



The first peer-reviewed journal article describing a smart wheelchair was published in 1986-25 years ago this year

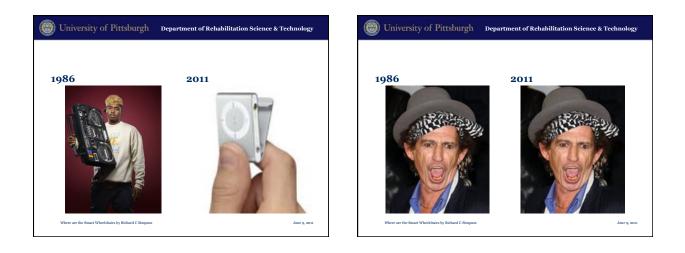
There have been over 50 "smart wheelchairs" built since then

June 9, 2011

So where are the smart wheelchairs?

Where are the Smart Wheelchairs by Richard C Simpson





#### Where are they?

Where are the Smart Wheelchairs by Richard C Simpson

- We have cars that parallel park on their own
- We have robot vacuum cleaners that detect drop-offs
- Why do I keep getting emails like this?

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My nephew, Andrew, has cerebral palsy and we are intending to purchase a 'smart chair' for him in the next few months. I read your 2005 paper in JRRD and wondered whether anyone has revisited this subject in the past 4 years. In particular, I wondered if there you were aware of any advances, particularly in the commercial availability of smart chairs, in the past 4 years.

#### Where are the Smart Wheelchairs by Richard C Simpso

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Why don't we have smart chairs?

- Sensors
- Universal Communication Bus
- Reimbursement
- Evidence

Where are the Smart Wheelchairs by Rich Simpsor



**Sensors** 

These days, the cost is in the sensors.

Where are the Smart Wheelchairs by Richard C Simpson

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#### **Sensors**

- People who don't work with robots don't appreciate how good our senses are
- Affordable sensors

re are the Smart Wheelchairs by Richard C Simpson

- Can't detect drop-offs
- Can't pass through narrow doorways
- Don't work outdoors

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#### Sensors

- Accurate sensors - aren't affordable
- Machine vision is a research problem unto itself
- The Geoff Fernie problem - There's only one way to get 100% reliability

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#### **Universal Communication Bus**

- There is no "USB" for wheelchairs
  - The good old days of analog...
  - Most wheelchairs now used a proprietary CANBus
- No incentive for manufacturers

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- No competition for input devices
- No worries about liability or tech support June 9, 2011

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#### **Universal Communication Bus**

- How do we create an incentive?
  - The lesson of Section 508

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- Tie it to wheelchair funding
- "We will reimburse more if..."
- "We won't reimburse unless..."

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#### Reimbursement

- It's hard enough to get reimbursement for a regular power wheelchair
- We don't have any evidence that smart wheelchairs improve outcomes
  - Collisions are rarely the only problem
  - 32 Skills on Wheelchair Skills Test 4.1

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About 6 involve obstacle avoidance

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#### Reimbursement

The lesson of the iBOT

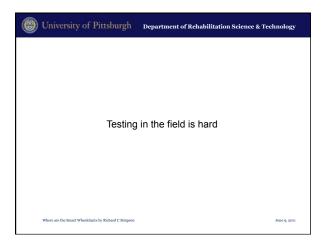
The "category without a distinction"

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#### **Evidence**

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- Smart wheelchairs are not rigorously tested
  - Most of what we have are small studies done in the lab with able-bodied users
  - We don't even have Level V evidence that smart wheelchairs *really* make a difference *in the real world*



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### **Field Trials**

- Cost and Duration
  - Each smart wheelchair costs a lot of money
  - Can only enroll a small number of people
  - We're looking for small effects
  - Really long studies

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Where are the Smart Wheelchairs by Richard C Simpson

## Field Trials

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Measurement

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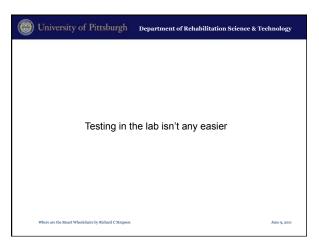
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- What do you measure?
  - Even bad wheelchair users don't crash that often
- How do you measure it?
- How do you combine or prioritize measures?

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Field Trials
The lesson of Honeywell

Tested smart home technology
Small sample size
Short study duration
No control group
No evidence



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#### Lab Trials

- Training
  - We gave each participant a LOT of training
  - It still wasn't enough in all cases
- Sample size

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- Getting target users into the lab isn't easy
  - By definition, they don't get around very well

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#### Lab Trials

- Getting people to hit things is hard
   Blindfolds help
  - Driving backwards helps
- Moving obstacles

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- Hard to implement
- Hard to assign responsibility for collisions

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#### Lab Trials

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- Single subject experimental designs – Difficult to generalize
- Group experimental designs – Small and heterogeneous subject population

