



Construction Ergonomics: **The Challenges of Moving from Innovation to Industry Adoption**

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Background: Intervention for Overhead Construction Drilling

Funding: Center for Construction Research and Training (CPWR)
and NIOSH

Overhead Drilling Risks



- Arm, shoulder fatigue & disorders
- Falling
- Dust
- Noise
- Hand vibration

Drill mass = 2 - 4 kg
Upward force = 25 kg





Goals

Develop and evaluate interventions for reducing fatigue associated with overhead drilling while preserving productivity.

Generation I (N=24)

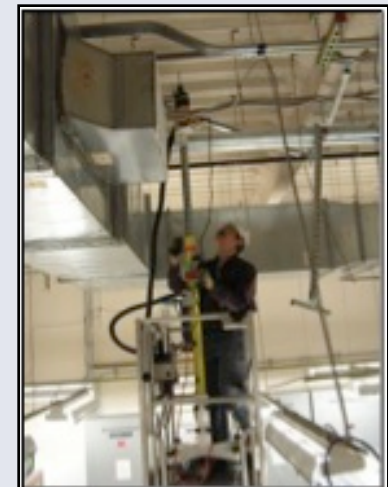
Generation II (N=16)

Generation III (N=23)



Methods

1. Focus group meeting: trade members & contractors
2. Design and build functional prototypes
3. Field test prototypes
4. Redesign and build prototypes
5. Repeat 3 & 4



Generation I Devices (n=24)

Foot Lever Drill Press



Inverted Drill Press



Generation 2 Devices (n=16)



Adjustable
Castor
Base



Collar
Base



Spring
Base



Collar

Generation 3



- Collar Base
- 3 wheel base
- Better wheel bearings
- Air or foam filled tires
- Better cord management
- Score column
- Laser near drill
- Light near drill







