# Safety and Health Investment Projects
# FINAL REPORT REQUIREMENTS

The purpose of the final report of your SHIP project is to:

1. Evaluate and document the achievements, challenges, and shortcomings of the project for the constructive benefit of others interested in learning from SHIP projects; and
2. Provide the Division of Occupational Safety and Health with information that shows:
   a. The outcomes specified in the project application were met; and
   b. The grant was used for the purpose(s) for which it was approved and in accordance with relevant WAC rules and any special conditions or requirements; and
   c. The outputs of the project have been disseminated as specified in the application.

The report format has four sections:

1. Cover Sheet
2. Narrative Report (part I)
3. Financial Information (part II)
4. Attachments (part III)

Please provide complete and detailed information in the final report. If you have questions, please call your SHIP grant manager.

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# SAFETY AND HEALTH INVESTMENT PROJECTS
# FINAL REPORT

Participatory Ergonomics: Early Identification and Reduction of Risk
SHIP Grant #2014WC00285
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# PART I

## Narrative Report: "Participatory Ergonomics: Early Identification and Reduction of Risk [in Custodians]"


**Abstract:**

Present a short overview of the nature and scope of the project and major findings (less than half a page).

Custodians and janitorial workers have among the highest injury rates of workers in the state of Washington. As part of a participatory ergonomics project, we began with the development and administration of a predominantly pictorial survey to the UW Facilities custodians. The survey asked them to identify which of their work tasks cause them discomfort, as the literature suggests that discomfort may be a predictor of future injury. From the survey results, we identified tasks that could benefit from ergonomic modification during the grant period. With input from custodians, managers, and health and safety professionals forming small groups to address the tasks individually, we reviewed and analyzed the tasks ergonomically and began to develop potential solutions to reduce the reported discomfort. After training, solutions were field tested initially by small group members and then additional custodians to further assess. Recommendations were made and we began training and implementation of ergonomic modifications of the custodians' work for 4 tasks--cleaning toilets, scraping floors, picking up trash from the floor, and using a vacuum backpack, each of which had high survey response rates for reported discomfort. Using an objective measure such as the Rapid Entire Body Assessment software posture analysis tool to compare pre- and post modification performance of the tasks we addressed, we calculated a projected decrease in musculoskeletal risks with our recommendations.

When we looked at those reporting high level discomfort post modification compared to all survey respondents, we saw large decreases in discomfort in multiple body areas for all four tasks modified, on average more than in the tasks we had not addressed. The follow up survey of custodians after the recommended modifications also revealed a decrease in high level discomfort overall in those that reported a high level of discomfort compared to those that reported any level of discomfort. In this group we saw a substantial decrease in back and knee discomfort in those tasks in which most custodians received training and tools (vacuum backpack use and toilet cleaning) and additionally a decrease in high level shoulder discomfort among the vacuum backpack users. There were increases in reported back discomfort (picking up trash from the floor) and shoulder discomfort (floor scraping) which were tasks where the majority of custodians had not received the new tools.

The collected survey data in conjunction with a set of short follow up questions may be useful for further assessing utilization, impact and the need for further education and training or tool fit following ergonomic modifications. In addition to continuing to refine these task modifications and addressing other tasks identified in the survey, the custodial department may benefit from the continued development of the participatory process involving custodians, supervisors and managers in identifying ergonomic issues and solutions.


**Purpose of Project:**

Describe what the project was intended to accomplish.

As discomfort may be a predictor of future injury, the project was designed to see if discomfort reported by custodians, could be reduced by including custodians, managers and health and safety personnel in a participatory process to address ergonomic aspects of the work custodians perform. The project team developed a mostly pictorial survey and administered it on a voluntary and anonymous basis to all interested custodians in order to identify work tasks that they report as causing discomfort. Once high discomfort tasks were identified from the survey data, we further engaged custodians in four small

groups in collaboration with supervisors and health and safety personnel to find solutions to improve ergonomic aspects of a limited number of the tasks. We purchased or devised and tested potential solutions for 4+ work tasks (cleaning toilets, floor scraping, picking up trash from the floor, use of the vacuum backpack, and throwing trash into the dumpster) and revised or abandoned concepts based on feedback from the small group participants and other custodians. Once potential solutions were identified, recommendations were made to the Facilities department for implementation. The remainder of the custodians were then invited to be trained in the use of the tools or equipment. After a period of time to acclimate to the new methods, comparison between the old method and the new method were performed with the objective measure of an ergonomic postural assessment tool, REBA (Rapid Entire Body Assessment). A survey similar to the original was administered to the custodians to see if the project achieved objective risk reduction and concomitant reduction in reported discomfort as was the purpose of the project. It is believed that early identification of discomfort will allow intervention to reduce the risk of work-related musculoskeletal injury in the future.

**Statement and Evidence of the Results:**

Provide a clear statement of the results of the project include major findings and outcomes and provide evidence of how well the results met or fulfilled the intended objectives of the project.

We developed a survey for the project and administered it to custodians to elicit reported discomfort as a surrogate for risk of future injury in order to identify work tasks that may pose a high risk of injury over time. The initial survey of the custodians revealed the following 5 tasks to cause significant discomfort: The vacuum backpack, picking up trash from the floor, scraping floors, cleaning toilets and dumping trash into the dumpster. Custodians voluntarily participated along with managers and health and safety personnel in 5 small groups to discuss and trial modifications of the tasks. All tools were optional to use, based on whether the new tool was more comfortable than the old. The technique of proper backpack harness wear, however, was determined to be mandatory by the Facilities department for those using the backpack, as a matter of safety. See Power Point Slides 67-73 of the NAOEM 9/10/16 presentation for the survey comparisons of frequency of discomfort pre- and post- modification which are discussed below.

