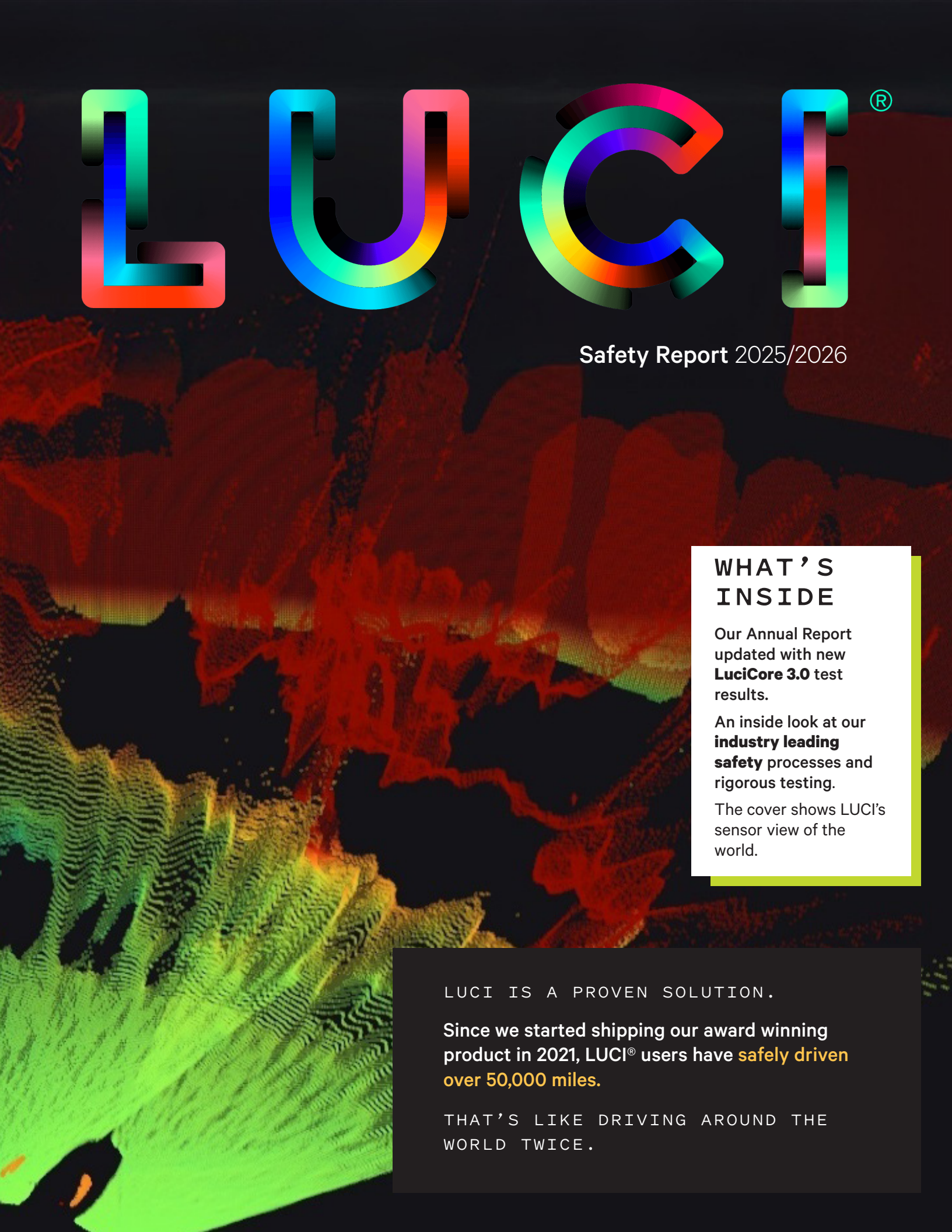
LUCI®

Safety Report 2025/2026



WHAT'S INSIDE

Our Annual Report updated with new **LuciCore 3.0** test results.

An inside look at our **industry leading safety** processes and rigorous testing.

The cover shows LUCI's sensor view of the world.

LUCI IS A PROVEN SOLUTION.

Since we started shipping our award winning product in 2021, LUCI® users have safely driven over 50,000 miles.

THAT'S LIKE DRIVING AROUND THE WORLD TWICE.

LUCI® gets better and easier to use with every **free, over the air software update!**

At LUCI, user safety and independence are at the heart of everything we do.

We invented the first and only active driver assistance system for power wheelchairs and in doing so are redefining safety for the entire industry. LUCI is in use today in homes, communities and clinics nationwide and has a proven track record of safety and effectiveness in the home and in the community. The LUCI team has completed countless hours of engineering testing since starting in a basement in 2018. In that time, we have built a comprehensive safety program to guide our testing and development of the future of power wheelchair driving technology.

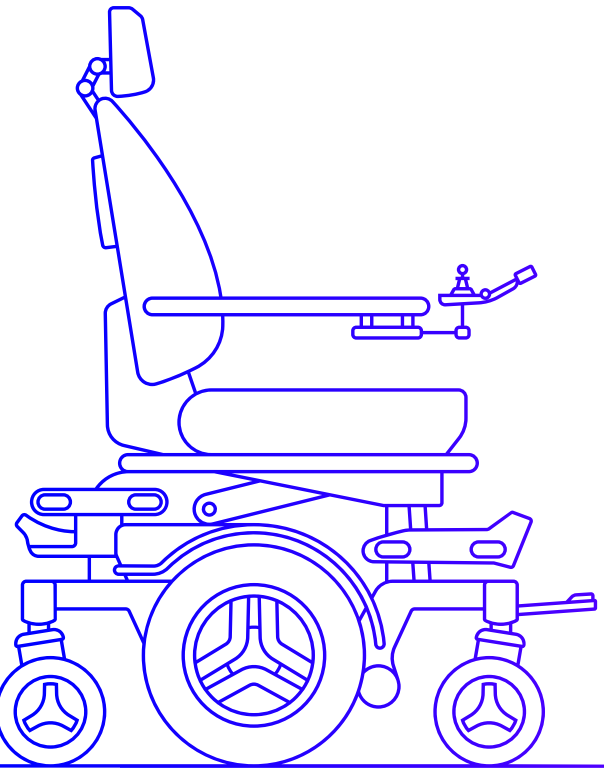
Testing shows that our product is safe and effective:

LUCI checks **10X every second, to avoid collisions, drop-offs, and potential injuries**, which is two times faster than a human can.

LUCI's **collision avoidance is 99% effective** at slowing the chair before a collision with a detected stationary object and is approximately 98% effective at stopping the wheelchair completely before contact based on our rigorous testing methods.

LUCI's **drop-off protection is more than 99% effective** based on our curb drop-off protection testing.

OUR MISSION



At LUCI we exist to reimagine mobility.

Our mission is to provide security, stability, and connectivity for power wheelchair users.

LUCI may be small, but we believe in leading. On the day we launched, we released Judging Smart[1], a framework for thinking about what "smart" should mean in power mobility products, and we have industry-leading transparency around product data and security practices[2]. Leading also looks like this report outlining our efficacy and our approach to ensuring safety for LUCI users everywhere.

Riders' capabilities, needs, wants and desires vary widely, and all are important to us. We are taking on the challenge of creating a new norm of transparancy for the industry. And we challenge others in the power mobility industry to join us in detailing their dedication to safety as smart technologies inevitably are the future.

USER SUCCESS

Success for LUCI looks like power wheelchair users living their lives with the confidence to drive themselves. We are proud to be trusted by hundreds of users, and their teams, to provide the active assistance they need to succeed.

From pediatric users driving with switches, to people with ALS driving with their eyes, to blind veterans relying on LUCI to back up their white cane skills, and joystick users with spasticity who need help in specific situations — LUCI is an integral part of what it means to succeed with a power wheelchair to our users. That is why we take the safety of the product so seriously.

LUCI users have successfully driven over 50,000 miles and counting.

We are on track to double that number before the end of the year. The fact is that LUCI is one of the most proven wheelchair driving accessories in existence.

That is why LUCI's registered medical device is trusted by top clinics, the VA, and payors in 41 US states and now Canada.

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[1] https://luci.com/smart/

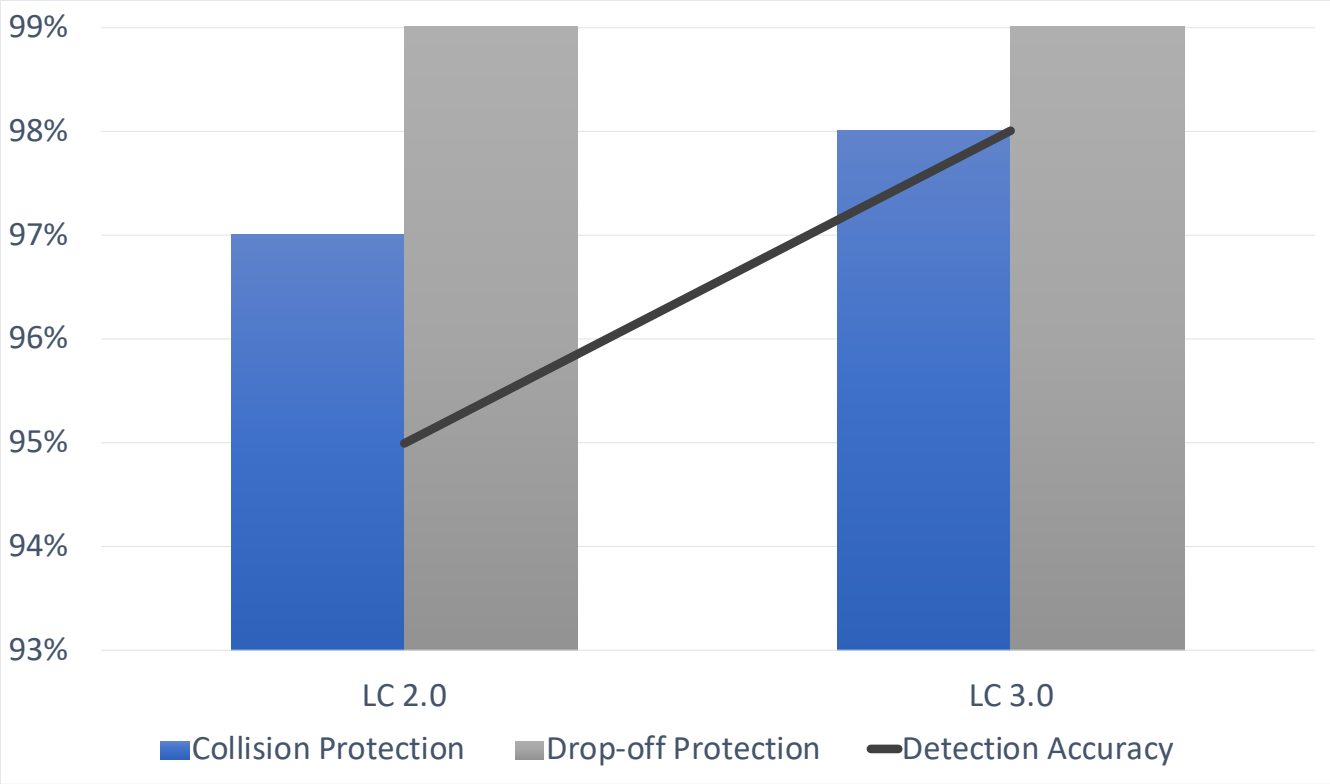
[2] https://luci.com/data/

[3] https://newsroom.aaa.com/2019/10/aaa-warns-pedestrian-detection-systems-dont-work-when-needed-most/

Always Improving

LUCI is the first, and only, active driver assistance product for power wheelchairs. We were the first in the industry to use over-the-air software updates to make the product better over time. Our list of technology firsts is long and growing, because our focus is on continous improvement of the user experience.