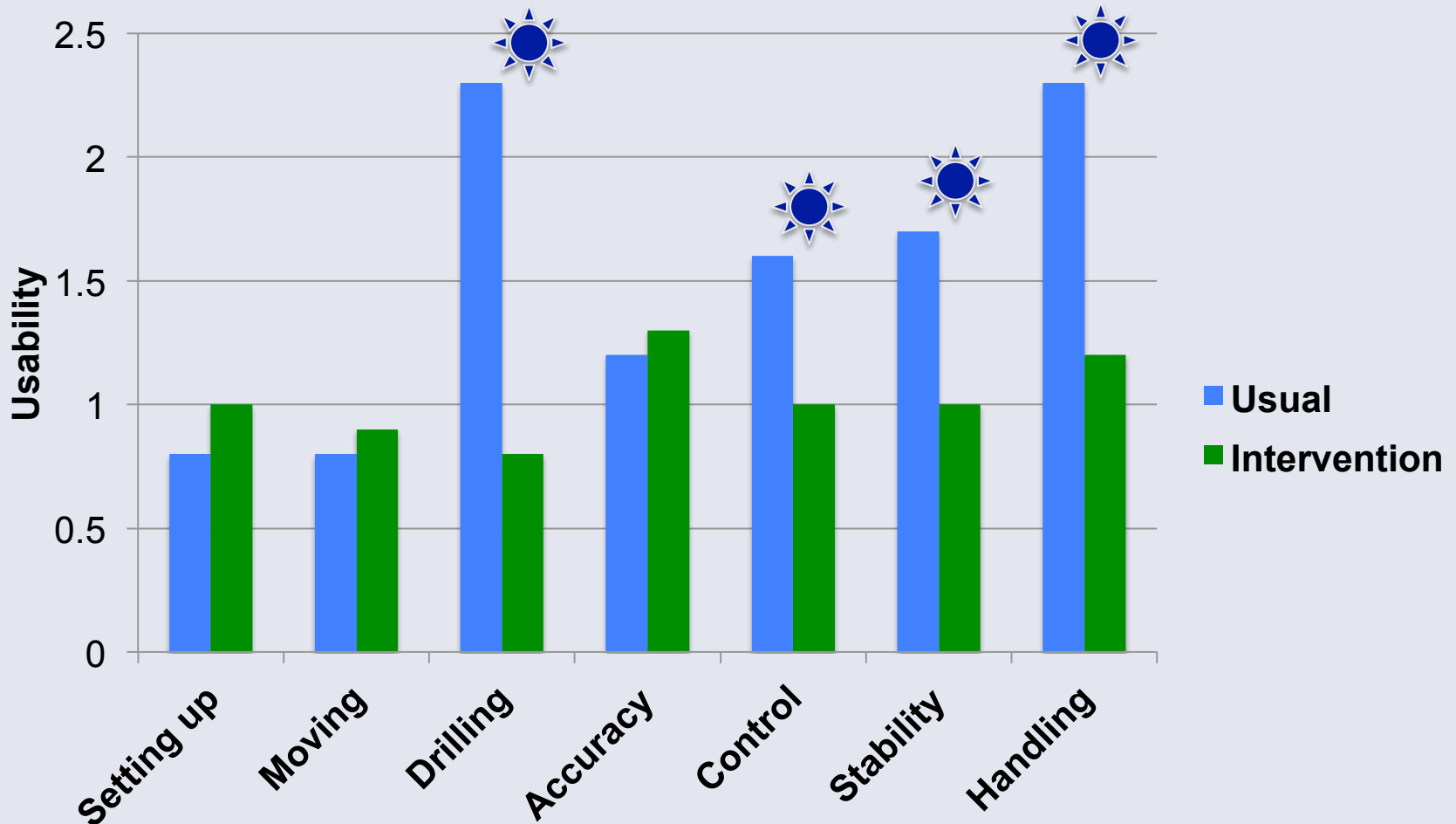
Current Design Specifications

- Reaches ceilings up to 12 feet
- Works in scissor lift
- Disassembles into 3 parts
- 30 in. base span
- Can drill within 12 inches of a wall
- Locking pneumatic wheels
- Accommodates most rotary drills
- Silica dust capture capacity



Usability

(0=excellent, 5=poor) (n=23)

