TRAINER'S MANUAL

PATH (Posture, Activities, Tools, and Handling) CODING METHOD for ERGONOMIC HAZARD ANALYSIS

Produced by
Department of Work Environment
University of Massachusetts Lowell

P R E F A C E

This Manual is intended for the training of PATH (Posture, Activity, Tools, and Handling) ergonomic analysis method. The overall purpose of this course is to give ergonomists:

- The capability to set up their own PATH coding system applicable to a specific industry or area of concern for ergonomic hazards
- The capability to train PATH coders
- The capability to set up a database system to collect and analyze the PATH data.

PATH is a work sampling-based approach to ergonomic job analysis. It was developed for application to construction work. Although PATH is not limited to construction, it is best used to analyze jobs which require whole body movements, on non-repetitive task-based work such as construction, agriculture, and forestry.

PATH is excellent for characterizing frequencies (as proportion of the workshift) of exposures such as awkward postures, loads handled, and specific hazards associated with job tasks, activities, and tool use. PATH can also be used to look at multiple exposures (i.e. the percentage of time a worker spends in an awkward posture while carrying a load). It should be noted here that PATH will not capture exposures related to wrist and finger postures and the duration of each exposure (such as how long a worker held a static posture).

This trainers' manual can be a very useful tool for identifying and quantifying ergonomic hazards. PATH analysis can also be used before and after interventions to evaluate their effectiveness in reducing ergonomic hazards. Safer and healthier work environments will result by using methods such as this to identify, analyze and prioritize interventions.

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CHAPTER 1

INTRODUCTION TO PATH

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OBJECTIVES

In this chapter, trainees will be introduced to ergonomic research in general. They will learn that there are many approaches to analyzing a job for ergonomic hazards. PATH will be introduced, and trainees should understand appropriate applicability for the method. The trainer should be an ergonomist and have background knowledge about the risk factors associated with ergonomic hazards, and methods other than PATH used to quantify ergonomic risk factors. The trainer should also understand the requirements and trade-offs associated with using different sampling procedures (i.e. work sampling vs. time motion studies, observational vs. instrumentation-based techniques).

The goals of this chapter are:

- To understand why ergonomic research is necessary
- To understand if PATH can and/or should be applied to identify and quantify the hazards of a particular trade or operation of interest
- To be able to identify the ergonomic hazards of a trade or operation
- To understand the types of analysis that can be performed on PATH data
- To understand entire PATH protocol procedures

On completion of this chapter, students will be able to:

- Give reasons for doing ergonomic research
- List typical activities, ergonomic hazards, and primary target body areas for the tile grouting trade
- List at least four trades/jobs which could be analyzed using PATH
- List at least four trades/jobs which should not be analyzed using PATH
- Identify the steps in performing PATH research

ACTIVITY 1

Why Are We Doing Ergonomic Research?

PURPOSE: *The purpose of this activity is to get trainees to think about why they are doing this type of research, and to get them to begin to be aware of ergonomic hazards.*

TASK: This is an activity for the entire class. As you go through these questions together write down the answers below:

1) Why are we doing ergonomic research?

2) List the major ergonomic risk factors:

3) List available ergonomic methods and their applicability:

ACTIVITY 1

Why Are We Doing Ergonomic Research?

PURPOSE: *The purpose of this activity is to get trainees to think about why they are doing this type of research, and to get them to begin to be aware of ergonomic hazards.*

TIME TO PERFORM: 15 min

MATERIALS: Easel paper, Student Worksheet for Activity #1

TASK 1: Initiate this activity with the question presented above: Why do you think we are doing ergonomic research?

APPLICABLE TEXT:. This should open up a discussion about different types of injuries and musculoskeletal health effects experienced by workers. There is a need to be able to quantify exposures to understand better where and how injuries are generated. **Record this discussion on easel paper and hang on the wall to refer back to throughout the training session.**

TASK 2: Ergonomic risk factors should be discussed and listed on easel paper. Different ergonomic analysis methods available should be briefly introduced and listed on easel paper. Advantages and Disadvantages of the different methods should also be briefly discussed and listed.

APPLICABLE TEXT: The major risk factors for cumulative trauma disorders are:

- Forceful Exertions
- Repetitive Motions or Prolonged Activities
- Awkward Postures
- Temperature Extremes
- Localized Contact Stresses
- Vibration

These can be briefly presented.

Many modern ergonomic analysis techniques are based on traditional industrial engineering approaches (time motion study and work sampling). These approaches often incorporate a variety of measurement devices and attempt to quantify one or more ergonomic stressors. Some modern approaches to quantifying exposures are:

- The Ovako Work Posture Analysis System (OWAS)

- Keyserling's simulated real time computerized model
- Armstrong's method for documenting hand positions and forces during manual work
- Garg's prediction of metabolic rates for manual material handling jobs

These can be briefly presented. If you are not familiar with these methods, papers are listed as reference articles in the back of this training manual. These are observational and/or instrumentation based methods, and different methods are used to evaluate at different risk factors (i.e. posture vs. force).

LECTURE

Introduction To Path

PURPOSE: *The purpose of this lecture is to introduce the methodology behind PATH and to have trainees understand where and how it should be used to do ergonomic analysis.*

TIME TO PERFORM: 30 min MATERIALS: Easel paper, Overhead slides #1 and #2

PATH (Posture, Activities, Tools, and Handling), is a work sampling based approach to ergonomic job analysis. PATH was developed to characterize the ergonomic hazards of construction work. PATH should be used only to quantify exposures in non-repetitive work. It provides a detailed analysis of postures used, loads handled, and activities performed during job tasks. Situations for which PATH should be used are:

1) Non-routinized work (not repetitive or assembly line type work) having variable ergonomic exposures and/or job tasks.
2) Work for which the physical demands have not been previously studied or described

The steps in the PATH methodology are as follows:

- Customize PATH
- Select Workers
- Perform PATH Coding
- Enter Data into the Computer
- Analyze Data to Determine Health Hazards

*****List the steps on easel paper as you go over them*****

Customize PATH

The fist step in the PATH methodology is to watch (and if possible videotape) the operation, and obtain a narrative of the operation from engineers, supervisors, and workers on-site. A description of the job tasks and activities performed in each operation by each trade is used to customize the PATH analysis.

Selection of Workers

After collection of preliminary data, each observer selects a number of workers performing the same operation for analysis. Workers' names and informed consents are obtained.

Perform Path Coding

The specific worker for each observation is randomly determined from those selected for analysis at the start of the day. The workers are watched for three or four hours during

each sampling period. Sampling periods are repeated until an adequate number of observations are collected (usually about 300 - 400 observations for each task being studied). Observations are made at fixed intervals usually 45 or 60 seconds, depending on analyst's skill level and the complexity of the job being analyzed.

*****Show Overhead Slide #1 - "Coding Logic for Each Observation"*****

PATH codes were developed to be able to break down an operation into its components, and then to be able to identify the health hazards associated with each component. The following PATH codes are entered onto a data sheet for each observation :

- **WORKER IDENTIFICATION NUMBER-** Each worker must have a unique identification number
- **TASK** - Tasks are the major categories of work within an operation. One task in the "tile grouting" operation is "cleaning". There will be many subcategories within each task called activities. For example, within the "cleaning" task, there are many activities such as "wiping", "filling bucket", and "rinsing sponge"
- **POSTURE** - The postures for four body segments (trunk, legs, arms, and legs)
- **ACTIVITY** - The activity used to describe what the worker is doing at a relatively basic level. Activity is coded for whole body exertion, gross motor exertion, and fine-motor exertions. More than one activity may be coded for each observation. Activity is subdivided into four categories:

    1) manual material handling activities
    2) activites common to most operations
    3) tool use activities
    4) operation/job specific activities

- **TOOLS/EQUIPMENT** - Tools and equipment used to perform the activity
- **HANDLING**

    1) hand postures
    2) actual tool weight or load handled

Enter Data Into The Computer

PATH coding generates a significant amount of information which will need to be entered into a computer database for analysis. This can be done by either using an electronic scanner or by entering the data by hand into a spreadsheet.

*****Show Overhead Slide #2 - What can we do with the data?*****

Analysis

The final step in the PATH methodology is the analysis of the data which will help identify the parts of the job where ergonomic hazards exist. SAS (statistical analysis system) is the current software program being used by the University of Massachusetts, Lowell. Results of data anlaysis can be used to:

- Determine the percent of time workers spend in awkward postures, handling loads, and performing various activities for different operations, tasks, days, etc.
- Determine operations and tasks which have the peak exposures

- Investigate combinations of exposures (such as posture used while handling loads)
- Investigate how other external factors (i.e., weather) affects exposures

Link exposure data to health effect data in an epidemiological study

ACTIVITY 2

Define an Operation/Job For PATH Coding

PURPOSE: *This activity will help coders to begin thinking about the activities involved in "The Tile Grouting Operation" and to define an appropriate job task of interest that they would like to do PATH research on and the specific activities involved in that job task*

TIME TO PERFORM: 10 min

MATERIALS: Easel paper w/ table of typical activities, ergonomic hazards, and primary target body areas

INTRODUCTION: PATH coding throughout this manual will be presented and taught using the "Tile Grouting" operation. PATH Coders will learn the appropriate posture codes, tasks, activities, tools equipment, and handled codes for "Tile Grouters". Some of these codes can be used across all jobs, and others are defined as "job specific". Therefore, in addition to learning how to code the "Tile Grouting" operation, PATH coders should be able to identify activities specific to any operation or job task (and consequently be able to set up a coding template). Throughout the training process while learning to code the "Tile Grouting" operation coders will be asked to develop a PATH coding system for an operation or job that they are interested in evaluating.

TASK 1: Define the Tile Grouting Operation

Opening Question: Has anyone done tiling work?

If no one has then ask if anyone has seen someone else do it. This will lead to a discussion about how tile grouters work, typical activities, and ergonomic hazards associated with this type of work. Then present the tile grouting information in table format on easel paper with space for additional Operations/Jobs which will be filled in as described later in this activity.

TASK 2: Have trainees define and describe a job task of interest for PATH coding.

Coders should be asked to fill in the table, using the "Tile Grouting" operation as an example, trying to pick an appropriate operation or job to do PATH research on (i.e. one that used whole body movements).

TASK 3: Review operations/jobs defined above.

Review trainees suggestions and put appropriate "PATH" coding suggestions in the table on the easel sheet.

STUDENT WORKSHEET

ACTIVITY 2

Define a Job Task For PATH Coding

PURPOSE: *This activity will help coders to begin thinking about the activities involved in "The Tile Grouting Operation" and to define an appropriate job task of interest that they would like to do PATH research on and the specific activities involved in that job task*

TASK: Fill in the table, using the "Tile Grouting" operation as an example, trying to pick an appropriate job task to do PATH research on (i.e. a non-repetitive job that uses whole body movements).

Job Description/Ergonomic Hazard Evaluation

Operation/Job Title	Typical Activities	Ergonomic Hazards	Primary Target Body Areas
Tile Grouters	Mix grout, Spread grout, Wash/wipe/clean, Scrape, MMH	Awkward trunk postures, Kneeling/squatting, Arms above shoulder height, Repetitive hand movements	Back, Shoulder, Knees, Hands

LECTURE

Path Research Procedures

PURPOSE: *This lecture will help to demonstrate the entire research protocol, to demonstrate where PATH coding fits in, and to demonstrate the need for coders to be aware that PATH codes are not valuable unless the entire protocol is followed.*

TIME TO PERFORM: 20 min

MATERIALS: Easel paper, Overhead Slide #3

INTRODUCTION: It should be stressed initially that workers names need to be identified and workers need to feel comfortable about coders watching them. If they are not comfortable they may not work normally, and the resulting data will be biased.

*****Show overhead slide #3, "PATH research protocol", and go through each step in detail as described below*****

APPLICABLE TEXT:

Make Site Contact:

A brainstorming session should be done to determine the possible site/company contacts. Write suggestions down on easel paper for reference in later sections. Possible site contacts for the construction site should also be described and written down.

Key people at the construction site are defined as:

A. People associated with the workers/crew:
   1) The Business Agent (UNION REP)
   2) The Shop Steward (UNION REP)
   3) The Foreman
   4) The Workers

B. People associated with the business
   1) The Safety Representative (Contractor REP)
   2) The Resident Engineer (Contractor REP)
   3) The Superintendents

The ability to get on site , and to ask the right questions in the correct manner is crucial to the success of the study. How to approach site contacts will be reviewed in Section 9 of this manual.