The vacuum backpack, which was not fully understood by the Department to be a significant source of discomfort, was one of the tasks/tools causing the most discomfort according to the survey of custodians. In our small groups we learned how to determine the optimal setting and size for fit of the vacuum backpack as well as how to properly wear the harness. In the large training groups with the manufacturer in attendance, we learned of clips that could stabilize the straps, the need to empty the bag even before it is full [or it could cause heating of the back], the need to provide a tool to allow the adjustment for fit to be changed, how to use the wand, how to secure the cord, store the vacuum backpack and how to build a bridge when it is necessary to bend with the vacuum backpack on. This fitting, training and return demonstration appeared to be new information for the majority of custodians. In addition to the training and education piece, other results of this small group endeavor is that custodians no longer share vacuum backpacks, those whose vacuum backpack did not fit because of body habitus received new ones that did fit and new harnesses were distributed to those in need. The REBA calculation for MSD (musculoskeletal disorder) risk for old use vs new , i.e. following new equipment and training, reduced from a level 4 (low medium) to a level 3 (low), however the REBA does not fully account for static load which is a major issue for vacuum backpack use. The pre- and post-survey of custodians revealed reductions in reported high discomfort after training and tool modification, in the back, shoulders and knees when we looked at the data by group that reported high discomfort in comparison to those that reported any discomfort as well as in the group who reported high discomfort compared to all survey respondents.

The long handled toilet brush was provided for cleaning the inside of the toilet. This tool may be more advantageous for taller individuals to decrease the extreme forward trunk flexion. The tool developed for cleaning the outside of the toilet was not met with enthusiasm by most members of the

small group and was put on hold. As an offshoot of this small group, it was noted that custodians list to the side to hold open the bathroom stall door with their hip while cleaning. We recommended magnets be inserted into the stall door and partition, to hold the door open without effort. This eliminates the side twisting spinal posture and also enables custodians to bring mechanized tile cleaning equipment into the stall without wrestling to hold the stall door open. The REBA calculations indicated a risk reduction from 7 (medium risk) to 2 (low risk). It appears that the training and tool modification associated with this task also resulted in a decrease in custodian reported discomfort on the survey especially in the back and knees. However, in the group reporting high discomfort compared to those reporting any discomfort, there was a smaller increase in discomfort in the upper extremity following tool and training receipt that was not seen when we looked at high discomfort reporters among the total respondents. As with any ergonomic modification, this suggested further refinement was needed for some. Follow up has indicated further adjustments that may address these issues.

Grabbers to pick up trash on tiered floors such as auditoriums were selected by custodians for their preferred individual grip fit. The department had opted instead initially to select the single most popular grabber and provide it to work areas rather than individuals. Not all types of grabbers had magnets attached and the department is in the process of gluing magnets on to those grabbers that didn't have magnets. The latter are very helpful for small objects like paper clips, rather than repeated bending or squatting to pick up objects. Grabbers are still in the process of distribution. A grabber bag was also recommended for placement of the trash, however although popular during the training, the department has not yet adopted that receptacle or another. The REBA calculation decreased from a previous 8-10 (high risk) to 3-4 (low to low medium). At the time of the survey we see that most attended training but 75% reported not receiving the tool. In the group reporting high discomfort compared to those reporting any discomfort after tool modifications and training, there was a decrease in knee discomfort but an unexpected increased report of back discomfort. This necessitates further follow up of those that are using the tool as well as assessing tool distribution and availability. However, when we compare the group reporting high discomfort compared to the total survey responders, this increase was not observed and instead decreases in high discomfort were reported in all body areas. We are in the process of reviewing distribution and mechanism of use and suspect not receiving the new tool may be the reason for reported increase in discomfort.

The floor scraper tool using a D-ring and an adjustable long handled scraper enables work [such as scraping gum, dental amalgam or other materials] to be done in a manner markedly decreasing flexion and squatting or kneeling. Not all custodians do this work regularly to any great extent, but the swing shift custodians and project crew utilize this tool on a regular basis. As an offshoot of this activity, mechanized scrapers were purchased by the department, however we are disappointed in the on-off switch process which promotes an awkward hand use plus vibration. We have made recommendations to the company via their sales rep. They appear to be addressing this and we have reviewed two concepts thus far. The mechanized floor scraper can also be utilized for cleaning bathroom tile, markedly decreasing force required for this work. The REBA calculation with the old floor scraping tool projected a risk of 10 (high) and decreased to 3 (low) with the new tool and training. Reviewing the survey data among all participants who identified and quantified discomfort as high, a large decrease in knee discomfort is noted and to a lesser extent back discomfort, but also noted is a possible small increase in shoulder discomfort. In those who reported high discomfort post-modification among those who reported discomfort, knee and back reported discomfort decreased the most following the training and new tool but an increase in shoulder and arm discomfort post modification was also noted. Although most attended training for use of the scraper, 85% reported not receiving the tool which may or may not be available within their group as opposed to individual possession. Scrapers are still in the process of distribution and we expect this impacts the response, however it suggests the need for follow up of those using the tool. Most likely, users may not be adjusting the D-ring or handle length for their body habitus, thus affecting the shoulder and arm.

A tool to hold open the dumpster lid while tossing trash is still under development. We have two portable prototypes but ideally we would like a mechanism that is affixed to the lid itself [for most circumstances] based on feedback from our small group custodians. REBA calculations would be

expected to markedly reduce shoulder risk as well as back injury risk.

Although the surveys were not completed by the custodians exactly as intended (16% of original survey and 5% of follow up survey), they still provided information directing us to identify the tasks causing high discomfort which was validated in our small group sessions and subsequent activities. Most commonly, custodians answered "no" when asked about discomfort with a particular task but then went on to choose a body part and a severity level for discomfort. Another common finding was in choosing more than one body part as the site of the most discomfort when the question specified one body area. Importantly, however, providing the anatomic location and perceived intensity of the problem allowed for targeted ergonomic intervention and pointed us to where improvements were made and whether new ergonomic issues arose after the modification was introduced. Survey completion is likely dependent on a combination of survey design, and/or language and comprehension and cultural issues which we consider may also impact safety training.

An abbreviated set of standardized questions that we used in the small groups for assessment of new tool feedback was also useful for implementation follow up and could be utilized for feedback going forward. We found opening the lines of communication to the workers to identify and help solve issues important to them to be extremely valuable.

Overall, the process of involving the custodians in identifying work tasks that cause them discomfort and together with managers/supervisors and health and safety professionals preliminarily addressing some of the areas of discomfort has resulted in a reduction in the most discomfort in those tasks where training and tools were received by custodians.

The project has laid the groundwork for participatory processes continuing forward to provide greater emphasis on ergonomic education and training of workers and supervisors with more collaborative participation from both groups and furthered development of their culture of safety.

**Measures to Judge Success: (Please see powerpoints and addenda)**

If relevant, state what measures or procedures were taken to judge whether/ how well the objectives were met and whether the project or some other qualified outside specialist conducted an evaluation.