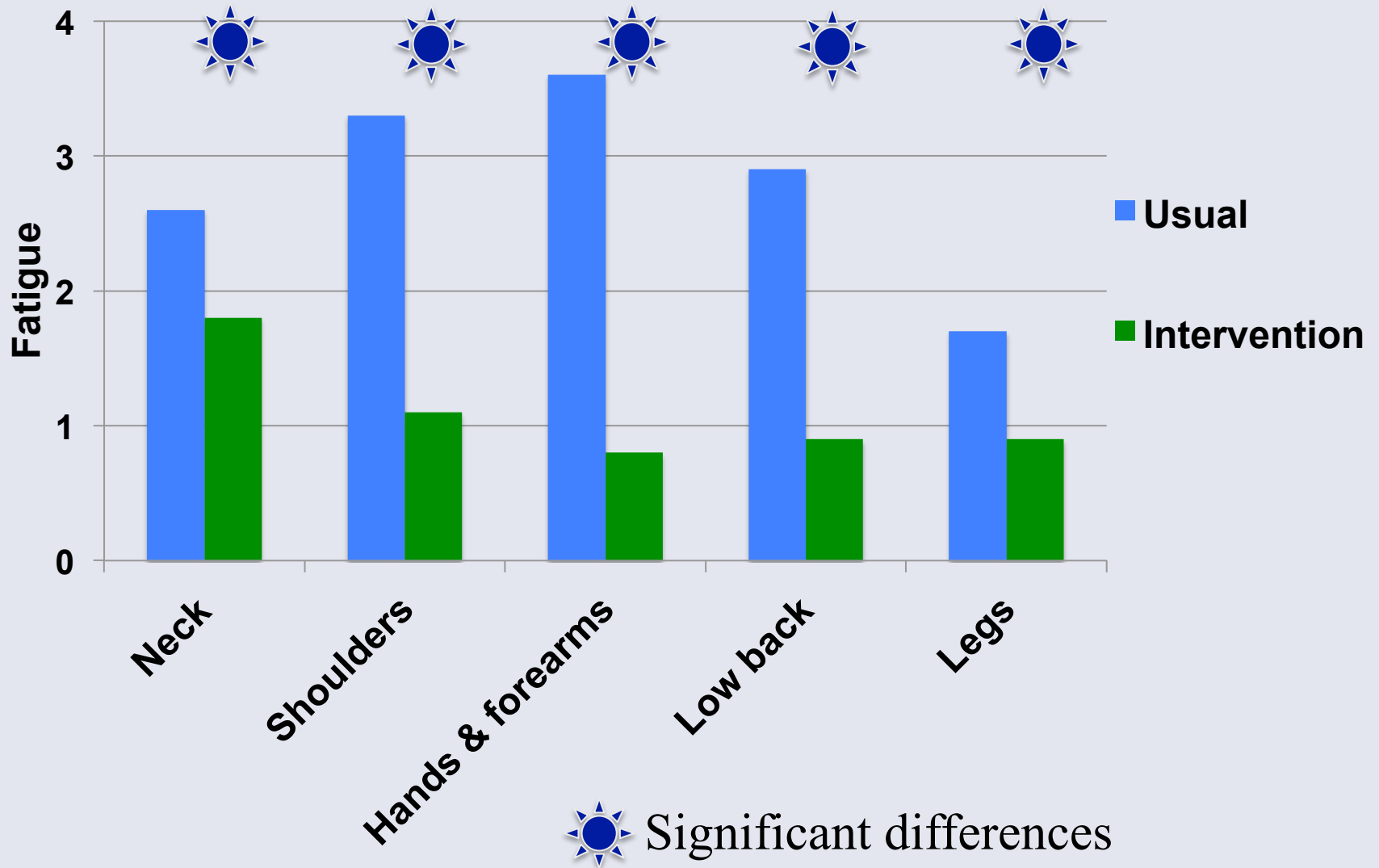


 Significant differences



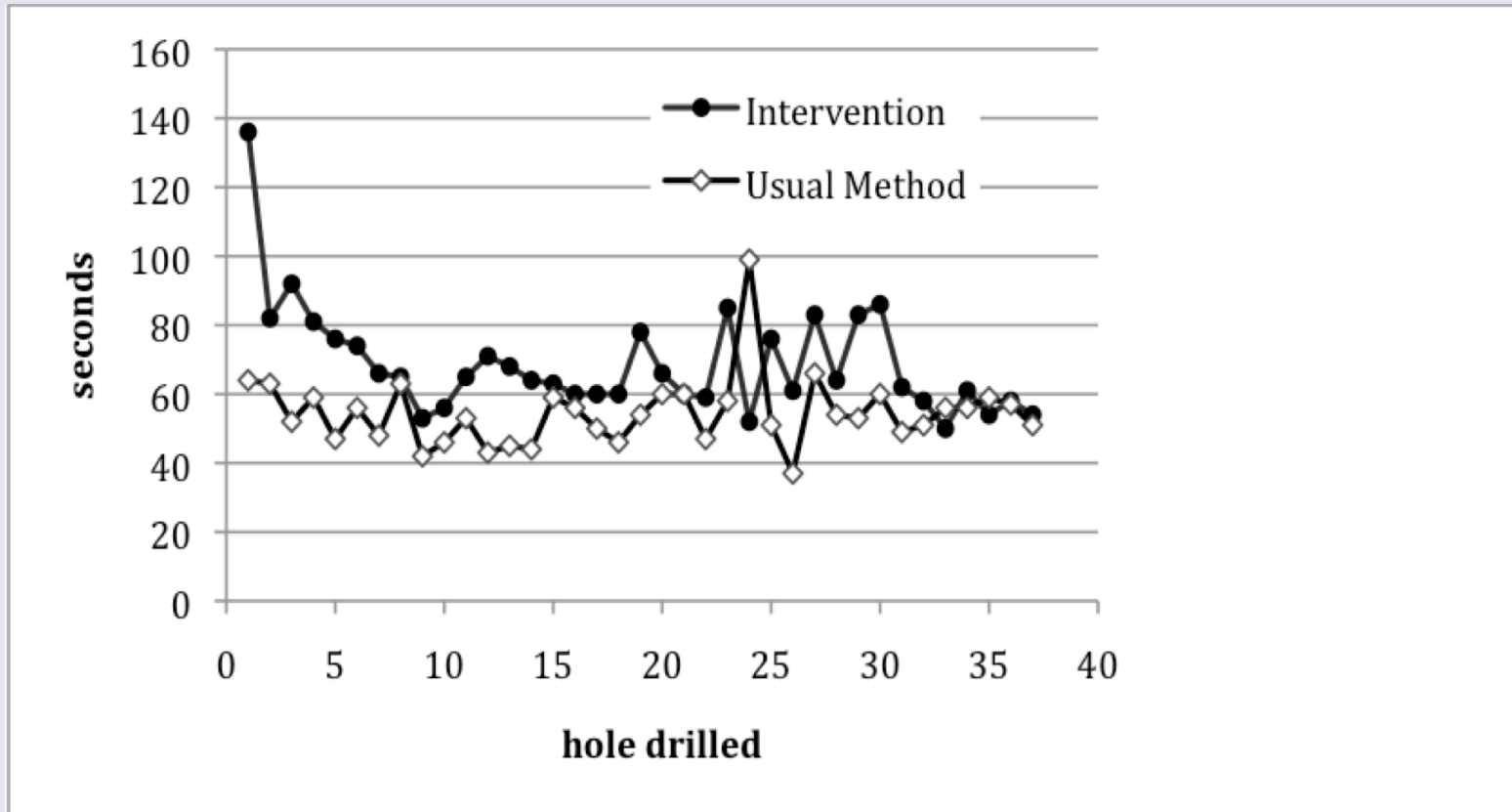
Fatigue

(0=none, 5=very) (n=23)



