THE WORK CREW PERFORMANCE MODEL: A METHOD FOR DEFINING AND BUILDING UPON THE EXPERTISE WITHIN AN EXPERIENCED WORK FORCE

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Abstract. This paper discusses a practical method for enhancing the performance of mining work crews. The method, described as the Work Crew Performance Model (WCPM), seeks to define performance variability within similar tasks of an underground work crew. Key components of the WCPM include: (1) job definition through task analyses; (2) the ranking of job elements by perceived cost consequence; (3) observational techniques to establish performance baselines; and (4) cost linkages between adherence to task procedures and measures of consequence for noncompliance. The components of this model emphasize a reliance on *learning* from a veteran work force and using that information to *reinvest* in strategies to enhance safety and efficiency. These strategies are not limited to technologic efforts but include consideration of the so-called "soft-skill technologies" aimed at reducing variability in individual performance and at effecting a continuous improvement in overall system effectiveness.

Introduction

The term "training" is often used in varying contexts. Regardless of the context, training implies increasing competence with respect to the task. Increasing competence implies improved performance, generally defined at some broader level that relates individual activity to the organization's goals. Evaluation is important, as it suggests a means for measuring improved performance.

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Robertson (1983), in his discussion of injury control strategies, states that "A basic cultural theme in the United States, perhaps as widely shared as any in a diverse society, is that sufficient education will resolve almost any problem....These programs would attempt to change behaviors that contribute to injuries...but the ultimate issue is whether the relevant behavior is changed and if the change is sufficient and sustained enough to reduce injuries. Success is claimed more often than demonstrated, and failure is experienced more often than admitted."

The difficulties inherent in evaluation of training are signified by the general industry's willingness to take training outcomes on faith, that is, by not establishing empirical links between training and profit or between training and safety. A book entitled <u>New Developments in Worker Training</u> (Mangum, et al, 1990) has recognized the difficulty and confusion in evaluating worker training by noting simply: "it is perhaps easier to trust [the return on training] than to measure." The authors assert that "perhaps the fact that training exists and persists should be taken as *prima facie* evidence that, at least in the minds of those who make the training decisions, the benefits exceed the costs."

When the benefits of training are unknown or limited to compliance with higher-order directives (corporate or government), the system can be expected to gravitate to greater *efficiency*. Without clearly defined output (e.g., training outcomes), improved efficiency (defined as the ratio of input to output) directly translates to lower cost. Under this scenario however, the *effectiveness* of training is, in essence, a non-issue. In a competitive system, minimizing expenses to achieve compliance becomes the norm. This creates an interesting paradox at the mine site, with managers lamenting: "we would spend more for training, if we could afford it." Fortunately or unfortunately, based on perspective, in the absence of performance outcomes and estimates for the cost of performance variability, the mining community has little if any idea as to what it can afford!

The WCPM offers an improved method of measuring training effectiveness and evaluating crew member performance within the practical confines of the work system. It relies on the cost-benefit assessment of operator skill based on observing those activities under the direct control of the equipment operator that are more reliable indicators of crew member proficiency. The model ranks behavioral measures relevant to the operator's task by assessing the relationship of errors (i.e., performance variability in critical job tasks) to the primary accomplishment of the job. In the case of the shuttle car operator in underground coal mining, that accomplishment might be to minimize the continuous miner wait time for an empty shuttle car. The WCPM is designed to more tightly couple training and performance at the individual, work crew, and organizational level.

The WCPM rests on a set of assumptions about the nature of the worker and the job. A basic assumption is that individuals make errors without intent to incur personal injury, induce downtime, diminish production, or damage property. Errors are defined as a deviation from [an element in] a standard operating procedure (SOP). To illustrate, for the shuttle car operation, standard operating procedures typically recognize as few as 50 to over 100 specific items. Only a portion of these, however, define performance errors that *significantly* impact the operator's job accomplishment - to minimize the continuous miner wait time for an empty shuttle car. The practical utility of these lists is limited without associated information about the relative frequencies of tasks or subtasks, and the probabilities that occurrence of errors will have a direct and important impact on the safety and efficiency of the work crew. Without this information (i.e., a norm), one could expect significant variability within the job task, dependent upon individual perceptions of accomplishment, task experience, risk taking, the design of the equipment, work procedures, and the management system.

Within this context, other assumptions of the WCPM include:

- All individuals will make errors, regardless of the level of training or experience.
- Error rates can be observed, measured, and managed. Although there may be cognitive components, such as errors in judgment and decision making, resultant behaviors and outcomes can, in most cases, be observed and quantified in terms of meaningful cost consequences.
- The measurement of crew output, with implications for individual task performance, is significantly more complex than measuring the output for isolated tasks, such as a welder or a beltman.

Thus, at one level, the WCPM can be thought of as a visual detection method to identify critical components of complex job performances such that wide differentials in performance for high-consequence tasks are identified and treated. Within this context, it is likely that the total set of errors of the exemplar even can *exceed* the error rates of the average operator. However, the *types* of errors committed may be quite different. The ability to define and discriminate error profiles within and across crew members is the essential element of the WCPM. It recognizes and seeks to address the complexities of crew performance and attempts to define and link error profiles of individual crew members to crew output and organizational goals.

