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Canter, David V.

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7 An Overview of Behaviour in Fires

The major differences between fires in the patterns of behaviour that are associated with them are not due to variations between the personalities of the people present or to particular physical details of the design of the buildings involved. Rather they relate to the type of 'place' in which the fires occur. The term 'place' here is used in the sense discussed by Canter (1977), implying a combination of social and physical processes that give any setting its particular qualities. In the parlance of the fire brigades a place is very similar in meaning to a 'building occupancy', because each occupancy has its own characteristic physical structure as well as its own type of organisation and associated fire risk. The following summaries will therefore consider fires in relation to the type of setting in which they occur.

In order to clarify and elaborate these aspects, details of behaviour in various types of buildings are worthy of closer consideration.

Fires in the home

In domestic fires people frequently rely on others for information and check the information they are given. It is also apparent that people frequently have to cope with smoke and other environmental difficulties in fire events. Furthermore, even though they often come into contact with smoke and other fire cues there is a tendency to ignore or misinterpret this as being an indicator of a serious event.

Sequence of events

Detailed analyses of the sequence of events in domestic fires can be summarised as follows.

1. In the very early stages people report noticing cues but finding them ambiguous, often hearing noises, misinterpreting or ignoring these, or discussing them with anyone present. If the cues persist, investigation will take place to find the source of the noise or smell. The only variation from this initial group of actions is if smoke or the fire is encountered directly.
2. If investigation follows the early ambiguous cues, then it inevitably leads to encountering smoke, either within the room of fire origin or outside

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This is a version of the chapter edited to make sense independently of the rest of the book.

this room if the smoke is spreading. If the latter people are still likely to enter the room where the fire is.

3.   A direct encounter with the smoke or fire generates variability in the likely response sequence. This variability is a function of the stage of fire growth and location of the fire at the time when it is encountered. Much of the variability present can be accounted for by differences between men and women, occupants and neighbours. In other words, it is the difference in the roles which people have in the setting which underlies their different behaviour.

4.   The main differences exist at the initial interpretation stage and the behaviour following investigation and encountering the smoke. While both males and females tend to misinterpret ambiguous cues, males are more likely to do so and delay investigation. The response of a female may be delayed by interaction with a male if present. Eventually one of them initiates investigative activity. Both males and females are likely to investigate.

5.   If informed by someone who has returned to say there is a fire, the tendency is to check this information for oneself. The indications are that this may be more likely if males initially receive a warning from females than vice versa. This tendency to continue investigation after being informed, is particularly characteristic of domestic as opposed to other building/occupancy types. It is apparently related to the role of the individual in his or her own home as well as the proximity of a fire. More responsibility may be felt for the safety of others who are likely to be present and for the prevention of damage.

6.   The variability of the actions which follow the encounter with the smoke and fire itself is explained by male/female differences. Females are more likely to warn others and wait for further instruction (for example, if husband and wife are both present). Alternatively they will close the door to the room of fire origin and leave the house.

7.   In both cases females are more likely to seek assistance from neighbours. Male occupants are most likely to attempt to fight the fire. Male neighbours are more likely to search for people in smoke and attempt a rescue.

Fires in hospitals

Act frequencies

In domestic fires the very high frequency of acts involving the search for information and of ambiguous behaviour seems to be characteristic of an essentially informal, unstructured situation. In hospital fires however there is an organised disciplined staff present throughout the 24 hours of the day. Therefore the role of the nurse in helping others to safety is to be expected and is reflected in the high frequency of acts of assistance. The more responsive role of nurses in receiving

instructions can also be seen.

A number of patterns of action sequences are revealed by the examination of the order of behaviours of those involved. These sequences are more complex than in most domestic fires, in part because of the larger number of people involved. However, some general event sequences can be summarised.

Sequences of actions

Detection and investigation of the fire takes place relatively early in fire development as compared with other occupancies. This is likely to be due to the more general spread of people throughout the building and the fact that there is always somebody awake, on duty. Once detected, the transfer of information concerning the fire is highly specified, with senior nursing officers tending to be initial recipients. Thus investigation is typically first carried out by these people. Shortly thereafter they relay information to their junior colleagues, although junior staff are likely to receive early warning that there is a fire. There is a great demand on their part for information concerning location and intensity which they will subsequently need to know in planning patient evacuation. Interviews suggest that from their point of view this information is often late in arriving.

Ultimately destinations and routes are usually specified by senior staff. Action by junior staff (except for preparing patients) is guided by prior instructions, both through previous training and orders received during the incident. The act of evacuating patients is often related to several other actions and processes which when viewed in toto reflect great behavioural complexity. However, due to greater organisational sophistication this higher action complexity does not appear to be strongly related to increased threat.

