CHAPTER 8.—WAYFINDING AND ESCAPE BEHAVIOR

The notion of wayfinding, as conceptualized by planners, geographers, and psychologists, denotes the ability of an individual to move from one point to another through physical space. In order to achieve this movement, a person relies on a cognitive map of spatial representations [Passini 1984]. Which features of this cognitive mapping will be stressed depend, in part, on the researcher's perspective. A planner, for instance, would tend to emphasize the effect of physical structures on mobility. A psychologist, on the other hand, might focus on individual differences in how human minds encompass and represent physical space [Evans et al. 1984]. There is yet another dimension to wayfinding that needs consideration, and it rests upon the idea that reality, as experienced by human beings, is mediated: "[People] have preselected and preinterpreted this world by a series of commonsense constructs...which help them find their bearings in their natural and socio-cultural environment and to come to terms with it" [Schutz 1967].

These "common sense constructs" are arrived at socially and constitute the agreed-upon schemas that guide people's everyday activities. According to this principle, cognition is governed by some nonlogical factors that reflect not only individual procedures but collective ones as well. These group strategies, which are shaped by shared rules and values, influence "the information gathered, the ways it is processed, the inferences that are drawn, the options that are being considered, and those that are finally chosen" [Etzioni 1992]. From this perspective, cognitive maps, rather than being individual-centered templates of environmental images [Rovine and Weisman 1989] or representations of spatial relationships [Evans 1980], are partially group-centered schematic processes. As such, they are subject to reinterpretation, revision, and outside intervention [Kaplan and Kaplan 1982].

As intermediaries between the environment and behavior, cognitive maps serve as bases for decision-making. Traditionally, it has been assumed that good maps facilitate correct decisions, which in turn leads to optimal performance during wayfinding [Hunt 1984]. Given the argument that there is a social (noncognitive) facet to cognitive mapping, however, this image of a cognitive map as some sort of static reference construct that motivates individual action is too narrow and mechanistic. If cognition involves less a knowledge of the environment than it does the process of "giving it meaning through imposing an order on it" [Rapoport 1976], then wayfinding behavior is not just a function of setting and individual differences, but is also a function of one's "normative-affective" structure [Etzioni 1992].

Rapoport [1976] used such an assumption as the base for a set of hypotheses about the connection between "external demands" and "organismic factors." One significant assertion deriving from Rapoport's ideas is that environmental

knowing, the way people order their spatial world and act within it, is partially dependent on "cultural habit." Camic [1992], citing the 19th century French sociologist Emile Durkheim, underscored this function of cultural habit by noting that as long as an equilibrium exists between the environment and individual dispositions, action takes place without much reflection. That is because humans behave habitually. Furthermore, these habits are external to the individual since they are a product of socialization, and constrain people by imposing customary practices upon them.

An interesting implication becomes apparent at this point. Just as there are supposed to be individual characteristics of spatial representations, there ought to be cultural ones as well. In other words, every social group will share some distinct cognitive categories that help its members order the world conceptually. While these "noticeable differences" [Rapoport 1976] may be more pronounced between a simple society and an industrial nation, it is logical to assume that a certain amount of taxonomic differentiation will also exist within a populace. Even researchers who do not engage in cross-cultural comparisons can still contribute to a greater understanding of wayfinding behavior by focusing on the immediate cultural context within which spatial problems are defined and solved. This chapter intends to make such a contribution, while examining escape activities during the three underground coal mine fires that are the subject of this book.

The Mine as an Ecological System

In effect, coal miners spend their working days encapsulated in a gigantic maze that may lie a thousand feet below the Earth's surface. The floor of this maze is composed of fire clay, its walls are unmined coal, and the ceiling is made up of slate or shale. The height of a particular coal seam determines if workers must crawl from place to place or whether they will be able to stand upright and move around freely. Seam heights vary from less than 3 ft at one operation to 12 ft (or more) at another. In either instance, workers' environs are well-defined and rigidly bounded. This section contains a discussion of how the process of extracting coal and the culture miners have created helps them make sense of this environment.

Because underground coal mines are dangerous, rules have been promulgated to help support and protect workers. For instance, Federal regulations (30 CFR 75) require that a routine communication system be installed in each mine. This system must include a telephone (or some other two-way device) connecting the surface with each working section. The regulations also mandate installation of automatic fire warning devices on each underground belt conveyor. These devices must furnish audible and visual signals at either of two locations: (1) all work areas where miners may be endangered or (2) a staffed

location at which personnel have an assigned post and there is telephone or similar communication with all workers underground who may be endangered. Finally, the Federal code stipulates that underground operations have to maintain separate and distinct passages, to be designated as escapeways, which are properly marked by reflective signs and symbols. There must be at least two of these travelable escapeways, one of which is to be ventilated with intake air, extending from each working section to the mine's opening.

While formal rules are critical, the most immediate source of support and protection miners have is their workplace culture. Social scientists recognized early that work groups share some sort of informal structure, but have agreed on neither its coherence nor overall importance [Roethlisberger and Dickson 1947; Roy 1953; Stoddard 1968; Bryant 1972; Schwartzman 1986]. It has been argued by those studying dangerous occupations, however, that a rather cohesive body of beliefs, values, and behavioral norms exists in risky work settings. Furthermore, these cultural elements function to increase certainty of action by subordinating individual will in order to realize larger group objectives [Hayner 1945; Janis 1968; Fitzpatrick 1974; McCarl 1976; Vaught and Smith 1980; Smith and Vaught 1988]. These arguments are supported by the work of Kaplan and Kaplan [1982], who pointed out that any culture, in order to be viable, must be a mechanism for coping. The three avenues through which culture should provide a template for individual cognition, according to Kaplan and Kaplan, are (1) relating people to ecological constraints in their environment, (2) guiding interpersonal behavior by enabling one to anticipate his or her cohort's likely actions in a particular situation, and (3) orienting members to the larger world that they might be expected to deal with.

The ecology of an underground coal mine is one in which humans are busily creating a void beneath the Earth's surface. This act produces dust that is unhealthy, because some of it is respirable and dangerous. Explosive gases are liberated during the mining process and water may seep in from disturbed aquifers. Additionally, massive forces brought to bear upon the newly exposed mine roof and coal pillars present the possibility of cave-ins or floor upheavals. Men and women work routinely in the face of these hazards, because they can draw upon a stock of accumulated knowledge intended to help them control such situations. Mine workers believe that they will be able to grasp both obvious and subtle cues about changing conditions and take action in time to prevent mishap, which gives miners a feeling of mastery over their work environment [Althouse 1974].

