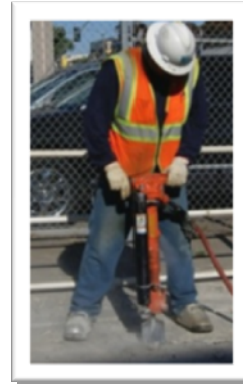


## **UC Ergonomics/Safe Pavement Breakers**



**By: Diana J. Flores & Michael Lopez**

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Site Sponsors and Collaborators:

UC Ergonomics Facility

California Department of Public Health-Occupational Health Branch (OHB)

## **Abstract**

Our OHIP project for summer 2010 was a collaborative effort between the California Department of Public Health and the UC Ergonomics Program. The main focus of our project was to evaluate the usability of the Jackhammer Lift Assist device. It is well understood that pavement breaking (jackhammering) for extended periods of time increases shoulder and/or lower back injuries (musculoskeletal disorders). Additionally, it is known that when the jackhammer becomes stuck in the ground (a common occurrence), further stress is placed on the lower back and shoulders of the jackhammer operator.

The Jackhammer Lift Assist device is a potential solution to jackhammering woes. Its inventor claims that it helps minimize the effort a jackhammer operator must use to pull the jackhammer out of the ground. By reducing the effort of lifting and repositioning the jackhammer there is a decrease in shoulder and lower back strain. Though the Lift Assist appears to offer many benefits to jackhammer operators, many workers still prefer not to use it. Our summer project focused on trying to understand why workers preferred not to use the Lift Assist and offering our recommendations on what changes can potentially make the device more widely accepted among jackhammer operators.

In order to carry out our project we conducted background research on jackhammer injuries and interviewed construction workers who had experience jackhammering with and without the Lift Assist device. We also interviewed professionals in the occupational health field such as ergonomists, construction experts and a Pacific Gas & Electric (PG&E) Union Health & Safety lead.

At the end of our project, we concluded that the Lift Assist device is a good idea but it still needs some work. Our recommendations for improving the device based on our interviews with workers can be found on the following pages.

We also produced a 4-minute informational video (our giveback product) detailing the pros and cons of the Lift Assist and our recommendations. Ultimately, we hope to be able to present our final video to the workers at PG&E and the Northern CA Laborers Training Center, both of who were instrumental in helping us make our video.

## **Background**

In construction, nearly 5 out of every 100 workers are injured, and more than half of these injuries can be attributed to musculoskeletal disorders (MSDs). Pavement breaking, or jackhammering, is one of many construction tasks that puts construction workers at risk for developing musculoskeletal disorders. This is believed to be due to the fact that jackhammers often weigh 90 lbs so lifting and repositioning a jackhammer can put serious strain on one's shoulders and back. This strain may ultimately result in back and shoulder musculoskeletal disorders. It should be noted that lifting a jackhammer that is stuck in the ground can be especially damaging to the shoulders and back. For these reasons, scientists and construction workers alike are looking for an ergonomic intervention to prevent the musculoskeletal disorders associated with jackhammering.

The Jackhammer Lift Assist from Integrated Tool Solutions is an ergonomic intervention that may relieve some of the ergonomic issues with jackhammering. The Lift Assist is a tool that attaches to the side of a jackhammer and allows the user to operate a pneumatically-powered foot that pushes the jackhammer out of the ground. This assisted lifting mechanism reduces the effort that the user must expend to lift and reposition the jackhammer, which, in turn, may reduce the incidence of back and shoulder musculoskeletal disorders. According to the manufacturer, the Lift Assist weighs 9.5 lbs and is capable of producing 350 lbs of lifting force.

The San Francisco branch of Pacific Gas and Electric (PG&E) has purchased two Lift Assists and has made the devices available to their work crews. However, a significant portion of work crews at PG&E prefer the traditional method of jackhammering (without the Lift Assist).