Evacuation and movement through smoke does occur. It would seem to be due to inadequacies in the building structure (exits not wide enough to accept beds leading to slower or delayed movement; ventilation systems contributing to smoke spread) or delays in information reaching junior staff.

Multiple occupancies

High rise apartment blocks and hotels known as 'multiple occupancies' provide a particularly interesting combination of the domestic setting in which some overall, large scale organisation exists, although it is very informal. In a fire the effectiveness of the communications within this organisation becomes critical. Seeking information is therefore, not surprisingly, the most frequent act in multiple occupancy fires. However, the more passive position people can find themselves in is reflected in the high frequency of noting the fire cues. Nonetheless there are still a large number of instances of the passive reception of ambiguous information. It should also be noted that behaviour in multiple occupancy fires does involve quite a lot of contact with other people, giving and receiving assistance. Acts are thus not the isolated events which might be anticipated in single occupancy dwellings.

Act sequences

As with domestic fires, the awareness that something unusual is happening commences with the hearing of strange noises which are usually misinterpreted or ignored. However, in this case, if the cues persist investigation normally follows. Typically this gives rise to direct contact with fire or smoke and consequent return of the person to where he/she was.

The characteristic sequence which follows from this then relates to the individual going to the window, shouting for help and being rescued. Clearly the multiple occupancy case, especially that occurring in hotels, produces a pattern much more complex than that for domestic fires. This complexity is most apparent in the number of possible outcomes of any given act and the number of sequences of act which are found to occur. The increased complexity appears to be a function of the range of potential sources of information about the fire and about appropriate actions.

Where actions in the domestic situation could be related to the roles of husband, wife or neighbour, in the multiple occupancy setting a person can be at a loss as to whether he is the prime discoverer of the fire or one of many individuals with similar experience. This added complexity can be highlighted by the emergence of the action cycle associated with receiving a warning, receiving instructions, seeking assistance and making attempts to cope with the increasingly dangerous situation before again interacting with others who can possibly help.

The fact that people are aware of the likelihood of meeting others is demonstrated most directly by the way in which their assessment of the fire is typically followed by their dressing and gathering valuables. Surely these acts, which waste time, would feature less if the individual did not anticipate that there were others in the immediate vicinity? There is no clear indication of any parallel acts in the domestic situation.

Returning to the opening acts, these are associated with the reception of ambiguous cues, usually odd noises, followed by a process of misinterpretations. The misinterpretation seems to be of more danger in the multiple occupancy fires studied than in the domestic fires. In the multiple occupancy situation the options for leaving the building appear to reduce more rapidly because the initial time loss militates against later unassisted escape.

It is also of interest that the early cues to the fire in domestic settings may more often be olfactory and/or auditory as opposed to just the auditory cues of the multiple occupancy fires. A further distinction from the domestic settings is the absence of any attempt to fight the fire in multiple occupancies. Indeed, people rarely get to know where the room of origin of the fire is as they do in a domestic setting. People become vaguely aware of something happening at some distance from where they are, realise there is danger, then draw upon whatever information they can obtain from others in order to get away from the danger. It is worth noting that many individuals return to their rooms in multiple occupancies, particularly hotels during a fire.

Public buildings

Another occupancy for which there is concern regarding the potential fire hazard to occupants is that of buildings open to the public, such as department stores and recreation complexes. The scale and complexity of the few fires which do occur in this building type are such that a detailed consideration of them has not been possible in earlier chapters. Furthermore, because of the resources required to collect and analyse information on human behaviour in such fires there is very little information available on the major incidents which have happened.

There are, nonetheless, four fires for which interviews have been collected either by social scientists or by the police in the form of witness statements. Here, these are used as the basis for considering human behaviour in these events. Information on a further eight fires, on which less detail was available, was also examined to establish whether there were any indications that the conclusions from the detailed studies were atypical. Indeed, the general patterns found appear to be similar to those found in other types of fires, with some notable differences.

Because of the complexity of fire incidents in public buildings it is appropriate to focus on limited aspects of human behaviour, the early stages of fire recognition and the decision to leave the building being of special interest, dealing, in particular, with the effectiveness of the behaviour which the public display. This can done by considering all the actions which occurred prior to a given individual deciding to leave the building. A simple classification of these actions is given in *Table 1* and their frequency is summarised in *Table 2*. This shows that although the majority of people perform effectively, early on in the fire growth, there are still a large minority carrying out ineffective acts, most notably delay in responding to the early warnings.

Table 1 Examples of actions in fires in public buildings

Examples taken from transcripts, of the main classes of action identified in the fire. (Table 2 gives the frequencies of each class of action occurring in each fire.)

Effective actions

Getting a fire extinguisher (or hose reel):
General Manager of Henderson's '... and saw flames of a minor nature coming through the ceiling tiles ... I ran to the Church Street end of the floor for a fire extinguisher ...'

