Interventions to Reduce Ergonomic Exposures during Drywall Installation

Priyadarshini Sengupta Dasgupta

2014
Background – Drywall Installation

Weight of the drywall

- 4ft X 8ft (70 lbs)
- 4ft X 12ft (105 lbs)

(5/8 inches thickness)

(Yuan, 2007)
<table>
<thead>
<tr>
<th>Study, year</th>
<th>Concerns of drywall installation task</th>
<th>Affected body area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipscomb, 2008</td>
<td>• Repeated handling of heavy panels</td>
<td>Lowback</td>
</tr>
<tr>
<td>Pan, 2000</td>
<td>• High postural demands while being on ladder</td>
<td>Lowback, neck, shoulder, wrist</td>
</tr>
<tr>
<td></td>
<td>• Fall from ladder during panel installation</td>
<td></td>
</tr>
<tr>
<td>Pan, 1999</td>
<td>• High compression force while lifting panels</td>
<td>Lowback</td>
</tr>
<tr>
<td>Yuan, 2007</td>
<td>• High compression force during drywall installation</td>
<td>Lowback</td>
</tr>
<tr>
<td>Lipscomb, 2000</td>
<td>• Overexertion of muscles</td>
<td>Lowback</td>
</tr>
<tr>
<td></td>
<td>• Fall from ladder during drywall installation</td>
<td></td>
</tr>
<tr>
<td>Chiou, 2000</td>
<td>• Overexertion of muscles</td>
<td>Lowback, shoulder</td>
</tr>
<tr>
<td></td>
<td>• Awkward bodily motion or position during installation process</td>
<td></td>
</tr>
</tbody>
</table>
STUDY I-Assessing the Ergonomic Exposures for Drywall Workers

Greater Boston Area

2006-2009

7 observers

>80% inter-rater reliability

110 hours of observation

Direct observational method (PATH)

18 drywall workers

Focus groups
STUDY I: Methodology

PATH (Posture, Activity, Tools and Handling) (Buchholz, 1996)

- Posture categories based on OWAS (1977, 1981)
  - Trunk, arms, legs
- Direct observation
- Fixed interval sampling (1 min)
- PDA with data collection template (PenFact)

Taxonomy to collect exposure data (Moir, 2003)


Study Results - Arm postures

- 2 arms > 60
- 1 arm > 60
- Arms down

- Observations:
  - fit panel
  - install panel
  - housekee.
  - fit studs
  - install studs
  - layout
### Workers’ perception

<table>
<thead>
<tr>
<th>WEIGHT OF PANELS</th>
<th>AWKWARD POSTURE</th>
<th>OTHER RISK FACTORS</th>
</tr>
</thead>
</table>
| • Bulky weight of panels  
  • Pressure on shoulder  |
| • Overhead arm postures  
  • Shoulder and wrist fatigue  |
| • Risk of falling from ladder during ceiling installation  |

### Summary of key findings

- Install drywall panel - load handled (18% of work time)
- Lifting load on ladder with awkward body postures
- Layout - does not include load handling
- Housekeeping - carried out at the end of work day
Study II: WORKERS INNOVATIVE IDEA FOR REDUCING THE ERGONOMIC EXPOSURES IN DRYWALL INSTALLATION

Research questions

- Could workers’ innovative idea(s) be implemented as an intervention for drywall installation?
- Would it reduce the exposure(s)?
- Could it lead to the formation of a permanent assistive tool?
Focus groups (2010-2011)

Discomfort/ concern

• Back pain
• Shoulder pain
• Hands over shoulder

Suggestions

• Lighter weight of the panel
• 4 men lifting
• Higher ladder

FEASIBILITY

SUSTAINABILITY
Methodology

Site
- Commercial residential construction site in Boston

Participants
- 5 drywall installers at the site
- All agreed to participate
- All men, between 23-55 years of age
- All right handed and English speaking

Focus Group Meetings
- Meeting 1 – Possible modification of any activity
- Meeting 2 – Potential intervention ideas
- Meeting 3 – How to implement?
Equipment Use (Pre-Intervention)
Methodology: Pre-post intervention exposure assessment

- Baseline: 10/25/2011
- Intervention: 1/26/2012
- Path
- 3DSSPP
- Qualitative Data
Methodology: 3DSSPP

- Anthropometric measurements
- Still frames from video at 10s interval
- Sequence of static postures
- Hand forces estimated using weight of drywall and static model

- Compressive force at the low back
- Moments produced at the shoulder joints
Results: Qualitative Approach

Meeting 1
- Shoulder pain during ceiling installation on ladder
- Wrist pain while driving screws

Meeting 2
- Stilts (pros and cons)
- Lighter drywall

Meeting 3
- Electric lift and “deadman” (a scrap drywall panel piece to hold the ceiling drywall)
Results: Equipment Use (Intervention phase)

Results: PATH Data Analysis - Arm Postures

Baseline ceiling/upperwall

Intervention ladder for ceiling/upperwall upperwall

Intervention electric lift with 'deadman' for ceiling/upperwall
Results: PATH Data Analysis - Weight Handling

Baseline ceiling/upperwall

Intervention ladder for ceiling/upperwall

Intervention electric lift with 'deadman' for ceiling/upperwall

PATH Categories

0-5 lb = very light
5-15 lb = light
15-50 lb = medium
>50 lb = heavy
# Results: 3DSSPP analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline mean</th>
<th>Intervention mean</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low-back Compressive Force</strong></td>
<td>2689.8 N Standard Dev. = 971.52 N</td>
<td>1280.1 N Standard Dev. = 680.24 N</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Right Shoulder Moment</strong></td>
<td>383.4 N-m Standard Dev. = 256.5 N-m</td>
<td>311.8 N-m Standard Dev. = 249.7 N-m</td>
<td>0.43</td>
</tr>
<tr>
<td><strong>Left Shoulder Moment</strong></td>
<td>556.4 N-m Standard Dev. = 374.0 N-m</td>
<td>359.1 N-m Standard Dev. = 233.5 N-m</td>
<td>0.04</td>
</tr>
</tbody>
</table>