The Work Crew Performance Model

The WCPM (Figure 1) includes provisions for: (1) job definitions based on information from mining personnel expert in the operation, repair, and maintenance of the equipment; (2) the ranking of job elements by perceived cost consequence; (3) observational techniques to establish performance baselines by measuring adherence to operating procedures; and (4) linkages between observed performance profiles and resultant costs (measures of injuries, downtime, productive capability, and maintenance overhead).

The WCPM approach is unique in that it seeks to integrate these typically exclusive provisions within a work organization. For example, common methods used to define standard operating procedures, to establish job performance requirements, and to evaluate operators' work behaviors, have been based primarily on checklists of appropriate or desired behaviors. However, these lists are typically divorced from day-to-day records of production downtime, lost-time injuries, system inefficiencies, and maintenance overhead. It is sometimes forgotten that these formal checklists were made up in the first place and therefore should serve as a beginning, not an end. The WCPM advocates the more functional and practical use of checklists. It relies on the ranking of job elements by experienced crew members. An integrated approach also allows the WCPM to be used as an evaluative and a proactive, problem-solving tool with veteran as well as novice equipment operators. Within this context, training (learning) is an on-going, iterative process, not limited to administrative or regulatory requirements.

Field Application of the Work Crew Performance Model

The WCPM was tested through a study of shuttle car operation at an underground mine in the eastern United States. The particular site was a multi-section mine located in the Coalberg seam with an average coal height of 7 ft. It is served by two Jeffrey continuous miners and three Joy 10SC shuttle cars. At the time of study, the section mined approximately 1200 st of coal per shift. Of note, the mine had not experienced any lost-time injuries to shuttle car operators (while operating the shuttle car). This was important as management recognized that the absence of injuries did not necessarily imply the absence of problems, nor the potential for serious injury.

While the details for the complete study is referenced in a Bureau of Mines' publication (Wiehagen, et al, 1994), this section highlights a nominal group technique (NGT) that was used to draw upon the expertise of miners to rank job elements contained within a standard operating procedure. This unique feature of the WCPM is that it is an important departure from traditional, written job procedures, whereby:

- SOPs and job safety analyses (JSAs) recognize (or imply) that there is one, *and only one*, right (safe and efficient) way to perform a task.
- It is presumed that each element within the SOP or JSA is of *equal* importance.

The difficulty with these conventions is that they tend to limit creativity in how the task might be better performed, and they give the appearance that "safety and efficiency" are guided by some mysterious, yet simple, formulas of work life. The NGT provides a mechanism where elements within the job procedure can be linked to likely consequences. This process enhances participation and knowledge sharing on the part of the experienced worker, supervisor, and safety professional.

Job Definitions

A job analysis for shuttle car operation might locate *subtasks* into one of six major task categories: preshift inspections, tramming, loading, dumping, idle-time, and end-of-shift activities. An example of a subtask in the tramming category might be switching the headlights to the opposite direction after reaching the continuous miner. As the WCPM relies on visual detection, all subtask descriptions *must be observable.* Observed variability in the adherence to the subtask constitutes an error, again defined as a deviation from the

SOP.

Drawing on available information and shuttle car operator job descriptions provided by the cooperating mine, an initial list of 112 separate operator activities was compiled by the research staff. This comprehensive listing was grouped into the six major task categories. The list was then screened for redundance, modified, and condensed to reflect only those behaviors that were observable and appropriate for the operations at the cooperating mine. Fifty-eight distinct activities (subtasks) were retained and used to guide the ranking of each subtask, using a two-stage, nominal group process.

Ranking of Errors

A nominal group technique (Q-sort, see Figure 2) was used to rank each of the 58 shuttle car operator activities. The mechanics of Q-sort rely upon individual evaluation and group consensus. The only ranking criterion was "perceived likelihood of a costly consequence being associated with a performance error." Costly consequences include a wide range of items involving downtime, injuries, maintenance overhead, equipment damage, and system inefficiencies. Of importance, the relationship of errors to injuries can be explained, as noted by one researcher (Cherns, 1967), by defining an injury as "an error with sad consequences."

At this stage of the NGT process, those factors (e.g., equipment design, workplace congestion) contributing to the likelihood of an error were *not* considered. Individuals were asked only to sort the activities based on their perceptions of the relative importance of each item. "Relative importance" was defined as the cost consequence if the activity was *not* performed, or, *incorrectly* performed. For the shuttle car experiment, five people participated in the subtask ranking: two researchers (both former shuttle car operators), a maintenance supervisor, a section supervisor, and a mine safety and skills trainer.

Initially, each participant was given a stack of 58 cards containing activity descriptions and asked independently to divide the stack into low and high priority groups. Cards from each of these two stacks were again sorted into high and low priority groups (yielding four stacks), with the middle two groups combined to form the Medium grouping. Each participant then divided the low and high priority groups into two subgroups each, again on the basis of perceived priority. The result is a series of five stacks, with priorities of Very High through Very Low.

