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Expert and Novice Fire Ground Command Decisions

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There is a need to develop descriptive models of decision making under conditions of risk, ambiguity, and time pressure. As part of an ongoing effort to develop such a model, the present study performed a Critical Decision analysis of decisions made by 12 Expert and 12 Novice fire ground commanders. A coding system was developed for this study and 104 decision points were classified and described. The findings do not support the prevalent view of decision making as evaluation between options. 54% of the decision points relied most extensively on pre-decisional processes involving problem identification and clarification, 15% involved questions of specific timing or control, and 13% involved serial evaluation of a single option. Thus, only 18% of the decisions involved concurrent option evaluation. Differences between Expert and Novice commanders are also discussed. (25)

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Executive Summary

Requirement

Current models of decision making based on the prevailing laboratory-based research paradigms have been primarily focused on static and well structured decision tasks that have limited applicability to operational settings such as tactical command and control. There is a need to perform naturalistic studies of decision making under conditions of risk, ambiguity and time pressure.

The present study is part of an ongoing research program to generate a descriptive model of naturalistic decision making. a method of eliciting reports of critical decision events is used to obtain protocols of the decision making of personnel during and/or after real or simulated operational maneuvers. Specific probes are employed to identify the cues and decision strategies that led to a choice of action. Thus far, the method has been used to study the tactical decision making of urban fire ground commanders (FGCs), wildfire incident commanders, and tank platoon leaders.

The goals of the present study were to replicate and extend the findings and methods of an earlier study of FGC decision making and to investigate the role of experience in decision strategies by comparing the protocols of highly experienced FGCs ("Experts") to those of newly promoted officers ("Novices").

Approach

Critical Decision interviews were conducted with 12 Expert and 12 Novice FGCs, yielding a total of 104 separate decision points for study. Specific probes designed to elicit detailed information about the nature of the decision process were tested and modified.

A conceptual analysis of types of the decision strategies was developed as part of the coding effort in the present study. The resulting framework was termed a Decision Continuum because decisions were classified by the degree and nature of the deliberation processes. The Continuum is anchored on one end by "choices" that required little or no deliberation by the FGC. For these events, action appeared to be based primarily on the FGC's previous experience with similar events. When conscious deliberation was required, it frequently involved identifying and clarifying the nature of the situation itself or the specifics of action implementation or timing. These processes are commonly relegated to "predecision" stages or studied as aspects of monitoring or supervisory control, but we found them to be inseparable from decision making in this natural context. At the other end of the Continuum were decisions fitting the

definition of decision making more closely, in which action choices were deliberated in an attempt to meet multiple and sometimes conflicting goals.

Decisions were further classified by whether serial or concurrent evaluation was employed. Concurrent evaluation implies a direct comparison of situational or option possibilities in relation to at least one common evaluation dimension. In serial evaluation, only a single possibility is considered at any point in time. It is evaluated in relation to the relevant dimensions, and then either accepted, modified, or rejected.

Findings

Our results confirmed and extended our findings from previous studies. In 54% of the cases, deliberation primarily involved the predecision or situational component of the decision problem. In these cases, identification and recognition of the situation allowed a choice of action to be generated and implemented without further deliberation. In 14% of the decision points, implementation and timing of a highly preferred or standard option was the most crucial issue. Even in the 32% of the cases that involved evaluation between options, 14% were serially evaluated. Thus, only 18% of the decisions fit the classical definition of decision making as concurrent evaluation between options.

Experts and Novices were roughly equally likely to deliberate about options, but Experts used an approximately equal mix of serial and concurrent strategies whereas Novices appeared to rely exclusively on concurrent deliberation. Experts were also more likely to deliberate about situational aspects of the decision problem, whereas Novices deliberated more about option implementation and timing. Experts also appear to construct novel option solutions much more frequently than Novices, and to report the use of imagery to evaluate potential options more frequently than Novices. Experts were also almost twice as likely as Novices to consider future contingencies in their decision making.

Utility

We believe that the findings of this and other investigations in this program have implications for the development of sound, useful decision support systems, and training programs. For example, it would appear that decision support systems developed for highly proficient decision makers should consider giving much more attention to supporting situational assessment than is typically the case. Forcing experts into an exhaustive option evaluation may actually degrade overall performance in some cases.

The implications for training are less direct, but our concern is that the current emphasis on providing explicit training in formal option evaluation techniques may be misguided. The findings of this study suggest how important it is in operational environments to consider decision making from a broad perspective, one that gives equal emphasis to situational components and general problem solving skills such as the ability to visualize and evaluate alternative future states.

Introduction

This study is part of an ongoing research program to develop a descriptive model of decision making in natural settings. Our focus is on environments in which strategic and tactical decisions must be made under conditions of extreme uncertainty, risk, and time pressure. Because it has proven extremely difficult to translate the findings and formal models of current decision theory into such environments, we have sought to develop alternative methods of study that can support and complement laboratory-based methods. Thus, we are in the position of attempting to construct a model of decision making in natural settings at the same time we are developing methods to test and refine it.

The present investigation was designed as a replication-extension of an earlier study of urban Fire Ground Commander (FGC) decision making carried out by Klein Associates (Klein, Calderwood & Clinton-Cirocco, 1986). The domain was chosen because it closely parallels some important aspects of military command and control. FGCs must establish strategy and oversee tactical maneuvering of personnel and equipment against a potentially lethal (albeit non-human) enemy while considering numerous factors of risk, including lives and property, under conditions of time pressure and ambiguity.

Because the study questions and method refinements of the present investigation are so closely linked to the earlier study of urban fire ground command decisions, it will be helpful to first review the Klein et al. (1986) study before reporting the methods and findings of the present investigation. Throughout this report, the earlier study will be referred to as the "Urban Fire Ground Command (FGC) Decision" study to distinguish it from the present study, the "Expert-Novice FGC Decision" study.

Review of Urban Fire Ground Command Decision Study

In order to begin to understand the task of the FGC, we developed a semi-structured interview we have called the Critical Decision method that is organized around a specific incident (fire or rescue) in which an officer made command decisions. The officer was asked to recount the incident in his own words and then to construct a detailed timeline of all of the important incident events, including what he had seen, heard, felt, smelled, and thought at each event time. Each command decision was then probed along a number of dimensions including: a) the objective or goal of the decision; b) the nature and sources of information relevant to the decision; c) what other options were considered; d) how the chosen option was selected (i.e. could a selection rule be articulated, what evaluation dimensions were contrasted); e) the amount of time taken to make the decision.

Our analyses of these retrospective protocols revealed several unexpected results. Perhaps the most striking finding was the FGCs' frequent denial that they made decisions, at least in the usual sense of selecting from among alternative options. That is, even when it was clear that a command had affected the course of an incident and that other actions could have been taken, an FGC would nonetheless assert that he had never actually considered alternative actions.

Initially, we thought these statements might be due to inadequate memory for decision events, or to some unanticipated demand characteristic of our interviewing method. Nonetheless, the consistency and adamancy of these reports eventually convinced us to consider them as providing valid and important insights into the nature of decision making from a phenomenological perspective. For this reason, we found it necessary to develop the concept of a decision point. This was defined as a point in time when alternative courses of action were available, even if there was no conscious deliberation between options reported by the FGC. Of the 156 decision points that we coded (extracted from 32 incidents), over 80% were of this non-deliberated type. In these cases it seemed the FGC's situational awareness enabled him to select a course of action without consciously deliberating among alternatives. Because incidents were often described to us as "a typical case of 'x'," it appeared that some type of matching to a prototype was occurring that allowed rapid access to appropriate action patterns (similar to what Rasmussen, 1979, calls rule-based actions). Conversely, when an atypical pattern of cues was encountered, the mismatch to a prototype appeared to trigger a halt to ongoing or standard procedures.

The 20% deliberated decisions also contained some surprising aspects. First, we had initially hypothesized that due to time pressure and workload constraints, only a limited number of options (most probably only two) would be evaluated at any time. Instead, the protocols suggested that the most common evaluation strategy was one in which a single option was generated, and then either implemented or rejected in a serial fashion.

The serial evaluation strategy contrasts sharply with standard decision models that posit use of exhaustive option generation and concurrent evaluation to reach an "optimal" choice. Yet for these FGCs who must be prepared to act very rapidly, a serial strategy that meets a sufficiency criterion (Simon, 1955) may be the most rational and effective strategy.

Deliberated decisions were further classified into three sub-types that reflected the nature of the option comparison processes. We had expected to find some evidence of deliberation among a standard, or pre-defined, set of alternatives. This is the type of decision making most commonly studied in the

laboratory. However, we found no cases that could be so classified. It seemed that in truly standard situations, an FGC's situational awareness made it apparent what action to take without the need for comparing options.

A majority (56%) of the deliberated decision points were classified as context generated, indicating that within the specific incident context, it was quite clear what general types of options were available (and could probably be generated by equally experienced officers), but the options could not be predefined as in the standard case.

A substantial number of options (34%), were constructed by the FGC. In these cases no standard procedure was available and creative solutions had to be built. We find this an interesting example of the difficulty of separating real-world decision making from general problem solving (Huber, 1986), although these two areas are treated quite separately in the psychological literature.

A second hypothesis we explored was based on related work on natural reasoning (Klein, 1980; Klein & Weitzenfeld, 1982) that proposes that real-world decisions are frequently made on the basis of an analogue or comparison case, rather than using formal operations. However, we found little evidence of analogical reasoning. In only three cases did an officer report that a particular past event was instrumental in deciding a course of action. When memories for past events were reported, they seemed to serve as "flags", alerting the officer to specific aspects of a situation that were unusual. For example, in one case an officer ordered crowds to be moved further back from a burning building when he noticed that the building had billboards on its roof. He was reminded of an incident in which a billboard had collapsed and injured civilian onlookers.

It seemed possible that the small number of cases obtained might be due to a lack of sensitivity of retrospective interview methods for retrieving this information. But, it may also be the case that because our participants were so highly experienced (an average of 23 years firefighting experience) that previously encountered cases had become merged in memory, with specific incidents no longer standing out. If the latter is the case, then we could expect to find a higher percentage of analogues among less-experienced personnel as compared to more-experienced. This was a specific prediction of the present study.

Study Goals

As intriguing as these findings were, the study also raised a number of conceptual and methodological issues that warranted further investigation. First, we had several questions about the interview method itself. Although there are inevitable problems

associated with the use of verbal report data (Nisbett & Wilson, 1977), we wanted to explore ways of increasing the objectivity and usefulness of the knowledge elicitation method. Second, we wanted to verify the findings of the original study using a refined method, and a comparable set of cases. Third, because the interpretation of our findings was based in large part on the importance of experience in determining decision strategies, we wished to compare the decisions made by more and less experienced commanders. On the basis of several current models of skill development (de Groot, 1965; Glaser, 1981; Dreyfus & Dreyfus, 1986) we expected to find systematic differences. For example, it was predicted that less experienced commanders would show greater evidence of deliberation in their decision making, because they do not have the repertoire of prototype cases on which to base a rapid recognitional match. One indication of this would be a finding that less experienced officers relied more on analogues and/or the application of rules in making their decisions.

Although these issues are clearly inter-related, this effort had three major goals:

* Refine Critical Decision method
* Confirm findings obtained in previous Urban FGC study
* Compare the decision making strategies of expert and novice FGCs.

Critical Decision Method

Interview Modifications

In recent years there has been a reemergence of interest in verbal report data, and there is now widespread recognition that verbal reports can serve as an important source of empirical evidence (Ericcson & Simon, 1984; Rouse & Morris, 1986). The Critical Decision method is a technique currently being developed by Klein Associates for obtaining retrospective verbal protocols of decision events. The method was first used in the study of urban FGC decisions described earlier (Klein et al., 1986), and is an adaptation of the critical incident method developed by Flanagan (1954). The central feature of the approach is that information regarding a decision process is elicited in relation to a specifically recalled event. This is in contrast to the relatively unstructured approach of asking people to explain "how" or "why" they had performed some action in general terms (Nisbett & Wilson, 1977). Instead, specific events are anchored to objective records whenever possible in order to increase the accuracy of recall, and as many specific contextual details as possible are elicited in order to improve the quantity and

accuracy of recalled events (Geiselman, Fisher, MacKinnon, & Holland, 1985).

We see the method as being a useful complement to traditional methods of task analysis that take a formal, objective perspective. For example, a task analysis defines the logical requirements of task performance; it does not usually distinguish these logical requirements from the way a task is viewed from the performer's perspective. The Critical Decision method is an attempt to use this phenomenological perspective as the defining basis of study, a point of view less often considered in standard research paradigms. Thus, for example, in contrast to a task analysis approach, we do not attempt to define even the minimum requirements for programming or simulating the task. We would note however, that task analytic approaches are hard pressed to go much beyond minimum requirements and provide scant information about expertise. This can be seen in the difficulties repeatedly encountered in attempting to build truly "expert" systems. Such systems are most often modeled upon novice, or at best proficient, performance levels (Dreyfus & Dreyfus, 1986).

The rich and detailed descriptions we were able to obtain from FGCs in our initial Critical Decision study clearly pointed to the approach as an extremely promising source of information on decision events. We saw it as providing important descriptive data and as serving as a basis for hypotheses not available in preselected, degraded environments. We saw the contributions of the method to include:

(a) A **phenomenological account** of experts' decision making, not usually available, that could provide important insights on the nature of expertise.

(b) A **timeline reenactment** that provides a much higher and more focused level of detail than results when individuals are simply asked to explain why or how they behaved as they did.

(c) A way of tracking the **contextual elements** that surround decision events, thereby allowing the importance of real-world constraints to be represented within the decision event.

(d) A fuller and more representative sampling of decision events. By asking FGCs to describe incidents that represented a challenge, we obtained information on non-routine decisions as well as routine ones.

Not unexpectedly, our use of the Critical Decision method had drawbacks as well. Some of these are inevitable, given the use of an open-ended interview method. However, with the goal of developing the method to be as objective and efficient as possible while still maintaining experts' perspective and natural

ways of describing events, we focused on three areas of concern. All are related to the more general goal of increasing the degree of structure of the interview in order to improve the completeness and consistency of the elicited information.

Incident selection. In the urban FGC decision study, we asked the FGC to choose an incident that presented a "command challenge" and accepted the FGC's choice of incident without seeking additional clarification about the nature of the incident. It was felt that the FGC would most likely choose an incident that was meaningful and remembered well if he were allowed to select the incident to be recounted. Using this approach, we were generally able to obtain information about both routine and non-routine decision events. As the study progressed, however, we realized that our instructions were occasionally taken to mean the "most serious" or "most disappointing" incident the FGC had ever encountered. In these instances, FGCs would often tell us about incidents in which deaths had occurred, or where there had been unusual property loss. Though memorable, such incidents did not necessarily involve a challenge from a command perspective. Rather, they represented incidents that had been emotionally painful and/or professionally difficult.