*Figure 1: Worker using traditional jackhammer*



*Figure 2: Worker using jackhammer with Lift Assist. (Note: Lift Assist is the black cylinder attached to the jackhammer)*

## **Objectives**

The goals of our summer project are twofold:

- (1) To investigate the reasons why many workers prefer the traditional method of jackhammering
- (2) To evaluate the usability of the Lift Assist and to determine its effect on back and shoulder strain

## **Methods**

To accomplish our goals, we conducted two site visits at PG&E in San Francisco. We observed four PG&E utilities workers performing jackhammering using with and without the Lift Assist. We also administered four separate questionnaires that were approved through University of California San Francisco's IRB. At the end of the study, we obtained four sets of completed questionnaires. Additionally, we obtained video footage of workers performing pavement breaking and also filmed worker testimonials. This video footage was used to help us make our recommendations for improving the device and to make our give back product.

To expand our knowledge of the construction field, we interviewed several ergonomics and construction experts and an IBEW Local 1245 union representative (It should be noted that all PG&E workers in San Francisco are part of IBEW Local 1245.)

Finally, we visited the Northern California Laborer's Training Center in San Ramon in order to develop an understanding of how jackhammering is taught at the introductory level.

## **Results and Observations**

After concluding our site visits and reviewing the completed questionnaires, we have determined that the Lift Assist has several pros and cons:

### *Pros:*

- Many workers noted that the Lift Assist does indeed reduce back and shoulder strain while jackhammering.
- We found that the Lift Assist operates best when used on flat, open ground.
- Some workers were resistant to try the Lift Assist because they were used to their own method of jackhammering. However, the device was generally well accepted once workers gave it a try.

### *Cons:*

- The Lift Assist may be difficult to use on a hill or in situations with limited space.
- Every worker noted that using the Lift Assist decreases the accuracy of their work.
- Some workers noted that the Lift Assist has an uncomfortably large reach for the activation trigger, which can make the device difficult to operate.
- Many workers expressed concern that the added weight from the device (9.5 lbs) made lifting, repositioning, and transporting the jackhammer more difficult.

## **Evaluation**

We believe that our evaluation of the device can be summarized by a quote from a PG&E worker: “It’s a good idea, but it needs some work.”

We think that the Lift Assist is a great tool for reducing back and shoulder strain when it is used on flat, open ground, but, with a few improvements, could become more useful in other jackhammering situations.

## **Recommendations**

Upon reviewing the questionnaire responses we received from workers and studying our worker interviews, we came up with the following recommendations to help make the Lift Assist a more useable tool:

- **Decrease activation trigger reach**

Several workers expressed concern that the activation trigger of the Lift Assist is uncomfortably far from the jackhammer handle. This may lead to overextension of the operator’s hand. While the Lift Assist trigger was designed with a “one size fits all” mentality, the reality is that the shape, length and grasp of different operators’ hands may differ. This is a notable issue because the large activation trigger reach may inadvertently introduce a new ergonomic problem: causing hand discomfort when trying to activate the trigger. We feel that this problem could be easily be addressed by designing the trigger to be closer to the jackhammer handle.

- **Decrease the weight of the device**

The Lift Assist weighs 9.5 lbs. After the device is attached to the side of a jackhammer, the weight of the jackhammer is increased from 90 lbs to 99.5 lbs. Many workers expressed concern that it is more difficult to transport a jackhammer that has the Lift Assist attached to it than it is to transport an unmodified jackhammer. They also noted that manually lifting and repositioning a jackhammer is more difficult with the Lift Assist attached. To remedy this issue, we suggest either designing the Lift Assist out of a less dense (but equally durable) material or designing a new 90 lb jackhammer with an integrated Lift Assist.

- **Modify foot such that it conforms to sloped surfaces**

Many workers noted that it is difficult to use the Lift Assist on a hill. This is because the foot of the device is fixed in orientation, so the operator may be pushed backwards when the foot hits the pavement thus causing the user to fall back. In order to improve the device’s usability on a hill, we recommend redesigning the foot such that it can conform to sloped or angled surfaces. This may reduce the backward push experienced by the operator when the Lift Assist is used on a hill.

