An Evaluation of the Cleveland HealthLine Mechanical Guide Wheel

FINAL

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March 2011

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13. ABSTRACT Vehicles on the Cleveland HealthLine Bus Rapid Transit (BRT) system are equipped with a mechanical docking arm and guide wheel to assist with precision docking at the stations. This report documents the evaluation of the guide wheel in 4 areas: how close to the platform the vehicles were able to dock; how fast the vehicles were able to dock; how much money was spent on damages related to docking; and how well the guide wheels are regarded by the HealthLine drivers. The evaluation compared the performance of the HealthLine to the EmX BRT in Eugene, Oregon. The EmX uses the same model vehicle as the HealthLine but does not come equipped with a docking arm and guide wheel.			
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Funded by the Federal Transit Administration

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F	=	y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

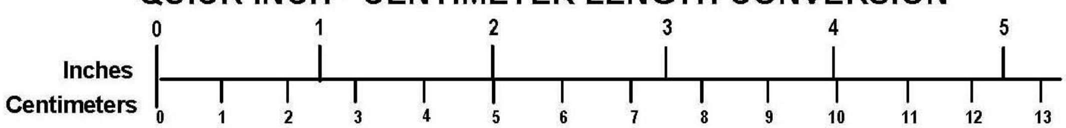
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C	=	x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

Updated 6/17/98

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Executive Summary

In July and August 2010, the National Bus Rapid Transit Institute (NBRTI) conducted an evaluation of the mechanical guide wheel used for precision docking by the HealthLine Bus Rapid Transit (BRT) service. The HealthLine is operated by the Greater Cleveland Regional Transit Authority (GCRTA). The mechanical guide wheel evaluation is part of a larger effort by the NBRTI to evaluate vehicle automation and assist (VAA) technologies being used by transit agencies in the U.S.

VAA technologies help a driver maintain control of the vehicle (assist) or provide full control of the vehicle (automation). In transit, VAA can be used for a variety of purposes including lateral guidance of a bus within a lane or shoulder, precision docking at bus stops/stations, and collision avoidance. The guidance system can be as complex as magnetic markers embedded in the road pavement or as simple as guide wheels mounted to the front and/or rear axle, as with the HealthLine BRT.

GCRTA equips each of their HealthLine rapid transit vehicles (RTVs) with two mechanical guide wheels mounted on each side of the front axle (see Figure 1). The purpose of the guide wheels is to get the RTV as close to the edge of the station platform as possible and thereby simulate the experience of passenger rail docking. As the HealthLine RTV approaches a station, the driver angles the vehicle toward the platform until the guide wheel makes contact. When properly aligned, the side of the vehicle is nearly flush with the platform edge leaving only a small gap in between.

Because all of the HealthLine RTVs are equipped with guide wheels, NBRTI conducted a “with” and “without” evaluation by comparing the docking performance of the the HealthLine BRT to the EmX BRT in Eugene, Oregon operated by Lane Transit District. Both systems use the same style New Flyer 60’ articulated RTV. However, the EmX RTV is not equipped with mechanical guide wheels. Instead, EmX station platforms are outfitted with polyethylene guide strips that stick out 5 ½ inches to prevent collision damage (see Figure 4). Both BRT systems include stations with near level boarding. HealthLine station platforms are 14 ½ inches high, and EmX station platforms are 14 inches high. All of the comparisons involved left-side docking as the two BRT systems did not have comparable stations for right-side docking.

The evaluation looked at four specific areas.

1. **How close to the platform the RTVs were able to dock.**
2. **How fast the RTVs were able to dock.**
3. **How much money was spent on damages related to docking.**
4. **How well the guide wheels are regarded by the drivers.**

Results

At stations with straight approaches, the HealthLine and EmX vehicles docked with nearly the same level of precision. On average, the HealthLine vehicles had an 8 inch gap between the edge of the platform and the door while EmX vehicles had an 8 ½ inch gap. At stations with curved approaches, the HealthLine vehicles did slightly better than the EmX vehicles. On average, they were just under 6 inches from the platform while the EmX vehicles were 9 ¾ inches from the platform. A possible explanation is that on curved approaches the mechanical guide wheel helps the driver to better align the vehicle. During the field observations, the smallest observed gap between the edge of the platform and the door on the HealthLine was 4 inches while the smallest observed gap on the EmX was 6 ½ inches.