Workers underground recognize, of course, that nonroutine events do occur. This is a major reason why they expend so much effort achieving mastery over the social domain. An elaborate unwritten normative structure has evolved to ensure group cooperation and individual predictability in the mine setting. The details of miners' preoccupation with rules of interpersonal behavior and the

ritualistic sanctioning mechanisms they invoke to enforce these norms have been discussed in other publications [Lucas 1969; Althouse 1974; Fitzpatrick 1976; Douglass and Krieger 1983; Smith and Vaught 1988]. The point to be made here is that in this environment, as in others where group survival is problematic, there is little tolerance for personal aggrandizement. Rather, a lot of concern is focused on the ideals of shared expectations and coordination of efforts.

The resulting consensus, based on workplace norms, implies that everyone has approximately the same cognitive map of their underground world. According to Kaplan and Kaplan [1982], such uniformity is of benefit to the members of any culture because, as they put it, "Sharing and affirmation...lead to conviction, which in turn reduces...the confusing." This type of arrangement is especially functional in coal mining, where section crews must labor as cohesive units in order to perform their tasks safely [Vaught and Smith 1980]. Cohesion does not, however, imply rigidity. It should be obvious that no cognitive structure which did not provide a great deal of flexibility could serve as a coping mechanism in the underground environment. Thus there exists, on an individual level, a tension between control and complaisance. As will be seen in the analysis, this contradiction is apparent when miners must draw upon cognitive templates to devise escape strategies during emergencies.

How Workers' Ability Will Be Analyzed

It was stated in the section above that workers have roughly the same cognitive map of their mine environment. That is to say, each miner carries an internalized representation of direction, distance and material structures, which allows him or her to interact and work cohesively with others in the setting. In an elaboration of this notion that coherency is a requisite of crew functioning, workers' environmental cognition was depicted as orientation not only in natural space, but in a nonphysical or social one as well. The process of wayfinding, then, may be characterized as "purposeful mobility" [Passini 1984] during which spatial problems are solved on the basis of systemic images. Results will hence be discussed in terms of how ecological constraints, interpersonal behavior, and conceptual content affected information gathering, item processing, inferences drawn, options considered, and choices made during the escapes under investigation.

Ecological Constraints

Ordinarily, the question of how to exit a familiar setting will have a straightforward solution based on environmental information recalled from past experience [Passini 1984]. In all three mines, the normal means of exit would be travel by portal bus to the shaft bottom. The fires, however, presented an unusual factor:

> We had power on the mantrip, so we figured we can get out with the mantrip. We started out in the mantrip, got out so far, and we hit... smoke.

Upon finding they could not evacuate along their normal course of travel, workers were faced with the necessity of generating alternative escape routes. It was this exigency that changed the behavior at all of these sites from a more or less automatic series of responses to the known (or expected) into actual spatial problem-solving activities.

Adelaide

A physical characteristic of the affected sections at Adelaide that had wayfinding implications was the ventilation setup. Because working sections were being advanced farther from the main fan and there were a limited number of intake aircourses going into the 2 Northwest area, it was decided to ventilate active working places with belt air. The operator requested and was granted permission by the MSHA District Manager to make these modifications. Requirements contained in the approved request were made a part of Adelaide's existing ventilation, methane and dust control plan. One of the requirements was that management would install a carbon monoxide monitoring system and locate the sensors in belt entries at distances of 1,000 to 2,000 ft (depending on air velocity). A second aspect of the plan allowed suspension of the requirement to separate the belt and track entries with stoppings. In actuality, this had only been done on 3 Left.

At the beginning of 2 Northwest, it was the belt and track entries that carried most of the air. The belt was a high-resistence entry, however, and lost its air rapidly. Most of this air went into the track and an adjacent intake entry. The result was that perhaps as much as 60,000 cfm of air passed over the belt at the fire site. Also, the belt entry at that point contained a velocity of more than 1,000 fpm. The fire therefore had enough oxygen to propagate rapidly, while the smoke-filled air started dumping into the intakes within a few breaks. Thus, when workers inby the source of combustion began evacuating, they found that not only their track but all intake entries had been contaminated with smoke.

One of the crew members from 1 Right found a novel use for some of the lids that were discarded when everyone put on their SCSRs in the smoke:

> And when we first started out I was picking up the lids...Every time we would turn I would drop one of those orange lids. Because I figure if we get down there and we can't get out, because we didn't know where the fire was, exactly...and we got to backtrack, I wanted to know where I came from. And if I find one of them lids, I know that I had been there

> and...follow my way back...I was saving them like Hansel and Gretl—drop the little bread trail.

Another individual, the miner helper, made use of physical characteristics with which he was familiar because he had worked as a fire boss for several years:

> There was guys walking up this bleeder—the old bleeder...[There] are reflectors in there. They were following the reflectors. I told them, ignore the reflectors, because you're going to get lost. I said, "Keep the stoppings to your left."

By using the stoppings to maintain their orientation, the group was able to travel their left return to an area outby the fire.

The 2 Northwest crew had comparatively little trouble finding their way, since their face boss was very familiar with the area. Because they did not know the fire's location and were in such thick smoke, however, there were times when they had problems. The former mine rescue team member recounted the effect this smoke had on even one as experienced as he:

> But from my experience...I thought...we were walking right into this fire...I started to get a little upset, a little tight...And in our returns we have reflectors...And it's a good idea if there's no smoke but...you ought to have something in there to grasp a hold of [to] tell you...if you're going the right direction. You fall down and you get up and you get turned around, you know, if somebody doesn't know where you're going, you could be crawling around down there.

Some of the group, being new to the section, had not walked their escapeways and were dependent on either being able to see the reflectors or having someone to help them: "I wasn't up on that section [very long] but I know that big man, the boss, knew how to go and I figured I'm sticking with him." It was the face boss who kept everyone together and led the group out.

3 Left, as mentioned previously, did not have belt stoppings all the way up. As the crew was on its way out, they "just hit a wall of smoke" and had to stop the mantrip. The group first went into their intake escapeway and, when they encountered smoke after traveling only a few breaks, got into their return:

> When we got to the return, why someone just took off, you know, never waited on anybody...They panicked and got scared...That's the worst thing in the world to do...Everybody should stick together and then there's everybody in one place...They know where you're at; they know if you're strangled out there.

