Smart Wheelchair (SWC) Automation Levels

A Smart Wheelchair is integrated or retrofitted self-monitoring technology for a power wheelchair that provides enhanced, independent mobility to a wheelchair user, is able to collect and report user health and wellness data and provides connectivity to integrate with the connected world.

SWC Level	Name	Definition	Human Role	Functional Example	Product Feature Example	Product Example
Human driver monitors the driving environment						
0	**Warning Systems**: no automation/ intervention	A warning system that monitors and provides feedback to enhance the situational awareness of the user but does not affect user inputs.	Operator-the user is always in complete control.	The system does NOT intervene- reliance is solely on the driver to respond appropriately/timely to the warning given	Sensors that warn driver of potential collisions or other hazards	**Braze Mobility:** collision warning systems (auditory, visual, and haptic warnings) **ASL:** 404 Four Sensor Alert & 405 Two Sensor Alert, collision warning system, (auditory) **LUCI**: Incline/tip warning (auditory)
					Backup camera gives visual display of potential collisions or other hazards prior to driving in reverse	**Cheelcare:** Aware A1 / A2 / A3 backup Cameras **Tadibrothers**: backup camera **Quantum Rehab:** backup camera
Human driver and automated driving system monitor the driving environment						
1	**Driver Assistance:** Single function assisted navigation (Speed or Steering)	A system that can adjust user inputs for only one function (e.g., speed, seating control, or steering) to assist with operation. The system DOES intervene.	Collaborator-the user is in control with assistance from the system	Driver controls all driving options except for emergency stops in response to detected collisions or other hazards	Sensors that warn driver of potential collisions or other hazards and the system stops the wheelchair if the driver does not respond appropriately	**NA**
				Increases driving efficiency by reducing compensatory	Tracking technology: reduces joystick movements or switch	**Quantum Rehab:** Accu-Trac **Invacare:** G-Trac **Permobil:** ESP

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				movement, for example driving on a side slope.	activations and reduces time to move between locations	**Sunrise Medical**: SureTrac **AMYLIOR:** Smart-Track
Human driver and automated driving system monitor the driving environment, cont.						
2	**Advanced Driver Assistance:** Multiple function assisted navigation. (Speed and Steering)	An active system that can make both speed and steering adjustments simultaneously to the driver's inputs to assist with navigation. The system DOES intervene.	Cooperator- The user-monitors and engages while the system can adjust inputs.	Driver can steer. System will avoid collisions, drop-offs, and/or tipping by Simultaneously controlling speed and direction	Driver can continue driving, but not in the direction of a hazard. System imposes a restriction in travel that can be overridden	**LUCI:** Navigation assistance/collision avoidance, Drop-off protection
				Driver can control speed. System will automatically slow, as needed	Driver can increase speed, but system will slow in response to environment, such as walking in a crowd	**LUCI:** Crowd confidence and dynamic slowing
Automated driving system monitors the driving environment						
3	**Conditional Automation:** Autonomously navigate through a specific process and adapt under specific conditions.	An active system that makes limited, fully automated actions in response to the user inputs. The system DOES intervene.	Initiator/Supervisor- Users must be ready to drive when autonomous features are not engaged.	Ability to navigate to a destination. The driver can initiate and stop movement, as desired, but stopping is not required	System follows a preprogrammed 'map' or tape on the floor and modifies driving in response to sensor feedback	**Smile Smart System (SSS):** driver initiates and stops movement with switch **LUCI:** RampAssist™

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4	**Highly Autonomous System:** The wheelchair is fully autonomous for an entire trip in specific environments.	An active system where driver input is unnecessary in specific environments and situations.	Occupant in specific environments-no human interaction needed	Ability to navigate to a destination while deciding an optimal process for negotiating obstacles and terrain. The system controls all features in specific environments	The system controls all features in specific environments	**NA**
5	**Fully Autonomous System:** The wheelchair can navigate without a human in all environments.	An active system where driver input is not required.	Occupant in all environments -no human interaction needed	Autonomous in all environments -The system controls all features, everywhere, at all times, in all conditions.	The system controls all features	**NA**

Connectivity	Name	Definition	Functional Example	Product Feature Example	Product Example
System provides connectivity to integrate with the connected world					
	BT Connection to external technologies for Mouse Emulation	System has the ability to connect with external technologies outside of the PWC	Driver can emulate a mouse on a computer, tablet, smartphone, or speech generating device	Driver can use the PWC driving method to emulate a mouse using integrated Bluetooth	**Invacare:** LiNX **Permobil:** R-net **Quickie:** R-net **Quantum:** Q-Logic **AmyLior:** R-net **Merits:** VR2 and R-net
	BT Connection to Apps for specific monitoring	System has the ability to connect with external technologies outside of the PWC	Driver can monitor whether the battery needs charging and where they are on a map (Permobil) Driver can monitor how often and how far power seating changes are made and share those 'reports' in an email (Quickie).	Driver can monitor chair activity and receive limited information from the system. Some information can be shared via email.	**Permobil:** MyPermobil App monitors and tracks battery status, distance, and seating activity. Integrated map, GPS. Android, iOS. **Quickie:** Switch-It Remote Seating App (on Sedeo) measures and tracks duration of seating angles. Can email info to others. Alerts user to adjust seating. Android, iOS.
	BT Connection to external technologies	System has the ability to connect with external technologies outside of the PWC	Driver or caregivers can receive active notifications on a smartphone or consumer technologies (i.e. Intelligent Virtual Assistants like Alexa)	System can be programmed to send notifications or alerts to driver and others	**LUCI**: MyLUCI App -notifications of obstacle avoidance occurrences, tip alerts, chair usage and GPS location. Luci View and power seating reminders. -Alexa & Google Assistant -Android, iOS, web portal **Permobil:** MyPermobil App voice assist feature works with Alexa & Google Assistant
System provides user health and wellness data collection capabilities					
	Connection to sensors and/or wearables to monitor driver health data	System has the ability to connect to sensors and/or wearables to monitor, record, and report medical data	Driver or caregivers can view data on a smartphone	System can be programmed to share health data.	**LUCI:** MyLUCI App -Apple Health and Google Fit compatible heart rate monitoring; heart rate tracking and notification of elevated heart rate sent to care team.

Connectivity	Name	Definition	Functional Example	Product Feature Example	Product Example
System has WiFi Capability					
	WiFi Connectivity	System has the ability to connect to available WiFI for over-the-air updates and troubleshooting.	System updates automatically via WiFi connection for most up-to-date software version.	Over-the-air updates include new product features and software patches/system improvements.	**LUCI:** Over-the-air updates are pushed automatically; LUCI updates overnight to the latest software version. Tech support can “see” what LUCI “sees” to assist with troubleshooting.