We were able to engage custodians, health and safety professionals, Facilities department high level management and supervisors working together for the length of the project in the goal of decreasing discomfort of custodians. In the initial survey, the custodians identified work tasks that cause them discomfort. Their localization on the body diagram with back, shoulders and knees as the most common areas of discomfort supports our hypothesis of discomfort as a possible predictor of future injury. These body areas identified by the custodians are the three most commonly injured areas of custodians when we review the UW Workers' Compensation data from previous years.

By using the REBA (Rapid Entire Body Assessment) software tool, the outside specialist (ergonomist) provided an objective measure to calculate ergonomic risk pre- and post training and/or tool modification. We saw a reduction in calculated MSD (musculoskeletal disorder) risk in each of the tasks for which we addressed training and tool modification.

The follow up survey post-modification revealed all the tasks to have reported total decreases in discomfort possibly due to general ergonomic training and increased awareness but there may have been variability in the work performed at the different times of the year. From the non-modified task changes in discomfort, there is a suspicion that less trash was generated at the time of the second survey. Looking at the tasks which we addressed, the tasks for which custodians received training and received the tools resulted in the greatest decreases in back discomfort (Vacuum Backpack and Cleaning Toilets). Picking up garbage from the floor increased in back discomfort reported but since only 25% reported receiving the new tool, it is possible a greater awareness of not having the tool resulted in an increase in discomfort reporting for this task. It is also possible that the tool opted for by an individual, was not the tool provided to the individual's work group. The grabber is believed by some to be most useful for tiered lecture halls and auditoriums which not all custodians have responsibility for. We also saw some smaller increases in

discomfort for some of the tools which suggests a need for further follow up as is the norm for ergonomic modifications.

We also looked more closely at the tasks that we did not address in comparison to those that we modified:

- We reviewed the previously calculated high discomfort levels (discomfort levels 5-7 from the discomfort survey scale) among all surveyed in the unmodified tasks to help determine future priorities . Picking up and dumping garbage [from dumpster and barrels] and wiping surfaces are the remaining unmodified tasks causing the most discomfort. Also of interest is the degree of impact the school year has on the discomfort caused by these tasks, previously under-appreciated and that offers opportunities for other types of interventions. Although the original intent was to survey custodians during the school year, delays in obtaining modified tools, also delayed follow up survey administration. Initially we viewed this as a negative impact, however, looking at reported discomfort in trash-related tasks that were unmodified but included in both surveys at two different times, i.e. during the school year and after the school year, we were able to see the important discovery of the large impact of trash and recycling tasks on custodian discomfort. There is now a post-grant focus on additional ways to reduce discomfort associated with trash and recycling.
- Average discomfort level was significantly higher at baseline for the modified tasks, but at follow-up was not significantly different from discomfort for the unmodified tasks. This suggests that at follow up, discomfort was reduced to the level of unmodified tasks which were not addressed in this project because of their lower baseline discomfort level.
- Average discomfort level was reduced for all tasks, and for the modified and unmodified tasks measured separately. The reduction was twice as great for the modified tasks as for the unmodified tasks.
- The proportion of participants reporting any discomfort was reduced over all tasks and for modified and unmodified tasks separately.
- We looked to see what using a different high discomfort cutoff points would yield (ie. 6 and 7 on the discomfort survey scale) and found the proportion of participants reporting high discomfort was reduced by 18.6% on the modified tasks and 6.3% on the unmodified tasks.
- Participants who were at least 5'8" tall had significantly lower mean discomfort levels while dumping trash from barrels at both baseline and follow-up, and while dumping garbage at follow-up.
- The height advantage was significant for back discomfort while dumping barrels at baseline, but not at follow-up, or for shoulder discomfort at either time point. This suggests that the height advantage may be helpful in reduction of back discomfort but not shoulder discomfort in dumping trash from barrels.
- There were no significant differences by height in mean back or shoulder discomfort while dumping garbage into the dumpster. Although this is unexpected, it may suggest predominantly one handed dumping garbage appears to cause back and shoulder discomfort regardless of the height of the custodian. Dumpsters are 4’ tall and only 5% of the custodians exceed 5’10” in height. At baseline, participants whose primary language was not English were significantly more likely to report high discomfort (67.7% vs. 45.4%). At follow-up, reports of high discomfort among participants whose primary language was English remained relatively unchanged at 46.5%, while the reduction in high discomfort among people who primarily spoke a language other than English decreased to 51.6% not significantly different from that of English speakers. This may suggest a benefit in training that was greater for non-English speakers.

Importantly, the project served to increase awareness of and commitment from the Facilities department regarding a greater need for training and education especially as involves the vacuum backpack, but for the remainder of the work as well. This need as well as a willingness to continue pursue tool modifications was conveyed by managers to the custodians. The department wishes to proceed with the ergonomic activities initiated by the project and also further develop a workplace culture emphasizing both safety and productivity. They seek to engage more custodians in the process going forward. The project also highlighted the importance of the hands on role of Facilities Safety/IH personnel who going forward it is hoped will provide interactive guidance toward ergonomic aspects of the work identified in this project and work toward establishing a train-the-trainer approach. The Facilities department has decided to continue the work initiated by the project in terms of the participatory model of custodians, managers and health and safety engagement in ergonomics and safety.

The custodians expressed gratitude at having received the training from the health and safety professionals and that they would have liked to have received the training earlier.

Physicians at the NAOEM conference voiced appreciation for the awareness of possible solutions and etiologies of injuries for their patients who are custodians. As an indication of interest, they requested and will be provided our list of products and vendors. Presentations at the regional AIHA and national AOHC conferences were equally well received.

**Relevant Processes and Lessons Learned:**

Specify all relevant processes, impact or other evaluation information which would be useful to others seeking to replicate, implement, or build on previous work

AND

Provide information on lessons learned through the implementation of your project. Include both positive and negative lessons. This may be helpful to other organizations interested in implementing a similar project.

Relevant processes and lessons that we have learned from the project which consisted of 7 major phases are as follows:

1) Survey development and administration to UW Facilities custodians to elicit discomfort location and severity in relation to 16 of the work tasks performed by the custodians.