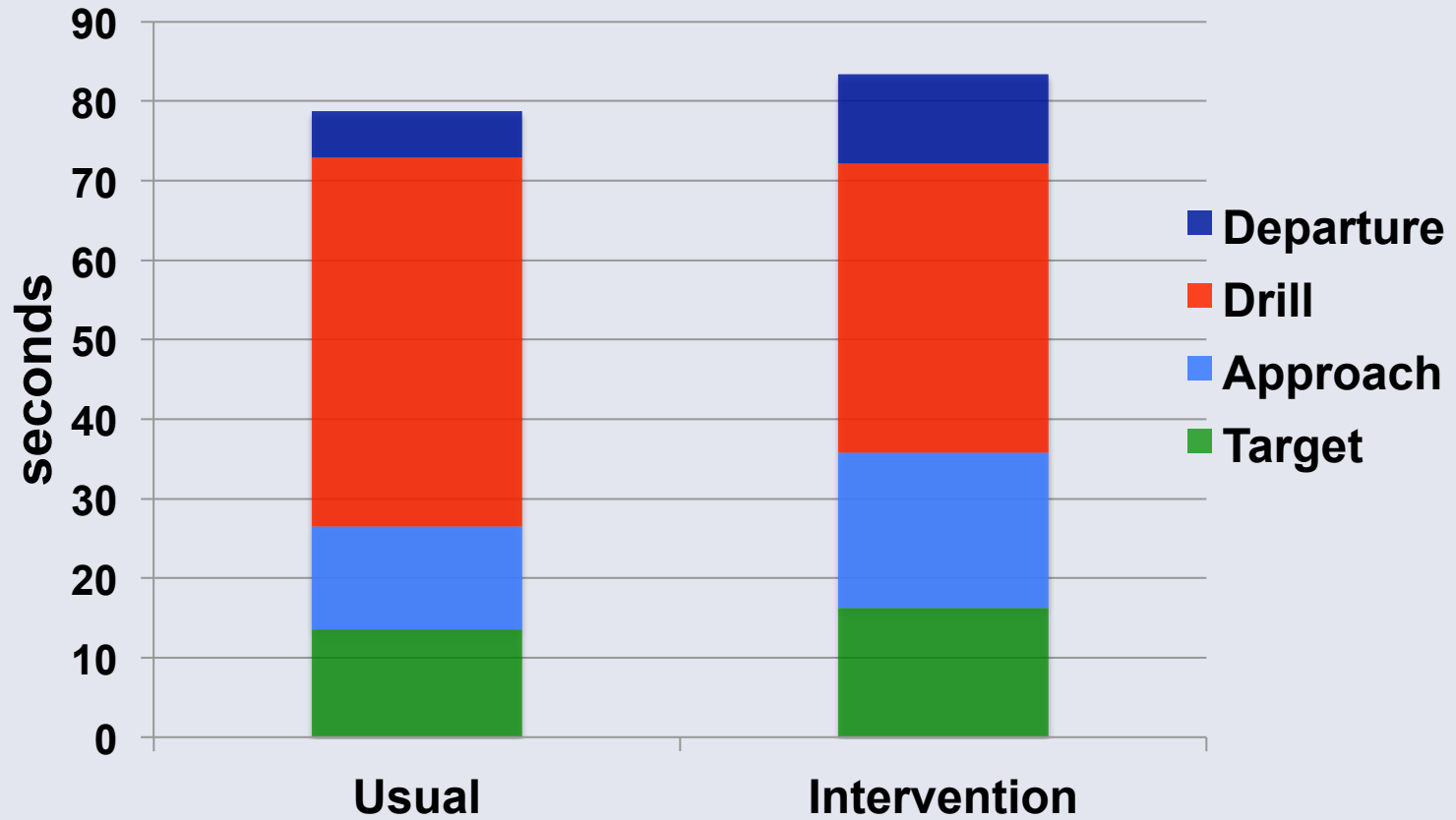


Productivity



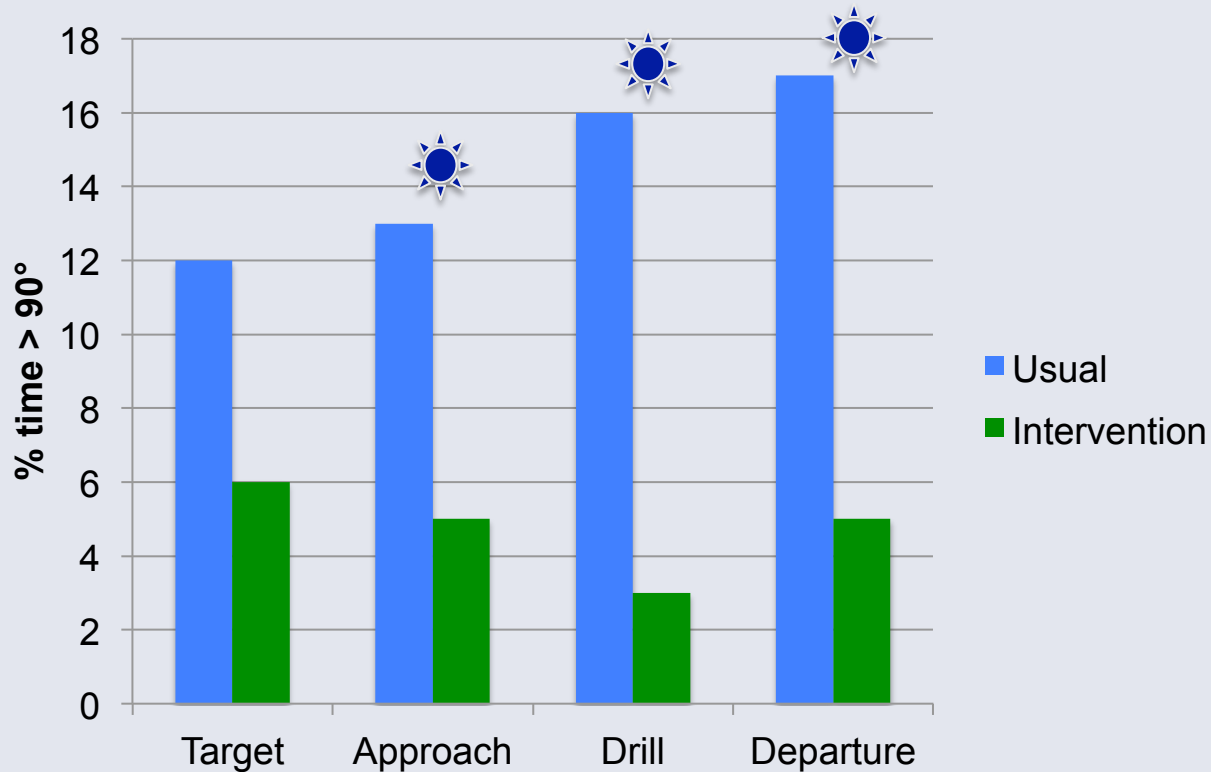