The men who "just took off" were four buddies who had worked on that section for several years and, as a result, knew the area well:

> We were all...together because we're all real familiar with that escapeway...So we were more or less in the front, leading the way and the foreman was back with some of the other people and I'm not sure who was in—at dead rear...We were the ones that were picking the escapeway out.

Those who had gone ahead were also the ones who balked at crossing the overcast located at 3 Left junction, according to the face boss:

> I could see lights coming back at me and they said they couldn't make it over those overcasts; there was too much smoke. So we started back because I noticed the 3-by-3 door in the return. So I wanted to get back into the intake. Well, I couldn't find that 3-by-3 door and I knew I didn't want to start running around in circles. So I sort of collected myself and we started up over an overcast in the return and in the...sidewall of the overcast there was a 3-by-3 door and one of my men opened it up and said, "This is the intake escapeway." So everybody went out into the intake escapeway...We started walking and we were in the intake escapeway but something didn't look right to me...Around vacation time they had dug the sump and you had a path—as you come out your intake escapeway, the slate's on your left side and the path's on the right side and...I'm walking along and I started thinking something's wrong because that damned slate should be on my left side, not on my right.

When he realized his crew was headed back into 3 Left section, the face boss decided to get back in the return. The crew discussed their next move, then traveled to the overcast once again, where, upon opening the mandoor into their intake this time, the boss felt air movement on his face and was able to determine which direction the group should go from there.

Brownfield

A physical factor that affected group escapes from locations inby the fire at Brownfield was a double set of doors in the 4 South supply chute. A door in the second set was open to a width of approximately 6 ft. A locomotive parked in the chute had been left with its controller set on first point. When the motor overheated, smoke passed through the open door into the intake aircourse of 6 West Mains. In a short time, the intakes of 4 South and 5 South were contaminated as well. This forced all miners inby the source of combustion to evacuate through moderate to heavy "white smoke."

When smoke was discovered coming up the intake into 4 South, a Federal inspector who was on this section quickly checked the belt entry. The inspector and face boss decided to go out that way, because the belt was clear. Within a few hundred feet, however, the group encountered smoke on the belt. After donning their self-contained self-rescuers, the crew continued on down the belt line. The face boss began looking for a way out of the heavy smoke:

> I knew there was a crosscut—on 5 South it cut down into our belt line, and I knew there was a wall there with a door. I thought, well, maybe if we got to that door and went through it, maybe it would be clear in there. That was just a future longwall face area; [there wouldn't] be much smoke in it...So it got to the point where you had to feel the rib, you couldn't see. You might see water line. I was feeling the rib just to find out where that crosscut was and finally found the crosscut. We went up through the brattice door.

The face boss and three men who were with him paused to get their breath and formulate a plan for exiting the mine:

> I told them since the smoke was in the belt line...and track, we were going to have to get over into 7 aircourse [of 6 West] Main on the other side...Maybe that one was clear. That's where I told them we would probably be heading...And [the smoke] was all heavy, so we continued across the main and we got out into the track area and it was the same out there...There was no door to go over into...the intake on the other side.

Unable to get into 6 West right intake, the face boss and his companions decided to travel outby in the track entry. After going four or five blocks, they found themselves past the burning locomotive:

> I'm kind of glad there wasn't a door at 7, 'cause...I guess they opened the door on that right side to help clear the smoke out...I would have been worried if I had gone to 7 and saw smoke on that side, too, 'cause then I would have known [mistakenly] we'd have a long way to go to get out.

In the next several minutes, the face boss was joined by others from 4 South and learned that his miner operator was down up the belt line. He then went back after this individual.

Although the 5 South group started to evacuate by way of their intake escapeway, they only traveled a hundred feet before deciding to enter the belt entry. Unlike the crew from 4 South, however, they did not stay there. After proceeding approximately 400 ft with the smoke increasing in density, the group

came to a steel door: "I don't know his name, the bratticeman, he was first. He went into the return." The smoke was lighter here, so everyone continued down their return until they reached a regulator at 6 West left-side return. At this point the miners donned their self-contained self-rescuers. According to the face boss, his crew was somewhat strung out by the time they had gotten outby to the 5 South intake overcast:

> A couple guys had already come out and went over this way trying to get to this door. 'Cause this is the belt line, track entry, then [6 West right] intake. In my opinion, they did the right thing, you know, trying this way. But then they got out to this intersection here, they couldn't see...anything, so they turned around and come back to the door.

The face boss then decided to make an attempt to reach the 6 West right-side intake himself. Telling those with him to wait, he opened the door and went into the belt entry. The smoke was so thick he ran into the belt. The face boss crossed it and came to a second door:

> I opened this door and the power center's setting here. I couldn't even see that from the door...Right then, I tell you, panic hit, believe me. 'Cause all the teaching and training, everything, these are all supposed to be separate splits. Well, the first thing that goes through your mind is everything's burning. In my opinion, there was no sense even trying to get [to the right-side intake], so I come back. There's a bleeder pipe that goes from this overcast over to the power centers and that's how I found my way back over here. They waited for me. They made up their minds that they was going to wait 10 minutes for me and then go. When I come back, the smoke was getting a little bit heavier in the return...I said, "You guys want to try to make it over there" and before I said much more...the bratticeman said, "We're ahead of the smoke! Let's go!" Well, right then—well, everybody seen the smoke here. That's when there was not much control, you know, and everybody started just going.

One of the masons, who thought his SCSR was not working properly, took it off and threw it away. The face boss helped him don his filter self-rescuer. The group, with "everybody stringing out pretty good [by] then," passed across the overcasts at 4 South, the face boss checking doors as they went. He came to a door outby the fire area, opened it, and found fresh air. The boss called everyone back and they went through that door onto the track.

A maintenance foreman working on 6 West took the fire boss's call. He then gave himself an advantage over members of the other two groups by discovering the fire's location:

> And I knowed I had to go down past 4 South here...I was the only one out of all the guys that knowed where the fire was...And the reason for that is I took and asked [the fire boss] where the fire was.

The maintenance foreman, a mechanic, and a State mine inspector met at the beginning of the intake escapeway. The three men donned their SCSRs at that time because they could see light smoke coming up the intake. The group traveled down to 8 Left aircourse, where they encountered heavy smoke. About 50 ft past that point, unable to see, the maintenance foreman decided to backtrack:

> The smoke was so heavy you couldn't even find the mandoor at the overcast. But I knowed if I went up one more crosscut and I went up along the rib pretty close and went into the left and then come back a crosscut [I'd get] into the return.

