

## **Can Ergonomics Effect Efficiency and Productivity in the Construction Industry—Is it a Fallacy?**

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### **Introduction**

The construction workforce in the United States has many obstacles to overcome, however one of the most prolific today is the aging workforce with few skilled tradesman entering the ranks.

Through extensive research and analysis of our construction book of business at CNA, we have gained a real understanding of jobsite ergonomic exposures, specific job tasks, and workforce limitations within the construction trades that impact productivity, efficiency, and risk factors.

This paper will focus on areas and the methods to enhance production, efficiency, and reduce risk factors on construction sites.

### **Aging Workforce**

America's workforce is changing. Baby boomers, defined as those born between 1946 and 1964 are now reaching the age where retirement is just around the corner and there are 79 million strong. The official retirement age of the first of these boomers is 2011.

What is the impact of aging on the construction industries health and safety? Addressing the health and safety means looking at the physical, psychosocial, and cognitive issues related to aging. The construction industry in the United States cannot continue to run their businesses as usual!

The number of workers age 45 and older has doubled since 1950. According to the AARP: the number of older persons (55 plus) in the labor force, which stood at about 18.2 million in 2000 is projected to rise to 25.2 million in 2008 and 31.9 million by 2025. The resulting increase is 38% over 10 years and 75% percent over the next 25 years.<sup>2</sup>

What is so significant about human aging and our bodies? As we age the following bodily changes and functions begin to occur:

- Loss of strength
- Loss of muscular flexibility
- Loss of joint range of motion
- Diminished postural steadiness
- Reduced grip strength
- Reduced blood flow and tactile feedback
- Reduced visual capacity
- Slowing of our mental processing

### Strength:

Loss of strength happens due to decreased muscle mass and diminished force capabilities of our muscles. The muscles take longer to respond to action and fatigues faster as we age. As muscles age, they begin to shrink and lose mass. The number and size of muscle fibers also decrease. It takes muscles longer to respond in our 50's than they did in our 20's. Heavy lifting and lowering, awkward positions and static postures are all risk factors for injuries in the construction industry. Task requiring grip force and exertion as well as repetitive task are more difficult with decreased strength and endurance.

Reduced grip strength goes along with reduced muscle and soft tissue capabilities. Hand grip strength decreases, making it more difficult to accomplish routine activities such as gripping and using tools, lifting and lowering, pushing and pulling tasks, as well as climbing ladders, scaffolding etc...

### Vision:

Vision is by far our most important sensory channel. We receive a wider range of information from light than all other senses combined. Approximately 90% of the information we learn in a lifetime enters through the eyes. A 60 year old person requires 2 to 3 times the amount of light as a 20 year old.

Normal age related changes in vision include impaired ability to adapt to changes in light levels, extreme sensitivity to glare, reduced visual acuity (ability to discern detail) and restricted field of vision and depth perception. Impaired depth perception may cause a person to perceive a shadow on the floor as a step or a hole and visual misinterpretation based on visual misinformation can severely impair an individual's ability to function safely in and around the jobsite.

Many contractors operate various vehicles such as lowboys, bottom dumps, tandem dumps as well as back hoes, blades, pans etc... Another important aspect involving the vision is night vision with many of the drivers operating during the over night hours. As we age the act of driving at night becomes more difficult and stressful. Drivers lose the advantage of color and contrast that is available during the day and depth perception and peripheral vision are also diminished. Pupils shrink and don't dilate as much in the dark as we age, preventing older drivers from focusing as easily as younger people. The aging cornea and lens in the eye become less clear as we age, causing glare and light scattering, which makes it harder to see objects on the roadway at night. So, we must be aware of these changes and make sure we have the best available lighting source specified for the vehicles to allow the drivers to have the best advantage of navigating the roads at night.

### Cognitive Ability:

Mental processing and reaction time become slower with age. This slowing of information processing speed actually begins in young adult hood (the late 20's) by the time people are 60 or older they will generally take longer to perform mental tasks. It is now thought by some experts that older adults do not lose mental competence; it simply takes them longer to process the necessary information. In addition to cognitive decline, slowed processing speed has also been linked to decline in motor function. So, older workers may have less dexterity and coordination than when they were younger. This is critical in the construction industry as the aging workforce carries out many highly skilled tasks where motor skills and dexterity are paramount in dealing with quality and productivity.

Currently in the United States there is a shortage of skilled construction workers which is preventing companies from adding to their staffs making it difficult for them to grow their operations. As a result, they are looking to fill these voids with workers over the age of fifty. The industry in general has begun an intense recruiting effort to fill the void. As companies hire workers over the age of 50 they must begin to understand how to accommodate the aging construction worker. This means changing how they have done business for the past fifty years, in other words not just stepping out of the box, but building a new box.

Some of the areas the construction industry must begin to understand are the inefficiencies and risk factors involved in proper staging and the amount of walking that is completed on the jobsites. Questions need to be asked, "Why do parts, materials, and tools have to go on the floor or ground?" "How many times does the average construction worker bend in a year?" How are we going to keep the aging worker productive and free from injury if we do not start questioning the day to day job task that have not been seriously questioned in forty years? These are difficult areas to affect change, but to remain competitive over the next 10 to 15 years the relationship between the functional capabilities of the older workers and the task performed in and around the jobsite must be designed to accommodate their capabilities. This will affect productivity, efficiency, and risk factors for all ages and genders.

