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Department of Health and Human Services
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By William J. Wiehagen,[1] Donald W. Conrad,[2] and James M. Baugher[3]

ABSTRACT

This report describes a process for quickly developing information that is useful for skills training. The process is called job training analysis (JTA). Its main use is to structure skills training at the jobsite. JTA supports structured skills training by identifying the job duties, tasks, and steps and the reasons why those job components are important. The outcome of the JTA process is a worksheet—a training outline based on the knowledge and expertise of experienced workers. Time invested in developing a JTA will result in significantly more time saved when it is used appropriately by skilled trainers. Like a roadmap, JTA saves time and energy.

Experimental work at several mine sites helped document, refine, and validate the JTA process. JTAs for two mining jobs—roof bolting and lift truck operation—at two different mine sites are used to illustrate some of the concepts and the specific JTA process described in this report. The work at these two sites was influenced by cooperative work between the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) at several other mine sites and prior collaborative work with the U.S. Navy. The mining JTA process is grounded within the military research on the design of instructional systems. MSHA and NIOSH worked to simplify and apply the military training development model for mining industry use through collaborative work at several mine sites.

The JTA process involves three activities: (1) planning, (2) a 1- to 3-day workshop where the JTA is developed using facilitated work with subject-matter experts, and (3) followup. Guidelines and considerations for each of these activities are included. Results indicate that the JTA process has been well received and valued by mining industry participants. It blends aspects of health and safety, production, maintenance, and crew coordination.

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INTRODUCTION

On-the-job learning and on-the-job training (OJT) are similar concepts. It is natural, in any organization, for on-the-job learning to occur. Learning occurs whether there is a mechanism in place or not. Work will always get done by trial and error or some other way. Trial-and-error performance always carries a consequence, although it is not always recognized, measured, or significant. In a practical sense, learning is doing. Part of learning is making and recovering from mistakes. To recover suggests learning.

In contrast, it is always a choice as to whether or not organizations invest in structured skills training. Every job has a learning curve, which can range from very short to extensive. Structured training involves a commitment and plan to accelerate learning that may or may not happen on the job through informal methods. These informal methods include self-instruction or the "follow Joe" method[4] of developing skills.

One reason why organizations invest in structured training is that decision-makers are not content with the consequences of trial-and-error learning. Training accelerates what *might* occur (improved performance) on the job. When done at least reasonably well, structured OJT is a better gamble than the alternative. It carries better odds for creating more effective and efficient consequences for the individual, the work unit, and the organization.

Even though quality training takes effort to plan and implement, the payback can be considerable. Structured training can be a good business decision if it is done well. Small investments in structured training (e.g., time to plan, conduct, and follow up) should save considerable time down the road and allow workers to produce a better-quality product in a timelier manner. Intuitively, structured training accelerates learning and reduces variability in task performance. Trial-and-error performance encourages greater variability in what is done and how the task is done.

The benefit of structured training resulting in acceptable job skills should be obvious to the individual, the work team, and the organization. If the benefit is not obvious, then the problem might be related to the ability and motivation of the trainer, the expectations from training, the trainee's motivation and ability to perform, or subtle organizational incentives that oppose safe, productive performance. Organizations are dynamic; none are perfect.

This report is a followup to an earlier paper [Wiehagen et al. 2002] that describes small investments by organizations to develop and enhance job skills. Wiehagen et al. [2002] review the literature on structured jobsite training and discuss small investments by organizations that can help improve the effectiveness of OJT. Two avenues were identified for enhancing OJT: (1) the need for a teaching outline, and (2) the need to train the OJT trainer in how he/she transfers job-related knowledge and skills in an on-the-job environment.

This report deals with the first avenue—a method for developing a practical teaching outline. The process is called job training analysis (JTA). The purpose of the outline is to assist the OJT trainer(s) in transferring knowledge and skills. A useful perspective is offered by Semb et al. [2000]:

> While advances in technology may result in more sophisticated tools for conducting OJT, the knowledge and skills of the individual trainer will always be the most critical component of OJT. These include both knowledge of the job and the ability to communicate that job effectively to the on-the-job trainees.

[4]The British call this training method "sitting with Nellie."

Putting Experience Into Perspective

Experienced workers have learned their jobs by many different methods. Beyond their initial job training, their on-the-job performance has been influenced by a lot of factors.[5] As a result, one can expect some significant differences in how these veteran workers complete a job or job task. Those differences can be thought of as *performance variability*. In and by itself, the variability in how they perform a task may *or may not* be significant to safety, production, or maintenance.

In effect, each experienced worker (e.g., a roof bolting machine operator) developed his/her own roadmaps for how the job duties are completed (e.g., performing a preshift walkaround inspection, tramming the machine, and drilling and bolting the roof). It can be logically surmised that more consistency across the work crews, influenced by supervision, yields less variability in how or how well the tasks are completed. The opposite also holds true.

In the JTA process, experienced job performers are the subject-matter experts (SMEs). They contribute their time and expertise to put their knowledge into perspective in order to outline the job and discuss options and considerations for practical, efficient, and safe (lower-risk) ways of doing that job.

The JTA workshop uses brainstorming and outlining software, group discussion, and decision-making techniques. Discussions yield information that can be powerful in creative and practical ways to define the job. The hierarchy of job duties, tasks, and steps *and the reasons why those procedures are important* are the basis for a training outline. An outline such as a JTA worksheet is a central part of structured skills training.

Learning on the Job

Table 1 suggests OJT varies naturally within organizations. It also suggests that risk should be a key consideration in making decisions about the level of structure—the riskier the job when performed *independently*, the more consideration should be devoted to structured training. Informal job training can include reading and following a process diagram, a set of instructions, or seeking advice from the supervisor or coworkers. Workers appreciate and value OJT for many reasons. Billett [1993, 1994] suggests that, within the coal mining community of Queensland, Australia, workers value informal settings, such as the mine site, because those environments are authentic and offer access to experts as well as peers. He suggests that these characteristics make for a highly valued learning environment. This is not surprising as one of the key benefits of OJT is that learning is doing, and *the results are visible* as skills are being developed. In general, workers prefer instructional methods that are realistic and practical. OJT is both practical and realistic;[6] it happens naturally in all organizations.

[5]Those factors include the individual's work experience, motivation, and abilities; the supervisor; other crew members; additional skills training; and the culture of the organization.

[6]In fact, the benefits of worksite training are significant, and many believe its value is in the informal and conversational style. So formal, structured OJT programs need to consider ways to keep the value of informality and the natural learning from experts and coworkers.

