ASER06
3rd International Workshop on Advances in Service Robotics, Vienna, Austria

RoboChair

name recently changed to the:

HLPR Chair

H**ome **L**ift, **P**osition, and **R**ehab **Chair

A Service Robot for the Healthcare Industry

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NIST • Manufacturing Engineering Laboratory • Intelligent Systems Division

Outline

- NIST Healthcare Program/Project
- Why Advance Patient Lift and Mobility Devices?
  - Caregiver and Patient Perspectives
  - Background examples of lift and mobility devices
- RoboChair (HLPR Chair)

NIST Healthcare Program

Healthcare Enterprise Program under MEL

- Standards and measurements for the healthcare industry
- Healthcare records, surgical robotics, devices (hearing aids and mobility)

Healthcare Mobility Project

- To provide advanced mobility assistance for the disabled to improve their quality of life, while reducing potential injury to the WCD and/or caregiver.
  - In some cases, an improved quality of life can mean rehabilitate to eliminate reliance on wheelchairs.
- To develop intelligent and lift-wheelchair standards
  - Current standard includes manual and powered wheelchairs along with seating standards.
  - Presently, there appear to be no intelligent (robotic) wheelchair standards

Why Study Patient Lift Devices?
Caregiver Perspective

From: LIFTING PATIENTS POSES HIGH RISK FOR BACK INJURIES, William Marras, Professor of Industrial, Welding and Systems Engineering, and Physical Medicine and Rehabilitation, Ohio State University.

"The question is, what does it cost not to buy this equipment?

A **back injury** can cost as much as **$50,000**, and that's not even including all the indirect costs.

Healthcare Statistics: Blevins Medical, Inc.

1 in every 3 nurses become injured from the physical exertion put forth while moving non-ambulatory patients; costing their employers $35,000 per injured nurse.

U.S. Bureau of Labor Statistics, 1994

1 in 2 non-ambulatory patients fall to the floor and become injured when being transferred from a bed to a wheelchair.

OSHA Website

"**Nursing and personal care facilities** are a growing industry where hazards are known and effective controls are available," said OSHA Administrator John Henshaw. "The industry also **ranks among the highest in terms of injuries and illnesses, with rates about 2 1⁄2 times that of all other general industries**..."

Why Advance Wheelchair Lift Devices?

Patient Perspective

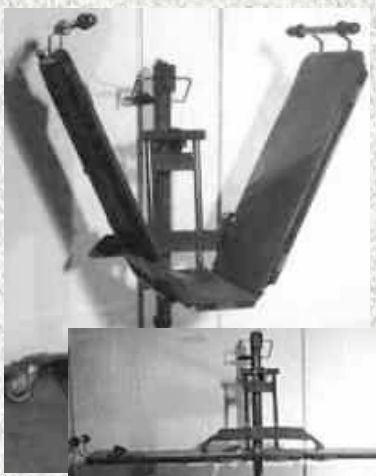
We predict:

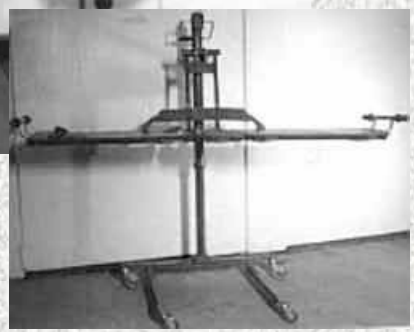
- Wheelchair dependents want to be self-sufficient, even in a typical home
- WCD's and/or homeowners don't want the home changed due to costs and intrusive changes, or even radically exchanging homes (e.g., selling 2 story to buy a 1 story).
- Want to be mobile; pick from and place things on shelves and cabinets; be at eye level to others; sit in their favorite chair; use a standard toilet; perform household tasks (cook, clean, hobbies); etc.
- Want more than minimal devices (e.g., more than a wheelchair and trapeze)
- Would probably like to have even better features than non-WCD's (e.g., 2 story lift?)