The demographic data revealed an older population of workers, many with long term employment and approximately 35% of whom feel more comfortable speaking or listening in a language other than English. Using the pictorial display of the task was an appropriate method and confirmed that we and the custodians were referring to the same task. That the surveys were anonymous precluded our direct comparison in a follow up survey however there was a greater concern that custodians would speak more freely if their responses were not linked to them. We did however ask in both surveys if the custodians had taken the survey previously, which does allow some comparison of the groups who took the pre-and post-modification surveys, but does limit the data analysis because of the different composition of the groups.

Although we included manager feedback in survey design and a custodian participated in survey development, the survey was not further validated. We vetted our survey with the managers, many of whom had risen from earlier custodian positions, and made modifications based on their feedback. The survey was frequently not completed as intended in that answers seemed to contradict each other. Custodians often indicated they had no discomfort with a task but then continued on to select an aspect of the task, a body area and a severity index for the discomfort for that same task. There may be a cultural barrier to directly reporting discomfort but in the subsequent questions, when given the opportunity to locate and quantify the degree of discomfort, custodians were able to do so. In our data analysis, we took

the identification of a body area and quantification as a positive indicator of discomfort, rather than the yes or no answer if they were in conflict. Also common was more than one body area identified or more than one aspect of a task selected when we were hoping the survey would provide the major aspect of the task that was problematic and what body part was affected most. The information the custodians provided was useful, particularly multiple body areas, but made analysis more challenging. Focus groups with a larger group of current custodians may have been more informative in terms of survey design. Other researchers have utilized one to one survey completion with custodial workers.

Four tasks were identified in which the custodians reported a high degree of discomfort and which we believed we could achieve a modification of that task within the grant period. They were vacuum backpack use, toilet cleaning, scraping floors, and initially dumping trash into the dumpster. When we realized the dumpster project was more complex and could not be completed within the grant period, we continued to work on prototype development but added picking up trash from the floor as a fourth task to modify in its place.

2) Small Groups

The next phase involved assembling small groups of workers for each of the above tasks (4 groups), with and without discomfort plus supervisors and managers and health and safety professionals (ergonomist, health and safety industrial hygienist, the ship project manager and occupational medicine physician). Postures while performing tasks were observed, photographed/videographed and used for discussion in subsequent small groups. Sample tools were obtained or prototypes developed. The small group members were trained in use and took the tools for trial for the next several weeks. Feedback occurred onsite and at actual work locations as well as in small groups. A brief set of standardized questions were informally included in assessing each new tool---did you use it, how often, did it cause less discomfort (where), did it cause new discomfort (where), how would you transport it and where would you store it, and finally, would you use it.

Work involving the vacuum backpack was one of the tasks with the most frequently reported complaint of discomfort of high severity of which management was not fully aware. In our small group, we became aware of the need for training in proper fit, adjustment, and harness wear as some of the key learning points of this task. Proper use of the harness should shift the weight of the pack from the shoulders and back to the hips as with any backpack.

Another group formed around toilet cleaning which had a process and tool purchased for cleaning the inside and another was developed for the outside of the toilet. The members of the small group except for one with a pre-existing injury preferred the long handled brush for the toilet bowl. We took the long handled toilet brush to another 2 work areas for additional feedback. These groups liked the long handled toilet brush for the interior as it reduced trunk forward flexion and initially preferred a softer bristle over the firmer bristle.

During the process of bathroom tool trials it was observed that custodians were using their hip to hold the stall door open while cleaning the toilet. As a result, to eliminate this awkward posture, magnets on the stall doors are being installed in the over 3000 campus bathroom stalls to allow the door to remain open without the need for the lateral trunk deviation. The magnets also allow for bathroom tile and floor cleaning equipment to be more easily utilized in this small space without the need to manage the stall door.

Floor scraping tool prototypes with adjustable long handles for the blades and adjustable D-rings for gripping the handle were developed for that group. The custodians and managers worked to find the best blade for that job. This tool reduced the trunk and knee flexion significantly.

The next group that was formed was for the dumping of trash into the dumpster. There were multiple aspects to this task, of which process change such as cart loading or cart compartments, was met with the most resistance by custodians. The focus turned solely to tool prototypes to open the dumpster lid so that the worker could keep the lid open and have both hands free to dump the trash. Many custodians use a one handed lift and toss technique which places significant stress on the shoulder and back. The University of California tool for lid opening was unavailable so two prototypes were developed by our group. One was similar to the UC concept and the other involved an adjustable rod with a hook.

Both tools were again also trialed outside the small groups to additional custodians. Some custodians were not enthusiastic about the need for carrying an additional tool and expressed a preference for something to be attached to the lid instead. Because both options may be valuable, we became involved in a UW engineering class to further assist development of a fixed dumpster tool which is attached to the lid. The internal device would need minimal machining but would need installation on the over 200 dumpsters on campus. The portable lid opener option would need machining/manufacturing or once available, purchasing for the number of custodians who will opt to use it. The Department is also looking at the possibility of purchasing automated dumping equipment for some high volume areas.

Because we had hoped to have a total of 4 tasks completed during the project, we began an additional effort to investigate whether grabbers would be useful for picking up trash from the floor. This was positively received particularly when grabbers had magnets to pick up metallic items like paper clips. Using the grabber could result in decreased forward trunk flexion and knee flexion. We found that not all grabbers had magnets drilled into them and have taken to glueing magnets on preferred grabbers that don't have magnets.

A drawback to small group participation for custodians was that there was not sufficient coverage for their usual work. After 3 of the projected 4-5 sessions, custodians (particularly those who did not have discomfort with the task) were reluctant to continue meeting because they did not want the quality of service to diminish in their work areas due to time involved with attending the meetings. Although we projected 4-5 meeting sessions for each task, the reality of that time commitment (which also included travel to a central location) was not well appreciated at the time when custodians were volunteering to participate. We transitioned to smaller groups at the respective work sites of more custodians so that a smaller amount of their time was required. This also allowed for greater input by more individuals. A future study consideration would be to offer an incentive after hours for participation or to provide some means of work coverage for the participants' time spent with the project.

3) Training

Approximately 180 custodians met in small groups of 20-40 custodians to be fit and trained for use of the vacuum backpack. Health and safety, managers, ergonomist, occupational medicine physician, vendor and the manufacturer's representatives met with each of the groups. Custodians were fit based on their trunk size and comfort. After education and demonstration, each custodian had the opportunity to demonstrate back, their knowledge of how to adjust the vacuum backpack harness and fit. We also noted the state of disrepair of many of the harnesses. Many aspects regarding use of the vacuum backpack were discussed. Custodians viewed the educational content very positively. As a result, some custodians were fit to different sized vacuum backpacks, many received new harnesses and there is no longer sharing of this equipment between custodians.