Perform a site walkthrough :

It is important to initially perform a walkthrough to determine if PATH is the appropriate ergonomic method and to be able to tailor PATH for that operation. Detailed notes should be taken and a videotaping or taking pictures of the operation at this point would help in later identifying tasks, activities etc. However, videotaping might make workers feel uneasy or make them less likely to participate in the study. If so, video taping at this point may not be appropriate. You should be able to determine this from what happens when you make site contact.

Meet a Crew of Workers:
Prior to most studies which use human subjects, workers should be informed of the study objectives, and should give consent to be watched. It is important to meet the workers, get their names, and/or descriptions, and informed consents prior to doing coding.

Pilot PATH data collection:
A PATH template needs to be constructed, and all coders need to agree on codes prior to data collection. Definitions for each task and activity should be documented. Observations should be made by coders simultaneously and inter-rater reliabilities should be calculated. Coding problems should be discussed and more inter-rater reliabilities should be taken until coders are coding consistantly. In addition, workers must be identified so that a worker number can be assigned.

Perform PATH sampling:
Perform PATH sampling by randomizing the workers and filling in operation cover sheets and PATH data sheets.

Interview workers and videotape/photograph important aspects:
Supplemental information about workers is also a necessary component of this method. In addition to "coding" activities, workers need to be interviewed about individual characteristics such as age, years in occupation and other characteristics that may contribute to exposure. A questionnaire can be used to obtain information after the PATH data have been collected. Video taping and photographing the operation will also provide supplemental information.

CHAPTER 1

TRAINER'S MATERIALS

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CHAPTER 2

PATH POSTURE CODES

Department of Work Environment
University of Massachusetts Lowell

OBJECTIVES

In this chapter students will learn the PATH posture codes. The most challenging part of PATH is to be able to code postures in real time. Because bodies come in many shapes and sizes, and bend and flex differently, learning to code postures accurately is difficult and as much time as is needed for coders to learn the posture codes should be used. PATH posture codes are presented in the training manual with text and pictures. Some time should be spent going through the codes verbally, pointing out that there are critical angles which will need to be learned for each code.

Prior to training you need to decide whether to use a scanner for data input or input data manually. If a scanner is available the coding template can be introduced (option 1), or if you will be entering data manually into a spreadsheet or database, the work sampling worksheet (option 2) can be used. The two options are presented in the back of this section. The format for coding should be introduced at this point so coders can begin to become familiar with the coding sheet.

The goals of this chapter are:

- To have students visualize the posture cutoff points
- To have coders familiarize with filling in data sheets
- To have coders code postures of different body areas simultaneously
- To have coders understand that different shaped people look different in the various posture codes
- To introduce the format used for collecting codes (i.e. option 1 or option 2)

On completion of this chapter, students will be able to:

- Accurately code postures of workers in real life and from pictures
- Accurately code postures in the available format (i.e. option #1 or option #2)

LECTURE

Posture Code Definitions

PURPOSE: *This lecture will define PATH posture codes.*

TIME TO PERFORM: 15 min MATERIALS: Overhead slide #4

*****Show the slide "PATH Posture Codes" and go through the definitions below*****

Trunk

1. **Neutral:** trunk bent in any direction less than 20 degrees

2a **Bent Forward Slightly:** trunk bent forward 20 to 45 degrees; trunk twisted less than 20 degrees

3b **Bent Forward Severely:** trunk bent forward at least 45 degrees; trunk twisted less than 20 degrees

4. **Straight and Twisted or Laterally Bent:** trunk bent forward less than 20 degrees; trunk twisted or bent to the side at least 20 degrees
5. **Bent and Twisted:** trunk bent forward and twisted at least 20 degrees

Head and Neck

1. **Neutral:** neck bent forward, to the side, and backward less than 30 degrees; or rotated less than 45 degrees
2. **Non-neutral:** neck bent forward, to the side, or backward at least 30 degrees; or rotated at least 45 degrees

Legs

1. **Neutral:** both legs are supported by the feet and knees are bent less than 35 degrees
2. **One Leg in Air:** one foot is not supported and the worker is not walking
3. **At Least One leg Bent:** both legs are supported by the feet and at least one knee is bent at least 35 degrees
4. **Squatting:** both legs are supported at the feet and both knees are bent at least 90 degrees
5. **Walking/Moving:** both legs are being used to move the worker
6. **Kneeling:** at least one or two knees are touching the ground
7. **Sitting On Chair:** worker is seated with both feet below buttock height
8. **Sitting On Floor:** worker is seated with both feet at buttock height
9. **Crawling:** worker is moving with hands and knees touching ground. Trunk posture is not coded when the worker is crawling.
10. **Legs Not Fully Supporting Body:** worker is not seated but is supported by something other than the legs (e.g. harness)

Arms

1. **Both Elbows Below Shoulders:** lateral sides of both elbows are below shoulder height
2. **One Elbow Above or at Shoulder Level:** lateral portion of either elbow is at or above shoulder height
3. **Both Elbows Above or at Shoulder Level:** lateral portions of both elbows are at or above shoulder height

LECTURE

Data Sheets

PURPOSE: *This lecture will present the media and procedure used for collecting data.*

TIME TO PERFORM: 10 min

MATERIALS: Coding Templates and Bubble Sheets with Overhead Slide #5, or Work Sampling Worksheets with Overhead Slide #6

INTRODUCTION: There are two different options presented here for collecting data. If you have a scanner available then option #1 should be implemented, where bubble sheets are used with coding templates tailored for an operation. Using a scanner will eliminate the need for entering data by hand. However, if you do not have a scanner available then "Work Sampling Worksheets" are provided as option #2.

OPTION #1: Bubble sheets/ coding templates

*****Show overhead slide # 5 - "Template Overlay onto Bubble Data Sheet" to demonstrate how the template fits over the bubble sheets*****

After a description of the tasks and activities performed in each operation is determined the coding templates can be tailored for that operation. A blank coding template and a trade specific "tile grouting" template are provided in the training manuals to demonstrate where tailoring for a particular operation is integrated into the coding process. Note where "tasks" must be filled in and trade specific "activities" and "tools/equipment" must be filled in for a particular trade or operation. All other coding is standard for any operation.

Bubble sheets are currently designed to collect 6 observations per sheet. The coder fills in the date and time at the top of the page, his/her unique coder identifier and record number. Then the template fits over each set of three columns designed to collect PATH coding of an observation, and 6 consecutive observations are taken.

OPTION #2: Work Sampling Worksheets

*****Show overhead slide #6 - "Work Sampling Worksheet Tile Grouting Operation"**

After a description of the tasks and activities performed in each operation is determined work sampling worksheets can be tailored for that operation. A blank work sampling worksheet and trade specific "tile grouting" worksheet are provided in the training manuals to demonstrate where tailoring for a particular operation is integrated into the coding process. Note where "tasks" must be filled in and trade specific "activities" and "tools/equipment" must be filled in for a particular trade or operation. All other coding is standard for any operation.

It should be noted here that it will be necessary for coder's to memorize numeric PATH posture codes when using the worksampling worksheets.

ACTIVITY 3

Demonstration of Posture Codes

PURPOSE: *This activity will teach coders the posture codes. They will need to be aware of how differences in body shapes and statures may effect the viewing angles. Sufficient inter-rate reliability will be very dependent on this part of the training process*

TIME TO PERFORM: 20 min

MATERIALS: Laminated Easel Sheets #1-#4, Planar goniometers for measuring joint angles, Mannequins and "posture guideline" sheets, a facilitator to help demonstrate postures.

TASK 1: Setup Procedures

Prior to this activity the large easel sheet with 20 and 45 degree angles marked (easel sheet #1) should be placed on one wall of the training room at a height where the hip joint as marked on the sheet is at the height of your facilitator's hip joint. The other large easel sheet (easel sheet #2) demonstrating 20 degrees rotation angle should be placed on the floor just below the first sheet. These two sheets will be used to demonstrate all trunk postures.

Another sheet is provided for the head postures (easel sheet #3). The neck joint as marked on the sheet should be hung at the same height as your facilitator's neck joint on the wall. If the facilitator is facing laterally to the wall his/her head will be movable to 30 degrees flexion or extension by moving an imaginary straight line through the center of the head from the neck joint to the appropriate lines marked on the sheet. A similar procedure should be used for lateral bends at the neck with your facilitator positioned frontal to the wall.

A final easel sheet (easel sheet #4) is provided to demonstrate leg posture code number 3 where one or both knees are bent at least 35 degrees. The sheet should be hung on the wall so that when your facilitator's knees are bent 35 degrees the knee joint marked on the sheet is at the same height as the knee joint, and the lines draw match up with the leg segments.

TASK 2: Demonstrate each posture code individually:

When demonstrating each posture code all other segments should remain neutral for this initial code identifier session. An extra person is necessary so that you can make an accurate assessment of angles. Placing your facilitator accurately in a posture is critical since the initial view that coder's get of him/her in a posture will likely effect the cutoff angles a coder draws in his/her mind for separating out posture codes

Trunk postures 2A, 2B, 3 and 4, head postures, and leg posture number 3 are the most difficult to learn, so spend time putting your facilitator into these postures accurately and have coders view him/her from all angles. Also leg posture 5 is defined as "walk/move". This should be pointed out as including a lateral, backward, shuffling type of movement. The training tape provided with this manual similarly demonstrates the postures and coders may want to take the tape home to be able to view the angles longer. This should be encouraged

During this session trainees should be asked to take out their mannequins, and "posture guideline" sheets and they should put the mannequin in each posture as it is demonstrated by the facilitator

ACTIVITY 3

Demonstration of Posture Codes

PURPOSE: *This activity will teach coders the posture codes. They will need to be aware of how differences in body shapes and statures may effect the viewing angles. Sufficient inter-rate reliability will be very dependent on this part of the training process*

TASK: As you watch each trunk posture code (trunk flexion and lateral bends) being demonstrated line up your the mannequin on the posture guidelines provided below:

Trunk Flexion/ Lateral Bend:

20 °

45°

TASK: As you watch leg posture code #3 (at least one knee bent > 35 degrees) being demonstrated line up your the mannequin on the posture guidelines provided below:

Knees Bent > 35°:

ACTIVITY 3

Demonstration of Posture Codes

PURPOSE: *This activity will teach coders the posture codes. They will need to be aware of how differences in body shapes and statures may effect the viewing angles. Sufficient inter-rate reliability will be very dependent on this part of the training process*

TASK: As you watch each head code (neck flexion/extension) being demonstrated line up your the mannequin on the posture guidelines provided below:

Neck Flexion/Lateral Bend:

30° 30°

ACTIVITY 4

Begin Coding Postures

PURPOSE: *This activity will give trainees the opportunity to begin coding on bubble sheets using templates or the work sampling worksheet , and to begin thinking about how posture combinations appear*

TIME TO PERFORM: 30 min

MATERIALS: Laminated Easel Sheets #1-#4, Planar goniometers for measuring joint angles, a facilitator to help demonstrate postures, Bubble Sheets and Coding Template or Work Sampling Worksheet

TASK: Have trainees code non-neutral posture combinations
Still standing with feet centered on easel sheet #2 help your facilitator get into some typical tile grouting postures. This should include a combination of segmental non-neutral postures (such as: trunk in a 2A, legs in a 4, arms in a 2, and head in a 1)

Trainees should be encouraged to look at the facilitator from all different views, and they should fill out their estimates of the posture codes on a bubble sheet using a template.

Following each posture coding, you should measure the actual angles as well as possible with your planar goniometer and report the actual angles to them.

STUDENT WORKSHEET - Option #1(scanner)

ACTIVITY 4

Begin Coding Postures

PURPOSE: *This activity will give trainees the opportunity to begin coding on bubble sheets using templates or the work sampling worksheet , and to begin thinking about how posture combinations appear*

TASK: Use the bubble sheet and coding template provided in this section to code the posture combinations demonstrated.

Use the area below to write down notes:

ACTIVITY 4

Begin Coding Postures

PURPOSE: *This activity will give trainees the opportunity to begin coding on bubble sheets using templates or the work sampling worksheet , and to begin thinking about how posture combinations appear*

TASK: Use the Work Sampling Worksheet provided in this section to code the posture combinations demonstrated.

