Ergonomic Analysis of Construction Tasks

1.0 Project Descriptions

1.1 University of Michigan: Mosher Jordan Renovation and New Dining Center
The Mosher Jordan (MOJO) Renovation and New Dining Center project consists of a complete renovation of the residence halls as well as the addition of a brand new dining center that will serve the entire Hill Area residence halls and has a construction budget of $65.1 million. The renovation portion of the project consists of complete gutting and reinstallation of all MEP within the building. The restrooms will be completely gutted and refurbished and the rooms will be equipped with new electrical and data outlets as well as a complete fire suppression system. Each room will now have its own Fan Coil Unit to control the individual desires of each student within their own room. The new dining center will comprise of a large cafeteria on the first floor and a food emporium on the second floor for those who wish to purchase snacks in times of closing of the cafeteria. The dining center and residence hall will be serviced by a brand new Mechanical Service Building that is being built between MOJO and Alice Lloyd. This is where the new HVAC systems and electrical units will be housed. This project is set to be completed by August 2008 allowing for residence to move in for the Fall '08 semester. You can visit the site listed below to find more details about the project:

http://www.aec.bf.umich.edu/projects/MosherJordan/index.html

1.2 University of Michigan: C.S. Mott Children's & Women's Hospitals Replacement Project
The C.S. Mott Children's & Women's Hospitals Replacement Project comprises of the new construction of a hospital that will hold the Women's and Children's departments. They currently are located in the main hospital here at the University of Michigan's Hospital. This expansion will allow for the pediatrics department to be located in the same area and also allowing for more space for each of these very important and critical departments. The construction started in October of 2006 and is scheduled to be completed in the fall of 2010 allowing for the building to be occupied and open by 2011. The construction budget is set at $523 million at this point. By moving these departments into the new facility, it will create an opportunity to renovate the current U of M Hospital where these departments are currently located. This new facility will be approximately 1.1 million gross square feet and will comprise of a 9 floor clinical building and a 12 floor inpatient building along with a mechanical penthouse for the mechanical equipment. For more detailed project information, you can visit the site listed below:

http://www.aec.bf.umich.edu/projects/ChildrensWomens/index.html

2.0 Activity Work Sequence Descriptions

2.1 Terrazzo Grinding/Floor Polishing
This construction activity was seen at the MOJO Renovation and New Dining Center Project at the University of Michigan. The new dining center will have multiple areas with a terrazzo floor. This grinding activity is done to grind the concrete type floor down to expose the aggregates below the surface for the final finished product.

The grinder is a large floor polishing type machine with diamond blades on it to grind away different depths of the floor to expose the aggregate. This is a very repetitive task and also required the worker to use an 8 to 10 gallon bucket. This bucket is used to scoop water from a large barrel and pour the water over the area to be ground. This adds a large lifting motion to the task and is a significant reason for the high score in the lifting portion of the analysis. The worker would then pour the water over the area and begin the repetitive motion of forward and backward grinding with the machine while also moving the machine in a small left to right motion as you would with a typical floor polisher. These motions are repeated throughout the entire workday depending on the current state of the project. This activity received a score of 25 according to the Workplace Risk Factor Checklist developed by OSHA.

2.2 Installing Suspended and Acoustical Ceiling Grid
This construction activity was seen at the MOJO Renovation and New Dining Center Project at the University of Michigan. The new ceiling was being installed in the dining center back in the kitchen area.

This activity first involved the worker using a nail gun above his head to insert the wire supports for the suspension portion of the ceiling grid. The worker would then use his hands as well as thick wire cutters to tie pieces of the support wire from these clips which would eventually be tied to the grid itself. The worker was working on stilts for the main portion of the work allowing him to move easier and quicker during the job. Once the support wires were installed, the worker was then able to begin to install the grid. This was comprised of using a level to ensure a level ceiling and also continuously bending

over and picking up pieces of the grid and then lifting them above his head while on a ladder to attaché the grid to the suspension wire above. This task was performed throughout the duration of the day. Because of the continuous work above his head and the continuous bending over and lifting the grid over his head, this task received a score of 20 according to the Workplace Risk Factor Checklist developed by OSHA.

2.3 Wiring

This construction activity was seen at the MOJO Renovation and New Dining Center Project at the University of Michigan. New electrical wiring is being installed throughout the entire building including the new dining center areas as well as the renovated hallways, rooms and bathrooms. This task consists of a worker being on its knees, grabbing the end of the wire and pulling it from the cable reel for as long as needed. The worker would then cut the cable whenever it was required. This is an extremely repetitive task given that the worker has to pull the wire consistently throughout the day. As the worker told us, depending on the size of the project, he might be on his knees pulling wire all day. If it is a smaller project, then he would do both the wire cutting as well as the installation. This very uncomfortable position causes knee bruises as well as back and neck pains. It also takes considerable amount of grabbing force to perform this task which the worker told us sometimes bruises his fingers.