Therefore, in the present study we emphasized our interest in command decisions and also asked for a brief summary of the incident before trying to obtain a timeline. In this way we were better able to screen incidents for those that were unlikely to provide information relevant to our study questions.

Consistency of protocol content. In developing the Critical Decision interview method, we had sought to impose minimal structure on the FGCs' incident accounts, preferring instead to let the FGC "talk us through" the incident unimpeded. Our reasoning was that encouraging FGCs to tell their stories using their own words and ways of structuring information would provide us with a mapping of the event that was unbiased by our questions and interruptions. After establishing a timeline of the events, information was explicitly sought only when some particular point seemed unclear or as though it had not been given adequate coverage by the FGC. As a result, there was considerable disparity across interviews, both in the range of topics covered and in the extent to which any particular topic had been pursued. In some cases, important material was missing altogether. This in turn made the task of coding and quantifying the interview material more difficult.

Given this, one modification employed in the present study was use of a Consensus Timeline. After obtaining an initial account of the incident, interviewers formulated and agreed upon the content and sequence of the events they understood to have comprised the incident. This timeline was shared with and

verified by the FGC. Once this initial set of procedures had been completed, then, we had an agreed-upon set of discrete decision points, verified in terms of order, timing, and labeling before proceeding with probes.

An attempt was also made to generate a set of standardized, specific, and focused probes. Successive versions of a structured interview procedure were tested in an attempt to find a method of asking a standard set of questions in a specified order for every decision. We soon realized that we had overcorrected for the non-uniformity and lack of structure of the initial study, for when each decision point was probed in a totally standard way, the interviews became extremely repetitive. Indeed, the tedium of this approach risked boring the participants to the point that an important degree of rapport could be lost. Moreover, the length of interviews was substantially increased, without any noticeable gain in quality of the interview material.

After considerable piloting, we became convinced that a semi-structured format in which we functioned as sensitive, active listeners was a better and more productive interview method for the present purposes. We settled on an approach that took each decision point as a point of reference, and worked outward from it, letting the natural flow of conversation lead us to pre-established questions and probes about option considerations and evaluations, situational assessment, and critical cues. (A copy of the Interview Guide can be found in Appendix A.)

Implications for Decision Point Coding

In refining the Critical Decision interview, one of our goals was to address certain problems we had encountered in the initial study in organizing and coding the data. It will be recalled that our approach to data gathering in that study had resulted in considerable disparity across interviews in the amount of information gathered on any particular topic. Moreover, as we noted earlier, the task of defining and identifying decisions proved to be extremely troublesome. For both reasons, when we began coding the retrospective protocols, we had found ourselves employing levels of inference we held to be unacceptably high. In addition, we were hopeful that ways could be found to reduce the amount of time it took to code interviews--included transcribing information from taped interviews, written notes, interviewer impressions, and to arrive at some acceptable level of inter-coder agreement. A conservative estimate is that for every hour spent in the field, we spent approximately six hours organizing and coding data.

Perhaps our most successful modification along these lines was the Consensus Timeline. By confirming with the FGC precisely

what constituted a decision point prior to probing, we hoped to increase the consistency of our data and reduce the level of inference required to code it. An additional modification was a standard use of asking the FGC to produce a drawing of the fire scene, including the structure, avenues of approach, equipment placement, etc. This was found to be very helpful in communicating aspects of the event to the interviewers, and seemed to serve as a valuable memory enhancer and point of focus for the FGC. Finally, the several changes designed to increase the structure of the interview itself were aimed in part at reducing the inferential load of interviewers and increasing coding efficiency.

Protocol Analysis

Coding of the Critical Decision protocols began with a reconstruction of the event timeline, organized around the decision points and coding dimensions. In addition, we developed a system for identifying the cues and goals that the FGC was considering at the time of each event. We have called this context situational awareness because it reflects the FGC's understanding of the dynamics and key causal factors of the incident. In a brief or straightforward incident, the situational awareness may remain constant, with new information serving merely to elaborate or confirm what was originally known. In other cases, there were shifts in the situational awareness, as new information changed the FGC's expectations and goals.

The earlier urban FGC decision study was largely exploratory, and the coding scheme used in it had been developed in an iterative and data-driven manner. Our express purpose had been to record whatever we could of the natural decision processes employed by experienced commanders and to generate hypotheses for future research. Thus, the protocols remained in an essentially narrative form to allow us to reconstruct and recode the data as our understanding of the important parameters deepened.

One of the goals of the present research was to develop a coding strategy that would allow for more precise and fine-grained exploration of the data and that would begin to address the reliability of the Critical Decision method.

The Decision Continuum: A Proposed Decision Taxonomy.

A guiding assumption of the present study was that the apparent dichotomy between Deliberated and Non-deliberated could be more accurately represented as a continuum, similar to the intuitive-analytic dimension of Hammond's Cognitive Continuum Theory (Hammond, Hamm, Grassia & Pearson, 1984). Thus, Deliberated decisions were assumed to be those in which some type of selection rule or evaluation criteria could be articulated and

systematically applied, corresponding to the analytic pole of the continuum. Non-deliberated decisions are presumably made in an intuitive mode. In these, the decision maker cannot articulate a decision rule; in fact, the words most often used to describe such decisions were "it was automatic" or "I just knew based on experience". We equate recognitional processes with this intuitive mode, and have proposed a Recognition-Primed Decision (RPD) model to describe these decisions (Klein et al., 1986).

We expected that there might be differential degrees and/or combinations of deliberation and non-deliberation and that they could be reliably distinguished. We began the present study by trying to recode a subset of the original protocols as well as some additional preliminary protocols with this distinction in mind. Although some cases continued to be clearly distinguishable instances of Deliberated or Non-deliberated decisions, we began to be aware that this classification was inappropriate in many cases. These cases were ones in which deliberation was clearly involved. However, the deliberation did not occur in terms of what option to select, but entailed classifying and analyzing the nature of the situation itself. Thus, there might be a great deal of mental effort involved in dealing with the uncertainty of defining the situation itself, but once the situation had been recognized (or classified) it was clear to the FGC what courses of action to select.

An example will help to illustrate this point. In one case, an FGC described a seemingly typical house fire. During the course of knocking down the apparent seat of the fire, the manner in which the fire re-flared made him wonder whether it was being fueled by a gas leak. He checked for cues that would be expected (smell, color of flame) and none indicated the presence of gas, so he proceeded as if the situation did not involve a gas leak (it turned out he was correct). This moment was described as a decision point by the FGC, a point at which he had to decide exactly what he was dealing with. This decision represents a critical point in the overall incident because gas-fueled fires are not fought with a direct water attack. If he had decided that there was a gas leak, he would have pulled all of his men out of the building, called the gas company, and begun searching for the source of the leak.

How should this decision be characterized? Is it a choice between proceeding with an inside attack or defensive pullout? This seems misleading. His decision was verbalized in terms of deciding whether or not a gas leak was present, not as a choice between what courses of action he might take. Indeed, the course of action is prescribed, once the determination of the nature of the situation has been made.

Although this distinction may seem subtle, it has profound implications for how decision-making processes are

conceptualized. Most studies of decision making begin at what Berkelely and Humphreys (1982) refer to as "the moment of choice". That is, the state of the world has been structured and options defined; the "decision" involves evaluating tradeoffs between selected courses of action given uncertainties and probabilities attached to possible future states of the world. Thus, most decision tasks investigated by established methods involve a variation on a gambling task, with specified outcomes and associated probabilities. This framework does not seem to capture the situation in which there is an active search for clues nor does it reflect the dynamic nature of a task that requires constant monitoring and reevaluation over time. This apparent mismatch between formal approaches to studying decision making that involves static and well-defined events, and decision making as practiced in dynamic operational settings is becoming increasingly recognized (e.g. Berkeley & Humphreys, 1982; Brehmer & Allard, 1986; Dreyfus & Dreyfus, 1976; Ebbeson & Konecni, 1980; Hogarth, 1982).

We propose that a fruitful approach to studying decisions in natural settings is to view decisions as the search for solutions to two logically distinct questions "What is my situation?" and "What am I going to do about it?" These questions can be translated for purposes of discussion into the two "sides" of a production rule of the form "if X then do Y". In some decisions, the greatest uncertainty is associated with the Y or action part of the rule. In fact, a classic decision task based on some variation of a gambling dilemma could be written as "Given X, then do Y_1 or Y_2". The decision is concerned with which of two available options is best. However, many real world problems appear to have much more uncertainty involved with the X, or conditional, side of the equation. In such cases the decision is best represented as "If X_1 do Y_1" but "If X_2 do Y_2". The decision requires coming to some determination about the actual state of the world, from which a general course of action is implemented based on experience or explicit procedural guidelines.

The conjoining of these two dimensions--the degree of deliberation along the recognitional-deliberated dimension and the nature of the decision task, "X" or "Y"--formed the basis for the present conceptualization of decision types. A coding scheme was developed that allowed classification of each decision as primarily involving either X or Y deliberation or no deliberation. Of course, it is logically possible for a decision to have involved both X and Y deliberation. However, preliminary analyses of these protocols indicated that decisions could be classified as having primarily involved X or Y deliberation, so this dichotomy was adopted as a simplifying assumption. Additional categories were developed for specifying the number of options considered in making a choice, and whether or not the selection appeared to have been made by concurrently comparing

and contrasting options, or by serially evaluating a workable option as described in the RPD model. Protocol analysis began by coding each decision along these dimensions and then worked iteratively from actual cases to define superordinate categories that seemed to adequately describe the decisions obtained in these protocols. The resulting decision typology will be described in greater detail in the description of the decision point analysis in the Results section.

Method

Study Participants

Participants were obtained by contacting the Chiefs of six professional midwestern urban fire departments, and asking for volunteers from among their most and least experienced command-level personnel. From the pool of potential participants, 12 highly experienced (Expert) and 12 less experienced (Novice) FGCs were interviewed.

Departments ranged from a large metropolitan area with twenty-seven fire stations, including one of the busiest battalions in the United States, to a department in a small, new suburb with only a single station. In order to establish an absolute index of the base rates for incidents in these widely divergent departments, the average number of working fires per month was calculated over a three year period (1982-1984) in which statistics were available for all of the departments. Table 1 shows this distribution of base rates and the number of interviews conducted in each locale.

It should be noted that because of the vastly different experience levels and promotion opportunities in these departments, neither rank attained nor years of experience could be assumed to provide absolute indices of expertise. For example, a seven year veteran in a large and busy company may have experience equivalent to that of a fourteen year veteran in a company where base rates are low or fires tend to be small and routine. In order to gain some control over these potentially confounding factors, an equal number of Experts and Novices were selected from each department.

In this study, the Expert FGCs held the rank of Captain or above (6 Captains, 6 District or Battalion Chiefs) and had an average of 19.5 years of firefighting experience with an average of 11.1 years of experience as an officer. Novice FGCs were newly promoted lieutenants who had at least one fire ground command incident to their credit, with an average of 10.0 years of firefighting experience and an average of 1.5 years of experience as an officer.

Table 1

Distribution of Interviews as a Function of Department Base Rates*

Base rates	Number of interviews
650	10
416	2
295	2
196	6
39	2
4	2

*Estimated average number of working fires per month.

Interview Procedures

The Interview Guide was a modification of the guide used in the urban FGC decision study (Klein et al., 1986). The major modifications have already been described and a complete Interview Guide is included in Appendix A.

The interview structure is briefly summarized as follows:

1) Introductions/biographical data. The interview began with an explanation of the general purpose of the study and a set of questions designed to obtain biographical information and job experience information from the officer.

2) Incident selection. An incident was selected on the basis of its having presented a command challenge (with more recent challenging incidents preferred).

3) Incident description. The officer was asked to relate all of the events of the incident from the beginning in a step-by-step fashion, focusing on any command decisions that influenced the course of events.

4) Timeline. The incident account was then organized into a timeline in which the sequencing and duration of events were verified in detail.

5) Consensus timeline/decision point verification. A final check of the accuracy and concurrence of the incident events was reached by summarizing and sharing the timeline with the officer, verifying wording of events, cues indicated, and goals stated. Decision points were defined and verified at this time. A decision

point was defined as any event expressly designated as a decision ("I made a decision" or "I decided to") or an event that received a yes response to one of the following probes: a) the officer had considered a different action, b) the officer had actually seen or considered doing something different in a previous incident, c) another option was suggested at the incident or in a formal or informal critique of the incident, or, d) a less-experienced officer might have done things differently (or the officer might have done something differently earlier in his own career).

6) Decision point probing. Each decision point was then systematically probed for the following information: a) other options (if considered) and reasons for selection/rejection; b) whether options were standard, typical or constructed (see coding instructions for definitions); c) whether options were evaluated serially or concurrently; d) what rule or advice would summarize why the option had been chosen.

7) Situational Awareness probing. A summary of the situation was elicited at each decision point, as well as the officer's formulation of goals, and specific knowledge and cues that were active at the time of the decision. After the initial situational awareness was established, probes elicited shifts or elaborations on the situational dimensions.

8) Analogy/Prototype. An additional probe attempted to establish whether the decision had involved a memory for any specific similar incident.

Interviews were conducted at the various station houses to which FGCs were assigned during their regular shift. In some cases, interviews were interrupted one or more times as the FGCs responded to incoming calls. The typical interview lasted approximately 2 hours with the shortest 1.5 hours and the longest almost 3 hours.

With the exception of three interviews conducted by one of the principal investigators, all interviews were carried out by pairs of interviewers. Permission was sought in each case to tape the interview in order to aid in the reconstruction and coding of the protocols. Permission to tape was denied in 6 of the 24 interviews. The reasons for refusal had to do with sensitive or legal issues surrounding the case, or that being recorded made the FGC uncomfortable.

Decision Point Coding

The basic unit of analysis in this study was the decision point, i.e., the point in time where multiple options existed and a plan or course of action was implemented. From the 24 incident protocols obtained, 104 decision points were identified and coded,

56 from the Expert FGCs and 48 from the Novice FGCs with an average of 4.6 per incident.

Each decision point was classified on the coding dimensions by at least two independent coders, most typically the two interviewers on the incident. Coding disagreements were resolved by the principal investigator who performed a final coding of each incident.