Productivity (n=19)





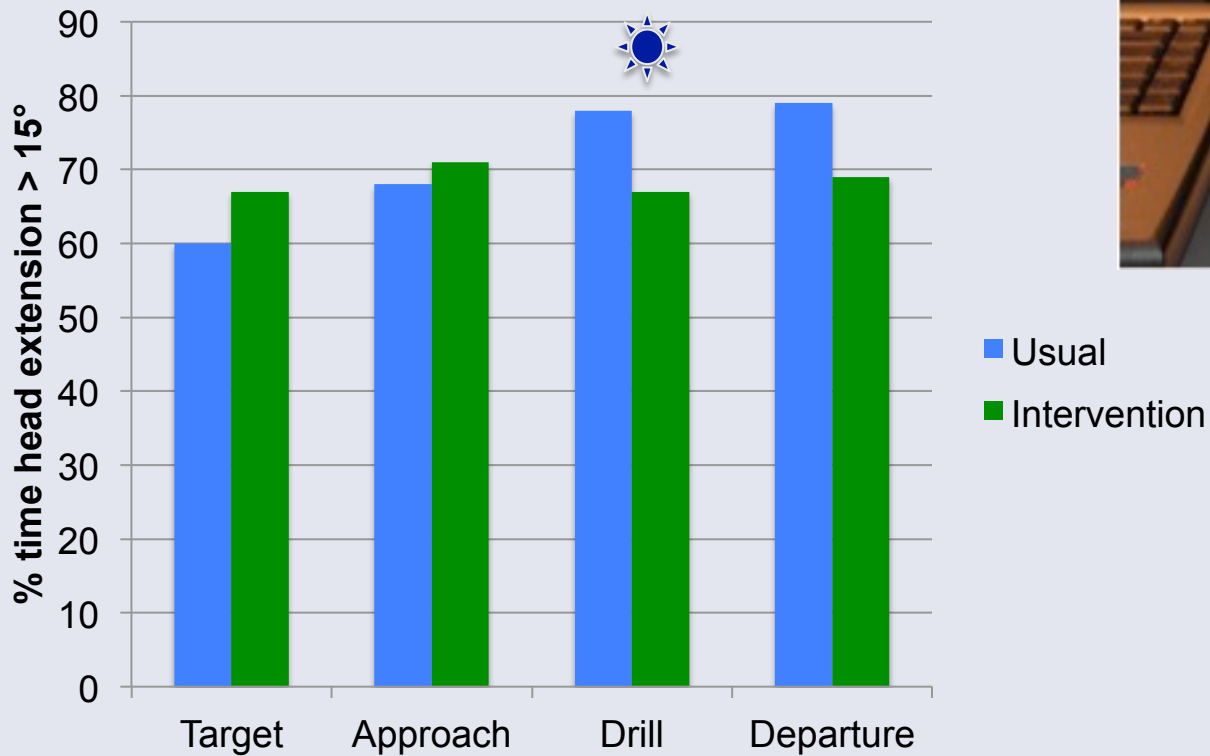
Shoulder posture $> 90^\circ$ (n=16)