On average, HealthLine RTVs took 5 to 7 ½ seconds longer to dock. While collecting data in Cleveland, the observers noticed anecdotally that there was a wide variation in approach times. Some of the drivers glided into the station rather quickly while others came almost to a complete stop just before the platform and then slowly crept forward. With the EmX, there was little variation in approach times. This could be due to driver experience. Lane Transit District pays a premium to drivers who commit to staying on the EmX route in exchange for giving up bidding rights on other routes. As a result, the EmX has seasoned drivers. RTA used to be able to screen drivers for the HealthLine based on seniority, but a new union leadership has opposed that practice. Currently, the HealthLine is open to bid for any driver.

When looking at capital and maintenance costs, the polyethylene guide strip used by Lane Transit District offers an advantage over the guide wheel used by GCRTA. This is chiefly due to the fact that the guide strip is a one-time capital expense. It costs LTD roughly $5,000 to outfit both sides of a station with the guide strip. LTD has spent $1,252 in Calendar Year 2009 to replace 6 tires damaged at pullout from the stations. LTD has not reported any direct damages to the guide strips themselves. On the other hand, it costs GCRTA roughly $3,700 to equip each HealthLine vehicle with two guide wheels/docking arms. In Calendar Year 2009, GCRTA spent $15,060 on repairs to broken docking arms.

Overall, the mechanical guide wheels are highly favored by the HealthLine drivers. Over 80 percent of the drivers surveyed agreed or strongly agreed that the guide wheel helped them to dock the RTV more precisely and quickly, that it was easy to use, and would recommend it to other transit systems with elevated platforms. A full 77 percent agreed or strongly agreed that the mechanical guide wheel made docking the RTV less stressful.

Background

GCRTA's idea for the mechanical guide wheel dates back to a BRT Scanning Tour of Europe that they attended with the Federal Transit Administration (FTA) in Fall 2000. On that trip, they witnessed the mechanical guide wheel in operation in the cities of Essen, Germany and Leeds, England. The buses in Essen use mechanical guide wheels mounted to the front and rear axles and operated on specially designed track in the median of the A430 motorway. In Leeds, the Superbus uses mechanical guide wheels on the front axle only for precision docking at stations. Precision docking is what GCRTA had in mind for their planned BRT. Their staff was able to bring back a used docking arm and guide wheel from the service yard in Leeds and reverse engineer it.

GCRTA reported in an interview with NBRTI that they had to overcome two obstacles to implementing the mechanical guide wheel. The first was convincing FTA to allow it. Because the RTV is considered similar to a rail vehicle and rail vehicles are required by the Americans with Disabilities Act (ADA) to have no more than a 3 inch gap between the door and the station platform, FTA was concerned whether the guide wheel alone could achieve that standard[1]. As a result, GCRTA had to agree to equip the HealthLine RTVs with deployable ramps for wheelchair boarding. The second obstacle was convincing ArvinMeritor, the manufacturer of the axles and suspension system for the HealthLine RTVs, to manufacture and install the docking arm and guide wheels. Because this device had never been used before in the U.S. and the potential impact on other structural components was unknown, ArvinMeritor insisted that GCRTA waive the warranty on the axle and suspension system. GCRTA did eventually agree to this, but they first had to convince their internal legal staff that the risk was minimal. They made the case, and their legal staff agreed, that the amount of torque that would be put on the docking arm would be less than the torque put on the front axle of a snow plow truck, which is considered normal and acceptable for liability purposes. Once those hurdles were overcome, the docking arms and guide wheels were manufactured and installed. They have been in operation on the HealthLine since its opening in 2008.