The men did this and went through a door into 6 West main return, which was their alternate escapeway. They proceeded outby in that entry:

> And we was probably halfway between 5 South and 4 South whenever I heard the 5 South crew coming. I heard them coming over the overcast, and then I was relieved a little bit because I knowed that boss coming with that crew was real familiar with the mine.

Knowing that the fire was at the 4 South supply chute, the maintenance foreman continued in the lead. He passed up a mandoor that would have brought his group into clear air outby the chute, however, and was called back by the 5 South face boss. The 5 South and 6 West groups then entered the intake and from there proceeded out onto the track.

Cokedale

One particular physical characteristic of that area of the Cokedale Mine where both affected crews were located proved to have a significant impact on everyone's wayfinding behavior. The primary (intake) escapeway, which in most mines would have extended "separate and distinct" to an air shaft or portal, led instead onto Cokedale's main haulage track. Since the source of combustion was on this track, that meant the escapeway could rather quickly become smoke-filled. If anyone possessed a clear picture of the layout and was able to communicate this fact to his group, no time would be wasted on attempts to evacuate down the intake entry. Without knowledge of the source of combustion, however, this primary escapeway should be the first choice. Thus, what might have been a minor component of even the most comprehensive cognitive map became critical in this case.

After encountering smoke on their section track, the group from 8 Face Parallels held "a small discussion as to where we were going to go, what we were going to do." A trackman, who had just delivered a load of rails to the area but who was unfamiliar with that part of the mine, recounted his reaction when those supposedly more cognizant of their immediate surroundings began to consider going out the intake escapeway:

> According to the old laws they didn't have to [route] it to the shaft and this fell under [the old laws] since it was an old established section... And that stuck with me, and when they decided they were going to walk the intake, I specifically said to [the general foreman], "We can't go out the intake."

Regardless of this warning, the accounts show that "it was the consensus of everybody [to] head for the intake." Additionally, the decision seems to have been based not on any stock-taking but on a generalized training protocol that suggests miners should always travel their primary escapeway if possible.

A problem arose immediately because "nobody seemed to know how to get into the intake escapeway from where we were out at the mouth of the section." The general foreman mentioned above, who had been leading this group initially, decided to "go back [and] get into the intake from the face." The workers then returned to the section in order to enter their primary escapeway. Everyone walked across the face area, got into the designated intake entry, and proceeded down it until "we came to an overcast and as we walked over top of the...steps, you could see on the other side the smoke was coming in the intake." At about this time "the guys started...making the decisions on what to do," although there was still little discussion taking place. Since there was only one way out of the smoke—back up the entry to the face—the miners, led now by a trackman, retreated in that direction.

Once again on 8 Face Parallels section, the group was faced with yet another decision. Given the general instructions miners receive in training classes, "naturally the next thing would be...the return [secondary escapeway]." Their choice was made fairly quickly, and, while appropriate under the circumstances, did not get translated into proper action. In fact, a procedural error was committed, further compounding the crew's earlier decision error:

> So we decided to try the designated return, at which point [the general foreman] did not know which was the designated return.
>
> We headed out...on the right side and...went five or six blocks and...one of the guys up front noticed there's no arrows; we're in the wrong return. We're not in the return escapeway. So then the bratticeman from the

> section, he said, "Oh, yeah—that's on the other side of the section." So then we turned around.

For the second time, then, an important item in at least one person's cognitive map was disregarded, causing the men to travel an additional thousand feet before ending up back where they had started from.

Regrouping in the face area, several workers decided to gather information before beginning the next attempt to find their way out. An individual remembered the section map, which had been hanging in their dinner hole:

> I stopped and got the map, read the map, and two other guys...they stopped and was reading the map with me and...what we wanted to do was see where it brought us out...and once we...saw where it brought us out...we knew the smoke was coming down there so we knew...the fire had to be fairly close.

Reassured by this knowledge, the miners entered their designated return escapeway and, led by a general inside laborer who had once been a foreman, finally started their ultimately successful exit from the section.

Those on 7 Butt had a somewhat different experience. According to a general foreman who was with this group, "we all started out at the same time...and we ran into that wall of smoke [on the track]." When they ran into the smoke they also collided with a stopped vehicle. As a result, one person lost his hard hat and cap lamp. He was assisted by his buddies as the general foreman gathered everyone and planned their next step:

> I [had] set all the ventilation up down there and I knew basically what was going on with all the smoke. The intake escapeway would have been full of smoke.

Informed by his cognitive map of the area, this individual was able to depict for these miners some of the features that would be affecting their intended escape. He first told crew members the location of a mandoor they should go through to get into one of their return entries. Next, the general foreman assured everyone that they would encounter less smoke by taking his course of action. Finally, he provided a preview of their route:

> The return that we started going out was not a return escapeway; it was just a return airway. I told them...we go through the mandoor, follow [the return entry], ...cross over the overcast, check the doors up there... get into the return escapeway and follow it up to [the portal].

Thus, the workers all had at least a limited notion of where they were going and how long it would take to get there. As the crew walked, the general foreman was able to keep them updated:

> Everybody was asking me where we were...what direction we were headed. And with the information that I had...I knew first-hand...what direction we were headed, ...where the mandoors were, ...[our] location [in reference to] the motor road...and where I was gonna bring 'em out.

With these reassurances, the miners from 7 Butt were able to stay together and exit their section in an orderly manner.

Interpersonal Behavior

Overall group performance largely depends on how well group members can play their assigned roles. In nonroutine situations, difficulties may arise if someone who normally holds a leadership position is not prepared. The same may be said of a person who, because of his or her experience or expertise, is considered to be "mine wise" but who does not use that wisdom. Workers still look to these people for guidance. This complication stems from the fact that roles which people enact during an emergency, instead of being expressly different from their typical roles, are existing ones that have been carried over and tailored to unusual circumstances [Best 1977; Johnston and Johnson 1988]. Worker accounts reveal clear differences in behavioral patterns within and among the eight groups under discussion here. This section addresses some of the ways these and other social phenomena began to have a bearing upon individuals' use of cognitive maps and their subsequent wayfinding activities.

Adelaide

The section foreman on 1 Right had been recalled only recently to Adelaide. While this might not have been too detrimental to his performance of duties at the face, he encountered difficulty when he had to extend his leadership role into emergency circumstances. The miner operator explained his attitude toward the boss's performance:

> The boss; I can't blame that boss...This was the first time he was on the section in 5 years; he'd been laid off...He...didn't actually know just where to go, but [the utilityman] was a fire boss at one time, so more or less...took the lead.