Use the area below to write down notes:

ACTIVITY 5

The Effect of Different Statures

PURPOSE: *This activity will give trainees the opportunity to see the effect of different stature people in coding postures. This activity will also give the trainees the opportunity to actually "feel" the different postures.*

TIME TO PERFORM: 30 min

MATERIALS: Laminated Easel Sheets #1-#4, Planar goniometers for measuring joint angles

TASK 1: Setup Procedures

Divide Trainees into groups of three. If possible put different stature people in each group. There are two more sets of easel sheets #1-#4 provided in this section, one for each group. The easel sheets will need to be set up separately for each person in each group (refer to activity #2 setup procedures for direction on how to set up easel sheets for each person)

TASK 2: Have Trainees get into posture codes

Begin with the trunk and have each trainee be put in each posture code individually. Have the other trainees view each trainee from all views. Brainstorm notes on easel paper as comments are made by the group of the effects of different shaped and sized people.

Similarly continue with the head, leg, and arm posture codes

ACTIVITY 5

The Effect of Different Statures

PURPOSE: *This activity will give trainees the opportunity to see the effect of different stature people in coding postures. This activity will also give the trainees the opportunity to actually "feel" the different postures.*

TASK: You will work in groups. The easel sheets will need to be set up separately for each person in your group. Setup the easel sheets for each person as it was demonstrated to you in Activity #5. As you view each person in your group, discuss and write down notes on differences in coding necessary for different stature people.

ACTIVITY 6a

Homework #1: PATH Posture Code

PURPOSE: *This activity will give trainees the opportunity to study typical postures, and to generate questions based upon the difficulties they have coding. They will become more familiar with clueing in to particular parts of the body for coding (i.e. the elbow position when coding arms, the height of the shoulders for lateral bends etc.)*

TIME TO PERFORM: 30 min

MATERIALS: Homework pictures, Protractors, Bubble Sheets and Coding Template or Work Sampling Worksheet

TASK : Have Trainees take home and posture code homework pictures.
Assign a coder number to each trainee. Have trainees posture code homework sheets. They should use a bubble sheet and coding template (option #1) or Work Sampling Worksheet (option #2), and enter in the month/day, hour/minute, coder, and record number codes. Have them use the "worker number" coding area to assign problem numbers for each observation. Therefore they will be coding two bubble sheets or one Work Sampling Worksheet (posture codes only) for homework.

ACTIVITY 6b

Review Posture Code Homework

PURPOSE: *This activity will give trainees the opportunity to resolve the problems they are having with posture coding.*

TIME TO PERFORM: 45 min

MATERIALS: Homework pictures, Protractors, Laminated Easel Sheets #1-#4, Planar goniometers for measuring joint angles

TASK: Go over each posture code worksheet individually. If any trainee had a problem coding trunk, and/or leg postures you should position a trainee as close as possible in the posture presented. Measure angles using the easel sheets and goniometers of the person demonstrating the posture.

Be aware of and review thoroughly any postures trainees are consistently coding inaccurately.

ACTIVITY 6

Homework #1: PATH Posture Code

PURPOSE: *This activity will give trainees the opportunity to study typical postures, and to generate questions based upon the difficulties they have coding. They will become more familiar with clueing in to particular parts of the body for coding (i.e. the elbow position when coding arms, the height of the shoulders for lateral bends etc.)*

TASK: Enter in the month/day, hour/minute, your unique coder number, and record number code onto your coding sheets. Use the "worker number" coding area to assign problem numbers for each observation. You will be coding a total of 12 observations. Hopefully, this homework assignment will generate questions. Write your questions in the space below:

As the codes are reviewed write down notes below to clarify coding elements that were confusing to you while doing the homework problems:

CHAPTER 2

TRAINER'S MATERIALS

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CHAPTER 3

TASKS ACTIVITIES TOOLS EQUIPMENT and HANDLING CODES

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University of Massachusetts Lowell

OBJECTIVES

In this chapter coders will learn the PATH tasks, activities, tools, equipment and handling codes.

The goals of this chapter are:

- To have coders understand the breakdown of an operation to the activity level
- To have coders become familiar with filling in data sheets
- To have coders understand that all postures, tasks, activities, tools, equipment and grasps will need to be coded for the same point in time
- To have coders understand that different people use different work methods.
- To become more familiar with completely filling in a data sheet.

On completion of this chapter, students will be able to:

- Perform PATH coding completely on a static observation

LECTURE

Tasks, Activities, Tools, Equipment, and Handling Code Definitions

PURPOSE: *This lecture will help to define tasks, activities, tool use, equipment, and handling codes. This will define how the work is broken down into discrete elements for analysis.*

TIME TO PERFORM: 45 min

MATERIALS: Definitions, any tile grouter tools and/or equipment available, Overhead slide #7 .

*****Show overhead slide #7 "Coding Logic for Each Observation", and define each element using the definitions provided below*****

Tasks:
Tasks are operation specific. Each operation can be divided into a few major tasks that a worker encounters to get the job done.

An example of how tasks are derived can be seen by looking at 'Tile Grouter" tasks. The tile grouter tasks are:

1. Prepare Joints
2. Prepare to Grout
3. Grout
4. Clean
5. Misc.

A compilation of various activities can be found in each task.

Activities:
Activities are grouped into four major sections:

1. Manual Material Handling
2. Tool Use
3. Common Construction Activities
4. Trade Specific Activities

1) **Manual Material Handling Activities** - Manual material handling (MMH) activities are those activities which include a significant load in the hands. The worker may either be "lifting", "lowering", "carrying", "moving", "pushing", "pulling", "dragging" or "throwing" the load. If a tool which weighs less than 2 pounds is being held by the worker this will not be considered a manual material handling task, and will be covered by "hold tool not operate" or "operate hand" or "operate power tool" in the Tool

Use section. Whenever, a manual material handling task is filled in there must always be a weight filled in. Complete text descriptions for MMH activities are:

MMH*

- **Lift:** worker is not walking; load is fully supported by worker; load is being moved upward or laterally. If a worker is holding a load statically, this will be considered a "lift".
- **Lower:** worker is not walking; load is fully supported by worker; load is being moved downward
- **Carry:** worker is walking; load is being moved
- **Move/Place:** worker is making a fine adjustment of an object's position
- **Push/Pull/Drag:** load is being moved but is not fully supported by worker

* MMH may include the handling of tools if the tools are being moved. .

2) **Tool Use Activities** - Tool Use activities are those activities which are specific to any type of tool use. If a tool is in the hands one of these codes should be filled in: "Operate hand tool", "Operate power tool", or "Hold tool not operate". Whenever a tool is in the hands there must always be a weight filled in. Complete text descriptions for Tool Use activities are:

Tool Use

- **Operate Hand Tool:** worker holds tool; tool is being used for a task
- **Operate Power Tool:** worker holds tool; tool is activated; tools is being used for a task
- **Hold Tool (Not Operate):** hand tool - worker is holding tool; tool is not being used for a task; power tool - worker is holding tool; tool is not activated; tool is not being used for a task

3) **Common Construction Activities** - There are common activities associated with any PATH appropriate operation. Some or all of these may be incorporated into an operation specific template or Work Sampling Worksheet. It can be seen from the Tile Grouter Operation that only some of the common activities will be used. It is important during the site walkthrough while watching workers, to be able to identify just those activities which are fairly common (i.e. which will occur at least 5 % of the time). This is important because template space is limited, and must be optimized. Complete text descriptions for common activities are:

***Common Construction Activities**

- **Hammer:** the cycle of motion when the worker is repeatedly hitting one object (e.g. nail, peg,...) with another (e.g. hammer, shovel, rock...)
- **Shovel:** the cycle of motion when the worker is performing a digging task
- **Reach:** worker's arms are in motion toward a load; worker has not touched the load
- **Point/Direct:** worker uses arm signals to convey information
- **Walk:** worker is walking or running forward
- **Between tasks/wait/watch/idle:** worker is waiting to begin a new activity
- **Hold Wall/Table/ Rail:** Worker is touching or grasping a wall, table, or railing, but is not supporting it.
- **Other:** shake:, untangle/unfasten, remove/put on garment, cut, assemble/disassemble, pour, mix, swing, climb/descend, measure, steer/drive, close, roll

* To optimize space on templates or Work Sampling Worksheets, Common Activities which are predicted to occur < 5% of the observed time should be taken off the coding template or Work Sampling Worksheet.

It is important here to differentiate between the "hold" activities and manual material handling activities. "hold" activities listed in this section are not fully supported by the worker, only partially supported. "Hold wall/table/rail" is used when the worker is touching the wall, a table or grabbing some type of railing. "Walk" is coded here if the worker is definitely in a forward walking motion moving from one destination to another. This should be discriminated from leg posture code 5, "walk/move" which incorporates any type of movement in the positioning of the legs.

4) **Trade Specific Activities** - These activities are those activities which are unique to the operation you are studying. These activities will be defined during the site walkthrough while watching workers. Again it should be stressed that space on a template is limited, and there will be oddball events which will occur very infrequently, and can be incorporated into "other" or should be combined with another activity. Therefore, it is important during the site walkthrough while watching workers, to be able to identify just those activities which are fairly common (i.e. which will occur at least 5 % of the time).

("Tile Grouter" specific activities are listed on the template/work sampling worksheet, and can be used to demonstrate trade specific activities)

Tools/Equipment:

Most tools/equipment will be operation specific, and will need to be defined during the initial site walkthrough. It is important to determine weights of tools/equipment. A list of

tool weights should be generated during the site walk through so that coders can code with real weights known.

Hand Postures

Hand postures are described as follows:

1) Gross Grasp: A gross grasp is when the worker is grabbing an object with fingers completely wrapped around the object. The thumb should be in a flexed and hooked position for a true "gross grasp".
2) Pinch Grasp: A Pinch is when the external phalanges of the fingers are being used to grasp an object. Also the hand is only flexed at the third metacarpal joint. There is no flexion through the 2nd joint.
3) Other Grasp: An other grasp is when the grasp can not be defined as either a pinch, nor a gross grasp, but the worker is clearly using his/her hands.
4) Empty: An empty grasp should be used when there is clearly nothing in the worker's hands.

In addition to these codes if a worker's hand is not viewable no code should be entered for that hand.

CODING LOGIC
FOR EACH OBSERVATION

WORKER NUMBER
(randomized and filled in
at the start of a coding session)

TASK

POSTURES
Trunk
Head
Leg
Arm

ACTIVITIES
(usually consists of the activities of 1 or 2 hands
or both used together)

FOR EACH ACTIVITY
Manual Material Handling
or
(Tool Specific
and/or
Trade Specific Activity)
or
General Activity

TOOLS/EQUIPMENT
(in hands)

HAND POSTURE 1 HAND POSTURE 2

TOTAL WEIGHT IN HANDS
(That is being supported fully by the worker)

CHAPTER 3

TRAINER'S MATERIALS

Department of Work Environment
University of Massachusetts Lowell

CHAPTER 4

CODE TILE GROUTERS

Department of Work Environment
University of Massachusetts Lowell

OBJECTIVES

In this chapter coders will learn the PATH tasks, activities, tools, equipment and handling codes specific to coding tile grouters.

The goals of this chapter are:

- To have coders understand how a template becomes unique to a trade.
- To define tile grouter specific codes
- To have trainees experience fully coding an observation

On completion of this chapter, students will be able to:

- Perform PATH coding completely on a static observation
- Define how trade specific codes are developed.

