

SESSION 3: CONTROLLING MSDS AND SOFT TISSUE INJURY RISK FACTORS

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Laborers Health and Safety Fund of North America (A Joint Labor-Management Fund)

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Doyle & Gibbons, Salem, Oregon

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John Rosecrance, Assistant Professor
Department of Occupational and Environmental Health, University of Iowa, Iowa City, IA

[Please note: The following presentation summaries are transcriptions from the 2-day meeting. These transcriptions have been edited and reworded for clarity of meaning. The presentations, including questions and answers, are included in the proceeding as documentation of the meeting. The content, however, might not reflect current NIOSH policy or endorsement.]

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SESSION 3: PRESENTATION 3-1 THE HIERARCHY OF CONTROLS FOR ERGONOMIC SOLUTIONS IN CONSTRUCTION

Scott Schneider, *Director of Health and Safety*
Laborers Health and Safety Fund of North America (A Joint Labor-Management Fund)

Many exciting things are going on in construction ergonomics, and we need to figure out ways to make them widely available.

These things are not necessarily new. Maybe what's new is how we now think about these controls systematically. We use these ideas in training. We ask, "What's an engineering control; what's an administrative control we could use for this job?" We walk people through it, and it expands their horizons. When before, they were thinking, "There is nothing you can do about it," or, "We will just give the guy some kneepads." If you go through the hierarchy of controls, you can get people thinking.

The types of controls we use are the following:

- Eliminating or substituting the process
- Ergonomically-designed tools
- Changes in work practices
- Administrative controls
- Personal protective equipment (PPE)
- Training
- Stretching*

This is the classification we have been using, and I'll talk about each of these.

The best solution is to eliminate exposure to the risk factors. However, that may mean eliminating jobs because you mechanize, and now you have only one person, where before you had five. Sometimes you can do a process change that makes the job easier by doing it differently.

We've heard some examples here today. Prefabrication is an example. Another example occurred on the Central Artery project in Boston, on which Mark Noll was working. The workers were drilling overhead to put in a dropped ceiling and had to drill hundreds of holes overhead. They decided that on the next tunnel, the hangers would be built into the pour. They saved thousands of hours of overhead drilling. Tony Barsotti was talking about the same thing at Intel, where they are making process changes.

To reduce or eliminate material handling, you can plan where materials are to be used, where they will be delivered, and how they are going to be stored. We saw this earlier today with pipe racks (e.g., storing pipe at waist height).

*The effectiveness of stretching exercises in preventing injuries from work has not been proven. For more information on this topic, see Hess et al., 2003.

Mechanization Using Carts, Dollies, or Cranes: These three trades (electrical, plumbing and pipefitting, and sheet metal) are usually working in a building that is finished, and you have flat surfaces on which to roll carts and dollies.

New Materials That Are Easier to Handle: You can use fiberglass, instead of wooden ladders.

Suggestions from audience: (1) Aluminum handles for pipe wrenches; (2) lightweight concrete blocks; (3) fiberglass conduit, rather than aluminum or galvanized; (4) anti-vibratory plastic hammers, instead of sledgehammers.

Power Tool Instead of a Hand Tool: As batteries get lighter, smaller, and stronger, it is easier to switch to power tools. Using scissor lifts for overhead work is becoming much more common. Workers can substitute powered or cordless screw guns, instead of hand-cranking (Figure 3-1.1). These tools are very inexpensive now. It does not change the skill of the job; it just makes it easier. Five or ten years ago, these tools were not being used. When they became less expensive, they became more widely used in the industry.



Figure 3-1.1 Substitute powered/cordless screw-guns

Ergonomically Designed Tools: Tools are now designed to require less force. They reduce awkward postures, and you can work from standing height (e.g., in roofing for putting decking together, or for rebar tying). Some tools reduce overhead reach, such as extenders for drilling. The tools reduce contact stress, so they are more comfortable for your hand. Sit-stand stools can be used for welding. If you are welding in one posture all day, there are static posture issues.

Handles: Handles can be added for carrying materials. Many handles are available for carrying drywall, particleboard, plywood, or sheet metal. Generally, they are not that expensive. Sometimes there is a premium for ergonomically designed tools, but they are not that much more expensive. If they are relatively inexpensive, and they are easy to use, they are going to become very popular. Figure 3-1.2 shows a pipe wrench with an ergonomically designed handle.

Figure 3-1.3 shows magnetic sheet lifters for moving sheet metal. The worker can attach the lifter and carry the sheet metal much more easily.



Figure 3-1.2 Ergonomically designed wrench

Work Practice Changes: Bring things up to waist height on worktables. Learn from experienced workers. They have figured out easier, smarter ways to do things, and they can transfer those skills and knowledge to younger workers.

