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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Application of Industrial Engineering Techniques to Reduce Workers' Compensation and Environmental Costs - Deliverable E

U.S. DEPARTMENT OF THE NAVY
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NAVAL SURFACE WARFARE CENTER

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DELIVERABLE E

STEEL ERECTION

SUMMARY

Steel erection encompasses all of the on-board construction of the ships. This area is responsible for the erection of fabricated units from the on-block assembly area. Due to the nature of work in this area, there is variety of trades involved in the on-board erection process. The trades assigned to this department are, Shipwrights, Shipfitters, Pipe welders, Line-heaters, Layout W&O and P&S, Fire watches, Code Welders, Welders, Chipper, and Burners. Other activities such as launching are also included in their processes.

Since 1995, the steel department has cost NASSCO the most money in regard to workers compensation costs. Of all reported workers' compensation injuries, back injuries were the most expensive injury. Steel erection costs for workers' compensation for back injuries totaled $1.4 million during a two year (1995 & 1996) time-frame. Because shipfitters and welders are the most numerous of the trades represented in the steel erection group, they had the most back injuries and were selected for study.

The nature of work required for Shipfitters and welders, such as cutting, grinding, lifting strongbacks, lifting turnbuckles and ripout of shipboard structures, was the major cause of injuries for these trades. Additional job duties include repetitive or prolonged bending, stooping, kneeling, squatting, climbing, lifting of welding equipment, handling pipe, carrying equipment, and lifting from fifty (50) to seventy (70) pounds in awkward, contorted positions.

In 1996, NASSCO instituted measures that changed work processes and procedures. These measures increased productivity, and increased safety awareness. During this time, NASSCO instituted a stretching program throughout the shipyard that began to gradually decrease injuries and increase employee awareness of safety in steel erection for 1995/96. The steel erection back injury rate was at 40.2% in 1996. In 1997 the rate was at 15.3%. Currently the rate is at 11.5%.

In 1997, steel erection began to realize injury and cost reductions, due primarily to the stretching program, increased education and training on back injuries. Additionally, steel erection witnessed cost and injury reductions in part, because of the process improvement team efforts. Saving estimates for 1997 and 1998 are based on page 18-see below. The 1998 savings and rate projections are based on annualized figures of five months. **(Figure 1.)**

PARTICIPANTS

Due to injuries and the tremendous amount of money spent each year on workers' compensation costs, Bob Hillstrom, Steel Erection Manager assembled a process improvement team to help reduce injuries. IN order to get honest and unbiased opinions from the team members, it was decided to leave supervision off the team. The steel erection team consisted of only hourly employees.

During the first meeting, Bob reviewed such information such as, safety statistics, NASSCO safety record, safety costs. It was explained to each member of the team why they were selected. Bob explained to the project engineer and team facilitator, that he would give clarification and /or understanding of any suggestions or terminology, made by the team. Andre Dorais, facilitator, from the training department suggested the following guidelines for the team: **(1) Identify Problem, (2) Charter- what are we doing here?? define mission, (3) Identify roles of each team participant.** Each team member had the option of resigning from the team if he was uncomfortable in this role.

Each team member was selected because of skill level, length of time in the trade, evidence of being a team player, and have a good reputation with co-workers. Another important aspect, was that they had the respect of their co-workers regarding their communication and trade knowledge. The members were also selected because of their dedication to safety and their total personal safety record.

After preliminary information was disseminated to the group, the team charter was distributed and discussed.

TEAM CHARTER

Review injury and workers' compensation data for 1995 through present, select one injury type (body part) which consistently reoccurs, causes pain and suffering to employees and has a significant cost impact on the company, analyze the causes of the injury chosen, support and assist in the implementation of your recommendations with co-workers.

TEAM PARTICIPANTS

Name	Position	Work Area
Pete Castro	Shipfitter	Steel Erection
Louis Fraire	Shipfitter	Steel Erection
Carlos Castro	Shipfitter	Steel Erection
Stanley Szumilas	Welder	Steel Erection
German Magadia	Welder	Steel Erection
Ernie Alvarado	Shipwright	Steel Erection
Andre Dorais	Facilitator	Paint & Blast / General Services
Bob Hillstrom	Manager	Steel Erection
Tony Walsh	Design Engineer	Engineering
Freddie Hogan	Project Engineer	Human Resources

BACKGROUND

Because these team members were from the production areas,and had not recieved any formal training in team interaction, the facilitator decided to teach team building skills. Early evidence of this lack of training, was when ideas were generated, other team members began to add input without documenting ideas. During the early meetings, the facilitator closely monitored the comments, ideas, suggestions, and feedback to keep the team members on track. Each week, the team members rotated team positions such as, timekeeper, team leader, and scribe in order to experience the whole team building concept.

