



NORTH CAROLINA
Department of Transportation



cassi
Connected Autonomous Shuttles
Supporting Innovation

CASSI in Cary, North Carolina's Bond Park

Exploring Accessibility with an Autonomous Shuttle

2023 Automated Road Transportation Symposium (ARTS)

Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina

What is NCDOT's Vision for Mobility in the State?



Integrated **Mobility** Division
N.C. DEPARTMENT OF TRANSPORTATION

IMD's Mission: Provide leadership for safe, affordable, and innovative multimodal transportation throughout North Carolina

IMD's Vision:

- Transportation barriers and unmet needs are minimized.
- Equal access to opportunities and services.
- Multimodal options rival driving in terms of time, convenience, and cost.
- Zero transportation-related fatalities, injuries, or greenhouse gas emissions.

IMD's Core Goals:

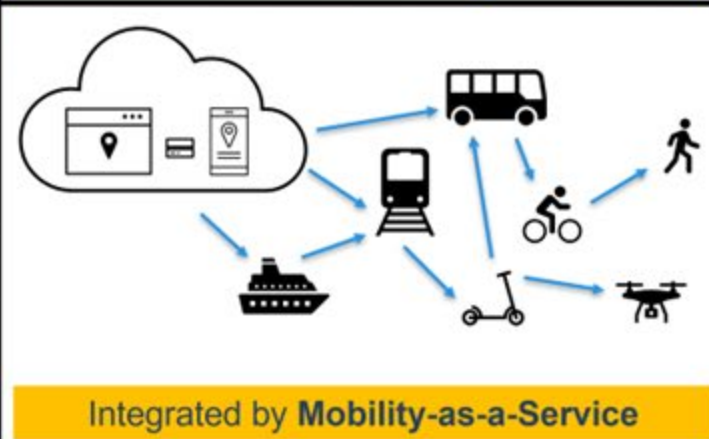
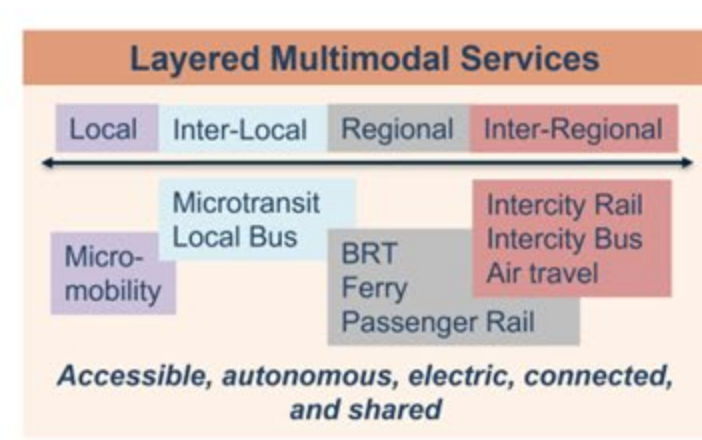
**Increase
Access**

**Enhance Quality
of Life**

**Ensure
Safety**

Ecosystems of Mobility Produce Equitable Outcomes

Imagine a transportation system in North Carolina where **shared mobility options are convenient, reliable, affordable, clean, and safe.**



Everyone should have equal access to opportunities and services through transportation systems that make traveling across shared modes and to destinations near and far as easy and convenient as driving.

Robust Shared Mobility Options Benefit All People

To create **multimodal transportation systems that work for everyone**, we need **high quality, shared mobility options** throughout the state that meet the needs of all populations.

Transportation disadvantaged populations experience barriers to their participation in daily life and have limited access to employment, education, health care, and healthy food.

- Older adults
- Youth
- People with disabilities
- Racial and ethnic minorities
- BIPOC people
- People with low incomes
- People in households with limited vehicle availability
- People in rural areas

Shared mobility options help eliminate transportation barriers to opportunities and services.



Why and How is NCDOT Exploring Shared Autonomous Vehicles?

CASSI Advances Shared Autonomous Mobility Technologies in NC

NCDOT's **Connected Autonomous Shuttle Supporting Innovation (CASSI)** is a program (not a product) that **demonstrates the capability of shared autonomous vehicles** to prepare for the future of mobility and enhance public transportation services.



CASSI evaluates how autonomous vehicles can best be used by riders with different needs and in different environments.

Examples include:

- Transit applications such as first mile/last mile solutions
- Connected vehicle infrastructure

CASSI is Evolving to Include Latest Technological Advancements

CASSI includes the **continued demonstration of novel-design, low-speed autonomous shuttles** and the **testing and integration of autonomy-enabled conventional vehicles** into high quality, on-demand transit services.



Novel-design, low-speed automated vehicles



(3) Completed Projects
2020-2021



NPS Report



USDOT Report



(1) Completed Project & (1) Planned Project
2023

Autonomy-enabled conventional vehicles



Connected, Rural, Equitable, and Autonomous Transportation for Everyone (CREATE)

FY 2022 USDOT Advanced Transportation Technology and Innovation Program Grant Application



Grant Application Information

Connected Autonomous Vehicle (CAV) Testbed



NCDOT is supporting NC A&T State University to develop **shared autonomous vehicles, an innovative rural test track, and an autonomous shuttle pilot** between the university and downtown Greensboro.