After each participant had rated all activities, the results were tabulated and summarized to determine the composite group rating and degree of prevailing consensus for each activity. Figure 3 is an example of a composite ranking for selective shuttle car Tramming Activities. A few days later, the summary information resulting from the initial Q-sort session was reviewed with the entire group, and participants were asked to discuss the ratings given to each activity. At this time, participants were given back their individual stacks and afforded the opportunity to reevaluate their ratings on the basis of new information. The basis for this "new information" was the discussion of individual subtasks by the five-member ranking team. In several cases, comments offered by the mechanic were used by the section supervisor and shuttle car operators (proxies) to revise their rankings. Likewise, information offered by the section supervisor and crew members was also used by the representatives of maintenance and safety to revise their individual rankings. For those subtasks where a tentative consensus was apparent (Figure 3, Items 24-26, 28-30, and 34) across the group, discussions centered on descriptions detailing the team members' opinions on "costly consequence." In other words, why the raters "agreed." In several cases, for example, the panel would rate an activity as "Very High" or "High" but for different reasons. Clarity of the "subtask" became increasingly important as the discussions evolved. At the conclusion of the Round 1 discussions, individuals re-sorted the subtasks and the results were summarized by the research team in preparation for Round 2.

The individual rating data were again tabulated and summarized to determine the degree of consensus (Figure 4). This information was shared and participants were again asked to comment on their ratings. At times, discussions centered on "why" the subtask was "desirable" in the first place. With consensus, the particular activity was either removed from the SOP, rewritten, or combined with another job element. At this stage, participants were encouraged to comment on the specific nature of the potential costly consequences that might result from inadequate performance in each subtask.

During this Q-sort procedure, the list of 58 steps was further reduced to 48: thirteen preshift activities, three idle-time activities, nine tramming activities, nine loading activities, twelve dumping activities, and two end-of-shift activities. The result of this round was a consensus profile for many of the operational activities, resulting in the placement of each subtask into one of five categories based upon individual and group perceptions of cost consequence. Again, during the Round 2 discussions, a few other activities were seen as not applicable to the particular mining operation and were dropped from the list. In some cases, closely related activities were clustered under more general descriptions. A partial listing of the 48 subtasks and the corresponding ratings developed through the Q-sort procedure are given in Table 1. During the in-mine use of a behavioral observation checklist derived from the Q-sort, the list of 48 subtasks was reduced to 46.

Of note, the ranking of subtasks is often, and necessarily, mine-specific. For example, the importance of the rating of the shuttle car operation subtask "prevents load from piling too high and 'roofing' or catching overhead cables" can vary in relation to shuttle car geometry, to mining height, or to cable placement practice.

Table 1. Shuttle car operation (partial steps) rated according to perceived cost consequences of inadequate performance

Task area	Does the operator—	Rating[1]
Preshift:		
1	Look for poor electrical connections at power center	L
2	Check location of cable snub to insure snub will keep cable out of path	H
3	Conduct walk around check of machine; examine fluid levels, reel compartment, tires and wheels; report missing bolts and covers.	M
13	Tram slowly with first load near cable snub to check clearance	VH
Tramming:		
14	Tram appropriately for haul road conditions, rounding corners smoothly and keeping body inside compartment	H
15	Watch for water hose and continuous miner and roof bolter cables while tramming	VH
16	Make certain that there is sufficient cable on reel to reach continuous miner	VH
22	Ring bell before moving machine[2]	VL
Idle time activities:		
23	Clean operator's compartment	M
24	Check reel compartment for mud, damage, etc.	H
25	Check cable periodically for worn spots, damaged splices, etc.	H
Loading:		
26	Watch out for continuous miner cable and hoses when loading	VH
27	Position shuttle car under continuous miner boom while loading to prevent spillage	M
33	Signal continuous miner operator when shuttle car is full using bell, lights, or caplight	M
34	Ring bell before leaving the continuous miner with a load[2]	VL
Dumping:		
35	Raise boom (if height permits) when approaching feeder	M
36	Raise boom high enough to get good fall of coal when dumping	M
37	Pull shuttle car into feeder to prevent spillage when dumping	M

45	Sound bell before leaving the feeder[2]	VL
46	Swing shuttle car away from trailing cable when leaving feeder	VH
End of shift:		
47	Tram shuttle car to allowable parking area at end of shift	M
48	Cut wheels on shuttle car when parking to prevent roll away	VL

[1] VH = very high; H = high; M = medium; L = low; VL = very low; NR = not rated.
[2] Original text modified after Q-sort.

In another example, the Q-sort panel considered failure to consistently ring the shuttle car bell during tramming, loading, and dumping operations (Activity 22, 34 and 45) very unlikely to result in a costly consequence. Members of the crew had worked together for some time, were experienced machine operators, and were cognizant of the habits and location of their fellow workers. As one rater suggested, changing these elements to "conditional" performance (e.g., ring bell when *uncertain* of other workers' location" - Activity 22; make certain the area is clear of other workers and equipment before leaving CM with a load - Activity 34) could modify substantively the nominal group rating and, perhaps, be of more value during the observations of veteran operators. On the other hand, and even with an experienced crew, the face advanced rapidly in this section and therefore failure to check for sufficient cable (Activity 16) could easily and consistently result in a costly downtime event. This was borne out by the ratings of the Q-sort panel.