LUCI today is over twice as effective as automotive grade crash prevention systems[3]. Our latest software LuciCore® 3.0 increases collision avoidance protection while also increasing detection accuracy. This report documents LUCI's capabilities today as we continue to redefine what is possible.



HOW LUCI WORKS

LUCI adds smart technology to an existing power wheelchair for stability, security, and connectivity. For LUCI to do the amazing things that it does, three elements must work together with the user:

1. The base wheelchair, as certified by the wheelchair manufacturer,
2. The LUCI hardware, and,
3. LuciCore software.

Each of these subsystems is then combined to form a LUCI enabled wheelchair. Individually and collectively testing the hardware and software ensures that our collision avoidance and drop-off protection systems meet the safety requirements that we establish for our system.

The Base Wheelchair

LUCI's current generation of collision avoidance and drop-off protection systems mount to the power base of existing power wheelchair assemblies (PWA) made by Quickie, ROVI, Amylior, Permobil, and other manufacturers. These power wheelchairs have been certified by the manufacturer as compliant with all applicable ANSI/RESNA/ISO standards that regulate the safety performance requirements for wheelchairs in the US and Canada.

Every wheelchair manufacturer is required to meet a minimum braking distance from full speed. These distances are how long it takes the manufacturer's chair to come to a stop if the user is traveling on flat ground, after they recognize an obstacle ahead and let go of the joystick. It takes a wheelchair without LUCI a lot longer to slow down than most people think!

The ISO test ignores the user's ability to see and react to obstacles which can make actual stopping distances much greater in the real world. This is what LUCI starts with.

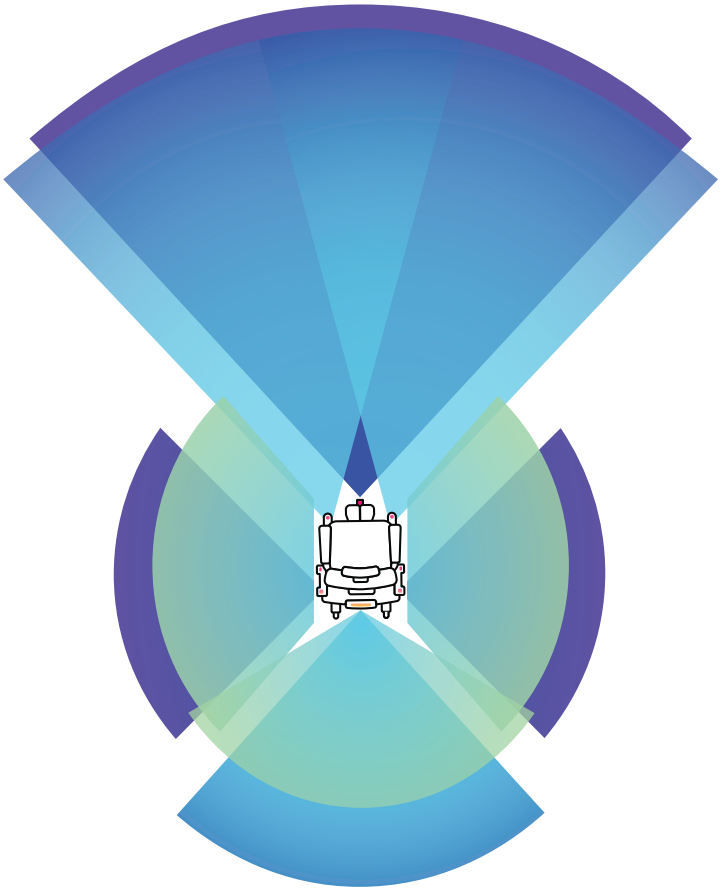
Chair Type	Model	Braking Distance[4]
Group III	Permobil M3, Permobil F3, Quickie Q300 M, Quickie Q500 M, Quickie Q700 M, ROVI X3, ROVI A3, Amylior Alltrack R3	6.6 feet (2 meters)
Group IV	Permobil MVS	9.2 feet (2.8 meters)

[4] Obtained from manufacturer based on testing to ISO Standard 7176-3.

LUCI Hardware: SmartFrame™, a System of Sensors and a Brain

LUCI is an accessory for specific power wheelchair models. LUCI interfaces with and mounts to the existing power wheelchair. It consists of wheelchair mounted hardware (SmartFrame, Scout™, Dashboard™, and LuciLink® Hub), the LuciLink Wheelchair Key™, and the MyLUCI® App. LUCI is intended to be installed on a power wheelchair by a trained technician and proper installation and setup of the hardware and software is an important part of making LUCI safe.

After proper installation and setup, LUCI begins working as soon as the user turns the wheelchair on. It connects to the wheelchair's power system and assists the driver in maneuvering their environment safely.



To meet the complex demands of collision avoidance and drop-off protection for power wheelchair users, LUCI has developed an array of sensors that provide 360-degree coverage, both in daytime and at night.

LUCI's patented system combines stereo vision, infrared projector, inertial measurement unit (IMU), ultrasonic and radar data into a single view of the world, enabling never-before-seen possibilities for power wheelchair riders. The sensor coverage is best illustrated from a bird's-eye view. In the image:

- **light blue** represents coverage by the stereo vision cameras,
- **purple** represents radar coverage, and,
- **green** represents ultrasonic sensor coverage.

One type of sensor isn't enough.[5] The combination of sensors, fused into one real-time view of the world, maximizes coverage and mitigates interference sources to give LUCI the best chance of detecting and avoiding the highest number of collisions and drop-offs possible.

We developed a cutting-edge mmWave radar, custom camera pods and multiple custom ultrasonic sensors to keep users safe.

Sensor	Why it is cool
Stereo vision camera with infrared projector	These sensors perceive depth like your eyes do. They give LUCI a depth value to every pixel in the image. Thanks to the infrared projectors (which LUCI controls intelligently) LUCI can still see in the dark! LUCI uses these sensors to map the ground and look for potential collisions.
mmWave Radar	This was the first FCC-certified mmWave radar of its type used outside of military or automotive environments. Radar uses electromagnetic waves to perceive objects and movement. Radar remains effective in rain, fog, and operates equally well day or night. It is the size of a business card but can see things over 20 feet (6 m) away!
Custom Ultrasonic	Our ultrasonic sensors see things that a typical ultrasonic sensor can't, and they do it in environments with other ultrasonic noise too.
IMU	LUCI's IMU modules use accelerometers and gyroscopes to figure out how the wheelchair is moving. Since current power wheelchairs don't have modern control systems, we use our onboard IMUs to do amazing things anyway.

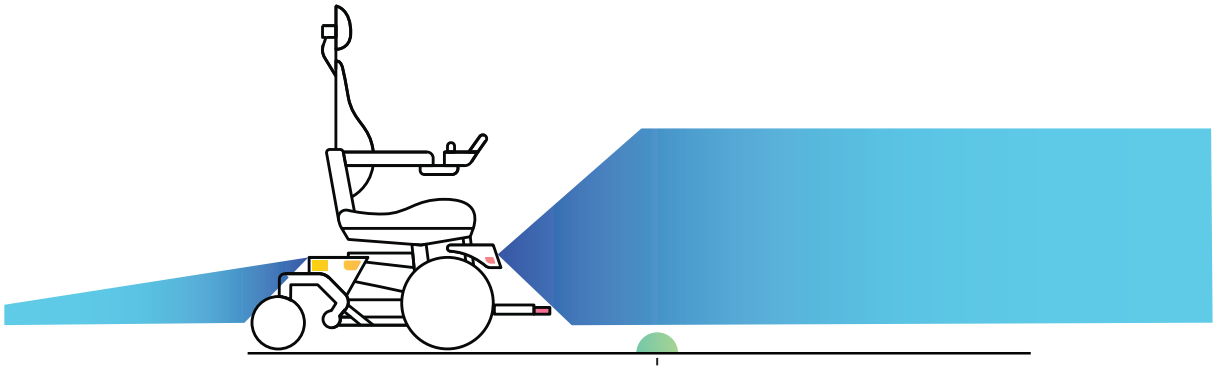
[5] https://luci.com/2020/06/3-reasons-why-one-type-of-sensor-is-not-enough-for-wheelchair-safety/

Collision Avoidance

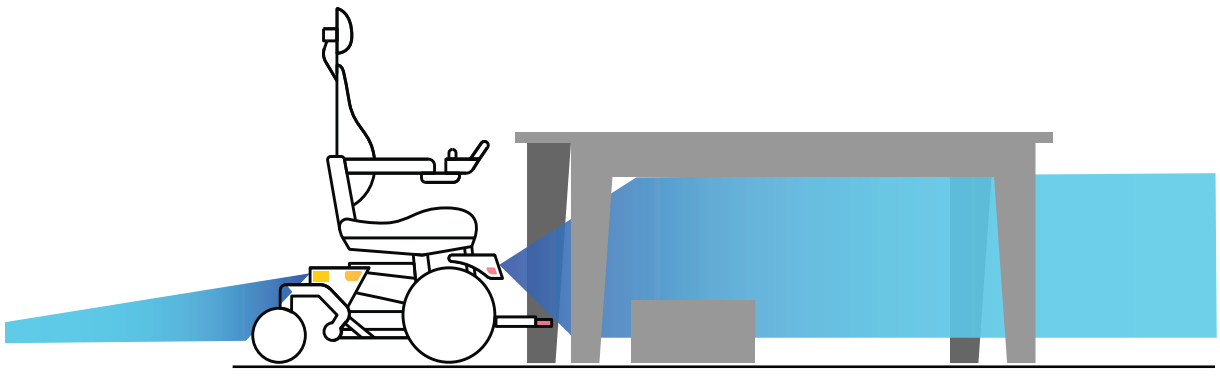
LUCI uses multiple types of sensors to identify and cross-check potential obstacles. The data from these sources is fused and analyzed to ensure the safety of the surroundings. LUCI obstacle detection has the following capabilities.