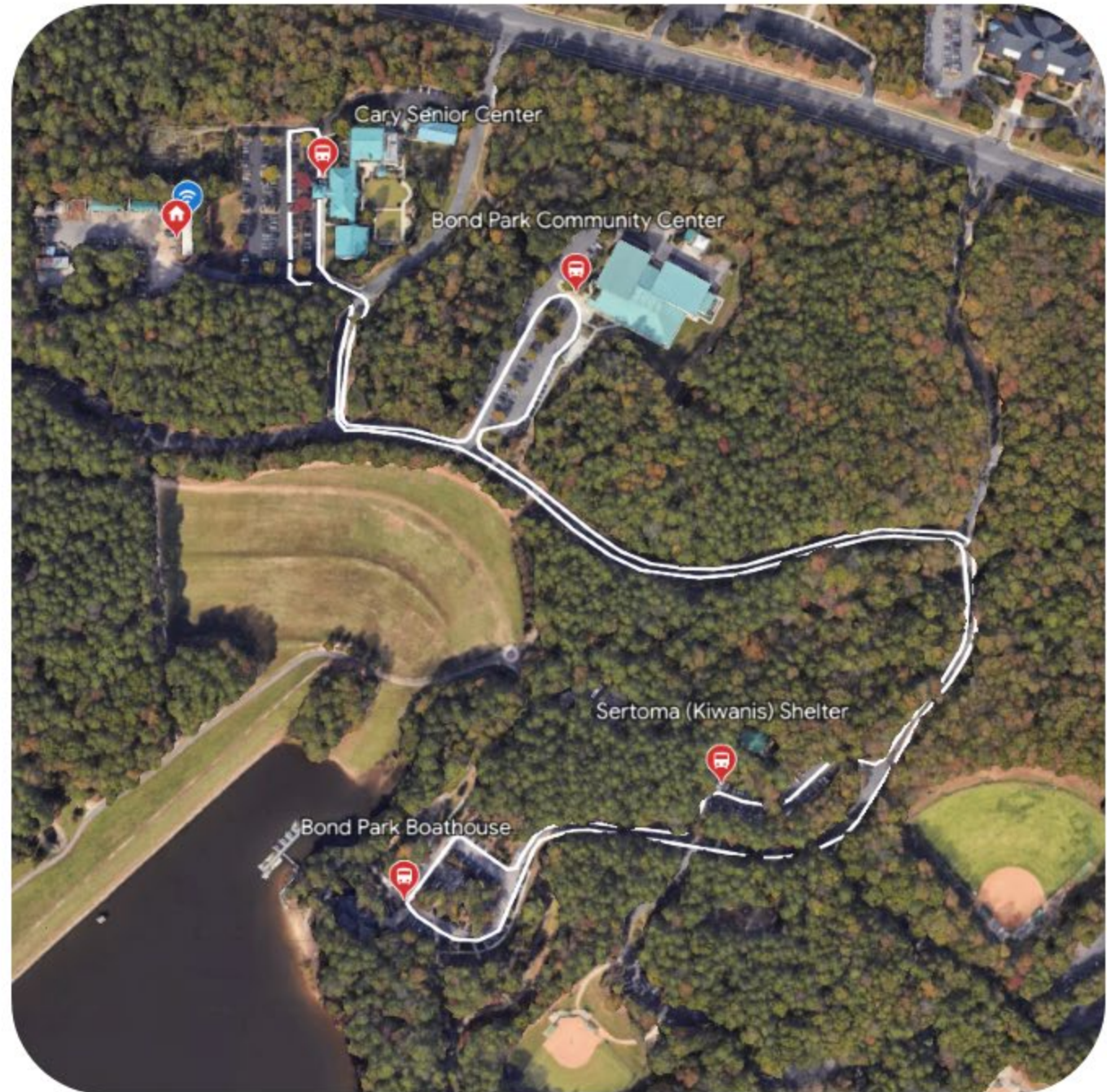
Autonomy at A&T

CASSI in Cary's Bond Park

CASSI in Cary's Bond Park

NCDOT partnered with the Town of Cary to bring a novel-design, low-speed autonomous shuttle to Fred G. Bond Metro Park.

- ❖ 13-week pilot from March 6-June 2, 2023
- ❖ Free and open to the public on weekdays, 10 a.m. to 4 p.m.
- ❖ 1.6-mile route with four stops



CASSI in Cary's Bond Park

Special features of the project included:

- ❖ Shared stop with GoCary Routes 4 and 8 at the Cary Senior Center
- ❖ Temporary traffic signal that demonstrated the shuttle's vehicle-to-infrastructure communication capabilities