The utilityman, who was working as 1 Right's miner helper that night, initially wanted to lead this group through the bleeder system to Peterson shaft:

> I told them if we get [back] in the mantrip and...go back to 35 stopping or 36 stopping, there's a door in a left return. I said, "You can walk across the bleeders to Peterson shaft." I said, "Let's all get in the mantrip, we'll go back, and we'll get out of the mantrip, we'll call and tell them that we're getting out and we're walking to Peterson; they'll have a mantrip waiting for us at Peterson."...We was standing by the mantrip, but they wouldn't get in it.

Having failed to convince his coworkers to backtrack, the utilityman then began acting as advisor to the face boss and crew: "I don't know...They say I [took charge] but I don't think so...I just knew where to go...that's all." Regardless, the accounts show that this person's recognized "mine wiseness" and relationships with other crew members played a significant part in how his group found its way out of the mine:

> And when we walked down through here, you had to watch because if you followed the reflectors, you'd end up in this bleeder here or in the gobs, because they had reflectors. And [the utilityman] kept telling them, "Hey! Keep the stoppings on your left. If you veer off, you're going to end up in a bleeder or gob." So twice he had to say, "Hey! No, no! You're going the wrong way."

Thus, the utilityman apparently used his fire bossing experience to compensate for the face boss's lack of familiarity with the area while refraining, in his view, from actually assuming control.

On 2 Northwest, the section foreman moved quickly to control the situation, drawing upon the experience of one of his buggy operators, who had been a mine rescue team member:

> We got everybody together and [the boss] said, "You take the back, I'll take the front...we're going in single file...Don't let anybody in back of you...and we'll keep everybody together." The boss took control...He told them, "This is what we're going to do." There was no, well, I think we ought to go here; I think we ought to go—we knew what we were going to do...where we were going...I had confidence in him; everybody did...And he had confidence in...me...being from mine rescue.

The behaviors of both individuals were consistent with their roles. 2 Northwest's face boss was familiar with the area and continued to direct his crew. The buggy

operator performed according to certain expectations of his mine rescue role. This group escaped without undue complications.

Leadership roles on 3 Left shifted during the course of their escape, with individuals making suggestions or taking the lead at different moments:

> I was the first one in line going over the second overcast and when I seen that smoke coming up out of there, it was so bad, I told everybody in line, "There ain't no way in hell I'm going...I'd rather have it coming in my face [than] at my back." And we got back into our intake escapeway and had the smoke coming in our face.

Some of the miners attributed the vaguely defined leadership in this group to panic. Another, and perhaps better, explanation stems from the fact that 3 Left was a "split crew." Some of the miners were buddies who had been on the section for several years and knew the escapeways well. Others had been there only a few days or weeks and were unfamiliar with the section. They were left behind by those who could more readily find their way. Unlike the foreman on 2 Northwest, who was able to take the head of the line because of help from a person well-versed in mine rescue procedures, the foreman of 3 Left found it necessary to stay with the workers who were having trouble. His ability to control the escape was therefore hampered.

Brownfield

There were two individuals on 4 South who possessed not only a certain degree of "mine wiseness," but who were also in authority positions: the face boss and a Federal inspector. As the group proceeded down their belt line, some members began to get ahead of others. The inspector broached this problem to the face boss:

> I said, "Those guys are getting ahead and I don't think we can slow them down. Someone better travel with those guys." There was never any discussion on who was going to go with them. I said, "Why don't you go down there and go with those guys and run them ahead and I'll stay with these guys." I knew the mine quite well so I didn't have a problem with where we were going or where the aircourses...[were].

Later in the escape, however, the inspector encountered difficulties of a different sort. One of the two workers he was with (the miner operator) became unable to continue. The inspector's knowledge of the mine, combined with his lack of information about the fire's location, presented him with a predicament. Should he continue his helping role or leave the victim behind in order to save himself?

> I knew we were in the belt entry, but I didn't know where we were as far as getting out to the main but here again, not knowing where the fire was, I didn't know how far we had to go once we got to the main. Once we got to the main...if we had to travel in smoke, I knew it would be at least another hour to get to the portal. So it started to concern me, the time element and getting out of this section.

The inspector did not immediately make a decision to depart. Rather, he kept trying to assist until the victim himself suggested the others leave:

> He looked at the mechanic. I saw him look at the mechanic and he said, "You guys go. You just leave me here. I can't go no more. I'm just going to stay here." I looked at the mechanic and I said, "I got to go. There is no sense in me staying...I can't breathe now...I can send somebody back. I'll go out and get somebody. If it's only out to the main track, there will be somebody, I hope, out there. I can send them back and I know exactly where you're at..." Even when I told this man I thought I was out of air, I got to go get help, I was still carrying an extra self-rescuer and I guess I had taken enough smoke...I didn't realize I had it.

The mechanic, left alone with the miner operator, soon became convinced there was nothing further he could do:

> I didn't know my way out of there. I lost all orientation how to get out of there. I knew my way out, but I forgot. It was just a panic thing...so anyway, I thought, "Well, [the miner operator's] not going to make it; I'm going to try and get out. So I started out and I was only about a hundred foot from [the miner operator] when I came through the overcast and I opened the door and I saw No. 7 and I thought, "Good. This is fresh air...the way out." I thought I was out to the track, but I was only into No. 4 aircourse. So I thought, "Well, I'm going back in and get [the miner operator]. I'm this close, we're going to get out of here."

Buoyed by his mistaken belief that the victim was only a hundred feet from fresh air, the mechanic went back to renew his rescue efforts. He was soon joined by the face boss, who brought two replacement self-contained self-rescuers. The face boss informed both men that fresh air was just 500 ft away. The mechanic and face boss then got the miner operator on his feet and supported him as all three made their way outby the burning motor.

The workers on 5 South stayed close together during the first part of their escape. When asked how much planning was done before they left the face area, the section foreman replied:

> Actually, there was no real planning until we got down to this regulator. We put our self-rescuers on, then we got down and couldn't get out here [into 6 West right intake]—then everybody knew they was going down the return. Everybody knew where they were then...and there is no turns. Everything's straight in that return.

The section foreman finally came to a "void" in the smoke where he spotted the door that led into fresh air. He then shouted for those group members who had gotten ahead and the crew all exited into the intake and from there into the track entry outby the fire source.