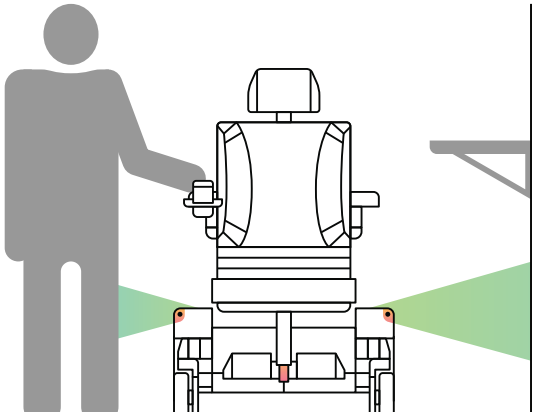
MINIMUM DETECTION RANGE	Objects closer than 1.2 in (3 cm) to the wheelchair may not be registered accurately	Measured from the edge of the wheelchair
MAXIMUM DETECTION RANGE	Forward: up to 14.8 ft (4.5 m) Backward: up to 3.9 ft (1.2 m) Sides: up to 4.2 ft (1.3 m)	Measured from the edge of the wheelchair
MINIMUM OBJECT DETECTION	Hard objects: 1.2 in (3 cm) Soft objects: 2.4 in (6 cm)	Measured as the cross section of the object facing the wheelchair
LIMITATIONS	Fast moving objects traveling directly at you and objects traveling across your path may not be detected in time to be avoided. Objects smaller than the above minimums, such as cables, may not be detected by LUCI.	

LUCI can see almost 15 feet (4.5 m) in front and almost 4 feet (1.2 m) in back as shown below. LUCI will not limit the wheelchair's capability to climb smaller curbs and slopes. This means that LUCI ignores items below your ground clearance like door thresholds, ramps, and uneven sidewalks. Each chair manufacturer specifies a certain safe curb height. LUCI allows your chair to operate within its published climbing ability.



LUCI's collision avoidance intentionally does not limit chair navigation for obstacles above the power base of the chair. This allows LUCI to still pull into open spaces like under tables or desks. However, if you want LUCI to stop your chair at the same spot under a table every time then you can place an object under the table (like a box).



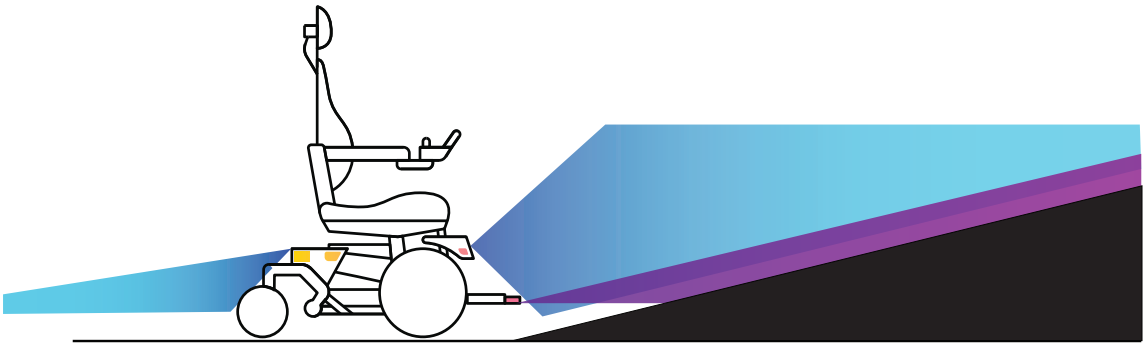


Side sensor coverage is like front-back coverage. LUCI will see a person's legs, but not their toes. LUCI will see a wall, but not an overhanging object like a wall shelf, doorknob, or handrail. It is important to know that, based on user feedback, LUCI is tuned to get close to things on the side, even sometimes lightly scraping the armrest, depending on how wide the seating assembly is set.

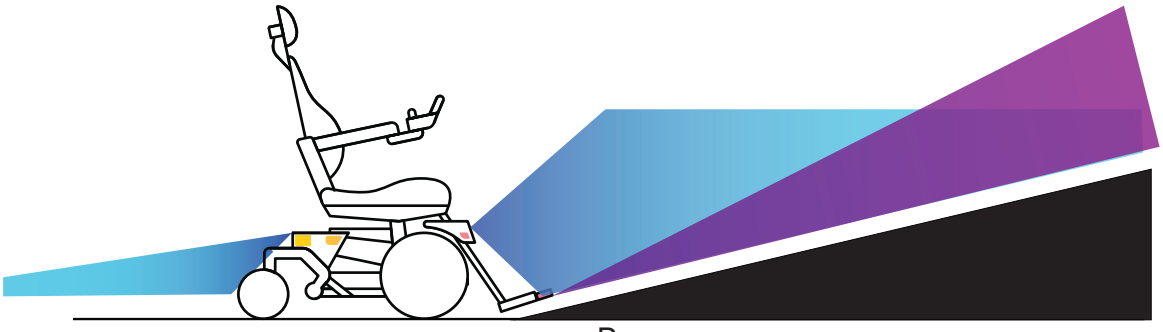
LUCI's front sensor coverage changes with the seating assembly position, specifically with the height and angle of the Scout. The Scout is LUCI's forward facing radar.

The fact that the Scout moves with the seating assembly is a good thing!

The first image below shows a wheelchair with the Scout low and pointed straight at a ramp. The light blue indicates camera collision coverage; notice that it is limited so that LUCI's cameras won't see the ramp as an obstacle and stop you from going up. The dark purple indicates the Scout collision coverage, which may identify the ramp as an obstacle. If you tilt the seating assembly or elevate the legrest, the ramp will no longer register as an obstacle for the Scout as shown in the bottom image below.

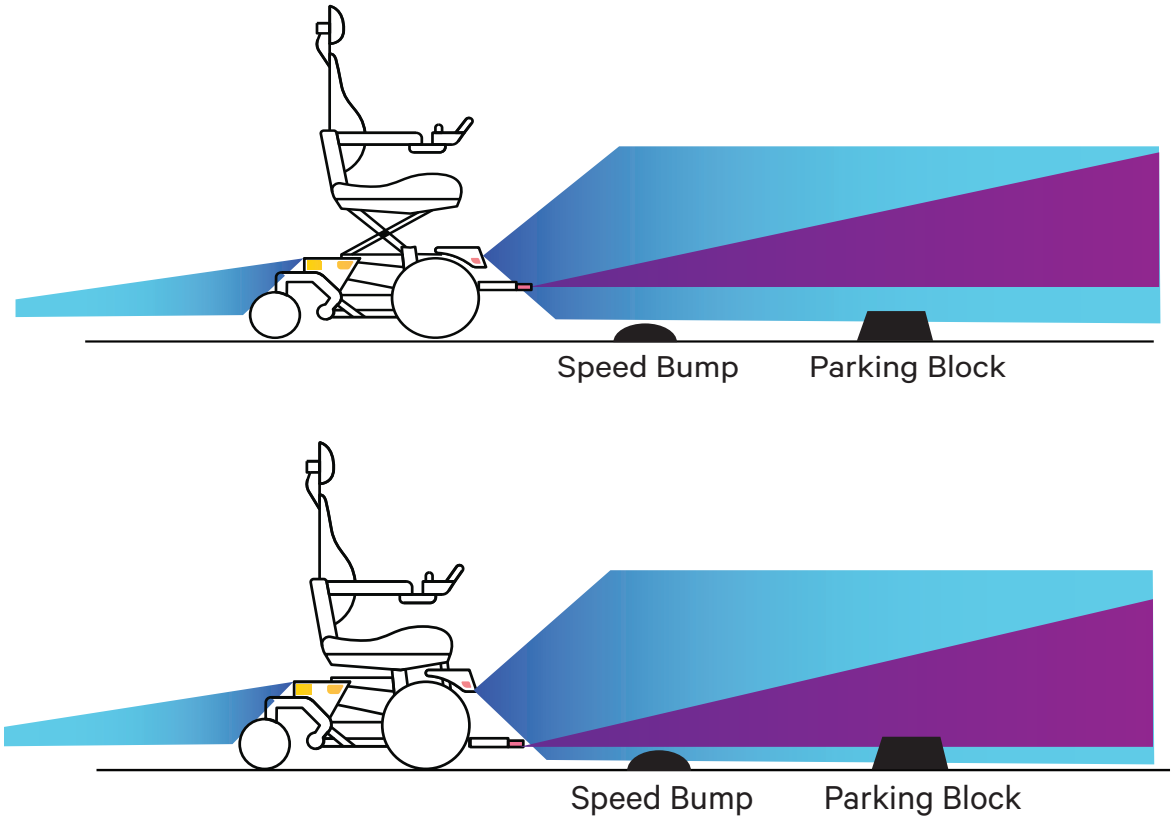


Ramp



Ramp

This same behavior impacts LUCI's ability to see speed bumps, parking blocks, and other ground objects in front of the chair. If, as shown in the image below, the seat height is raised then the Scout is also elevated off the ground and LUCI's ability to see low objects decreases. As the seat height is lowered, the Scout is in line with the obstacle. In this case, the radar can detect the obstacle and LUCI will slow the chair.



LUCI is a driver assistance system. It is important to keep in mind several things when using LUCI:

- **LUCI's sensors are not only the best ones in the industry, they are best-in-class in any industry**; but just like all the sensors on cars, trains, and airplanes, that doesn't mean that they can see everything.
- Sloped ground and high speeds cause momentum that can prevent LUCI from coming to a complete stop before colliding with a detected object or stopping completely before a detected drop-off. Once LUCI detects anything, however, the driver will be 'assisted' in a response, by the slowing of the chair by LUCI.
- LUCI does not apply emergency braking, to prevent tipping the chair and/or throwing the occupant in an avoidance maneuver.
- A power chair, like all motorized vehicles should be operated with an awareness of the dangers in the environments of use.
- LUCI is not a replacement for wheelchair skills training.

Drop-off Protection

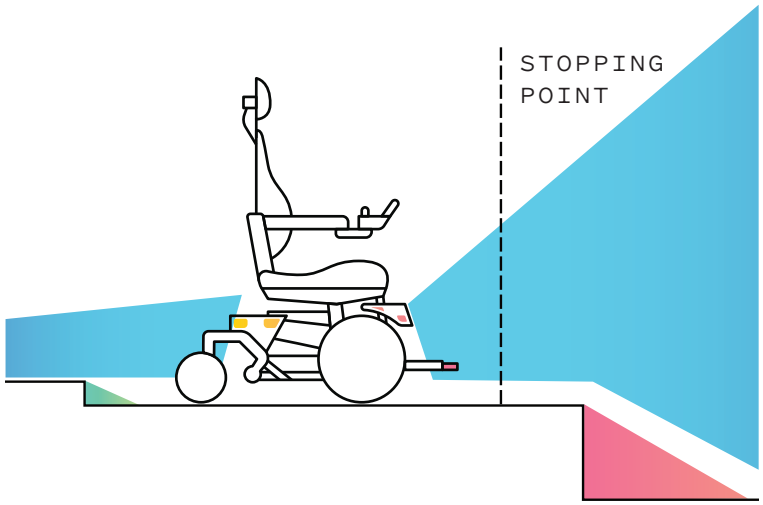
LUCI helps you manage the stability of your wheelchair by monitoring ground features, including the slope of the ground and ramps as well as drop-offs such as curbs and steps with its cameras and IMUs.