Table 1.—Range of on-the-job training

Higher risk: Very informal OJT	Lower risk: Structured OJT
• No plan developed • Shadow another employee • Self-teaching • No evaluation other than self-assessment or feedback from the boss or coworkers	• ***Plan developed*** • Trainer present • Trainer has learned skills in— - Teaching - Evaluating • Supervisor follows up

Roadmaps for Teaching

A practical training outline is like a roadmap for teaching, evaluating, and learning new skills. Roadmaps save time and energy when the route is new or has not been traveled recently. The destination for structured training—safe, productive performance—is often difficult to quantify. Roadmaps are useful as they save time by helping to plan and plot progress. The JTA process can produce a worksheet or training outline that organizes the job into teachable components. The outline can be used as a practical guide to save time in helping the employee perform at an acceptable level. The JTA process itself can help define a range of acceptable performance.

Learning a new task without a plan is like taking a trip without a map. The only guidance would be a general goal, our personal experience, and trial and error to help reach a destination. Without a map, finding our way would be an adventure. Time would be lost and extra expense incurred as we would likely spend more time and incur higher energy costs getting to an unfamiliar destination.

Training someone new to a job is not something most of us do every day. An experienced worker might have the job skills, but lack the training skills or the motivation to help an apprentice get to the destination—acceptable job performance. In many cases, skilled workers feel that critical job steps are nothing more than common sense. They take their knowledge and experience for granted, which may result in omitting key steps, procedures, and safety practices/concerns when conducting OJT. Experienced workers may not remember what it was like to have done the job for the first time. For someone new to a job, most *everything is new*.

Giving and getting feedback is a key element in teaching and learning. The JTA document, like a roadmap, allows for the trainer to chart progress of the trainee and offer specific feedback. JTA should have value to both the trainee and the skills trainer.

JOB ANALYSIS

Job analysis forms the foundation for every job as it describes what people do to complete a job or work task [Brannick and Levine 2002]. There are different ways to analyze a job; these depend mostly on how the information will be used [Kirwan and Ainsworth 1992]. Job analysis is critical to the human resource function, managing an organization, and production

activities. Job analysis goes back a long time.[7] It is a tool for both administrative and line functions within organizations [McCormick 1982; Brannick and Levine 2002]. Job analysis is useful for a multitude of purposes, including human resource planning, performance feedback and evaluation, and examining options for better ways to do a job.[8] It is a snapshot of how a job is done. That snapshot is useful both as a baseline and for improvement. Standard operating procedures (SOPs) are often the result of a job analysis. Operating procedures are useful as they offer consistency in training or serve as a reminder (e.g., a job aid) as to how a task should be done.

Performing a job or task analysis to structure training also goes back some time and is grounded in military research on the design of instructional systems. Task analysis is considered a key part of designing effective training [Tennyson and Foshay 2000]. It is an *early, essential* step in preparing a training needs assessment leading to a functional plan for skills training.[9] The value of a task analysis is that teaching and learning are much more effective with a logical and practical way to segment the job and break the content into understandable parts. In this way, the job instruction, including feedback, can be focused and consistent. Consistent training can lead to less variable performance on the job. It is an antecedent to good performance as the odds are better than those of more informal learn-as-you-go methods.

A job analysis needs to make sense to those who perform or have a stake in the job. Functional job analyses break down a job into useful components.

JOB TRAINING ANALYIS (JTA)

JTA is a type of job analysis. The process encourages general agreement among the experts as to what will be done and how the job *should* be done. In that sense, it helps to get experienced workers on the same page for the purpose of instructing those who are new to the job. Jobs are usually performed in various ways. The discussions among the SMEs will develop more favorable, lower-risk ways of performing the job by integrating aspects of safety, production, maintenance, and crew coordination.

The result of the JTA process can be thought of as a roadmap for teaching, evaluating, and learning new skills. Learning is doing, and structured job training involves a plan for the *transfer of skills* from the experienced performer to a person with less experience. In that context, the JTA is a checklist to help the trainer cover all aspects of the job*, especially* those steps considered by the trainer to be common sense. For the trainee, the JTA is a useful reference for job duties, tasks, and steps and the reasons *why* those job elements are important.

[7]The subject of job analysis is rooted in the early 20th century literature on "scientific management" [Taylor 1911].

[8]For a more complete listing, see Brannick and Levine [2002, pp. 3–7], Gael [1988], and DOL–ETA [1991].

[9]There is no shortage of books, how-to manuals, and formal training sessions on the subject of task analysis and its essential role in developing training materials (e.g., Hartley [1999], DOE [1994], and Langevin Learning Services [2006]). The need for a task analysis supporting the development of training materials and learning environments is well documented in military training research (e.g., Tennyson and Foshay [2000]). In many cases, the methods suggested for performing a task analysis are time-consuming. It simply depends on which resource is followed and how much information is pulled together before the rubber meets the road and someone is "trained."

Job Training Analysis Versus Job Safety Analysis

JTA is different from job safety analysis (JSA). JSAs are normally the product of safety departments and are limited to health and safety aspects of the job being analyzed. In many cases, the JSA procedure can give the appearance that safety is an "add-on" consideration to a production process simply because safety was not integrated at the onset. For example, JSA lists safety considerations in preparing for or while performing a task. JSA assumes that the individual is skilled in performing the production task, and the JSA documentation offers a series of safety cautions or advisories. JSA is designed to reduce health and safety risk. It is valuable, although singular in purpose.

Alternatively, JTA includes aspects of safety, production, maintenance, and crew coordination. It is, by design, broader in concept and approach. It serves to integrate safety and health with production skills. The process addresses risk within the context of production, maintenance, and safety. It allows for discussion of why those job procedures help reduce the risk of injury and production downtime. In that sense, a job *training* analysis will examine a job in its entirety, including risk to the individual, the work crew, and the organization.[10]

In short, JSA and JTA can be considered a subset of the job analysis literature and methods. Working through the JTA process helps experienced workers get on the same page concerning safe *and* efficient procedures for doing a job. In that context, *JTA treats aspects of safety as a skill*. Skilled performance is the desirable outcome of training. Balancing safety with production seems a worthy goal in the JTA process by making use of the tacit knowledge and skills of experienced workers.

Sample JTA

Table 2 is a portion of a JTA worksheet for a twin-boom roof bolter. Table 3 is a portion of a JTA worksheet for lift truck operation in a warehouse. These examples are from two different mine sites.[11] Each JTA team involved a facilitator, a recorder, and a number of subject-matter experts (SMEs). The SMEs were experienced roof bolter and lift truck operators, mechanics who service and repair the equipment, safety professionals, technical representatives of the equipment manufacturer, and supervisory personnel. The mine site teams developed their respective JTAs using the process described later in this report.