Activating the fire alarm:
Security Guard 'Up to this point when I turned off the escalator there was no alarm bell ringing in the store. I activated it on the first floor ...'

Evacuating the area:
Security Guard '... I also checked the first floor to see that it was evacuated'.

Telephoning for the fire brigade:
Telephone operator at Henderson's 'The first time I knew that there was a fire in the Store was when I received a call from Mr Cannon (the General Manager). He said to me: Fire Brigade, second and third floor. I immediately dialled 999 and told the Fire Brigade ...'

Raising alarm/warning others:
Shopper in Woolworth's, having lunch with her brother '... we were having a laugh,... all of a sudden I looked up and saw all this smoke coming ... I just shouted 'FIRE' because I saw a lot of people'.

Ineffective actions

Repetitive/pointless. Bartender in the Empire Room at Beverly Hills: '... my first instinct was to go back to the Empire Room. So, that's where I went'.
Buyer at Hendersons's: (having lunch in restaurant, 4th floor): As soon as he saw the smoke he got up and went to speak to Mrs Summer and asked her if she had phoned for Mr Terry. Then 'I went to the escalator ... and I turned back, (to see if all the customers and staff were out)'.

Ignoring or delaying actions. Holidaymaker at Summerland, in Terrace Bar: '... I heard some commotion and on looking towards the Amusement Arcade I saw a small amount of black smoke ... I then left the Terrace Bar and went into the restaurant'.
Waitress at Beverly Hills:
'I saw some smoke in the front bar and thought it was peculiar, but I went on to the Zebra room anyway ...'
Shopper in snack bar at Henderson's:
'... as soon as I entered the restaurant I noticed smoke hanging about but nothing very much and it didn't appear to be causing any concern; I had started to eat a sandwich ...'

Misinterpreting situations. Casual relief telephone operator at Woolworth's: 'He came in and the door didn't shut behind him and he shouted something and then went back out again. I thought he said "There's a fight on the 2nd floor" ... I just continued working on the phone. I wasn't aware of anything untoward'.
Shopper having lunch with mother in Woolworth's restaurant: 'Then I saw some smoke. It seemed to be coming from the kitchen. There was a small flame. I thought it was the chip pan. I just continued chatting to my mother'.
Model at Beverly Hills: Asked if she noticed any change in the temperature of the room: 'I didn't because well because they turned up the air conditioning because they said it was hot in there ...'
Incautious actions. Waitress in restaurant at Henderson's: 'I waited to see what their reactions was when I told them there was a fire and we had better get out. One went back to get her handbag. I waited for her to come back'.

Waitress in restaurant at Henderson's: On telling a customer in the restaurant that the place was on fire and would she please leave quickly: '... she started banging the floor with her stick. She said "I want to see the Manager". I said "You can't see him. He's rather occupied at the moment". She said "This is disgusting!" The customer still wouldn't leave. She went over to the cash desk and more thick smoke entered the restaurant'.

Cashier in restaurant at Henderson's: 'Miss F ... the supervisor of the Jiffy Bar, told me to collect the money out of my cash desk and get out of the building. ... Just before Miss F told me to get the money from the till all the lights went out. At the time there was a queue of people at my cash desk waiting to pay their bills'.

The four fires listed in Table 2 are:

(a) Andersons department store in Liverpool, 22nd June, 1960.
(b) Beverly Hills Supper Club, Kentucky, 28th May, 1977.
(c) Woolworths department store in Manchester, 8th May, 1979.
(d) Summerland recreation complex, Isle of Man, 2nd August, 1973.

The initial stages of the fire appear again, in these fires to be characterised by ambiguity and misinterpreted cues. But in public buildings the context is of great significance. For example, in a restaurant area smoke is frequently assumed to be from the kitchen and non-threatening. Other cues, such as smells are often also interpreted as non-serious. Once people have recognised that there is something untoward happening there is a tendency for investigation and thus a movement towards the fire area.

Delay in response to a fire in public buildings is likely to depend on the nature of the present activities in which the individual is engaged. For example a delay is probably more likely when the activities have a clear, expected sequence of events each of which lasts for a few minutes, such as having a meal. The sequence of ordering, eating, paying, for instance, is rarely broken in a conventional restaurant and so people anticipate completing this sequence before they move on to other activities.

Of the ineffective actions more are to do with a misinterpretation of what is going on, rather than directly incautious actions such as going into smoke. This misinterpretation, on occasions, is clearly supported by the social situation. People in a group look to each other to confirm or deny the presence of danger. Within this group context there is often a tendency to play down the risks involved, relating in part to the possible desire not to 'lose face' when there may be no danger. Importantly, families that have a clear 'head' such as the mother or father may not operate in this way, but take their lead directly from the person in their group who they all see as the most responsible figure.