## **CNA Research**

CNA completed extensive research on the construction trades which included roofers, electrical trades, mechanical, road & bridge builders, and general contractors. We completed essential job functions on each critical job within the various construction groups and analyzed the physical exposures for each one of those construction groups. In addition, we completed physical capacity testing of the employees to ascertain if they were capable of performing the essential function of the job task. Some of the areas that were tested included grip and pinch forces, push and pull forces, lifting from the floor to waist and waist to shoulder height, and range of motion. Once the testing was completed the test subjects were placed into job function classifications ranging from a level one which was sedentary to a level 6 which was extreme.

The essential functions of the job tasks were observed and collected by CNA ergonomists in the field with the physical capacity testing being completed by our nurse case manager RN's. The testing criteria was developed through a collaboration of the ergonomist and nurse case manager working together to match the job skills with a testing protocol.

During our research we found that only 42% of the groups tested were physically capable of completing their job tasks as required by the essential job functions. This research allowed us to have a much better understanding of the jobs and how they were carried out especially in relation to body movements and the awkward postures along with wasted motions during a particular job task.

### Productivity

We also conducted very careful studies on the productivity on the job site. Observations were completed of the job task and broken into productive and non-productive time. Productive time was considered to be actual direct installation of a material, parts fixtures etc..., on-site prefabrication operations, and any type of testing operations.

Non-productive time was classified as in-direct operations which included talking about a job, setting up the operations, receiving instructions on the job task, planning the job, and getting out, putting up and setting up tools. Observations on the previous area of getting out and putting up tools are especially revealing. There is a tremendous amount of wasted time by high paid journeyman walking to and from the toolbox throughout the work day.

Material handling is another non-productive area where materials are unloaded from trucks coming from a vendor or the contractors own shop. Materials are pushed, pulled and hoisted to staging points in the laydown yards or in a building being constructed. It was observed that approximately twenty to twenty-five percent of the time a worker is completing some type of manual material handling function.

There was another category we used as non-productive which was in-effective use of time. This area involved late starts and early finishes, early lunches and late returns from lunch. Our observations of the lunch hour was particularly revealing in many cases with the actual foreman leading his crew to lunch as much as ten minutes early and returning fifteen minutes after the designated return time. This area was also fascinating from a superintendent and above level as they perceived the lunch breaks were being properly observed, however we found that superintendents are pulled in many directions and very seldom actually observed crews leaving and coming back from lunch. The last area to be mentioned here is essential, but our observations indicated that there was a tremendous amount of wasted time ~ going to the potty! Workers ran into many different obstacles such as having the potties only on the ground floor and having to wait for man lifts to get down and back up. Once on the ground many times the potties were located away from the building sites. This is also a time workers visit with fellow workers on events, ball games etc... In several observations it took workers as long as thirty minutes to go round trip to the potty and this was usually completed three times a day. On one jobsite where the contractor was on the job over a year calculations indicated that it cost \$35,000 for his crew to walk back and forth to the rest room.

## Opportunity

### Our Focus

From our research and extensive observations in the field we developed three areas of focus which we concluded could impact the ergonomic risk factors and enhance the productivity and efficiency of our insured's operations.

- Staging Areas
- Manual Material Handling
- Work Method Techniques

### Staging

In regards to staging there is a reoccurring theme whether it was in the shop, laydown yard, or installation staging point and that was the amount of walking and handling of the materials that was carried out.

There were several areas in regards to the staging area that were focused on. First was the warehouse or shop and how the materials were staged to go out to the jobsite in relation to how many times the material, equipment, and tools are actually touched, how they are physically moved and where are they staged in relation to the truck or trailer taking them to the jobsite. We have been able to effectively rearrange several shops to reduce the walking making loading more efficient and number of times the material must be handled, thus reducing the risk factors and improving productivity.

Where is the laydown yard in relation to the jobsite? The laydown yard can be located a short distance or in some cases up to a mile from the jobsite. Working as a subcontractor have you challenged the General Contractor on where you are to be located in the front or back of the laydown yard. Who is allowed to go to the laydown yard and trailer? Are all the employees allowed to go or is their a designated group or material handler?

While the material is in the laydown yard is it staged on the ground? If it is on pallets then in most cases it is considered to be on the ground. Using extra pallets can easily address this issue. Strap three pallets together and use them as the base to place the material pallet, thus staging the material off the ground. This is most affective on material that can be handled by the human. If it is too awkward or is too heavy for a man to handle it does not make any difference since a machine will most likely handle the material.

Once the material gets to the installation point where is it staged in regards to the actual installation? A good rule of thumb is to have the material within twenty-five feet of the installation point. We realize that in many cases this is not feasible because of various issues of configuration, too many trades in the same general area, etc... In these cases try to stage the material as close as feasibly possible. In the studies we completed there is the potential to save thousands of dollars in cost associated with walking. The same concept should be used as in the previous paragraph in regards to getting the material off the floor or ground. During our observations many foreman would indicate there is not enough room to get the material off the ground. In many cases the material would be on pallets on the ground. By raising the pallet it does not take up anymore space.