All HealthLine drivers receive classroom and field training on the guide wheels. The training is a minimum of two days - one full day and two half days. Day 1 includes classroom instruction using the Bus Operators Handbook, familiarization on the RTV, driving the RTV on the WestPark Training Track, and driving on the Euclid Avenue HealthLine corridor with concentration on the left-side docking. The two half days of instruction include more practice driving on the Euclid corridor and final assessments of the operator's capabilities. If the instructors determine that additional driving time for practice is required, the length of the individuals training is extended to ensure safe driving practices are followed.

[1] The 3 inch standard can be found in Title 36, Code of Federal Regulations, Section 1192.73.

Docking Tools for the HealthLine

The HealthLine BRT uses three tools for precision docking, the primary one being the mechanical guide wheel/docking arm (Figure 1). The other two tools are a painted blue guide stripe on the pavement (Figure 2) and a docking assist system (Figure 3). The blue guide stripe helps the driver to align the vehicle as he/she approaches the station. The docking assist system (DAS) consists of 2 ultrasonic sensors, 1 system controller, and an audible warning device. As the driver approaches the station, the DAS will emit four successive beeps when contact with the platform is imminent. It is important to note that the painted guide stripe and DAS are not required for proper operation of the mechanical guide wheel. They were added as an extra assist to the guide wheel.

Figure 1 - Mechanical Guide Wheel

Figure 2 - Blue Guide Stripe

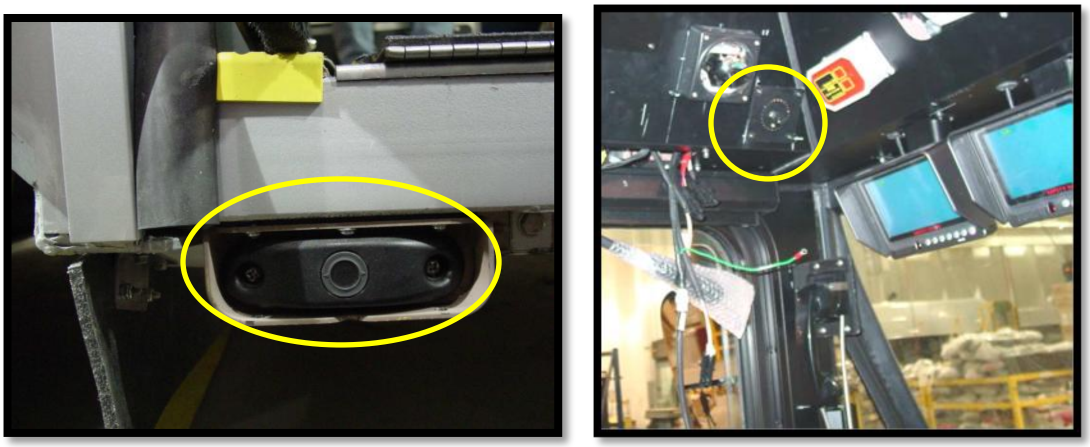

Figure 3 - Docking Assist System

Docking Tools for the EmX

In Eugene, all EmX station platforms are outfitted with a yellow, polyethylene guide strip that sticks out 5 ½ inches from the base to prevent the RTV from hitting it (see Figure 4). This is not a precision docking device per se. Unlike the HealthLine's mechanical guide wheel which is supposed to make contact with the curb, the EmX guide strip is not meant for contact by the RTV. It is there simply to prevent damage to the station platform and RTV should contact occur.