*Student t-test*
Results: Qualitative analysis

Disadvantages of the ‘deadman’

- Holder has to stand on the floor
- Upward force applied to ceiling panel
- Not a permanent structure
- Can not be placed on its own
Study III: IMPLEMENTATION AND EVALUATION OF A DRYWALL INSTALLATION ASSISTIVE TOOL (structured by the research team)
Objective of the research

- To evaluate this prototype tool to find out its efficacy in reducing existing drywall installation exposures
- Sustainable intervention

**Specific Aims**

- Quantitative evaluation of efficacy of the tool (PATH, 3DSSPP)
- Qualitative evaluation of efficacy of the tool (Focus group, questionnaire)
Methodology: Qualitative efficacy evaluation

**Focus group scripts**
- Ways to install ceiling drywall panels with the tool
- Feasible idea that can be carried out at the site

**Suggestion box and opinions**
- Modification of the tool

**Questionnaire**
- Workers perception on stability, usability, ceiling supportive structure etc. of the tool
- Tool’s effect on the working speed
BASELINE/Pre-INTERVENTION PHASE
Use of the tool at intervention

- 6 (3*2) installers working as 3 pairs
- Baseline PATH data collection = 20 hours (n=6)
- Intervention PATH data collection = 27 hours (n=6)
- 3DSSPP analysis on 2 pair of installers
- 1 installer added for qualitative evaluation

(1 pair was shifted to other job at the intervention phase)
RESULTS: Arm postures while ceiling installation

Arm posture for either on floor or ladder (whole day)

Arm posture while working on ladder
RESULTS: Load handling while whole day ceiling installation

While being on ladder

PATH Categories
0-5 lb = very light
5-15 lb = light
15- 50 lb = medium
>50 lb = heavy
### Results: 3DSSPP analysis - paired t test results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline mean</th>
<th>Intervention mean</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lowback compressive force</strong></td>
<td>1544.4 N</td>
<td>1084.4 N</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Stand. Dev. = 655 N</td>
<td>Stand. Dev.= 695.2 N</td>
<td></td>
</tr>
<tr>
<td><strong>Shear force</strong></td>
<td>171.8 N</td>
<td>180.7 N</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Stand. Dev. = 59.4 N</td>
<td>Stand. Dev. = 91.08 N</td>
<td></td>
</tr>
<tr>
<td><strong>Right shoulder moment</strong></td>
<td>486.2 N-m</td>
<td>154.5 N-m</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>Stand. Dev. = 258.66 N-m</td>
<td>Stand. Dev. = 95.58 N-m</td>
<td></td>
</tr>
<tr>
<td><strong>Left shoulder moment</strong></td>
<td>348.5 N-m</td>
<td>186.8 N-m</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Stand. Dev. = 194.6 N-m</td>
<td>Stand. Dev. = 143.1 N-m</td>
<td></td>
</tr>
<tr>
<td>Questions</td>
<td>extremely easy (%)</td>
<td>easy (%)</td>
<td>somewhat easy (%)</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------</td>
<td>----------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Tool set up</td>
<td>85.7 (6/7)</td>
<td>0.0 (0/7)</td>
<td>14.3 (1/7)</td>
</tr>
<tr>
<td>Length adjustment</td>
<td>85.7 (6/7)</td>
<td>14.3 (1/7)</td>
<td>0.0 (0/7)</td>
</tr>
<tr>
<td>Moving the tool</td>
<td>71.4 (5/7)</td>
<td>14.3 (1/7)</td>
<td>14.3 (1/7)</td>
</tr>
<tr>
<td>Stability</td>
<td>71.4 (5/7)</td>
<td>28.6 (2/7)</td>
<td>0.0 (0/7)</td>
</tr>
<tr>
<td>Ceiling support</td>
<td>57.1 (4/7)</td>
<td>42.9 (3/7)</td>
<td>0.0 (0/7)</td>
</tr>
</tbody>
</table>
Qualitative analysis: Focus group

<table>
<thead>
<tr>
<th>Discomfort feeling</th>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back</td>
<td>0 (0/7)</td>
<td>100.0 (7/7)</td>
</tr>
<tr>
<td>Shoulder</td>
<td>0 (0/7)</td>
<td>100.0 (7/7)</td>
</tr>
<tr>
<td>Wrists</td>
<td>14.3 (1/7)</td>
<td>85.7 (6/7)</td>
</tr>
</tbody>
</table>

Features of the tool that reduced bodily discomfort
- An extra third palm
- Less amount of wrist force
- Takes pressure off the shoulder

Could you modify/suggest a feature
- Foldable tool
- Stronger top portion
Key findings

Changes observed at the intervention phase
- Reduction of 2 arms elevation
- Reduction of heavy load handling
- Increase in arms down posture
- Increase in one arm elevation
- 6-7 extra panels/day

Some quotes from the workers
- “Both of my hands are free so I can screw faster”
- “The pole supports the weight of the sheetrock so the pressure on the shoulders get diminished and I can work more”
- “I feel I have better energy in the afternoon to work faster”
- “I just love this tool, I do not have to stretch my hands and use my head to hold the sheetrock, the tool is just so cool…………..”
Limitations

- Convenience sampling
- No control group
- Small sample size
- Only one site
- No commercial site included

Strengths

- Data collected in real field working situation
- Preliminary effectiveness
- Biomechanical variables based on direct field observation
Thank you for your attention!