LECTURE

Tile Grouter Codes Defined

PURPOSE: *This lecture will help to define specific tile grouter codes so that coders will be able to practice coding tasks, activities, tool use, equipment, and handling codes.*

TIME TO PERFORM: 15 min

MATERIALS: Definitions, any tile grouter tools and/or equipment available

Tile Grouter Tasks:

1) Prepare Joints - After tiles have been set (by tile setters), the excess cement that got into the joints must be cleaned out and the joints must be grouted. The task of preparing joints includes all activities necessary to prepare the joints for grouting.
2) Prepare to grout - After joints are cleaned out and ready for grouting, prepare to grout will include those activities necessary to initiate grouting. This will include activities such as filling the bucket with water, and pouring and mixing grout.
3) Grout - Grout includes all activities necessary to place grout between the tiles
4) Clean - Clean includes all activities necessary to clean excess grout off the tiles
5) Misc. - Miscellaneous includes all activities which do no fit under another task defined above

Tile Grouter Activities:

1) Pull Rope- rope is pulled out of space between rows of tile
2) Scrape - excess grout is scraped out of space between rows of tile
3) Pour Mix - grout mix is poured into bucket
4) Mix - grout is mixed with water
5) Scoop Grout - grout is scooped out of bucket
6) Wipe float w/trowel - grout is wiped onto float with trowel
7) Spread Grout - grout is spread in-between tiles with float
8) Rinse bucket - bucket is rinsed out with water
9) Tie/Untie bucket - bucket is tied or untied from rope used to lift and lower bucket up to and from high scaffold levels
10) Fill bucket w/ water - bucket is filled partially with water
11) Wash/Wipe/Clean-worker wipes grout from tile with a wet sponge, or cleans grout off of tools
12) Rinse sponge - sponge is rinsed after being used to wash off grout from tiles
13) Dump water - water is dumped out of bucket
14) Clean Tool - grout is cleaned off tool

Weights of Various Tools and Equipment that Tile Grouters Use:

Bucket	
empty bucket	2.5lb
full bucket of water	45 lb
2/3 full bucket of water	35 lb
Knife/razor/Scraper	1 lb
Bag of Grout	50 lb
Trowel	1 lb
Rubber Float	2 lb
Sponge	1 lb
Hose	2 lb

ACTIVITY 7

Code Pictures Completely as a Group

PURPOSE: *This activity will help trainees understand the logic of figuring out tasks and activities.*

TIME TO PERFORM: 1 hour

MATERIALS: Templates and bubble sheets or Work Sampling Worksheets, Tile Grouter Worksheets

TASK: Go through each tile grouter worksheet in sequence by first having trainees attempt to fully code the worksheet, and then discussing each code thoroughly. Where similar problems/confusions exist from several worksheets, go back and redefine in more detail.

ACTIVITY 7

Code Pictures Completely as a Group

PURPOSE: *This activity will help trainees understand the logic of figuring out tasks and activities.*

TASK: This is a group activity. Code tile grouter worksheets discussing. coding difficulties with the class. If you still feel uncertain about a posture code in a picture have the instructor demonstrate it and measure the angles.

ACTIVITY 8

Code a Set of Pictures Alone and then Discuss

PURPOSE: *This activity will bring out individual problems with coding*

TIME TO PERFORM: 1 hour

MATERIALS: Templates and bubble sheets or Work Sampling Worksheets, Tile Grouter Worksheets

TASK: Have coder's completely code the following set of worksheets. Go over each coded worksheet individually. If any trainee had a problem coding tasks then go back to the definitions, and make sure trainees understand where one task ends and the next task begins.

ACTIVITY 8

Code a Set of Pictures Alone and then Discuss

PURPOSE: *This activity will bring out individual problems with coding*

TASK: Completely code the following set of worksheets.

ACTIVITY 9

Code Frozen Frames of Tile Grouter Video

PURPOSE: *This activity will help trainees to approach coding real time.*

TIME TO PERFORM: 1 hour

MATERIALS: Templates and bubble sheets or Work Sampling Worksheets, Tile Grouter Video

TASK: Frozen frames have been chosen to represent some of the typical challenges experienced during coding. These frames have been pre-coded.

Frame No. (Time from zero)	Description	Record # (Obs #)
*Activity 13a)		
*Activity 13b)		

*Note: This Activity should be split into 2 days. Refer to Syllabus

STUDENT WORKSHEET

ACTIVITY 9

Code Frozen Frames of Tile Grouter Video

PURPOSE: *This activity will help trainees to approach coding real time.*

TASK: Your instructor will freeze frames of a video of tile grouters. Frozen frames have been chosen to represent some of the typical challenges experienced during coding. Use the coding sheets provided to code each frame.

ACTIVITY 10

Create Your Own Template

PURPOSE: *This activity will help trainees to better understand the breakdown of tasks and activities, and will introduce to them how to setup an operation for PATH coding.*

TIME TO PERFORM: 45 min

MATERIALS: Templates and bubble sheets or Work Sampling Worksheets, Tile Grouter Video

TASK 1: Preparation
Divide Trainees into groups of three. Have each group pick one of the approved PATH operations/jobs generated during Activity #2. Go back to the easel sheet developed during that session.

TASK 2: Have each group create a coding template/Work Sampling Worksheet.
Provide each group with a skeleton template or Work Sampling Worksheet, and give them 30 minutes to develop a template or Work Sampling Worksheet for an operation.

TASK 3. Discuss the results.

ACTIVITY 10

Create Your Own Template

PURPOSE: *This activity will help trainees to better understand the breakdown of tasks and activities, and will introduce to them how to setup an operation for PATH coding.*

TASK: You will work in groups. Each group will be assigned an operation. Try to outline tasks for that operation. Make up all possible activities for each task. From this information create a coding template or Work Sampling Worksheet for that operation. Use the skeleton coding template or Work Sampling Worksheet provided. Make up different activities, and think through the possible coding possibilities.

ACTIVITY 11

Homework #2 -PATH code frozen frames of video

PURPOSE: *This activity will give trainees the opportunity to practice at home if they feel uncomfortable about proceeding into coding real time. They will gain confidence in recognizing tasks and activities, and in completely coding all PATH parts of an observation before moving on.*

TIME TO PERFORM: 1 hour

MATERIALS: Templates and bubble sheets or Work Sampling Worksheets, Tile Grouter Video

INTRODUCTION: The next step in the training process is to code the video real time. This is a challenging step, and if coders are not familiar with the tile grouting codes it will be difficult for them to code real time. Therefore this homework is offered optionally, for those coders who want more practice with the codes before attempting real time coding.

TASK 1: Have coders who want more practice take home and code completely the following frozen frames that have been pre-coded:

Frame No. (Time from zero)	Description	Record # (Obs #)

TASK 2 : Review problems briefly in class the next morning

STUDENT WORKSHEET

ACTIVITY 11

Homework #2 -PATH code frozen frames of video

PURPOSE: *This activity will give trainees the opportunity to practice at home if they feel uncomfortable about proceeding into coding real time. They will gain confidence in recognizing tasks and activities, and in completely coding all PATH parts of an observation before moving on.*

TASK 1: Take home and code completely frozen frames that have been pre-coded (defined below):

Frame No. (Time from zero)	Description	Record # (Obs #)

ACTIVITY 12

Code Video Real Time

PURPOSE: *This activity will give trainees the opportunity to practice coding real time.*

TIME TO PERFORM: 2 hour

MATERIALS: Templates and bubble sheets or Work Sampling Worksheets, Tile Grouter Video

TASK 1: Describe setup

The training video has a voice dubbed in which counts down at timed intervals for real time coding practice. Explain to coder's that intervals are first set at 2 minutes apart. A voice will say 'get ready' at 10 seconds left till coding time. The voice will then count down from 5 seconds left. Coders should code the same worker consecutively through the 2 minute interval section (10 consecutive codes) for a total of 20 minutes coding.

TASK 2: Initiate coding session for 2 minute coding intervals
Start the tape at frame 15.11. This is where 2 minute coding intervals begin. Do two trials of 2 minute coding sessions stopping after 10 observations to check codes.

TASK 3: Initiate coding session for 1 minute coding intervals
Start the tape at frame 55:11. This is where 1 minute timed coding intervals begin. Do 2 trials of 1 minute coding sessions stopping after 30 observations to check codes.

CHAPTER 4

TRAINER'S MATERIALS

Department of Work Environment
University of Massachusetts Lowell

CHAPTER 5

SUPPLEMENTARY PATH INFORMATION

Department of Work Environment
University of Massachusetts Lowell

OBJECTIVES

In this chapter coders will learn the importance and details of approaching workers to obtain additional information to codes necessary for a complete and accurate ergonomic assessment of the ergonomic hazards presented

The goals of this chapter are:

- To learn how to approach workers for additional technical information supplemental to PATH codes in a non offensive way.
- To learn the best way to handle typical difficult situations.
- To learn how to take notes, so that information is gathered in a useful way and so that you don't have to ask the same question twice.

On completion of this chapter, students will be able to:

- Approach workers for information
- Take adequate field notes

ACTIVITY 13

Role Play 1: How to Introduce the Project to Workers

PURPOSE: *This activity will give ideas on how to initially introduce the project goals to workers in an easy to understand, non-offensive matter, and also on how and when to get as many names, and informed consents as possible.*

TIME TO PERFORM: 30 min.

MATERIALS: Role Play #1 instruction sheet, Overhead slide # 8

INTRODUCTION: Before you can do PATH coding you will need to:

1) introduce yourself and the project goals to workers
2) identify workers preferably by their names
3) have workers sign informed consents

*****Show slide #8 - Informed Consent Form*****

Informed consents may be necessary to demonstrate that workers have been briefed on the project goals and that they are aware of their rights in the scope of the project. The following role plays were developed to provide guidance on how to approach workers for this type of information.

TASK 1: Choose three people from the group to role play (one researcher, and two workers) presenting possible conflicts that may arise while introducing yourself to the workers and asking for informed consents.

Role Play #1: Scenario #1

Researcher: Introduce yourself and describe why you are there. (For example - "I am Jane Doe from the University of Massachusetts Lowell, and I am involved with an occupational health study to determine the long term health effects of doing your work") Go into a long explanation about occupational health research, and the technicalities of the coding process. Tell the workers that you will be watching them, and will need informed consents.

Workers: Express fear of being a part of this, make some harsh comment about OSHA and losing your job. Say "No Way am I going to sign anything !!!" Finally stop talking completely to interviewer.

TASK 2: Have the rest of the group discuss mistakes made, and better ways to do it. Present these ideas on easel paper. Discuss when to back off, when to jump in, and when and how to record names and get informed consents.

Important mistakes which should be noted:

-
-

Important Recommendations which should be noted:

- As soon as possible write down names and descriptions so that the information is not lost
-
-
-

(A recommended format for informed consent is enclosed in the materials for this section).

TASK 3: Have the same two people perform the role play integrating corrections for the mistakes made the first time through.

Re- do Role Play #1: Scenario #2

Interviewer: Introduce yourself and describe why you are there. (For example - "I am Jane Doe from the University of Massachusetts Lowell, and I am involved with an occupational health study to determine *long term* health effects associated with your job"). Let them know that this study is being supported by the unions. Stress that you are not in any way connected with safety issues or OSHA. Then introduce an open ended question to get them into the discussion (For example - Have you ever been involved with anything like this before? What time do you start in the morning? Do you like this type of work? Is it hard on your back to lift that?) Also ask them if they have any health concerns, and take a genuine interest in the type of work they are doing. Say how it appears to be tough if it does etc. Tell them when you will be back. While this discussion is going on take note of who is participating the most. When the group discussion is over try to carry on additional individual conversations with the most willing people and at that time be more personal and try to get their names. You will use these people probably later on to open up some of the more difficult people to approach.

Workers: Be reluctant to answer questions at first. As the interviewer becomes more personal become more involved with the discussion, and express your concerns.

TASK 4: Have the rest of the group discuss results and their impression of the differences in scenario #1 vs. scenario #2.

ACTIVITY 14

Role Play 2: Ethnographics

PURPOSE: *This activity will provide a role play example of how to get additional personal ethnographic information about the workers which will be important during analysis when describing the characteristics of the group studied.*

TIME TO PERFORM: 30 min. MATERIALS: Role Play instruction sheet (From Dorothy Wigmore)

INTRODUCTION: Important information which supplements PATH coding data includes:

- Age
- Race
- Years in trade
- Level in trade
- Approximate height
- Approximate weight
- If worker has been injured (what part of the body)
- If worker experiences pain during work (over what part of the body)
- Work methods particular to a given worker or group of workers
- How they would do job/task differently
- What "tricks" workers use to do their job
- Why work is done a certain way
- Other information about the job (hours worked, layoffs, pressures, likes & dislikes)

This information will be gathered from many work breaks spent with the workers during the coding period. Some workers will be more open to telling their personal details than others. However, to eliminate bias, it is good to get similar data on all workers. The following role play should help you to understand how to get information from people about their jobs and to take notes about it.