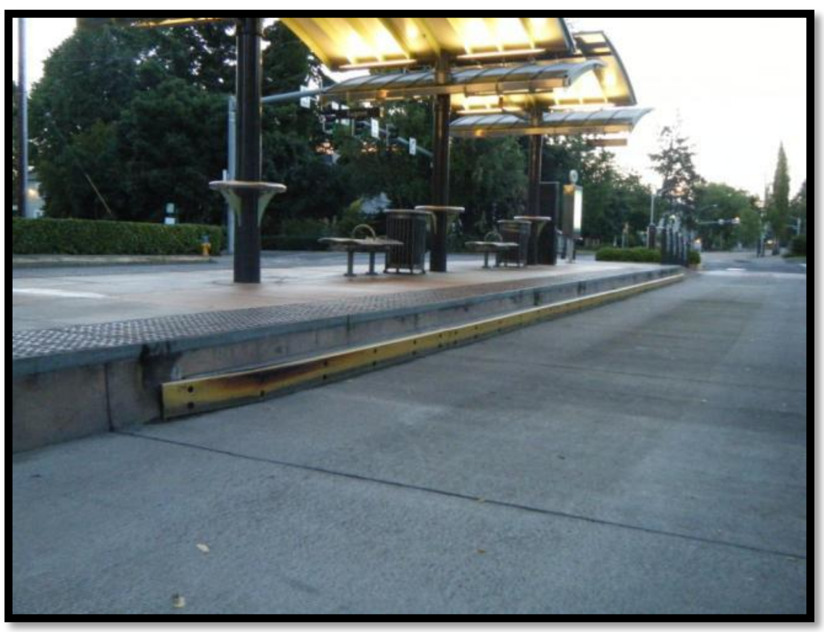

Figure 4 - Yellow Guide Strip

Methodology

In order to have comparable results, it was important to identify stations in Cleveland and Eugene that had similar design characteristics and roadway geometry and to collect the data in a manner that was as consistent as possible. In a conference call between NBRTI, GCRTA, and Lane Transit District, several candidate stations were discussed. As-built drawings were later exchanged and compared. It was determined that the westbound side of East 9^{th} Street Station in Cleveland was comparable to the westbound side of Hilyard Station in Eugene. It was determined also that eastbound side of East 6^{th} Street Station in Cleveland was comparable to the westbound side of Dad's Gate Station in Eugene. These stations are illustrated in Figures 5 and 6 below. All of these stations are for left-side boarding. There were no comparable stations for right-sided boarding.

Figure 5 - 9th St. Station (westbound) & Hilyard St. Station (westbound)

Figure 6 - 6th St. Station (eastbound) & Dad's Gate Station (westbound)

For measuring the gap between the RTV and the station platform, measurements were taken at the second door on the left side of the vehicle, at the forward most side of the doorway (see Figure 7). In the figure, the front of the vehicle is towards the left. The reason why the second door was chosen is because the HealthLine and EmX BRTs both use articulated vehicles, and the second door is located aft of the articulation point. It was agreed by NBRTI, GCRTA, and Lane Transit District staff that the true test of precision docking would be how close the second door came to the platform.