In summary, for this particular experiment: (1) twenty-two operation activities were determined to be High to Very High priority in terms of cost consequence; (2) ten operation activities were determined to be Low to Very Low; and (3) fifteen items were determined to be Medium; and one item was "not rated."

The Q-sort procedure provided useful information, from several perspectives, about perceived cost consequences of operational errors. For example, of those activities rated

Very High and High, most concerned easily definable functions such as cable management (ten items), preventing damage to the continuous miner (three items), spillage (three items), and tramming at an appropriate speed. Specific penalties for noncompliance with activity descriptions rated Low to Very Low were much more variable and difficult to quantify.

In practice, the Q-sort method is viewed as a useful technique for tailoring general task analyses to fit specific mine environments and operating procedures using knowledge elicited from a veteran work force. Consensus is accomplished through the sharing of information among supervisors, machine operators, safety, and maintenance personnel. The procedure, in retrospect, was a training intervention. The benefit might have been measured (although not in this study) by the shifting of rankings of the panel based on knowledge offered to the group by individual participants.

Information learned from the ranking sessions can be used in a variety of ways. For example, it could be used: as input for measuring training transfer for occupational skills training; as input for conducting safety checks by supervisors and safety representatives; as guidance for engineering changes to the mining system, management practice, or the equipment itself; or as a method for employees to profile their own performance in line with the ranking of activities by the NGT panel. For this particular study, the Q-sort procedure was used to research methods for the conduct of visual observations, the analysis of performance data, and the engineering of linkages between this data and the cost consequences for noncompliance with job elements.

Visual Observations: Visual observations of three regular and three incidental shuttle car operators were recorded by two members of the research team during several shifts over a period of three weeks. The observers sampled each operator's performance in each activity and task area defined by the task analysis and Q-sort process. An event sampling method was used, with observations of discrete events recorded at different locations, which, it was assumed, had equal likelihood of occurrence among subjects. Dichotomous observational data were recorded using a behavioral observation checklist similar to the abbreviated example shown in Figure 5. A "+" was indicated if the appropriate behavior was observed. A "-" indicated a performance error, omission, or inadequacy. Observers were free to move about the section to permit viewing of all shuttle car operation steps. Each observer watched each operator performing each routine activity at least ten times over the observation period. Preshift and end-of-shift activities were evaluated approximately five times for each operator, as data collection opportunities were presented. Notes were kept on operator performance, as well as on mining conditions and other factors that might affect shuttle car operation. Performance Data Analysis: After a few shifts of observation, differences were noted in levels of performance among the shuttle car operators. As a result, evaluators were able to rank all regular and incidental shuttle car operators according to proficiency profiles based on the visual observation data. Figure 6 illustrates the differences in performance between regular and incidental operators for selected groups of shuttle car operation steps. This data is aggregated by task type and cost consequence.

Proficiency profiles were the highest for both incidental and regular operators among those tasks (aggregates of subtasks involving tramming, loading, and dumping) often associated with bottom-line, traditional measures of crew output. Of note, performance profiles, for both the regular and incidental operators, paralleled the subtask ranking from the nominal-group, Q-sort procedure. The adherence, though, of incidental operators to task procedures was substantively *below* the regular operators when analyzed by task or by consequence.

Operator proficiency was calculated by:

$$Proficiency = \frac{no.\ of\ correct\ behaviors\ observed}{total\ no.\ of\ behaviors\ observed}\ .$$

In this study, sample size was not critical to the outcome of the project. The large number of subtasks observed in this study, the varying observed percentages of activities, and the limited time for observation in a production setting made compromises in study design necessary. Of significance is the new opportunity for evaluating performance made possible by the use of the WCPM.

Cost Linkages: The objective of the initial cost linkage studies (Wiehagen, et al, 1994) was to examine relationships among machine operator proficiency profiles and a variety of logical, dependent variables which can be associated with operator error. Traditional dependent measures (production and injury data) were discounted for their limited utility in decisions regarding the selection of performance improvement strategies or the allocation of treatment resources. As a more reliable proxy for these conventional measures, mechanical and production downtime data for shuttle cars were obtained for the mine site where the behavioral observations were conducted. Information for the one-year period which encompassed the three-week observation period was analyzed (Table 2).

The mechanical and production downtime data were entered into a database, and over 800 separate downtime incidents were isolated. Only data for coal production shifts were entered; data for events associated with idle and maintenance shifts were excluded. The reported downtime event information included shift number, shuttle car number, date of the occurrence, downtime delay code (a code number assigned by the company to identify the nature of the delay), number of minutes of mechanical and production delay, and descriptions or remarks about each delay. The downtime data were sorted and grouped according to shuttle car number and delay code. The number of delays for each code category for each shuttle car was tabulated. At the same time, total production and mechanical downtime incurred for each delay type was also calculated.

The delays reported were compared with the 46 shuttle car operation steps to determine which steps, if not performed properly, might result in each reported delay. For each delay, the steps that possibly could be linked to the delay were listed.

