Judging Smart

A Framework For Assessing "Smart" Technology In Power Mobility Today

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>
> ## Point B and beyond.
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Our greatest hope is that this document creates a change.

At LUCI, we do things a bit differently. We may be new and small, but we still believe in leading. And in this case, leading really means being willing to share some thoughts on navigating what is sure to be a busy season for the word "smart."

By offering some initial ideas and questions around the concept of "smart" technology in power mobility, we hope to help mobility professionals in their discussions and offer real questions about the word "smart," as it continues to pervade our industry. This document is not meant as a decree or an end-all, be-all definition, but as a catalyst for conversations our industry should have about possibilities, evaluation, and even accountability when it comes to technology and marketing.

Companies in our industry (mine included) play an enormous role in defining what the future will be for so many people – people like my niece, Katherine. By deciding which products or solutions are made available to drivers, suppliers, and clinicians, manufacturers can silently shape, limit, or expand the possibilities without any public discourse. As one person involved in the design, manufacture, and distribution of seating and mobility products, I am looking forward to more transparency and more discussion. Drivers deserve a bigger

conversation. If we, the professionals who live and breathe this work every day, are not the ones asking the hard questions, we run the risk of allowing mere good intentions, corporate goals – or worse, disingenuous marketing hype – to turn attention away from where it should be. And all those things slow much-needed innovation.

At LUCI, I've met so many wonderful drivers, clinicians, supplier ATPs, and technicians and learned so much from listening to the issues they are facing. Special thanks to Michelle Lange and Jean Minkel for great discussions, education and brainstorming on this topic in particular. Michelle, Jean, and many other passionate voices will, hopefully, present their views on this topic, and that's exactly what we are hoping for.

People outside this industry may assume the job of a mobility professional is just simply trying to help drivers go between points A and B (bedroom to the living room, etc.). You and I know, it's more than that. We are all seeking to use our expertise, understanding, innovation and technology to enable power wheelchair drivers to decide when, why, and how they move. That's a lot more than "point A to point B." We believe in helping drivers retain, regain and seize as much control over their lives as possible while assisting them in pursuing Point B and beyond.

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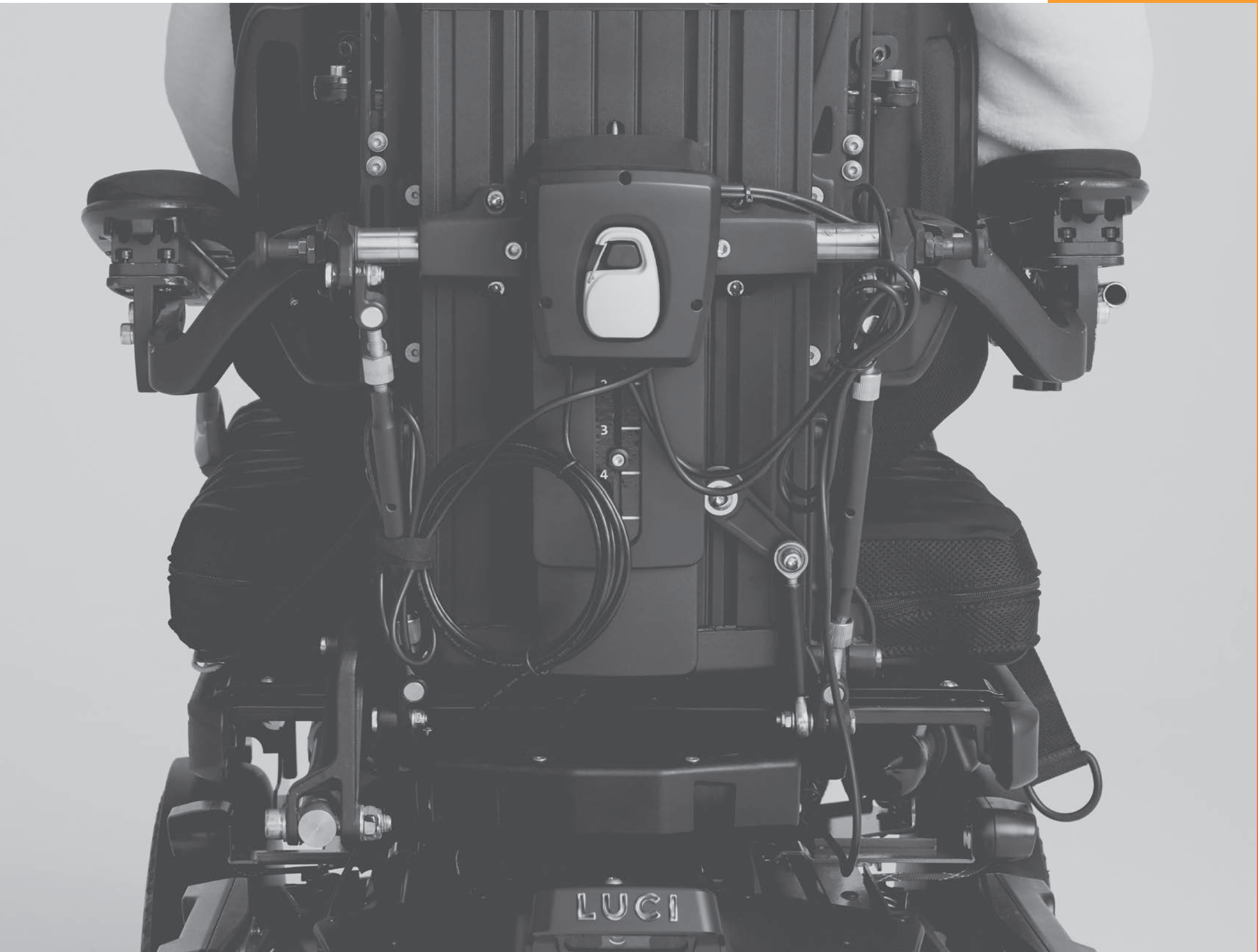
Defining Smart Technology in Our Space