MINIMUM DETECTION RANGE	Drop-offs closer than 1.2 in (3 cm) to the wheelchair may not be registered accurately	Measured from the edge of the wheelchair
MAXIMUM DETECTION RANGE	Forward: up to 13 ft (4 m) Backward: up to 3 ft (1 m)	Measured from the edge of the wheelchair
STEP DETECTION	LUCI detects drop-offs with a height greater than the wheelchair manufacturer's published step threshold and sudden changes in ground slope greater than 14-degrees.	See your wheelchair user manual for the published step threshold.
TILT DETECTION	LUCI will detect when your chair is at an angle greater than the wheelchair manufacturer's published tilt threshold	See your wheelchair user manual for the published tilt threshold
LIMITATIONS	Conditions that may challenge the sensors are sudden changes in light level and extremely rough terrain. Mud, snow, water, sand and other soft surfaces may be incorrectly detected as rigid and/or safe surfaces.	

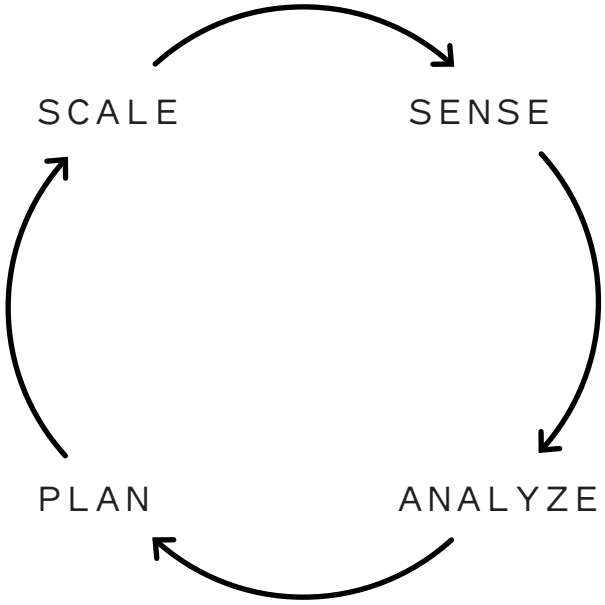
LUCI's edge detection attempts to prevent users from driving off a curb, stairs, or other drop-off that would cause the wheelchair to tip over based on the published curb capability of the base wheelchair. LUCI will allow users to drive down small steps (~2-3.5 inches for most wheelchairs depending on make and model) which are within the wheelchair manufacturer's specified capability but will monitor for dangerous curbs and steps.

Drop-off protection is like emergency braking, pedestrian detection, or air bags in an automobile – please don't test it on purpose! If you drive at high-speed settings toward an unsafe drop-off, LUCI may not be able to overcome the momentum of the chair to bring the chair to a complete stop in time.

NOTE: Just like with collision avoidance, once LUCI detects a drop-off, LUCI will slow the chair, assisting the driver to be aware that there is a drop-off ahead.



LuciCore Software: Plan and Scale



LUCI's goal is not autonomy, it is driver assistance that leads to increased independence. LuciCore is our software, the brain, that makes everything LUCI does possible.

LUCI's processing involves receiving massive amounts of asynchronous data from our sensor system. Data from our **Sensors** arrives anywhere from 12 times per second to 100 times per second depending on the sensor type. Our software then **Analyzes** the surroundings and **Plans**, using user input, for what needs to be done. Finally, LUCI **Scales** the user input to slow the chair if an obstacle or drop-off is detected in the direction the user wants to go.

Throughout this whole process **LUCI's collision avoidance and drop-off protection never add to the joystick input of the user, they only reduce the drive input to the wheelchair.** This entire decision-making loop is repeated 10 times per second to keep users safe. Which means...

LUCI takes action to avoid collisions, drop-offs, and potential injuries 10 times per second, which is two times faster than a human can.

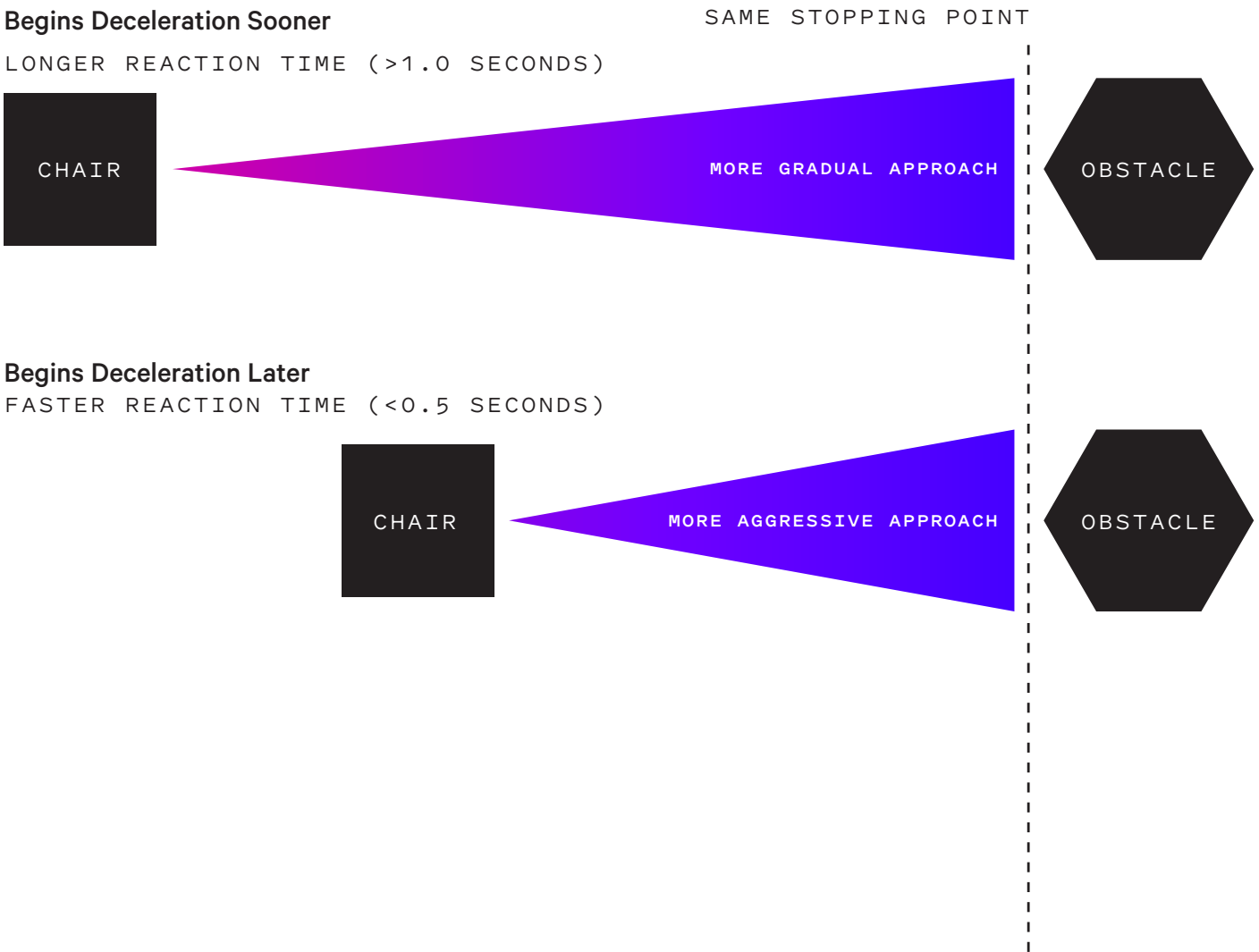
KEEPING THE HUMAN IN THE LOOP

LUCI provides wheelchair drivers the time they need to successfully navigate their environment independently.

To accomplish this, LUCI's calculations incorporate the user's reaction time in the hope that LUCI won't need to completely stop motion of the wheelchair. When LUCI is working best for a user, it is assisting them to drive safely and smoothly in situations they might not otherwise be able to navigate successfully by keeping the world within their ability to react to it. A user with a faster reaction time will find that LUCI speeds up and slows down more rapidly than it does for a user with a longer reaction time. LUCI has been adopted early on by users with longer reaction times or those that use alternative drive methods, but no matter what, LuciCore keeps the human in the loop.

A user's reaction time tends to remain relatively consistent day-to-day, but many LUCI users struggle with spasticity, poor muscle tone, vision deficits, or other intermittent issues with focus or motor control. These can cause driving in one part of the day to be safe and effective and driving in other conditions or times to be a real challenge. LUCI's human in the loop processing listens to the user and helps correct driving errors that could cause collisions and injuries leading to safer, more effective driving for longer periods of time and in more conditions.

In short, keeping in the human in the loop leads to more confident mobility for a wide range of users.



OVERRIDE IS A FEATURE

To catch as many unsafe conditions as possible, LUCI is tuned to be cautious, which will inevitably lead to some situations where the user would like to continue moving in a direction where LUCI is stopping or slowing movement. LUCI users always have the option to reject the assistance offered by LUCI and move in any direction they desire. This feature is called Override and it's available at the push of a button.

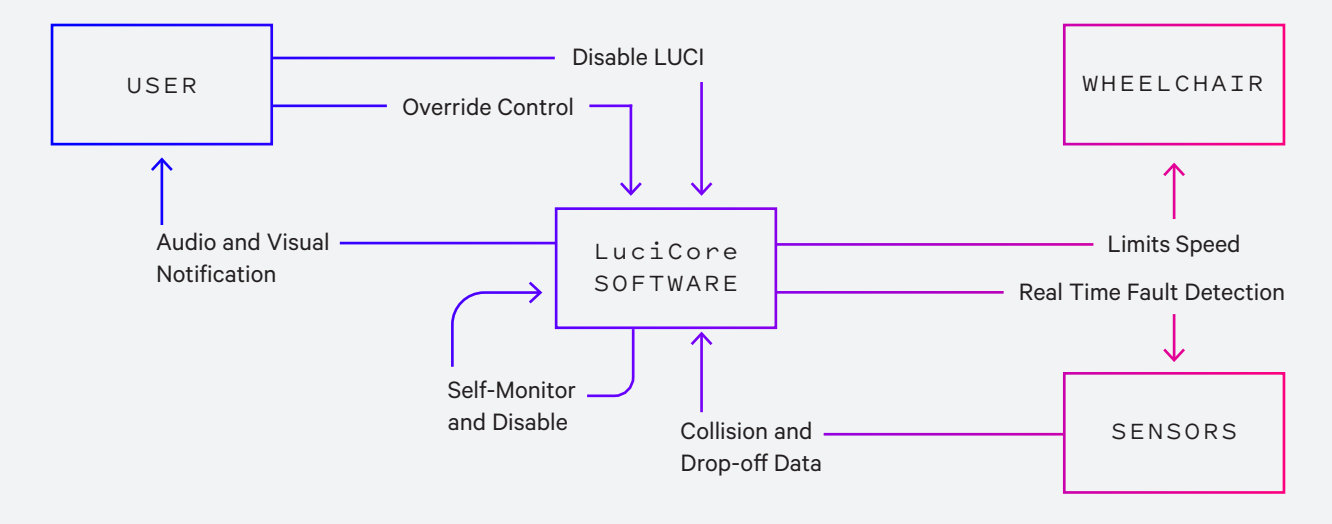
Override is a LUCI feature that should be used!