Twenty-nine sources of downtime were listed. These were categorized into four groups: electrical, hydraulic, mechanical, and miscellaneous. Many downtime sources are relatively rare and not reasonably attributable to operator errors, such as the single instance of pump motor failure. Others, such as steering arms, spooling device, or cable problems, could be related logically to operator error or lack of proficiency over a period of time, leading to eventual mechanical failure. The linkage between the operator profiles (i.e., performance errors) and cost consequences (i.e., downtime) proved inconclusive in this experiment, for the following reasons:

- Records did not identify the individual operating the shuttle car when a downtime incident occurred. Without this information, it was not possible to associate the downtime data with the proficiency profiles of individual operators.
- The downtime data gave no clue regarding how many reported incidents were carry-overs from the previous shift. Both shuttle cars studied had more incidents of downtime reported for the first shift than for the second. Nevertheless, some of the instances reported for the second shift may have occurred originally on the first. Since the machine would still be unavailable at the start of the second shift, additional downtime would be reported.
- The narrative descriptions of events surrounding downtime incidents were inadequate for research purposes in terms of clearly delineating the root cause(s) of the downtime event.

For example, a cable downtime incident might have been accompanied by a remark: "Splice cable." This remark does not explain why the cable required splicing. An improved narrative might be: "Splice cable - operator caught cable when leaving feeder." Improved narrative descriptions would aid in determining which incidents might be attributable to operator error and which might be the result of component wear, improper maintenance, and equipment degradation.

Summary

The WCPM represents an empirically-based research model that provides a framework for developing practical strategies for identifying engineering, human factors, and human resource needs *at the working section*. It comes at a time in which further significant gains in both safety and productivity likely will come about not through technologic advances, but rather by enhancements in overall system effectiveness (Adler and Lineberry, 1988). Most of these enhancements will be made possible through the upgrading of so-called "soft-skill technologies," with the goals of reducing variability in individual performance and of effecting a continuous improvement in performance.

The WCPM provides a framework for designing and implementing intervention strategies aimed at: bringing an individual to an initial adequate level of competence; maintaining adequate performance and improving performance so that the trained worker becomes a closer approximation of the exemplar; and improving the trained worker's contribution to organizational accomplishment.

From the managerial viewpoint, the WCPM offers: better ways to conceptualize, measure, and rank performance and to rationally explain performance variability; opportunities to improve the quality of supervision through coaching, feedback, and reinforcement; and insights on how to change the training (content, frequency, priorities, mode of delivery, duration) or the system itself (job redesign, job simplification, or task reassignment).

The use of Q-sort to obtain input and learn from experienced crew members for updating SOPs or JSAs may be of value as a method for utilizing the high levels of expertise that reside within a veteran work force. The NGT, as used in this study, helped to define the difference between the rather pure and sterile job procedures and actual mine practice. This bridge was constructed through the interchange of ideas among experienced mine personnel, guided by the design of the NGT. Used in this manner, the Q-sort procedure establishes a *process* to empower participants to engineer their own solutions to problems. Although beginning at the level of individual accomplishment, these solutions ultimately affect organizational profitably and competitiveness.

The WCPM can serve to heighten the awareness of the industry's need for: defining and ranking job elements through structured task analyses; developing and testing observational techniques to establish performance baselines and to measure variability; linking job competencies and performance measures on a cost basis; and adopting and adapting performance-based intervention strategies appropriate for both novice and experienced personnel. Moreover, it begins to provide incentives to mining companies for strengthening investments in the work force. These investments can facilitate a cogent linkage between the human resource function and its impact on safety and productivity.

Finally, it is maintained that practical use of the WCPM methodology offers a continuous thread of data to define realistic goals for successive improvement within the management system, the mining system, and the work crew itself. A better understanding of operator and system variability, through economically justified on-site interventions, can serve to institutionalize continued investments in the work force through the application of human factors and human resource technologies.