Furthermore, there is a reliance by the public on people in authority (usually

Table 2 Frequency of actions prior to deciding to leave in four fires in public buildings

FIRE	ACTIONS							
	Effective			Ineffective				
(Total No.			Total					
Actions)	Freq	%	Freq	%	Pointless	Delay	Misinterpret	Incautious
Andersons Liverpool (89)	43	(48)	46	(52)	2	14(30)	14(30)	16(35)
Beverly Hills (65)	33	(51)	32	(49)	2	17(53)	11(34)	2(6)
Woolworths Manchester (75)	51	(68)	24	(32)	1	11(46)	4(17)	8(33)
Summerland I.O.M. (404)	217	(54)	187	(46)	1	62(34)	90(49)	29(16)
(633) Total Frequency	344		289					
Average % :		55		45				
Average percentage of ineffective actions:	<1%	41%	33%	23%				

staff) for information, also on senior staff by juniors. If the staff do not realise this and do not give the necessary leadership this can create a situation of great danger as in all four cases in Table 2. However, even when staff recognise their role in helping people to evacuate the building they sometimes feel the need to inspect the fire or try to do something about it even when evacuation would be the most effective action. The reliance on senior staff to define the situation as a 'fire emergency' can lead to serious delay. Yet, when appropriate information is given evacuation is frequently rapid.

Relationship to other studies

A few researchers in North America have also carried out detailed case studies of fire incidents (Lerup, 1980; Haber, 1980; Edelman et al, 1980; Bryan, 1983; 1983a). With the exception of Bryan's study (1983a), of the Westchase Hilton Hotel fire, these studies tend to be of domestic fires or fires in institutions such as prisons or nursing homes.

All of these studies support the trends described from the British cases cited above. For example Bryan 1983, reviewing behaviour of 580 people in fires which were mainly in dwellings, showed that the first action of 15% was to notify others, and for a further 10% it was to search for the fire. Nine percent called the fire department as their first action and 8% got dressed. In a second study also reported by Bryan (1983), which focused on nursing homes and other therapeutic institutions, of the 149 people questioned the first action of 45% of them was to investigate the initial cues.

The consistency found across case studies conducted independently by five different research teams in Britain and North America are remarkable, given the popular view of the unpredictable irrational behaviour which is supposed to characterise fires. A general agreement amongst researchers does provide the basis for proposing a general model of behaviour in fires. But before discussing this model further it is of value to consider the results of questionnaire studies which provide a further statistical basis, whilst not providing the detail of the case studies considered so far.

Corroboration for a questionnaire survey

Each approach to studying behaviour in fires has its biases and difficulties. Questionnaire surveys have the advantage of larger data sets, but they are especially difficult to carry out. The first major survey of fire victims was carried out by Wood (1972). Bryan (1983) developed this survey further with similar results. The Fire Research Unit at the University of Surrey completed a further survey, the results of which have not been widely disseminated. There, therefore, follows a summary of the conduct of this survey and its main results. Brief comparison is made with the results from the case studies.

The main purpose of the questionnaire survey was to extend the sample of fires

and people covered beyond those of earlier studies. Furthermore, as the case studies had revealed some interesting details about certain events which were apparently common in fires it was decided to obtain more information on these events. In particular, the survey to be reported focused on:

(i)   early stages of behaviour in a fire
(ii)   actions during the fire in a building
(iii)   escape from a building on fire

Questionnaire development

On the basis of material collected from the case studies and earlier published questionnaire surveys of behaviour in fires (Wood 1972, Bryan 1978), a questionnaire was developed and then posted to addresses of recent fires in London. On the basis of these responses and discussions with the fire brigades a revised questionnaire was developed. This was designed for distribution by the fire brigade to the victims of fires they attended. The following fire brigades were approached and agreed to cooperate: 1. London 2. West Midlands 3. West Yorkshire 4. Greater Manchester and 5. Merseyside. This range of brigades provided a suitable geographical spread and included areas which would be associated with a large, varied sample of building types.

Senior staff of the brigades were visited by members of the Fire Research Unit and briefed as to the nature of the study and the reasons for conducting it. A set of consultative notes concerning the method of distribution were also provided for the senior liaison officers.

Each brigade was to give out the questionnaires at fires they attended. Together with the questionnaire was a freepost envelope for returning the completed questionnaire to the Fire Research Unit at the University of Surrey, and a letter explaining the nature of the survey and instructions.

578 questionnaires were returned during the period of the survey, December 1977 to March 1980 (some returns contained incomplete information).