Tables 2–3 also show the hierarchy of duties, tasks, and steps. These tables reflect *only one* of several duties for each job. For example, the mine site SME teams identified seven duties[12] for the roof bolting machine and eight duties for lift truck operation in the warehouse.

[10]In a practical sense, training should be connected to performance [Mager 1999]. Training can reduce performance variability within a work system [Gilbert 1978; Wiehagen et al. 1994]. A good job analysis would lay out the job procedures in a fashion that would allow experienced workers to consider how the system might be redesigned to foster desirable, lower-risk performance.

[11]Appreciation is expressed to management and a number of employees at the Weeks Island Facility (Morton Salt, Inc.) and the Foidel Creek Mine (Twentymile Coal Co.) for their time and contributions in developing experimental JTA products used to define a mining JTA process.

[12]The number of job duties would naturally vary by the type of job, but should be limited to a manageable number. It would rarely seem to be a good idea to have 20 or 30 job duties. Most jobs would have 10 duties or fewer. Some of those duties would be conditional or nonroutine.

Table 2.—JTA worksheet
Duty 2: Tramming a roof bolting machine

Objective: Learner will demonstrate and explain how to safely and effectively tram the roof bolter

Tasks and Steps	Why Important? Consider Safety, Production, and Maintenance If this job task or step is not done correctly, what would be the consequence?	Importance 1 = Important 2 = Very important 3 = Critical	Satis-factory or Needs Work	Comments[1]
Walk roadway before tramming.	Two people needed for moves—one to walk and one to operate bolter to avoid cables and give lamp signals. Also a good time to check and make sure no other equipment is parked in blind spots, e.g., on other side of curtains.	2		
Prepare for tramming: • Collapse ATRS. • Bring booms in. • Lower canopy. • Raise drop mast. • Raise drill head.	Machine damage, dislodge roof supports, saves time when tramming. See operator's manual.	3		
Communicate intention to tram and cable reel coming on.	Avoid personal injury from unexpected machine or cable movement. Include telling trainee importance of position in relation to cable and bolter.	3		
Monitor position of the machine. • Watch for contact with roof. • Watch for other miners. • Center machine in entry.	Avoid machine damage and personal injury.	1		
Tramming the machine • Note bottom conditions and clearance. • Note location of other miners – communicate. • Manage cable. - Observe cable pickup and payout. - Check for enough cable. - Hang cable/bridge cable where other equipment may run over it. - Stop tramming if another miner is walking by the bolter.	Take your time. If not sure of conditions, get out and check. Watch for proper cable reel function. Note that (oversized) splices can get hung up in the reel. Prohibit standing on booms when tramming. Watch for contact with the roof and rib. Watch for pinch points; communicate with helper. Before anyone gets in between the bolter and the rib, he/she should notify the bolter operator before getting into a potential pinch point.	2 1 3 3 3		

[1]In practice, the "Comments" column should be wider to allow for notations.

Table 3.—JTA worksheet
Duty 5: Loading trucks – lift truck operation at a warehouse

Objective: Learner will demonstrate and explain how to safely and effectively load trucks

Tasks and Steps	Why Important? Consider Safety, Production, and Maintenance If this job task or step is not done correctly, what would be the consequence?	Importance 1 = Important 2 = Very important 3 = Critical	Satis-factory or Needs Work	Comments[1]
Obtain loading instructions specific to the van or flatbed.	Check with foreman. Improper loading costs time and money.	2		
Check truck position. • Backed in properly? • Wheels chocked? • Engine off? • Has the driver turned in keys?	Personal injury, equipment damage, difficulty in installing the dock plate and more load time if truck is not positioned. Operator must guide truck into proper position when backing, operator should be on driver's side when guiding a truck, operator should wear orange vest when guiding trucks, operator should be aware of obstructions when backing trucks. Before beginning to load the truck, the operator must make sure wheels of the truck are chocked; truck may move if the wheels are not chocked. The foreman can authorize a driver to leave engine running (precautions must be taken in this instance).	3		
Open loading screen.	The loading screen should be closed (fall prevention) unless trucks are being loaded.	1		
Install dock plate.	Make sure area is clear, make sure truck is fully backed into loading dock before attempting to place dock plate.	1		
Check trailer for cleanliness. • Fill out rejection form if not Suitable. • Check with supervisor for unusual problems.	Check for holes, insects, general conditions, odors, leaks in top. Unsatisfactory trailers could cause a truckload of product to be rejected on delivery.	3		
Load according to pattern.	See duty 4 – general lift truck operations. Incorrect loading could lead to the load shifting, causing product damage and downstream consequences.	2		
Remove dock plate. • Make sure area is clear. • Back away from dock slowly. Place dock plate in storage area.	Properly stored equipment or materials make for a safe and productive workplace. Identify proper storage areas for dock plates.	1		
Install screen.	It is important for good manufacturing practices to close door after loading trucks. This prevents employees from walking off of dock and falling.	2		

[1]In practice, the "Comments" column should be wider to allow for notations.

MINING JTA PROCESS

The mining JTA process is composed of three sequential activities: (1) planning, (2) a 1- to 3-day workshop where a JTA worksheet is developed for a specific job, and (3) followup.

Planning and Preparing a JTA Workshop

Selecting a job for JTA can be a combination of items, including production, maintenance, and safety. If a job is essential or there is little margin for error,[13] then it would be a good candidate for analysis by an SME team. For some jobs, allowing workers to "learn as they go" can increase individual and organizational risk. Risk is evidenced in different ways, e.g., injuries, production downtime, and unexpected maintenance costs. There will always be some risk in performing a job. The question of how much risk is "acceptable risk" is hard to answer. The JTA process, involving SMEs, can offer practical insight to the concept of risk and ways to reduce it within the job being analyzed.

JTA might be considered for—

- Any job where there is noticeable variability in the way a job is performed and there is a significant consequence for that variability affecting injury risk, production downtime, or unnecessary maintenance.
- Any job where there will be new workers and the organization is not comfortable with informal on-the-job experience:
    - Through expansion
    - Through attrition of experienced workers
- Any job where there will be new technology introduced and the organization is not comfortable with informal on-the-job experience.[14]

The JTA process can be used to (1) offer an opportunity for experienced workers to share information with their peers, thereby improving work system performance; (2) examine better ways to perform the job; or (3) help prepare for instructing new job performers.