Also,

- Wheelchairs/powered chairs mobilize but, typically cannot lift (except 10" - 13" lift units) nor place WCD's in favorite chairs, etc. And assist devices can be difficult to use.
- Gyro-stabilized lift chair cannot lift patient to reach upper cabinet/shelf (nor 2nd house level) heights, it balances on two wheels (e.g., market acceptability?), and may be relatively expensive.
- Ceiling and other patient lifts do not have full user-controlled mobility and/or are usually location specific
- Need multiple devices for mobility and lift equating to more patient/insurance costs, and providing cumbersome maneuverability for the patient.
- Rehabilitation assistance is virtually non-existent with current wheelchairs, some basics in stander, walker, rollator and patient exercise technologies.

Some Existing Dependent-Care, Patient Lift Technology





Stretcher Lift: $4,500

Patient Pivot

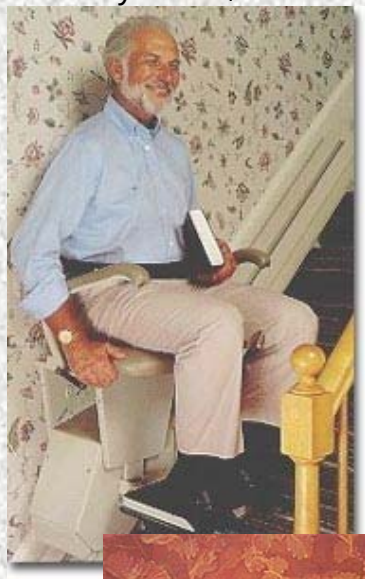
Mobile Lift: $1,495

Some Existing Independently-Controlled Patient Lift Technology

Ceiling Lift-$3,700*

Transfer Lifter: $3,995

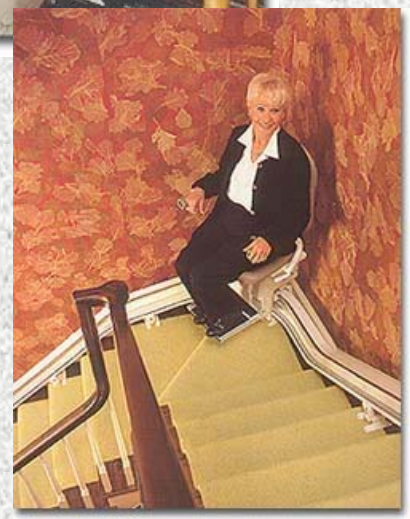
Stairway Lifter:$2450 min.



Wall Lift: $3,250*

Some dependence possibly needed

*Installed costs. Second unit ~ 1/5th to 1/10th this first cost



Curved Stairway Lifter:~$7500

Some Existing Patient Mobilization Technology

Retail Price: $495

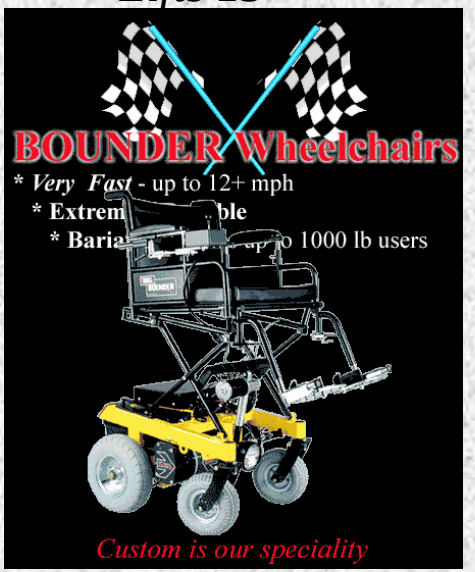
Retail Price: $4000-$9000

Retail Price $2298 to $3598

Some Lift Wheelchairs

iBOT™

Lifts 13”



specialized toilet and shower chair

Some Additional Support Equipment for the Disabled

Commodes: $100-$300

Trapeze: $222-$2800

Transfer benches: $120-$275

Grab bars: $25-$60
plus installation

Bed rails: $170 +

Some Patient Standing, Walking and Rehabilitation Devices

Patient Stander

Walker: $81

Rollator
Retail Cost: $500

HLPR Chair - Mobility

- Designed with elderly driver and caregiver walking speeds in mind
- Current speed is ~ 0.7 fps max.
  - OK walking speed
  - 1/3 HP motor
- Can be increased with larger drive motor
- Thin system design for small doorway access
- Unique single, rear wheel drive and steer.
  - Electronics provides return to center joystick control
  - Grant to Univ. of Delaware to study this area.