TASK 1: Choose three people from the group to role play (one researcher, and two workers) presenting possible conflicts that may arise while trying to talk to the workers about personal information. The researcher should have a small notebook.

Role Play #2: Scenario #1

Researcher: Start by asking how long this kind of work has been done

Worker 1: Respond curtly

Researcher: Say that the foreman says they don't use lights when they should, to see their work; ask one worker why not?

Worker 1: Curse foreman

Worker 2: Say something about the foreman and how he yells at them regularly

Researcher: Ask if the foreman pushes them to do work, perhaps to take chances (e.g. how the scaffolding guards are set up)

LECTURE

Developing a Worker Matrix / Taking Field Notes

PURPOSE: *This lecture will help demonstrate organization of the important ethnographic information you get while talking to workers.*

TIME TO PERFORM: 15 min. MATERIALS: Overhead slide #9

*****Show overhead slide #9 - Worker Matrix*****

APPLICABLE TEXT: The results of the ethnographic conversations with the workers described in this chapter will be used to develop a worker matrix. Identification of the workers is the first entry and allows coders to randomize workers and perform PATH coding.

Other characteristics such as age, years in trade, level, height and weight allows an demographic understanding of the population under study. Because this information is probably obtained at many small meetings with workers, the information may become lost unless organized into a worker matrix. Continual maintenance and entry of data into a worker matrix also allows coders to see where holes exist in their ethnographic research. This type of characteristic data on workers becomes useful during analysis of the data.

TAKING NOTES:
Researchers should be provided with a small notebook specifically for taking notes in the field. It is important to always try to get down the information contained in the Worker Matrix. It is also valuable to capture good quotes. You should try to take notes as people talk. Put down everything that the worker said paraphrased if possible. Also in your field notes try to note how you got to talk to someone and/or the general circumstances/context of your conversation. If two researchers are working together, have one be assigned to taking notes while the other is talking. Also compare notes and thoughts after you have finished your conversation.

If the workers you are speaking with look nervous, you may not want to take notes in front of them, or you may want to ask them if it is o.k. with them to do so. One way is to make a joke about not remembering well. If you are not able to write as you talk to people then make sure you write down new information before leaving an area or within 5 minutes if possible.

CHAPTER 5

TRAINER'S MATERIALS

Department of Work Environment
University of Massachusetts Lowell

UNIVERSITY OF MASSACHUSETTS LOWELL
Institutional Review Board
Informed Consent Form

NOTICE: This Informed Consent Form is for a period not to exceed one year from date of approval appearing on this page.

Prepared: June 29, 1995
Project Title: Health Hazard Evaluations of Heavy Highway Construction Workers

Researcher(s): David H. Wegman, M.D.
Bryan O. Buchholz, Ph.D.
Laura Punnett, Sc.D.
Susan Woskie, Ph.D.

Approved for use by the
University of Massachusetts Lowell
Institutional Review Board

Signed: _____
IRB Chairperson

July 28, 1995
Date of Approval

Purpose
The purpose of this research project is to evaluate health hazards among heavy highway construction workers.

Procedure and Duration
You may be videotaped and/or observed in the workplace as you perform your normal work duties, so that ergonomically stressful conditions may be noted. You also may be asked to wear a personal air sampling device so that the exposure levels to various target agents may be measured. There are no risks associated with these procedures. The findings of this study will be made available in aggregate form through the Boston Building Trades Council or your employer. The study team will not be responsible for any necessary medical care.

Risks and Discomfort
There are no foreseeable risks or discomforts in being a participant in this research project.

Benefits
You will receive no direct benefit from your participation in this study, but the information gained may result in the improved health of construction workers.

Refusal or Withdrawal of Participation
Participation in this study is completely voluntary, and your participation, or non-participation, will not effect other relationships (e.g., employer). You may discontinue your participation in this research program at any time without penalty or costs of any nature, character and kind.

Privacy and Confidentiality
Every precaution shall be taken to protect your privacy and the confidentiality of the records and data pertaining to you in particular, and the research program in general, disclosure of which may contribute to identifying you specifically to persons not related to this research program.

Additional Information
If you do not understand any portion of what you are being asked to do, or the contents of this form, the researchers are available to provide a complete explanation. If you have any questions relating to this research project or would like a copy of your individual sampling results, please contact David H. Wegman, M.D., at the following address and phone number:

David H. Wegman, M.D.
Department of Work Environment
University of Massachusetts Lowell
One University Ave.
Lowell, MA 01854
(508) 934-3265

I understand and have been informed about the risks and/or discomforts, that I may experience as the result of being a participant in this research program.

I have read the statements contained herein, have had the opportunity to fully discuss my concerns and questions, and fully understand the nature and character of my involvement in this research program as a participant and the attendant risks and consequences.

_____ Date
Participant

6-29-95
David H. Wegman, M.D. Date
Principal Investigator

Worker Matr

Name	Description	Age	Years in trade	Occup./ Level	Height	Weight	Previous Injury (where)	Presence of symptoms in last week	Code #
T.C (Tom)	white hat, large, grey go-tee, glasses			Steward					1
Frank Sr.	green hat, mustache, late 40's, medium build, dark glasses			Foreman					2
Frank Jr.	white hat, thin, (early 20's)			1st year Apprentice					3
Creg	short black beard and mustache, blue eyes,			Apprentice					4
Randy	black, brown hair, short pony tail, beard, dark glasses, mean			Foreman					5
Ray	red hat, blond hair, pony tail, dark glasses, 5'6", medium build, beard, yellow suspenders, friendly								6
Paul L.	white hat with big flag sticker, short dirty blond hair, mustache, smokes cigars			Journey					7
Jean	white hat with flag sticker, heavy, bushy beard, dark shades, tall			Foreman					8
Jake (John)	black hat with orange specs, brown hair, medium slender build, smokes cigars								9
	black hat heavy, greying hair, beard								10

CHAPTER 5

STUDENT MATERIALS

Department of Work Environment
University of Massachusetts Lowell

CHAPTER 6

ON-SITE TRAINING

Department of Work Environment
University of Massachusetts Lowell

OBJECTIVES

In this chapter coders will learn how to fill out "operation cover sheets", split up workers and randomize in a non-biased way, set up data sheets for coding, and perform inter-rater reliability checks.

The goals of this chapter are:

- To have coders become comfortable with coding on-site
- To introduce the operation cover sheets.
- To introduce real coding by sampling workers randomly at 1 minute intervals
- To demonstrate the procedure for collecting and grading inter-rater reliability data

On completion of this chapter, students will be able to:

- Be able to code reliably on-site at 1 minute intervals
- Perform inter-rater reliability tests

LECTURE

On-Site Protocol

PURPOSE: *This lecture will define the procedure necessary for initiating coding on-site.*	
TIME TO PERFORM: 15 min.	MATERIALS: Overhead slides #10 and #11

Once on-site the following protocol should be followed:

- **Check in with your site contact**

You should always first check in with your site contact when arriving on-site to do coding.

- **Fill out an Operation Cover Sheet**

Show overhead slide #10 - "Operation Cover Sheet" ***

After checking in with your site contact, an "operation cover sheet" should be filled out. Operation cover sheets have been designed to gather additional information on environmental conditions and a description of the type of work performed for that day. They will also help coders to identify which workers are present that day. After a list of workers is generated on the operation cover sheet, they will need to be split up amongst coders and each coder will need to randomly sample his/her assigned workers.

- **Randomize workers**

Data sheets need to be set up prior to coding with the worker number's randomly preset for each observation. To randomly preset worker's numbers on-site a random number's generator has been developed.

*****Show overhead slide #11 - " Work Sampling Randomization Routine"*****

First identify which column you will be using, based on the number of workers you will be coding that day. Then on a scrap piece of paper assign a worker number to each sequential number listed. For example if you are watching 5 workers, whose numbers from the Worker Matrix are: 3, 7, 8, 10, and 15 then set 1=3, 2=7, 3=8, 4=10, and 5 =15. Go sequentially down the column labeled '5' on the random number's table. The first number is 4 so for the first observation on your first data sheet fill in "10", since the 4th worker you were assigned was worker number 10. Similarly the 2nd observation should be given worker number

3, because the 2nd entry on the random numbers table is a 1 and the first worker you were assigned was worker number 3. Continue until you have filled in enough data sheets to last you until at least break time.

- **Fill in the date, coder, and record number variables**

In addition to worker numbers other general information such as date, coder, and record number can be entered onto the data sheets prior to actual coding.

- **Initiate Coding**

After all of the preliminary information is entered onto data sheets coding can begin.

ACTIVITY 15

Simultaneous Coding of an Observation

PURPOSE: *This activity will allow coders to generate questions about coding of the particular operation you are watching. This will be a new operation that you have developed a coding template or Work Sampling Worksheet for.*	
TIME TO PERFORM: 1 hour	MATERIALS: *Coding Templates and bubble sheets or Work Sampling Worksheets applicable to the operation being watched

* A coding template will be developed by the trainer for the on-site training. The coding template or Work Sampling Worksheet should be briefly introduced at the last classroom training session.

TASK 1: Discuss tasks and activities particular to this operation. Discuss what workers are doing (describe w/ PATH codes). Generate questions about coding which will get coders thinking about what they should be looking at prior to the exact moment of coding. That is, codes such as tasks, tools/equipment and even activity can often be predetermined since they do not usually change over a few second interval.

TASK 2: Code an observation simultaneously. Count down from 10, "10-9-8-7-6-5-4-3-2-1-**Code**", to initiate coding an observation together. Immediately following the coding of an observation, discuss the codes, and answer questions which help to clarify codes. Repeat this process, until it appears that all coders are coding similarly.

Note: If postures and activities, if the coders are coded by different coders at different times as little as 1 or 2 seconds apart, different codes may result. Therefore, it is important to recognize if the worker may have changed his position shortly after the signal was given to code, because this could be the cause of discrepancies in codes between coders, and not that one coder was correct and one coder was incorrect.

ACTIVITY 16

Continuous Real Time Coding for Inter-rater Reliability Check

PURPOSE: *This activity will be performed initially to determine if coders need more practice coding, and then later it will be filed for reference when doing analysis and writing up conclusions.*

TIME TO PERFORM: 2 hour 30 min.

MATERIALS: Coding Templates and bubble sheets or Work Sampling Worksheets applicable to the operation being watched

TASK: Break down class into groups of two to four coders
Inter-rater reliability checks should be done into groups of 2 to 4. If you have more than one group you will need a facilitator(s) to help with count down's, or set up coding sessions for the groups (one group will break while the other is coding). One of the 4 coders should be an experienced PATH coder.

TASK 2: Make sure the worker you will be watching is optimally viewed by all coders. Inter-rater reliability coding is difficult and stressful, because coders are essentially being graded on accuracy of coding. Therefore it is important that optimal conditions for coding are provided. Coders should also have similar views of the worker and therefore coders should stand next to one another while coding

TASK 3: Initiate inter-rater reliability coding. Inter-rater reliability coding should entail 30 consecutive observations at 1 minute intervals. The person counting down should be aware of observation which may be coded inconsistently due to coders initiating coding at slightly different intervals (i.e. when worker appears to have changed posture or activity significantly within 2 seconds after the "code" signal was given). These types of observations should be noted and possibly deleted from the inter-rater reliability calculations.

TASK 4: Calculate Inter-rater reliability's:

Inter-rater reliability's are calculated separately for each exposure variable (i.e. task, trunk posture, head posture, leg posture, arm posture, load handled, activities, tools/equipment, and hand postures). Inter-rater reliability's are based on a comparison of two coders only. The procedure for calculating inter-rater reliability's is as follows:

1) Count up the total number of codes for each coder (TotObs). This will be the denominator of the inter-rater reliability calculation.
2) If one coder did not code one or more of the same variables (i.e. one or more task, head posture etc.) then eliminate them from that individual calculation. That is, do not use any data that only one coder coded. This becomes tricky when analyzing tools used or activities, because first you need to look at hand postures and determine if the coder could just not view the hands or if he/she really did forget to enter in the activity.
3) From the observations that both coders coded count the number of times they agreed on a code. This will be the numerator of the inter-rater reliability calculation (TotAgree).