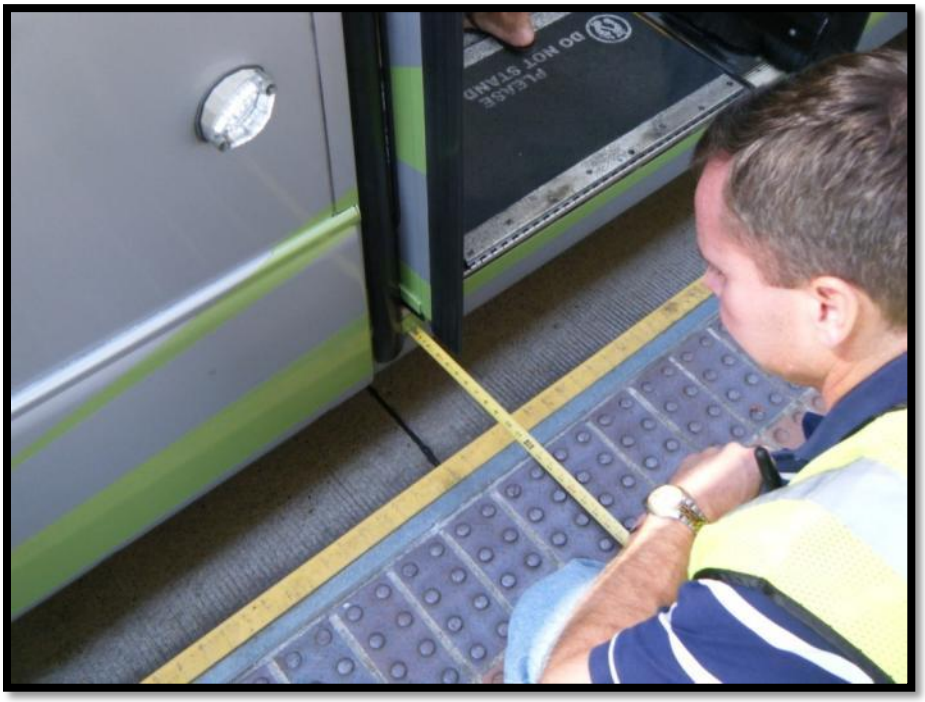

Figure 7 - Precision Docking Measurement

For measuring the amount of time it took the RTVs to dock, NBRTI staff identified a location 120 feet out from where the RTV regularly stopped, marked it, and timed how long it took the vehicle to cross that point and come to a complete stop. The reason why 120 feet was chosen was because that is twice the length of the RTV used by GCRTA and Lane Transit District. For the purpose of this evaluation, the vehicle was considered to be in "docking phase" once it was within 120 feet of its stopping point at the station.

Both the HealthLine and EmX stations incorporate features that show the driver where to stop. At the HealthLine 9th Street Station, the drivers stopped once he/she was personally aligned with the grey colored brick paver on the opposite side of the platform (see Figure 8). At the 6th Street Station, drivers stopped once they were personally aligned with a marker post just past the platform (see Figure 9).

Figure 8 - Grey Colored Brick Paver at 9th St. Station (Cleveland)

Figure 9 - Marker Post at 6th St. Station (Cleveland)

In Eugene, the EmX drivers stop their vehicle once they are personally aligned with an EmX logo that is painted on the station platform (see Figure 10).

Figure 10 - EmX Marker (Eugene)

From these stopping points, 120 feet was measured using a distance wheel, and the spot was marked with chalk (see Figure 11).

Figure 11 - Measuring and Marking 120 feet

During data collection, the person collecting the data would stand at a vantage point with a stopwatch. When the RTV's front bumper crossed over the chalk, he would start the clock. When the RTV came to a complete stop, he would stop the clock and enter the elapsed time on a tracking sheet. For data collection on the HealthLine, the observer would discard the time if he observed that the guide wheel did not make contact with the platform. The reason for this decision is that we were attempting to gather data on "precision docking". If a driver was not making an effort to dock with the guide wheel, the time recorded would not be reflective of the true time it takes to precision dock.

The posted speed limit where all of these stations are located is 25 miles per hour. On the days of data collection, both Cleveland and Eugene had similar weather, sunny and warm in the 80s. Data collection was conducted on two days in each city. Day 1 was data collection to measure the gap distance between the RTV and the platform. Day 2 was data collection to measure the time it took to dock. Data was collected from 6 to 9 a.m. and 4 to 6 p.m. on both days.

Gap Distance

The results show that on average there was not much difference in the vehicle-to-station gap when comparing docking at the HealthLine's 9th Street Station to the EmX's Hilyard Station. On average, the RTVs of both systems docked at about 8 to 8 ½ inches from the platform. However, there was more of a difference when comparing docking at the HealthLine's 6th Street Station to the EmX's Dad's Gate Station. The RTVs at the 6th Street Station were almost 4 inches closer on average compared to the RTVs at Dad's Gate Station.

Why did the first set of stations show virtually no difference in gap distance, but the second set of stations did? One possible explanation is the roadway geometry at the station. The approach to 9th Street Station and Hilyard Street Station is straight. However, the approach to 6th Street Station and Dad's Gate Station has a slight curve to the right just before the station. It is conceivable that at stations with a straight approach, the driver can just as easily align the vehicle without the assistance of a guide wheel. However at stations with a curved approach, the guide wheel may offer an advantage.