The maintenance foreman who took the mine examiner's warning call on 6 West asked him where the fire was located:

> Well, he told me there was a fire at 7 Left ramp. He didn't know what was burning, because he couldn't get in to it. But I knowed how far I was from 7 Left and I traveled as fast as I could to beat it. Only you don't beat those things. I found that out real quick.

The maintenance foreman reported that he walked ahead of the mechanic and State mine inspector who were with him, looking back frequently to make sure they were keeping up. There was little discussion among the three, because the maintenance foreman was familiar with the area and knew what point the group needed to reach in order to be outby the fire.

Cokedale

One early problem for 8 Face Parallels (8FP) stemmed from the fact that Cokedale's dispatcher, whose functions may be envisioned as somewhat akin to those of an air traffic controller, did not inform everyone of the fire's location:

> He was trying to call the other section right away. So...I can understand...what he has to go through trying to call everybody and try to get them out, call the DER [State enforcement agency] and everything else. He got his hands full.

Worker accounts indicate that the resulting uncertainty heightened this crew's confusion and indecisiveness. Where they would ordinarily look to management for direction, the miners had a general foreman who was as confused as they

were. Additionally, given Cokedale's authority structure and work rules, an alternative leadership mechanism was not in place—one had to emerge. This emergence was a process negotiated over an extended period of time, seemingly at the expense of efficient wayfinding behavior.

It has already been stated that by the time 8FP began its final attempt to exit the section, the workers were being led by a general inside laborer who had once been a foreman. Researchers reached this conclusion by weighing various responses to questions about who was actually making decisions at certain points during the escape. While there was much agreement in everyone else's accounts, the general inside laborer himself had a slightly different interpretation:

> At that point in time me and [the boss] was close together—there was nobody right there that could hear what I was saying. I say, "I didn't bring the map, [but] we have to go out this return." Being as [the boss] knows me, it was more a mutual agreement...He respects my knowledge from mining and I respect his so...that he understood more or less what I was talking about—that...we were running out of time. That wasn't the time for no argument.

Thus, this worker cast himself in the role of advisor, deferring as much as possible to his general foreman's authority and legitimate leadership position. Also, the general inside laborer presented himself much the same way during interactions with his buddies: "I was not in a foreman capacity, but I could see things going on that was wrong...so I would say, 'I sure wouldn't [do that].'"

Eventually, the crew traveled outby to their section air regulator and stopped. At this point the general foreman decided to explore ahead. The general inside laborer chose to accompany him, so both men went through the regulator and proceeded some 100 ft farther outby:

> You could see 50 feet and then you couldn't see 2 feet...[I thought] there was a stopping blew out [or something] because [the air was] all mixed up no matter which way you turned...[The boss] said, "We can't lose the smoke this way." I said, "We have to go through this—go out the return. Smoke or no smoke...we can't keep changing our minds...else we'll be here forever."

After regrouping, the miners did continue out their return through smoke that kept varying in density. This phenomenon concerned the general inside laborer as he tried to orient himself, because "if something happened at one point [and] you walk six, seven, eight hundred feet, then you could be in a better situation or a worse situation—but that wasn't happening." The smoke's behavior confused everyone, and, as one motorman observed, caused a few individuals to waste time looking for ways out of it where there obviously were not any:

> We would come to places in the return where the bleeders were and people would actually go and look over the wall at the bleeder—for what purpose, I don't know...maybe they weren't familiar at all with what the return looked like or whatever an old bleeder would be.

It was this person's opinion that the aimless search for alternative routes as they traveled could have been curtailed by more forceful leadership.

Even though the men were wearing emergency breathing apparatus and were not supposed to remove their mouthpieces, they did so in order to communicate. As the general inside laborer's comments suggest, crew members seem to have kept up a running commentary regarding their location:

> Somebody mentioned..."We're going parallel to the track..." I'm thinking, "Boy, that's a bright deduction after we walked all this way—whoever said that's really thinking. If we ain't parallel to the track, we're in a lot of trouble...what the hell's wrong with these people?"

What was wrong, in the motorman's opinion, involved a circumstance of past experience and perspective:

> Now I found...out after[ward] that the older fellow had worked in those returns off and on [setting timbers] and things like that...But...one old entry looks like another one...as far as I'm concerned.

The men therefore drew upon each other for support and continued to speculate about their progress, since "we still didn't have the slightest idea where we were or how long [we had been walking]."

The general inside laborer checked behind mandoors as the group came to them. He eventually located one that opened into fresh air on the loaded track. The miners crawled through onto this track and began to get their bearings:

> My buddy immediately recognized where we were. He said, "We're between 18 and 19 crossover." Because he'd run motors out there for so many years...he could recognize where we were...We gathered ourselves. The elation was just unbelievable.

After resting a few moments the crew members made their way over to the empty track and up it to 19 crossover, at which point they joined with workers escaping from 7 Butt.

It has already been stated that the people from 7 Butt did not have as many problems finding their way as did those from 8FP; nor did they waste time trying to go out their intake escapeway, because the general foreman with this group knew where that entry led. The workers still encountered some difficulties,

however. At one point, according to several accounts, the pace quickened almost to a run. This proved particularly stressful for that individual who had lost his hat and lamp in the vehicle collision and was depending on his buddies to lead him:

> My buddy in front...I held onto his belt all the way out...I followed their lights plus held onto his belt...I lost him a couple of times. I kept yelling...'cause everybody was running—everybody was in a hurry.

Aside from aiding their coworker, who began to "get excited," these miners' biggest concern was staying together and keeping themselves oriented. Although there was little talking reported among this crew in comparison to the miners from 8FP, several still queried the general foreman about their location as they traveled.

The group proceeded out their main return, with the general foreman checking through mandoors to see if they had yet reached a point where there was fresh air in the track entry:

> Every time he would check a door he had us stop to cut our breathing down a little bit, which was nice—everybody kinda got a little rational... I think we had to check maybe two or three.

The workers came finally to a set of double doors situated between 18 Face and 19 Face: "It...probably took about an hour, but...you weren't doing anything or really thinking 'cause it was just basically following the leader at the time." The general foreman led them through these doors into clear air, across the loaded track entry, and into their intake. The men walked outby to 19 crossover, where they met 8FP crew. Following a head count and brief telephone report to the outside, these combined groups continued toward 20 Face, where mine management had arranged mantrip buses to take everyone to a portal as yet unaffected by smoke.