The other three tasks also offered training in small groups with participants rotating from one task to the next. Each custodian had the opportunity to utilize each tool after a demonstration. As was true with the backpack harness, almost no one learned by watching demonstrations. Cueing was necessary to transition from the old posture to the new posture improved by the proper use of the new tool. Custodians were measured for optimal grabber length and given a choice of 5 grabbers with different grips to select. A trash receptacle tool was also utilized to place the trash into, to minimize new awkward postures involving the upper extremity that could develop.

4) Distribution

As mentioned previously new harnesses and vacuum backpacks were provided to most custodians as needed, although due to manufacturer lack of supply distribution was delayed for up to a month after the training for some custodians. Tools for adjustment are now available in each area (screwdrivers that fit this bolt and clips that maintain the stability of the harness adjustment were also needed). Health and safety observations of workers and vacuum backpack use since that training indicate the need for ongoing education and training.

Unexpectedly, based on our ease of ability to obtain sample tools within days, long handled toilet brushes also, were not available in the full amount requested. These have been distributed within a few

weeks of the training, but there is management and custodian disagreement as to which brush bristle to select. Initially only the management selected option (stiffer bristled brush) was provided.

Management decided on limited options for the grabbers based on the expected use, rather than offering a selection of options as in the training. Because only 1 grabber came with a magnet attached, management is attempting to retro fit magnets, glueing them onto each grabber because of their utility and popularity among custodians.

Similarly, scrapers were not provided for individual use but were provided in a central location for use as needed, again after a gap post-training.

5) Re-Survey

The participation rate was less in the second survey than the first. Further comparison of demographics of participants in the pre- and post-surveys, indicates attrition was least likely among younger, less-experienced, or male workers, or those whose primary language was English. Survey participation may have been affected by differential emphasis of supervisors, some of whom apart from the neutral recruitment material provided, encouraged workers to take the survey if they felt discomfort. This might be expected to potentially skew the follow up survey toward participation by those continuing to experience discomfort in contrast to the study intention, toward a reduction in reported discomfort following ergonomic modifications. While we appreciate the enthusiasm of some of the managers, it was a reminder of the importance of clarity of messaging at this crucial point in the project. Although approximately 2/3 of the re-survey participants indicated they had taken the previous survey, together with the survey participants anonymous, limited statistical analysis.

The follow-up survey was distributed due to time constraints with less than optimal tool distribution as noted previously. The post-modification survey was adapted from the original survey to include such variables as receiving and understanding training and receiving the tool. Administering this survey, we also realized that there may be issues related to language and understanding, despite having interpreters present for those that were known to prefer such assistance. For future research, we might recommend neutral party one-to-one assistance with survey completion for all and continuing to use interpreters as necessary, given the high percentage of custodians who prefer listening in a language other than English. We would also consider working more directly with custodians in survey design for future efforts.

Survey completion once again contained many inconsistent responses as in the first survey, (responding no to discomfort but identifying an anatomic location and degree of discomfort) despite our leading the participants through the questions as a group. In the first survey, we led the group through the same example twice whereas in the second survey, we didn't use an example but went through the actual first ten sets of task survey questions one by one together as a group. The remaining six task questions were identical in format to the previous six.

The consistency of the responses in both surveys also suggests there may be cultural issues [which we see clinically], that inhibit a direct response to the question regarding discomfort. We feel we were able to identify discomfort however by the subsequent questions in which custodians' selection of a body area and degree of discomfort, even if the custodian answered the previous question denying discomfort.

The follow up survey did show overall discomfort severity reduction in all tasks, even those we did not address. The general ergonomic education may be in part responsible since every training we performed involved postural and other ergonomic information. Another potential source of this impact may be due to the survey having been distributed at a different time of year, i.e. when there is a somewhat different workload or work organization. Importantly, however, the data indicated a reduction in degree of reported discomfort in those tasks especially that more consistently received the tool or the training. Importantly, that unintended difference in timing of surveys allowed for us to appreciate the impact of trash and recycling on the reported discomfort of custodians. This allows us to prioritize efforts and think more expansively as to how to reduce trash and recycling volume or weight (e.g. request emptying of bottles for recycling).

Much simpler and very fruitful was our brief follow up survey instrument which asked a few

basic questions and which gathered much useful information. This was originally used in the small groups but was also helpful following the post-modification survey when an increase in discomfort was unexpectedly noted in some new body areas. Despite flaws, the larger survey was found to be valuable in identifying high discomfort tasks, localizing the problem anatomically and allowing us to prioritize modification, given the level of discomfort reported. It was also helpful in alerting us to new problem areas that arose post modification, although the shorter survey instrument could be used to follow up each task modification.

6) Comparison of pre-modification objective ergonomic measurements using the REBA calculations indicated risk reductions in each of the tasks we addressed giving us a relatively objective measure of musculoskeletal risk reduction. We believe this is a good communication tool to bring ergonomic risks to management attention, although in our case management was already engaged in the process.

7) After the survey

Equally as important as reductions in discomfort, we noted some increases in complaints of discomfort in previously unaffected body parts in some of the modified tasks. Using the same standardized set of questions previously used in the small groups, supervisors were able to get custodian input as to potential problems. This led to further engagement in refining the process.

In summary, the project has identified gaps in training and knowledge, equipment and supervision through a participatory ergonomics process in which custodians, managers, and health and safety professionals (ergonomics, industrial hygiene and occupational medicine) worked toward solutions to reduce discomfort. Preliminary data suggests that training and more ergonomic tools may be beneficial in reducing custodian discomfort in their work. It is hoped that the project work will continue with refinements of the above tasks, reviewing additional high discomfort tasks not addressed by this project, additional supervisor training so that they can be resources to the workers collaboratively, review of possible language and comprehension issues, and further development of its health and safety culture to continue toward incorporating ergonomic aspects of work into their program.

While we focused on the ergonomic aspects of tasks, we were made aware of the need for greater staffing of custodial positions. Work load began to impact the custodian’s desire to participate in the small groups or not be able to perform their usual work to their satisfaction. This called for smaller groupings at the custodian’s worksite rather than a central location to which custodians travelled as we originally begun. If the project were repeated, an option would be to offer custodians an incentive for participation after work hours if staffing wasn’t at a level to allow for coverage of a worker's position.