Make Administrative Changes: Administrative changes include job rotation, rest breaks, and special instructions for handling heavy objects.

For example, I fly a lot and see these tags to put on bags, which tell airline personnel—This is a heavy bag. At least the tag warns somebody before they lift it. In some cases, the weight is written on it. Figure 3-1.4 shows an example of an airline baggage warning tag.

When we make sheet metal ductwork, it comes from the shop with a label that tells dimensions and gauge, and where it is supposed to go. Can we not also program that computer to spit out the weight and put that on the label, as well? I do not know if anybody's tried that. In Holland,

they use a system with glasswork, where the pieces are labeled with the weight and a sticker, either green or red. If it is less than 20 kg (44 lb), it has a green sticker, meaning the worker can lift it by himself. If it is red, he needs to get help. Another administrative control is a weight limit. We have heard somewhere in the range of 35-50 lbs, depending upon the amount and awkwardness of the lifting being done. This is a useful intervention. A number of companies do this, and it has had a big impact.

Personal Protective Equipment (PPE): There is a lot of kneeling involved in several of the trades. The new kneepads are much more comfortable and easier to use than older versions.

Kneepad pants have a pocket in the pants leg for the pads. They are not very expensive and work pretty well. Figure 3-1.5 shows a picture of Snickers kneepad pants. Shoulder pads are available for carrying materials on the shoulders. Shoulders are a nice way to carry things, because the



Figure 3-1.3 Magnetic sheet lifters



Figure 3-1.4 Airline baggage warning tag

object is closer to your center of gravity. Unfortunately, the worker does not have a lot of padding there, and can get contact stresses. The shoulder pad is a simple intervention (Figure 3-1.6).

Neck pillows attached to suspenders are used in Europe for people doing overhead work. They are similar to the pillows people use when flying, to lean against to sleep. Neck pillows are not used in the United States.

Standing on concrete for more than three hours a day is harmful for a worker's back. Some interventions are matting, which is used on the Intel job site, or shoe inserts (Figure 3-1.7). We do not recommend back belts, because there is no evidence to show they prevent injuries.

Training: We have developed programs for the laborers. I worked on a program several years ago for the building trades, which is available to all of the appren-

ticeship schools for all 14 trades. Training programs are generally awareness programs, to make people aware of what the risk factors are—the hazardous tasks. We encourage people to brainstorm about how to make the job easier, and what solutions already exist. They can do a lot of sharing.

We prioritize the solutions: We ask which would give us the most bang for the buck, which would be easiest to implement, which ones are simple to do with materials here on the site, and which ones are harder to get going?

How then do we evaluate these solutions to see if they are really helpful or not? That is the area where we are lacking. We need to see which solutions are best and then publicize that information. NIOSH wants to do with that with the control technology assistance for the construction industry project.



Figure 3-1.5 Snickers kneepad pants



Figure 3-1.6 Shoulderguard for carrying

Stretching exercises are becoming very popular.** They have been popular in the northwest for years. Ten years ago (1992), Brian Clark at Hoffman published a magazine article about people at a Hoffman site doing stretching exercises. I called Brian, and that is how we got started on this Intel project. Hoffman has been doing stretching exercises for a long time, and the workers there like it.

On one project, Hoffman estimated that the cost of having the whole crew stretch for 10 minutes a day would be \$2 million over the life of the project, but the owner believed it would have a big payback. Steve Hecker has done work on the impact of stretching programs [2001]. I think stretching is probably helpful, but it is no 'silver bullet,' and not the same as making ergonomic changes—but I think it helps. Figure 3-1.8 shows a work crew performing stretching exercises.

Questions from Presentation 3-1

Question for Scott Schneider: You said back belts were not helpful. I think you're referring to the NIOSH study showing there's no evidence. I think there's continued work in that area, so I don't think the final chapter is written. You talked about kneepads, shoulder pads, neck pillows, and shoe inserts. Can you cite published literature that shows that those do have benefit, or are you just using some sense and your experience?

Answer: There's published literature that shows that matting—not necessarily shoe inserts—will reduce your risk of back problems. For the other ones, what we do know is that they reduce contact stress, whereas back belts don't do that. Back problems are not a contact stress injury.