Conceptual Content

As Kaplan and Kaplan [1982] observed, "humans are inclined to be painfully distressed by confusion and by helplessness." When they experience this anguish, people most commonly resort to authority, either social or cultural. Social authority involves the positions held by individuals and their expertise in playing roles incumbent to a certain position. Cultural authority is derivative, following from widely shared beliefs and values. An essential function of authority, in whatever form it takes, is to convey certainty in an uncertain world. Thus, a great deal of human effort is spent interacting with others for the purpose of evoking authority in an attempt to achieve clarity and agreement upon matters that would

otherwise be disturbing or even disruptive. Such was the circumstance at the three sites under study here. This section presents a brief overview of various ways in which the miners strove to reach a consistency of perspective.

Adelaide

It was stated earlier that the utilityman on 1 Right suggested the crew, once they encountered smoke on their track, retreat to 35 or 36 stopping and walk across the bleeders to Peterson shaft. Evidently, he did not argue his point; at least, this is what one of the roof bolter operators remembered: "Well, he kind of mentioned it, see, then he just left it go." A missing piece of information, and one that, in the opinion of the bolter operator, would have predisposed the group to follow the utilityman's suggestion, was the fact that 2 Northwest had been forced to abandon their mantrip near the mouth of 1 Right:

> When they got into the intake...they called the dispatcher and told him, "Hey, we're going in the intake. The smoke is too heavy at the mouth of 1 Right." So when we called the dispatcher and told him we're going in the return, he should have told us that 2 Northwest stopped down at the mouth...the smoke may be too thick down there.

Instead, the 1 Right group, thinking they might soon be out of the worst of the smoke, entered their return and traveled in increasingly worsening conditions.

According to one of the shuttle car drivers, the group engaged in some discussion of where the fire was probably located:

> We were going to try...getting to Peterson, but we didn't know exactly where the fire was. We thought that the fire was at 3 Left. No. 2 transfer, the low spot, there's always a bad place the belts fall in and everything else. So that was our idea...I wished we knew where the fire was for one thing. It's like you're going into the unknown; you don't know exactly where you're going.

Near the end of the crew's escape, this individual, recognizing his location from a series of overcasts he had helped construct, left the group.

After the members of the group from 2 Northwest abandoned their mantrip, they walked back into the face area in order to reach their intake escapeway:

> The boss, he said, "We'll be all right." He said, "Everything'll be fine as soon as we get up into the fresh air." So we was scooting along pretty good and went back up the track, went over to the intake...It was smoke. There wasn't any fresh air there. So that was the point there where we all put on our rescuers.

The crew proceeded down their intake for a short distance and then decided to get into the right return. According to one of the roof bolter operators there was not a lot of conversation, although group members engaged in stock taking during rest stops:

> Yeah, we stopped different times—one guy fell down. I pulled him back up. He fell down. He was a little red and hysterical there a little bit of the time. And we stopped and the boss talked to him and calmed him down. We stopped periodically if anybody was having problems. We'd stop and check. Not long, but long enough to talk and see where to go and calm down.

The right return was designated an alternate escapeway, so all that was required of the 2 Northwest crew was that they stay in that entry until they were outby the fire. Because group members did not know the fire's location, the face boss, who was leading, would feel and open each mandoor they came to. At last he opened the door in No. 3 stopping and encountered fresh air. The bolter operator quoted above was one of the first through:

> I know I went through it and hit that fresh air and I was hollering at the other ones, because they was kneeling down there taking a little break. I told them to get...over here and get out of there. We appreciated that air more than you ever did.

After contacting the shift foreman and notifying him that everyone had gotten off 2 Northwest, the face boss was given instructions to take his crew to the surface.

The crew from 3 Left contained some members who had not been on the section for very long. One of these was the bratticeman who, because he was new, had been selected recently to walk the escapeways:

> I walked that the first day I was there, 3 weeks before. My boss wanted—he comes to me and says, "I want you to walk out with me and I want to get a couple of other volunteers to walk out. So you'll know in case something happens." But it's kind of—when you're walking out and you know there's nothing wrong, you're just strolling through because you have to do it. You know the reflectors are up there so you really don't pay attention to the markings or anything other than the reflectors and what door you go through; you know, where you go out.

At one point the group became disoriented and was actually headed back into their section. The bratticeman recounted how this confusion raised the miners' anxiety level:

> We went down this breakthrough and we couldn't go through and we come back, we come back like around the block and we got confused and we sort of all just grouped together in one place trying to decide what would be the best way to go out...We were walking down—we ran into our shift foreman who said at six more breakthroughs, five or six, make a right and you'll be out of this. That's when the two guys that always seemed to be ahead really took off.

One individual who was having problems received help from the utilityman, a shuttle car driver, and the shift foreman who had been looking for them. The crew finally reassembled outby the fire and found transportation to take them out of the mine.

Brownfield

4 South's face boss was able to take advantage of the Federal inspector's presence during that group's escape:

> So we started down the belt line and there was three guys that wanted to take off. They ran like deer...I was trying to stay in the back being the last one to make sure everybody was ahead of me. And it got to the point where I could see these guys were going too quick. The Federal inspector was back there with me, too, and I finally told him, I said that if he would stay with the slower three guys or four guys, I was going to go ahead with those faster guys, 'cause I didn't want them to walk into something that they weren't ready for. I walk that belt line every day... I didn't know what we had down there.

Near the mouth of 4 South the face boss led those workers who were with him into a future longwall face area. His intention was to get them out of the worst of the smoke and give everyone a chance to catch their breath. At this point he outlined the route they would take to try to get into the right-hand aircourse of 6 West:

> So everybody got settled again and we went back out and worked our way down the belt line. It was a slow process. The smoke was so heavy you just couldn't see.

The group members eventually arrived at 6 West track but were unable to find a door that would let them into the intake entry they were trying to reach. At that point, one miner left the others:

> My supplyman, he had gotten ahead. He took off again. He was the quickest one of the bunch, so when we got out into the high track,

> I called for him 'cause I didn't know—he could have took a left, took a right, fell down, I wouldn't have seen him. So I yelled—that's when the people down below the fire yelled that there was fresh air down that way.

After getting his small group outby 4 South supply chute, the face boss learned that his miner operator had not made it out. He then went back into the smoke in search of this individual.

A rapid pace was set by the bratticeman, who was leading initially as 5 South crew made its escape. One of the roof bolter operators recounted how this put stress on everyone else:

> To the best of my recollection, the bratticeman just took off running. He says, "Come on—we got to get out this way." And he took off. Well, he took off and he was leading the pack, okay. When we got down to where the regulator was at and put the self-rescuers on, that's when [the boss] took over. One of the things I told him later on, I says, "You're the boss—one thing you got to do if this ever happens again, you should have a man that's in charge that's going to take his time and walk out of there slow and easy with his self-rescuer on."...[You go] six, seven, eight hundred feet before you even try to put one of them things on, you're winded. [Then], it's like trying to suck through a straw.