After a couple of months, the team members gradually the skills of team building. The team members met once a week so they would not get discouraged, but get accustomed to the idea of meeting regularly. An agenda was set up prior to the meeting, so that each member knew what was to be discussed during the meeting and therefore came prepared if they had assignments. During the early meetings, the team performed weighted voting of ideas to narrow the field of ideas into a manageable categories. Video presentations were presented that demonstrated learning points such as: cause/effect diagrams elements, steps in creating diagrams, how teams work together to create one. Additionally, the team used a fishbone or cause and effect diagram to help narrow the field of ideas.

The eam identified back injuries as the **effect,** and six categories of causes for the effect: People, Materials, Equipment, Environment, Methods, Training. The team decided to concentrate on two categories "People and Training" after initial voting indicated that preference on the part of the team. After considerable discussion , the team decided to concentrate on the "people" issue and assume that the "training" concerns might be part of the solution to the problem of back injuries. After even more debate, the team tentatively agreed that **"bad lifting practices"** was the base cause of back injuries with other probable causes as associated with lifting. **(Figure 2. & Figure 3.)**

Jim Ferguson, NASSCO's Industrial Hygienist, defined "soft tissue" for the group. He explained the relationship among the muscles, tendons, ligaments, cartiledge, and bursers and how they are affected by various activities. Some of the key points of the presentation included: FROI (first report of injury) information shows where problems lie and suggest areas to put our training and dollars to work; look at the job and see why people may be working beyond their capabilities (as it relates to overexertion); how stretching/warmup exercises are very good for soft tissue, energize blood flow and contribute to alert and good spirited workers. He further explained "FROI" terminology as it relate to soft tissue injuries. Explanation of the FROI terms such as: "overexertion"," repetitive motion", and "not classified" were given for informational purposes.

Cost of Back Injuries

During the 1995/96 loss period, the steel erection group had a back injury rate of 40.2%. In other words, if the department had 100 employees, then forty of them would have had a back injury during the year. The cost of these back injuries in one steel erection group for the two year time period was $1,255,668 or over $600,000 per year.

After the steel erection process improvement teams began studying one injury statistics and implementing recommendations, the 1997 back injury rate went down to 15.3% and the 1998 rate is on an annualized basis at 11.8%. Saving estimates for 1997 and 1998 are based on page 18- see below.

Causes of Chosen Injury

The team began to analyze the causes of back injuries in steel erection. The group talked about "at risk" and "acceptable" behaviors and identified the following at risk and acceptable behaviors:

At Risk Behavior	Acceptable Behavior
Rushing your tasks	Proper planning
Poor housekeeping	Use of teamwork and greater emphasis by supervisors to improve housekeeping.
Bad attitude/Stress	Proper communication, respect for co-workers, and controlling anger
Bad lifting practices, lifting beyond limitations, improper body position	Proper training in lifting practices, use of proper equipment
Ignoring safety rules	Following safety rules
Improper warm-up	Morning warm-up exercise, proper exercise
Repetitive motion, lack of breaks or rest	Alternate tasks
Cramped areas	Alternate tasks
Bad physical condition	Good physical health, proper exercise
Failure to notify supervisor of previously existing condition (past injury)	Proper communication

After "at risk" and "acceptable behaviors" were identified, a discussion was held on why people put themselves at risk. The following barriers to at risk behavior was discussed: **Readiness...**The ability to respond correctly to a safety challenge or situation. From group observation there were three stages to readiness such as:

1.) Starting a new job, concern is high but knowledge and skill are low resulting in low readiness.

2.) Concern has dropped but knowledge and skill have improved resulting in

high readiness.

3.) Concern is low and knowledge have plateaued so readiness drops.