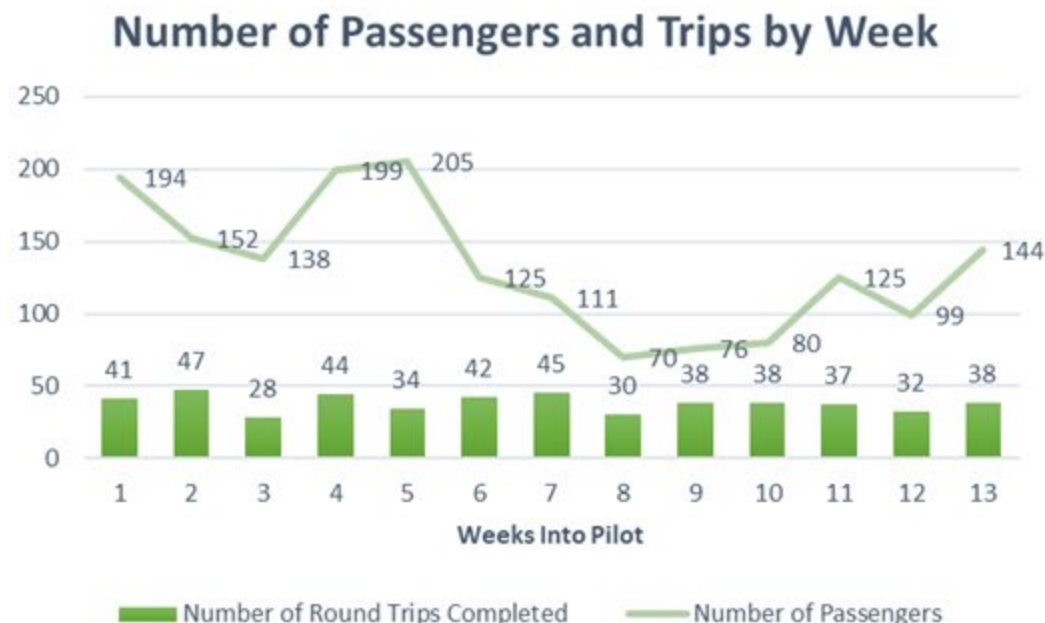


CASSI in Cary's Bond Park – Weekly Data Reports

Beep provided weekly data reports that included ridership and operations data.

Through Week 13 (March 6-June 2, 2023):

- **85.2% uptime**
 - 61 out of 65 scheduled days in operation
 - **332 actual hours of operation out of 390 scheduled hours**
 - 28 days with complete service
 - 33 days with partial service
 - 4 days with complete suspension of service *due to attendant absence, inclement weather, controller not connecting, or road closure*
- **1,718 passengers and 494 trips**
 - 3.5 passengers per trip
 - 5.2 passengers per hour
 - 28.2 passengers and 8.1 trips per day



Wake County Public Schools were on Spring Break from March 31 through April 7 which aligns with week 5 of the pilot. This week showed the highest ridership during the pilot period.

80 passengers were served on Friday, March 31, the most of any date during the pilot period.

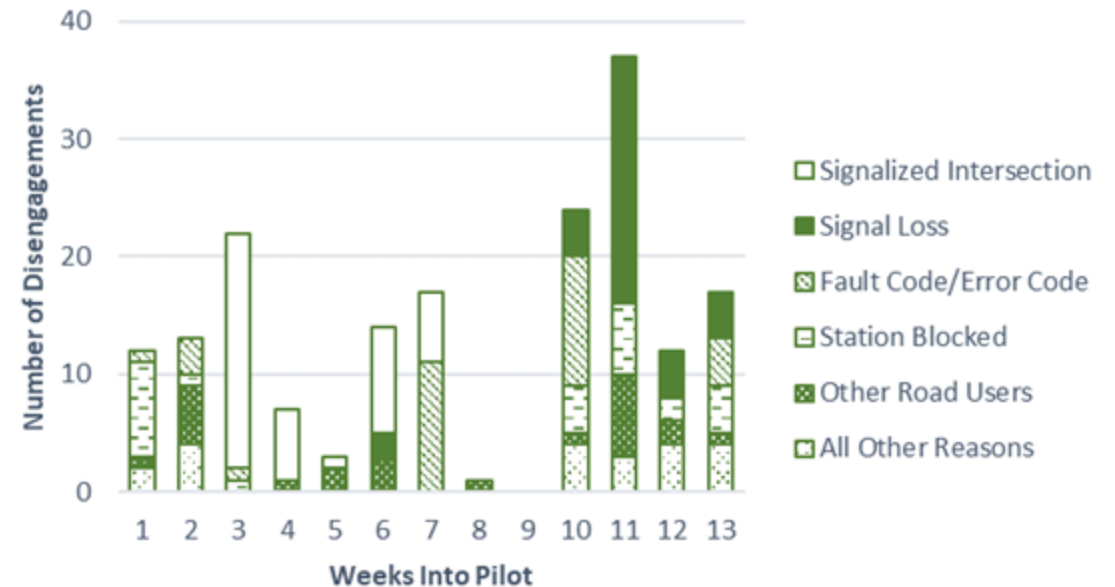
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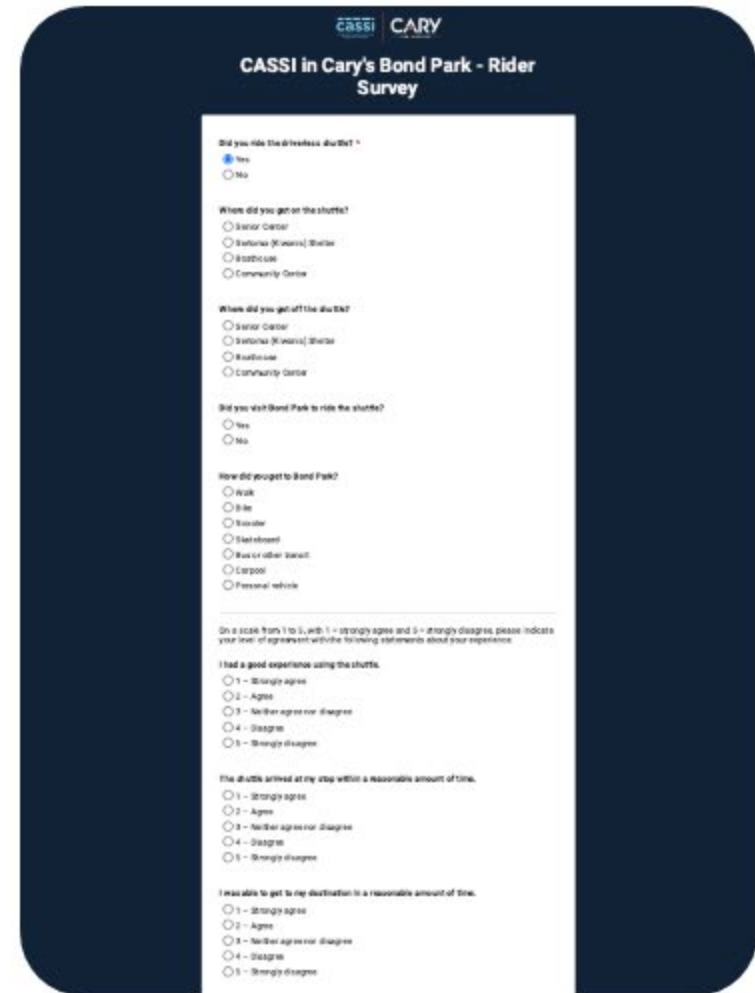
- **98.3% of time in autonomy**
 - 179 disengagements
 - **4.2 per day on average**
 - Most common causes were:
 - Signalized intersection (23%)
 - Signal loss (20%)
 - Fault code/error code (17%)
 - Station blocked (15%)
 - Other road users (13%)
- **5.4 mph average vehicle speed**
- **11.4 mph maximum vehicle speed**