A shuttle car operator also discussed the difficulties group members were having getting enough oxygen from their apparatus. Added to this concern was the fact no one knew the fire's location at first:

> So we went and then we run onto three other guys coming down from 6 West, too, which was the maintenance foreman and an inspector—and a mechanic. Yeah. And then they told us where the fire was at. But we was still up away from where it was at a good bit. But they told us it was down at—what was it—4 South—4 South sidetrack where the motor was sitting. But we had to go down below that, so then we had an idea how far we had to go, so it took a little bit of the pressure off 'cause we knew we was going—we had a pretty good chance now.

5 South crew, together with the three individuals from 6 West, eventually came out onto the track one door down from the burning locomotive.

The maintenance foreman on 6 West intended originally to ride out in his three-wheeled jitney. He was dissuaded from doing so, however, by the State mine inspector accompanying him:

> Well, it could cause an explosion, he said, for one thing. I mean, I was on the damn thing and so was [the mechanic] when he says no. I know one thing—if it ever happens again and there's something to ride...I'm riding.

The fact that he knew how far his group must travel in order to get outby the fire influenced this person's approach to their escape. During their walk out, the maintenance foreman kept an eye on his two companions and made sure all three stayed together.

Cokedale

The workers from 8 Face Parallels apparently kept up an almost constant stream of communication. At first, conversations were directed toward assuring each other that nothing much was out of the ordinary:

> The dispatcher started calling us, and...said that they had detected some smoke and that we should come out. Well, this isn't real uncommon because...belts or something might burn off a pump or...you can get a hot hanger once in a while. So at that point we really weren't all that concerned.

People's tendency to treat a nonroutine situation as normal until it is no longer possible to do so is a well-documented phenomenon [McHugh 1968]. This fits well with the notion that human beings have a predisposition to impose order on their world as a way to minimize uncertainty. However, in events needing a quick response, critical time may be lost. This is especially true in cases where there is an effort to reach group consensus before action is taken.

As the escape off 8FP progressed, miners' talk shifted from efforts to normalize their situation and focused instead on a need for cohesive performance:

> The older man...said, "Why don't you guys stay right here, and [we] will take a walk up through and just see if...it looks passable." So those two proceeded to walk—I couldn't tell you how long they were gone...And they came back and they said, "This is definitely the return, and I think we can get through, so we should try it."

To bolster this endeavor, which the workers were unsure would be successful, they used various interpretive strategies [Kaplan and Kaplan 1982]. Chiefly, the men seemed to seek information about their location and progress, even though these actions did not always appear to make sense. A couple of cases in point are the motorman's account of people looking over into old bleeders and the

general inside laborer's bemused reaction to an observation that his group was walking parallel to the track. Additionally, however, some individuals imputed expertise they did not have to someone else. For this group, their authority became the general inside laborer, who had once been a boss and who had "worked in those returns off and on."

7 Butt personnel were less distressed during their escape because there was a convergence of formal authority and expertise in the general foreman who led this group out. These workers seemingly devoted more effort to dealing internally with their predicament than in information seeking:

> I felt pretty confident...because I knew [the general foreman] had been up there for a long time walking returns and this and that and he was real familiar with this area.

Having someone in control, as they did, enabled group members to pose alternative scenarios based on properties of individual cognitive maps:

> If I would have been left to my own devices, I knew that I could have made it out following the track.

This activity undoubtedly had a calming effect on the person, but may also have helped each worker establish a better grounding in relation to his environment and how it could be negotiated.

Both groups, in essence, utilized strategies that differed according to their circumstances. The 8 FP group focused more on information exchange and a search for authority; the 7 Butt group tended to deal "intrapsychically" [Kaplan and Kaplan 1982] with the situation that confronted them, getting their heads straight by talking to themselves. In this event, the effects of social dynamics can be seen in those coping mechanisms used. It is thus arguable, given these divergent patterns of interaction and reaction, that individuals' conceptual content was shaped by their shared experience. Such a notion takes cognitive mapping and wayfinding beyond the psychological domain and situates it within a broader social science perspective. Also, this paradigm focuses on group effects rather than positing personal differences as a variable of interest.

Discussion

What can be gained from introducing a diverse level of analysis to the problem of wayfinding? First, it opens up a new realm of possible questions and answers. As Simmel [1971] pointed out, each level of the social world provides valid insights, but can only be understood in terms of its own unique rules of evidence. Second, since the escape behavior discussed above clearly took place

in a group context, an individual differences approach would lack explanatory power when applied to wayfinding in that situation. Clearly, broader analysis is needed in relation to these mine fires. By considering the cultural and social milieu of cognitive mapping and wayfinding behavior, social scientists will be able to more readily explain how people in crisis go about deciding what to do next when more than one person is likely to have input into the decision.

Several key points about wayfinding and cognitive mapping have been raised in this chapter. First, the way human beings make sense of their environment is, according to some theorists, socially mediated. In other words, people's definition of even the most taken-for-granted elements, such as time or distance, is a result of group consensus. Thus, mental maps are not wholly idiosyncratic constructs. Second, cognitive mapping is a dynamic process. The map one has in his or her mind can be acted upon by forces both internal and external to the individual. As a wayfinding tool, then, a cognitive map acts mutably rather than in some mechanistic fashion. Personal decisions about a best course of action are therefore more problematic than they have sometimes been portrayed as being. Third, it has been suggested that some settings in modern society may be characterized by a sameness of cognitive maps. This would help to ensure predictability in situations calling for close coordination of action. Finally, wayfinding is a spatial problem-solving activity in which factors external to the individual (such as ecology and interpersonal relations) have a significant impact upon outcomes.

The purpose of applying certain theoretical notions to real-world problems is to attempt a better understanding of some empirical phenomenon or phenomena. In the present case, the issue to be understood is how workers go about moving from one point to another in a mine fire. The approach used here should be highly generalizable, however. It is hoped that in the future, more attention will be paid to those intersubjective factors once thought to have little bearing on such "intrapsychic" processes as cognitive mapping. Social scientists may benefit from new avenues of inquiry. In addition, planners and engineers would almost certainly gain by having a deeper understanding of what variables motivate the behavior of those who inhabit their structures.

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