Inter-rater reliability Calculations:

$I.R_{task} = (TotAgree_{task})/(TotObs_{task})$
$I.R_{trunk} = (TotAgree_{trunk})/(TotObs_{trunk})$
$I.R_{head} = (TotAgree_{head})/(TotObs_{head})$
$I.R_{leg} = (TotAgree_{leg})/(TotObs_{leg})$
$I.R_{arm} = (TotAgree_{arm})/(TotObs_{arm})$
$I.R_{load} = (TotAgree_{load})/(TotObs_{load})$
$I.R_{Tool\ use} = (TotAgree_{Tool\ use})/(TotObs_{Tool\ use})$
$I.R_{Activities} = (TotAgree_{Activities})/(TotObs_{Activities})$
$I.R_{Tool/Equip} = (TotAgree_{Tool/Equip})/(TotObs_{Tool/Equip})$
$I.R_{Hand} = (TotAgree_{Hand})/(TotObs_{Hand})$

Sample data and inter-rater reliability calculations are provided in Appendix B of this manual.

TASK 4: If inter-rater reliability's are low (below .80) then repeat activity #16 and try inter-rater reliability coding again.

TASK 5: If inter-rater reliability's are sufficient (above .80) then document and begin taking data.

CHAPTER 6

TRAINER'S MATERIALS

Department of Work Environment
University of Massachusetts Lowell

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
7:00 AM	1	2	2	2	5	6	1	9	1
7:01 AM	1	1	4	3	2	6	7	9	3
7:02 AM	2	2	3	5	5	7	5	9	3
7:03 AM	1	1	4	2	2	3	1	8	2
7:04 AM	1	3	3	1	5	5	2	9	4
7:05 AM	1	3	1	2	6	3	1	1	1
7:06 AM	1	1	4	4	6	6	4	1	9
7:07 AM	1	1	4	1	3	7	6	7	5
7:08 AM	1	2	4	5	3	6	7	2	4
7:09 AM	1	1	4	4	6	6	8	3	8
7:10 AM	2	3	1	5	3	3	4	3	3
7:11 AM	2	1	3	4	2	2	6	5	1
7:12 AM	1	3	2	3	4	1	2	7	3
7:13 AM	2	3	3	3	2	7	6	5	5
7:14 AM	1	1	2	1	5	5	2	2	5
7:15 AM	2	1	2	2	6	5	5	4	4
7:16 AM	2	1	4	4	5	3	8	5	6
7:17 AM	2	1	1	3	5	6	4	8	3
7:18 AM	2	1	1	1	5	6	2	9	4
7:19 AM	1	1	4	3	1	4	5	8	2
7:20 AM	1	2	3	5	6	1	1	6	8
7:21 AM	1	2	4	3	1	3	2	9	8
7:22 AM	1	3	3	3	5	7	6	1	8
7:23 AM	1	1	4	1	1	4	7	8	8
7:24 AM	1	1	3	4	3	1	7	9	4
7:25 AM	2	2	4	2	1	1	6	9	5
7:26 AM	2	2	2	5	5	6	1	2	1
7:27 AM	2	1	3	5	3	6	4	6	5
7:28 AM	2	3	2	5	4	4	6	4	4
7:29 AM	2	3	4	5	4	2	1	1	5
7:30 AM	1	3	4	3	5	3	4	3	3
7:31 AM	2	1	1	5	1	4	2	5	6
7:32 AM	1	3	2	1	1	1	5	7	10
7:33 AM	1	1	4	2	3	4	3	3	10
7:34 AM	2	3	1	1	1	2	4	5	1
7:35 AM	1	1	3	1	1	5	1	8	5
7:36 AM	2	1	4	5	1	2	8	8	8
7:37 AM	2	2	2	2	5	5	2	9	9
7:38 AM	1	2	3	4	3	6	4	8	7
7:39 AM	2	3	3	5	2	4	7	7	6
7:40 AM	1	3	4	3	3	1	5	2	1
7:41 AM	1	1	4	2	1	3	5	1	6
7:42 AM	2	1	4	5	3	7	8	6	4
7:43 AM	2	1	4	1	1	4	6	6	1
7:44 AM	2	2	3	5	1	4	8	9	9
7:45 AM	1	3	4	5	5	7	2	9	10
7:46 AM	2	2	4	5	3	1	5	1	5
7:47 AM	1	3	2	3	2	1	3	2	6
7:48 AM	1	2	2	2	3	4	3	7	6
7:49 AM	1	3	1	5	4	7	4	5	9
7:50 AM	1	3	3	5	1	3	4	3	1
7:51 AM	1	2	4	1	2	4	5	8	4
7:52 AM	2	3	4	5	6	4	4	2	1
7:53 AM	2	1	1	4	2	4	6	5	4
7:54 AM	1	3	3	3	3	7	5	7	8
7:55 AM	1	2	3	3	3	7	4	6	2
7:56 AM	1	2	4	5	3	5	8	2	7
7:57 AM	1	2	1	5	4	7	2	7	2
7:58 AM	1	3	4	2	3	7	5	1	10
7:59 AM	2	2	3	3	1	6	1	1	8
8:00 AM	2	1	3	3	6	7	4	7	7

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
9:02 AM	2	1	2	4	3	2	8	3	4
9:03 AM	1	1	3	1	5	1	4	2	4
9:04 AM	1	1	1	1	4	4	4	8	2
9:05 AM	1	2	3	3	5	3	6	6	8
9:06 AM	1	2	2	4	1	3	1	1	3
9:07 AM	1	3	2	2	1	2	6	7	9
9:08 AM	2	2	2	1	6	4	6	6	5
9:09 AM	1	1	2	4	6	7	3	2	5
9:10 AM	2	1	1	1	1	1	4	6	8
9:11 AM	1	3	1	2	5	6	2	7	3
9:12 AM	2	1	3	3	1	6	7	4	9
9:13 AM	1	2	4	1	1	1	4	3	10
9:14 AM	2	1	4	5	6	6	6	5	9
9:15 AM	1	3	2	1	6	4	7	7	8
9:16 AM	2	3	3	5	3	3	4	6	6
9:17 AM	1	3	4	5	5	5	5	9	6
9:18 AM	1	2	4	5	2	1	8	6	4
9:19 AM	1	3	3	4	4	4	8	8	2
9:20 AM	2	1	3	4	1	7	7	1	5
9:21 AM	2	2	4	4	2	2	4	5	3
9:22 AM	1	1	2	5	3	4	8	6	4
9:23 AM	1	3	2	2	4	2	8	1	6
9:24 AM	1	2	2	4	2	1	2	8	2
9:25 AM	2	1	3	2	2	1	1	2	8
9:26 AM	1	3	2	1	4	5	1	3	2
9:27 AM	2	1	2	2	3	1	5	1	2
9:28 AM	2	2	1	1	3	6	2	5	8
9:29 AM	1	1	1	1	4	6	2	6	1
9:30 AM	2	1	1	2	3	2	2	6	7
9:31 AM	1	1	2	5	4	1	7	6	4
9:32 AM	1	3	3	1	3	2	6	3	5
9:33 AM	2	1	1	4	3	3	3	2	3
9:34 AM	1	1	3	4	4	5	6	6	8
9:35 AM	1	3	1	4	4	5	8	9	9
9:36 AM	1	1	2	1	1	7	5	4	9
9:37 AM	1	2	4	5	6	7	3	8	8
9:38 AM	1	2	2	3	4	3	7	1	7
9:39 AM	1	2	2	5	2	6	5	4	5
9:40 AM	1	3	1	4	6	7	3	6	6
9:41 AM	2	1	3	2	6	4	5	3	8
9:42 AM	2	2	1	2	3	5	8	4	4
9:43 AM	2	2	1	5	1	3	2	2	4
9:44 AM	2	2	2	4	3	7	8	5	5
9:45 AM	2	3	2	2	1	7	1	9	6
9:46 AM	1	2	4	5	6	6	8	4	2
9:47 AM	1	1	3	3	6	1	8	1	3
9:48 AM	1	2	4	3	1	4	4	7	10
9:49 AM	2	3	1	3	5	4	2	6	3
9:50 AM	1	3	3	3	4	6	7	4	10
9:51 AM	1	2	3	4	2	5	7	5	2
9:52 AM	1	1	2	2	2	7	1	5	6
9:53 AM	2	2	3	4	5	4	2	8	9
9:54 AM	2	2	1	2	3	6	7	4	2
9:55 AM	2	2	3	5	3	3	5	8	3
9:56 AM	1	1	1	2	5	4	6	6	2
9:57 AM	1	3	2	5	4	1	2	9	10
9:58 AM	2	1	2	3	2	6	8	2	8
9:59 AM	1	3	4	2	6	5	3	1	5
10:00 AM	2	1	4	1	2	2	3	5	7
10:01 AM	1	2	1	2	5	7	3	9	9
10:02 AM	2	1	1	5	5	4	8	9	3

Date: Record Numbers:_____

OPERATION COVER SHEET

Job site:

Contractor/ subcontractor:

Contact person at site:

Stage of work project and brief description of what is involved:

Projected length of work stage, operation:

Physical conditions (temperature, rain, muddy, noise, etc.):

trade	names and initials	description: color hat, clothes, height, weight	trade yrs.	PPE?

Union local:

Tools and materials	weights

Number of people on crew____. Performing of same or complementary tasks? describe.

Approximate viewing distance away from worker(s), viewing from well above worker? below? about the same height ? Mainly from behind, in front?

CHAPTER 6

STUDENT MATERIALS

Department of Work Environment
University of Massachusetts Lowell

STUDENT WORKSHEET

ACTIVITY 15

Simultaneous Coding of an Observation

PURPOSE: *This activity will allow coders to generate questions about coding of a new operation on-site.*

TASK: Take out coding templates and several bubble sheets or Work Sampling Worksheets. You will be coding at varied intervals, where your instructor will count down from 10 to "code". Make sure you ask questions now because later on it will be more difficult.

Month / Day

0 1 2 3 4 5 6 7 8 9 10 11 12

Hour / Minute

0 1 2 3 4 5 6 7 8 9 10 11 12

Coder

1 2 3 4 5 6

1
2
3
4
5
6
7
8
9

Rec No.

1
2
3
4
5
6
7
8
9
12
13
14
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29
30
31
32
33
34
37
38
39
40

Work Sampling Worksheet
Tile Grouting Operation

Date:	Time:	Coder:	Record No:
		Observations	

			1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Worker Number:															
1	Task :	Prepare Joints														
2		Prepare to Grout														
3		Grout														
4		Clean														
5		Misc														
6	Posture:	Trunk (1-4)														
7		Head (1-2)														
8		Legs (1-10)														
9		Arms (1-3)														
10	Weight in hands (total lbs):															
11	MMH:	Lift														
12		Lower														
13		Carry														
14		Move/Place														
15		Push/pull/drag														
16	Tool Specific	Operate Hand Tool														
17	Activities:	Operate Power Tool														
18		Hold tool Not Operate														
19	General	Hold: Steady/Maintain														
20	Activities:	Hold: wall/table/rail														
21		Walk														
22		Point/direct														
23		Reach														
24		Climb/Descend														
25		In Between Tasks														
26		Not Obs./not sure														
	Tile Grouter	Pull Rope														
	Activities	Scrape														
29		Pour Mix														
30		Mix														
31		Scoop Grout														
32		Wipe Float w/ Trowel														
33		Spread Grout														
34		Rinse bucket														
35		Tie/Untie bucket														
36		Fill bucket w/ water														
37		Wash/Wipe/Clean														
38		Rinse sponge														
39		Dump water														
40		Clean tool														
41		Other														
42	Tools/	Knife/Razor/Scraper														
43	Equipment	Bag of grout														
44		Trowel														
45		Rubber float														
46		Bucket														
47		Sponge														
48		Hose														
49		Rope														
50		Ladder														
51		Barrel														
52		Board														
53		Scaffold														
54		Other														
55	Hand Postures	Hand 1: gross grasp														
		Hand 2: gross grasp														
		Hand 1: pinch														
		Hand 2: pinch														
59		Hand 1: other														
60		Hand 2: other														
61		Hand 1: empty														
62		Hand 2: empty														

ACTIVITY 16

Continuous Real Time Coding for Inter-rater Reliability Check

PURPOSE: *This activity will be performed initially to determine if coders need more practice coding, and then later it will be documented for use in ergonomic analysis write-up.*

TASK : You will be split into groups two to four for this activity. Coding of 30 consecutive observations will be at 1 minute intervals. You will be watching only one worker for the entire duration of this activity. If you cannot see a code and/or are unsure of a code then leave it blank. This is important because it is better to leave a code blank than to code inaccurately.