Appendix A offers considerations in planning a JTA workshop.

Conducting a JTA Workshop

The success of a JTA workshop will depend on the active participation of SMEs coupled with a skilled facilitator and a recorder. Two full days should be allocated for the workshop. The result will be a good working draft of a JTA worksheet—the basis for a training outline. The JTA worksheet is a living document and can easily be refined during followup and use as a training outline.

Appendix B offers considerations in conducting a JTA workshop.

[13] A small margin for error implies that risk is high (unacceptable negative consequence) if the job task is not done, or not done to some accepted standard.

[14] Initial training is often conducted by the original equipment manufacturer (OEM) when new technology is installed. The JTA process is a natural fit once workers at the site obtain experience in using that technology.

JTA Followup

Refining the worksheet requires someone at the mine site who can—

(1) Develop learning objectives for each major job duty and insert them on the worksheet.

(2) Review and adjust the JTA worksheet for clarity and consistency.

(3) Make the JTA worksheet available to the mine site SMEs for review and comment. This gives the SMEs the opportunity to make adjustments to the worksheet that they may not have thought of during the workshop.

(4) Review the JTA worksheet with others who were *not* in the JTA workshop and who perform or have a stake in the job at the worksite. Consider their suggestions in adjusting the worksheet. This will improve the JTA worksheet while building ownership across the site.

With review and comment, there is always a natural desire to expand and elaborate. Keep in mind that the worksheet is a training outline to be used by experienced workers in transferring skills and knowledge. A good goal for adjusting the worksheet is to be sure to keep it concise and useful for the skills trainer, trainee, or supervisor.

JTA Use

The JTA worksheet design (see Tables 2–3 for examples) is such that each major duty is organized to show a logical hierarchy of tasks and steps connected with the job duty. This helps to organize the on-the-job instruction so that the trainer and trainee can focus on one job duty[15] at a time. Experienced workers will most likely conduct the training.[16] Good OJT trainers are competent in the job and are interested in teaching others [Semb et al. 2000]. Many seem to like the job they are teaching. One analogy useful in planning and implementing skills training is to consider "layering" the training, similar to working with fiberglass.[17] Fiberglass products are layered. If the layers are put together too fast, they may not cure correctly, thereby creating a weak product. The same is true with training. The final JTA product is designed to be used as short lesson plans. Skills training could be "layered," with enough time allowed for the skills to be practiced ("cured").

After OJT, the trainer should evaluate the JTA in terms of its effectiveness in supporting skills training.

- Did the JTA make the job of training easier?
- Did the JTA save the trainer time in teaching new skills?
- Did the JTA save the trainee time in learning the job?
- Did the JTA help standardize work procedures?
- Should anything be added to, or deleted from, the JTA?

[15]For example, the trainer is not teaching someone to "operate a lift truck." He or she is teaching someone to perform a preoperational inspection; fuel a lift truck; pick up, carry, and place a load; stack material; and load trucks.

[16]The organization should consider how it prepares its OJT skills trainers to teach and evaluate skills on the job (see Mallett et al. [2005]).

[17]From discussions with Tom Friend, Training Manager, Drummond Coal Ltd., who has applied this conceptual model in his training of off-highway equipment operators.

In addition to initial skills training, the JTA process and worksheet can be used as—

(1) A tool for examining ways to improve the work process. For example, the JTA team at one mine site examined the field procedures for changing out a belly pan on a dozer. The JTA team discussed and documented field procedures for the task. The current procedure was to loosen the bolts and support the pan with a cable winch from a maintenance truck. This required one mechanic to be under the dozer guiding the belly pan as it was being lowered to the ground. The other mechanic operated the winch. The JTA team members discussed the risk and difficulty in performing this task. They also discussed how this job was done in the shop using a jack designed for that purpose. The group developed a new process for doing this task in the field using a steel plate and the shop jack. The result of the modified process was that it took less time to remove and replace a belly pan in the field. It also reduced the risk of injury as a mechanic was not in a risky position (e.g., underneath the dozer) to be crushed by losing control of the pan as it was lowered to the ground.

(2) A tool for followup observations by supervisors or other crew members. The JTA worksheet includes a ranking of job tasks/steps. The critical items (those ranked as a "3") would be those items the supervisor or other crew members might look for *first* in their day-to-day observations. Mining relies on work crews and crew members who should be mostly on the same page relative to critical skills impacting safety, production, or maintenance. Work life is not black and white and might be unrewarding and confusing if it were too simple or too complex.

(3) A job aid for certain duties that are nonroutine or important enough that you do not want to rely completely on the memory of the person performing the task. For example, there are 15–20 steps involved in fueling a lift truck with propane. These steps should be taught to new operators during initial training as the steps are essential for safe fueling, but complicated enough where they are seldom committed to memory. This is an example where the refueling task and associated steps are good content for a checklist. The list can be posted at the fueling station. It serves as a job aid.

The efforts of the JTA mine site team are meant to be a starting point for supporting good methods for doing the job. JTA is a *tool*, and other components are necessary for a complete skills training program.

RESULTS

The Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) collaboratively developed a mining JTA process useful for structuring skills training. The team initially worked with the U.S. Navy to learn its job analysis process [Duke and Vance 2001]. Then, MSHA and NIOSH worked with several mine sites to customize a JTA process that would match the needs, culture, and time constraints found in mining.

Two models were developed. One involved extensive brainstorming activities concerning job duties, tasks, and steps. The second model made use of available job information and used a more limited brainstorming activity to define this information.

Collaborative work at Tilcon, Wingdale Materials, Cortez Gold, Twentymile Coal Co., Sahara Sand, Morton Salt, and TJS Mining served to define a mining JTA process. JTAs prepared by mine site personnel included the following—

- Caterpillar 980G front-end loader
- Terex 100 haul truck
- Terex T–40 haul truck
- Fletcher walk-thru roof bolting machine
- Komatsu 980–E Haulpak
- Joy 14 CM remote-control continuous miner
- Nissan 60 lift truck
- Euclid R35 haul truck

Once a mining JTA process was defined, efforts continued at other mine sites to apply and evaluate the process. Evaluation data were gathered from six sites. The workshop evaluation form can be found in Appendix C. Table 4 summarizes the results.

Table 4 evidences that SME participants valued the JTA process. They indicated that the discussions offered opportunities to learn job-specific, useful information from their peers. The SME participants also appreciated the opportunity to discuss options and considerations in doing the job; learning never stops regardless of the level of experience.

