careless/Unsafe Driving	25	14 (5 validated)	44.0%
Other Operator Actions	13	8 (1 validated)	38.5%
Subcontracted Services	16	13 (9 validated)	18.8%
Total	161 (57 validated)	76 (23 validated)	52.8%

Conclusions:

Results from these analyses of AATA records did not demonstrate measureable improvments in broken trips, or trip delay. Nominally, reported incidents and passenger complaints appeared to decline significantly. Yet these items appear to be subject to a great variability; thus attributing the apparent improvement to AOS exclusively would not be supported. In addition, basing conclusions on these records would require improvements in record keeping, with systematically accepted standards for recording various events or passenger complaints.