Work Sampling Randomization Routine

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
7:00 AM	1	2	2	2	5	6	1	9	1
7:01 AM	1	1	4	3	2	6	7	9	3
7:02 AM	2	2	3	5	5	7	5	9	3
7:03 AM	1	1	4	2	2	3	1	8	2
7:04 AM	1	3	3	1	5	5	2	9	4
7:05 AM	1	3	1	2	6	3	1	1	1
7:06 AM	1	1	4	4	6	6	4	1	9
7:07 AM	1	1	4	1	3	7	6	7	5
7:08 AM	1	2	4	5	3	6	7	2	4
7:09 AM	1	1	4	4	6	6	8	3	8
7:10 AM	2	3	1	5	3	3	4	3	3
7:11 AM	2	1	3	4	2	2	6	5	1
7:12 AM	1	3	2	3	4	1	2	7	3
7:13 AM	2	3	3	3	2	7	6	5	5
7:14 AM	1	1	2	1	5	5	2	2	5
7:15 AM	2	1	2	2	6	5	5	4	4
7:16 AM	2	1	4	4	5	3	8	5	6
7:17 AM	2	1	1	3	5	6	4	8	3
7:18 AM	2	1	1	1	5	6	2	9	4
7:19 AM	1	1	4	3	1	4	5	8	2
7:20 AM	1	2	3	5	6	1	1	6	8
7:21 AM	1	2	4	3	1	3	2	9	8
7:22 AM	1	3	3	3	5	7	6	1	8
7:23 AM	1	1	4	1	1	4	7	8	8
7:24 AM	1	1	3	4	3	1	7	9	4
7:25 AM	2	2	4	2	1	1	6	9	5
7:26 AM	2	2	2	5	5	6	1	2	1
7:27 AM	2	1	3	5	3	6	4	6	5
7:28 AM	2	3	2	5	4	4	6	4	4
7:29 AM	2	3	4	5	4	2	1	1	5
7:30 AM	1	3	4	3	5	3	4	3	3
7:31 AM	2	1	1	5	1	4	2	5	6
7:32 AM	1	3	2	1	1	1	5	7	10
7:33 AM	1	1	4	2	3	4	3	3	10
7:34 AM	2	3	1	1	1	2	4	5	1
7:35 AM	1	1	3	1	1	5	1	8	5
7:36 AM	2	1	4	5	1	2	8	8	8
7:37 AM	2	2	2	2	5	5	2	9	9
7:38 AM	1	2	3	4	3	6	4	8	7
7:39 AM	2	3	3	5	2	4	7	7	6
7:40 AM	1	3	4	3	3	1	5	2	1
7:41 AM	1	1	4	2	1	3	5	1	6
7:42 AM	2	1	4	5	3	7	8	6	4
7:43 AM	2	1	4	1	1	4	6	6	1
7:44 AM	2	2	3	5	1	4	8	9	9
7:45 AM	1	3	4	5	5	7	2	9	10
7:46 AM	2	2	4	5	3	1	5	1	5
7:47 AM	1	3	2	3	2	1	3	2	6
7:48 AM	1	2	2	2	3	4	3	7	6
7:49 AM	1	3	1	5	4	7	4	5	9
7:50 AM	1	3	3	5	1	3	4	3	1
7:51 AM	1	2	4	1	2	4	5	8	4
7:52 AM	2	3	4	5	6	4	4	2	1
7:53 AM	2	1	1	4	2	4	6	5	4
7:54 AM	1	3	3	3	3	7	5	7	8
7:55 AM	1	2	3	3	3	7	4	6	2
7:56 AM	1	2	4	5	3	5	8	2	7
7:57 AM	1	2	1	5	4	7	2	7	2
7:58 AM	1	3	4	2	3	7	5	1	10
7:59 AM	2	2	3	3	1	6	1	1	8
8:00 AM	2	1	3	3	6	7	4	7	7

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
8:01 AM	2	2	2	5	4	6	2	9	7
8:02 AM	1	3	4	2	6	3	4	1	10
8:03 AM	1	2	3	4	6	1	6	4	2
8:04 AM	2	2	3	2	3	7	6	1	6
8:05 AM	1	1	2	4	2	3	3	1	8
8:06 AM	1	1	3	5	6	6	1	6	5
8:07 AM	2	1	1	1	6	7	2	6	4
8:08 AM	2	2	3	3	6	1	5	2	3
8:09 AM	1	1	1	1	1	3	2	1	3
8:10 AM	2	1	4	4	2	5	4	2	6
8:11 AM	1	3	2	1	1	3	1	6	10
8:12 AM	2	2	1	3	5	5	2	1	6
8:13 AM	1	2	1	1	1	2	4	7	4
8:14 AM	2	2	4	5	1	2	5	5	8
8:15 AM	2	2	2	1	6	5	8	1	9
8:16 AM	2	2	2	2	6	6	8	8	9
8:17 AM	1	3	3	1	6	1	1	1	5
8:18 AM	1	1	4	3	2	1	4	5	8
8:19 AM	2	2	3	5	4	1	8	2	3
8:20 AM	1	2	1	2	1	1	8	4	3
8:21 AM	1	3	2	4	6	3	7	5	10
8:22 AM	2	2	1	3	5	3	8	3	7
8:23 AM	2	3	4	4	5	5	1	8	2
8:24 AM	2	1	2	1	2	1	8	5	6
8:25 AM	2	1	1	4	1	3	6	6	9
8:26 AM	2	3	2	5	4	2	4	1	8
8:27 AM	1	2	4	5	5	6	1	8	10
8:28 AM	2	2	4	1	1	3	2	5	4
8:29 AM	2	2	1	2	2	2	6	7	3
8:30 AM	2	3	4	1	5	7	5	4	7
8:31 AM	1	1	3	1	3	1	5	8	4
8:32 AM	2	3	1	5	1	4	6	8	4
8:33 AM	2	3	4	4	6	7	7	4	2
8:34 AM	1	2	4	1	5	6	3	9	3
8:35 AM	2	3	4	4	4	2	8	3	7
8:36 AM	1	3	1	3	6	3	3	1	5
8:37 AM	1	1	3	2	6	4	1	6	6
8:38 AM	1	1	2	3	2	2	8	7	7
8:39 AM	2	3	3	5	3	2	6	6	6
8:40 AM	2	2	4	3	2	5	2	3	8
8:41 AM	2	2	4	4	2	3	2	7	7
8:42 AM	1	3	2	5	1	5	7	5	1
8:43 AM	2	2	4	1	2	4	4	4	2
8:44 AM	2	1	3	5	5	4	8	8	5
8:45 AM	2	3	2	1	3	2	1	3	10
8:46 AM	2	2	3	2	2	5	4	4	10
8:47 AM	2	3	2	3	2	6	5	9	1
8:48 AM	1	1	2	4	2	7	7	3	9
8:49 AM	2	3	4	1	1	5	3	4	3
8:50 AM	2	2	3	1	5	2	8	9	7
8:51 AM	2	1	3	4	1	7	2	6	2
8:52 AM	1	3	3	1	4	3	8	6	3
8:53 AM	2	1	4	2	2	2	7	4	5
8:54 AM	1	2	4	3	3	7	5	2	4
8:55 AM	1	1	4	1	1	2	4	4	9
8:56 AM	2	3	2	5	3	2	2	5	1
8:57 AM	2	1	4	4	4	7	3	8	5
8:58 AM	1	2	3	2	2	7	1	4	8
8:59 AM	1	1	1	2	3	4	5	2	10
9:00 AM	2	3	1	4	5	2	6	4	9
9:01 AM	1	2	3	1	1	1	5	8	4

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
9:02 AM	2	1	2	4	3	2	8	3	4
9:03 AM	1	1	3	1	5	1	4	2	4
9:04 AM	1	1	1	1	4	4	4	8	2
9:05 AM	1	2	3	3	5	3	6	6	8
9:06 AM	1	2	2	4	1	3	1	1	3
9:07 AM	1	3	2	2	1	2	6	7	9
9:08 AM	2	2	2	1	6	4	6	6	5
9:09 AM	1	1	2	4	6	7	3	2	5
9:10 AM	2	1	1	1	1	1	4	6	8
9:11 AM	1	3	1	2	5	6	2	7	3
9:12 AM	2	1	3	3	1	6	7	4	9
9:13 AM	1	2	4	1	1	1	4	3	10
9:14 AM	2	1	4	5	6	6	6	5	9
9:15 AM	1	3	2	1	6	4	7	7	8
9:16 AM	2	3	3	5	3	3	4	6	6
9:17 AM	1	3	4	5	5	5	5	9	6
9:18 AM	1	2	4	5	2	1	8	6	4
9:19 AM	1	3	3	4	4	4	8	8	2
9:20 AM	2	1	3	4	1	7	7	1	5
9:21 AM	2	2	4	4	2	2	4	5	3
9:22 AM	1	1	2	5	3	4	8	6	4
9:23 AM	1	3	2	2	4	2	8	1	6
9:24 AM	1	2	2	4	2	1	2	8	2
9:25 AM	2	1	3	2	2	1	1	2	8
9:26 AM	1	3	2	1	4	5	1	3	2
9:27 AM	2	1	2	2	3	1	5	1	2
9:28 AM	2	2	1	1	3	6	2	5	8
9:29 AM	1	1	1	1	4	6	2	6	1
9:30 AM	2	1	1	2	3	2	2	6	7
9:31 AM	1	1	2	5	4	1	7	6	4
9:32 AM	1	3	3	1	3	2	6	3	5
9:33 AM	2	1	1	4	3	3	3	2	3
9:34 AM	1	1	3	4	4	5	6	6	8
9:35 AM	1	3	1	4	4	5	8	9	9
9:36 AM	1	1	2	1	1	7	5	4	9
9:37 AM	1	2	4	5	6	7	3	8	8
9:38 AM	1	2	2	3	4	3	7	1	7
9:39 AM	1	2	2	5	2	6	5	4	5
9:40 AM	1	3	1	4	6	7	3	6	6
9:41 AM	2	1	3	2	6	4	5	3	8
9:42 AM	2	2	1	2	3	5	8	4	4
9:43 AM	2	2	1	5	1	3	2	2	4
9:44 AM	2	2	2	4	3	7	8	5	5
9:45 AM	2	3	2	2	1	7	1	9	6
9:46 AM	1	2	4	5	6	6	8	4	2
9:47 AM	1	1	3	3	6	1	8	1	3
9:48 AM	1	2	4	3	1	4	4	7	10
9:49 AM	2	3	1	3	5	4	2	6	3
9:50 AM	1	3	3	3	4	6	7	4	10
9:51 AM	1	2	3	4	2	5	7	5	2
9:52 AM	1	1	2	2	2	7	1	5	6
9:53 AM	2	2	3	4	5	4	2	8	9
9:54 AM	2	2	1	2	3	6	7	4	2
9:55 AM	2	2	3	5	3	3	5	8	3
9:56 AM	1	1	1	2	5	4	6	6	2
9:57 AM	1	3	2	5	4	1	2	9	10
9:58 AM	2	1	2	3	2	6	8	2	8
9:59 AM	1	3	4	2	6	5	3	1	5
10:00 AM	2	1	4	1	2	2	3	5	7
10:01 AM	1	2	1	2	5	7	3	9	9
10:02 AM	2	1	1	5	5	4	8	9	3