A standard definition for smart technology helps encourage innovation by starting the dialogue and defining the necessary framework to usher in a new era of what's possible in seating and mobility.

Without it, it's difficult to have the exciting conversations that will lead to smarter products. And, we leave ourselves susceptible to marketing confusion and subpar innovation.

Here is a working definition, inspired by decades of experience in product development, to begin the conversation:

A smart power wheelchair is integrated or retrofitted with technology that provides enhanced, independent **mobility** to a wheelchair user, user **health and wellness** data collection capabilities, and/or **connectivity** to integrate with the connected world.

Enhanced Mobility

Autonomy is not synonymous with mobility, and in most cases, it's **not** the preferred option for power wheelchair drivers.

But it does provide a good starting point for standardizing conversations around Smart Mobility.

Why? Because research and work has already been done by respected organizations, like Society of Automotive Engineers (SAE) International, to define levels of autonomy and automation in consumer goods.

SAE International is a "global association of more than 128,000 engineers and related technical experts in aerospace, automotive and commercial-vehicle industries." Its mission: to be "the leader in connecting and educating mobility professionals to enable safe, clean, and accessible mobility solutions."

SAE International's J3016™ Levels of Driving Automation are of particular value to anyone in the mobility industry seeking to evaluate the features of automation. These guidelines describe six levels of automation, providing useful clarity and standardization for automotive and aerospace engineers. Our task, then, is to apply their highway and skyway learnings to power chair drivers' living rooms, sidewalks, and everyday landscapes.

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Vehicle Automation

Let's start by looking at SAE International's Levels of Driving Automation.
On the following page, we have created a parallel progression to show Smart Mobility levels.

LEVEL 0
No Automation
Back up beeper or blind spot warning.

LEVEL 1
Driver Assistance
Adaptive cruise control (adjusts speed without steering assistance).

LEVEL 2
Partial Automation
Smart cruise control, adding lane following and steering assistance to adaptive speed.

LEVEL 3
Conditional Automation
Traffic jam chauffeur (Tesla Autopilot) or remote parking assist (Hyundai Smart Park).

LEVEL 4
High Automation
Driverless taxi on controlled routes.

LEVEL 5
Full Automation
Autonomous car, works anywhere; may not have steering wheel or pedals.

The stages shown in the graphic below provide a Smart Mobility progression – and suggested definitions to aid discussions around what constitutes a smart wheelchair. Using this framework, we can review what is currently available in the mobility market at each level.

We can also begin to identify the levels at which we begin to encounter increased opportunity for transfer of control to or from the driver. Increased autonomy will not uniformly be desired by drivers and, in fact, preferences around levels of control may vary widely between drivers.

As mobility professionals, it is our job to know our clients individually. When evaluating devices against these levels, we must think about what the specific driver will want or not want.

More automation is not necessarily better. **It must be up to the individual.**

What is transfer of control, and why is it so important?

Transfer of control occurs at the moment decision-making power is turned over from an individual to a machine.