A primary goal of the present study was to further develop the distinction identified in the urban FGC decision study between the classical definition of decision making as a deliberated choice among option alternatives and the phenomenological description of RPD decisions obtained in our Critical Decision protocols. The basis for the development of the typology was five codes related to the Decision Continuum conceptualization discussed previously.

The first code, Problem-type, was a judgment about the nature of the cognitive "work" involved in solving a decision problem. We identified three different types of deliberation that correspond roughly to the three characteristics of a problem, 1) the initial state of the world, 2) the desired goal state, and 3) operators for transforming the initial state to the desired goal state (e.g. Newell & Simon, 1972). We started by informally identifying these problem aspects in our decision domain as What-X, Which-Y, and How/When-Z. A What-X decision refers to a case in which the primary mental work is involved in deciding what the nature of the problem is. Although an experienced decision maker may immediately recognize a situation as familiar, if a situation is unusual or cues are ambiguous, the decision maker will be forced to analyze elements of the situation and actively generate hypotheses about the nature of the current state of the world.

A Which-Y decision refers to the more classic type of decision making in which the state of the world is known (at least to some acceptable criterion of confidence) and the primary problem is in deciding among alternative courses of action that represent numerous and sometimes conflicting goals.

A How/When-Z decision refers to those occasions when the state of the world is established and a preferred plan of action has been identified, but questions about the implementation of the action (e.g., precise timing or procedures) remain.

An additional distinction that attempted to distinguish the degree and nature of the deliberation process was made as well. This formulation was derived in part by working back and forth among logically defined categories and decision point cases until all decision points had been classified into what seemed a reasonable number of categories. The final result was eight decision types, defined as follows:

What-X

Automatic-X. At times the recognition of the What-X appeared to be essentially automatic. These cases correspond to many of the RPD decisions identified in the earlier FGC study, in which a scene or situation was so thoroughly familiar that the FGC recognized what to do almost immediately. These are decisions only in the abstract sense that when viewed from an outside perspective, other courses of action could have been taken. Phenomenologically, however, the decision never presented itself as a dilemma, only as a task to be carried out. Decisions to call additional alarms, or to lay line to the apparent seat of the fire, are typically made automatically by experienced personnel. These decisions represent expert "reflex".

Confirmation-X. In other cases, there is basically a match to a prototype, but the protocols suggest that some minimal degree of analysis occurs in order to check the accuracy of the initial reflexive judgment. Often these decisions follow a form of "this looks like a case of X, check for disconfirming evidence, if none, then go ahead". For example, in a department that prides itself on aggressive interior attack, the first impulse of an experienced commander will be to immediately lay lines and gain entry to search for the seat of the fire. There seems to be only the briefest moment in which he scans the setting for signs that entry might pose a greater than acceptable safety hazard, confirms for himself that it does not, and issues the order to enter. Many of these decisions follow a pattern that Lipshitz (1987) has recently identified as a "pseudo double-option choice". That is, one can artificially frame the decision in terms of a Go/No-go branch of a decision tree, but the options are clearly not equivalent psychologically, and represent instead a strong prior commitment to a particular course of action.

Serial-X. These decisions clearly reflect consideration about the current hypothesized state of the world, and a series of alternative states are generated and tested. This frequently occurs because of a mismatch between some cue(s) and what was thought to be typical in a situation or what was originally assumed, so that the original prototype is rejected in favor of one that fits better with present critical cues. For instance, an FGC is fighting a fire inside a building when something draws his attention to the smoke. After observing the smoke and noting its behavior, he finally decides that the burning material is unusual and may be toxic, so he orders his crews outside.

Concurrent-X. In Serial-X decisions there is clearly a preferred or original hypothesis, against which available cues are checked for adequate fit. In Concurrent-X deliberation, one or more alternative states are considered that hold roughly equal chances of being true from the perspective of the decision maker. This represents the analytic pole of the continuum, and these seem

to be the hardest decisions for the decision maker, reflecting his sense of his own fallibility in the face of uncertainty.

For example, an FGC considered whether to send rescue crews into a burning apartment building in the early morning hours. Although residents on the scene indicated that everyone was accounted for, the FGC was aware of consciously weighing the tradeoffs involved in sending more crews in to search (thereby delaying fire control efforts) versus accepting the civilian reports that the building was vacant and proceeding with a fire attack (with the possibility that someone was left inside).

What-Y

Serial-Y. Once a relatively stable understanding of a situation has emerged, there may still be need for deliberation among alternative courses of action. One of the most interesting findings of the original study was that deliberation in time-pressured and risky situations seems to occur in a serial rather than a concurrent fashion. That is, a possible course of action is generated, and if it is a plausible solution, it is accepted. If the decision maker evaluates the first option as not workable, it is rejected and another alternative is generated and evaluated for plausibility. This strategy is quite dissimilar to the usual conceptualization based on normative models. These models assume that a decision maker should actively generate something approaching an exhaustive set of alternatives and then systematically evaluate them on common evaluation dimensions.

Many of the instances of this decision strategy we found have the same general form as the Serial-X strategy, wherein a standard or preferred option is rejected as implausible in a specific case, and the next available option in the "queue" is chosen and tested. Our best example of this strategy, drawn from the earlier FGC decision study, is one in which five different alternatives were generated and rejected before a workable option was found. An FGC was called to the scene of an accident in which an unconscious woman had jumped or fallen from a highway overpass and was suspended from a sign beneath the overpass. In this situation, the immediate need was to get a ladder up to her and to provide a firm basis of support. The standard approach is to use a Kingsley harness, which snaps onto a victim quickly and allows the victim to be moved and raised. However, the woman's position was not standard; she was face down, and a Kinglsey harness is designed to be strapped on from the front. The FGC tried to modify this option by considering whether it could be strapped on backwards, but by imagining her position being lifted he decided this would place a severe strain on her back. He next considered a Howd strap, another standard piece of rescue equipment but determined that it was subject to the same weaknesses as the Kinglsey strap. This process of considering available options continued until a workable solution was discovered.

Concurrent-Y. These decisions comprise the best fit with standard conceptualizations of decision making based on static, laboratory-based tasks. In these cases, two or more options are compared and evaluated in terms of a relatively well defined goal. For example, an FGC discovered that because a hose had been inefficiently placed, water was not reaching the fire to the full extent possible if an alternative placement were made. However, fire hoses once charged are almost impossible to move. He therefore had to weigh the benefits of achieving a better access route against the cost in time lost while shutting down and relaying hose.

When/how-Z

Timing. One theme we heard during our interviews was that many of the decisions FGCs' viewed as crucial were not matters of what action to take, but rather when to take action--that is, the timing of events that made the difference between a successful or an unsuccessful operation. This is exactly the kind of dynamics that prevailing research paradigms based on static decision tasks have ill prepared us to study and represent. For example, it may be clear to everyone that an attack is being lost, but the timing of when crews are pulled outside seems to be a hallmark of expertise that is commonly recognized. Too early, and the chance for success is lost; but too late, and the safety of the crews is at risk. Often the key to these decisions seems to be expertise in recognizing critical cues and "seeing" when events are at a turning point.

Control. A symmetrical notion is that some decisions have to do with deliberating about precisely how to implement an already chosen option. For example, one FGC identified as a crucial decision his placement of a truck to reach a burning attic. This involved getting as close as possible to the building while avoiding overhead wires and leaving plenty of access room for incoming equipment. Although this type of decision was included for symmetry, there were actually very few of these cases obtained. We suspect that this type of activity is most often conceptualized by an individual as something closer to a skilled action, rather than a decision.

Additional Codes

Option type. In keeping with the distinctions employed in the earlier urban FGC decision study, we tried to code the type of option identified for each decision point. Standard options were those that could be pre-defined in some sense. They are either taught explicitly or occur so commonly that everyone would agree as to the relevant alternatives. Typical options are more contextually bound, and represent interpretations and modifications to standard operating knowledge, refined through experience and modified to meet the specific requirements of a situation.

Constructed options are those for which there is no standard or agreed upon solution available; they typically involve creative problem solving.

Command decision. It was clear from the outset that in attempting to let the FGC's perspective be the point of departure, there were going to be differences in how "decisions" were defined by different people. One individual might conceptualize almost every thought and action as a decision, whereas another person would see only the high-level strategy decisions as worth discussing. By using the operational definitions of decisions already described, we tried to obtain decisions that represented comparable levels of decision responsibility. Nonetheless, because we adopted a phenomenological perspective, the content and scope of the decisions differ, sometimes dramatically, from one incident to the next.

As a partial solution to this problem, each decision was coded as to whether it was a command decision in the judgment of the coder. This was an attempt to distinguish decisions that clearly related to tactical and strategic decisions and those that tended to be more relevant to general firefighting duties.

Decision speed. Based on the timeline information and direct estimates elicited from the FGCs, time taken to make each decision was estimated within the following boundaries: less than 30 seconds, 1 - 2 minutes, 2 - 4 minutes, 5 minutes, over 5 minutes. These times are distinguished along the X, Y, and Z "stages" of the decision process.

Analogy. This code identified those cases in which the FGC indicated that he had been reminded of a similar situation at the time of the decision and had used this comparison to help make the decision.

Image. This code was applied to indications in the protocol that imagery had been used to evaluate the plausibility of an option or to generate a possible course of action.

Future planning. This code was added when it was observed that some decisions could be characterized as reflecting a present need whereas others clearly entailed contingency plans for dealing with future eventualities.

Reasoning type. For each decision point, the FGC's reasoning, or basis, for making a choice was probed. This was assessed by asking if the FGC could state a rule that he was following in making the decision. We then asked him to imagine that a film of the incident events was being shown as a training tape and that it had been stopped at the moment of his decision. How would he justify or explain his decision to trainees viewing the film? We knew from our previous study (Klein et al., 1986) how difficult it

was for the FGC to state a meaningful rule in many cases, but the responses to this probe seemed potentially interesting nonetheless.

We attempted to categorize these expressed rules in terms of how abstract or concrete (experiential) they were. Abstract rules were defined as involving relatively context free analysis, such as the relationship between water pressure and square footage of fire involvement that would dictate the hose size required, or between water pressure required from an engine (pumper) as a function of hydrant pressure, hose length, and the stream elevation. Although such rules do exist and are part of a firefighter's formal training, we found virtually no evidence that such rules were applied directly in decision making. Instead, they seemed invariably to be translated into useful heuristics based in experience and perceptual learning, e.g., "if the hose feels too squishy, give it more pressure", "small fires get a 1-1/2 inch hose, medium a 1-1/3, really large get a 2 inch".

At the other extreme were answers to the probe for which no meaningful rule could be stated. Instead the officer would indicate that his intuitive judgment was operating based on "seeing/experiencing this same sort of thing". Our favorite example of this involved an officer's reasons for ordering his men off a roof that he judged to be too "squishy". It seems that roof squishiness is an extremely important cue to a firefighter, and it is the term applied to a roof whose structural integrity is compromised and which threatens to collapse. We probed extensively for a rule that could be applied in knowing how to make this decision, yet the officer was very clear that no rule was possible. "You simply have to stand on enough squishy roofs and enough un-squishy roofs until you know the difference. To a novice, all roofs are squishy".

Realizing that we had no clear-cut operational definitions for classifying the absolute degree of abstractness of rules, it seemed possible, nonetheless, to make relative judgments for broadly classifying stated rules as 1) more abstract than experience-based, 2) a mixture of abstract and experiential, or 3) primarily experienced-based.

Results

Incident Characteristics

The criterion for selecting a particular incident was that it presented a command challenge to the FGC. Most often the officer chose a recent challenge. Over half of the incidents had occurred within six months of the interview, with the oldest occurring thirteen months prior to the interview.

In addition, the incidents chosen often included a degree of unusual risk. The officers rated each incident for the level of risk (high, medium, low) on 4 separate dimensions: risk to firefighters, risk to civilians, risk to involved structure, and risk to exposed areas. Over 70% of the incidents were rated as high risk to the firefighters (3 incidents involved firefighter death or injury), 50% as high risk to the involved structure, 33% as high risk to civilians (7 incidents involved death or injury to civilians), and 20% as high risk to exposed areas. Six incidents were rated high risk on 3 of the dimensions, 9 on 2 dimensions, and 5 on 1 dimension. Only 4 incidents were not rated as high risk on at least 1 dimension. Four of the incidents were chosen primarily because they represented highly unusual cases, and 2 incidents were chosen specifically because command mistakes had been made.

Nineteen of the incidents involved fires as the major command focus. These included fires in 11 single occupancy dwellings, 2 multiple occupancy dwellings, 2 hotels, 2 restaurants, 1 high rise and 1 fire in a rural fairground setting involving several barn-like structures. In 5 of the incidents, hazardous materials or gas leaks were the primary focus of the operation.

The number of alarms called at these operations provided an additional index of their scope, although procedures vary so widely among departments in precisely what equipment (trucks, engines, rescue) and crew sizes constitute an alarm that absolute comparisons are difficult. Ten of the incidents were 1-alarm responses, 4 were 2-alarms, 7 were 2-plus alarms (additional equipment and/or manpower above second alarm), and 3 were 3-alarm fires.

Time to containment gives an indication of length of operation. Defined as the time from the first alarm to when the incident is judged to be "under control," the average time to containment was approximately 1.5 hours with a range of 5 minutes to 6 hours.

Decision Point Results

The basic unit of analysis in this study was the "decision point," i.e., a point in time where multiple options existed and a plan or course of action was implemented. From the 24 incident protocols we obtained, 104 decision points were identified and coded. Of these, 56 decision points were drawn from Expert protocols, and 48 from Novice protocols.

Decision types. Table 2 shows the frequencies and percentages of each of the types of decisions defined in the Decision Continuum described previously. This classification scheme was developed as part of an effort to derive a general taxonomy that could be used for synthesizing the results of studies being pursued in other decision domains in the overall research effort. Development of

Table 2

Frequencies and Percentages of Decision Point Types

Decision Type	f	(%)
Which X		
Automatic	7	(6.7)
Confirm	25	(24.0)
Serial	11	(10.6)
Concurrent	13	(12.5)
What Y		
Serial	14	(13.5)
Concurrent	19	(18.3)
How/when Z		
Timing	11	(10.6)
Control	4	(3.8)
Total	104	(100.0)

the typology was data-driven in that it grew out of our attempts to code the decision points obtained in this study. It therefore reflects the specifics of these cases to a certain extent. A complete list of the decision point descriptions and their decision point classification is contained in Appendix B.

These results are relevant to the major foci in this study: (a) whether findings of our earlier study of FGC decisions would be replicated, and (b) whether experts and novices differ in reliance on analytic decision processes. These two issues will be discussed in turn.