I've thought about what evidence you would need to show that a kneepad will



Figure 3-1.7 Shoe inserts



Figure 3-1.8 Work crew performing stretching exercises

**The effectiveness of stretching exercises in preventing injuries from work has not been proven. For more information on this topic, see Hess et al., 2003.

reduce your risk of knee injury. NIOSH was looking at this problem, but the man who was looking at it, Dr. Tanaka, retired. In terms of shoulder problems, I don't think we need a \$50,000 study to show that shoulder pads are helpful. They reduce contact stresses, and it is not an expensive intervention. I guess you could argue that if it gives people a false sense of security, they'll carry more, but I feel comfortable recommending shoulder pads even though there aren't randomized, controlled studies to back up the effectiveness of their use.

Question for Scott Schneider: I wanted to pursue the point about training and see if you were aware of any follow-up studies that show any real benefit. There's a long history of training programs in the building trades that tell people to bend their knees and keep their backs straight, and nobody pays attention and they go back to working the way they have to, or are used to doing. Are there any actual outcome studies showing any effectiveness of training?

Answer: There's been a lot of research on the effectiveness of occupational health and safety training, though not specifically on ergonomics. There is a very good review of the literature published by NIOSH [Cohan and Colligan 1999] about four years ago. Alex Cohen and Mike Colligan looked at all the studies on the effectiveness of safety and health training, and they did include ergonomics, though it wasn't in the building trades. I think the training programs in the building trades act more as an awareness mechanism, because the workers by and large do not have a lot of control over their own jobs. They do have some control, but we are really focusing more now on supervisor and foreman training, in terms of actually making changes.

Rod Wolford and Marilyn Larson did a study looking at the effectiveness of training on health and safety for the painters union in Alaska, Washington, and Oregon [Wolford et al. 1997]. They did find a positive impact, but the NIOSH report is comprehensive.

SESSION 3: PRESENTATION 3-2 DEVELOPING ERGONOMIC INTERVENTIONS IN CONSTRUCTION

Billy Gibbons, Ergonomist
Doyle & Gibbons, Salem, Oregon

I'll start with a "pet peeve." One of the reasons we have such a hard time getting people on the ergonomics "bandwagon" is that just the word, "ergonomics" (if they even know what it means or have had some history with it) leaves a "bad taste in their mouths." We have to own some of that responsibility. When we call things ergonomic disorders, ergonomic injuries, ergonomic risk factors—there are no such things. If you subscribe to the camp that I subscribe to, "ergonomics" is the solution. It is *not* the problem. We should talk about ergonomic principles, ergonomic interventions, ergonomic applications, and ergonomic design; then, we can "turn the tide."

Ergonomics looks at all of the factors in the workplace. People want to know engineering solutions. Ira asked about the effectiveness of training. These things do not stand alone. Training, engineering—all of these things that ergonomics looks at have to stand together. Training is just helping to establish a baseline on which you can get people speaking the same language, so that you can then do the real work of intervention. With just training itself, you may not get anything. Engineering—I know a company that spent \$25,000 on an intervention that nobody would touch, because of the process they used to develop it. So, ergonomics looks at all of these factors in the workplace—layout of the work,

housekeeping, tools and equipment, specific work methods, and pace of the work. We also can't ever under-estimate the importance of the design of the structure the worker is putting together. We are barely scratching the surface of the role of architects, engineers, and designers in constructibility.

Figure 3-2.1 shows an electrician's tool bucket on wheels. At the Hanford Hotel, where we are staying, there is a general contractor who is just finishing construction there. He had a tool bucket. It was really a cart, a big plastic storage container.

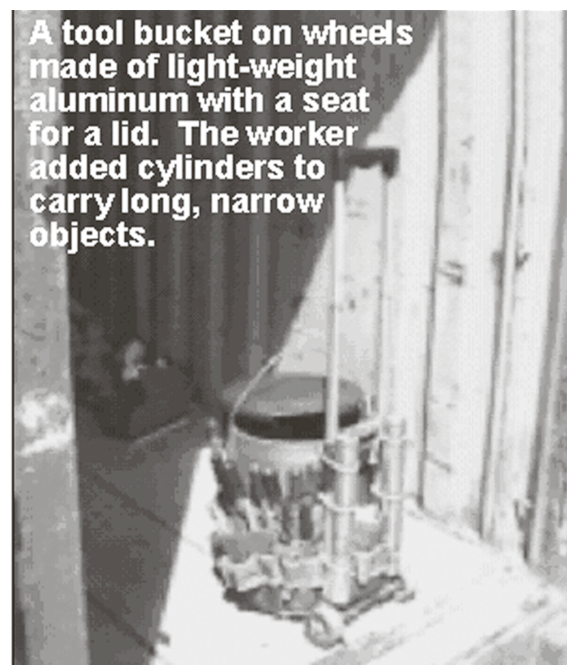


Figure 3-2.1 Tool bucket on wheels

The toolbox lifted off at the top, which was the lid, and it was on wheels on the back. If you pulled out this handle and lifted up, the entire tool chest moved on wheels. The general contractor purchased it at Home Depot, which is also where this one was purchased. If you are doing outlets or something below waist height, you can sit on it. This particular electrician attached these cylinders to hold things that are long and narrow.