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LIST OF FIGURE CAPTIONS

Figure 1. **The Work Crew Performance Model.**

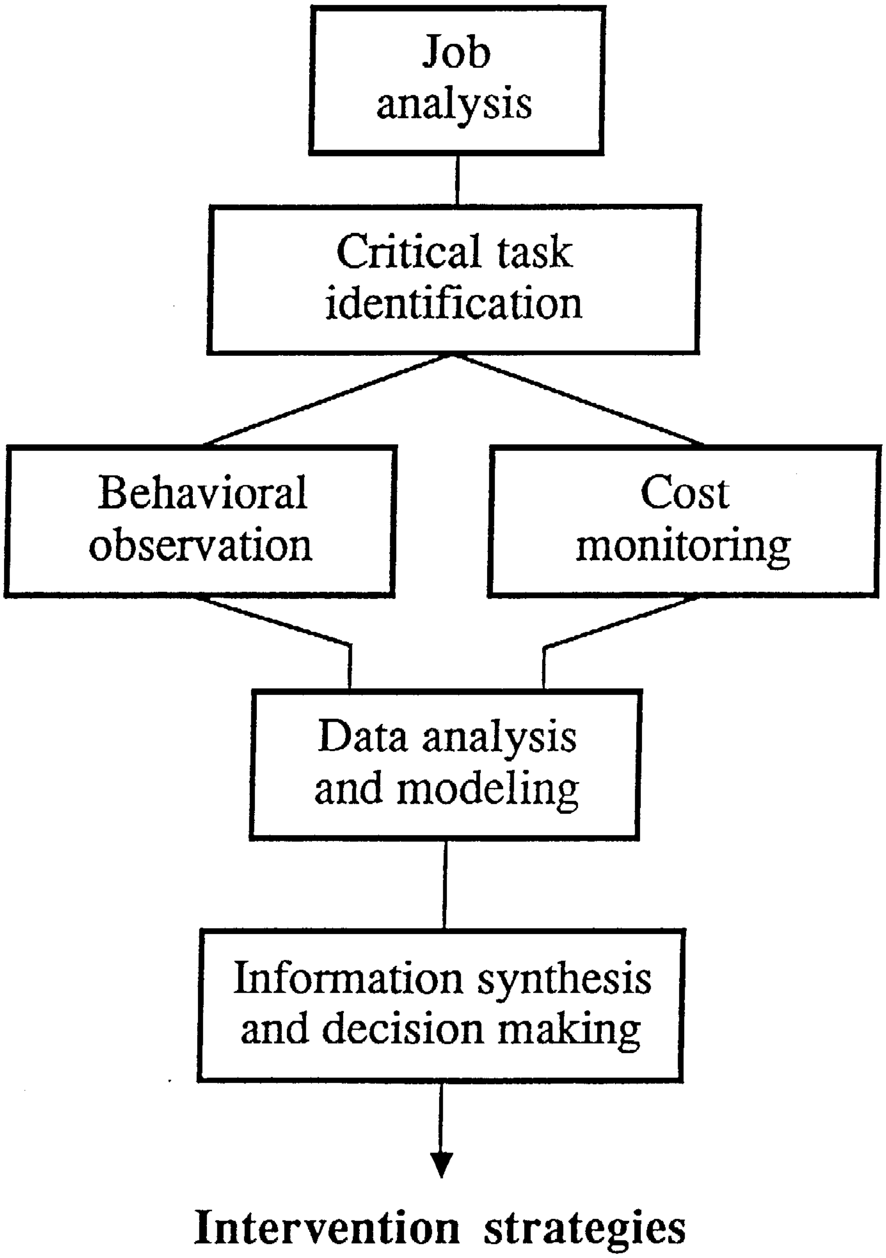
Figure 2. **Q-sort procedure.**

Figure 3. **Sample Round 1 results.**

Figure 4. **Sample Round 2 results.**

Figure 5. **Behavioral observation checklist.**

Figure 6. **Operator proficiency.**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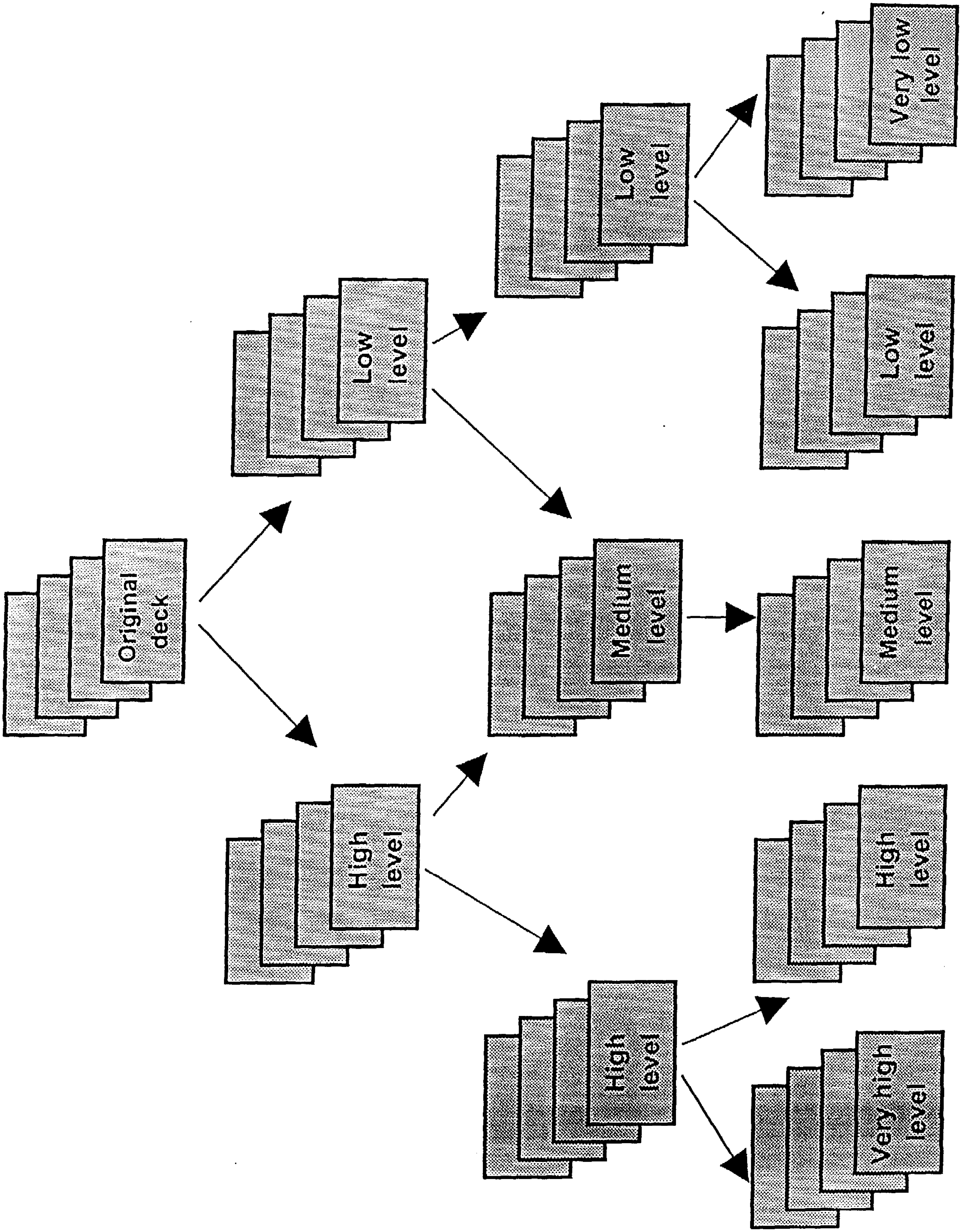
Behavioral observation
Cost monitoring
Data analysis and modeling
Information synthesis and decision making
Intervention strategies