Replication of Urban FGC decision study. One of the most intriguing outcomes of the initial firefighter study was the rarity with which FGCs evidenced analytic approaches to decision making. Conscious deliberation of options, along with option comparison and evaluation, were found to have occurred in only 20% of the decisions obtained in that study. Yet the vast majority of decision models, whether intended as prescriptive or descriptive accounts of decision making, assume concurrent option deliberation to be inherent in the decision process. Given this, the fact that option deliberation failed to occur in even one-fifth of the cases we examined was truly startling. Nevertheless, the preliminary

nature of that study caused us to treat the findings with caution, and we were eager to see whether results of the present study would provide confirmatory evidence.

As noted in the preceding section, the distinctions we attempted to make in the present study were a good deal more fine-grained than had been the case in the original study. The most straightforward comparison between the present and the previous studies is the degree to which concurrent option deliberation occurred. In the previous study, 12% of the decision points showed evidence of option generation and concurrent evaluation. In the present case, 18% of the decision points were coded as Concurrent-Ys. We had actually expected an even higher percentage of concurrently deliberated options in the present study, both because we used more focused probes and because the study includes less experienced FGCs who were, in fact, predicted to rely more on deliberated strategies. On the other hand, the earlier study had included one very long and complicated incident at an oil pumping station that accounted for almost half of the deliberated cases we found, thus inflating this percentage in relation to the somewhat more homogeneous set of incidents in the present investigation.

From the broader perspective of the Decision Continuum, some degree of deliberation was involved in most of the decision points that were elicited (only 7% of the decision points were classified as automatic), but the majority of these decisions (54%) involved deliberation in terms of classifying and articulating the nature of the decision problem (Which X) rather than the systematic evaluation of alternative options (What Y). Another 14% of the decision points involved monitoring and timing of actions (How/when Z) rather than option selection. Even for the 33 decision points in which option selection was clearly present, almost half of the decision points (42%) were reported to have been evaluated using a serial decision strategy rather than any direct concurrent evaluation. Thus, the present investigation confirms the basic finding of the earlier study that phenomenological accounts of decision making do not match the standard prescriptive assumptions.

Expert vs. Novice FGC Decision Making

We suspected that one reason for our failure to find option deliberation in the previous study was our use of subjects who were extremely knowledgeable and highly experienced in this domain. The use of such subjects contrasts sharply with laboratory-based research that typically employs naive, inexperienced subjects. The results of the initial urban FGC study, along with a model of expertise developed by Dreyfus & Dreyfus (1986), suggested that less experienced decision makers should show greater reliance on analytic decision strategies than more experienced decision makers who rely more on their abilities to automatically recognize the nature of an event (see Hammond et al., 1984, for an opposite view, however). Thus, in the present study, we predicted that we should

find a greater proportion of deliberated decision points for the Novice FGCs.

While both the Expert and Novice FGC groups are comprised of experienced firefighters, they differed markedly in their experience in making command decisions and viewing the emergency scene from a command perspective. Because of this, it seemed likely that the severity of the incidents, and the complexity of decisions individuals in the two groups might be called upon to make, would differ as well. In order to gain some degree of control over such potential differences, we restricted comparisons between the Experts and Novices to decision points that had been identified as command decisions. This yielded a total of 48 decision points for Expert FGCs and 33 decision points for Novice FGCs (total = 81).

Our hypothesis about greater use of deliberation by Novice FGCs had to be reconceptualized, in accord with the more finely grained Decision Continuum types developed as part of this investigation. Table 3 contains the frequency and proportion of Expert and Novice decisions that fall in each of the Continuum categories.

Differences in the distribution of Expert and Novice decision points across the Continuum were highly significant ($X^2(6, n = 81) = 16.72$, $p < .05$). Moreover, the nature of Expert-Novice

Table 3

Frequencies and Percentages of Command Decision Point Types for Expert and Novice FGCs (N = 81)

Decision Point Type	Expert FGCs		Novice FGCs	
	f	(%)	f	(%)
Which-X				
Automatic	1	(2.1)	2	(6.1)
Confirm	12	(25.0)	8	(24.2)
Serial	6	(12.5)	5	(15.2)
Concurrent	10	(20.8)	1	(3.0)
What-Y				
Serial	9	(18.8)	0	(00.0)
Concurrent	6	(12.5)	10	(30.3)
How/when-Z				
Timing	4	(8.3)	7	(21.2)
Control	0	(00.0)	0	(00.0)
Total	48	(100.0)	33	(100.0)

differences depends upon the X versus Y nature of the decision, and whether deliberation, if it did occur, was carried out serially or concurrently. Thus, for example, while Experts and Novices were equally likely to serially deliberate Which X ($z = 0.35$, n.s.), Experts were significantly more likely to concurrently deliberate X than were Novices ($z = 3.23$ $p < .01$)--probably reflecting their greater sensitivity to, and ability to simultaneously consider, alternative interpretations of a given situation. In contrast, Experts were found to serially deliberate What Y more often than Novices ($z = 2.63$ $p < .01$), while Novices evidenced greater concurrent Y deliberation than Experts ($z = 2.00$ $p < .05$). Thus, in the portion of the Continuum that most closely corresponds to classic decision research--the simultaneous consideration of alternative actions--we find that Novices are indeed more likely than Experts to engage in option deliberation.

Additional Findings

Number of options. Looking at the deliberated decision points in which more than a single option was considered, it would appear that there was a strong tendency to limit option evaluation to pair-wise comparisons. In all but four of the serial and concurrent decision points ($n = 57$), deliberation was reported to involve only two alternatives, and all of these involved deliberating between options (Ys). In three of these cases three options were considered and in one case the number of options was unspecified and apparently quite large. In this case, the officer described scanning a number of objects and areas in a burning kitchen in order to locate the sites that seemed to pose the greatest risk (of toxicity) in order to direct fire streams to these areas.

This finding is in stark contrast to the prescriptive decision model that assumes that good decision making involves exhaustive option generation, and even this conclusion may be understated when it is realized that many of the pair-wise cases involved choices that were in no sense equivalent. That is, there was often a strong preference or initial impulse to act in a given way, and deliberation involved momentarily considering whether this choice was workable in the present situation. For example, an FGC decides a situation warrants calling in additional crews. His initial impulse is to call for an additional truck and engine, but he momentarily considers whether he might need a full second alarm (2 trucks and 1 engine in this case). He rejects the full alarm, thinking that the two additional crews will most likely be sufficient, since it is important not to order unnecessary crews. Of course it is possible that the prevalence of pair-wise comparison found in this study is an artifact of the retrospective method. Memory limitations, or difficulties justifying more complex option evaluation strategies, may have disinclined the FGCs to report larger numbers of options that were actively considered and rejected. All that can be said at this point is that given the

high level of cooperation that we enjoyed from these participants, we view this finding as representing the FGCs' own perspective on their decision strategies. For them, decisions present themselves as highly focused choices, often with a clear preference identified. Mental effort is expended either searching for "fatal flaws" in this initial impulse, or in a rapid comparison to a single alternative on a single key dimension.

Decision speed. Estimates of the amount of time taken to make each decision were collapsed into 5 categories of decision speed. Examination of the resulting distribution generally confirms those obtained in the initial FGC study, that decisions in this domain are typically made within minutes. According to the estimates, over 35% of the decisions were made in less than 30 seconds, and 79% in less than 1 minute. Virtually all the decisions were reported as taking less than 5 minutes to accomplish. We would note, however, that we question the utility of attempting to obtain more finely grained estimates of decision speed using the present method, since memory for durations of such short events is undoubtedly highly inaccurate. Although we would anticipate that the time taken to arrive at a decision would be positively correlated with the degree of deliberation represented by the Continuum, a test of that hypothesis will require a set of assessment procedures that allow for more precise measurement of decision speed.

Analogy. Findings from our previous study (Klein et al., 1986), had led us to hypothesize that Novice FGCs would employ analogues more frequently than would Expert FGCs. This expectation was based on our speculation that the cause of the low incidence of analogues found in that study (2%) was the selection as subjects of highly experienced FGCs for whom events had become merged in memory into something akin to a prototype. This prediction was not supported. As in the preceding study, we found use of analogical reasoning to be relatively rare, but for both groups of FGCs. Only 8% of Experts' decision points, and 3% of Novices' decision points contained explicit references to analogues, a difference that was not significant ($z = 1.31$, n.s.). We have begun to consider the possibility that analogical reasoning typically occurs at such a subliminal level of cognitive processing that our methods are simply not able to elicit information about it in any consistent fashion.

Nonetheless we continue to suspect that analogues do play a role in the decision process, for when analogical reasoning was reported, it took the form of extremely vivid memories for specific events. Thus, for example, an FGC arrived on the scene of a warehouse fire and noticed a low-lying vapor cloud next to the building. Several years before, he had fought a fire in a chemical plant and had been contaminated with toxic material. In his incident account, he referred several times to the previous

incident as guiding his situation assessment and the options he considered.

Option type. Table 4 contains the distributions of option types coded for the deliberated decisions, with Expert and Novice percentages computed separately.

Table 4

Frequencies and Percentages of Option Types for Command Decision Points (N = 33)

Option Type	Expert		Novice		Total	
	f	(%)	f	(%)	f	(%)
Standard	2	(11.1)	6	(40.0)	8	(24.2)
Generated	12	(66.7)	8	(53.3)	20	(60.6)
Constructed	4	(22.2)	1	(6.7)	5	(15.2)
Total	18	(100.0)	15	(100.0)	33	(100.0)

Recall that in the earlier study, we found no evidence (0%) of the use of standard options, whereas here 24.2% percent of the options are standard. This reflects a change in the definition of standard type from that employed in the previous study. In the present study, the definition was broadened to include any mention of a "mental checklist" of standard procedures, even if the checklist inevitably required some interpretation within the current context. Of greater interest are the apparent differences in the proportions of standard options used by the Expert and Novice commanders (11.1% to 40%, respectively). This provides some support for the idea that Novices are more likely to "go by the book" in formulating their decision choices. Similarly, Experts appear to rely more on creative solutions, as seen in their greater use of constructed options (22.2%) than the Novices (6.7%). However, none of these differences reached statistically reliable levels (largest z = 1.88, n.s.), and we would note that these comparisons are subject to the same potential confounding as other comparisons of Expert and Novice decisions: the scope and demands of the incidents themselves may be quite different. For example, the Experts' incidents may have been more unusual in general, and therefore required more creative option generation.

Imagery. We also found that Expert FGCs reported using imagery, most often in the form of specific visual images, more often than did Novice FGCs (Expert = 19.6%, Novice = 8.3%, Z = 1.76, n.s.). We suspect that this reflects Experts' greater capacity to assess a situation and generate action alternatives in terms of potential future events. Most typically, this was reported as a series of imagined events in the form of hypothetical

"IF . . . THEN" predictions. The imagined results allowed the FGC to simulate and test out what the outcome of a particular sequence of events would be. Thus, the greater use of imagery is probably related to the Experts' greater sensitivity to contingencies and future-oriented planning, discussed next.

Future planning. After protocols were collected, an additional code was suggested based on our noticing differences in the time orientation of decision points. Some decisions were clearly concerned with an immediate problem, and in fact much of the decision making in this domain is "reactive". A need presents itself and must immediately be addressed. Other decisions, however, are based on an envisionment about the future--what might occur. Twice as many Expert decision points as Novice decision points were found to contain indices of future planning as part of the decision process (Expert = 47.9%, Novice = 23.5%, $Z = 2.26$, $p < .05$). One FGC referred to this skill as the ability to "think ahead of the fire" and considered it an essential component of fire ground command expertise. Interestingly, it is this same "think ahead" aspect of cognition that seems to best distinguish other forms of skilled performance, for example, in chess (Holding, 1985). Of course, we hope eventually to be able to analyze this ability into its component processes, but the present study offers an interesting confirmation that this ability is reflected in the conscious processing of these skilled performers.

Reasoning type. This code allowed us to examine potential differences between Experts and Novices in the expression of rules (this may also be seen as justification or advice giving). On the basis of the Dreyfus & Dreyfus' (1986) framework for viewing skill development, one would expect Novices to be more likely to report use of abstract rules in making (or at least justifying) decisions than Expert officers. Shulman's (1986) interesting longitudinal study of skill development in teachers also suggests that knowledge is transformed along such a dimension, with experienced teachers relying more and more on illustrative cases rather than on abstract relationships gleaned from formal analyses.

Table 5 summarizes the results of this coding.

The first observation we would make based on these frequencies is how rarely rules were expressed in an abstract form; only 12.2% of the command decision points were classified as being based primarily on an the application of formal rule. The majority of the decision points (52.4%) were judged to be a mixture of abstract and experiential reasoning. These rules are similar in nature to what are generally referred to as heuristics and represent the translation of knowledge into a useful form given the variety of contexts most typically encountered. A substantial minority (35.4%) of the decision points were classified as primarily experientially based. In many of these cases, no rule or heuristic

Table 5

Frequencies and Percentages of Reasoning Type

for Command Decision Points (N = 82)

Reasoning Type	Expert		Novice		Total	
	f	(%)	f	(%)	f	(%)
Abstract	4	8.3	6	17.6	10	12.2
Abstract/ Experiential	23	47.9	20	58.8	43	52.4
Experiential	21	43.8	8	23.5	29	35.4
Total	48	100.0	34	100.0	82	100.0

was even articulated. The FGC would merely stress that he simply "saw" what was needed.

Of primary interest to us was whether there was any difference in the reasoning as expressed by the Expert and Novice FGCs. A Chi square analysis performed on these data was not significant ($X^2 = 4.02$, n. s.) but the absolute differences in the percentages are at least in the directions predicted in that Experts showed a nominally higher percentage of experience-based decisions and Novices somewhat more abstractly stated rules. Still, for both groups reasoning was most typically characterized by a mixture of abstract and experience-based reasoning.

Discussion

This study, in conjunction with a previous study of fire ground command decisions (Klein et al., 1986), has lead us to question some of our basic assumptions about decision making. The retrospective verbal protocols obtained in this study provide a phenomenological perspective on decision making that contrasts sharply with classical views and their focus on analytic option generation and evaluation. When examined from this perspective, decision making takes on a broader meaning that encompasses problem definition, learned response control, and monitoring, as well as more deliberative option generation and selection processes.

Our goals in this study were to test and refine our data-gathering methods in order to facilitate the development of valid

descriptive models of operational decision making and to further explore the role of experience in this decision domain.