Observation Process

Once it was decided that the group would investigate back injuries, the team immediately made preparation to do observations. The observations consisted of watching their co-workers during the course of the day performing job assignments. It was agreed that, everyone would make one observation a day. The group not only observed safe lifting practices but also noted unsafe lifting practices. These observations were performed in order to test the group's hypothesis that bad lifting practices were causing back injuries in steel erection . The group conducted observations to analyze trends in lifting practices. The group decided to continue performing observations in order to obtain valid conclusions. **(Figure 4. & Figure.5.)**

The group initially agreed to perform 500 observations, but as the team members began to work in different areas of the yard, over sixteen hundred (1,600) observation were done. From July 1997 to September 1997, the team collected observation data and discovered that steel erection were performing safe lifting practices fifty one percent (51%) of the time. **(Figure 5.).** So as not to make workers cautious or nervous, the observations lasted approximately two to three minutes.

The data was collected and charted for patterns and consistency to note any unusual trends towards other possible causes of back injuries. The data was analyzed weekly for group discussions and possible intervention to increase the percentage of safe behaviors. Once the team members were trained in the "DO IT" process, observations were again conducted from December 1997 until March 1998. The percentage of safe behavior increased from fifty-one (51%) to seventy-one (71%) percent after a second set of 1,600 observations. **(Figure 5.)**.

Behavior can be managed at the organizational level by systematic application of the DO IT process. In other words, disirable (e.g., safe) behavior can be increased or undesirable (e.g., at-risk) behavior can be decreased, and the impact of a behavior change intervention can be evaluated objectively by following the steps represented by the DO IT acronym: **D =** Define the target behavior, **O =** Observe occurences of the target behavior, **I =** Intervene to change the frequency of the target behavior in desired direction, and **T =** Test the impact of the intervention strategy by continuing to record occurences of the target behavior.

1. **Define** the target behavior. [What behavior do you want to decrease or increase?]

2. **Observe** the target behavior. [How will you observe the target behavior?]

3. **Intervene** to change the target behavior. [What intervention techniques will you use to influence the target behavior?]

4. **Test.** [What data or information will you use to test the impact of your intervention?]

Rewards and Recognition

Employees understand what is expected of them. If rewards/recognition are based on production, employees do what it takes to get the job done which may include taking risks. Rewarding production without equal emphasis on safety will cause safety to suffer. Employees will perform their work based on rewards and ignore safety to attain the rewards. (jackets, cups, hats, etc.)

It has been researched and reported (Geller. 1997), that we learn from success than failure. Behavioral scientist have shown quite convincingly that success--not failure--produces learning. Edward Lee Thorndike, for example, studied intelligence at the start of this century by putting chickens, cats, dogs, fish, monkeys, and humans in situations that called for problem solving behavior. Then he systematically observed how these organisms learned. He coined the "Law of Effect" to refer to the fact that learning depends upon behavioral consequences. When a behavior is followed by a "satisfying state of affairs" the probablility of that behavior occurring again is increased. But, if an "annoying state of affairs" follows a behavior, that behavior (considered an error) is less likely to occur again. With this in mind lets consider the following seven steps of quality recognition.

1. Deliver it during or immediately after safe behavior.

In order for recognition to provide optimal direction and support, it needs to be associatied directly with the desired behavior. People need to know what they did to earn the appreciation. Then they are motivated to continue that behavior. If it is necessary to delay the recognition, then it is important to relive the behavior or activities that deserve recogniton. Reliving the behavior means talking specifically about the performance warranting special recogniton. Don't hesitate to ask the recipient to describe aspects of the situation and the desirable behavior. This assures direction and motivation to continue the desired behavior. Connecting a person's behavior with recognition also makes the recognition special and personal for the recipient.

2. Make it personal for both parties.

Recognition is most meaningful when it is perceived as personal. Recognition should not be general appreciation that could fit anyone in any situation. Rather, it should be customized to fit the particular individual receiving it. This happens naturally when recogniton is linked to the individual's performance under designated circumstances.

3. Connect specific behavior with general higher level praise.

Recognition is most memorable and self-esteem boosting when it reflects a higher-order characteristic. Adding a universal attitude like leadership, integrity, trust-worthiness, or actively caring to the recognition statement obviously makes the recognition more rewarding. But it's important to state the specific behavior first, and then make an obvious linkage between the behavior and the positive attribute it reflects.

4. Deliver it privately and one - on -one.

Because quality recognition is personal and indicative of higher-order attributes, it needs to be delivered in private. After all, the recognition is special and only relevant to one person. So it will mean more and seem more genuine if given from one individual to another.

It seems conventional to recognize individuals in front of a group. This approach is typified in atheletic contests, as witnessed worldwide in the 1996 Olympics. Many managers take the lead from these events and give their individual recognition in group settings. Indeed, isn't it maximally rewarding to be held up as an exemple in front of one's peers?