## **Further Recommendations**

Other recommendations we came up with that are not specific to the Lift Assist device itself yet are still pertinent to jackhammer work in general are as follows:

- **Larger storage compartment for jackhammers**

In our discussions with the first set of PG&E workers one common theme that was brought up was the weight of jackhammers and the difficulties storing them on trucks. The Lift Assist exacerbates this problem because it adds an additional 9.5lbs of weight to the jackhammer. The workers said

that the spaces on their work trucks were too compact and thus caused them to contort their bodies in odd angles in order to put jackhammers and other large tools away. We were even told of a worker who was injured as a result of trying to put a jackhammer away. We feel that if the work trucks were designed in such a way that the workers had more space to put large tools like jackhammers away, then perhaps there would be fewer injuries resulting from attempting to put away jackhammers.

- **Put jackhammers away as a team when possible**

Hearing concerns about jackhammer transportation to and from work trucks has impelled us to suggest that work crews instill a policy in which jackhammers and other large tools are carried in teams of two. Having a team storage policy would reduce the risk of an individual sustaining injury from jackhammer transportation because the force required to lift and move a jackhammer would be distributed between two people.

- **Conduct periodic safety training for individual work crews on jackhammer risks and precautions**

We feel that it would be advantageous if crews underwent periodic training regarding jackhammer risks and hazards. We feel that this is important because work crew members frequently change. Crew members retire, become injured, or change jobs and are replaced by new members who may not have had the same training or experience with jackhammers. We recommend that work crews undergo a jackhammer health and safety training at least once a year to ensure that crew members have the same level of knowledge with regards to jackhammer safety.

- **Incorporate Lift Assist into initial jackhammer trainings**

Incorporating Lift Assist training from the commencement of employment at PG&E would be beneficial because then all PG&E jackhammer operators would be introduced to the Lift Assist and trained on how to properly use it. This is especially important because learning how to use the Lift Assist may be difficult for older and/or more experienced jackhammer operators, who may be accustomed to their own particular method of jackhammering. This may help address the issue of the Lift Assist facing increased resistance from more experienced workers.

Additionally, if Lift Assist training is incorporated at places such as the Northern California Laborer's Training Center, where jackhammering is taught at the introductory level, then additional workers outside of PG&E will gain exposure to the Lift Assist and may be more likely to accept the device.

## **Challenges**

We encountered a number of challenges throughout the course of our project. The most significant of these challenges are noted below:

- **Project time limitation**

Although we were able to accomplish most of the goals that we set out to achieve, we felt constrained by the 8 week time period of our project. For example, we would have liked to have conducted more work site visits, but this was difficult to do because of the large amount of time required to clear these site visits with site coordinators from PG&E.

- **Small sample size**

Partly due to time constraints, we were unable to obtain a larger sample size of workers filmed, surveyed, and interviewed. An additional challenge for us was that not all of the crews at PG&E do work that requires jackhammering as PG&E only uses jackhammers intermittently. Also, our sample size was further decreased because of the fact that not all workers on a given work crew are trained to jackhammer.

- **Not much literature specific to jackhammer MSDs**

Upon the start of our project we began doing background research and to our surprise we had difficulty in being able to obtain statistics and literature in scientific and and/or public health journals that specifically pertained to musculoskeletal disorders as a result of jackhammering. This finding was interesting for us as it indicated that there is still more research in the field of occupational health, particularly with regards to jackhammering, that needs to be done.

- **Jackhammer injuries are not limited to MSDs**

When we first began our project we were solely focused on musculoskeletal injuries. During this time we were under the false impression that MSDs were the only types of injuries that one could suffer as a result of jackhammering. Interestingly, during the course of our interviews with workers, we soon realized that MSDs were only one part of a myriad of safety concerns that workers had with regards to jackhammering and construction work as a whole.

- **PG&E concerns about our video**

One unexpected challenge that we encountered towards the end of our project was to get PG&E to show our video at their Health and Safety Fair in early September. We had hoped that on this date we would be able to make our video public to a larger audience than only PG&E management and a few workers. While we met a bit of resistance from PG&E, we are hopeful that in the end our video will be granted approval to be shown to a larger group of PG&E workers.