This activity received a score of 20 according to the Workplace Risk Factor Checklist developed by OSHA.

2.4 Welding

This construction activity was seen at the *Mott Children's and Women's Hospital* construction project at the University of Michigan. The activity consists of using a welding torch to perform installation of steel connections as well as any additional cutting in the building's steel frame. In our specific activity the welder (wearing his safety equipment) would hold his hands above his waist while looking up to perform a steel cut. As the worker told us, depending on the type of work, he could be welding in the same position for hours or changing different positions throughout the day. The most common positions included welding on his knees, sitting down, standing up looking

down and standing up looking up. The worker agreed that he mostly had a sore neck from having it bent for too long while performing a cut.

This activity received a score of 1 according to the Workplace Risk Factor Checklist developed by OSHA which is very low. Nevertheless, this should not be considered a safe activity since several other factors can negatively affect the worker. He is more prone to receiving burns in his body as well as damage to his vision.

2.5 Tower Crane Operator

The crane operator is confined to a small space throughout the entire work day. He must climb up to the top of the tower in the morning and back down in the afternoon. The operator's main task is to lift heavy items such as structural steel, rebar, concrete buckets, and other objects too heavy or large to carry from one area of the site to another. The operator experiences very little down time during the work day. The operator sits in an enclosed cabin just below the boom where he operates the crane. The operator uses a combination of joysticks and buttons to control the crane. Because the crane boom is very high in the air, the operator cannot swing the boom quickly whether he is lifting an object or not. For one lift, the crane operator must lower the hook down to the ground where a worker attaches an object to the hook. The operator then lifts the object to a safe height. Then the operator can rotate the boom towards the destination. Once at the destination, the operator lowers the object where it is removed by another worker on the ground. Crane operation was observed at Mott's Children's Hospital.

This activity received a score of 6 according to the Workplace Risk Factor Checklist. The only points came from a repetitive motion for 4 to 8 hours a day in the hands and arms. Also being confined to a small space and sitting for almost 8 hours a day.

2.6 Backfill Compaction using a Plate Compactor

Backfill can be compacted by mechanical methods with rollers or hoe packs, however we observed workers using a plate compactor to compact sand. A loader would dump sand around the foundation walls which were being backfilled. The loader dumps 8-12 inches of sand and the workers helps even out the sand and cover the area with a shovel. Once the sand is relatively flat, the worker walks behind a plate compactor. He makes a circle around the area and slowly works his way in, making sure he compacts all of the surface area. The worker repeats this step going over each stop 5 to 6 times. A tester from an independent testing company tests the compaction percentage. If the percentage is high enough, usually 95%, compaction is done. If the compaction is not up to the standard, the worker must re-compact the sand. Backfill compaction was observed at Mott's Children's Hospital.

This activity received a score of 8 according to the Workplace Risk Factor Checklist. Contributing factors were primarily from repetitive motions and heavy vibrations.

2.7 Drywall Finishing

This construction activity was seen at the MOJO Renovation and New Dining Center Project at the University of Michigan. The plaster was being installed in a hallway on the second level of the dormitory.

This activity first involves the worker using a paint scraper above his head to smooth off the ceiling. The worker would then apply a basecoat of plaster to the ceiling. Next, the worker would switch to a twelve inch blade to smooth out the plaster. After letting the plaster set for a few hours, the worker would then come back and apply two finishing coats. This task was performed throughout the duration of the day. Because of the continuous work above his head and the continuous bending over and lifting of the plaster above his head, this task received a score of 23 according to the Workplace Risk Factor Checklist developed by OSHA.

2.8 Sawing wood for forms

This construction activity was seen at the MOJO Renovation and New Dining Center Project at the University of Michigan. The sawing was being performed in one of the rooms on the second level of the dormitory.

This activity was very repetitive and involves the worker using an electric saw to create the wood beams necessary for the formwork. The worker had the stack of wood next to the saw and was working continuously on his knees. After sawing the wood to specifications, he would then lift the wood and hand it to the worker installing the formwork. This task was performed for 1-2 hours at a time throughout the day. Because of the continuous work on his knees and the lifting of the boards above his head, this task received score of 20 according to the Workplace Risk Factor Checklist developed by OSHA.