Description of the sample

There were 29 cases of injury, three cases of serious injury and, 40 people required help in leaving the building. The lack of fatal fires in this sample is due to their general rarity and the social and legal difficulties inherent in obtaining completed questionnaires from such a tragedy

From the figures in *Table 3* it is apparent that although there was a range of building types and fires in the sample the majority were domestic fires occurring in the daytime, of relatively little severity. The fire brigades' assessment of damage also indicated that, in general, the fires surveyed here did not have a large amount of damage associated with them.

Table 3 Summarises the main characteristics of the sample

	Numbers
Number responding	
Women	310
Men	268
Total	578
Time of fire	
2200 - 0800	118
0800 - 1700	285
1700 - 2200	141
Building type	
House	297
Hospital	21
Hotel	14
Factory	53
Office	23
Flats	167
Age of respondents	
< 15	8
16 - 35	273
36 - 55	156
> 55	128

Results of questionnaire survey

Early stages of behaviour in a fire

Recognition. As can be seen from *Table 4* the early stages of fires are clearly characterised by the awareness of something unusual, often smells or noises rather than direct contact with the fire. There is a common tendency for these to be treated as insignificant but on their persistence the most dominant response is to investigate the suspected source. It is this investigation, or a report from someone else who has made such an investigation which leads, most often, to an individual becoming definitely aware of a fire.

The figures in Table 4 are very sparse, with a great deal of missing information. This does mean that on their own these figures would need to be treated with caution. However, when they are compared with the sequences established in the case studies and data from other investigations it is plausible to assume that the sparse data here are a direct product of the ambiguity and confusion present in the early stages of a fire. It is likely that many respondents were not sure what to put

in answer to these questions because they were not really sure what was happening at these very early stages.

Table 4 Early stages of behaviour in a fire as indicated from questionnaire responses

A *Cue to fire presence*

	Frequency
No cue	160
Smell	144
Noise	99
See something unusual	76
Hear alarm	22
See brigade	5
Feel temperature change	4
No answer	18

B *Interpretation of cue*

	Frequency
Event	
Not significant	138
Don't know	126
Fire	29
Significant event	11
No answer [or no cue]	202

C *Response to cue*

	Frequency
Investigate	171
Have a look (curious)	79
Other	28
Continue previous activity	22
Ask someone to look	8
No response	268

D *Became definitely aware of fire due to*

	Frequency
Investigation	240
Was told	146
Interrupted by smoke and flames	56
Present when fire started	40
Accidentally noticed fire	34
Other	47
No answer	15

Communication. In more serious fires it has been suggested that access to a telephone might have played a crucial role. Therefore it is valuable to consider in the present, less serious fires whether there was any evidence of ready use of the telephone. *Table 5* provides a summary of telephone use. 490 respondents reported having a telephone available. 336 of these people did use it, in the great majority of cases to call the brigade.

Thus the relevance of telephone use in these fires is clearly established. It is also of interest to note that of the 154 people who said they did not use the telephone 78 said that this was because they knew someone else had called, showing the importance of social contacts with others in these fires. This is further supported by the direct answer to the question of who else called the brigade besides the respondent:

Who else called the brigade?

Neighbour	86
Staff	70
Relation	47
Friend	17
Stranger	9

Table 5 Telephone use in fires

Total Sample (578)

Telephone not available (53)	Telephone available (490)
No response (30)	
Do not know (5)	

Did not use telephone (154)	Used telephone (336)
Because:	to call:
Knew someone else had called (78)	Brigade (313)
Could not reach it (17)	Switchboard (14)
Too pre-occupied (16)	Warn others (4)
No urgency (11)	Get advice (5)
Location unknown (1)	
Forgot (1)	
Other (30)	

Actions during the fire

Sequence. Table 6 gives the most frequent first four acts for all respondents at each of five positions in the act sequence. These figures support the earlier findings that investigation is often the first conscious action. Thereafter the likely sequence is not

as clear cut, presumably depending on what is discovered. There is a slight tendency for those who do not call the brigade as a first action to call it as a second action, but quite a high proportion of people will tackle the fire in these early actions while those who do not will tend to warn others. Overall 268 people did attempt to fight the fire and 273 did not.

Table 6 Four most endorsed acts over five positions (all applicable respondents)

Act Position		Frequency
1st	Have a closer look	149
	Combination/contain fire	103
	Warn others	86
	Call brigade	50
2nd	Call brigade	103
	Warn others	82
	Combat/contain	73
	Secure immediate area	52
3rd	Call brigade	78
	Combat/contain	73
	Secure immediate area	50
	Organise others ·	36
4th	Call brigade	55
	Secure immediate area	46
	Combat/contain	41
	Attempt to bring others to safety	36
5th	Organise others	30
	Call brigade	30
	Combat/contain	29
	Attempt to bring others to safety	26

Fire Fighting. In answer to the question of how the fire was fought the following frequencies of answers were given:

Various (not listed below)	88
Bucket of water	68
Extinguisher	65
Blanket	20
Hose-reel	17
Unknown	10

The frequency of extinguisher use here is higher than reported for the detailed case studies of more severe fires (Sime et al 1981) and could have been a contributor to the low amount of damage reported in these fires. Of interest also is the use of extinguishers in relation to knowledge of their presence. 268 people were aware of an extinguisher being present nearby. Of these 135 made some attempt to combat the fire but only 61 actually used the extinguisher to tackle the fire. Of the people who had not been previously aware of an extinguisher being present, 85 in all, only 7 found and used an extinguisher in the fire. Of 82 people reporting an attempt to use an extinguisher 9 were unable to get it to work. These figures accord well with Chandler's (1978) study which showed that people were less likely to use fire extinguishers on small fires. It also supports the findings of Ramachandran et al (1972) that people are 'less successful with extinguishers than with other first aid methods'. Although when a fire is attacked by people before the brigade arrives Ramachandran et al found that the severity of the fire is reduced.

Thus, although fire extinguishers can clearly make an important contribution to fire fighting, as previous research has shown, this contribution is subject to many constraints in an actual fire.

Escape. The generally 'benign' quality of the fires in this sample is revealed by the escape routes available to and used by the respondents. In general, where people did leave the building they left by the exit stairs they normally used. As *Table 7* also shows 10 out of 77 people also used lifts to escape from the fire, a potentially dangerous route, but apparently causing no injury in the present sample. 6 out of 85 people did not use the emergency stairs because they could not gain access to them, the route being too dangerous. Thus once again, as with fire extinguishers, the significance of special escape routes is shown to require further examination. Even in such a sample an identifiable proportion find these routes unusable, thus it is clearly important to establish the conditions under which they are likely to be of especial value.

Smoke and egress. One question on the survey explored the conditions under which people left the building, asking about smoke, injury and assistance. On the basis of this question the difficulties of egress can be examined. In effect, each individual can be classified in accordance with the difficulty he/she found in escaping. Using a (i) to indicate no problem and higher values to indicate degrees of problem, so a person with least difficulty would be one who did not encounter smoke (i), left by the normal exit route (ii) and experienced no difficulty in leaving the building (i). Such an individual is represented in *Table 8* by the profile 111, there being 86 such individuals in the survey sample. By contrast there were two individuals who experienced very thick smoke (a value of 4), had much difficulty in leaving (3), and had slight injury (2). The profile of these two individuals is thus, 432, in Table 8.

If the profile values for each person are added then this total 'joint score' provides a basis for ordering people in terms of the difficulty of their egress. In some cases, it is found that people with the same 'joint score' have different

profiles. For example there are three individuals who were slightly injured (2), experienced no difficulty in leaving (1), but experienced thick smoke (3); a profile of 312 giving a joint score of '6'. This is the same value as the six individuals with a profile of 411 and the 22 individuals with a profile of 321.The profiles with identical joint scores are qualitatively different although quantitatively similar. They thus indicate different *kinds* of fire event, of similar severity.

The reason for carrying out the analysis illustrated in Table 8 is to establish if the severity of a fire can be related clearly to particular types of experience or to see if there are so many qualitative differences that no generalisations about severity can be made. To answer this question Table 8 lists all the profiles for people who left the building without anyone's help and by an often used entrance or exit. What it shows clearly is that there is indeed a strong quantitative trend throughout these fires. This is revealed by the fact that the central column of the table accounts for 234 out of the 252 cases. In other words, 93% of the cases fit a single order relating to the experienced severity of the incident. A closer examination of this order also indicates some interesting trends.

Table 7 Means of escape

Was a lift available?

No	452			
Yes	77	Did you use it?	No	67
			Yes	10

Were emergency stairs available?

No	311				
Yes	148	Did you use stairs?	Yes	63	
			No	85	Why Not?
					No urgency
					Used different exit
					Remaining in building
					Route too dangerous
					Location unknown
					Was trapped

No urgency	40
Used different exit	21
Remaining in building	17
Route too dangerous	5
Location unknown	1
Was trapped	1

Was the exit you used the one you normally use?

Yes	302
No	38
Did not leave	156

The overall benign nature of the fires from which these people escaped is shown by the fact that the great majority of the profiles have low joint scores. Nonetheless the profiles do show the important role of smoke spread even in these fires. It is only when there is some smoke (2) that anyone admits to some difficulty in leaving (2), but the frequency of the 221 profile is still considerably less than the 311

profile. So moderate smoke is more likely to be associated with no difficulty. However, once the smoke is classified by people as 'thick' then the great majority of people are likely to describe egress as being with 'some difficulty'. No-one who experienced 'very thick smoke' described their egress as having 'no difficulty'. Thus smoke is usually present when people find themselves in difficulty, but even thick smoke does not necessarily cause difficulty in egress (cf Bryan, 1977).