Sometimes users need to push things open with their footplate. Sometimes they need to pull in and touch the Dashboard when they get in their van. Sometimes they want to jam the chair up against something for transfer. In all these situations LUCI is going to stop the user short and it's ok to use override.

The Dashboard, typically located just above the joystick on the wheelchair control panel includes a LUCI Button, which can be used to temporarily override LUCI. This button should only be pressed in situations when LUCI sees a danger that the user knows to be false, allowing them time to stop, consider the situation and then to navigate without LUCI's assistance. When this button is pressed, the blue light will blink for 30 seconds, 60 seconds, or until the button is pressed again, depending on the settings the user has chosen. During this time, LUCI is temporarily disengaged, and users should take extra precautions to ensure their personal safety.

Override can be personalized to meet each user's individual needs in software and by installation.

In the LUCI Setup Tool, the allowable wheelchair speed during override can be adjusted to the user's comfort level and capabilities. Override can also be completely disabled if desired. In addition, the Dashboard can be mounted in multiple locations to meet the needs of a user and an auxiliary switch plugged into the port on top of the Dashboard can be used to trigger override, which provides additional options for safe, effective use of the override feature. Users should work with their team to configure button access to override that works for them.



LUCI IS "FAIL SAFE"

LuciCore software has been written from the ground up to keep users safe and keep them moving. LUCI uses a multi-tiered architecture to monitor and react to any failures in a safe way.

If the blue LUCI button light on the Dashboard is on, the user can be confident that LUCI is monitoring the environment. LUCI actively monitors the onboard sensors for faults. If LUCI detects that sensor data is corrupt or missing, it safely stops the chair and notifies the user with both audio and visual indicators.

LUCI controls the wheelchair speed at the most fundamental levels of hardware and software using a real-time system. If this system detects hardware or software issues in the LuciCore collision or drop-off protection systems, it will safely bring the wheelchair to a stop. At this point, if a user wants to continue 'unassisted' then LUCI can be turned off and the chair will continue to operate.

In either of the above scenarios, LUCI mitigates risk and brings the wheelchair to a stop safely in the event of a system failure. LUCI then mitigates leaving the user stranded.

- If a sensor on LUCI stops working, the user can press the LUCI button on the Dashboard to activate override and continue driving. Restarting the wheelchair will typically allow LUCI's self-recovery to fix sensor errors.
- If restarting the wheelchair doesn't fix the issue, then the user can use the Setup Tool to disable LUCI for a longer period until LUCI can be serviced.

LuciCore uses onboard hardware and software to monitor operation and status of LUCI. If low-level firmware detects that a core electronic component has failed, or LUCI is not correctly operating, it disables LUCI automatically to allow the wheelchair to operate without LUCI, but at a reduced speed. Failsafe mechanisms in LUCI ensure that if LUCI is not active, the LUCI light on the Dashboard will not be illuminated so that the user knows they are operating without LUCI. Furthermore, if LUCI's computer experiences a catastrophic failure, there is an automatic switch that closes, enabling the wheelchair to be driven until LUCI can be serviced.

In all cases, the worst failure of LUCI leaves the user with a wheelchair no more dangerous than a wheelchair without LUCI.

SAFETY IS A PROCESS

As the first company to produce an active driver assistance system for wheelchair users, we are leading the way on safety in the industry.

Current wheelchair standards are primarily written to deal with one-time testing of the physical durability and minimum electrical safety of the power base of a wheelchair. LUCI is an accessory for a wheelchair, not a wheelchair, and is therefore outside the defined scope of these wheelchair standards (ISO 7176 and ANSI/RESNA WC-1). However, we have gone above and beyond to ensure that LUCI meets the applicable requirements of ISO 7176. Meeting these durability minimums is important, but safety at LUCI goes much further.

From the beginning, LUCI established our quality system, with documented practices that ensure safety is always front of mind in the development of our technology. We leaned on our experienced advisors to take best practices from the medical device, automotive, and aerospace worlds to embed safety into how we work every day. Over time, these practices have evolved into the first comprehensive and robust system for evaluating wheelchair driver assistance devices.

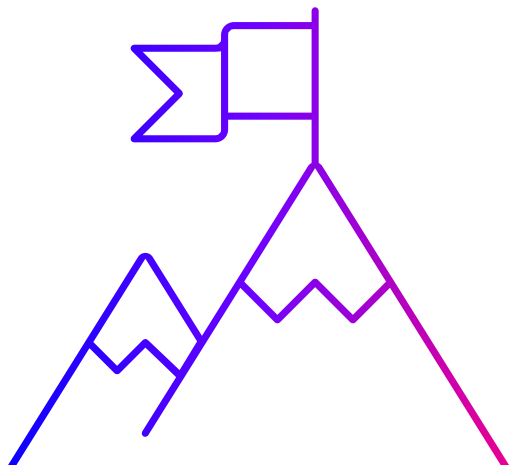
LUCI's safety process involves risk assessment, manufacturing controls, simulation and physical testing, customer engagement, and fleet data analysis. By implementing a rigorous safety process, we not only catch and eliminate potential issues before they reach users, but also continously refine LUCI to meet and exceed customer expectations.

It is impossible to develop a perfect collision avoidance or drop-off protection system that will work in all environments and all settings. However, our process for developing the most capable system in the world includes identifying hazards to the wheelchair user and implementing potential mitigations that can reduce risk. The process is built on ISO 14971 Risk Management for medical device best practices. We use a variety of hazard identification methods such as Hazard Analysis and Design Failure Modes and Effects Analyses (DFMEA). Mitigations take various forms such as software or hardware requirements, hardware or software design elements, training, and disclosures.

Each LUCI unit is manufactured as a medical device under an ISO 13485:2016 compliant quality management system. As part of this system, we are constantly looking for better, more effective ways to make the product more robust.

Our engineering team is in constant communication with our customer success and sales teams getting feedback from the field and engaging with end users. Many of the features and updates that get pushed in our over-the-air software updates are the direct result of customer feedback.

This continuous process goes together with ongoing engineering simulation, data analysis, and test activities to continually increase the capabilities of LUCI and improve user safety.

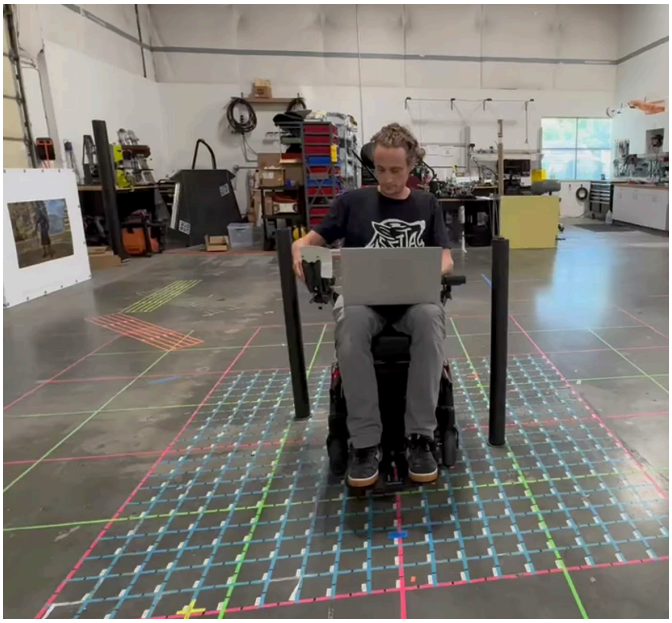


TESTING METHODS AND RESULTS

LUCI gives power wheelchair riders unparalleled stability, security and connectivity through cloud-connected software and hardware mounted between the seat and base of their current chair.

As an accessory to a power wheelchair LUCI is a Class I, exempt medical device and meets the associated requirements of the US FDA and Canadian MDD. In addition, LUCI meets the applicable requirements of IEC 60601 for home use medical electrical equipment.

The essential performance of the system requires that LUCI not create unintended motion of the wheelchair and that LUCI alert the user to detected unsafe conditions. These basic safety requirements have been tested in a wide variety of environmental conditions, while exposed to extreme electromagnetic interference, and under multiple failure conditions of both the base wheelchair and LUCI itself.



LUCI's internal technology verification process involves completing over sixty-five analyses, simulations, tests, and reviews covering...well...everything.

LUCI tests at the module, subassembly, and final assembly level to prove that it is worthy of use by the wheelchair riders we know and love. While we could dive into the details of our IP54 water and dust protection testing, medical grade electromagnetic immunity, impact and durability testing, or use of third parties to review our architecture and risk assessment methodologies, this report is focused on the collision avoidance and drop-off protection safety test standards that we have pioneered.

No system will ever prevent all collisions or tip events, but we have developed rigorous test protocols to evaluate LUCI. We are constantly working to find the perfect balance between an amazing user drive experience and the impossible bar of absolute safety. It is our sincere hope that by sharing these methods and results we can spark an honest discussion in the industry around user safety.

To that end, LUCI is leading the charge at the Rehabilitation Engineeing Society of North America (RESNA) and International Organization for Standardization (ISO). In 2022 LUCI, in collaboration with clinicians, proposed the creation of a RESNA Wheelchair Standards Working Group to collaborate on standards for Warning and Driver Assistance Systems. That group is now at the international level working as part of ISO TC176/SC1 Working Group 10. The goal is to define a new section of international standards, built on LUCI's proven approach, which would directly apply to all robotic and driver assistance systems internationally. The following sections detail the foundational test methods LUCI has developed .