 Significant differences



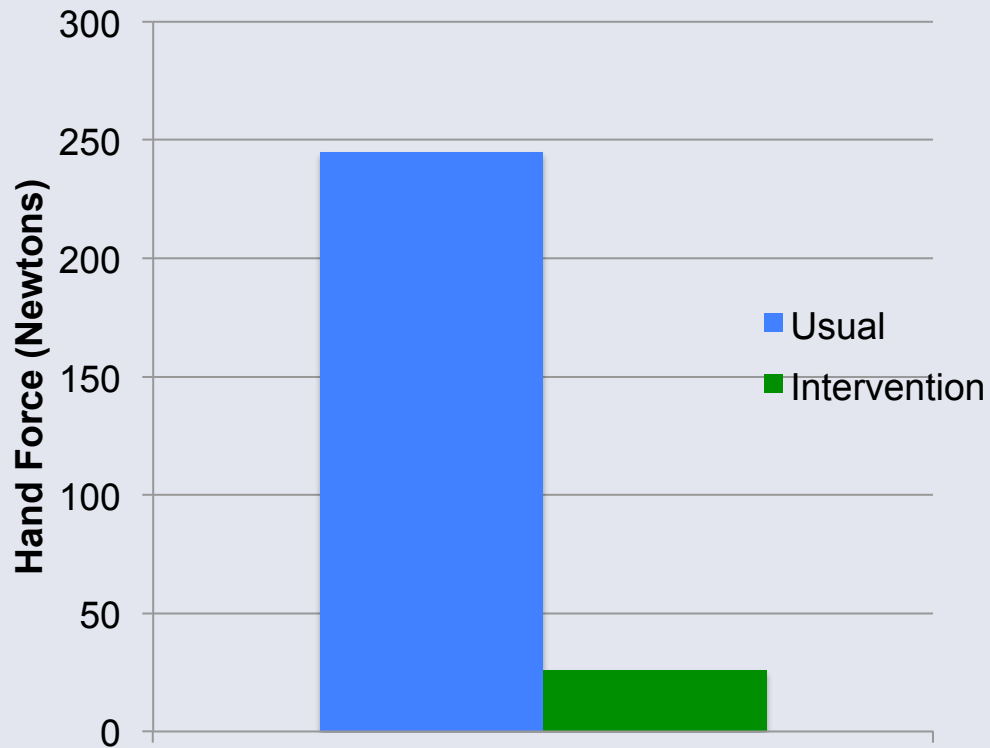
Head extension > 15° (n=7)



 Significant differences



Hand force drilling (n=3)





“It is the best device I know of for this difficult job.”





“This device is a time and injury saver when used in a high volume application.”



Current Design Advantages

- Drilling productivity same
- Less fatigue and pain
- Captures silica dust
- Less ladder use/reduced falls risk
- Good mobility
- Some noise reduction
- Works in scissor lift



Current Design Challenges

- Storage and transportation
- Does not insert and seat anchors
(so limited usage for all tasks involved in process)
- Mostly used for high production specialty trades work



Challenge: How do we diffuse a proven innovation?



According to Rogers (1996):

Diffusion refers to “the process by which an innovation is communicated through certain channels over time among members of a social system. An innovation is an idea, practice or object perceived as new by an individual or other unit of adoption. The diffusion of innovations involves both mass media and interpersonal communications channels”.



Challenge: How do we diffuse a proven innovation?



Ryan and Gross (1943) found:

“the adoption of innovation depends on some combination of well-established interpersonal ties and habitual exposure to mass communication”

(others more recently found interpersonal channels, e.g. opinion leaders, more important than mass media)

- That the rate of adoption followed an S-shaped curve;
- That there are four different types of adopters.
- Five major stages in the adoption process:
awareness, interest, evaluation, trial, and adoption



Adoption Incentives



- Favorable industry/worker response to ODP
- High rates of MSD's in construction
- Ave. WC claim cost for shoulder injury: \$31,000
- Time off due to injury: weeks
- Time off to safely drill again: months or never
- Loss of skilled tradesperson, impact on family/company
- Cost of Overhead Drill Press: \$4,000