Methodological Issues

The Critical Decision method used in the previous study of urban FGC decision making had provided a rich source of hypotheses about the nature of naturalistic decision making. Obviously, we wished to retain those aspects of the method that seemed most useful in allowing our subjects to reveal their conscious strategies and cue utilization in making key decisions. At the same time, we sought to refine our protocol method to reduce the need for post hoc inference and interpretation, and to increase the efficiency, completeness, and consistency of the elicited information.

Interview procedures. Several procedural modifications to the Critical Decision interview used in the earlier study were attempted and evaluated. All were related to the general goal of increasing the degree of structure and consistency of our assessment methods. Perhaps the most successful modification was the use of a Consensus Timeline. It allowed a greater degree of formalization of the decision points to be probed and at the same time served to aid communication between the interviewer and interviewee by increasing the degree of shared perspective and language. Additional helpful modifications included more consistent and focused screening of the choice of critical incidents, thereby reducing time spent discussing issues not relevant to decision making. Finally, the use of map drawings aided interviewer understanding of the incident scenario and also seemed to serve as an excellent memory aid and communication tool for the participant.

Other modifications designed to standardize the wording and timing of decision point probes were judged to be less successful. Too much standardization led to loss of engagement and interest on the part of the FGC, and increased interview length without achieving noticeable improvements in the data collected. A semi-structured approach in which interviewers function as sensitive, active listeners seems to be the most productive method for retaining the richness and detail of the verbal accounts that were, after all, the primary focus of the study.

Protocol analysis. One goal of this study had been to develop a more formal method for analyzing the protocols and for classifying and relating variables of interest to the decision points. We believe that the Decision Continuum model described earlier has been a major step towards achieving this goal. It provides a framework for distinguishing between the problem formulation and definition stages of decision making and the option generation, selection, and evaluation processes

traditionally studied. We have conceptualized these two global aspects of a decision problem as the two sides of a production rule, if X then do Y, and attempted to classify each decision point in terms of this structure. If the decision primarily involved finding an appropriate match to the conditional of the rule, it was classified as a "Which X". If alternative actions and/or goal choices were the primary focus of the decision, it was classified as a "What Y". A third category was identified in which both problem formulation and action choice were carried out relatively automatically, with deliberation involving specifics of timing or implementation.

This classification system, along with information obtained from probes designed to elicit the strategies and heuristics employed during a decision event, was used to develop a decision taxonomy based on eight decision types. This taxonomy of decision types was compared to the findings of the previous FGC decision study and used to compare the decision processes of more and less experienced FGCs.

Findings

Descriptive decision model. Findings from the present study strongly supported the basic conclusions of our initial investigation of FGC decision making. Taken together, the two studies provide important convergent evidence that in high risk, time-pressured domains, decision making does not typically involve analytic option generation and evaluation. In both investigations, phenomenological accounts have indicated that less than 1/5 of the decisions made in this operational setting fit standard views of decision making as involving concurrent comparisons among alternative options. Moreover, when concurrent comparison did occur, the number of alternatives reported as having been considered seldom exceeded two. These results have been obtained despite our best efforts to elicit evidence of option consideration, including repeated probing of our participants for any indication that option generation and evaluation might have occurred. The ease with which they describe consideration of alternatives on those occasions when option comparison does occur, and the firmness with which they otherwise deny such cognitive activity, have convinced us that our results, at the very least, accurately portray the FGCs' own awareness of their decision strategies--a perspective that could be very important to the extent that it conflicts with standard prescriptive models.

We would note that our subjects did engage in conscious deliberation during the course of decision making. Over half of the decisions we studied involved deliberation, but we found it to occur in terms of classifying and articulating the nature of the decision problem itself (Which X) rather than the systematic evaluation of alternative options (What Y). We also found a

small but intriguing set of decisions that involved monitoring the timing or control functions of incident command, rather than option selection. Finally, for those decision points in which option selection was clearly the issue, almost half were reported to have been evaluated using serial decision strategies rather than direct, concurrent evaluation. The prevalence of serial option evaluation found in the current study is in accord with evidence obtained in the original Urban FGC study.

The role of experience. Based on the model of skill development proposed by Dreyfus & Dreyfus (1986) we predicted that less experienced officers would be more likely to use deliberated decision strategies than were the highly experienced population we examined in the first study. This prediction was, in fact, borne out by the present data. Novices were more likely to concurrently deliberate options than Experts. However, in reconceptualizing the decision points into the more finely grained Decision Continuum analysis, we now see the original question as overly simplistic. Experts and Novices show a number of interesting differences related to the X and the Y Continuum dimensions. We take the differences revealed by this study as an initial validation of the usefulness of the Decision Continuum framework.

The strength of our conclusions concerning comparisons between more and less experienced FGCs is tempered by inherent differences in the content of the decision tasks faced by these two groups. It seems likely that the more experienced commanders were in charge of larger, less routine incidents, and that many factors differed in the command and control environments of the two groups. Nonetheless, we find the results intriguing and hope to pursue them further in a study examining decisions during realistic, simulated fire events, so that the content of the decisions made by the two groups can be held constant.

Along with the decision point analysis pursued in this study, a simulated environment would allow us to pursue other points of interest that were uncovered in the present study. One of the most striking findings was the tendency for the Expert commanders to evidence what we termed future planning in their decision making. By comparing the decision making of experts and novices "commanding" the same simulated environment, it should be possible to explore these differences in planning ability to a much greater extent. In addition, we hope to investigate differences in the way decision points are conceptualized by the two groups. Informal observation has suggested that the decision points elicited from the Expert commanders were more complex than the Novices'. For example, what might be considered a single decision by an Expert would be identified as several distinct decisions by a Novice. This corresponds to the pervasive evidence that Experts are able to employ larger chunks in

perceiving and remembering events (see Holding 1985 for a review of this finding in chess).

Summary

The Critical Decision method used in this study offers an alternative to standard laboratory paradigms for studying decision making in complex operational settings. While the need for experimental control is an ingrained axiom of our scientific training, there has in recent years been a growing sensitivity to the cost of making inferences on the basis of generalizing evidence obtained in impoverished and well structured tasks to real-world settings (e.g. Ebbesen & Konecni, 1980; Keen & Scott-Morton, 1978; Kahneman & Miller, 1986). Fortunately, verbal report data is reemerging as a valuable source of empirical evidence (Ericcson & Simon, 1984). At the very least, naturalistic and quasi-naturalistic methods are a way of generating hypotheses about specific real-world constraints that shape decision making. They also serve as a means of testing the plausibility of inferences based on findings from formally developed models. We feel that a commitment to studying decision making in natural settings can go a long way toward bridging the gap between theory and application that currently exists in this field.

A specific goal of this study was to develop a more fine-grained method of analyzing the Critical Decision protocols. We believe that the proposed Decision Continuum framework is a promising step toward this goal. In recognizing that decisions are made with varying degrees of deliberation and analysis, we believe that much confusion about naturalistic decision making may be alleviated. The reliance of laboratory-based investigations on relatively unfamiliar tasks and "novice" decision makers, has given rise to a distinctly analytic bias in models of decision making. This bias has led many investigators to ignore the importance of perceptual and concept learning in structuring and formulating a decision problem. Similarly, there has been little appreciation of how practiced responses enter into decision processes (Connolly, 1982).

In addition, in focusing only on the "solution" side of decision making in our formal models, we have undoubtedly been overly constrained in our approaches to decision aiding and support (Landry, Pascot, & Briolat, 1985). Even the best analytic option evaluation techniques may be useless if they are too time consuming (Zakay & Wooler, 1984) or if goals and options have not yet been formulated (Berkeley & Humphreys, 1982; Gettys, 1983; Pitz, Sachs, & Heerboth, 1980).

Finally, our attempt to elucidate the role of experience in affecting decision strategies was highly successful, even though the limits of the study design meant we had limited control over

the specific content of the decision tasks. Several hypotheses were generated that could be fruitfully pursued in a more controlled environment. For example, it appears that Experts and Novices may deliberate about somewhat different aspects of the decision problem, with Experts being more sensitive to the uncertainties in judging the current state of the world (which X) and Novices more apt to evaluate the utility of pursuing different courses of action. There was also some indication that Experts were more involved in considering future events than Novices and that Novices might use more abstract reasoning in selecting and/or justifying selected courses of action. These differences could be explored as a basis for developing guidelines for decision support systems that match these different natural tendencies.

Taken together, the studies of FGC decision making reviewed and reported here offer strong support for our contention that decision making examined from a phenomenological perspective yields a radically different view from that provided by classical decision models. Because the decisions made by these experienced commanders share the essential characteristics that define military command and control decision making (cf. Wohl, Entin, Kleinman & Patti-Pati, 1984), we believe it will be worthwhile to continue to develop this approach as a means of providing descriptive models of decision making that can guide efforts to support and develop expertise in these domains.

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Appendix A

FIREGROUND DECISION INTERVIEW GUIDE

Department:_____ Interview Date:_____
Conducted by:_____
Transcribed by:_____ Date:_____
Interview Time/Transcription Time (in person hours):_____

I. INTRODUCTION

Describe purpose of the study -- learn about how new and experienced command level fire officers make decisions under extreme time pressure. Klein Associates is a small consulting firm established in 1978.

Department Of Defense
Combat/firefighting
Real world Vs. laboratory
Found good results
Talking to experts and new officers
Learn from you

Interview will focus on decisions made at fires which were demanding from a command perspective. Approximately 2 hours to conduct interview.

II. BIOGRAPHICAL DATA

A. Name/rank:

B. Firefighting Experience (years, where, positions held, approximate dates):

C. Optional remarks (special training, job satisfaction, etc.): Talk to gain rapport. May need to answer questions from officer.

III. INCIDENT DATA

A. Choice of Critical Incident

The incident may have been preselected as recent incident of interest. If not, officer should choose most recent incident which presented a challenge, where their expertise as important, or where a decision they made was critical to the outcome. In these types of fires it is more likely that a command, rather than procedure will play an important role. Any factors which make the incident exceptional in some way should be noted, such as risk of life, non-standard operations were employed, mistakes were made, etc. Errors in judgment may be particularly informative.

1. Date of the incident:
2. Why the incident was chosen:

B. Officer's Incident Report **ON TIMELINE**

1. Officer's accounting

   Ask the officer to relate all the events from the time the alarm was received, focusing on his commands and critical decisions. This part of the interview should be structured to allow the perspective of the officer to emerge. Probes on decision making and timeline details should be carefully timed so as to interfere as little as possible with important points the officer wishes to make. The timeline serves as a partial checklist for the types of information which we wish to have for each key command/decision.

2. Reflective verification

   We wish to gather as much information as possible as to the **sequencing and duration** of events occurring at the fireground. The timeline also functions to clarify and **aid the officer in recalling** the incident. From the officer's own account, reflect the ordered sequence of events and ask the officer for a **running account of time.** If this is difficult, stress that relative time information is more important than clock time.

3. Consensus: Interviewers and Officer reach consensus, "rewrite timeline", including timeline; critical moments/incidents; separately record critical cues (as they increase/decrease/change), etc. Serves as time for all to'catch-up' ...continue from common ground.

Probes around decisions

(on timeline)

****
* A "YES" RESPONSE INDICATES A DECISION POINT *
****

Consider What other options did you consider ?

Previous	Have you ever seen/done something different in a similar situation?
Suggested	If the fire was critiqued, were other options suggested?
Earlier	Do you think at an earlier time in your career as an officer you might you have chosen a different option?
Novice	Think of the most/least experienced member of your crew/company. Would they have chosen a different option?

****

IF THIS WAS A DECISION POINT
CONTINUE WITH THE DECISION ANALYSIS FOR THIS DECISION POINT

****

IV. DECISION ANALYSIS OF KEY COMMAND/DECISIONS
(Identify for the officer the decision point that will be probed.)

If A Considered Option do A &B...if not go to C

A. Rejected Options
(If the interviewer is unclear as to the possibility of other options considered, recheck the timeline information using the appropriate probes.)

1. Restate first rejected option.

a. Reason for rejection.

2. Restate second rejected option.

b. Reason for rejection.

B. Classification of the types of options elicited.

1. The following probes are used to classify the entire set of options.

Standard: In a situation such as this one, what (set of) options are fireground commanders commonly taught to consider?

Standard/ Typical: Is the option(s) common firefighting knowledge that a novice officer would be aware of?

Typical: Describe a situation where you have considered a similar set of options or known other experienced officers in a similar situation to consider similar options?

Typical: Was a similar situation discussed in a critique or with fellow officers in the department? Was an optional option or decision identified?

Constructed: If the officer describes the option(s) as created or was unable to respond to previous questions, ask him to describe what experience was necessary to generate and evaluate the option(s) in this situation. (His personal firefighting experience, special training, etc.)

2. Evaluation of the options

a. To the best of the interviewer's knowledge, these options were evaluated (circle better match):

Serially Concurrently

b. What did the officer say that allowed the interviewer to make this judgment?

C. Rule

1. Imagine that a new firefighter was standing beside you during this incident and asked you what rule (advice) you were following when you made this decision. Ask him to imagine the critical moments leading up to the decision as a training film. Review the moments for him from the timeline. Stop at the point of the decision and ask him to state the rule(s) he was following (what advice he would give to a new firefighter).

D. Situational Awareness

1. Description of the situation. What was happening that caused you to choose this course of action/strategy?

2. Goals
   What were your specific goals at this time?
   (Beware of getting only 'standardized' FF goals/strategies.)

3. Knowledge
   (specific to context or situation, from previous experience)
   What did you have in your mind that was helpful in this situation?

4. Point of action or decision
   (what information was necessary to move to point of action)
   When did you know when to give the command, when did you have enough information?

5. Analogy
   Were you thinking of a similar case or situation? If so, please describe it.

   Specific Case _____ Date _____

6. Shift in situational awareness (if it happened)
   a. Was there anything different or atypical about the situation at this point? If you were telling someone back at the station about this situation, what made it unique?

   b. Were features of the situation different enough to suggest a revision of the strategy?

      yes _____ no_____

   c. Describe situation to Relief Officer. Always ask this first time... and when ever Change in Situational Awareness.