## **Other Factors**

Through our interviews with workers and construction experts, we learned about the following additional hazards related to jackhammer work:

- **Noise**

Workers are required to wear ear protection when working on a construction site. However, we saw that jackhammer operators rarely wore protection beyond foam ear plugs. We believe that ear muffs used in conjunction with foam ear plugs would provide workers with more adequate noise protection. Operating a jackhammer with minimal hearing protection can have adverse consequences on one's hearing, especially when jackhammering for extended periods of time.

- **Vibration**

Workers reported vibration as being one of their primary safety concerns when jackhammering. At least two workers pointed out that when they use the jackhammer for extended periods of time their hands cramp up and they may temporarily lose the ability to close their hands or grasp things.

- **Road traffic**

Most workers that we spoke with said road traffic was a major concern when jackhammering because they are unable to hear oncoming traffic when operating the loud jackhammer. Fear of being run over or hit by a passing car is a serious cause of anxiety among workers. Despite setting

up cone zones and increasing fines for speeding violations in construction zones, many workers still feel that they are at a high risk for being hit by a car. In order to try to address this issue, work crews strategically place metal signs at locations near oncoming traffic. The logic is that if a car hits these metal signs then the noise will be sufficiently loud to alert the jackhammer operator so that he can move to avoid the car.

- **Silica dust**

Interestingly, not all workers view dust and possible exposure to silica as a concern in their jackhammering work. This may be for several reasons. We believe that one reason is that the effects of silica exposure are chronic rather than acute. This means that workers may not associate symptoms of silica dust inhalation with jackhammer work right away. Additionally, we believe that some workers may not even be aware of the dangers of silica dust exposure. We recommend mandating safety training on the subject of silica dust exposure in order to raise worker awareness of this issue.

## **Successes**

The following is a list of some of the successes we achieved this summer:

- **Cooperative PG&E liaisons and crews**

We feel very fortunate to have been in contact with our liaisons (Health and Safety Coordinators) from PG&E as they were very receptive to our project. Our liaisons went out of their way to accommodate our filming and survey needs by actively searching for crews who would be jackhammering during our available times and who would be cooperative to our project. We are certain that we would not have been able to complete the majority of our project without the help of our supportive liaisons.

- **Editing experience**

We expected our inexperience with video editing software to be a major hurdle in completing our give back product, but in reality, grasping video editing software was not as tedious or difficult as we had thought. At first, we grappled with a few problems such as deciding on which video editing program to use, but once we settled on a video editing program (iMovie) we realized that we could create a high quality video without any major impediments.

- **Interviews with ergonomics and construction experts**

We feel that the additional interviews we conducted with construction and ergonomics experts such as Dr. Ira Janowitz (former employee of the UC Ergonomics program) and Mr. Walter Jones, CIH (from the Laborer's Health and Safety Fund of North America) provided us with very important background on the construction trade in general. It also provided us with important insights on the Lift Assist device and its implications for construction workers. We were able to learn a lot from these individuals during our interviews including possible ways of effectively promoting this new method of pavement breaking. Our interview with Ralph Armstrong of IBEW 1245 also gave us a perspective on the health and safety efforts that the union is promoting among its workers at PG&E.

- **Sufficient videotape footage**

One of our primary concerns during the course of our project was making sure that we obtained enough footage of worker interviews and workers jackhammering to produce a four minute informational video on the Lift Assist device (our give back product). By the end of our second site visit we felt confident that we had obtained enough footage to produce our give back video. We



hope to distribute this video to PG&E management, PG&E workers, IBEW Local 1245 members and instructors at the Northern CA. Laborer's Training Center.

- **Understanding additional construction work hazards that we were not previously aware of.**

We were not previously aware that noise, vibration, road traffic, and silica dust were significant safety issues associated with jackhammering. By interviewing workers we were able to gain insight on these issues and eventually develop safety recommendations for each of these issues.