Disengagements by Week



CASSI in Cary's Bond Park – Rider Survey

Online survey in Smartsheet was accessible through URL and QR codes at the shuttle stops and inside the shuttle.



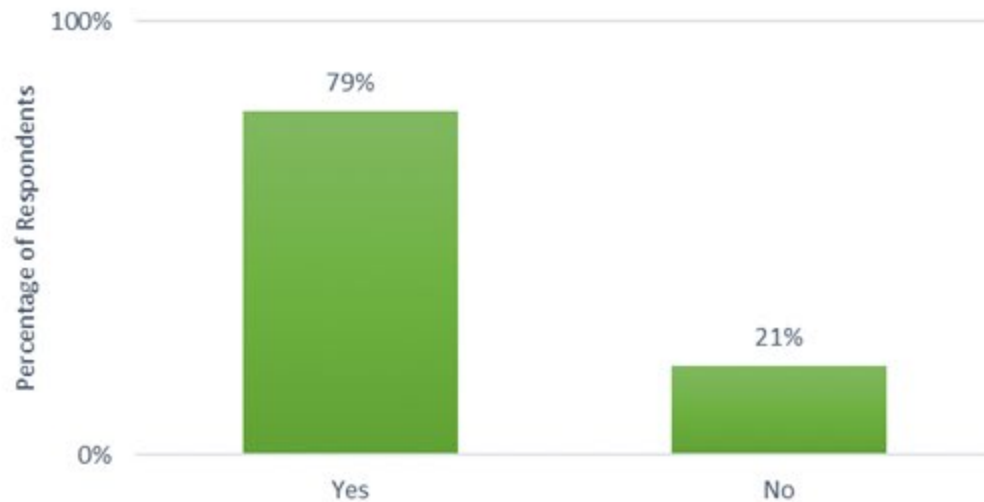


CASSI in Cary's Bond Park – Rider Survey Results

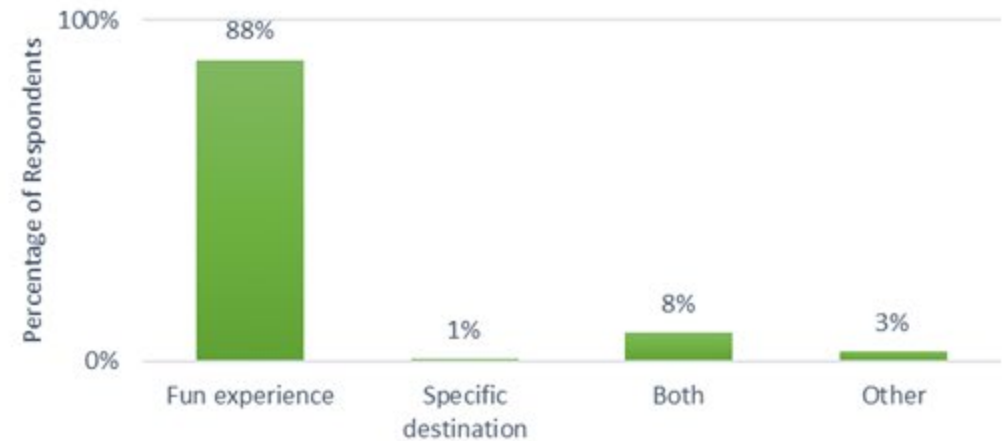
160 responses total – 145 rode the shuttle, 15 did not ride the shuttle

For respondents who rode the shuttle:

Did you visit Bond Park to ride the shuttle?