Appendix B

Incident Accounts and Decision Points

This Appendix includes a brief account of each of the 24 incidents that formed the basis of this study, with a designation of whether the incident was obtained from an Expert or a Novice officer as defined in the body of this report. Following each incident account are the decision points (DPs) associated with the incident and the decision type code for the decision. Abbreviations used in the Appendix follow:

FGC	= Fire Ground Commander
FAO	= First Arriving Officer
IC	= Incident Commander (for incidents other than fires)
SC	= Sector Commander
FF	= Fire fighter
HAZMAT	= Hazardous Materials
SOP	= Standard Operating Procedure

Incident #1: involved an extensive 1.5 alarm fire in a large 3-story older home; the house had been subdivided into several apartments, making access to different parts of the structure more difficult. The officer interviewed was "Acting Central Chief," arrived with additional equipment that had been called in, and was given command of the rear of the building. The officer selected this incident as an example of a poorly fought fire--in his view a number of mistakes were made by the overall FGC. (Expert)

DP 1.1 - SC considered whether to order roof ventilation immediately or to follow standard operating procedure--going through the chain of command. Because of imminent danger to the inside crew decided to issue order on his own. (Concurrent X)

DP 1.2 - SC considered moving an ineffective deck gun operation to get it at a better angle. He had not agreed with the superior officer's original decision to use gun in the first place decided to leave it in position judging it wasn't worth risking open disagreement. (Concurrent Y)

DP 1.3 - SC considered whether to hit visible flames with a full stream or to let fire go. Even though he judged it to be unnecessary, he decided to hit with the stream in order to satisfy the press and other observers at the scene. (Concurrent Y)

DP 1.4 - SC deliberated whether to put fire out as it came through the roof, or to let fire continue burning for a time in

order to ventilate the roof. He decided to let the fire self-ventilate on the basis of low risk to exposures. (Serial X)

DP 1.5 - The sector commander considered keeping quiet, but then decided to confront an inexperienced FGC with his opinion that trying to extinguish the roof fire with pumper streams was a bad decision, in that the stream was ineffective. (Concurrent Y)

Incident #2: a single alarm fire located on the third floor of a large, empty warehouse. On arrival the FGC noticed what appeared to be a steam cloud, settling down close to the ground behind the burning building. Noting that water vapor does not sink, the FGC speculated that the building might contain hazardous materials and that the vapor cloud might be toxic--he suspected chlorine gas, but was not close enough to get a good whiff of the vapor. Throughout the incident, the FGC attempted to substantiate his suspicion that hazardous material was involved, but continued to receive conflicting reports regarding the contents of the warehouse and the possible composition of the vapor cloud. While the warehouse fire was fairly quickly contained, the overall incident spanned 3 hours. (Expert)

DP 2.1 - On the basis of unusual behavior of the steam cloud, FGC stopped routine fire operations and instituted standard operating procedures for handling hazardous material spills, including calling specialized HAZMAT team. (Concurrent X)

DP 2.2 - During the interior attack FGC considered whether to pull crew out of building entirely due to potential hazardous chemical risk; decided not to in order to continue attack at third floor entrance. (Concurrent X)

DP 2.3 - FGC considered momentarily whether to continue holding action; given escalating danger and possibility of explosion FGC decided to order fire fighters out of building and moved command to staging post away from building. (Concurrent Y)

DP 2.4 - Still assuming that the cloud was evidence of hazardous material spill, FGC ordered evacuation of area. At this point, FGC still getting conflicting information from personnel and mixed cues, some indicating the fire might be routine, some indicating presence of hazardous material. Followed rule: better safe than sorry. (Serial X)

Incident #3: a 1+ alarm fire in a 2 1/2 story residence. What made this fire unusual for the FGC was that the house was packed with massive amounts of clutter. Firefighters found it difficult to gain entry through the front door because it was blocked by trash. Once inside, the crews found they had to crawl on top of the accumulated litter, falling through holes in it, to fight the fire. Although FGC could see flames, the clutter made locating

the seat of the fire very difficult. Time to containment was 1 hour. The cause of this fire was suspected to be arson. (Novice)

DP 3.1 - During interior attack FGC noticed the way the fire reflared and wondered if it could be a sign of gas leak involvement. He checked for other cues, color, sound, flame intensity, but none "fit," so decided this was not a gas leak. (Serial X)

Incident #4: involved a single alarm fire in a 2-story residential building. As he approached the scene, the FGC could see a tremendous amount of smoke coming from the building, and his initial size up was that most of the south side of the ground floor was involved, and perhaps part of the upper floor as well. The building's occupants assured the FGC that no one was in the building. Fire control was fairly routine, and time to containment was less than 10 minutes. The FGC chose this fairly routine incident because it was the first working fire of any size he had the opportunity to function in a command role. (Novice)

DP 4.1 - FGC ordered a poorly laid hose line to be straightened. He could have left it "as is", but personal rule was to suffer lost time to get hose properly laid. (Automatic X)

DP 4.2 - FGC ordered attack from burning side of building. Standard procedure is to order attack from unburned side, but in this case officer judged to do so would have driven fire into the house. (Concurrent Y)

DP 4.3 - As interior attack progressed, heat and smoke became very intense. FGC considered whether to stop fire operation and order crews to ventilate, or to hold off and wait until truck arrived and accomplished ventilation for them. Issue was one of timing, how long to wait. (Timing)

DP 4.4 - FGC identified decision as to where to start fire stream during inside attack. Ordered stream directed to most potentially toxic materials to extinguish first. FGC noted a novice might not have thought of the toxicity issue. (Concurrent Y)

Incident #5: began in the basement of a 3-story frame house. Upon arrival, the FGC judged the fire to be fairly routine and that the men and equipment on the scene were sufficient for the task. As the incident progressed, his crews had trouble locating the seat of the fire, and it became increasingly clear to the FGC that the fire was getting away from them. Forty minutes into the incident, he called a second alarm. He noted several times during the interview his reluctance to cause unnecessary property damage (e.g. breaking windows, ventilating roof) and generally

appeared to take a conservative approach to fighting this fire. (Expert)

DP 5.1 - FGC momentarily considered calling an additional alarm but judged the situation was not severe enough. NOTE: This was probably a mistake according to FGC; fire was more extensive and additional help would have been useful. (Concurrent X)

DP 5.2 - FGC rejected standard operating procedure to ventilate roof. He judged smoke and fire not sufficient for ventilation, and his personal rule was to hold back on damaging roof. NOTE: This was identified as a possible mistake because house was of balloon construction and fire damage more extensive than he realized. (Concurrent X)

DP 5.3 - FGC had to consider whether to call for an additional crew or to call full second alarm. Issue was how much help would be needed. Decided on additional crews only, following rule to keep manpower cost to a minimum. (Serial Y)

DP 5.4 - FGC ordered roof ventilation. The issue was one of timing, and it appeared that ventilation at this point was possibly too late to do much good. Another FGC officer might have accomplished it in a more timely manner. (Timing)

Incident #6: a fire in a 3-story apartment building at 2 AM. The individual interviewed was the First Arriving Officer (FAO), and served as FGC until his Chief arrived midway through the incident. Upon arrival, the FAO found a crew there already, and one line laid. He prepared to enter the building but then heard the sound of breaking glass and realized it was civilians breaking windows. The FAO noted that if it had been firefighters breaking glass, he wouldn't have noticed. Concerned that there might be some one trapped in the building, he sought information on whether everyone was out of the building--noted several times through interview that even though occupants reported every one out, that given a middle of the night fire in an apartment house, someone might be unaccounted for. Once his Chief arrived, the FAO was given command of the interior attack--which turned out to be fairly routine. In all, the fire took 15 minutes to contain. (Expert)

DP 6.1 - As FAO was about to enter burning building, he noticed civilians around base of building, breaking windows. Instead of entering building he decided to check out possible rescue situation. (Concurrent X)

DP 6.2 - FAO ordered standard fire operations halted. He judged this might be a gas leak situation, primarily on the basis a of hissing sound. A less experienced officer might not

have recognized the sound and in fact it could have been the sound of steam releasing. (Confirm X)

DP 6.3 - FAO deliberated whether or not to send in crews to check for people. Issue was that people from the building had told him that everybody was out and accounted for, but the late hour (2 a.m.) made him feel that the assumption that no one was left asleep in the building was too risky. (Concurrent X)

DP 6.4 - FGC went in himself to check for fire extensions in two other apartments. This is a decision only because he noted a less experienced officer might not have realized the importance and risk of extensions in this situation. (Confirm X)

Incident #7: a 3-alarm fire at a fairgrounds, involving 3 wooden barns with wooden roofs, and one metal barn with a metal roof. The barns were used for storage of vehicles and equipment. The individual interviewed was the First Arriving Officer (FAO). Arriving at the scene, he saw a wall of flame 60 ft. X 100 ft. and heard gas tanks and tires exploding. He reported concern about the resources available--he had a reserve pumper that carried 1000 gal. of water instead of the more usual 1500 gals., and knew that the fairgrounds were on a "loop" system so that opening one hydrant could shut down others in the immediate area. Although he had a good crew to work with, they were not his "home" crew. He noted that one barn was fully involved, and that the roofs of the adjacent barns were wooden. The fire took 1.5 hours to contain, and damage was estimated at $1,000,000. (Novice)

DP 7.1 - FAO considered whether to hook hoseline to pumper or to street hydrant to fight fire. The issue was that the pumper supply was more limited but there might not be enough hose to reach the hydrant in this area, and that the hydrant might only have a limited supply. (Concurrent Y)

DP 7.2 - FAO considered whether to retreat from a position between two burning buildings or to even try and protect exposures given his judgment that things were getting too hot. This was a decision because another fire fighter thought that there was still a possibility of getting the fire knocked down from this vantage. (Confirm X)

DP 7.3 - The FAO allowed a civilian entry into a barn to remove some valuable boats and supplies and offered protection with a hand line. Although he did not consider an alternate course of action, he realized that this was a risky decision and that standard procedure would be not to allow the entry. (Confirm X)

DP 7.4 - FAO ordered the civilian to cease entering the barn

to remove boats and valuable supplies, judging further salvage efforts to be unsafe. (Serial X)

DP 7.5 - FGC ordered a ladder to protect roof of an adjacent barn. The issue was how to judge what exposures were at greatest risk. (Control)

DP 7.6 - FGC ordered his men off the barn roof after judging it to be unsafe. (Timing)

Incident #8: involved a 1-alarm fire that occurred in a 2-story frame house. On the way, the First Arriving Officer (FAO) had received several additional reports of this fire so anticipated that it was,indeed, a working fire. On arrival, did not see smoke or flames, though noted that since it was mid-winter and quite cold, all windows of the house were closed. He reported being most concerned at that point with whether the house was occupied, since that would determine how he would allocate his resources. He determined on basis of a civilian's report that no one was in the house, so ordered interior attack. Entered building ahead of his crew and directed search for the seat of the fire. Once seat located, fire knocked down and clean up efforts began. (Expert)

DP 8.1 - FAO ordered crew to stay with the truck while he investigated even though standard operating procedures is to lay line immediately. His rule was: don't commit men and equipment until size up is complete. (Concurrent X)

DP 8.2 - FAO decided on basis of sizeup that rescue was not necessary and ordered hose lines brought in for internal attack. (Confirm X)

DP 8.3 - FAO radioed chief with his current status on the fire. Considered not radioing chief but decided that this chief liked to be informed. (Concurrent Y)

DP 8.4 - FAO directed inside crews where to go to search for seat of fire. Issue was best places to search. Did not consider any other alternative, but noted that another officer might have made different choices. (Automatic X)

Incident #9: was a fire in a large abandoned building. The structure was brick and the original residence had been split up into a number of small apartments. FGC saw smoke coming out the front door as he arrived; entered building to locate the fire. Once inside the building, he found a lot of smoke, extremely thick 3-4 feet above the floor, and saw a red glow on the floor itself. He identified the material burning as foam rubber, which produces toxic fumes when burned. Since he was unmasked, he exited, and told crews location of the fire. The fire was contained within 4 minutes of their arrival. (Novice)

DP 9.1 - FGC decided not to put on a mask to go inside to investigate fire. He could have put it on per standard operating procedure but decided that it was too much bother and took too long for the task ahead. (Serial Y)

DP 9.2 - FGC ordered fans to be turned on to blow out smoke after knocking down the fire--this is standard operating procedure but the issue was when to turn the fans on. A novice fire fighter had almost turned them on too soon, before checking further for evidence of fire. (Timing)

Incident #10: involved a 2-alarm fire in a highrise hotel. There had been two previous arson attempts at this same location, and this fire too was later determined to have been caused by arson. The individual interviewed was the First Arriving Officer (FAO) at the scene. Entering the lobby he noted smoke billowing from upper part of elevator. Based on this and heat above elevator doors, he determined that the seat of fire was on the second floor; went with crew to 2nd floor and directed search for seat of fire. A variety of cues indicated that they were close to seat of fire, but as it turned out this was not the case. Actual seat was between 12th and 14th floors, but circulation of building was such that smoke and heat were being driven down the elevator shaft. The FAO was informed by overall FGC of that fact and he redirected crews and attack up towards seat of fire. Time to containment was 45 minutes, and the fire was judged to present a high degree of risk to firefighters and civilians. (Novice)

DP 10.1 - Officer judged location of fire to be on second floor and ordered line laid from standpipe on that floor. The decision about fire location was made on the basis of what he felt were strong clues. The heat was intense at the top of the elevator shaft in the main lobby and he could see pulsating smoke above the door indicating the fire was close. NOTE: This turned out to be a mistake as the fire was actually located further up. The circulation system was forcing the fire and smoke down the elevator shaft, from floors above. (Serial X)

DP 10.2 - Upon arriving on the second floor FAO ordered the elevator doors to be forced open because of sensed (but mistaken) certainty that the fire was located inside the elevator shaft on this floor. He momentarily considered the damage this action would cause but decided it was too important to gain entry to the seat of the fire. (Concurrent Y)

DP 10.3 - Officer received report that fire had now been found on the 8th floor. He orders the hose picked up and charged up the stairs. This was identified as a decision because the hose could have been left until further investigation verified the fire location. However, the officer wished to be first on the scene at all cost. NOTE: He judged this to be a possible

mistake. As it turned out, the hose was barely long enough to reach where he needed to go. He could have checked and verified the sufficiency of the hose length. (Serial Y)

DP 10.4 - Officer ordered fire crew to wait to charge the line until they were all the way inside the room containing the fire on the 8th floor. The issue was when to charge the line. A less experienced officer might have charged the line sooner given the intensity of the smoke and heat. (Timing)

DP 10.5 - Officer ordered fire fighter not to kick down fire door until the line was fully charged. Again, the issue here is timing. A less experience officer might have been anxious to get through to the seat of the fire. (Timing)