Concepts I'd like to discuss:

1. **Involve People in the Work.**
2. **Develop in Real Time:** That means you cannot go off-line for three or four days and go do some interesting research. You have to respond and maintain the interest of the people who are going to give you the solutions, which are the craft people and the people in the field. Get back to them, keep them notified of the progress you are making, ask them, run suggestions by them, operate in very real time. Your interventions, if you are operating on a project—just right here, right now, walking through and looking at risk factors and trying to solve problems—you have got to operate like this (snaps fingers).
3. **Think Outside the Box:** You must think outside of your trade, your industry, and your region. Share and disseminate information.

In the upper right-hand corner there is a screw gun extension for carpenters' to use if they are doing form work (*slide not*

available). A carpenter developed this tool. The electrical application would be a drill overhead. I see these more and more, where you can set them up like a reverse drill press on a scissor lift or a platform that drills up, so you do not have to hold it up here.

4. **Look Upstream Before Looking Downstream:** It “cracks me up” that we are so focused on the behavior of workers. What would be more difficult—developing a jig (or fixture) or changing somebody's behavior? When was the last time you altered somebody's behavior? That is a complex undertaking. But being creative and innovative, getting people to put their ideas together and come up with a solution, that is easy stuff. We need to shift away from “what they are doing right here, right now,” to upstream planning and development.

Figure 3-2.2 is a picture of modularizing sheet rock, an upstream idea. These people went to 2 x 8's; usually it is 4 x 12's.



Figure 3-2.2. Modularizing sheet rock

They modularized it and eliminated all the material handling, except for what goes on in the shop where they put the modules together. Now, they just hang them with cranes, and it is all brought in on a flatbed.

5. **Look into Resources—Vendor Resources:** Supply houses may have things on the market that you have not seen. “Cruise” through hardware stores, home improvement stores, and material handling companies. Tony and I called a material handling company about a particular problem. They prototyped us something, and then came out and helped us solve our problem.

Go outside the work environment entirely. We have gotten some “cool” grips in bicycle shops. For painting 14 feet overhead, you might come up with a flag holder.

I would like to leave you with a challenge. We are at various stages of dealing with this issue. In some states we are in a compliance mode, or are reacting to injuries and trying to figure out what to do next. Some of us are in a prevention mode. However, we are not going to get any dramatic solutions until we move away from prevention to a mindset of innovation—creating environments where people work to create and innovate. For example, someone was trying to figure out how to build a building 25% faster. You will not get improvements in productivity or quality by asking a construction worker to hammer 25% faster or to cut sheet metal 25% faster. Innovation and, likewise, innovation in ergonomics will come upstream: how we look at our work, plan our work, and design our work in different ways. We must have cultures that innovate.

You have to be careful about what your people create. They are installing these panels overhead (*picture not available*), so they put very lightweight poles in the corner of each scissor lift that are spring loaded. They have a cushion that goes across this 2 x 4, so as not to dent the sheet metal. There are really two things: there is this part that raises the panel up and holds it against the ceiling so that you eliminate overhead lifting, and there is this bit extension, which was welded onto the end of the extension here, so that it can be held here and eliminate this. Now you can purchase these things, but at the time this was done, you couldn’t find this bit extension. The workers had to put a sleeve over the top of it to keep it from spinning in their hands.

Here are some great material-handling devices (*picture not available*). The workers are using this Genie lift to hold ductwork in place, so they will not only install it with the lift, but work on it when it is on the lift. They do not have to work on the ground. It is a work platform. Here is a modification to keep it from rolling.

This is a fitter intervention (*picture not available*). The worker is holding a pipe reamer; he had to ream several thousand pieces of this polyvinylchloride (PVC) pipe. We had deviation, so this is what they whipped up: a drill bit. This is a whole classification of ergonomics interventions—anything you can attach to a drill. The workers had a coupler that bolted onto the drill, which fit the size of the PVC pipe. They took the pipe reamer and a pipe stand and bolted it down here. Did it reduce the number of times they had to do this? No, but it certainly made their work much easier. They were incredibly proud of this intervention.

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SESSION 3: PRESENTATION 3-3 DEVELOPING AND IMPLEMENTING ERGONOMIC INTERVENTIONS

John Rosecrance, Assistant Professor
Department of Occupational and Environmental Health, University of Iowa
Iowa City, IA

As distinct from Scott Schneider's hierarchy of interventions [1995], we can also look at interventions in terms of who implements them.