		Average Gap (inches)	Min. Gap (inches)	Std. Dev. (inches)
HealthLine	9th Street Station (westbound)	8.11	4.50	2.29
EmX	Hilyard Station (westbound)	8.55	6.50	1.45
HealthLine	6th Street Station (eastbound)	5.92	4.00	1.16
EmX	Dad's Gate (westbound)	9.73	7.25	1.23

Table 1 - Observed Gap Distances

When comparing the minimum gap distances between the two BRT systems, the HealthLine performed better than the EmX. The minimum gap distance is the smallest gap between the edge of the platform and the door that was observed during the entire data collection. For the HealthLine, the minimum observed gap was 4 inches at the 6th Street Station and 4 ½ inches at the 9th Street Station. The minimum observed gap for the EmX was 6 ½ inches at the Hilyard Station and 7 ¼ inches at the Dad's Gate Station. That the EmX RTVs would be farther away even at their best, is not surprising given that the yellow guide strips at the EmX stations stick out 5 ½ inches from the platform.

Time to Dock

The results show that on average the HealthLine drivers took 5 to 7 ½ seconds longer to dock than the EmX drivers. While collecting data in Cleveland, the observers noticed anecdotally that there was a wide variation in approach times. Some of the drivers glided into the station rather quickly while others came almost to a complete stop just before the platform and then slowly crept forward. By contrast when collecting data in Eugene, there was little observed variation in approach times of EmX drivers. This is borne out by the standard deviation figures shown below in Table 2. Standard deviation measures the amount of variation from the average, and Table 2 clearly shows is that there was a large amount of variation in approach times when it came to the HealthLine.

		Average Time (seconds)	Min. Time (seconds)	Max. Time (seconds)	Std. Dev. (seconds)
HealthLine	9th Street Station	14.04	9.15	21.59	3.14
EmX	Hilyard Station	8.66	7.51	10.59	0.72
HealthLine	6th Street Station	15.79	9.66	21.44	3.84
EmX	Dad's Gate	8.18	7.07	9.78	0.60

Table 2 - Elapsed Docking Times

One possible explanation for the wide variation in approach times by HealthLine drivers could be driver experience. Lane Transit District pays a premium to drivers who commit to staying on the EmX route in exchange for giving up bidding rights on other routes. As a result, the EmX has seasoned drivers. RTA used to be able to screen drivers for the HealthLine based on seniority, but a new union leadership has opposed that practice. Currently, the HealthLine is open to bid for any driver. It is conceivable that it is the less experiences drives who take longer to dock on the HealthLine.

Another possible explanation, related to the first, could be fear of punishment. As one HealthLine driver wrote in a completed survey, "If I break it [the guide wheel], I will get fired." If drivers are afraid they'll be punished for damaging the vehicle while docking, they may decide to approach much more slowly. Or they may decide not to precision dock at all. The observers noticed several times when the

HealthLine vehicle did not make any contact at all with the platform. On one such occasion, there was a woman alighting with a baby stroller who had to lift the wheels in order to bridge the gap between the vehicle and the platform.

Damages and Repairs

The repair costs per revenue mile for the two systems were nearly identical. In Calendar Year 2009 the HeathLine BRT logged 723,000 revenue miles, and GCRTA reported spending $15,060 on parts to fix or replace broken docking arms. That equates to $0.02 per revenue mile. That same year, the EmX logged 203,699 revenue miles, and Lane Transit District reported spending $1,252 to replace 6 damaged tires. That equates to $0.01 per revenue mile. Most of the EmX damages were caused to the left rear tire at pullout from the station.

	Repair Costs CY 2009	Revenue Miles CY 2009	Cost per Revenue Mile
HealthLine	$15,060	723,000	$0.02
Emx	$1,252	203,699	$0.01

Table 3 - Repair Costs

Capital Costs

GCRTA reports that it costs about $3,700 to equip each HealthLine RTV with two docking arms. Additionally, each RTV is equipped with a Docking Assist System (DAS) that consists of 2 sensors, 1 system controller, and an audible warning device. GCRTA reports that the unit cost of the DAS is $216 for each sensor, $647 for the controller, and around $150 for the speaker. However, they report that the DAS is an optional feature. If the entire package were installed on a RTV, the total costs would be $4,929.

Lane Transit District reports that the polyethylene guide strips cost about $2,500 per station side to install, or $25 per linear foot. That comes to $5,000 per station if both station sides are equipped with the strip. No data was available for lifecycle costs. Staff from Lane Transit District has not had to replace any of the strips since the initial installation.