Incident #11: occurred in a large, old wooden structure that had originally been a residential property, but had been converted some years earlier to a restaurant. The building had been remodeled and added to many times so that the structure was a labyrinth of hallways, air ducts, adjoining roofs, and concealed spaces. The building was recognized as holding the potential for a dangerous fire, and fire attack had been preplanned. This interview was conducted with the department's Shift Chief, who served as FGC for most of the incident. He reported that enroute to scene, he began to consider whether anyone was trapped in the building, where to lay supply lines and how best to place equipment, given that front driveway allowed minimum access to the building. After initial size up and placement of apparatus, directed interior attack and search for seat of the fire; thought he had located it in the kitchen and had it knocked down. However, unusual heat and thick dark smoke led him to suspect that there were extensions. He ordered roof ventilated and crews to search for extensions. Reports of fire in the walls and attic made him realize fire was not knocked down and probably much more serious than he had first thought. The FGC called in a 2nd and soon after a 3rd alarm. Despite preplanning, and assistance from other departments, the structure eventually burned to the ground. However, because the fire occurred early in the morning, before the restaurant had opened, the building was unoccupied and so there were no casualties. (Expert)

DP 11.1 - FGC ordered men to wait to charge the line until all the incoming equipment has arrived. This is a decision because it would have been a mistake to charge the line given the limited access route. The FGC saw this as a key awareness on his part. (Serial Y)

DP 11.2 - FGC directs incoming engine to rear of building by alternate route. Issue was the importance of setting up a good rear water supply which is often missed. (Confirm X)

DP 11.3 - FGC ordered crews to enter burning building without first ventilating. Although it is SOP to ventilate first, officer decided it was safe enough to enter. (Serial X)

DP 11.4 - FGC ordered first crew to first floor, which he judged to be the apparent seat of the fire. Momentarily considered sending crews to second floor where there was a lot of smoke, but decided most likely source of fire was kitchen. (Serial X)

DP 11.5 - FGC sent next crew to second floor, to search for the seat of the fire. This is a decision because this crew could have been sent to help search the first floor since this was the most likely seat of the fire. The officer was following the rule to spread out as much as possible. (Serial X)

DP 11.6 - FGC ordered Engine-2 to supply Engine-12. This was a tactical decision concerning whether or not the situation was stable. If stable, the supply pump would probably not be needed. If escalating, the supply pumper is a good measure. (Concurrent X)

DP 11.7 - FGC sent a crew to the second floor to check for extensions once fire was presumably knocked down. This was identified as a decision because of the possibility in this old building that concealed spaces could still hold fire, something a novice might not have considered. (Confirm X)

DP 11.8 - FGC ordered a ladder to ventilate the roof. Although ventilation is the default action this was a decision because the safety of the roof had to be verified before the order could be given. (Confirm X)

DP 11.9 - FGC called a second alarm. Although the crews might have assumed they could handle the fire at this point, his judgment was that they were getting too much dark smoke, and he suspected extensions were involved. (Confirm X)

Incident #12: occurred in a 3-story, 20-unit brick apartment building. The FGC arrived with his crew, saw flames coming out the windows and heavy smoke as they approached. As they were about to enter the building, FGC noticed a woman standing by the entrance to the building. He noted her extreme agitation, interpreted her behavior not as excitement and awe about fire, but a true state of panic. He learned from the woman that her two-year old child was still in the building and commenced rescue operations. She indicated the location of her apartment (on 2nd floor); he ordered crew to wait at entrance to apartment and to begin masking up while he went in alone and unmasked (because he could see better, and save time) to try to locate the child. Was not successful, and had to come out when he could not endure smoke any longer. Crew, now masked, entered and located the

unconscious child in the back of the apartment under her crib. The child was treated successfully by medical personnel, and the fire was contained after 15 minutes. (Novice)

DP 12.1 - The FGC ordered search and rescue on the basis of a woman's story that there was a baby trapped inside the building. Was self-identified decision point, although any other action would have been mistake. (Confirm X)

DP 12.2 - FGC allowed the search to begin with men still unmasked, although considered masking up, decided it would take too much time. (Serial Y)

DP 12.3 - FGC ordered men to check the bedrooms. Issue was that other areas could have been given higher priorities. (Confirm X)

Incident #13: occurred in a 3-story apartment building; the structure was over 50 years old, wooden, and contained 24 apartment units. While still 1/4 mile away from the scene, the FGC could see a column of thick black smoke, and he then heard a second alarm called in. Based on these two cues he knew he had a working fire, and that in all likelihood it was a bad one. Arriving at the scene, the FGC saw flames shooting from the 1st floor all the way to the third floor of the building, and companies extending a ladder to a 3rd floor corner window, apparently as part of a rescue operation. The FGC noted that the first responding unit was an under-manned task force unit, thus limiting manpower and equipment until additional alarm answered. The FGC received reports of a woman trapped on the 3rd floor. Having issued orders about how to proceed with frontal attack, he went around side of building to pinpoint location of trapped woman. Pulling ladder unit off of unsuccessful rescue attempt on the building's east side, redirected them to rescue operation on west side. The FGC then returned to the front of the building to check on attack there, and redirected a firefighter who was not attacking vigorously enough to come out of building entrance and close door behind him, thus providing a temporary firewall. As fire gained in intensity, FGC continued to monitor events. After approximately 30 minutes, knew that further rescue efforts were in vain until fire under better controlled. Turned then to problem of ventilation. The building had no windows on two sides, making interior ventilation impossible. Also knew that they had a limited amount of time in which to achieve roof ventilation, because with a fire of this size and intensity, structural integrity compromised after a certain amount of time had elapsed. Received reports that ladder crews were unable to gain access to the 3rd floor and were shifting their attack to roof and rear of building. The FGC ordered ventilation of rear roof. Receiving report from crews that roof felt "spongy," the FGC ordered crews off roof and interior attack abandoned. This

fire took 1 and 3/4 hours to contain and resulted in the deaths of three civilians. (Expert)

DP 13.1 - FGC gave order to take two lines inside to secure a stairwell to be used for rescue. The rescue operation was being conducted through an outside ladder which was being hampered by flames. This action was designed to alleviate pushing fire out at that ladder and to secure inside access. No other action was considered but the FGC thought it likely that other officers might have continued outright attack and possibly taken only one line in for rescue. The issue, then, was how best to secure the rescue operation. (Serial X)

DP 13.2 - FGC gave order to abandon the current outside rescue operation and redeploy the ladder to another side of building to attempt another rescue. The issue was at what point to abandon the east side rescue as hopeless. (Timing)

DP 13.3 - The FGC ordered a fire fighter pulled off an inside attack, and to close the door as he exited. The FGC judged the fire fighter's efforts to be ineffective, and faced with the choice of leaving him there, trying to direct him to be more effective or abandon the operation altogether. (He did not really consider the other alternatives). (Concurrent Y)

DP 13.4 - FGC ordered a roof ventilation; this meant abandoning ineffective front entry rescue operation and signified shift in strategy from interior to exterior attack. The FGC's stated rule: knowing when to ventilate is a key to success and if rescue is not working in terms of getting people out, the next best plan is to make an aggressive containment effort. (Timing)

Incident #14: involved a fire in an older, 2-story residence. The interviewee was the FAO, and as he approached the scene, he could see flames coming from the side of the building. He therefore ordered driver to park the pumper engine on that side of the building. (The FAO noted that he later recognized that this decision was an error. Although it "looked like it would have been easy to fight the fire from the side," a hydrant located at the front of the building could have been used if he had ordered the engine parked at the front, and the front was in fact the eventual entrance used.) After several unsuccessful attempts to gain entry through the side and front doors, the FAO broke in a picture window in the building front and after cleaning shards of glass away from opening, crews entered through that. Once in, FFs noted that heat was intense, and that the carpet had melted, a sign that the fire had been set. Under FAO's direction, crews headed down hallway toward apparent seat of fire; upon reaching 2nd floor, found heat extremely intense and fire spreading. FAO went outside to inform the FGC who had arrived in the meantime of conditions inside the building. The FGC ordered crews out of building at that point and called in

another alarm. The fire took over 3 hours to contain, and as the FAO had suspected, had indeed been caused by arson. (Novice)

DP 14.1 - The FAO directed a pumper to park at a particular place at the side of the building. He chose a point closest to the visible fire and still within distance for the hydrant. Another option, actually suggested by his driver, was to pull around closer to the hydrant. (Concurrent Y)

DP 14.2 - The FAO abandoned a forced entry attempt at the side of the building which was not being successful and redirected entry to occur from the front. FGC did not report considering doing anything else, but there was a great deal of uncertainty as to whether to continue to try for a rear entry, or a side entry, or to try some other avenue of approach. (Timing)

DP 14.3 - After ordering front window to be broken to gain entry, considered that entry from the back may have been a better choice (closer to seat of fire). (Concurrent Y)

DP 14.4 - Decided that fire was getting ahead of them and should persuade FGC to abandon inside attack. (Timing)

Incident #15: involved what originally appeared to be a limited and routine fire in an industrial storage facility. The Battalion Commander, who was also the FAO, was told on arrival at the scene that it was a small rubbish fire, and fire in the ceiling that "didn't amount to much." However, the BC had helped the building owners obtain permits and knew that they processed chemicals that have a high explosive potential. He also knew that the building could not be vented. Finally, he knew his men would find it difficult to hold off acting, and that their usual aggressive response to the fire was likely to produce a flashover. Based on these several pieces of information, he ordered crews out of the building. He entered building himself and chose to do so unmasked. Although this represented some degree of risk of exposure to toxic materials, he noted that the mask interfered to much with his ability to conduct a good size up. Once inside, he reported noting metal dust on floor and beam surfaces, fire in ceiling. He ordered crews back into building to wet down floor, and supervised this operation. At this point, his Chief arrived on the scene and he turned over command. This fire took over 6 hours to contain, and was considered extremely risky to firefighters. (Expert)

DP 15.1 - FAO arrived on the scene of a fire attack already in progress. He ordered men out of the building because of potential of hazardous material involvement. (Confirm X)

DP 15.2 - FGC went inside to investigate himself without taking someone else along or masking up, both being standard

operating procedures. Decided it was safe enough to proceed and wanted to save time. (Serial Y)

DP 15.3 - FGC orders crews to wet down the floor as a means of keeping down hazardous metal dust; he considered abandoning completely or remaining in an attempt to isolate the fire.

Incident #16: occurred in a 2-story frame house. The department received numerous calls reporting this fire and the fact that there were people trapped inside the burning building. While still 2 blocks away, the FGC could see heavy smoke, and arriving at the scene saw smoke billowing from 1st and 2nd stories. Civilians at the scene reported that an elderly couple lived in the house and were still inside. The FGC went to the front door and as he knelt down to put on his mask saw a woman's body sprawled on the floor about 5 feet inside the entrance. Dropping his mask, he ran into the room and carried the unconscious woman out of the building. As she regained consciousness, she began to rant and rave about her dog being trapped inside; after several minutes, she also mentioned that her husband was still in the house as well. The FGC questioned the woman about where her husband might be and she replied that he was in the back of the house, in the kitchen. The FGC, along with another FF carrying a charged line, entered the house. The interior was extremely smoky, and they moved in the direction of voices, ventilating windows as they went. Eventually realized the voices were coming from a radio or TV and retraced steps, trying to locate kitchen. At that point, there were flames billowing across the ceiling, and they were knocking flame down while searching for the husband. Finally found him, unconscious but still alive, in hallway outside the kitchen. Once outside, the FGC left the man with rescue personnel, and reentered the house with crews to help them locate the hose already laid inside. The fire was contained within 6-7 minutes. (Expert)

(There are no DPs coded for this incident, which represents a coding error. It turned out the main reason the incident was chosen was because of the "funny" story. After listening to the tapes, self-identified decision point involving which way to go to look for victims, seemed forced and artificial. As coding system developed, should have been coded as automatic RPD. Since this would not have been coded as a command decision, does not affect the Expert/Novice comparisons.)

Incident #17: involved a large dumptruck that had overturned on the highway. This incident occurred on a major artery at rush hour. As the Incident Commander approached the accident site he realized that he was in the opposite lane from it--chose to continue on down the highway to a nearby exit ramp and reenter on the other side of the road. Once on the scene, he found smoke coming off the payload, a small fire in the cab of the truck and diesel fuel leaking onto the highway. Ordered cab fire

extinguished, diesel fuel shut off, and highway closed. Then ordered crew to use payload, which appeared to be limestone, to cover over diesel spill. The first shovel full applied to the spill turned to mush and began to smoke, indicating that it was not limestone, but some other substance. Concerned that the payload material might be hazardous, the IC ordered crews to halt, and got hold of shipping papers. These revealed that the material was "quicklime," and therefore not dangerous. Ordered crews to rinse diesel fuel off highway with hoses instead. (Novice)

DP 17.1 - As rescue crew approached overturned truck in opposite lane of the highway, IC decided to exit highway and reenter to avoid blocking traffic in outer lane. Considered stopping and crossing median but judged that this would have caused additional problems for traffic. (Concurrent X)

DP 17.2 - IC ordered one line on the smoke coming from the road spill and one on the truck engine; he identified this as a decision because other priorities could have been chosen. (Automatic X)

DP 17.3 - IC called in police and ordered the highway closed on basis of his judged risk to travelers on highway. (Confirm X)

DP 17.4 - IC ordered what he thought to be limestone used to cover the diesel spill on the highway; an unconsidered choice might have been to use water to wash the fuel off the road. In his judgment, the quickest way to abate the situation was the best. (Automatic X)

DP 17.5 - Officer realized that load might not be limestone and decided to seek more information on his own. He considered calling in HAZMAT immediately, but HAZMAT was fairly new at that time and he judged he could handle the situation himself. (Concurrent Y)

Incident #18: was a fire in a 4-story hotel. The officer interviewed was FAO. The FAO knew that one of their pumpers was being repaired so only one engine would answer the initial alarm. Arriving at the scene, he noted quite a lot of smoke and flames coming from the 3rd floor, and that windows were blowing out as the fire grew in intensity. He directed the placement of arriving engines to allow optimal use of apparatus and prevent access to building from being blocked. Entered building with crews, searching for seat of fire. Went up to 3rd floor, but found it fairly clear of smoke and heat, so went on up to 4th floor, down corridor towards smoking suite at end of hall. Began spraying in that location, then got radio information from Capt. that fire was on third floor. However, did not go to 3rd floor, as per SOP, kept hose on 4th floor instead. (Novice)

DP 18.1 - FAO directed an engine where to park. NOTE: The parking area chosen turned out to be non-optimal. He was going by the rule that says to park as close to a known stairwell as possible. In this case there were actually better points of entry. (Confirm X)

DP 18.2 - Officer directed fire efforts to begin on the fourth floor after seeing flames on the third floor and judging that the fire would soon spread. NOTE: This decision was probably a mistake. It turns out the fire was being fought on the third floor already and men could have used some additional help. (Confirm X)