Sometimes there is a partial transfer of control – setting cruise control in your car, for instance. A full transfer of control means the machine has complete autonomy – imagine getting in the driver's seat, typing in your destination, then sitting back to scroll Instagram until your car pulls up to its destination.

This concept is particularly important in the world of seating and mobility. Where is the "sweet spot," the right amount of user control mixed with technological assistance? It's a matter of balancing safety and independence, and identifying where drivers feel the most comfort.

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Smart Wheelchair Mobility

Most power wheelchairs score **below** Mobility Level 0

Mobility Levels 3-5 increasingly transfer control from the user to the machine

MOBILITY LEVEL 0
Warnings
Beeper systems, sensor alerts, and backup cameras.

MOBILITY LEVEL 1
Driver Assistance
Tracking technology.

MOBILITY LEVEL 2
Partial Automation
Real-time speed and steering adjustments for navigation assistance.

MOBILITY LEVEL 3
Conditional Automation
Limited, fully automated actions executed at the user's command.

MOBILITY LEVEL 4
Highly Autonomous
Driver input unnecessary in specific environments, for example at a given location.

MOBILITY LEVEL 5
Fully Autonomous
Fully autonomous operation. Driver speed or steering input not required.

Mobility Questions That Need Answers

What is the level of automation and assistance the driver requires and desires for independent mobility?
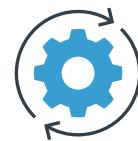
Does the product provide the necessary level of automation and assistance for increased independence?

What happens if the product malfunctions? What happens if the driver disagrees with the product's response?

Does the product limit the driver's ability use other functions or transfer out of their wheelchair?

What is the impact of the product on wheelchair battery performance?

How are software updates handled? Is there a long-term support model?

How does the product work in all of the driver's preferred environments and landscapes? At home? At work? At play? Around town? In the clinic? Others?

Is the product safe to use? Does it meet the international standards set for medical equipment and rehab technologies?

To see our answers to these questions, go to **luci.com/smart**.

Health and Wellness

In the context of seating and mobility, "smart" can and should address the health and wellness of the user.

If our task was to allow for the transport of drivers from established, well-mapped points over and through well-regulated and well-funded pathways, our conversation could stop at the SAE International's Levels of Driving Automation.

However, mobility professionals have a much broader mission that surpasses simple transport. The job is both much bigger – opening up every explorable corner of the world – and much smaller – ensuring safe passage through the precious few spare centimeters of a wheelchair ramp. And, we must collaborate in support of drivers' health and wellness.

To advance our conversation around Smart Health and Wellness, I suggest we borrow a popular phrase from the digital health community: "Data, not programs. Sharing, not hoarding. Individuals, not populations."

With this phrase in mind, we can create Smart Health and Wellness levels, H0 to H5 – to complement our Smart Mobility levels of M0 to M5 – in order to evaluate how smart technology can enable data-driven, digital medicine in the context of seating and mobility.

Data, NOT PROGRAMS.

Sharing, NOT HOARDING.

Individuals, NOT POPULATIONS.

Smart Health and Wellness

As with Smart Wheelchair Mobility, we are now in a position to suggest a means of evaluating what is currently available in the Smart Health and Wellness market today and where opportunities exist for transfer of control to and from the driver. **We'll use seating as an example to illustrate the levels of Smart Health and Wellness possibilities.**

Today's current chair connectivity **barely registers at Health Level 0**

Most consumer wearables are Health Level 2. We must pose the question, "How can we better leverage consumer-friendly innovations that come from outside the industry?"

Health Levels 4-5 increasingly transfer control from the user to the device

HEALTH LEVEL 0
Spot Checks
Taking a pressure map reading at the clinic to evaluate cushion performance.

HEALTH LEVEL 1
Continuous Data Gathering
Continuous seat pressure monitoring when user is outside clinic.

HEALTH LEVEL 2
Data-based User Alerts
Alerting the user when to offload based on current sensor data.

HEALTH LEVEL 3
Secure Sharing
User can share seat pressure and/or offload data with others for health management.

HEALTH LEVEL 4
Conditional Interventions
Seat adjustments are suggested based on the real-time health data of the user, and implemented if the user approves.

HEALTH LEVEL 5
Automated Interventions
Seat adjustments are made autonomously to relieve pressure without user intervention.

Health & Wellness Questions That Need Answers

These are difficult questions for many reasons, mostly because they're new to our industry. These questions represent incredibly important conversations and debates that we must have.

These questions address driver privacy.

Mobility professionals are healthcare professionals and wheelchair drivers' strongest advocates within the industry. Who better to answer these questions?