Table 4.—Summary of JTA workshop evaluations

Site	A	B	C	D	E	F
Job analyzed	Continuous miner	Crusher move	Bagging	Drilling and blasting	Load-haul-dump	Underground section supervisors
No. of JTA participants	5	7	8	5	5	12
Overall mining experience (years)	Range 29–33 (n=4)	Range 0–48 (n=6)	Range 1–30 (n=7)	Range 7–35 (n=4)	Range 1–21 (n=4)	Range 1–30 (n=12)
How **practical** was the JTA workshop for developing a plan for skills training?	Very (5)	Very (4) Quite (3)	Very (7) Quite (1)	Very (5)	Very (4) Quite (1)	Very (5) Quite (6) Somewhat (1)
Was the workshop organized so that it was **easy** to participate?	Very (3) Quite (2)	Very (4) Quite (3)	Very (6) Quite (2)	Very (4) Difficult (1)	Very (5)	Very (9) Quite (3)
How **useful** do you think the worksheet will be?	Very (4) Quite (1)	Very (3) Quite (4)	Very (7) Quite (1)	Very (5)	Very (5)	Very (6) Quite (5) Somewhat (1)
Will this JTA workshop **change** anything about the way you do the job?	Quite a lot (3) Somewhat (2)	A lot (2) Quite a lot (4) No (1)	A lot (4) Quite a lot (3) Somewhat (1)	A lot (5)	A lot (2) Quite a lot (1) Somewhat (2)	A lot (1) Quite a lot (4) Somewhat (5) No (2)
How much did you **learn** from the JTA workshop about the job that was discussed?	A lot (1) Quite a lot (4)	A lot (3) Quite a lot (4)	A lot (5) Quite a lot (3)	A lot (5)	A lot (3) Quite a lot (1) Somewhat (1)	A lot (3) Quite a lot (5) Somewhat (3) Nothing (1)
Would you recommend JTAs for other jobs at your site?	Yes (5)	Yes (5) No (2)	Yes (7)	Yes (5)	Yes (4)	Yes (12)

A sample of specific comments from the mine site JTA teams included:

"Very informational."
"Helps to understand jobs better."
"Process is complete, leaving nothing to memory."
"Helps remove doubt about certain aspects of the job."
"Very detail-oriented; provides valuable tools for the training process."
"It keeps you from forgetting important information and will be useful for other trainers in the future."
"It will make it easier to train."
"I think certain procedures should be standardized for efficiency and safety."
"To keep training consistent and thorough."
"It gives a good roadmap for how to train new people."
"Very helpful."

At two other worksites, a limited brainstorming technique was used to develop the JTA worksheet.

Site 1: Underground Coal Mine

Prior job analyses were reviewed for roof bolting (Klishis et al. [1993a,b]; McDonald and Reinert [1977]; J. H. Fletcher & Co. [2001]). This was synthesized with information from J. H. Fletcher & Co. into a three-level hierarchy of duties, tasks, and steps. The preliminary job analysis (see Table 2, column 1) was presented to the JTA team at the mine site for discussion and modification. The mine site JTA team members adapted the generic job analysis for their machine and conditions and discussed why those tasks and steps were important.

Based on the JTA process, followup activities involved developing a trainer's guide along with short video segments that provided visual examples of the major job duties identified via the JTA process. The trainer's guide included a skill check, talking points, questions related to the mine's roof control plan, the JTA, and supplemental materials. The video segments and scripts were derived directly from the JTA.

Site 2: Surface Facility of a Salt Mine

At a second mine site, the JTA team used an existing training program for lift truck operations in a warehouse. Through facilitated discussions with lift truck operators, a mechanic, a supervisor, and safety/training personnel, the mine site team used its existing program as a starting point to prepare a JTA. This saved time during the workshop, as a tentative listing of job duties, tasks, and steps (see Table 3, column 1) could be drafted based on the existing documentation. In effect, the SME group had a head start in developing its JTA worksheet, but spent time reviewing and modifying the hierarchy of job duties, tasks, and steps. The completed JTA was incorporated into its training program, as it was viewed by mine management and employees as a valuable training tool.

SUMMARY

OJT is used in all industries; the question of how much structure is needed for OJT does not have a clear answer. The level of structure is often based on a decision-maker's perception of risk,[18] the importance of the task, and the risks of casual on-the-job learning (the informal "follow Joe" method) versus a more formal system where experienced job performers transfer their skills to someone new to the job. In this last case, it would make sense for the OJT trainer to have skills in good methods of training and evaluating. It makes equally good sense for these OJT trainers to have an outline to aid in their teaching and make sure that key points are not skipped. A job *training* analysis is the start of a useful plan for OJT by adding some structure in skills transfer.

A JTA is a snapshot of how "a job" is done. It can also serve as a tool for exploring ways to perform the work that are less difficult, less costly, and less physically demanding. The result of the JTA process is practical information for conducting OJT. It is also useful for followup safety observations and discussions on better ways to plan and perform the work.

The JTA process is a way of learning from experienced workers and using their shared knowledge to develop a reasonable roadmap for teaching those who are new to a job. It captures the knowledge of experienced workers as to how a job or task should be performed. In this sense, the discussion among peers serves as an opportunity to learn from one another on how a job might be done, or done better. As a training outline, JTA will help structure how experienced workers logically transfer their job skills. They have the knowledge and experience; it is a matter of helping them commit it to an outline to train others.

Effective OJT involves structure and planning. Structured OJT saves time over casual, trial-and-error methods. It accelerates learning and *reduces the variability* in job performance. Trial-and-error learning results in greater time to learn a job and *higher risk.* Critical errors can result in injury, production downtime, and greater maintenance costs. Table 5 compares traditional job training with an improved method for conducting on-the-job training using JTA.

The JTA process has evolved over the past 3 years through collaborative work between NIOSH, MSHA, and mine operators. This collaboration began by working with the U.S. Navy to learn its process. Then, the Navy process was modified and streamlined by working directly with mining sites.

The JTA process helps structure skills training. Structured skills training will save organizations time via less risk of injury, less production downtime, and fewer costs associated with unexpected maintenance. The premise behind the JTA process is to invest time *now* in order to save a lot more time down the road. It is like a roadmap.

The product of the JTA process can help define acceptable performance. It helps the trainer teach and evaluate, it helps the trainee understand the job, and it can be used to enhance the work process.

Although evidence suggests that the JTA process is well liked and has strong potential, the impact can only be measured by *how the JTA products are followed up and used at worksites*.

[18]Risk is generic. It can imply the risk of production downtime, unnecessary maintenance, the risk of an acute injury, or cumulative health effects, e.g., musculoskeletal disorders or hearing loss.