DP 18.3 - After considering, the FAO decided to override another officer's request to bring hose to third floor. He had already committed the line to the 4th floor and thought it would take longer to relocate than to wait for new equipment. In his view the original mistake had been to go to the 4th floor, and to try to change location at this point would only add to that mistake. (Concurrent Y)

Incident #19: involved a fire in a 4-story hotel; the FGC arrived by car, but knew a ladder truck was right behind him. As he pulled up to the scene, he saw smoke and flames coming from 3rd story windows. He noted that a 6-foot chain link fence surrounding the building would limit access, and the unavailability of certain equipment and crews on that particular day might make allocation and coordination of crews and apparatus difficult. He thought the building was vacant, but when he checked the lobby, learned there were people on the 3rd and 4th floors. As crews arrived, he directed placement and allocation, including laying a line to the 3rd floor, and sending a crew up to search and rescue. By this point, fire was venting out the front of the building, and he felt the fire was getting away from him. He thought he might need an additional ladder for rescue, so called in another truck. However, access was so difficult that when the truck arrived, it couldn't make the turn into the alley, and so couldn't be used. At this point, he became concerned about a firefighter who had been sent to the roof to ventilate, and could not hear orders to come down because of noise of the electric saw he was using. Another firefighter attempted to go up and get him, but was blocked by fire. The firefighter on the roof finally responded to men on the ground waving him down. As he was half way down, people appeared in a 4th story window screaming they were trapped and that others were behind them, also trapped. The FF made his way down the ladder and moved it to the window, and other ladders were moved to that location as well to help evacuate. The FGC saw the situation as seriously deteriorating. He called in an additional alarm and ordered complete evacuation of the building. At this point in the incident, approximately 15 minutes had elapsed since the FGC had arrived on the scene. The fire took 1 1/2 hours to contain,

and resulted in the death of one civilian and severe burns to 2 other civilians. (Expert)

DP 19.1 - The FGC considered placement of ladder and deck gun and he decided to place both vehicles in front at what he judged to be the best overall vantage point. Other options would have been to separate them more. (Control)

DP 19.2 - FGC allocated crew to the aerial ladder in order to ventilate the roof. He considered putting all these crews onto rescue but wanted an escape route available. (Concurrent X)

DP 19.3 - FGC ordered incoming squads split up in order to handle both search and rescue and to aid in attack; the officer considered other balances including putting all the incoming crew on to one or the other operation. (Serial Y)

DP 19.4 - FGC called in additional equipment after first considering whether to call full triple two alarm or just the additional piece of equipment that was most needed. (Concurrent Y)

DP 19.5 - FGC called additional alarm. At this point he considered calling a third alarm but rejected that option on basis that it would be too much. (Serial Y)

DP 19.6 - FGC gave order to abandon the inside search and attack efforts and to go to an outside defensive mode. He first considered sending more men inside for additional search and rescue. (Concurrent X)

Incident #20: was a fire in a 3-story vacant building located within a block of the station house. The structure was wooden interior, but its brick walls meant the fire would not spread to adjoining buildings easily. As the officer arrived, he could see smoke, but no flames were showing. He circled the building, looking for the seat of the fire. Entering, he saw fire falling from the ceiling, so ordered a line laid through second floor windows. Around back he noted fire in the window well, coming out the second and third floor windows and suspected it was in the cockloft as well. The FGC reported noting, in addition, the strength and direction of wind, and nature of adjoining exposures. Having completed initial size-up, FGC turned to allocation of resources, directing placement of engines and assigned crew tasks in the front and rear of the building. He also ordered in a snorkel (a specialized piece of apparatus) on the basis of the height of the building and the potential need to get to fire on the roof. At this point, the FGC ordered surrounding buildings evacuated. He walked back from the building in order to get a "wide angle" perspective on the fire; then entered the building. He could hear the roof beginning to come down. He ordered all crews out of the building, called in a

multiple alarm, and shifted from an offensive to a defensive attack. Late in this fire, superior officer arrived and became designated FGC. The fire took an hour to contain. Although it represented a high degree of risk to firefighters, there were no casualties. The FGC's account of this incident contains a number of excellent examples of "thinking ahead of the fire," of planning into the future for a variety of contingencies. (Expert)

DP 20.1 - The FGC requested a special piece of equipment (the snorkel) in addition to calling a full alarm response. He judged he might need the elevated stream ability of the snorkel if he later had to go into defensive mode. He did not consider not calling them because he recognized the potential for the fire to escalate. (Concurrent Y)

DP 20.2 - The FGC positioned box company truck in rear of building to ventilate and to protect access to fire pumping hydrant in case the fire escalated. This was a decision because other placements were possible. (Confirm X)

DP 20.3 - FGC positioned box companies in front. This involved repositioning a pumper to a supply hydrant in order to move in the snorkel. This was not standard operating procedure, but part of his envisioning the potential future escalation and involved his standard rule: use the right tool for the job as a means of saving man power. (Confirm X)

DP 20.4 - FGC decided not to ventilate the building front windows even though this was standard operating procedure and was in fact noticed later by his superior officer. His reasoning was that there was enough rear ventilation and that ventilating the front windows might jeopardize the snorkel's ability to get close to the building if needed. (Concurrent Y)

DP 20.5 - FGC ordered a truck to park across the street and shine lights on building to illuminate key positional fire. Although no other option was considered, this was an unusual action that other officers might not have taken. (Serial Y)

DP 20.6 - Officer ordered an incoming squad to building rear to aid ongoing crew efforts to ventilate rear of building. No other option was considered but action was taken on basis of his calculation of the number of men needed to carry out the assigned job. (Confirm X)

DP 20.7 - Officer ordered the evacuation of an exposed occupied dwelling which was judged to be in danger. (Confirm X)

DP 20.8 - FGC ordered switch from offensive to defensive mode. The issue was one of timing; at this point officer judged they were not getting ahead of the fire and yet enough time had elapsed to compromise the structural integrity of the building.

The decision involved pulling out inside crew and turning on aerial stream. (Timing)

DP 20.9 - FGC ordered snorkel stream redirected since at this point it could no longer dump water on the roof. Superior officer had reordered offensive attack. Because of this the snorkel could no longer dump water into the ventilated roof--to do so would have endangered the inside crew. Officer ordered snorkel pointed up and in full fog, hoping that this would create a fan effect. He thought this might pull out smoke and help to ventilate the building. This was not standard operating procedure, but a creative test of an idea that turned out not to work. (Serial Y)

Incident #21: took place in a wooden, 2 1/2 story abandoned building. Approaching the scene, the FAO saw a column of flame in the sky, and radioed dispatch of a working fire. He directed placement of engines and equipment as they arrived, noting that the location and access routes around this building made good placement particularly important. Directed deployment of crews. Because of danger to house next door, ordered it wet down. Entered building and went up stairs to second floor; found a lot of fire, and noted that because of turn in stairway, could not use a 2" line so called for a 1-3/4" instead. As he was coming down the stairs they gave way, and he fell through them. He was seriously injured, and required a 10-day hospitalization. (Novice)

DP 21.1 - FAO considered placement of incoming equipment. Issue was that there be enough room for the hook and ladder truck to be placed in the front of the building. (Control)

DP 21.2 - FAO ordered two inch lines from the back of the truck for the initial assault--size of lines matched to fire involvement, so this reflects officer's appraisal of fire scope. (Serial X)

DP 21.3 - FAO ordered a fire fighter to stay with the engine to aid in the hydrant hookup of a two inch hose. This is not standard operating procedure, but after consideration, the officer decided that ensuring adequate water supply was the primary need. (Concurrent Y)

DP 21.4 - FAO ordered an adjacent inhabited dwelling wet down before attacking fire in the abandoned structure. This action was taken after considering standard procedure of putting out the fire as soon as possible. The officer's reasoning was that the abandoned building was not that important and that the big line hookup would allow quick treatment of exposure with little loss of time. (Concurrent Y)

DP 21.5 - FAO ordered the inside crew to split up and search for the fire in both the basement and the second floor. It is not standard operating procedure to split up crews and clearly other actions were possible. (Concurrent Y)

DP 21.6 - FAO called for 1-3/4" hose to the second floor rather than the 2" hose. Although other actions were clearly possible, this officer's personal rule was not to be afraid to lay plenty of line. (Serial Y)

Incident #22: involved a fire in an apartment located above a commercial property. This fire was fought in concert with crews from another department, in accord with a mutual aid agreement between the two departments. The individual interviewed was commander of his department's crews (rear sector commander); the overall FGC for the incident was attached to the other department. He heard the alarm come in as he was returning from another call, and figured out, with his driver, what the most efficient route would be. On arrival, he was given command of the rear of the building; he could see smoke and 2nd floor involvement. He directed placement of aerial ladder noting as he did so the presence of overhead wires that could interfere if placement not done properly. SOP at this point would have been to send his crews on into the attic, but he was concerned that crews from the other department, on the opposite side of the building, might not take into account that they were there, might open hoses and blow fire towards his crews. Therefore, ordered his crews to hold back, vent windows they could reach and await directions, but not to enter building. Could see smoke and fire in the attic, so ordered a 2 1/2" hose to the roof, fought fire from exterior--fire had now extended through the roof. At this point, department chiefs arrived and command was turned over to them.
(Expert)

DP 22.1 - Officer had to decide on route to take to the scene of the fire. In looking at a map, he noted that most direct (shortest) route would be heavily trafficked at this hour, so rejected in favor of slightly longer but less-traveled route. (Serial Y)

DP 22.2 - The SC directed an aerial truck into a good position for fighting the fire while avoiding overhead wires. He noted a less experienced officer might not have positioned the truck in an optimal position. (Control)

DP 22.3 - Upon reaching the attic with his truck crew, the SC ordered them to hold back rather than entering immediately as would normally be done. The reason given was that he did not know the crew handling fire operations on the other side of the building and did not trust them not to endanger his men. (Confirm X)

DP 22.4 - After laying a hose up to the attic, the SC ordered his crew not to charge the line because of worry that inside crews might be near the attic floor. The officer identified this as the kind of mistake that can occur because of lack of coordination and communication between companies. (Confirm X)

Incident #23: began as a report of a natural gas leak in a railroad yard a short distance from the station house. While still 2-3 blocks away, the FGC could smell gas, so knew the leak was substantial. Arriving at the yard, the FGC located the broken pipe, which was, indeed, a main gas line. He reported hearing high shrill hiss, and noting that meant it was a high pressure leak. The FGC first checked as to presence of people in surrounding buildings, and was told that they were vacant. He then filled out the alarm, calling for 2 engines and 1 ladder truck, along with a special rescue dispatch and a utility company repair crew. He then turned to identifying potential sources of ignition. Realized his own pumper was one and ordered it out of the area, walked around area to survey instead of riding. Ordered nearby train engines moved away, and called into dispatch to have incoming traffic stopped until further notice. He noted that light breeze meant that the gas was being dispersed to some degree, but also that it might reach residential neighborhood nearby. Because he could not stop the leak himself, much of this incident involved preventative actions and contingency planning if gas did ignite. At this point, the District Chief arrived, and command was turned over to him. (Novice)

DP 23.1 - Upon arriving at the scene, IC calls in full alarm immediately based on his judgment of possible extensive gas leak. He momentarily considered waiting and trying to handle incident with smaller units first. (Confirm X)

DP 23.2 - IC ordered a pumper to stay out of the immediate gas leak area rather than follow common procedure and drive right up to incident site. He sensed the potential danger of the pumper engine igniting leaking gas. (Confirm X)

DP 23.3 - IC ordered removal of a train engine from the area as it, too, was a possible ignition source. This is standard procedure but a novice might have neglected this action. (Automatic X)

DP 23.4 - Commander called in a radio dispatch to order halt to all incoming traffic, including trains, from the area. Again, this is standard procedure that might have been neglected by a less experienced officer. (Automatic X)

DP 23.5 - Commander ordered two lines laid in the gas leak area to handle contingencies if leak ignited. This is standard

procedure that might have been neglected by a less experienced officer. (Automatic X)

Incident #24: provides another perspective on the fire reported in Incident #11. That fire occurred in a large, old wooden structure that had originally been a residential property, but had been converted some years earlier to a restaurant. The building had been remodeled and added to many times so that the structure was a labyrinth of hallways, air ducts, adjoining roofs, and concealed spaces. The building was recognized as holding the potential for a dangerous fire, and fire attack had been preplanned. (Incident #11 was based on the account given us by the FGC; this account is that given us by the First Arriving Officer, who also directed the interior attack.) As the FAO approached the scene, he could see smoke while still 1/2 mile away. The smoke became heavier as they got closer and he notified dispatch that smoke was extremely thick. Although it is common practice to wait for 2nd engine to get in before laying line, the FAO ordered line laid immediately. Noted that in the presence of so much smoke, important to ensure water. The FAO directed placement of arriving engines, then circled building to do size-up and to decide whether to ventilate before entering. The FAO noted windows darkened but not black, door was not hot, and smoke was coming out freely and was whitish, indicating sufficient oxygen still inside the building. Entered building with engine crew; they found fire in downstairs kitchen so they proceeded to pull the kitchen ceiling and knock down fire. FAO radioed to his FGC and they went in search of extensions. Noted that building still extremely smoky and steamy, indicating heat source, and became concerned that they had not gotten fire knocked down after all. Began to find extensions everywhere, chased fire all over the structure--crews eventually pulled out of building which burned to the ground. (Novice)

DP 24.1 - FAO ordered a line laid from his first arriving engine. It is more common to let the second arriving engine lay the supply line but in his judgment the situation was too serious to wait. (Confirm X)

DP 24.2 - FAO directed the positioning of an arriving engine. The officer considered that there was a 15 to 20 foot lead way and that he needed to judge which engine should go in first to ensure access and still leave room for a ladder. The issue was how to get close without getting in the way of arriving equipment. (Control)

DP 24.3 - FAO ordered crews to enter burning building after checking to see if it was safe enough. He indicated that he checked for signs of breathing, whether the windows were black, how hot the door was, whether the smoke was freely escaping, and the color of the smoke. (Confirmation X)

DP 24.4 - FAO allocated the inside crews on basis of his consideration of where the fire was most likely. He judged that there was more smoke upstairs so he sent the hose crew to the most likely scene of the fire. NOTE: This turned out to be a mistake.

DP 24.5 - FAO determined that the fire in the main floor kitchen had been knocked down. Given this he ordered the fire operations halted and sent crews upstairs to check for extension. It turned out that there was still fire in hidden areas kitchen. This was a question of when the fire was truly knocked down. The Officer was aware that some cues did not match his prototype for "knock-down." For example, it seemed to be too hot even after flames were no longer visible. (Concurrent X)