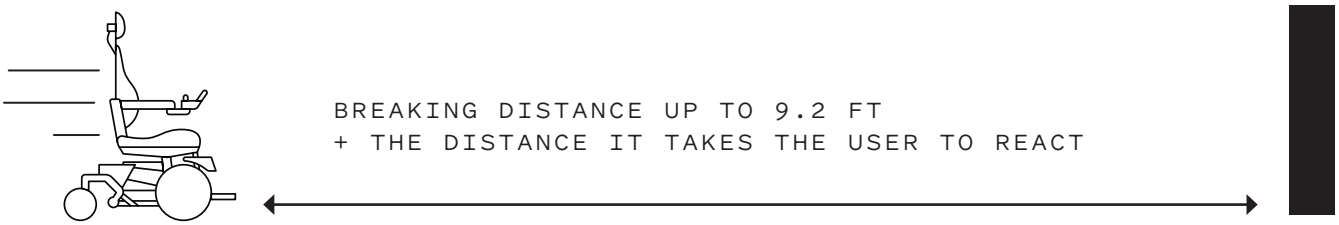
Collision Avoidance Testing

Collision avoidance testing is performed on each wheelchair model. Each model is driven at a target from various angles, at various speeds, and with different LUCI settings totaling 300 individual attempts to collide with obstacles per model of wheelchair.

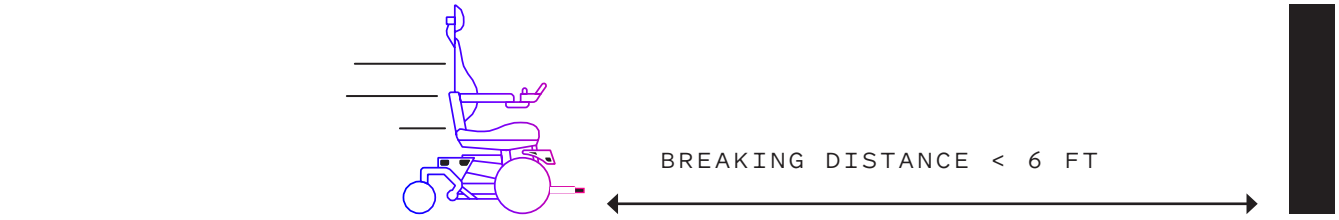
LUCI's collision avoidance is 99% effective at slowing the chair before a collision with a detected object and is approximately 98% effective at stopping the wheelchair completely before contact based on our test methods.

If LUCI stops the chair from colliding and then the user is allowed to aggressively attempt to hit the obstacle by moving the joystick around after the chair stops, we call this the swish test. Our data from the swish test shows that LUCI still manages to keep the chair from touching the obstacle in over 96% of cases. When there is a "collision" in this swish test case, it is typically a minor caster scrape or toe drag on the obstacle that is unlikely to harm the user.

SENARIO A: WITHOUT LUCI



SENARIO B: WITH LUCI

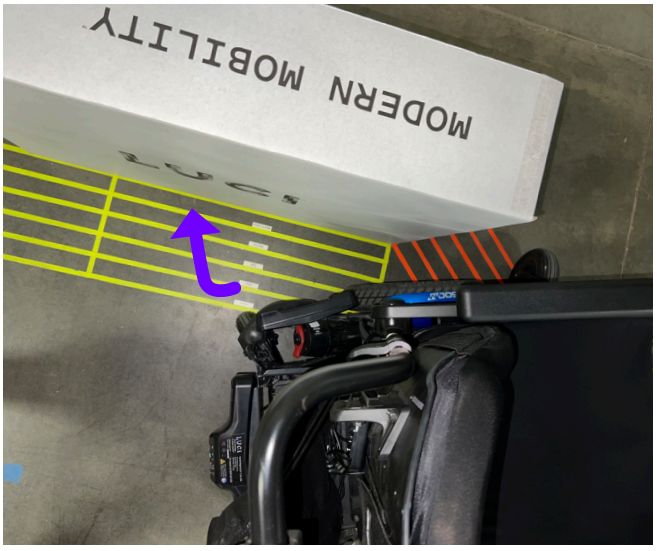


Let's compare the collision avoidance scenario for a power wheelchair user driving at top speed toward a detected target. In Scenario A, without LUCI, the user may need to identify the obstacle and let go of the joystick 9.2 feet (2.8 m) or more from the obstacle, depending on wheelchair model, in order to avoid a collision based on published braking distances of the wheelchair. Now looking at Scenario B, with LUCI, the same user driving at the same obstacle with the same initial speed could continue to hold full forward on the joystick while approaching the obstacle and would have a 99% chance of a lesser collision and a 98% chance that in spite of their reckless driving they would not even contact the obstacle! LUCI still takes time to slow the chair down smoothly to avoid launching the driver out of the chair (slowing a 300+ lb. object from 6 – 6.5 mph down to zero in less than 6 feet is a major deceleration). If you replace the reckless driver with a typical driver, then LUCI will slow the chair to a safe speed and give the user time to maneuver around the obstacle safely becauses we take user reaction time into consideration.

THE PROCEDURE

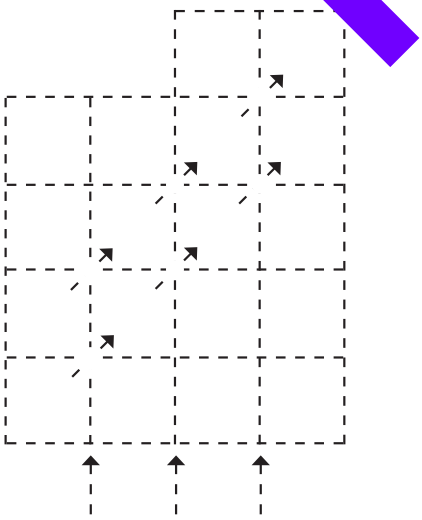
An obstacle is placed in an open space and the wheelchair is driven at the obstacle with combinations of three different speeds (slowest, medium and fastest for each model, which varies from 0.1 to 7.6 mph depending on model), three different reaction times, and various configurations of back and foot zone clearance (standard and extended). In all cases, factory default wheelchair electronics settings are used. For the purposes of this report we'll use a LUCI box since it is easy for anyone with a LUCI unit to get.

Front collision is tested by driving directly toward the obstacle after allowing the chair to reach maximum speed at the current speed setting. **Back collision** is tested by driving directly backwards toward the obstacle after allowing maximum speed to be reached.



Zero-point collisions are tested by parking the wheelchair 8-10 inches (20-25 cm) from the obstacle with the wheelchair's right or left side aligned parallel to the obstacle. In the reported results, the chair is first swung away from the obstacle and then turned back towards it in an attempt to bump into it.

Diagonal collisions are tested by driving forward at varying speeds and turning directly toward the obstacle at the last moment. The turn is initiated at varying distances, shown with the arrows on a 19.7 in (0.5 m) grid as shown below. The joystick is held full forward so the chair can get up to speed. When the footplate of the chair goes over the correct arrow, the joystick is pointed at a 45-degree angle towards the obstacle and kept in that position until the chair slows to a stop.



The swish test is performed during select runs of the front, back, and zero-point collision tests by continuing to hold the joystick towards the obstacle and then slowly "swishing" the joystick into a turn until the chair starts moving after the collision protection has already stopped the chair.

In all collision test cases, the test is considered a "pass" if the wheelchair does not touch the obstacle. If the wheelchair does touch the obstacle, the test is considered a "fail." In most cases with a reported fail, the wheelchair slows and gently bumps the obstacle, which is considered a "fail" by our rigorous standards, although a gentle bump would, in most cases, not cause injury to the rider. The swish test is an attempt to intentionally scrape against the obstacle from a standstill after the chair stops; failures in this test are typically a caster or armrest scraping the obstacle, which in most cases would not cause injury to the user.

Results are reported as a ratio of the number of tests passed to the total number of tests performed.

MODEL	FRONT COLLISION	BACK COLLISION	ZPT COLLISION	DIAGONAL COLLISION	SWISH TEST
100 - Permobil M3	48:48	57:57	105:105	53:54	25:36
101 - Permobil F3	48:48	57:57	105:105	54:54	36:36
113 - Permobil MVS	48:48	57:57	101:105	54:54	36:36
107 – Quickie Q500 M	48:48	57:57	105:105	51:54	35:36
108 – Quickie Q700 M	48:48	57:57	105:105	52:54	35:36
109 – Quickie Q300 M	48:48	56:57	105:105	54:54	25:36
110 - AMY R3	48:48	57:57	105:105	54:54	36:36
111 – ROVI X3	48:48	57:57	105:105	54:54	27:36
112 - ROVI A3	48:48	57:57	105:105	54:54	25:36

Drop-Off Protection Testing

Drop-off protection testing is performed on each wheelchair model. Each model is driven at a curb from various angles, at various speeds, and with different LUCI settings totaling over 200 individual attempts to drop off the curb, per model of wheelchair.

THE PROCEDURE

The wheelchair is driven toward a standard height curb (6 inch, 90-degree edge), with varying speeds (ranging from 0.5 to 3.5 mph[6] for each model), three different reaction times, and various configurations of back and foot zone clearance (standard and extended). In all cases, factory default RNET settings for the model being tested are used.

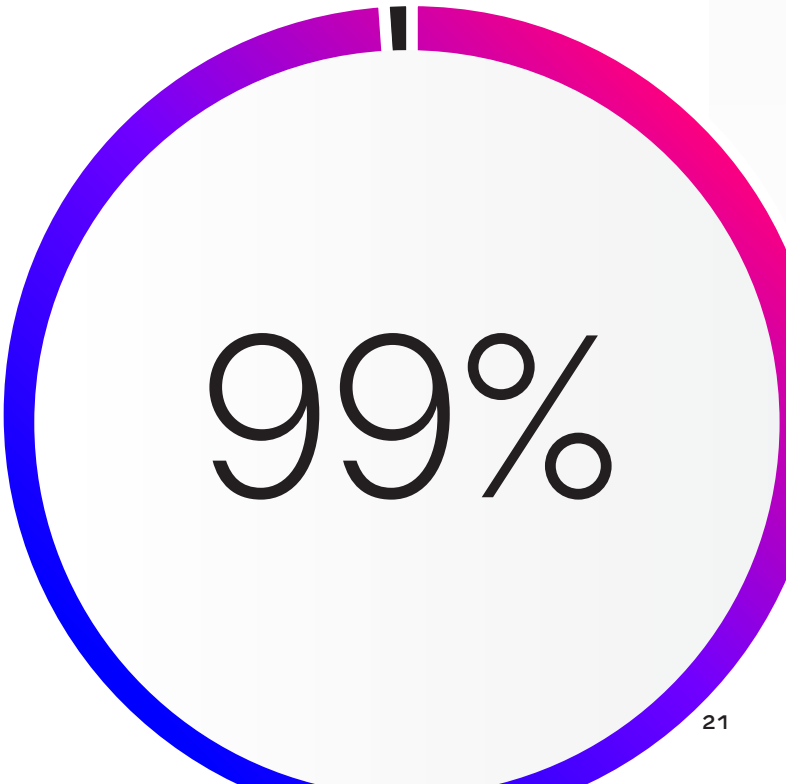
Front and back drop-off is tested by driving directly at the curb from 12 to 18-feet (3.5 to 5.5 m) away so that the wheelchair will be up to speed before slowing. The joystick is held at full speed the entire run.