Did you ride the driverless shuttle for a fun experience or to get to a specific destination?



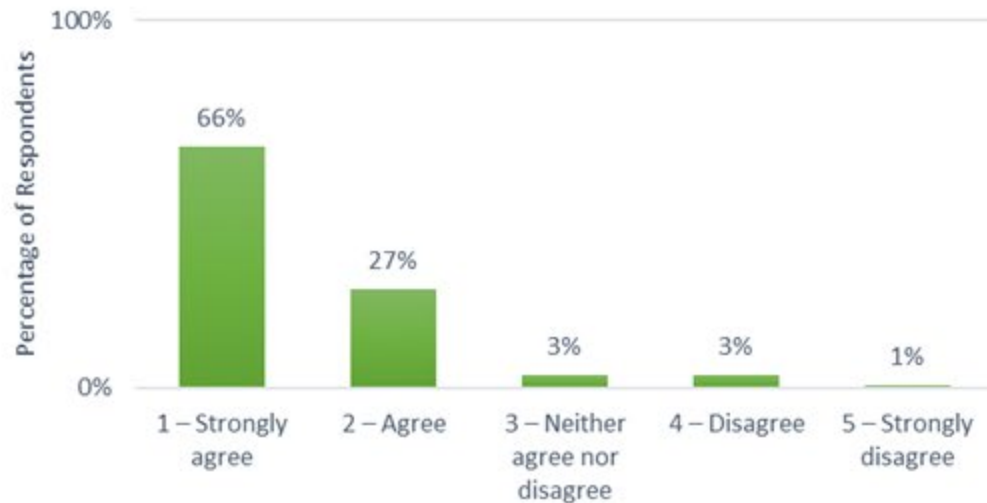


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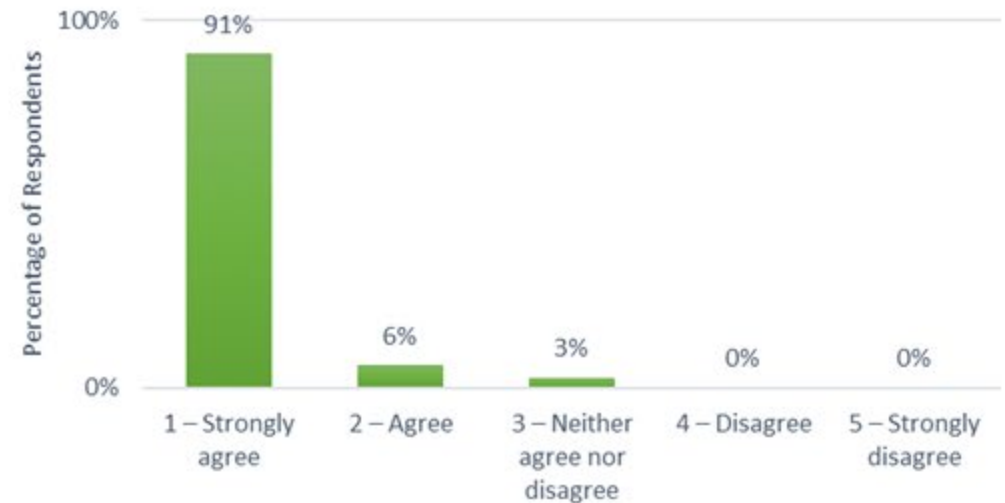
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For respondents who rode the shuttle:

I had a good experience using the shuttle.



I had a good experience with the attendant on the shuttle.