We need to realize that many people feel embarrassed when identified in a group setting. Part of this embarrassment could be due to fear of subsequent harassment by peers. Some peers might call the recognized individual an "brown noser" or accuse him or her of "sucking up to management."

It is beneficial, of course, to recognize teams of workers for their accomplishments, and this can be done in a group setting. Usually group accomplishment worthy of recognition can be documented for public review. And, since individual responsibility is diffused or dispersed across the group, there is minimal risk of individual embarrassment or later peer harassment. However, it's important ot realize that grou achievement is rarely the result of equivalent performance from all group members. Some individuals typically take the lead and work harder, while other do less and count on the group effort to make them look good. Thus, it's important to deliver personal and private recognition to those individuals who went beyond the call of duty for the sake of their team.

5. Let it stand alone and soak in

A psychologist has recommended a "sandwich method" for enhancing the impact of interpersonal communication. "First say something nice, then give corrective feedback, and then say something nice again." This approach might sound good, but is is not supported by communication research. In fact, this mixed message approach can cause confusion and actually reduce credibility. The impact of initial

recognition is canceled by the subsequent correction, and then the corrective feedback is neutralized by the closing recognition. Keep recognition simple and to the point, and give your behavior-based praise a chance t soak in.

In this fast track age of trying to do more wtih less, we all try to communicate as much as possible when we finally get in touch with a busy person. After recognizing a person's special safety effort, we are tempted to tag on a bunch of unrelated statements, even a request for additional behavior. This comes across as "I appreciate what you've done for safety, but i need more." To give quality recogniton, you need to resist the temptation to do more than praise desired behavior. If you have additional points to discuss, it's usually best to reconnect later after the rewarding recogintion has had a chance to be internalized and become a part of the individual's self-recognition system. By giving quality recognition we give people a script they can use to reward their own behavior. In other words, our quality recogniton strenghens the other person's self-reward system.

6. Use tangibles for symbolic value only.

Tangibles can detract from the self-recognition aspect of quality recognition. If the focus of a recognition process is placed on a material reward accompyning the social approval, the words of appreciation cand become less significant. And in turn, the impact on one's reinforcement system is lessened.

Tangibles can add to the quality of interpersonal recogniton if they are delivered as tokens of appreciation. If they include a safety slogan, tangibles can help to promote safey. But how you deliver a trinket will determine wherther it adds to or substracts from the long-term benefit of your praise. The tangible must not be viewed as a payoff for the safety-related behavior, but only as symbolic of going beyond the call of duty for safety.

Even in a behavior-based safety incentive program, the tangiblesshould not be considered fair compensation for extra effort on behalf of safety. In an incentive program, however, people know beforehand what they need to do to earn a certain tangible reward. That's the incentive. In contrast, recognition is a reward without and incentive. An individual is caught doing right and is recognized for that behavior. And, if a tangible is presentd along with verbal praise, it should be delivered with words that give it symbolic value.

7. Secondhand recognition has special advantages.

Up to this point, I've been talking about one-on-one verbal communication in which one person recognizes another for a particular safety related behavior. It is also possible to recognize a person's outstanding efforts indirectly, and such and approach can have special benefits. Suppose, for example, you overhear metalk to another person about your outstanding safety presentation. How will this

secondhand recognition affect you? Will you believe my words of praise were genuine?

Sometimes people are suspicious of the genuineness of praise when it is delivered face -to - face. The recipient of praise might feel, for example, there is an ulterior motive to recogniton. Perhaps the deliverer of praise is expecting a favor in return for the special recognition. Perhaps bothe individuals had recently attended the same behavior -based safety course, and the verbal exchange is recognized as an eextension of a communication exercise and thus devalued as sincere appreciation. Secondhand recognition, however, is not as easily tainted with these potential biases, and thus its genuineness is less suspect.

My main point here is that gossip can be beneficial--if it is positive. When we talk about the acievement of others is in behavior-specific terms, we begin a cycle of positive communication that can support desired behavior, as well as build internal systems of self-recognition. We also set and example for the kind of interpersonal communication that builds self-esteem, empowerment, and group cohesion. These are the very person states that increase actively caring behaviors and cultivate the achivement of a Total Safety Culture.

For additional information regarding recognition as it relates to safety, please refer to Scott Geller's, **Actively Caring for a Total Safety Culture Seminar, 1997:** Quality Recognition: Key to Safety Improvement.