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
10:03 AM	1	1	3	2	6	2	2	5	6
10:04 AM	2	1	2	1	3	6	8	8	9
10:05 AM	1	1	4	5	6	7	1	9	6
10:06 AM	1	3	4	2	1	7	2	2	8
10:07 AM	1	3	3	1	5	4	7	8	9
10:08 AM	1	2	2	3	6	2	6	6	6
10:09 AM	1	3	4	4	3	6	2	1	1
10:10 AM	2	3	2	3	3	4	2	1	6
10:11 AM	2	1	4	1	1	3	8	2	1
10:12 AM	2	1	2	4	3	4	1	2	2
10:13 AM	1	3	2	5	1	5	5	9	9
10:14 AM	2	3	3	1	1	6	6	7	5
10:15 AM	2	2	3	5	4	2	6	3	6
10:16 AM	2	1	4	2	5	1	6	6	5
10:17 AM	1	3	2	5	5	4	4	6	1
10:18 AM	2	3	2	3	5	5	6	3	1
10:19 AM	1	2	2	2	2	7	2	2	6
10:20 AM	1	3	3	4	2	4	4	1	7
10:21 AM	2	1	4	2	1	2	4	9	9
10:22 AM	1	1	2	2	1	2	5	6	7
10:23 AM	2	2	1	1	6	4	7	5	8
10:24 AM	1	2	4	2	1	7	4	9	8
10:25 AM	1	2	3	1	5	2	3	6	6
10:26 AM	2	2	2	4	6	5	1	7	8
10:27 AM	2	3	4	3	1	6	7	7	7
10:28 AM	1	1	3	5	1	7	5	4	10
10:29 AM	1	1	2	2	2	6	3	9	4
10:30 AM	1	1	4	3	1	1	2	8	5
10:31 AM	1	2	3	3	3	6	2	9	7
10:32 AM	2	2	2	4	1	5	5	8	1
10:33 AM	2	2	2	5	6	5	4	4	9
10:34 AM	2	2	4	2	2	4	1	7	6
10:35 AM	1	3	4	2	6	2	1	8	3
10:36 AM	1	3	4	1	1	1	8	3	9
10:37 AM	1	2	4	4	1	4	3	9	9
10:38 AM	2	3	2	1	3	4	8	7	6
10:39 AM	1	2	4	3	4	6	5	4	10
10:40 AM	1	1	1	4	3	2	2	3	7
10:41 AM	1	3	4	4	2	3	2	1	4
10:42 AM	1	2	1	2	6	5	8	6	4
10:43 AM	1	2	2	4	6	6	3	1	3
10:44 AM	1	2	1	1	1	7	1	4	2
10:45 AM	1	3	2	3	6	3	1	8	9
10:46 AM	1	2	2	5	3	5	1	5	1
10:47 AM	2	1	1	5	3	6	3	5	10
10:48 AM	1	3	1	4	5	7	1	8	1
10:49 AM	2	2	3	5	4	1	4	7	5
10:50 AM	1	2	2	3	3	5	1	5	4
10:51 AM	1	2	4	5	3	1	2	2	8
10:52 AM	2	3	1	5	5	3	2	7	6
10:53 AM	1	1	3	5	2	1	2	4	4
10:54 AM	1	2	1	4	1	6	1	4	5
10:55 AM	1	3	4	4	4	3	2	1	8
10:56 AM	1	3	3	3	6	7	4	4	5
10:57 AM	1	1	4	5	4	7	4	3	3
10:58 AM	1	2	4	1	3	6	4	2	2
10:59 AM	2	3	1	4	3	2	5	4	4
11:00 AM	2	1	3	2	5	2	6	8	7
11:01 AM	2	2	2	4	5	7	3	7	7
11:02 AM	1	2	2	5	5	1	3	8	9
11:03 AM	1	1	3	5	5	5	7	3	10

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
11:04 AM	1	2	4	4	5	5	7	8	2
11:05 AM	2	1	1	3	1	5	4	8	9
11:06 AM	2	1	2	1	2	3	3	6	2
11:07 AM	2	2	4	3	5	6	2	4	10
11:08 AM	1	2	2	2	5	5	8	3	2
11:09 AM	1	2	1	5	1	5	8	6	1
11:10 AM	2	2	4	2	3	4	5	6	2
11:11 AM	2	2	1	2	1	5	6	4	2
11:12 AM	2	1	3	2	2	4	3	5	6
11:13 AM	1	3	4	2	3	2	8	6	4
11:14 AM	2	2	1	1	3	5	4	8	1
11:15 AM	1	3	1	2	4	5	4	8	9
11:16 AM	2	1	3	4	6	5	7	6	10
11:17 AM	2	2	1	2	3	3	6	8	3
11:18 AM	2	3	1	4	6	7	7	1	4
11:19 AM	1	2	2	1	1	7	5	1	2
11:20 AM	2	3	3	1	4	6	6	1	1
11:21 AM	2	1	2	2	4	3	7	2	2
11:22 AM	2	3	4	3	2	6	1	8	8
11:23 AM	1	1	4	2	5	1	5	8	8
11:24 AM	1	2	4	2	5	4	5	1	8
11:25 AM	2	2	3	4	4	4	3	2	6
11:26 AM	1	3	1	1	5	7	4	2	5
11:27 AM	2	3	3	3	3	7	2	9	1
11:28 AM	2	3	2	5	6	3	4	5	5
11:29 AM	1	1	3	3	6	1	2	4	5
11:30 AM	1	1	4	1	4	7	1	3	9
11:31 AM	1	3	2	3	1	3	5	1	4
11:32 AM	2	2	1	3	1	5	7	8	9
11:33 AM	2	3	2	4	6	2	4	9	8
11:34 AM	1	2	4	1	1	2	8	5	1
11:35 AM	2	3	3	3	2	3	7	6	10
11:36 AM	2	2	2	1	1	7	4	6	6
11:37 AM	1	1	3	3	2	5	7	5	10
11:38 AM	2	1	4	2	4	4	1	1	1
11:39 AM	2	2	1	1	3	3	4	5	9
11:40 AM	1	1	1	1	1	3	1	6	7
11:41 AM	2	1	3	4	4	6	1	3	4
11:42 AM	2	1	2	3	1	3	2	7	6
11:43 AM	1	3	3	5	1	3	7	2	3
11:44 AM	1	1	1	2	1	2	7	6	10
11:45 AM	2	1	1	5	1	3	4	4	1
11:46 AM	1	1	4	5	6	2	8	4	5
11:47 AM	1	1	2	3	6	3	7	6	8
11:48 AM	2	3	4	5	2	6	3	7	4
11:49 AM	1	2	1	3	1	4	7	9	10
11:50 AM	2	2	1	2	4	5	8	3	5
11:51 AM	1	2	1	3	1	1	7	1	8
11:52 AM	1	1	1	5	3	3	4	1	1
11:53 AM	1	1	3	5	2	1	7	7	6
11:54 AM	2	1	1	2	3	7	6	4	7
11:55 AM	1	3	2	1	1	1	2	4	6
11:56 AM	2	3	3	2	3	7	6	3	2
11:57 AM	2	2	2	3	3	7	5	9	9
11:58 AM	2	1	1	1	4	2	4	4	10
11:59 AM	1	1	1	1	5	2	4	4	6
12:00 PM	2	3	1	1	2	5	7	5	4
12:01 PM	2	2	2	5	2	3	8	4	5
12:02 PM	2	3	3	3	3	1	5	5	9
12:03 PM	1	2	4	3	3	1	6	3	8
12:04 PM	1	1	1	5	4	5	5	5	2

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
12:05 PM	2	1	1	2	2	3	4	5	5
12:06 PM	1	1	4	5	5	7	8	2	10
12:07 PM	1	2	4	2	2	4	7	4	5
12:08 PM	1	1	4	3	2	5	7	4	4
12:09 PM	1	1	3	4	1	2	1	5	8
12:10 PM	2	2	3	4	2	3	1	4	1
12:11 PM	2	1	4	1	2	7	7	3	10
12:12 PM	1	3	1	2	5	6	5	6	8
12:13 PM	1	2	1	5	4	7	3	5	8
12:14 PM	1	2	1	4	3	4	4	7	9
12:15 PM	1	1	2	1	1	7	2	6	6
12:16 PM	2	3	2	2	6	5	8	5	5
12:17 PM	2	2	1	1	3	4	1	5	8
12:18 PM	2	3	2	1	4	5	1	6	9
12:19 PM	1	1	2	1	4	3	4	4	6
12:20 PM	1	2	1	3	6	6	8	1	3
12:21 PM	2	2	1	3	5	3	1	7	10
12:22 PM	1	2	3	1	3	3	1	5	3
12:23 PM	1	3	1	2	4	7	8	8	1
12:24 PM	2	3	4	4	5	5	7	5	4
12:25 PM	2	3	3	5	1	6	1	8	3
12:26 PM	2	2	4	2	4	4	5	9	9
12:27 PM	1	2	3	5	1	4	4	9	9
12:28 PM	2	2	2	4	6	1	5	8	7
12:29 PM	2	3	3	5	2	5	7	2	4
12:30 PM	2	2	2	2	1	5	2	5	4
12:31 PM	1	3	1	4	5	4	2	3	7
12:32 PM	2	3	3	2	4	4	4	1	4
12:33 PM	1	1	2	3	4	3	6	5	5
12:34 PM	2	3	3	5	4	7	7	1	8
12:35 PM	2	3	4	3	6	7	2	5	2
12:36 PM	1	1	1	3	6	3	7	1	8
12:37 PM	2	2	1	1	6	6	2	2	2
12:38 PM	1	3	4	1	6	2	3	5	5
12:39 PM	1	3	4	1	3	2	8	9	7
12:40 PM	1	2	3	3	5	5	4	6	8
12:41 PM	2	3	1	5	2	2	3	8	6
12:42 PM	1	2	1	3	5	5	4	2	1
12:43 PM	2	2	4	1	4	1	5	3	9
12:44 PM	2	1	4	4	2	7	2	6	3
12:45 PM	1	1	1	5	5	6	5	8	5
12:46 PM	2	3	1	1	6	4	1	5	10
12:47 PM	1	2	1	4	6	2	6	3	9
12:48 PM	2	1	2	1	3	3	8	2	3
12:49 PM	1	1	2	2	1	7	7	3	1
12:50 PM	2	1	4	5	3	6	5	1	2
12:51 PM	2	3	2	1	6	6	3	1	9
12:52 PM	2	3	1	2	4	6	8	9	8
12:53 PM	1	2	4	4	5	3	2	8	10
12:54 PM	2	3	2	5	1	4	7	5	10
12:55 PM	1	2	3	1	3	5	8	9	4
12:56 PM	2	2	3	5	5	4	7	9	5
12:57 PM	2	1	4	4	6	5	8	5	7
12:58 PM	2	1	1	1	3	3	6	6	8
12:59 PM	1	1	1	2	6	6	2	6	5
1:00 PM	2	3	3	2	6	7	3	4	5
1:01 PM	1	2	3	1	4	7	3	5	8
1:02 PM	2	2	2	5	6	6	3	5	2
1:03 PM	2	3	2	5	1	3	3	8	10
1:04 PM	1	2	1	1	5	5	7	5	10
1:05 PM	1	3	4	4	4	6	6	5	4

Evaluation Period	Crew Size								
11/2/94	2	3	4	5	6	7	8	9	10
1:06 PM	2	3	1	2	5	1	4	3	6
1:07 PM	1	3	2	4	3	3	5	1	10
1:08 PM	2	3	3	5	4	6	3	2	6
1:09 PM	1	3	4	4	1	1	8	9	6
1:10 PM	2	1	3	1	3	2	6	6	4
1:11 PM	1	2	4	4	5	4	4	5	1
1:12 PM	1	2	2	4	4	4	2	6	6
1:13 PM	1	1	3	4	3	3	4	1	9
1:14 PM	2	1	2	3	2	6	3	7	1
1:15 PM	2	3	3	4	6	2	6	9	3
1:16 PM	2	3	4	2	1	4	4	7	2
1:17 PM	2	2	4	3	4	6	3	7	8
1:18 PM	1	1	1	3	1	3	2	8	3
1:19 PM	1	3	1	4	5	7	2	3	6
1:20 PM	1	1	1	1	1	6	1	5	9
1:21 PM	1	3	2	1	3	4	4	7	6
1:22 PM	2	3	2	4	4	1	7	5	9
1:23 PM	1	3	2	1	6	3	1	7	5
1:24 PM	2	1	1	3	1	2	7	7	3
1:25 PM	2	1	2	2	1	5	7	2	3
1:26 PM	2	3	3	2	5	3	7	9	4
1:27 PM	2	3	1	2	1	5	5	9	5
1:28 PM	2	1	2	3	1	7	3	5	8
1:29 PM	1	1	2	3	4	5	2	9	5
1:30 PM	2	3	3	5	5	6	5	1	6