Another area to consider when you are thinking about staging concerns the job box or tool box. Where is it located in relation to the installation point? How far do the workers have to walk to get to the job box? The job box should be kept within fifty feet of the installation point. There is a tremendous amount of wasted time with journeyman and apprentices walking back and forth to the job box.

### Manual Material Handling

How much manual carrying of materials and tools are completed on your jobsite? Do you have the correct type of equipment available on the job to move the material or tools? Foreman should not be given an option if they want pallet jacks, carts, pipe movers, lifts, or two wheelers. The question to the foreman is how many of each type equipment do you need and what stage of the project do you need it.

Many times on a job the General Contractor dictates where material must be off loaded or restricts the off loading to a specific area. If you have a job where there are no restrictions then working with your vendors or your own shop becomes critical on where the material may be off loaded. You want to reduce the amount of hands touching the material and get it delivered as close to your installation point as possible.

If the volume of materials that you purchase from a vendor is high enough you may want to approach them about their employee delivering to your installation point; same holds true when working with your own shop. Can the materials be handled by the delivery employee, thus keeping your hands on the job completing their task and not handling material? We realize we cannot totally eliminate material handling on a jobsite; however what percentage of the material handling on the job can you reduce? Each job will vary, but our observations and studies conclude that there are opportunities at some point on each job to reduce the manual handling of the tools, materials, or equipment.

### Work Method Techniques

There are too many work method techniques to review all of them in this paper, however we will explore a couple of techniques that can increase productivity and reduce risk factors. The first one we are going to discuss involves ladders. Ladders are used and abused on most jobs and it is a tool that most foremen do not correlate as affecting efficiency, productivity, or risk factors.

There is little pre-planning with the human interface completed in relation to ladders. Do we have the correct height ladder for the job task? Observations indicated that on a regular basis workers would use the wrong size ladder creating excessive reaching or overhead work. It is understood that ladders do create working overhead and reaching. Do they have to be at the extremes because the ladder is too short for the job task?

Another issue observed in our studies was the worker would position themselves on the ladder where the reaches and postures were extreme, however by going up one more step it placed the worker in a better posture which would be less fatiguing and stressful. Inquiries to workers on why they did not go up the next step indicated they had always worked in that posture or they did not know why they did not go up another step. In cases where the questions were asked the employee had good head clearance and would never have to get up on the top rung of the ladder.

The last discussion point for the ladders involves working in a static twisted posture. Far too many job tasks facilitate the worker to be placed into this static twisted posture. This posture dramatically affects productivity as it is highly fatiguing to be in this posture the greater portion of the work day. In addition, it is a risk factor that can lead to the development of low back pain.

The solution to this highly fatiguing poor body posture is the use of platform ladders. Using platform ladders allows the worker to turn their feet and place the back into a neutral posture reducing the risk factors and fatigue level of the employee. We are not advocating doing away with the standard ladders, but there are job tasks where this type ladder is ideally suited. So, what percentage of the time could you utilize this type ladder? The anecdotal feedback from the workers is overwhelmingly positive that they could feel a difference in their fatigue level and completed job tasks quicker by using these ladders. They do come in various heights so they could be used in different applications.

Why do workers have to work on the ground or floor? During our observations of workers it was incredible the amount of work that was carried out on the floor. Invariably, chop saws were placed on the ground to cut various types of pipe and conduit placing the worker in poor postures on their knees or bending over. Other observations were of workers reading blueprints on the floor, assembling parts on the floor, and hand crafting various types of air conditioning and duct work. In each one of these activities it was affecting the efficiency and productivity, along with increasing risk factors to the back, knees, arms, and shoulders.

A solution to these poor postures and inefficient work techniques is providing rolling work tables that can be moved with the crew. These tables can accommodate materials and equipment to carry out the job task. The work tables can be various sizes depending on the needs of the job. These work tables are designed with roller bearing wheels, minimum of six inch wheels, lock down stops, and working heights of 42 to 44 inches. In our studies the foreman were not given an option if they wanted a work table. They are asked how many do you need and what stage of the job do you need them? Utilizing a work table of this nature puts the worker in a more neutral posture reducing the many risk factors associated with working on the floor and enhances the efficiency and productivity of the individual worker.

## **Summary**

In summary look at the age of your workforce and profile the future to see if you are going to have the skill sets at all levels to maintain your workload and profitability. Creating a competitive advantage requires you to make your business operations more efficient and reduce risk factors that facilitate injuries. A systematic process such as Motion is Money that measures performance against established criteria or best practices is the best method to improve bottom-line profitability.

## **Bibliography**

Wright, U – “Aging American Workforce.” *Ergo Solution Magazine*. October 2004

Gaither, A – “Health and Safety in the Aging Workforce” *ASSE Professional Development Conference Session 524*

Bade, S – “Ergonomics for the Aging Population” Applied Ergonomic Conference. March 2006