One further point worth noting from Table 8. Consider all those who were slightly injured, the two profiles in 312, 322, and the one at the bottom of the central column 432. These people did not necessarily describe their exit as difficult (although some did) but they all experienced thick smoke.

Once again this reveals the significance of smoke in hindering some people from making a safe escape from a fire.

Comparison with case studies

In the case studies of fires it was possible to deal with a few major, serious incidents. In contrast the questionnaire survey allowed the study of many more fires of a less serious nature. In effect, the questionnaire survey examined fires which were effectively dealt with before they became very serious, whereas the case study fires had all developed into extremely dangerous conflagrations. Thus the two sets of studies complement each other. The case studies emphasise what can go wrong in a fire which results in it becoming dangerous. The survey emphasises what people do which is effective in reducing the danger of a fire.

From the questionnaires it can be seen that when the early stages of investigation and clarification of ambiguous cues lead to early recognition of the presence of a fire, then people are able to cope effectively with that fire. This effective coping includes a high proportion of people attempting to fight the fire. Furthermore, from the case studies it would be expected that less dangerous fires would be characterised by ready access to a telephone in calling for help and productive use of fire extinguishers and fire escapes. These expectations are substantiated from the questionnaire results.

American studies of behaviour in fires

The studies considered so far in this chapter were conducted by the Fire Research Unit at the University of Surrey, under the aegis of the UK Fire Research Station. In the United States the National Bureau of Standards and the National Fire Protection Agency have commissioned a number of studies of human behaviour in specific fire events. These studies have usually combined detailed interviews with questionnaire surveys. They provide useful additional information on the many issues considered so far, more especially because the studies were carried out in a country where fire regulations and fire fighting procedures are different from those in Great Britain.

Studies of single fires

A nursing home fire

Haber (1980) describes a fire that occurred on the 3rd floor of a nursing home in which there were 21 deaths. The fire had been discovered by a nurse accidentally, through noticing unusual smoke and heat. Her initial reactions had been to call for assistance. The fire alarm was then sounded by a second nurse who had been alerted. Other members of staff came to assist. Most notably a senior administrator, who gave instructions to organise others, whilst nurses evacuated patients. Some of this evacuation was delayed whilst nurses and administrators discussed what might be done, especially to clear smoke. The director also took an extinguisher from a nurse to fight the fire.

The janitor of the building heard the alarm, but assumed it was a false alarm until personally told it was not. He then attempted to fight the fire, with the help of the administrators, until the heat became too intense. At this point he found that the heat was so intense that he could not shut the door to the room in which the fire was. This appears to have been the most direct cause of the deaths, as all deaths were caused by asphyxiation from smoke on the floor of the fire origin.

Table 8 Ordering of severity of incidents in relation to exit behaviour

Key to profiles:

Experience of Smoke	*Ease of Exit*	*Amount of Injury*
1 No smoke	1 No difficulty	1 No injury
2 Some smoke	2 Some difficulty	2 Slight injury
3 Thick smoke	3 Much difficulty	
4 Very thick smoke		

Overall frequencies in parenthesis next to profiles

			joint score
	1 1 1 (86)		3
	2 1 1 (87)		4
	3 1 1 (24)	2 2 1 (7)	5
3 1 2 (3)	3 2 1 (22)	4 1 1 (6)	6
3 2 2 (2)	4 2 1 (8)		7
	4 3 1 (5)		8
	4 3 2 (2)		9

A prison fire in a women's prison

Haber also describes a fire in a prison. The fire was started by a prisoner, who then shouted that there was a fire. The matron in charge then went to investigate and,

seeing the fire, got wet towels to give to the prisoner in the fire cell and told other inmates to lie on the floor. She then went to get keys to the cell and finally told other staff to sound the alarm. It took the matron two minutes to seek assistance and tell someone to sound the alarm.

When the others heard the alarm they assumed that it was a small fire because this had been a frequent occurrence. The men who came to help brought no equipment, having been given no clear information as to the extent of the fire. They eventually obtained fire fighting equipment and put out the fire before evacuating prisoners.

No one was killed in this fire, possibly because one wall of the cell in which the fire started was all bars, allowing the smoke to escape. The rapid response of the staff who came to assist once they knew of the seriousness of the situation possibly also helped save lives.

A fire in a home for 'retired aged'

The third incident described by Haber was started deliberately, at 3.15 a.m. by an ex-employee of a nursing home with petrol bombs. The nurse on duty heard breaking glass and went to investigate. She followed the intruder as he threw petrol bombs, closing doors as she went. She also tried to telephone for help but the telephone had been cut off by the intruder. She then pulled the alarm and told other nurses, after which she went to a public pay-phone in the building, but gave up half-way through the call because she thought that the telephone operator was being obstructive.