JOB SAFETY ANALYSIS OR JOB HAZARD ANALYSIS

Job safety analysis is a analytical tool that can improve a company's overall performance by identifying and correcting undesirable events that could result in accidents, illnesses, injuries, and reduced quality and production. It is an employer/employee participation program in which job activities are observed; divided into individual steps; discussed; and recorded with the intent to identify, eliminate, or control undesirable events.

JSA or JHA effectively accomplishes this goal because it operates at a very basic level. It reviews each job and breaks it down into an orderly series of smaller tasks. After these tasks have been determined, the same routine of observation, discussion, and recording is repeated, this time focusing on events which could have a negative impact on each step in the task. Once potential undesirable events are recognized, the process is repeated for a third time and corrective actions are identified.

Conducting a JSA or JHA can be a valuable learning experience for both new and experienced employees. Not only does it help them understand their jobs better, but it also familiarizes them with potential hazards and involves them in developing accident procedures. Workers are more likely to follow procedures if they have a voice in planning. Finally, the JSA/JHA process causes employees to think about and how it relates to their jobs.

Who Should Conduct JSA/JHA

The responsibility for the development of a JSA/JHA lies with the first-line supervision. These individuals have first-hand knowledge of the process, its potential hazards, and the need for corrective actions instituted at each step. This also provides the interaction with hourly employees necessary to complete the JSA. Initially, first-line supervisors must receive training in hazard recognition and procedures necessary to perform a JSA. This training will give them the knowledge necessary to explain the JSA to employees, what it is expected to accomplish, how it is conducted, and what their part will be in the program.

It has been proven that a well-organized and maintained JSA/JHA program can have a very beneficial effect on accident prevention, improved production, and product quality. Emphasis for this program, as with any other program, must start at the top and be conveyed down the line to all employees.

Procedures and Various Methods Used to Perform JSA's

A job safety analysis is a procedure used to review job methods and uncover hazards that:

1. May have been overlooked in the layout of the plant or building and in the design of the machinery, equipment, tools, workstation, and processes;

2. May have developed after production started; or

3. May have resulted from changes in work procedures or personnel.

The principal benefits of a JSA/JHA include:

1. giving individual training in safe, efficient procedures;
2. making employee safety contracts;
3. instructing the new person on the job
4. preparing for planned safety observation;
5. giving pre-job instruction on irregular basis
6. reviewing job procedures after accidents occur; and
7. studying jobs for work-methods improvements.

JSA's/JHA's can be performed using three basic steps, but a careful selection of the job to be analyzed is an important preliminary step.

Various Methods to Perform JSA's/JHA's

There are three basic methods for conducting JSA's. The direct observation method uses observational interviews to determine the job steps and hazards encountered. A second way to perform a JSA is using the discussion method. This method is typically used for jobs or tasks that are performed infrequently. It involves pulling together individuals who have done the job and having them brainstorm regarding the steps and hazards. The third way to perform a JSA is called the recall-and check method. This method is typically used when a process is ongoing and people can't get together or to the worksite. Everyone participating in this process writes down ideas about the steps and hazards involved in the job. Information from these individuals is compiled and a composite list is sent to each participant. Each person can then revise the list until consensus is achieved.

The following list gives the three basic approaches that can be used to determine how to perform a specific JSA/JHA.

1. By a specific machine or piece of equipment (for example: a lathe)
2. By a specific type of job (for example: welding)
3. By a specific occupation (for example: machinist)

Job Selection

A job is a sequence of separate steps or activities that together accomplish a work goal. Jobs suitable for a JSA/JHA are those which a line supervisor chooses. Jobs should not be selected at random. Those with the work accident history should be analyzed first if the JSA/JHA is to yield the quickest possible results. In selecting jobs to be analyzed and establishing the order of analysis, top supervision should be guided by the following factors:

1. Frequency of Accidents: A job that has repeatedly produced accidents is a candidate for a JSA/JHA . The greater the number of accidents associated with the job, the greater its priority claim for a JSA/JHA.

2. Rate of disabling injuries: Every job having a history of disabling injuries should have a JSA performed. Subsequent injuries prove that preventive action taken prior to their occurrence was not successful.

3. Severity potential. Some jobs may not have a history of accidents but may have the potential for causing severe injuries. The more severe the injury, the higher the priority for a JSA/JHA.