In a meeting six or seven years ago, Scott Schneider, Billy Gibbons, Steve Hecker, and others in this room came up with these five levels of intervention implementation:

1. Workers can develop ergonomic interventions and implement them. This is a very important intervention level. As Billy Gibbons demonstrated, there are many homemade ergonomic interventions out there—very wise and clever methods of making work easier and, in many cases, more efficient.
2. Local Unions develop ergonomic interventions through training and education. This is a great “road” for facilitating awareness of health and safety issues and ergonomic intervention.
3. Contractors, subcontractors, or employers have responsibility. Streimer Sheet Metal in Portland, Oregon, is a great example of a contractor that has been actively implementing ergonomic interventions for years.
4. Owners share responsibility. For example, Intel Corporation has estab-

lished a health and safety culture, and they demand this from their subcontractors.

5. Manufacturers of equipment and tools also have a role in designing ergonomic products and can facilitate the implementation process.

What about the effectiveness of these interventions? Many interventions are an obvious benefit, and we do not have to study or spend \$50,000 to determine if they are effective. However, there is also a need to determine effectiveness. For example, what is an ergonomic chair, an ergonomic keyboard, or an ergonomic wrist rest? How do they get that name? From marketing? You cannot buy a chair anymore that is not an ergonomically designed chair. You perhaps can't buy a hand tool or a car that is not ergonomically designed. We are working with tool manufacturers now to determine the ergonomic effectiveness of tools that are ergonomically designed. We are currently conducting research studies in our labs and in the field to evaluate new designs in hand tools.

Bricklaying is one of the oldest trades on earth. We are investigating the effectiveness of lightweight block vs. heavyweight block on the muscle activity in the low back and arms. It seems like common

sense that if it has the same structural qualities, a lightweight block will be easier to lay than a heavyweight block, especially for masons, but certainly for the laborers who keep these people stocked up with these blocks. But perhaps it is not better ergonomically. Perhaps if a masonry block is lighter in weight, the worker will have to move more blocks, so repetition goes up.

As you can see in Figure 3-3.1, we attach electrodes to the body to measure the muscle activity in the back and forearms. We are looking at other trades and working with tool manufacturers.

We just completed data collection on different designs of tin snips. Rather than say that these are ergonomically designed, we are looking at changes in grip force, and how the tool is used, and whether there are more or fewer deviations of the wrist, and whether or not it is more comfortable. We are working with Midwest Tool to determine the effectiveness of ergonomically designed hand tools for the construction trades.



Figure 3-3.1. Measuring muscle activity

We are investigating the muscle activity of the finger flexors, finger extensors, and shoulders during tin snips use. We recruit workers to cut sheet metal with different types of tin snips, both at waist level and at shoulder level. We take measurements of muscle activity when a worker is using the old and the new tool, and then again using the old tool and the new. This type of research allows us to quantify the effectiveness of the ergonomic intervention.

It is important that we do not blindly accept the manufacturers' claims that these tools are ergonomically designed. We should continue to do evaluation studies. The NIOSH has a book called *Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries—How to Show Whether a Safety Intervention Really Works* [2001]. It is important that this type of research is conducted.

Questions from Presentation 3-3

Question for John Rosecrance: Are there any results of your studies?

Answer: I have the results on the tin snips—the ones we were looking at most critically. They are bent at 90 degrees and there's less muscle force used. We thought the workers would use them upright. They chose to use them upside down, even at shoulder height. What we found is that there's less EMG [electromyogram] or muscle force in the low position, but more in the upper position. But, they prefer those in terms of how they rated them to others, although more force in the finger flexors was required.

Question for John Rosecrance: Are the results of the block study available?

Answer: We just finished data collection two weeks ago, so they're not ready yet.

Comment (Peter Vi): A comment about the lightweight blocks: I've asked a lot of architects whether they would prefer to use a lightweight block, and they say that it takes too much paint, so the cost would go up. The material is too porous, so the texture is not as nice as the heavier blocks. The cost is very high, so the owner doesn't want to use them. Those blocks aren't used too much, and there is a lot of negativity about them.

Comment (John Rosecrance): That may be different in different parts of the country. In Michigan, architects prefer light-weight blocks, and they find them cheaper, although they are more porous. They typically use a standard block for the foundation and the lightweight blocks when they build up, because they don't have the problems with water. But, they are finding they can lay the lightweight blocks much faster, so they're building into their bids those offsets in price. They think it washes out—there is no cost savings either way—but they think it may be easier on the laborers who have to handle the blocks.

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