Multiple layers of investment and collaboration were essential. The custodians working together with managers and health and safety professionals, EH&S working with Facilities, engaging HIPRC resources and UW engineering students all contributed handily the project. There is a lot of untapped talent, student and employee, that seemed to be eager to be invited for an opportunity to engage in this relevant work.

Our findings were not unique to UW custodial work. The same tools have been seen across the country and the same discomfort or injury can be seen in employees outside of the UW. Custodial equipment has not changed in large part over the past century unlike other equipment areas which have made greater ergonomic strides. Even those companies that provide tool modifications do not have volume on hand nor sufficient variation to account for the different body shapes and sizes. For long handled toilet brushes, the only company offering this product did not have 200 long handled brushes in stock. Grabbers to pick up trash from the floor had to be purchased from multiple vendors to allow for multiple options for grip fit and only one of the 7 had a magnet attached. The latter are excellent for picking up paper clips and other metal objects. This lack of in stock product availability in backpack harnesses, toilet brushes, and grabbers caused significant and unexpected project delay. Even some of the products meant to ease the force or flexion required, introduced other less ergonomically favorable design components. A scrubbing machine had an "on" button at the top of the long handle requiring continuous thumb or palmar pressure. They are responsive, however, and have designed a lever on the side of the handle.

Worker input was critical to what would likely be successful or not sustainable. There is a strong peer influence among the custodians which worked for and against the project at times. If one person in a group decided not to give consent for a photo, the remainder of the group was unlikely to participate. On the other hand, workers who were early adopters often engaged co-workers to participate in the project indicating to other custodians that the project is intended to help custodians.

The custodians were often heard saying "this will save our backs" which became a theme they used to engage other custodians. Management used it to engage supervisors by asking a question for which the answer from the supervisors was "to save our backs".

All of the trainings had verbal, demonstration and custodian return demonstration components. **Almost no one learned by watching.** After observing a new tool demonstration, sometimes repeatedly, workers first adopted their usual posture as if they had their old tool, i.e. got down to the ground with the long handled brush or scraper, despite their no longer being a need for that posture. This underscored to us the importance of allowing a worker to physically experience the new task with knowledgeable guidance at hand.

We believe that supervisors need the same training as the workers so that their responsibility encompasses both safety and productivity. To participate in the trainings hands-on is an important component to their being able to supervise that workers perform the job safely. We saw uneven engagement and abilities in this very critical supervisory role and strongly advocate further hands on/return demonstration training of supervisors along with custodians for all work performed. This is particularly important where there may be language barriers. This also needs to be done within the context of a culture of safety. We were pleased to note that many more managers began to appreciate the importance of hands on training with every new tool or process introduction.

Tasks and modifications were more complex than was initially apparent, requiring we take into account the task at hand, its multiple components, upstream and downstream effects, transportation, storage and accessibility of a tool.

Limitations are as follows:

- No control group: no way to test for placebo effect.
- Possible placebo effect: participants were aware that modified tools were available for certain tasks and they were asked about those tasks in the follow-up survey before being asked about the unmodified tasks.
- No identifier linking baseline to follow-up data: appropriate statistical tests for change over time are not possible; no way to test for differential attrition by baseline discomfort level. We do know, however that 67% of the people took both surveys. The survey was distributed anonymously to encourage maximal participation among custodians.
- Modified tasks had been chosen for ergonomic targeting due to the custodians' reports of higher discomfort in the survey they completed: this means there was less room for increase in discomfort at follow-up than among unmodified tasks. Since there is natural variation in any measurement, the mean estimated from this sample for the modified tasks could have been higher than a mean estimated from another sample. By picking tasks with a higher mean you are running the risk that the estimate would have regressed toward the true mean on its own. Repeated measures would help rule this out. However, there was at least 40% room for more discomfort to be reported.
- Seasonal effect: baseline measurements were taken August 25 – September 18, 2015, and follow-up measurements July 20 – 25, 2016, leaving open the possibility that changes in discomfort are associated with changes in workload due to differences in campus population associated with the academic calendar, however the benefit of ergonomic training cannot be ruled out, nor can a Hawthorne effect. In regard to the latter, when we looked at high discomfort post-modification we do not see improvement in those areas that did not receive the tools, making that a less likely hypothesis.

- The discomfort scale has not been validated in the scientific literature.

Despite limitations, the project led to greater custodian and supervisor participation in workplace ergonomic issues, reduced specific ergonomic risk factors identified in the survey as causing high discomfort, and continues to address additional ergonomic issues beyond the grant period. The project has developed into an ongoing participatory health and safety process of this department, expanding the previous practices and focusing mostly on ergonomics but not exclusively. Training of custodians and supervisors has developed further from the critical experiences learned during the grant. Looking at workers' compensation data and our survey data, we believe that our work process and tool modifications in the grant and ongoing will reduce custodian discomfort and ultimately, injuries and in the process, increase health and safety awareness and promotion.

**Product Dissemination:**

Outline of how the products of the project have been shared or made transferrable.

The PI presented a UW Grand Rounds on the preliminary results of the project on 5/4/16 in Seattle. The audience contained physicians, industrial hygienists, risk managers, ergonomists, occupational health nurses and custodial department managers in person as well as streaming. There was considerable interest and the talk was made available to those registered. Grand Rounds attendees were positive about the information content which they felt would be useful to them. It is also available on the DEOHS archives. The Facilities director, Gene Woodard also received requests for the talk and he will utilize presentation slides to present to his peers. He will be presenting to the IEHA (International Executive Housekeepers Association) in Chicago where he anticipates presenting to 300 members. He is leading a custodial ergonomics discussion July 2017 at the Green Clean Schools Leadership Institute. The PI has also presented a poster on the project progress at the Semiahmoo Occupational, Environmental and Public Health Conference January 7-8, 2016 and several UW seminars and NAOEM (Seattle 9/10/16), PNW AIHA (Portland 10/16) and AOHC (Denver, 5/17). We hope to continue advancing the work with further custodian feedback and refining of some of the products and completion of others. Slides of the project and vendors will be made available to attendees. We will also share some of the forms (vacuum backpack training points) and recording sheets we developed for this project if others wish to utilize them. The Facilities director has been contacted by a manufacturer who heard of the project and has been asked if interested in trying out a new piece of equipment, so we feel that we are making [much needed]ripples in the industries that provide equipment for custodians' use as well.