HLPR Chair – Lift

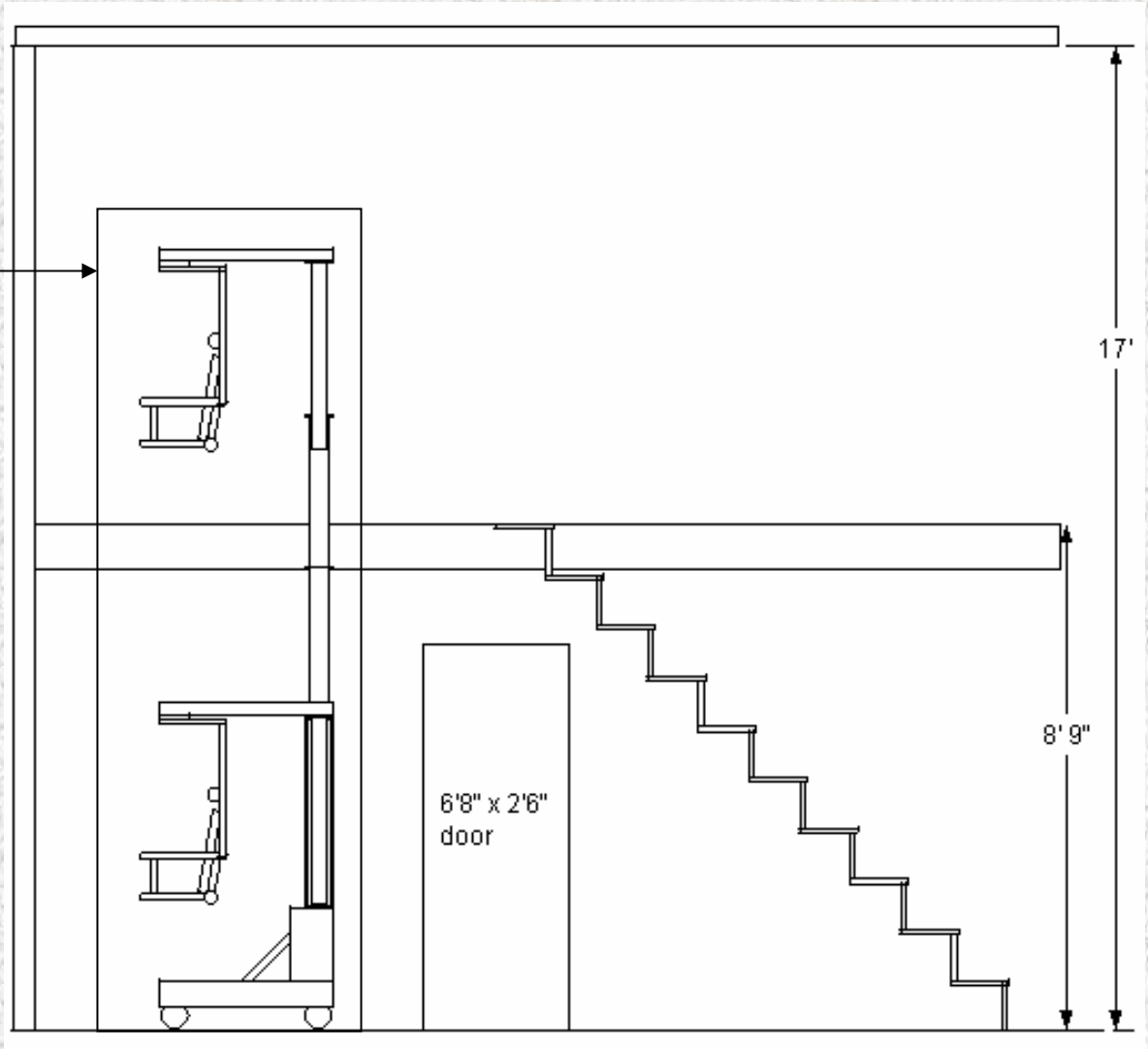
- Approx. 1 m lift
- Allows access to tall areas (and above!) that standing people can reach
- Can drive so patient is at eye level with person walking
- And reach down at chair level or below
- Lift speed can be increased as desired
- All mobility, lift, position and rehab cases should include seat restraints.