Table 5.—Comparison of traditional job training with skills training using the JTA process

Traditional job training	Improved method for job training based on the JTA process
Focus on compliance with task training requirements under 30 CFR[1] 48 and 46. Often makes use of JSAs to satisfy the above requirements. JSA treats health and safety as a separate or additional component of the job/task.	Focus on good operating skills and practices that integrate safety, production, and maintenance. JTA exceeds Parts 48 and 46 task-training requirements. JTA treats safety as an integral part of a production or maintenance skill.
The quality of training depends on who is conducting the training and how well those individuals are prepared to teach.	The quality of training depends on who is conducting the training and how well those individuals are prepared to teach. JTA is planned, which leaves less to chance. The JTA process can be used to reduce the variability in teaching and evaluating skills. It can increase the odds of providing quality training. JTA makes direct use of the knowledge and skills residing at a specific mine site. It couples mine site expertise with that of outside experts, e.g., OEM representatives, MSHA, NIOSH.
Makes use of generic training materials developed by the public and private sectors. Existing materials may be difficult to update and customize to conditions at a specific site.	JTA is make- and model-specific and fits the operating conditions at the mine site. It is based on developing a job outline with specific duties, tasks, and steps. The JTA process is designed to be fluid and requires only small amounts of time to keep it current.
Job steps may be missed or ignored by not thinking the job through. Traditional training is not likely to be based on a job analysis that connects training with performance within the context of the working environment.	JTA is based on a job analysis that considers safety, production, crew coordination, and maintenance. JTA is developed by those who have a stake in the job. JTA process connects training with job performance within the mining system.
Experienced workers are not likely to have been trained in methods for coaching and teaching in an on-the-job environment.	Mine sites are encouraged to offer training to their experienced workers in good methods for teaching in an on-the-job environment. This is a natural addendum to the JTA process. It requires only small amounts of time.
Experienced workers are not given much time to prepare for training someone new to the job.	JTA is based on planning and helping experienced workers transfer knowledge and skills.

[1]*Code of Federal Regulations*. See CFR in references.

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APPENDIX A.—CONSIDERATIONS IN PLANNING A JTA WORKSHOP

Choose Subject-matter Experts (SMEs)

Once a job is selected for analysis, planning a JTA workshop would hinge on choosing SMEs from within and outside of the organization. Selecting the proper mix of individuals is fundamental, although it is difficult to describe. The SMEs should be willing to share information with, and learn from, their coworkers.

Internal to the company, the SMEs could be those having an interest and relevant skills in how the job is performed and in exploring ways to minimize risk when performing the job. For example, mechanics might be interested in the job of a continuous miner operator from the standpoint of reducing the cost of repairing the equipment, which minimizes time and risk. A foreman would be interested due to the benefit to a smooth production run while minimizing the risk of personal injury to anyone on the crew. The SMEs should include those who have recent experience in doing the job and who see the job from different perspectives. A relatively new job performer[19] or someone interested in learning more can add significantly to the JTA workshop and to documentation resulting from the discussions. *These internal people will comprise the principal group of SMEs*.

In addition to internal experts, consider inviting outside experts[20] who can *contribute significantly* to the job being discussed. Examples include OEM representatives, MSHA, state agencies, and NIOSH. The goal is to invite those who will add technically to the SME discussions.

Gather Background Materials

For the job being analyzed, gather:

- Information from the mine company
  - Existing training materials
  - Job descriptions
  - Company policies
  - SOPs
  - JSAs
- Information from the OEM, e.g., operator's manuals
- Information from MSHA, such as injury records
- Prior similar task analyses or JTAs to see how others broke down the job into a hierarchy of duties, tasks, and steps

Make relevant materials available to the SMEs during the JTA workshop. Those materials can trigger thoughts.

[19]Someone with limited experience but interested in learning, as evidenced by asking questions or seeking clarification from the SMEs.

[20]The JTA process naturally involves an investment, defined in terms of SME time, facilitation, recording, and perhaps discretionary costs for outside experts.

Arrange for a Facilitator and a Recorder

In choosing a facilitator, consider selecting someone with the following traits and skills:

- Basic knowledge and interest in mining and understanding of the job being analyzed
- Significant interest and willingness to understand and apply the JTA process
- Facilitating skills to get the SME group thinking and expressing views about the job and how the job might be done
- Building ownership *within the SME group* of the JTA worksheet

In choosing a recorder, consider selecting someone with the following traits and skills:

- Proficient in the software being used
- Communication skills in working with the SMEs and the workshop facilitator
- Patient and able to summarize the discussions of the SMEs

Arrange for a Location for the JTA Workshop

In choosing a location, consider a comfortable room that is large enough to allow for—

- Plenty of wall space
- Seating that promotes discussion
- Computer projection with screen
- Seating for observers

The room setup will help the group work as a team.

APPENDIX B.—CONSIDERATIONS IN CONDUCTING A JTA WORKSHOP

Orient the JTA Group Via Short Lectures and Discussion

The workshop facilitator should overview the JTA workshop process (see MSHA [2006]). A few considerations[21] include the following:

- Keep it short—no more than 15 minutes. This gets the group oriented and shows them examples of what they will be doing for the next day or two.
- Make sure time is set aside for questions and discussion of any concerns or housekeeping issues.

Once the JTA group is oriented, the first block of time is devoted to developing column 1 of the JTA worksheet. *Column 1 is the job analysis.* This is a facilitated SME group activity. There are two methods for developing information for column 1 of the JTA worksheet: *full brainstorm* and *limited brainstorm*.

JTA Group Activity: Develop Column 1 of the JTA Worksheet

Method 1: Full Brainstorm

The purpose of this brainstorming activity is to get individuals to concentrate on the job being analyzed and identify how they define the scope, details, and intricacies related to that job.

- Have the SMEs work individually and quietly to brainstorm job tasks/steps. This will bring out unique and individual ideas and gives everyone an opportunity to identify a comprehensive listing of job steps/tasks connected to the job.
  - Pass out a package of post-it notes to each SME. Ask them to think about the job being analyzed and to individually brainstorm the job.
  - Ask them to write one job task or step on a post-it note. Have them continue filling out as many post-it notes as necessary until they believe they have accounted for all the job tasks/steps.
  - The time will vary for this activity depending on the job being analyzed.
- Have SMEs post their notes containing their job tasks/steps onto the wall.
- Discuss and get agreement from the SMEs on the terminology for the *major duties* that define the job. For example, job duties for a lift truck operator could include start-of-shift activities, fueling, loading trucks, moving bulk material inside the warehouse, etc.
  - Allow time for this discussion with the SMEs to gain agreement on the scope of the major job duties.