**Feedback:**

Provide feedback from participants, trainees, individuals who have used your products/processes, as well as any reports from an independent evaluator on the project.

Feedback from the custodians has been mostly positive. Many have expressed gratitude to us directly for having worked on this project either verbally or at the end of the survey. We have heard them convey to each other that our project is to help them. They created a slogan "This will save our backs" for some of the tools like the scraper. They voiced that they wished they had received the information and training, such as that for the vacuum backpack, sooner. Younger custodians are less inclined to believe this is relevant to them.

The ergonomist from Performance Ergonomics, Steve Davis, appreciated, enjoyed and thanked us for allowing his participation. The Facilities department felt they had learned a great deal and had only scratched the surface. They feel that it is a top priority to build upon and sustain what we have learned. They hope to carry forward the momentum of what we've begun.

Presentation at the NAOEM conference in Seattle, September 10, 2016 by the PI appeared to be well received. Most of the audience had experience in treating custodians and welcomed the work of this project. Requests were made for the sources of the tools and manufacturers of the products used in the study. The photos of the work were also helpful to the physicians who treat custodians to gain a better understanding of the risks and injury etiology.

**Project's Promotion of Prevention:**

Explain how the results or outcomes of this project promote the prevention of workplace injuries, illnesses, and fatalities?

Given that our survey identified the same body regions experiencing discomfort as UW Risk Management data from previous years identified as body parts injured, our project has identified likely sources of cumulative trauma in the work of custodians. These tasks can be improved to decrease the discomfort and risk of injury. Calculating the REBA risk of the tasks we worked on to improve the ergonomics and comparing those post-modification, we see that there is a significant potential risk reduction with the recommended modifications. Also important, we began a collaborative process where the department is more aware of the needs for training, equipment evaluation and further expanding a culture of safety more broadly featuring ergonomic issues. The project members promoting the work of this project to peers is an important component of prevention. As previously mentioned, we hope to impact the industries that provide tools for this work.

**Uses:**

How might the products of your project be used within the target industry at the end of your project?

Is there potential for the product of the project to be used in other industries or with different target audiences?

Our pictorial survey concept asking the workers what tasks cause discomfort, where and how much, produces useful direction overall that was not fully appreciated by the management previously. Our work also highlighted the need for development of training for the custodians and their managers. Once issues are identified, involving the workers and managers in a participatory process and collaborative solutions begins a more engaged work force and furthers a culture of safety. Given the injury rate in this worker population nationally and statewide, it may be advisable for other employers to similarly engage their workers. At a minimum, providing tool options that pose less risk and hands on training may be beneficial.

In settings where there may be language or cultural issues, an alternate approach to group survey administration may to administer on a one to one basis with a neutral party [so people feel free to speak] to verify the intent of the responses. The consideration in that case would be whether workers trusted the process as anonymous. The short follow up set of questions we developed for new tool trials is very useful as a means for workers to communicate with their supervisors in a manner that can be relayed to more senior personnel for translating ideas into action. Use of the REBA tool may prove useful in upper level management's understqanding of the risk.

The other products of the project include training in the tools they are already using (vacuum backpack) as well as a choice of new tools (long handled toilet brush, trash grabbers and a scraper tool with an expandable pole, and an D ring for gripping) that may allow them to work with less discomfort. We believe the magnets utilized for the bathroom stalls would be beneficial for other custodians as well. We anticipate finalization of products related to opening the dumpster lid in the future.

That a large influential institution such as the UW begins such endeavors can have an impact in preventing workplace injuries within other custodial venues in the UW system as well as externally, given the widespread presence of custodians in most if not all, medium to large businesses. Most of our

solutions at present were not costly which makes them more appealing to adopt for the prevention of injuries. The more aware this industry becomes of the training and tool needs of these workers, the greater demand for manufacturers for R&D, may result in an improvement in tool options as has occurred for other industries.

**Organization Profile:**

For awarded organizations, to include partners and collaborators, provide a brief description of each organization. Mission, vision, and purpose for each of the organizations who applied (this includes partners and collaborators) for the grant.

The mission of **Facilities Services** (FS) is to learn, adapt, and innovate to preserve the University's physical assets and deliver the highest-quality services to the UW. FS's Building Services Department preserves the university space to ensure a quality environment for the entire UW community. In doing so, their first priority is safety – of their own employees and of the entire UW community.

The mission of the Department of Environmental Health & Safety (EH&S) is to support the University of Washington's teaching, research and service missions by assisting organizational units in meeting their responsibility to protect the environment and by providing a safe and healthful place of employment and learning. EH&S's vision is to engage the UW community to ensure a healthy and safe place for advancing learning, teaching, research and service. The mission of EH&S's employee health clinic is to provide clinical services that focus on injury and illness prevention to UW employees and to participate in multidisciplinary programs that promote a safe and healthy work environment.

The mission of the Department of Environmental and Occupational Health Sciences at the University of Washington is to identify agents in the environment and workplace that affect human health, elucidate their mechanisms, develop strategies for confronting their effects, and share knowledge obtained. Preventing unnecessary work disability by encouraging early, safe return to work after workplace injuries and illnesses is an important part of the DEOHS mission.

# Additional Information

**Project Type**
☐ Best Practice
☐ Technical Innovation
☐ Training and Education Development
☐ Event
☐ Intervention
☒ Research
☐ Return to Work
☐ Other (Explain):

***Target Audience:***
Custodian workers employed by the University of Washington Building Services department.

***Languages:***
English, Chinese (Mandarin), Korean, Laotian, Tigringa and Mien

**Please provide the following information - -**
(information may not apply to all projects)

| | |
|---|---|
| **# classes/events:**<br>*(per group/tool)*<br>Small group trainings = 5<br>Backpack harness trainings = 9<br>Ergonomic tools trainings = 7 | **21 total** sessions |
| **# hours trained**<br>*(per training session)*<br>Small group training (30-60 min)= *4.5 training hours benefitting 21 custodians*<br>Backpack harness training (90 min)= *13.5 training hours benefitting 193 custodians*<br>Ergonomic tools training (60 min)= *7 training hours benefitting 185 custodians* | **25 total** training hours |
| **# students under 18** | 0 |
| **# workers** | 230 |
| **# companies represented** | 1 |
| **# reached (if awareness activities)**<br>*14 area supervisors and manager and 2 additional associate directors.* | 8 outreach meetings |
| **Total reached** | **246** |