Does the product allow the driver to share their data with others? If so, how?

What actions are or can be taken based on the data?

How is data security handled?

Who controls access to the data?

Is device data shared with the driver? And how do they access it?

Is the platform proprietary, or compatible with other digital health solutions?

To see our answers to these questions, go to **luci.com/smart.**

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"Mobility professionals are healthcare professionals.
Who better to answer these questions?"

Connectivity

In order for a power wheelchair to be considered "smart," one basic assumption should be that it connects to other technologies and makes data accessible to the people who matter most.

The fundamental question is whether the connectivity serves the person in the chair and their goals.

This sort of Smart Connectivity shares data with the driver's care team, provides voice assistance, supports a "second screen," integrates with smart home technology, and more.

Smart Connectivity demands industry standards in order to ensure smart

power wheelchairs do not transfer control to or from the driver in a way that threatens their physical safety, health data integrity, or personal privacy.

Smart Connectivity is the third category of smart technology in power wheelchairs. Integrating with consumer technology and open standards is the fastest way forward to create opportunities and benefits for drivers and the research they care about.

How should user data be used?

Power chair drivers should control the use of any personally identifiable data created through a smart product. Manufacturers should use anonymized data for product improvement and research. Personally identifiable data collection should emphasize driver rights, security, and dignity.

Connectivity Questions That Need Answers

What is the purpose of the connectivity?

Are there API's available for use by others?

How does the outside world connect to this technology?

How does this technology connect to the outside world?

What other things (voice assistants, smart devices, home automation devices) does the product work with?

How is long-term security handled?

How is driver data used?

Quick Reference Guide: Connectivity

We've mapped current connectivity categories to help you easily evaluate a product's capabilities. The more checkmarks, the more connected the device.

Connection Technologies	IR	Bluetooth Classic	BLE	Wi-Fi	Cellular
Connection Point	Wi-Fi dependent	Anywhere			
Connection Security	Encrypted data transfer	HIPAA compliant data handling	De-identified data transfered	Ability to receive security updates	Additional security features
Smart Device Compatibility	Android Device	Chromebook	iOS Device	Apple computer	Windows computer
Voice Integration	Alexa	Google Assistant	Siri	Other Voice Assistant	
Health Data Import	From specific devices	From open standard(s)	Google Fit	Apple Health	API available for 3rd parties
Health Data Export	Ability to export user data	Google Fit	Apple Health	API available for 3rd parties	
Smart Home Integration	Automatic door control	Automatic light control	Custom ECU/ EADL	Commercial smart home ecosystems	

To see our answers to these questions, go to **luci.com/smart**.

Evaluation Matrix

Given this framework we believe a smart power wheelchair should:
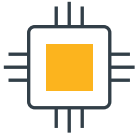
Include integrated or retrofitted technology

Provide enhanced, independent mobility to a wheelchair user

Allow for user health and wellness data collection

Connect to other smart products and the driver's surrounding world

Above all, we understand that every user is unique.

We hope you will use this matrix to evaluate smart power wheelchair products and their value to specific users. You can download additional copies of this matrix at **luci.com/smart**.

	Not Addressed	M0 Warnings	M1 Driver Assistance	M2 Partial Automation	M3 Conditional Automation	M4 Highly Autonomous	M5 Fully Autonomous
H5 Automated Interventions							
H4 Conditional Interventions							
H3 Secure Sharing				LUCI			
H2 Data Alerts	Consumer Wearables & Apps						
H1 Continuous Data							
H0 Spot Check	Smart Check BodiTrak						
Not Addressed	Current Wheelchairs	Braze Mobility			Smile Smart Technology		

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Conclusion

"Smart" technology is – finally, truly, inevitably – coming to seating and mobility.

We're seeing it in automobiles, kitchen appliances, writing utensils and every consumer product in between. The word "smart" is often used but rarely inspected using a lens of expertise and skepticism. That's the lens we're trying to bring here.

We won't be alone in our efforts to tie the industry to clear standards. But our hope is to start a conversation and establish a framework which keeps the driver, supplier, and the clinician at the center, instead of at the end of a funnel of corporations and the status quo.

Our industry is fortunate to have many excellent researchers who will add depth, detail, and granularity to these concepts. We are honored to work with them and among them, and we look forward to seeing how much the industry can accomplish by working together to improve power wheelchair performance, efficiency, and safety – far beyond Point B!

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We thank you for reading and support the fair use of this resource for educational purposes. We sincerely hope this discussion will contribute to more innovation for the people we serve.

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