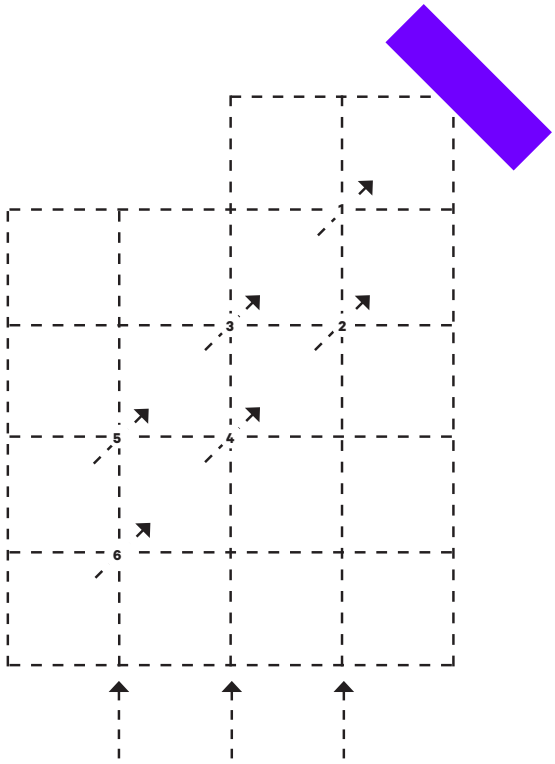
FRONT APPROACH

REAR APPROACH

Zero-point drop-off is tested by parking the wheelchair 8-10 inches (20-25 cm) from the edge of the curb/drop-off with the wheelchair's right or left side aligned parallel to the drop-off. Then the joystick is held toward the curb to turn the chair toward it and attempt to turn the wheel/caster off the drop-off.

LUCI's drop-off protection is 99% effective based on our curb drop-off protection testing.

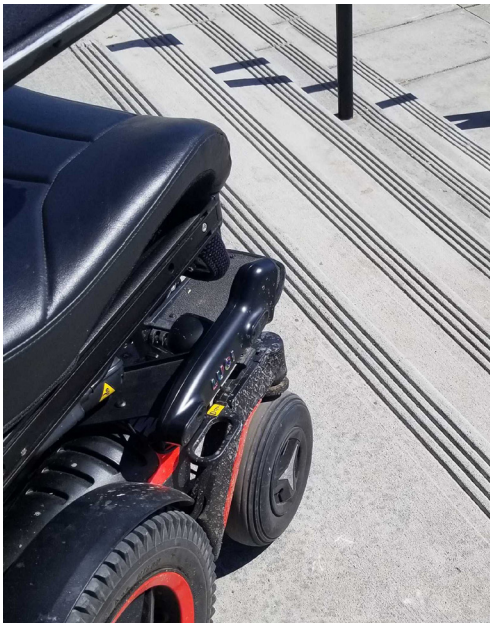




Diagonal drop-off testing is done by driving forward at varying speeds and turning directly toward the curb at the last moment. The turn is initiated at varying distances, shown with the arrows on a 19.7 in (0.5 m) grid. The joystick is held full forward so the chair can get to speed. When the footplate of the chair goes over the correct arrow, the joystick is pointed at a 45-degree angle towards the curb and kept in that position until the chair slows to a stop.

The 3-step test is done by driving directly toward three (or more) steps.

The swish test is performed by continuing to hold the joystick towards the obstacle and then slowly "swishing" the joystick into a turn until the chair starts moving after the drop-off protection has already stopped the chair.

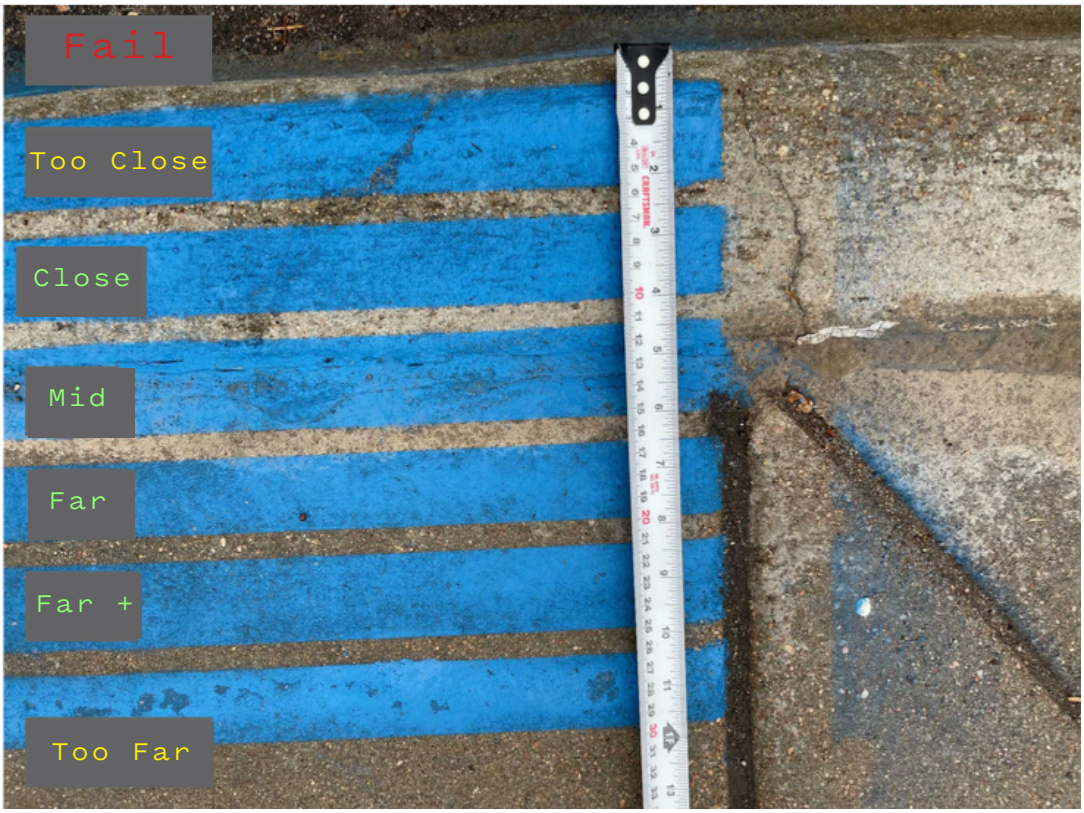


[6] This speed is approximately equivalent to outdoor or "normal" speed three on most chairs and represents an "average walking speed" for crowd travel on sidewalks.

Drop-off protection is considered a failure if the wheelchair falls off the curb or if the wheelchair caster goes off the curb when the wheelchair comes to a stop. In most cases when there was a failure reported, a single caster went off the curb slightly resulting in no unsafe chair movement. A worst case result in the testing completed was a wheelchair being tilted or unable to get back up onto the step without assistance. The wheelchair did not tip over in any of the tests.

Results are reported as a ratio of the number of tests passed to the total number of tests performed.

MODEL	FRONT DROP-OFF	BACK DROP-OFF	ZPT DROP-OFF	DIAGONAL DROP-OFF	3-STEP TEST	SWISH TEST
100 - Permobil M3	24:24	30:30	54:54	12:12	6:6	40:40
101 - Permobil F3	24:24	30:30	54:54	12:12	6:6	40:40
113 - Permobil MVS	24:24	30:30	54:54	12:12	6:6	40:40
107 – Quickie Q500 M	24:24	30:30	54:54	12:12	6:6	40:40
108 – Quickie Q700 M	24:24	30:30	54:54	12:12	6:6	40:40
109 – Quickie Q300 M	24:24	30:30	54:54	12:12	6:6	40:40
110 - AMY R3	24:24	30:30	54:54	12:12	6:6	39:40
111 – ROVI X3	24:24	30:30	54:54	12:12	6:6	38:40
112 - ROVI A3	24:24	30:30	54:54	12:12	6:6	40:40



LUCI In The Real World

LUCI achieves an incredible level of safety for the user in both collision avoidance and drop-off protection. However, most wheelchair riders aren't actively trying to drive off curbs and run into things on purpose like we do in the lab. Therefore, a large part of our testing is done in the real world just driving around in "typical" situations.

Real world testing is done in daylight and at night, in three main test courses: in our indoor "home test" facility, outside the home in the community around our offices, and while entering/exiting accessible vehicles to go places for testing. Because safety testing is broken out into separate tests, this group of tests is looking for areas that LUCI could cause you to use override when you wouldn't expect it to (a false positive). Because...

If LUCI isn't sure if a situation is safe, it will slow or stop the wheelchair out of an abundance of caution.

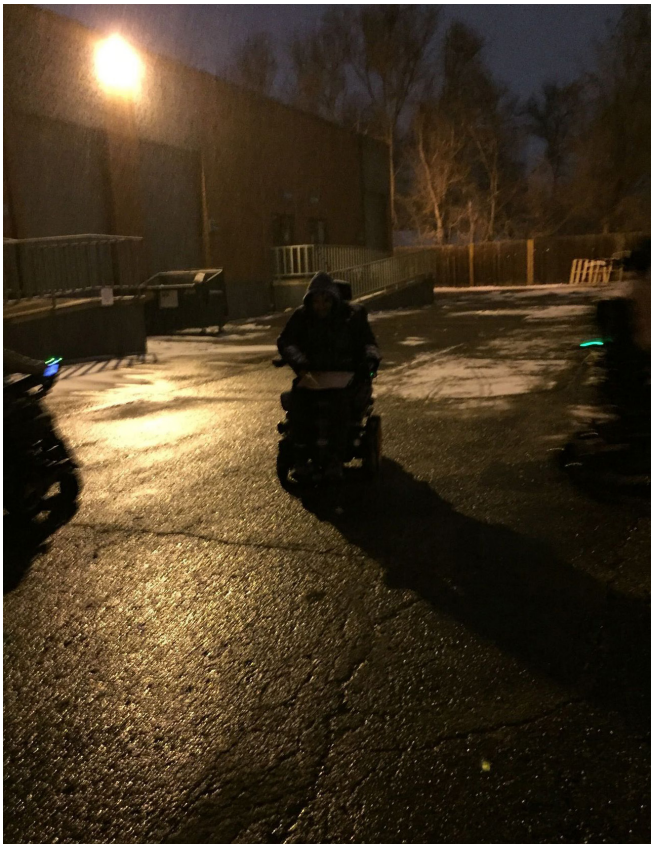
Don't worry though, that is what override is for. If you disagree with LUCI, you win and it's ok to use override when you know it's safe. At the same time, it's our goal to make LUCI drive so well that you forget the override button exists! **LuciCore 3.0 cut LUCI's false positive rate in half while also improving our overall safety and performance!** LUCI currently has an approximately 2% false-positive rate that would cause a user to have to use override when there is not a valid obstacle. Make sure your LUCI unit is connected to Wi-Fi so that your LUCI unit can get the latest software update.