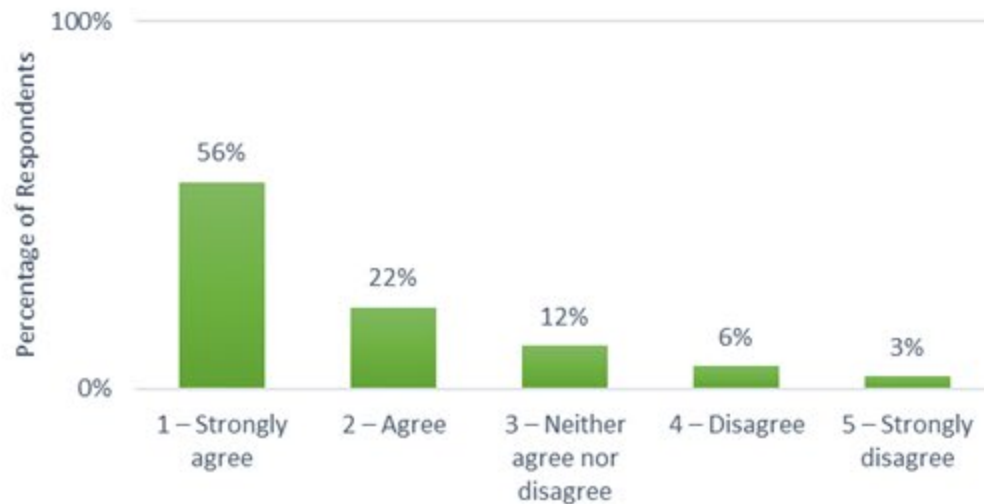


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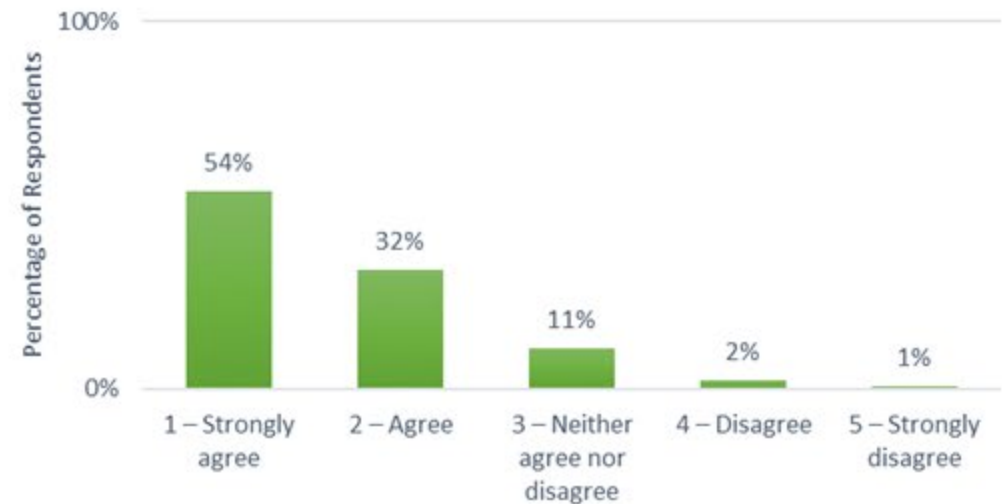
160 responses total – 145 rode the shuttle, 15 did not ride the shuttle

For respondents who rode the shuttle:

The shuttle arrived at my stop within a reasonable amount of time.



I was able to get to my destination in a reasonable amount of time.