3.0 Suggested Workplace Interventions and Feasibility Analysis for Specific Activities

Terrazzo Grinding

With an overall score of 25 from the Workplace Risk Factor Checklist developed by OSHA, this task is not ergonomically friendly to the worker. This task has great repetition involved and also involves a repetitive lifting of a water bucket throughout the course of the activity. This lifting is where most of the points are accumulated. This is a heavy lift (~50 pounds) and is done repeatedly throughout the work day. There are many workplace interventions that could help reduce the ergonomical risk involved.

One of the easiest fixes to the lifting issue would be to implement the use of a hose to spread the water about the site. This would then eliminate almost all lifting required for this task and would then greatly help reduce the risk. This seems to be a very feasible solution to this problem. There is almost always a reliable water source on every construction project and it would not take too much effort to supply a hose to the jobsite. Another possible workplace intervention would involve implementing a specific team of workers to carry out each separate task. One person in charge of the water, one in charge of the grinding, and another worker in charge of the squeegeeing of the water afterwards. This is only feasible if there are enough workers available and also if this doesn't raise the overall cost of the construction task to the point at which it is no longer profitable to perform this task. Along the same lines of this is to rotate the tasks that each worker performs throughout the day. This will allow the workers to not be exposed to certain risks for as long of duration as if they were to perform the risk for the entire day. This is also feasible if there is enough manpower available and also if the workers are able to perform different tasks at a high enough quality standards.

There are also other changes that could be implemented that don't actually change what the workers do. One of these changes would entail changing the design of the projects. This could entail specifying different floor coverings such as ceramic tile or carpet instead of terrazzo. This is always an option but it is up to the architects and owners to be aware of the construction process that each specification brings to the jobsite. Along the same lines would be a change in the technology or equipment that is used for the grinding process. If a machine is developed that could lessen the vibration, or automatically spread the water in the correct location, then why not use such a machine? This one machine could lessen the workforce required and also lessen the risk on each of the workers performing these tasks.

Any and all of these workplace interventions see to be feasible and some are more economical than others. If the employee wanted to make this task less harmful to its employees then it could rather easily and without too much of a financial burden.

Drywall Finishing

This task received a score of 23 according to the Workplace Risk Factor Checklist developed by OSHA. This score tells us that this task is unsafe for the workers who perform it. This task requires the worker to constantly bend over to pick up tape, plaster, or a sander. To lessen the amount of bending over, a simple stand or scaffold for the materials to be set on would allow the worker to bend over less. It is already hard enough for the worker to have to constantly work above his/her head for the duration of the day. This is a fairly feasible workplace intervention because it should take very little time and money to implement but at the same time will take away much of the risk involved in this task. Another great area of harm in this task is in the repetition of the sanding process to help finish the drywall after plastering and taping. If this task is being performed above the head, this can be a very daunting task. The use of an electrical sander would help take much of the repetition out of this task and would probably increase the production rate at the same time. The cost of the sander would obviously increase the overall cost of the task but at the same time you would be able to increase production rates and the machine sander would outlast the typical hand sander. This would then make this intervention more economical than the current methods. Along the same lines as an electric sander, devices that automatically roll tape and apply plaster could be used. With these devices, all the worker must do is raise or lower the device along the joint.

Yet again, you could also implement a rotation of workers which would allow the exposure of each worker to these harms to decrease. This would lessen the duration that each worker is doing each task. It is also feasible to let the worker work from a ladder instead of stilts. This would help lessen the continuous bending required for this task but would then take away from the current production rate. This would be the main reason for not taking away the stilts.

As seen from the terrazzo grinding activity, you could also change the design. Specifying an open ceiling or a suspended ceiling would take away the need for drywall finishing above your head. This is yet again a choice of the owner and/or architects in the design process. If the changes are made during the design process, you would then need to also see the score of the activity that would be replacing the other tasks. The lesser score would hopefully be the task that is chosen.

Management Solutions

Many of these changes that could be made need to come from the management side of the project. It seems that every task on a project is driven by the schedule. If management made deadlines that are more realistic and obtainable, then workers wouldn't be rushed to finish such tasks. Also, some of these tasks are done for the duration of a shift and this is due to the need to keep deadlines. If deadlines are easy to obtain, then workers may not need to perform such tasks for an entire shift but rather only portions of their shift thus lessening the exposure due to the duration of such a task. It is also the responsibility of the management to ensure that all workers have the proper equipment and tools to carry out each and every task to the best of their abilities. This

can make a large difference in the risk involved with each task if the proper tools are available to each worker.