Original deck
Low level
High level
Low level
Medium level
High level
Very low level
Low level
Medium level
High level
Very high level

TRAMMING OPERATION ROUND 1

	ACTIVITY		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	V H				▲▲▲	▲	▲	▲▲	▲▲▲	▲	▲▲▲	▲▲	▲	▲▲▲	▲▲▲	▲	▲▲▲	
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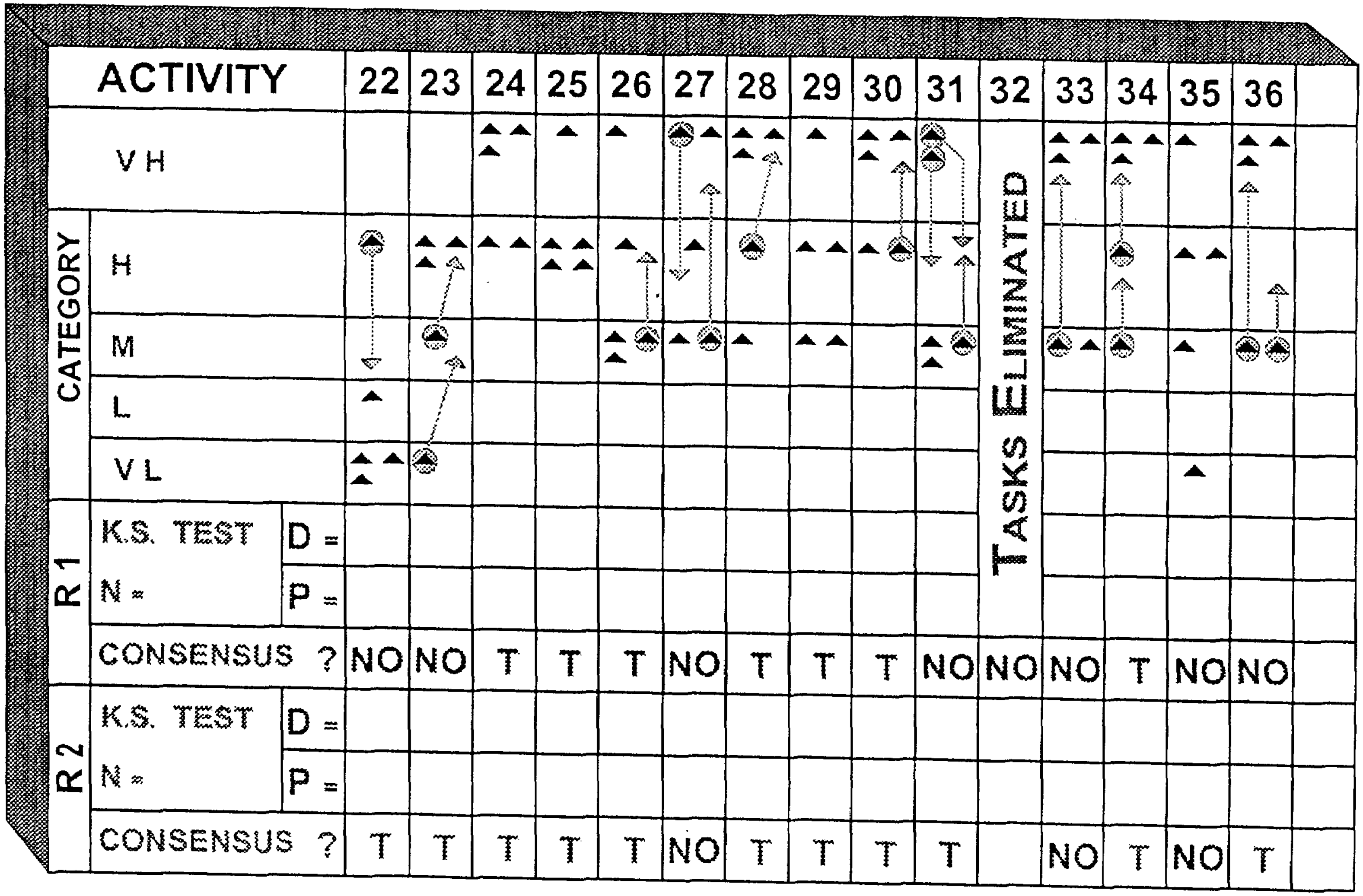
R 2	K.S. TEST	D =																
	N =	P =																
	CONSENSUS	?																