4. New Jobs: Changes in equipment or in processes obviously have no history of accidents, but their accident potential may not be understood. A JSA should be conducted for each new job. Analysis should not be delayed until an accident or near miss occurs.

After the job has been selected, the three basic steps in conducting a JSA are:

1. Breaking the job down into its component steps

2. Identifying the hazards and potential accidents

3. Developing solutions

1. Breaking the job down into its component steps

Before the search for hazards can be started, a job should be broken down into a sequence of steps, each describing what is to be done. There are two common errors in the process which should be avoided. They are:

a. making the job breakdown too detailed so that an unnecessarily large number of steps results.

b. making the job breakdown so general that the basic steps are not recorded.

To perform a job breakdown, use the following steps.

a. Select the right worker to observe. Select an experienced, capable, and cooperative person who is willing to share ideas.

b. Observe the employee performing the job.

c. Completely describe each step. Each step should tell what is done, not how it is done.

d. Number the steps consecutively.

e. Watch the operator perform the job a number of times until you are sure that all the steps have been noted.

f. Check the list of steps with the person observed to obtain agreement on how the job is performed and the sequence of the steps.

2. Identifying hazards and potential accidents

The purpose of a JSA/JHA is to identify all hazards, both those produced by the environment and those connected with the job procedure. Each step must be made safer and more efficient.

Close observation and knowledge of the particular job are required for the JSA/JHA to be effective. Job observation should be repeated until all hazards and potential accidents have been identified.

The sample worksheet **(Figure 6.)** will make it easier for the observer to make sure nothing was overlooked.

3. Developing solutions

The final step in a JSA/JHA is to develop a safe job procedure to prevent the occurrence of accidents. The principal types of solutions are:

a. find a new way of doing the job,
b. change the physical conditions that create the hazards
c. change the work procedure, and / or
d. reduce the frequency of the job.

Completion of the JSA/JHA

After completion of the worksheet, the data should be compiled and transferred to a actual JSA/JHA form. **(Figure 6.)** Once the data has been entered and verified, it is important to obtain signature approval for the JSA from an upper-level manager.

Once the JSA/JHA is completed, it should be discussed with those employees performing that job. Any necessary safety procedures or additional safety equipment required to perform the job should be reviewed with these employees. In addition, a copy of JSA/JHA should be available for the employees to use when they perform the job. This is particularly important for those jobs that may not be done on a regular basis. It is important to note that no job is static. JSA's/JHA's should be reviewed on a regular basis and any necessary changes should be made.

The major benefits of a JSA/JHA comes after its completion. Supervisors can learn more about the jobs they supervise. Employees who use JSA's/JHA's have improved safety attitudes and their safety knowledge is increased. Supervisors can also use JSA's for training new employees. JSA's provide a list of needed steps to perform the job, as well as identifying the procedures and equipment needed to do the job safely.

The JSA's/JHA's can furnish materials for planned safety reviews. All the steps in the JSA should be followed with an emphasis on the major safety hazards. Supervisors should occasionally observe employees as they perform the jobs for which the analysis has been developed. If any procedural deviations are observed, the supervisor should alert the employee and review the job operation with them.

Figure 1.

1997 STEEL ERECTION WORKERS' COMPENSATION COST SAVINGS (BACK)

Year	Number of Employees	Total Injuries	Injury Rate Per 100 Employees	Total Cost of Back Injuries	Rate Difference from Base	Total Cost Savings per 100 Employees
1995/96	383	154	40.20%	$627,834.00		
1997	235	36	15.30%		61.94%	$238,323.00
1998 (annualized	187	22	11.80%		70.65%	$216,737.00

******NOTE***** 1997 and 1998 Cost Savings calculated using 1995/96 headcounts and injury costs. This was done to isolate the injury rate as the only changing Variable.**