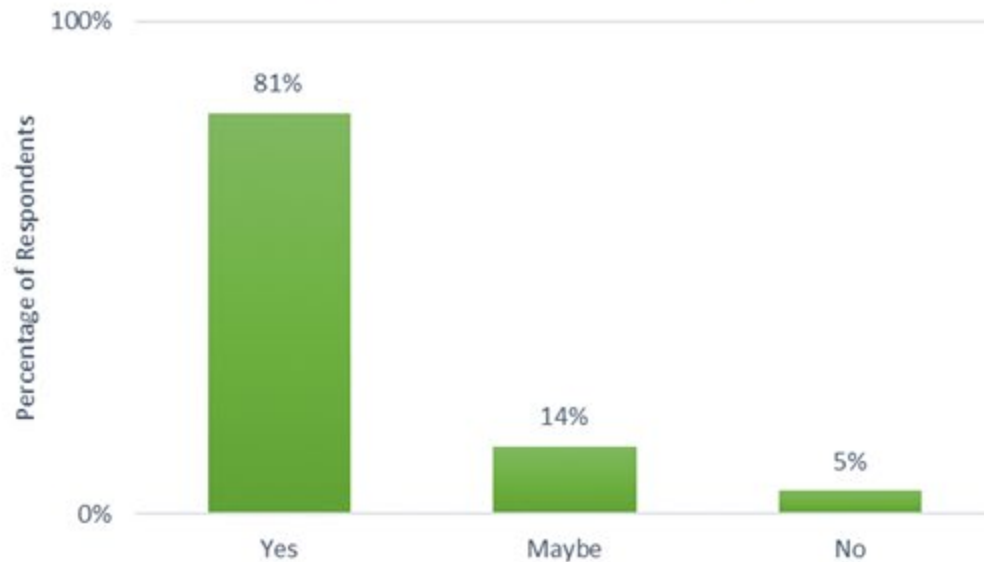


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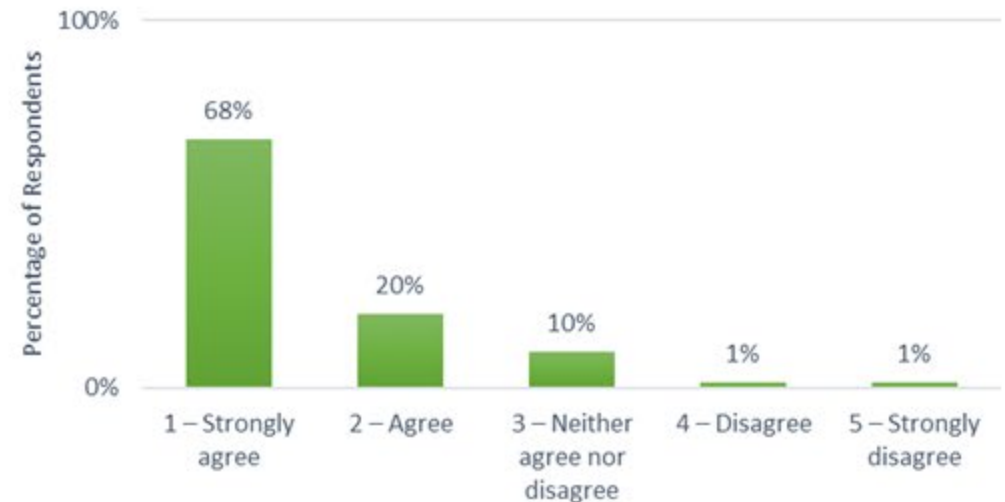
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For respondents who rode the shuttle:

Would you ride the shuttle again?



I support seeing more driverless shuttles in Cary.



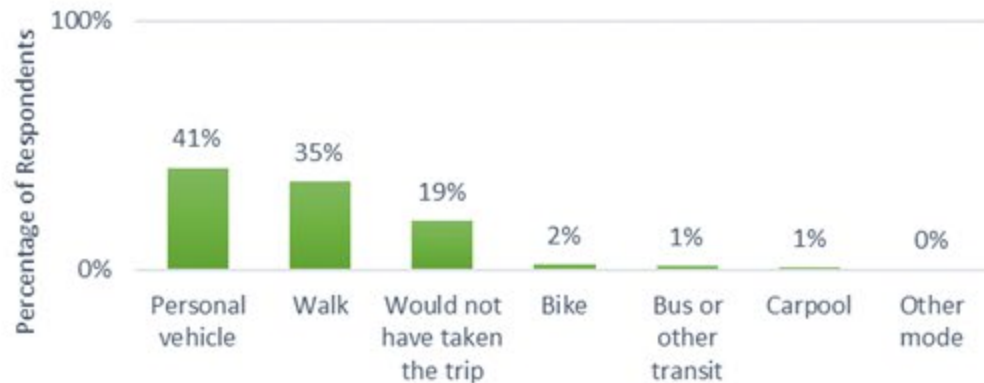


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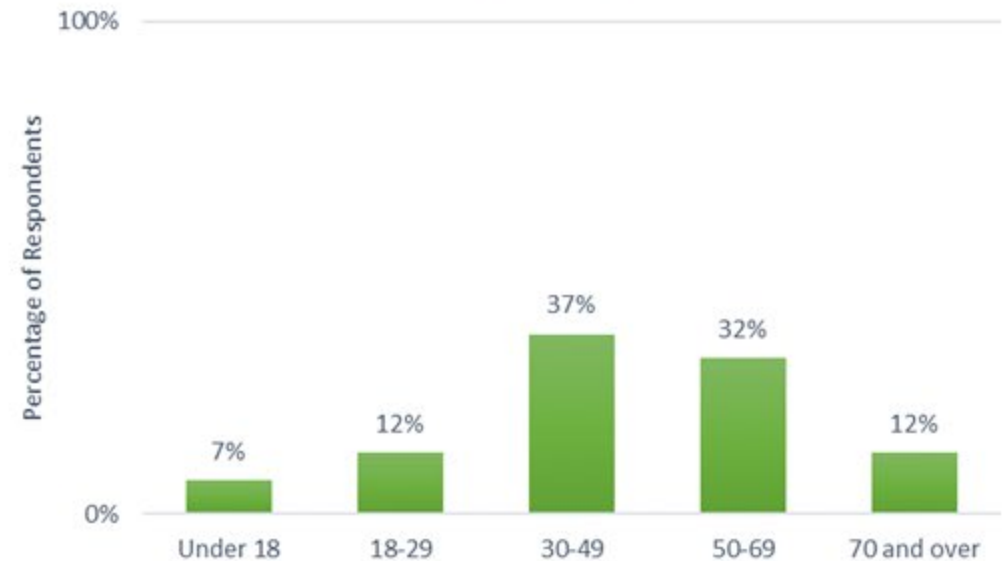
160 responses total – 145 rode the shuttle, 15 did not ride the shuttle

For respondents who rode the shuttle:

If you had not taken the driverless shuttle, which of the following modes of transportation best describes how you would have traveled?



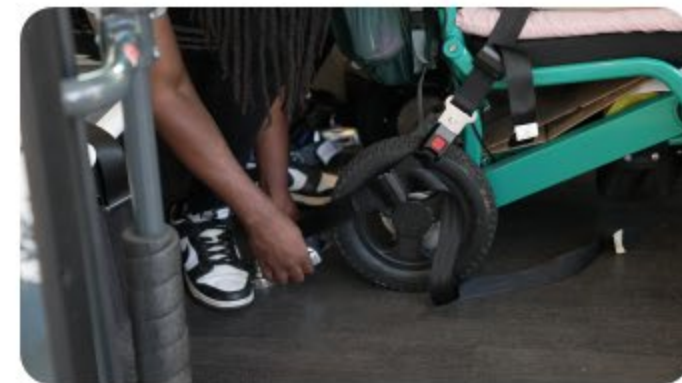
What is your age?