Inside the home testing includes driving down narrow hallways, through doorways, entering and exiting an elevator, pulling up to a kitchen cabinet, work bench, and toilet, and slowing to avoid collisions with objects that pass across the wheelchair's path.

Outside the home testing is performed inside and outside a mall. The course includes shiny floors, elevators, tight spaces, varying lighting conditions and floor patterns, driving up and down sloped sidewalks, curb cuts, drainage grates, accessible doors, packed-dirt paths, and other natural and man-made obstacles in and around the facility.

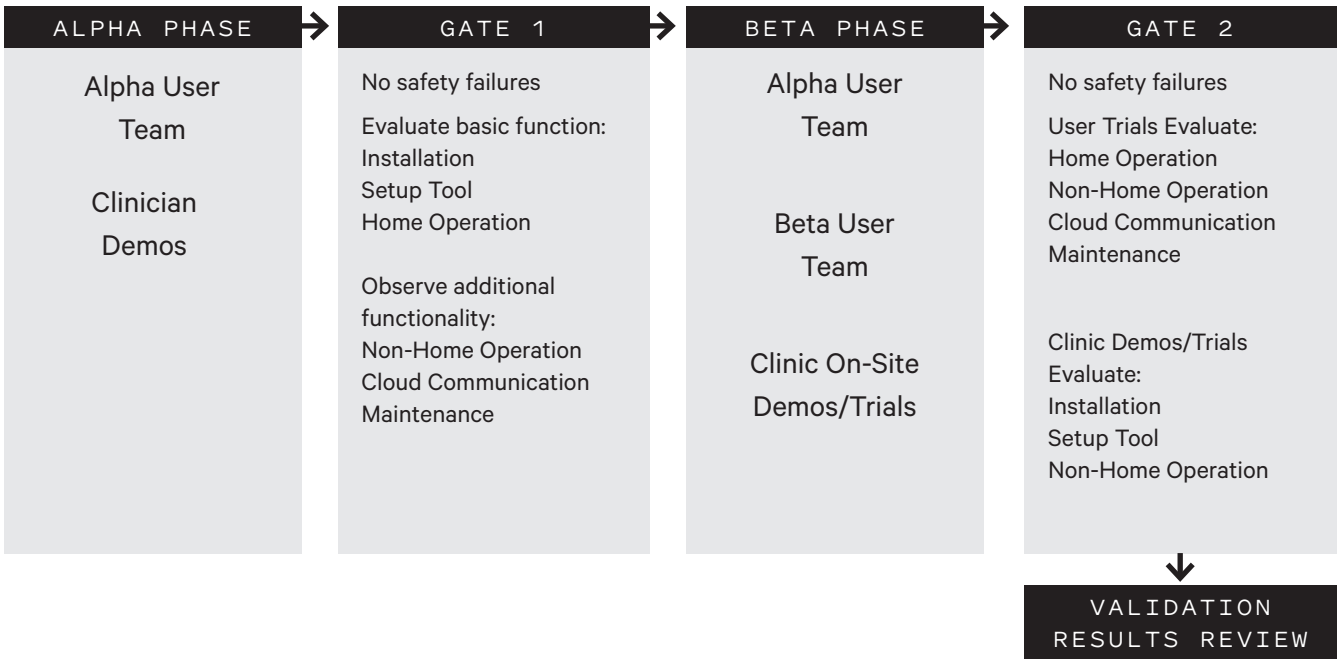
Night navigation involves driving both inside and outside in the dark, navigating hallways, ramps, and sidewalks, with varying terrain and lighting conditions.

Decreasing false positives without impacting system safety is a major focus of the LUCI development team.



LISTENING TO USERS

We believe “The Bridge Must Stand” regarding technical testing of the product. However, it is critical that users’ voices are included too! That is why, when we developed LUCI, we included wheelchair users, caregivers, and clinicians in a multi-stage, multi-year product validation process before we even announced LUCI. This product validation led to a number of changes to our hardware, software and user interface. The basic flow of our pre-launch validation is shown below.



This process of working with users and clinicians continues today. LUCI maintains an active program to give select users early access to future features we are exploring so they can provide us with feedback. In addition, our customer experience team is listening and feeding user feedback from the field to our developers constantly. We are always listening and improving. While we have the mandatory processes in place for receiving reports and addressing corrective and preventative action based on field reports, at LUCI we are using technology to go beyond basic compliance in two important ways.

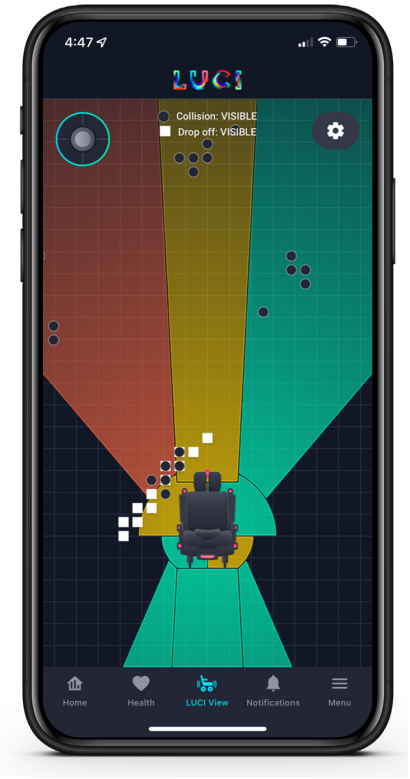
LUCI’s telemetry system collects and analyzes deidentified log data from all connected, deployed safety systems so LUCI can monitor fleet health, capture fleet-wide trends, and act on possible issues. The deidentified fleet-wide data aggregation allows us to evaluate the performance of the LUCI fleet in pseudo real time to inform future product changes. Our telemetry also allows LUCI to diagnose errors on individual safety systems if users call for customer support.

Every LUCI user can help us with this process of continuous improvement by quickly pressing the LUCI button on their Dashboard five times when they encounter a situation with LUCI that they don’t like. When you press the button on your unit five times, an anonymous packet of sensor data is sent to the engineering team at LUCI to analyze and used to improve the product.

All of this feedback and data gets turned into new software releases that are pushed over-the-air to LUCI over Wi-Fi and make it consistently better for every user.

Building To The Need

Billing codes should never limit wheelchair riders' hopes and dreams. As we listen to users, caregivers and clinicians, we continue to develop new features built on LUCI's core safety platform that build to the needs, the what-ifs and the why-nots. Some examples of user inspired innovations made possible by LUCI's collision and drop-off protection include:



Luci View™

With the MyLUCI app, users have access to a 360-degree visualizer tool that shows what LUCI sees. The Luci View visualizer shows where the nearest drop off and collision obstacles are located relative to the chair. It will also color zones in red if motion is stopped because of an obstacle at the wheelchair boundary, yellow for zones where an obstacle is approaching, and green for zones in which motion is unobstructed. Luci View can help users "see" obstacles behind them.

White Cane Filter™

Some power wheelchair riders who have visual impairments use a white cane as their primary method of safely navigating the world. When LUCI is installed, the white cane was often detected as a potential collision, resulting in a stuttering drive experience. The LUCI team developed an option designed to filter out the user's white cane without compromising LUCI's underlying safety system. Now users are able to take advantage of LUCI's collision and drop-off protection while using their white cane for a safe and smooth drive experience.

RampAssist™

Ramps are dangerous and difficult. Many ramps are about the same width as the arm rests on a power wheelchair and a single caster flip can be enough to knock a wheelchair off the center of the ramp. That makes it hard for users to safely and confidently drive up a narrow ramp. RampAssist is LUCI's answer to one of the most common difficult situations users encounter on a daily basis. LUCI can now help users navigate up and down ramps.

LEADING THE WAY

At LUCI we Love Tough, which means we tell the truth even when it hurts. Today's solutions for power wheelchair users simply aren't enough. We can do better. We must do better. And LUCI is leading the way.

LUCI is the first and only active driver assistance solution available in the world — the first modern driving technology to leave the lab and break through the barriers and excuses so often used to block innovation in the wheelchair industry.

LUCI has been recognized with so many awards including:

- Popular Science Best of What's New,
- Time Magazine Best Inventions,
- CES Tech for Change Award,
- Fast Company World Changing Ideas Finalist,
- 2025 Harding Award for Innovation,
- Multiple Mobility Management Magazine Product Awards, and,
- IoT Breakthrough Awards.

Those awards aren't the real measure of LUCI though...

The real measure of LUCI is how many lives we can change.

We imagine a future of confident, independent, and healthy mobility for anyone who wants to drive. Our latest products and software are the best technology available in the world. But today's LUCI is just the first step towards a better future of independent mobility and freedom.

LUCI SANDBOX

We are tired of waiting for solutions for our family and the people we serve. That is why LUCI launched Project Sandbox in 2022.[7] Project Sandbox opens our platform to leading developers and research partners that are commited to translational research. Research that leaves labs and changes peoples lives in the real world. Sandbox is the first open software development kit (SDK) ever in the wheelchair industry.

Along with our work on standards at ISO, LUCI Sandbox is another example of our commitment to work collaboratively with anyone in the industry that is committed to user success.

LUCI is leading the way. We continue to push the limits of today's technology while working on cutting-edge research that will define tomorrow's solutions. Through it all, our unwavering commitment to quality empowers users with solutions they can trust, driving their success.

[7] For more information see: https://luci.com/2022/12/introducing-luci-sandbox-accelerating-our-industry-to-bigger-and-better-solutions/

CONCLUSION

Since 2018, LUCI has been working to bring modern technology and safety to power wheelchair riders.

We are committed to safety by process, by design, by testing, and by engagement with wheelchair users and clinicians. At LUCI we have a culture that puts safety first and we are committed to openly communicating about where we are with our technology.

We are leading in safety:

- LUCI's drop-off protection is greater than 99% effective based on our published curb drop-off protection testing methods.
- LUCI's collision avoidance is greater than 99% effective at slowing the chair before a collision with a detected stationary object and is approximately 98% effective at stopping the wheelchair completely before contact based on our published test methods.
- LUCI currently has an approximately 2% false-positive rate that would cause an experienced user to have to use override when there is not a valid obstacle.

LUCI's technology has proven itself in the real world, with over 50,000 miles safely driven by users in homes and communities across the country.

In addition to our rigorous internal testing, we believe in leading the industry by helping develop the standards that govern it. To that end, we are involved in RESNA and ISO working groups. We are working with national and international stakeholders, including users, manufacturers, researchers, and regulatory bodies, to develop standards for power wheelchair robotics, warning, and driver assistance products and features.

We are committed to Reimagining Mobility® for the wheelchair users we know and love. This report summarizes our continuing efforts to ensure the safety of our product and is meant to spark conversations in the industry about how safety, and new technologies in general, should be defined and discussed.

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