[21] Either before or after the JTA workshop, organizations should consider setting time aside for a workshop for prospective on-the-job trainers. This coaching skills workshop [Mallett et al. 2005] includes short lectures and practice exercises. Content includes—

Unit 1: What Is a Coach?
Unit 2: The Coach/Trainee Relationship
Unit 3: Coaching Adults
Unit 4: Preparing a Training Outline
Unit 5: Coaching Practice
Unit 6: Wrap-up

- Have the SMEs sort their post-it notes into the job duties identified above.
  - The SMEs are working as individuals as they post their job tasks/steps under the major job duties.
  - Leave a few "blank duties" to temporarily locate job tasks or steps that do not seem to fit into the major duties identified earlier.

Working with one job duty, get the SMEs to work as a group to organize the post-it notes into a three-level hierarchy. Once this is complete, the recorder can use a software package to organize the three-level hierarchy into a diagram (see Figure B–1).

- Creating a diagram showing the hierarchical connections between job duties, tasks, and steps allows for arranging and rearranging the duties, tasks, and steps into a logical three-level hierarchy. Facilitated discussion among the SMEs is required for the logic diagrams to evolve into a useful, logical hierarchy describing the list of duties, tasks, and steps.

The facilitator works the SMEs through each job duty one at a time.

- Use already developed post-it notes as a check to make sure all ideas generated in the silent brainstorming session are taken into account.
  - Allow enough time (about 1–1½ days) to get to the point where a three-level hierarchy of duties, tasks, and steps is fully developed (column 1 of the JTA worksheet; see Tables 2–3).

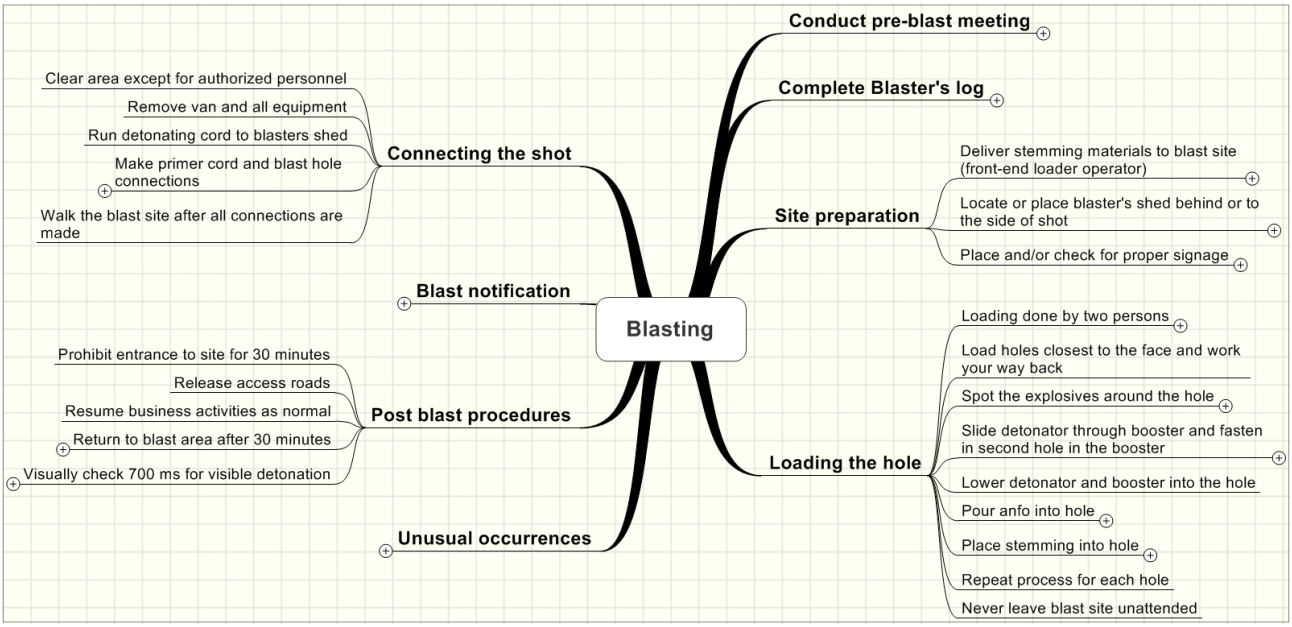

Figure B–1.—Spider diagram of job duties and tasks for surface blasting. ***(Diagram courtesy of MSHA, Arlington, VA, using MindManager® software.)***

- This facilitated group process will (1) create discussion about how the job is defined and (2) help the SMEs work as a team.
    - Although the goal is to develop a useful three-level job outline, a side benefit is that time invested in defining a job via individual and group brainstorming will identify potential production bottlenecks, work practices that would add injury risk, and maintenance or operating practices that add unnecessary cost to the operation. Therefore, the brainstorming exercise becomes a problem-solving tool.

Method 2: Limited Brainstorm

This method assumes that there is a significant amount of technical and training information already available for a particular job. The starting point for a limited brainstorming activity should take into account—

- Prior job analyses that are directly relevant
- Existing structured training programs for the job being analyzed

As a facilitator, from your review of available information, organize the job into a tentative outline identifying a set of job duties, tasks, and steps. Leave room for improvement.

During the JTA workshop, the facilitator would work with the SMEs to—

- Explain and show a few examples of a completed job analysis.
- Discuss a three-level hierarchy and why an outline is important.
    - For example, a job consists of a limited number of duties. Tasks are naturally connected to satisfy the job duty, and steps need to be performed to complete the task. Use visual aids to help SMEs understand the goal.
- Ask the SMEs to review the tentative listing of duties, tasks, and steps developed based on the review of existing information.
    - Discuss what kind of information should appear in column 1 of the JTA worksheet:
        - A three-level hierarchy/outline that is reasonable, fits the working conditions, makes sense to those with experience in the job, and considers all aspects of the job.
        - Only include tasks or steps that are considered "important." If a task or step is not considered "important," it should be eliminated.
        - All tasks/steps should be observable. Use action verbs to describe tasks and steps.
        - Remind the SMEs that the JTA will be used as a teaching outline, so it needs to be written in a style comfortable and of use to the person doing the training.
- Ask the SMEs to brainstorm individually or as a group to rework the outline to fit their worksite conditions, company policies, colloquial expressions, equipment, and tools.