HLPR Chair – Elevator??

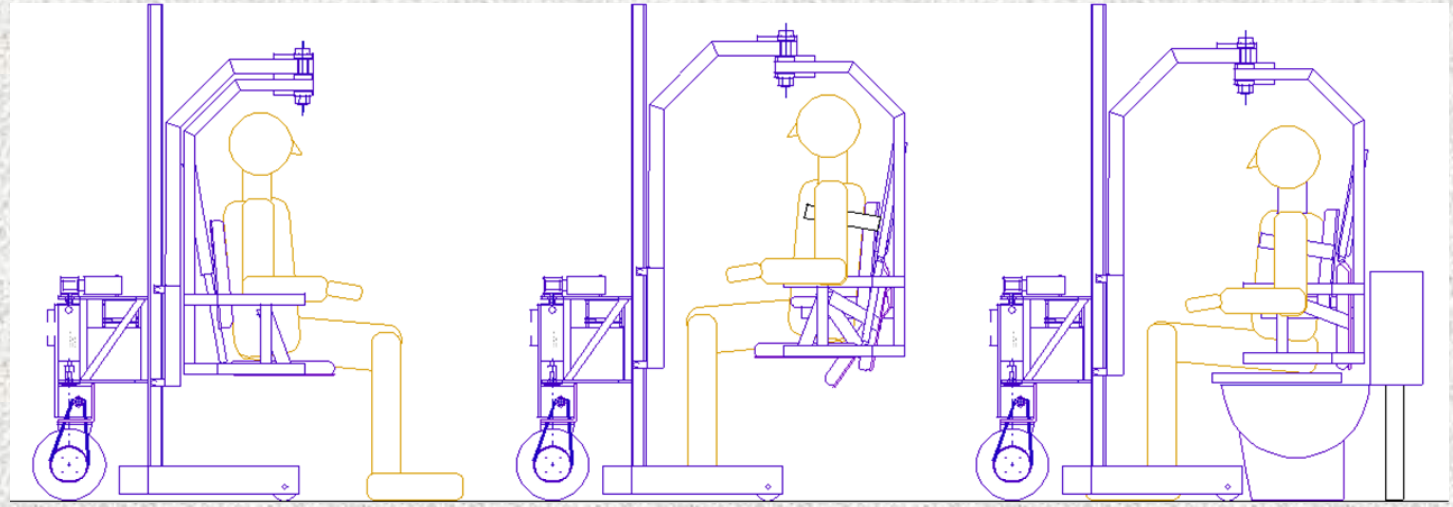
Could provide two story access to bypass stairs.