No respondents used a mobility device during their trip. Seven ramp deployments and seven wheelchair securements over the pilot period.

CASSI in Cary's Bond Park – ADA Engagement Event

Community members were invited to view and ride the shuttle then provide feedback on the shuttle's accessibility and usefulness to meet their transportation needs.



Eight participants completed exit surveys to provide feedback on their typical trips, what works well for them in the shuttle, and how the shuttle could work better for them.



CASSI in Cary's Bond Park – ADA Engagement Event

Community members were invited to view and ride the shuttle then provide feedback on the shuttle's accessibility and usefulness to meet their transportation needs.

What works well for you in the shuttle?

- Beautiful, clean, modern, lots of windows, open
- Good size and speed
- Smells nice, no exhaust that may trigger asthma
- Not too noisy inside, easy to understand friends talking onboard, quiet, no noise
- Wide entrance accommodates bariatric wheelchairs/walkers
- Easy to get on and off
- A/C works well

How could the shuttle work better for you?

- Automatic ramp, automatic wheelchair restraints
- Better kneeling to make the ramp less steep
- Room for more than one wheelchair so friends can ride together
- Smaller gap at platforms for wheelchairs
- Stop announcements and auditory prompts
- Shoulder harness, handrails, grab bar for taller passengers, wider seats with curved cushion
- Separation among seats, cup holder, radio
- Dedicated assistance from the attendant
- No hard brakes
- No signal loss, modernization from 3G to 5G

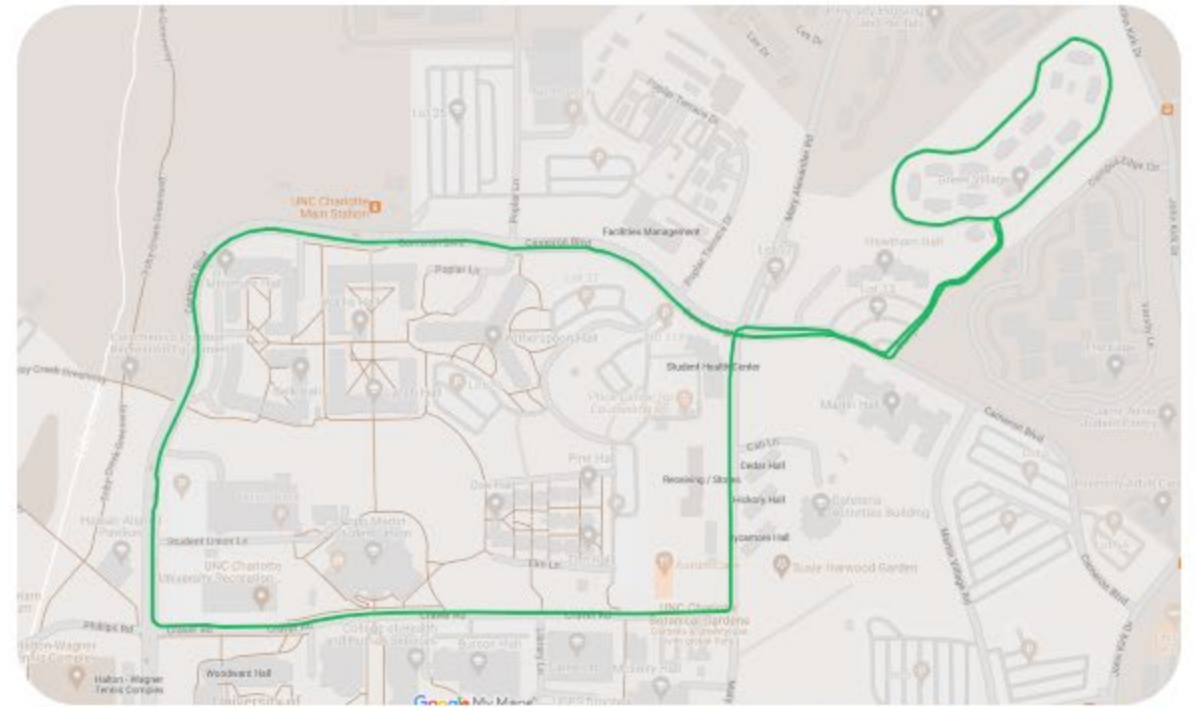
Feedback will inform a Request for Information (RFI) on automated bus technologies including automated wheelchair securement systems.

CASSI at UNC Charlotte

Launching July through December, 2023

Compared to previous pilots under the CASSI program:

- ❖ Most signals (four total)
- ❖ Longest route (2.2 miles)
- ❖ Longest duration (6 months)
- ❖ Most complicated mixed traffic environment
 - Includes bicyclist, scooter, pedestrian, motor vehicle, and transit interactions and shared stops with the existing campus bus fleet



Want to learn more about NCDOT's **Integrated Mobility Division** and the **CASSI Program**?

Contact Us




Sarah Searcy – Senior Advisor for Innovation | CASSI Program Manager


sesearcy1@ncdot.gov


(919) 707-4694 (office)

 <https://www.ncdot.gov/divisions/integrated-mobility>


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