**Industry Classification** (check industry(s) this project reached directly )
☐ 11 Agriculture, Forestry, Fishing and Hunting
☐ 21 Mining
☐ 22 Utilities
☐ 23 Construction
☐ 31-33 Manufacturing
☐ 42 Wholesale Trade
☐ 44-45 Retail Trade
☐ 48-49 Transportation and Warehousing
☐ 51 Information
☐ 52 Finance and Insurance
☐ 53 Real Estate and Rental and Leasing
☐ 54 Professional, Scientific, and Technical Services
☐ 55 Management of Companies and Enterprises
☐ 56 Administrative and Support and Waste Management and Remediation Services
☐ 61 Educational Services
☐ 62 Health Care and Social Assistance
☐ 71 Arts, Entertainment, and Recreation
☐ 72 Accommodation and Food Services
☐ 81 Other Services (except Public Administration)
☐ 92 Public Administration

**List, by number above, industries that project products could potentially be applied to.**
55, 61, 62, 71,72 (most medium to large size businesses employ custodians and janitors)

**Potential impact (in number of persons or companies) after life of project?**
No fewer than 230 custodial workers

**Have there been requests for project products from external sources?** Yes
*If Yes, please indicate sources of requests:*
NAOEM members who attended the recent 2016 session and non-UW attendees at the PI's Grand Rounds at UW presentation in May 2016 (attendance list previously provided to SHIP)

# PART II

*Financial Information*
*Budget Summary*

| | | | |
|---|---|---|---|
| **Project Title:** | Participatory Ergonomics: Early Identificationand Reduction of Risk | | |
| **Project #:** | 2014WC00285 | **Report Date:** | 6/26/2017 |
| **Contact Person:** | Dr. Debra Milek | **Contact #:** | 206.744.9377 |
| **Start Date:** | 2/16/2015 | **Completion Date:** | 4/15/2017 |

| | | |
|---|---|---|
| **1.** | **Total original budget for the project** | $ 242,246 |
| **2.** | **Total original SHIP Grant Award** | $ 198,408 |
| **3.** | **Total of SHIP Funds Used** | **$ 198,408** |
| **4.** | **Budget Modifications (= or - if applicable)** | **$ 9,750** |
| **5.** | **Total In-kind contributions** | **$ 65,890** |
| **6.** | **Total Expenditures (lines 3+4+5)** | **$ 274,048** |

Instructions:

- Complete the Supplemental Schedule (Budget) form first (on the next page).
- The final report must include all expenditures from date of completion of interim report through termination date of grant.
- Indicate period covered by report by specifying the inclusive dates.
- Report and itemize all expenditures during specified reporting period per the attached supplemental schedule.
- Forms must be signed by authorized person (see last page).
- Forward one copy of the report to **Arlene Hallom, SHIP Grant Manager** at **PO Box 44612, Olympia, WA 98504-4612**

# PART II *(Continued)*

## *Financial Information*
## *Supplemental Schedules (Budget)*

**Project Title:** Participatory Egornomics: Early Identification and Reducation of Risk

**Project #:** 2014WC00285 **Report Date:** 6/26/17

**Contact Person:** Dr. Debra Milek **Contact #:** 206-744-9377

**Total Awarded:** $208,158.00

**ITEMIZED BUDGET**: How were SHIP award funds used to achieve the purpose of your project?

| | Budgeted for Project | Amount Paid Out | Difference |
|---|---|---|---|
| **A. PERSONNEL** | 131,096.00 | 146,935.67 | -15,839.67 |
| Explanation for Difference and other relevant information: | | | |
| | Budgeted for Project | Amount Paid Out | Difference |
| **B. SUBCONTRACTOR** | 18,000.00 | 17,266.98 | 733.02 |
| Explanation for Difference and other relevant information: | | | |
| | Budgeted for Project | Amount Paid Out | Difference |
| **C. TRAVEL** | 2,850.00 | 1,007.23 | 1,842.77 |
| Explanation for Difference and other relevant information: | | | |
| | Budgeted for Project | Amount Paid Out | Difference |
| **D. SUPPLIES** | 22,900.00 | 7,382.62 | -15,517.38 |
| Explanation for Difference and other relevant information: | | | |
| | Budgeted for Project | Amount Paid Out | Difference |
| **E. PUBLICATIONS** | 2,525.00 | 3,827.60 | -1,302.60 |
| Explanation for Difference and other relevant information: | | | |
| | Budgeted for Project | Amount Paid Out | Difference |
| **F. OTHER** | 12,750.00 | 12,814.55 | -64.55 |
| Explanation for Difference and other relevant information: | | | |

| | Budgeted for Project | Amount Paid Out | Difference |
|---|---|---|---|
| **TOTAL DIRECT COSTS** | 190,121.00 | 189,234.65 | 886.35 |
| **TOTAL INDIRECT COSTS** | 18,037.00 | 18,923.50 | -886.50 |
| **TOTAL SHIP BUDGET** | **208,158.00** | **208,158.15** | **-0.15** |

| | Budgeted for Project | Amount Paid Out | Difference |
|---|---|---|---|
| **G. IN-KIND** | 59,942.00 | 65,890.00 | -5,948.00 |
| Explanation for Difference and other relevant information: | | | |

I hereby certify that the expenditures listed on this report were made with my approval:

7/14/17

Date

Signature of Project Manager

# PART III
## *Attachments:*

Provide resources such as written material, training packages, or video/ audio tapes, curriculum information, etc. produced under the grant.

Also include copies of publications, news releases, curriculum, posters, brochures, etc.

**The above information should also be provided on a CD or DVD for inclusion in the file.**

- DVD: must be in an MP4 format
  Other video files must be provided in uncompressed source files.

- Publications:
  PDF of publication should be provided. SHIP also needs the original publishing documents (design documents), .eps, and .psd (if any illustrations/graphics are used)

**REMINDER!!**: All products produced, whether by the grantee or a subcontractor to the grantee, as a result of a SHIP grant are in the public domain and can not be copyrighted, patented, claimed as trade secrets, or otherwise restricted in any way.