Elevator cage for HLPR

Wheelchair or another HLPR at top for top level mobility



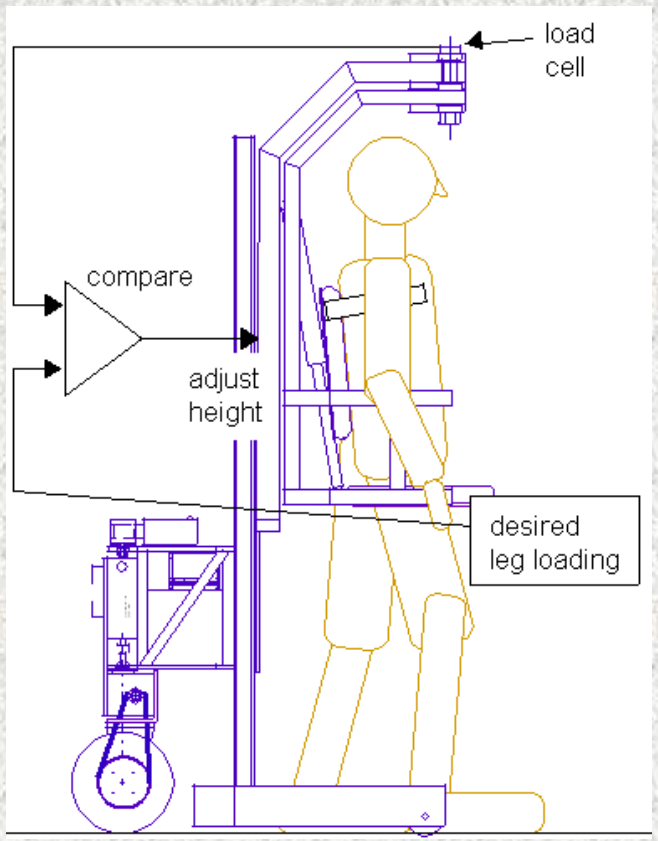
HLPR Chair – Placement/Pick-up



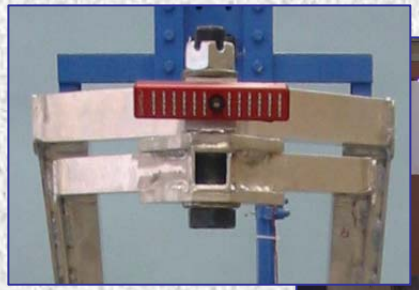
- Very difficult to pick and place a patient onto a chair, toilet or bed.
- Largest back injury area for caregivers
- HLPR Chair:
  - Moves the patient to the chair
  - Supports patient by torso
  - Rotates patient near chair
  - Moves back and places patient on the chair
  - Remains to support patient (e.g., on the toilet) or drives away.
    - Else, it lifts and rotates manually out of the way.
    - Could be made to drive away and return autonomously.

HLPR Chair - Rehabilitation

- Rehabilitation for stroke or other leg- injured patients
- HLPR provides:
  - a tool for patient lift to standing position,
  - nurse walks behind or beside patient
  - *or* HLPR is independently controlled by the patient
  - patient or nurse controls HLRP
  - future will have dial in leg loading

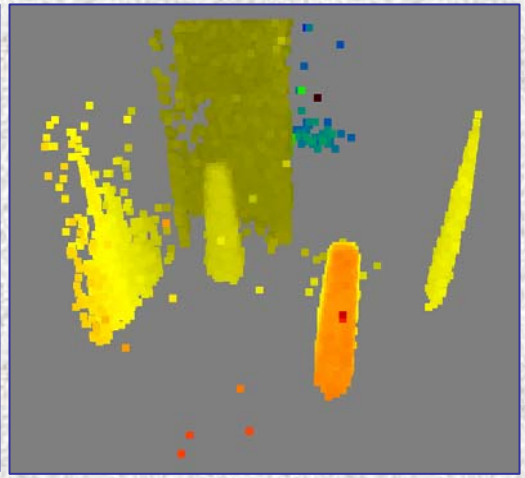


HLPR Chair - Intelligent Control

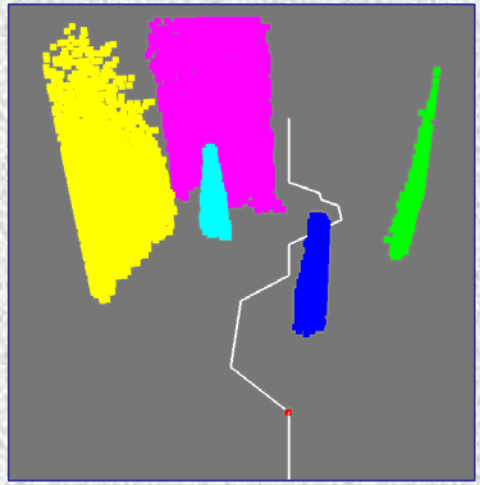


3D range imager

test scene



input to the planner algorithm



range data, objects and path planned

- Next, study computer control for:
  - incognizant driver obstacle avoidance
  - docking with a toilet or chair
  - lower chair height when passing low overhangs (e.g., door frames)
  - Adjust floor loading for leg rehabilitation

HLPR Chair Video