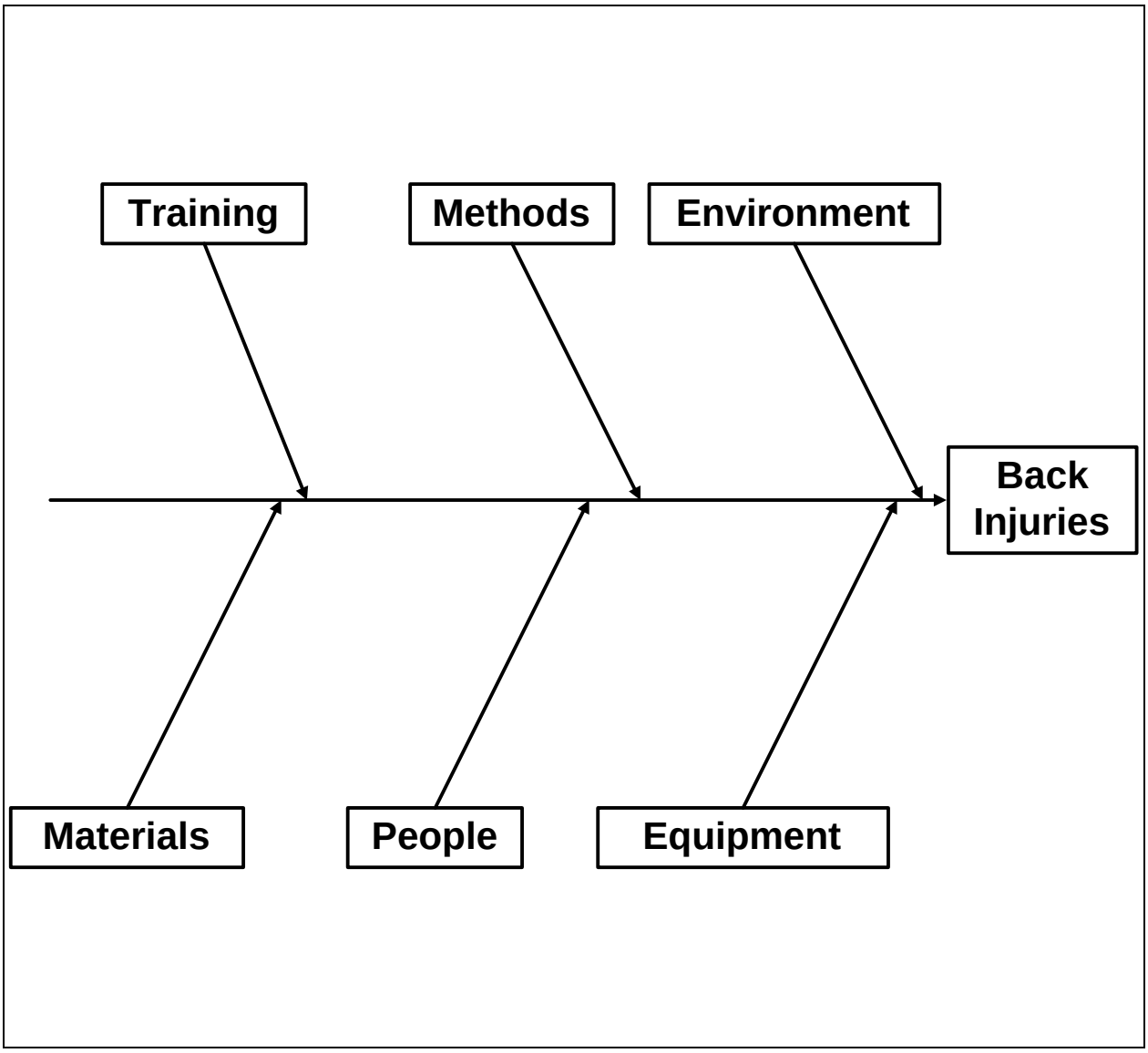

Figure 2.

Cause and Effect Diagram

Figure 3.