The facilitator should allow a couple of hours for the SMEs to make changes to reflect site-specific procedures. The SMEs should work as a team to identify a complete set of duties, tasks, and steps for the job being analyzed at their worksite.

- Flip charts or white boards could help the group look at alternative ways of organizing the job into a three-level hierarchy.

The facilitator should assess how the group is working. Remind the SMEs that this is a work in progress; the hierarchy/outline can change *based on its use*.

Once the SMEs complete their outline, the recorder inputs their information into column 1 of the JTA worksheet. When the worksheet is computer-projected for the SMEs, they again have an opportunity to review and make adjustments[22] to the listing of duties, tasks, and steps.

JTA Group Activity: Develop Columns 2 and 3 of the JTA Worksheet

At this point, regardless of the method, column 1 of the JTA worksheet is completed. The draft worksheet is computer-projected for the SMEs.

The facilitator provides a minilecture on what needs to be done to complete columns 2 and 3, including a discussion of the importance ranking and narrative. Allow 15 minutes for this lecture and discussion.

Column 2: Why is the job task or step important? This column on the JTA worksheet captures and stores information from the SMEs about the importance of the job task or step. This column should include short phrases that support the numerical rankings in column 3. The SMEs should consider aspects of safety, production, and maintenance. The short narratives in this column should indicate the consequence if this job task or step were skipped or not done correctly.

Column 3: Ranking of importance. This column is for a numerical ranking (1 to 3) based on the SMEs' qualitative assessments. A rating of "1" means the step is important, "2" means very important, and "3" means critical.

"Importance" could imply individual or collective aspects of safety, production, or maintenance. The rankings should be useful for the OJT trainer or coach. The rankings suggest (1) the level of emphasis during training, (2) the amount of practice required, or (3) the number of followup observations made by the supervisor or OJT coach.

During the JTA workshop, the facilitator asks the JTA group to give a rating for a particular job step. The rating would be from 1 to 3 based on its importance. The idea is to seek/build agreement among the experts on the relative importance of performing the job step.

For facilitators, it will be useful to have a set of definitions for each of the three numerical rankings.

[22]The JTA worksheet is always fluid—a work in progress. It can always be refined to better reflect key points and important information.

Some considerations on definitions[23]:

"1" – *Important:* The task should be performed, and most experienced workers routinely perform the task/step. Some variability is acceptable/desirable.

"2" – *Very important:* The task/step is most often performed by skilled workers. A little variability is acceptable/desirable.

"3" – *Critical:* The task is almost always performed by skilled and experienced workers. Only very little variability is acceptable/desirable.

The rankings of the SMEs imply their judgment as to the amount of variability that would be acceptable in performing the task or step as it is described in the JTA (column 1 of the worksheet).

Once a numerical ranking is suggested and the importance narrative is completed by the SMEs, the facilitator asks for hand signals from the group to obtain agreement.

Some useful hand signals include:

- Thumbs up (agree)
- Thumbs down (disagree)
- Thumbs sideways (needs more discussion)

For columns 2 and 3, the facilitator should—

1. Start with duty 1, task 1, and step 1.
2. Ask the SMEs to rank the item.
   The recorder places information into column 3.
3. Ask for discussion to support their numerical ranking.
   The recorder takes notes and places SME information into column 2. These should constitute short phrases to explain the numerical ranking. General instructions for these recording notes can be found in: MSHA [2006].
4. The SMEs either confirm or adjust their numerical ranking based on the discussion.

[23]Intuitively, all tasks or steps within a job are *not* equal with regard to risk if the task/step were not performed, or not performed up to standard. Some variability will always take place in job performance. The variability could be within the same individual as he/she performs the task many times, or the variability could be across individuals who are performing the same task. However, we suggest that highly skilled individuals often have little variability in critical parts of the job. For example, good carpenters might always doublecheck their measurements before they make a cut (measure twice, and cut once). Other examples include always locking out a circuit before it is worked on, always confirming the loading pattern of the truck before it is loaded, securing the base of an extension ladder, or never allowing an individual in between the roof bolting machine and the mine rib *while the bolter is being trammed*.

Variability will seldom equal 0 for the large majority of work tasks. However, it is important to know when to allow for variability and what precautions need to be taken if a work task is not performed according to standard. Therefore, if a job step is rated "critical" (a "3"), that ranking suggests very little, if any, variability is acceptable if the task or step is not performed or not performed well.

Some tasks and/or job steps could be ranked conditionally, i.e., they might be considered *important* under normal circumstances, but would become *critical* under other or changing conditions. Risk will never equal 0 in a work setting, but reducing risk to a more acceptable level is one concept supported by the JTA work. Risk implies aspects of production, safety, and maintenance.

5. Allow time[24] during these discussions for the SMEs to clarify, reorganize job tasks and steps, or add/subtract tasks or steps.

Facilitator note: The higher the ranking, the more group discussion/notes there should be as to *why* that task/step is ranked "critical." The ranking can reflect safety, production, maintenance, or crew coordination, either singly or in combination.

Repeat the above five-step procedure until the entire worksheet is completed. Completing columns 2 and 3 typically takes a full day. At this point, the workshop is concluded and the facilitator might ask the SMEs to complete a JTA workshop evaluation form (see Appendix C).

[24]The facilitator should keep in mind that leading a discussion of the importance of individual job tasks and steps offers an opportunity to validate, refine, or adjust tasks and steps (column 1 of the JTA worksheet) developed earlier.

APPENDIX C.—JTA WORKSHOP EVALUATION FORM

Please complete the following to help improve the quality of this workshop.

Job analyzed_____

Age: _____ Job title: _____ Experience in this job: ____ years

Overall mining experience: _____ years

Have you ever conducted on-the-job training at your worksite? Y N

If yes, what jobs did you teach?

How **practical** was the JTA workshop for developing a plan for skills training?

☐ Very practical ☐ Quite practical ☐ Somewhat practical ☐ Not practical

Was the workshop organized so that it was **easy** to participate?

☐ Very easy ☐ Quite easy ☐ Difficult ☐ Too difficult

How **useful** do you think the worksheet will be?

☐ Very useful ☐ Quite Useful ☐ Somewhat useful ☐ Not useful

Will this JTA workshop **change** anything about the way you do the job?

☐ A lot ☐ Quite a lot ☐ Somewhat ☐ No

How much did you **learn** from the JTA workshop about the job that was discussed?

☐ A lot ☐ Quite a lot ☐ Somewhat ☐ Nothing

Would you recommend JTAs for other jobs at your site? Y N

If yes, why?

For which jobs?

If no, why not?

How can we improve this workshop?

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