Bus Operator Satisfaction

Drivers at both systems were given a survey that asked five basic questions about the mechanical guide wheel or the yellow guide strip. The questions and the response are shown below in Table 4. Overall, the mechanical guide wheels are highly favored by the HealthLine drivers. Over 80 percent of surveyed drivers agreed or strongly agreed that the guide wheel helped them to dock the RTV more precisely and quickly, that it was easy to use, and would recommend it to other transit systems. A full 77 percent agreed or strongly agreed that the mechanical guide wheel made docking the RTV less stressful.

Among EmX drivers, not as many agreed that the yellow guide strip helped them to dock the vehicle more precisely or quickly, but it was still a majority. Likewise, only 56% of EmX drivers said they would recommend the yellow guide strip to other transit agencies with elevated platforms. However, it should be pointed out that there were far less responses received from EmX drivers compared to the HealthLine. While there were 47 completed surveys from HealthLine drivers, there were only 9 completed surveys from EmX drivers. The low number of EmX responses may have influenced the results.

HealthLine	Strongly Agree or Agree	Strongly Disagree or Disagree
Q1.The mechanical guide wheel helps me to dock the vehicle more precisely.	89.4%	10.6%
Q2.The mechanical guide wheel helps me to dock the vehicle more quickly.	80.9%	19.1%
Q3. The mechanical guide wheel makes docking the vehicle less stressful for me.	76.6%	23.4%
Q4. Learning how to use the mechanical guide wheel was easy.	83.0%	17.0%
Q5. I would recommend the mechanical guide wheel to other transit systems with elevated platforms	84.4%	15.6%
EmX	**Strongly Agree or Agree**	**Strongly Disagree or Disagree**
Q1.The yellow guide strips help me to dock the vehicle more precisely.	55.6%	44.4%
Q2.The yellow guide strips help me to dock the vehicle more quickly.	55.6%	44.4%
Q3. The yellow guide strips make docking the vehicle less stressful for me.	77.8%	22.2%
Q4. Learning how to use the yellow guide strips was easy.	87.5%	12.5%
Q5. I would recommend the yellow guide strips to other transit systems with elevated platforms	55.6%	44.4%

Table 4 - RTV Driver Survey Results

Conclusion

The mechanical guide wheel is a relatively low cost tool that can assist with bus docking at elevated platforms. However based on the results of the evaluation, it cannot be considered a substitute or replacement for deployable ramps. During the evaluation period, the average gap between the HealthLine vehicles and the platform was a little over 8 inches at the station with a straight approach and a little under 6 inches at the station with a curved approach. Neither one of these averages meet the requirement of 36 C.F.R. 1192.73, namely that the horizontal gap between the transit vehicle and platform be no more than 3 inches.

Overall, the guide wheel is highly regarded by the HealthLine drivers. Over 80 percent of them agreed or strongly agreed that the guide wheel helped them to dock their vehicle more precisely and quickly, that it was easy to use, and would recommend it to other transit systems. A full 77 percent agreed or strongly agreed that the mechanical guide wheel made docking their vehicle less stressful. Nevertheless, it was evident from the evaluation that there is a need for periodic re-training in the use of the guide wheel if its benefits are to be fully realized. During the evaluation, there was a wide variation in the amount of time it took different drivers to dock. This indicates that some of the drivers are less comfortable with docking and may need a refresher on how to use the guide wheel.

When looking at capital and maintenance costs, the polyethylene guide strip used by Lane Transit District offers an advantage over the guide wheel used by GCRTA. It costs LTD roughly $5,000 to outfit both sides of a station with the guide strip. This is a one-time capital expense. Although LTD has not reported any direct maintenance costs to the guide strip, they have reported some minor costs related to tire damage. On the other hand, it costs roughly $3,700 to equip each HealthLine vehicle with two guide wheels/docking arms, and this amount does not include the added cost of the optional Docking Assist System. In Calendar Year 2009, GCRTA spent $15,060 on repairs to broken docking arms. These recurring maintenance costs need to be considered by any agency wishing to adopt the guide wheel into their fleet.