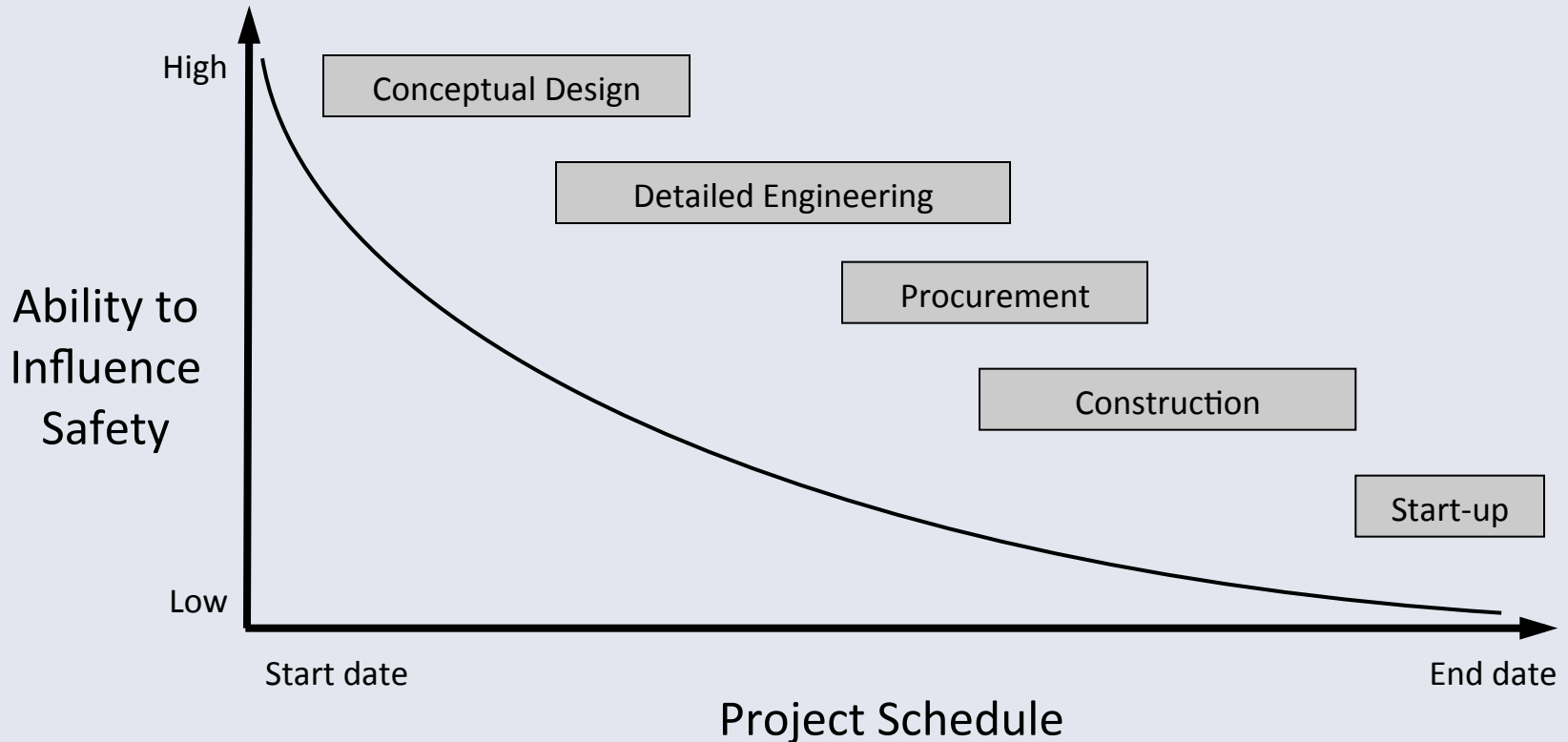


Adoption/Diffusion Barriers



- Weak California ergonomics standard
- No national ergonomics standard
- Now have manufacturer but took several years
- Off the shelf availability still pending/timing
- Tool purchase decision point differs between large and small contractors and scale of project
- Ability to influence safety purchases is time sensitive in a very high pressure culture

Ability to influence safety on a project



(Source: Szymberski, 1997)



Adoption/Diffusion Challenges



- Researches don't have staff nor expertise to do marketing (diffusion) phase
- How do we find early adopters?
- How do we communicate with them?
- What are our interpersonal channels?
- Tool sales reps have multi-faceted marketing strategies:
 - Better understanding of purchase decision points;
 - Onsite job visits/corporate visits and presentations;
 - Different sales packages for small vs. larger contractors;
 - Ongoing interpersonal communications with influential people and decision makers



Our Diffusion Approach



Six pronged approach:

1. Find manufacturer
2. Describe audience segmentation: the who
3. Targeted outreach to stakeholders
4. Recruit ODP users (earliest adopters)
5. Develop training module
6. Partner with manufacturer and others for larger marketing campaign and availability



Describe audience segmentation



ODP is mostly a specialty contractor tool:

- Plumbing/pipefitting
- Electrical
- HVAC/Mechanical
- Fire Sprinkler
- Some Carpentry
- Related unions and apprentice programs
- Related trade associations