TRAMMING OPERATION ROUND 2



	ACTIVITY		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
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	N =	P =																
	CONSENSUS ?		T	T	T	T	T	NO	T	T	T	T		NO	T	NO	T	

PRESHIFT - Does the operator:

1. Look for poor electrical connections at the power center.

Observations: ___ ___ ___ ___ ___ ___

2. Check location of cable snub to insure snub will keep cable out of path.

Observations: ___ ___ ___ ___ ___ ___

TRAMMING - Does the operator:

14. Tram appropriately for haul road conditions, rounding corners smoothly and keeping body inside compartment.

Observations: ___ ___ ___ ___ ___ ___

16. Make sure that there is sufficient cable on reel to reach the continuous miner.

Observations: ___ ___ ___ ___ ___ ___

LOADING - Does the operator:

32. Prevent load from piling too high and "roofing" or catching overhead cables.

Observations: ___ ___ ___ ___ ___ ___

DUMPING - Does the operator:

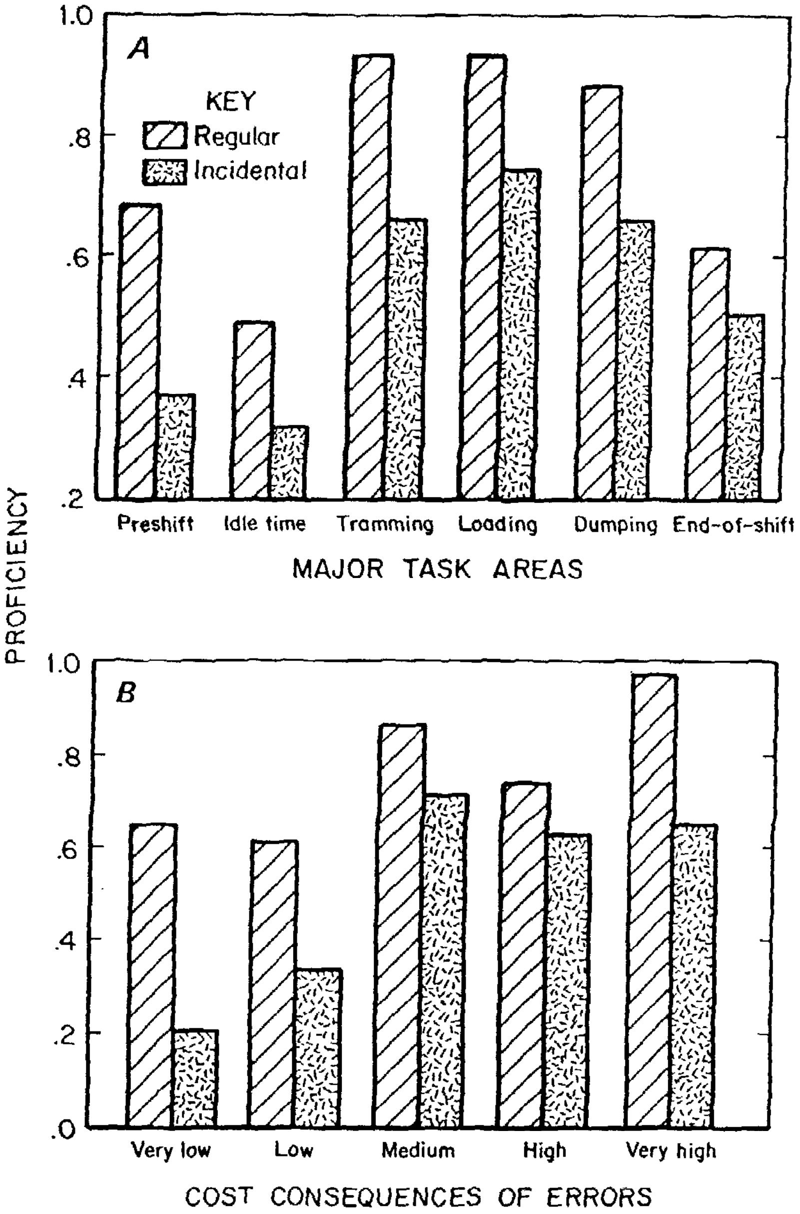
36. Raise the boom high enough to get a good fall of coal while dumping.

Observations: ___ ___ ___ ___ ___ ___

43. Shut off conveyor before pulling away from feeder.

Observations: ___ ___ ___ ___ ___ ___

Figure 5. Behavioral observation checklist.


A
KEY
Regular
Incidental
1.0
.8
.6
.4
.2
Preshift
Idle time
Tramming
Loading
Dumping
End-of-shift
MAJOR TASK AREAS
PROFICIENCY
B
1.0
.8
.6
.4
.2
.0
Very low
Low
Medium
High
Very high
COST CONSEQUENCES OF ERRORS