- **Quality of the Interviews**

Though we previously mentioned our small sample size as a challenge, we used it to our advantage by interviewing each worker for long periods of time (about 30 minutes). We believe that these long interviews allowed us to gain the trust of workers and thus obtain more helpful feedback from them. We feel that this was imperative in helping us develop valuable recommendations for the Lift Assist device.

## **Our Give Back Video**

The following is a link to our give back video:

[http://www.youtube.com/watch?v=l45QxhL\\_Tjg](http://www.youtube.com/watch?v=l45QxhL_Tjg)

(The video can even be viewed in HD!)

## **Acknowledgements**

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#### Northern California Laborers Training Center

Ollie Hurl  
Jerome Williams

#### IBEW Local 1245

Ralph Armstrong



## Appendix: Questionnaires

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### Usual Jackhammer Method Usability

Jackhammer Lift Assist project

1. Describe the usual way you use a jackhammer:

2. How **tired or fatigued** do you feel when using a jackhammer in the usual way? Rate on a scale of 1 to 5, where 1 is 'not tiring' and 5 is 'very tiring.' Circle *one* choice in each row:

| Is this part of your body: | Not Tired | Very Mildly Tired | Mildly Tired | Moderately Tired | Very Tired |
|----------------------------|-----------|-------------------|--------------|------------------|------------|
| a) Neck                    | 1         | 2                 | 3            | 4                | 5          |
| b) Shoulders               | 1         | 2                 | 3            | 4                | 5          |
| c) Hands and forearms      | 1         | 2                 | 3            | 4                | 5          |
| d) Lower back              | 1         | 2                 | 3            | 4                | 5          |
| e) Legs                    | 1         | 2                 | 3            | 4                | 5          |

3. Tell us how **easy or difficult** it is to jackhammer in the usual way. Rate on a Scale of 1 to 5, where 1 is 'very easy' and 5 is 'very difficult.' Circle *one* choice in each row:

| Easy or difficulty of:                          | Very Easy | Somewhat Easy | Not Easy or Difficult | Somewhat Difficult | Very Difficult |
|---|-----------|---------------|-----------------------|--------------------|----------------|
| a) Using jackhammer to break a hole             | 1         | 2             | 3                     | 4                  | 5              |
| b) Activating the jackhammer lifter             | 1         | 2             | 3                     | 4                  | 5              |
| c) Pulling jackhammer out of the ground         | 1         | 2             | 3                     | 4                  | 5              |
| d) Moving to the next spot to continue breaking | 1         | 2             | 3                     | 4                  | 5              |

4. How do you rate using a jackhammer as you usually do on the following **abilities**? Rate on a scale of 1 to 5, where 1 is 'very poor' and 5 is 'excellent.' Circle *one* choice in each row:

| <b>Abilities:</b> | <b>Very Poor</b> | <b>Fair</b> | <b>Good</b> | <b>Very Good</b> | <b>Excellent</b> |
|-------------------|------------------|-------------|-------------|------------------|------------------|
| a) Stability      | 1                | 2           | 3           | 4                | 5                |
| b) Control        | 1                | 2           | 3           | 4                | 5                |
| c) Accuracy       | 1                | 2           | 3           | 4                | 5                |
| d) Vibration      | 1                | 2           | 3           | 4                | 5                |
| e) Durability     | 1                | 2           | 3           | 4                | 5                |

5. What things do you **like** about using a jackhammer in the usual way?

6. What things do you **dislike** about using a jackhammer in the usual way?

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# Jackhammer Lift Assist Usability

Jackhammer Lift Assist project

1. How **tired or fatigued** do you feel when using the jackhammer with the Lift Assist device? Rate on a scale of 1 to 5, where 1 is 'not tiring' and 5 is 'very tiring.' Circle *one* choice in each row:

| Is this part of your body: | Not Tired | Very Mildly Tired | Mildly Tired | Moderately Tired | Very Tired |
|----------------------------|-----------|-------------------|--------------|------------------|------------|
| a) Neck                    | 1         | 2                 | 3            | 4                | 5          |
| b) Shoulders               | 1         | 2                 | 3            | 4                | 5          |
| c) Hands and forearms      | 1         | 2                 | 3            | 4                | 5          |
| d) Lower back              | 1         | 2                 | 3            | 4                | 5          |
| e) Legs                    | 1         | 2                 | 3            | 4                | 5          |