Targeted Outreach to Stakeholders



Outreach to industry specialty contractor trade associations including presentations, trainings, and booths at local, state and national events:

- Associated General Contractors (AGC)
- National Electrical Contractors Assn. (NECA)
- Sheet Metal & Air Conditioning Contractors' Nat Ass (SMACNA)
- Nat Assoc of Plumbing-Heating-Cooling Contractors (PHCC)
- National Fire Sprinkler Assoc
- World of Concrete
- Construction Safety Council
- National Safety Council (Labor Caucus)
- Am Society of Safety Engineers (ASSE)
- Am Industrial Hygiene Assoc (AIHA)



Targeted Outreach to Stakeholders



Outreach to unions, joint labor/management orgs, apprentice programs, public agency and regional events including presentations, trainings and booths at local, regional and state events:

- CPWR/NIOSH NORA meeting
- Cal/OSHA VPP contractors & ergo consultants meeting
- NECA/IBEW Health and Safety Committee
- IBEW, UA (Plumbers/Pipefitters), Sheet Metal, Carpenters, Laborers
- Laborer' s Union Apprentice program
- Various local Building Trades Councils
- CA Safety Expo
- AGC Health & Safety Committee
- Demonstrations at jobsites
- Two summers of Occupational Health Internship Program (OHIP)



Mass Communication Campaign



- Improved website with easier navigation/added video: ergo.berkeley.edu/ and YouTube: “Overhead Drilling”
- CSLB: California Licensed Contractor eNewsletter article, Winter/Spring 2011
- Developed/disseminated: Fact Sheet
Drilling Overhead: Ways to Make a Tough Job Easier
- Occupational Health Watch (Occupational Health Branch’s eNewsletter) distributed fact sheet to 4,200
- Additional 1200 employers, insurers, unions, apprentice programs, OSH professionals received eFactSheet
- Dr. Rempel: recipient ENR: Engineering News Record top 25 newsmaker of 2010 award



Recruited ODP Users



Recruited ODP users (early adopters) through outreach, opinion leaders, dissemination and mass communication:

- Outreach brought them to website then YouTube video
- Identify decision makers and decision pathways/points
- Some proactive larger contractors took blueprints and built their own rigs
- Build to Order: arranged with local fabrication shop to build rigs on a per order basis: shipped out
- Established Loaner Program:
shop built several more rigs for loaner program
(to appeal to one-time users/small contractors)



Still to Do



5. Develop training module:

in collaboration w/apprentice programs and others develop and field test short module that can be integrated into existing training curricula

6. Partner with manufacturer and others for larger marketing/sales campaign:

- advise/assist manufacturer on marketing campaign
- work with manufacturer on sales to tool rental companies
- work with manufacturer on training sales reps
- make the sales reps the information gate keepers



Evaluation



- **Formative Evaluation**

Ongoing feedback mechanisms in-place about project and materials: continuous improvement

- **Impact Evaluation: measured at two phases**

1. Tool design prototypes field testing

2. Did we reduce the # of shoulder injuries in these trades due to the widespread use of the ODP???

- **Outcome Evaluation**

Collect data on numbers of ODPs manufactured and purchased, availability from tool rental companies and usage rates by renters.



Recommendations



- Without an ergonomics standard or some other strong incentive only the early adopters act
- NIOSH should fund some diffusion/dissemination projects where research team has to partner with outside expert organizations/private sector
- Some NIOSH new technologies should just be licensed to the private sector and let the market forces happen
- The tool industry is so much better at selling products (but they only want to sell their product) so its still important to have clearinghouse centers like CPWR





Partners and Dissemination

<http://ergo.berkeley.edu>

YouTube: “Overhead Drilling”

General Contractors

Fortis Construction
Layton Construction
PCL Construction
Skanska Construction
Turner Construction

Contractors

Cherry City Electric (Electrical)
Electric Construction Co (Electrical)
Oregon Electric Group (Electrical)
Rosendin Electric (Electrical)
Cupertino Electric (Electrical)

Apollo Sheetmetal (Mechanical)
Interstate Mechanical (Piping)
JH Kelly Construction (Mechanical)
Temp Control Mechanical
Streimer Sheetmetal (Sheet metal)
Southland Industries (Mechanical)
Broadway Mechanical

Architectural Contractors

ASD
Advanced Technology Group

Contractors Associations

N Cal Mechanical Contractors Assoc
N Cal Nat Elec Contractors Assoc

Unions

IBEW-Local 48 & 595 & 6
Sheetmetal-Local 16 & 104
Piping/Plumbing-UA Local 490&38&342
Carpenters- Local 713 & 22
Pipe Trades Training Center – San Jose

Funding

CPWR U54-OH008307 (NIOSH)
WorkSafe BC

Agencies

California Department of Public Health