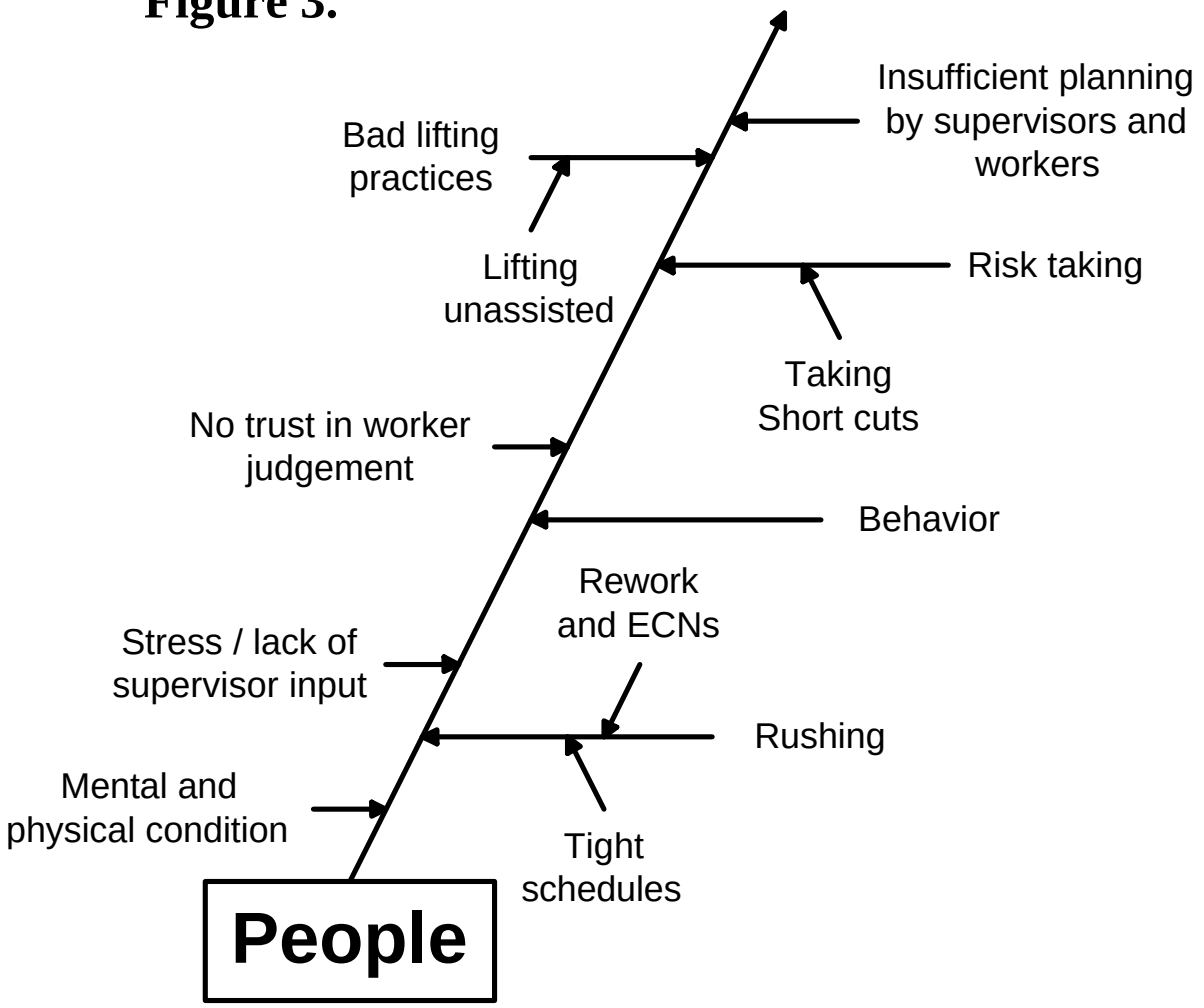
Insufficient planning by supervisors and workers
Bad lifting practices
Lifting unassisted
Risk taking
Taking Short cuts
No trust in worker judgement
Behavior
Rework and ECNs
Stress / lack of supervisor input
Rushing
Mental and physical condition
Tight schedules
People

Figure 4. SAMPLE OBSERVATION SHEET (DAILY)

Observer _____		**Date** _____
Location _____		
	Safe	**Unsafe**
Bend knees and use legs		
Keep back straight		
Keep load close to body		
Lift slowly and smoothly		
Get help with heavy loads		
Use tools/equipment to lift		
Build a bridge ***		

******* Added to checklist after training in 12/97

Figure 5. CUMULATIVE OBSERVATION TOTALS

	7/97 to 9/97	12/97 to 3/98
	Percentage Safe	**Percentage Safe**
Lifting Methods	**Pre-Intervention**	**Post-Intervention**
Bend knees and use legs	44.00%	79.00%
Keep back straight	47.00%	69.00%
Keep load close to body	56.00%	70.00%
Lift slowly and smoothly	54.00%	76.00%
Get help with heavy loads	60.00%	71.00%
Use tools/equipment to lift	51.00%	73.00%
Build a bridge	***N/A***	84.00%
Cumulative Total	**51.00%**	**71.00%**

Figure 6. SAMPLE ANALYSIS WORKSHEET

Job Name _____ **JSA/JHA Number** _____

Employee Name _____ **Area/Supervisor** _____

Employee Title _____ **Last Analysis Date** _____

Analysis By _____ **Analysis Date** _____

Job Steps	Potential Hazards	Necessary Safety Procedures	Required Safety Equipment