2. Tell us how **easy or difficult** the jackhammer with the Lift Assist device is to use. Rate on a scale of 1 to 5, where 1 is 'very easy' and 5 is 'very difficult.' Circle *one* choice in each row.

| Easy or difficulty of:                          | Very Easy | Somewhat Easy | Not Easy or Difficult | Somewhat Difficult | Very Difficult |
|---|-----------|---------------|-----------------------|--------------------|----------------|
| a) Using jackhammer to break a hole             | 1         | 2             | 3                     | 4                  | 5              |
| b) Activating the jackhammer lifter             | 1         | 2             | 3                     | 4                  | 5              |
| c) Pulling jackhammer out of the ground         | 1         | 2             | 3                     | 4                  | 5              |
| d) Moving to the next spot to continue breaking | 1         | 2             | 3                     | 4                  | 5              |

3. How do you rate the jackhammer with the Lift Assist device on the following abilities? Rate on a scale of 1 to 5, where 1 is 'very poor' and 5 is 'excellent.' Circle *one* choice in each row.

| <b>Abilities:</b> | <b>Very Poor</b> | <b>Fair</b> | <b>Good</b> | <b>Very Good</b> | <b>Excellent</b> |
|-------------------|------------------|-------------|-------------|------------------|------------------|
| a) Stability      | 1                | 2           | 3           | 4                | 5                |
| b) Control        | 1                | 2           | 3           | 4                | 5                |
| c) Accuracy       | 1                | 2           | 3           | 4                | 5                |
| d) Vibration      | 1                | 2           | 3           | 4                | 5                |
| e) Durability     | 1                | 2           | 3           | 4                | 5                |

4. How would you **change** the Jackhammer Lift Assist device to reduce pain or fatigue to the operator?

5. What things do you **like** about using the Jackhammer Lift Assist device?

6. What things do you **dislike** about using the Jackhammer Lift Assist device?

Date:

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## Comparing Methods

Jackhammer Lift Assist Project

Rank using the jackhammer with *and* without the assist device for each characteristic listed

|   | <b>Using jackhammer</b> | <b>Using jackhammer with Lift Assist device</b> |
|---|-------------------------|---|
| <i>Example:</i>                         | <i>2</i>                | <i>1</i>  |
| a. Breaking pavement                    |                         |   |
| b. Pulling jackhammer out of the ground |                         |   |
| c. Ease of use                          |                         |   |
| d. Accuracy                             |                         |   |
| e. Work speed                           |                         |   |
| g. Overall                              |                         |   |

below. Mark **1 for the best method** and **2 for the second best method**.

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## Demographic Questions

Jackhammer Lift Assist project

1. Age: 

|  |  |
|--|--|
|  |  |
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 years

2. Gender:  Male  Female

3. Height: 

|  |
|--|
|  |
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 ft 

|  |  |
|--|--|
|  |  |
|--|--|

 in

4. Weight: 

|  |  |  |
|--|--|--|
|  |  |  |
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 lbs

5. Check one:

Right-handed

Left-handed

(If you use both hands equally, check the one you use to sign your name)

6. Trade:  Laborer  
 Supervisor  
 Other,  
Specify \_\_\_\_\_

7. Level:  Apprentice  
 Journeyman

8. Years in the Trade: 

|  |  |
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|  |  |
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 yrs



9. Race:  American Indian or Alaskan Native  
 Asian or Pacific Islander  
 Black, not of Hispanic Origin  
 Hispanic  
 White, not of Hispanic Origin  
 Other (please specify) \_\_\_\_\_  
 I choose not to answer

10. In the last year, how often did you use a jackhammer?   days per month

11. In the **last two weeks**, have you had pain due to any reason in the following areas of your body: (Circle all that apply)

None      Neck      Shoulder      Hands/      Low Back      Legs