Eventually others called the fire department and a nearby policeman was brought in to help. Throughout, nurses closed doors to contain the fire and smoke. One nurse on hearing the alarm and breaking glass immediately switched off the oxygen supply. The engineer, located in the basement was the only one to attempt to extinguish the fires.

In general this potentially, extremely dangerous incident passed without loss of life because the nurses acted as a team in accordance with their nursing training. There was also only one chain of command present, unlike in the nursing home fire above, and so people knew who to communicate with and from whom to take instructions.

Survey of a nursing home fire

Edelman et al (1980) carried out a survey of 22 people involved in a nursing home fire, involving approximately 250 people, which occurred one evening and as a direct result of which two patients died. The people in the nursing home were, in the main, reasonably fit and able to move about on their own. The fire lasted 16 minutes, the fire brigade arriving after eight minutes. Five members of staff assisted the evacuation of the patients but no patient aided evacuation.

Edelman and his colleagues report that some people took the alarm bell being sounded as an initial indication of some 'trouble'. Six people did not interpret it as

a fire and took no action. One person closed his door to stop the noise. Of two people who were told by staff, one person was convinced and left the room. Three people heard screaming and went to investigate. Of the twelve people who heard others shouting 'fire' six took no action. Of the 22 people questioned, 14 were not convinced that there was a fire, even having heard noises suggestive of one.

In leaving the building, 16 people used the centre stairway taking them closer to the fire rather than emergency exit routes away from the fire source. The remaining six received assistance from the fire brigade. In all 85 residents were evacuated via the centre stairway. Some respondents had to pass the room in which the fire was contained, which meant that they had to pass through smoke. They ignored emergency exits within feet of their own room for a number of reasons.

1.   They were told to leave by staff. This usually meant via the centre stairs, it was assumed that this was the appropriate action in this event.
2.   Use of any other stairway normally resulted in an alarm sounding and a severe reprimand for the resident by the staff.
3.   Residents saw others leaving by this exist and simply followed.

This led to even greater problems as the fire brigade used the centre stairway to gain access to the fire.

Studies of hotel fires

As mentioned earlier Bryan (1981, 1983) has carried out a number of detailed questionnaire surveys of behaviour in fires. Of particular note here are his studies of people who were guests in large hotels when a fire started. His detailed analyses are best summarised, for the present purposes as follows.

1.   The fire alarm evacuation signalling system was not effectively utilised in either hotel fire, guests becoming aware of the fire by a variety of means over an extended period of time.
2.   Guests did tend to help each other, by such actions as knocking on doors admitting others to safer rooms and rescuing people.
3.   No nonadaptive behaviour ('panic') was observed.
4.   The early actions of the guests on discovering an unexpected event were the seeking of information and making contact with others. Packing and dressing prior to leaving were also not uncommon.
5.   Instructions obtained from hotel staff, primarily from telephoning to the hotel reception, were instrumental in many cases in influencing the actions of the guests.
6.   Those people who left the buildings, did tend to leave by the available stairs, although smoke sometimes cut-off this escape route. However, a number of people did move through smoke under conditions they described as zero visibility.

7. No guests re-entered the building once they had left and only one guest attempted to fight the fire.

The project people studies

In two major questionnaire surveys of fires carried out by Bryan for the National Bureau of Standards (summarised in Bryan, 1977), a procedure was used based on that first established by Wood (1972) and elaborated by the Fire Research Unit, as reported above. This involves fire officers giving out questionnaires to fire victims. In the first major study by Bryan (Project People) 584 individuals returned completed questionnaires from 335 fire incidents. In the second study, focusing on health care occupancies (Project People II) interviews as well as questionnaires were used to obtain information from 159 people involved in 59 incidents.

This extensive data base was analysed, in the main, to look at the frequency of events and actions. Unlike the case study material, the details of the actual sequence of events or the organisational aspects of individual fires were not established, but some valuable general trends were drawn out of the data and presented in 81 tables. Bryan uses this data to test a variety of proposed models of behaviour in fires, and in order to comment on fire regulations.

Bryan summaries the behaviour response pattern observed across all fires as follows:

A. Investigation
  1. Investigated cues
  2. Discovered fire
  3. Searched for fire
B. Alerting
  1. Pulled manual fire alarm
  2. Called operator
  3. Called fire department
  4. Alerted other staff
  5. Notified others
  6. Had others call fire department
  7. Enter building
  8. Went to fire alarm
  9. Telephoned others/relatives
  10. Woke up
C. Fire Fighting
  1. Got extinguisher
  2. Attempt extinguishment
  3. Fought fire
  4. Went to fire area
  5. Removed fuel
D. Evacuation
  1. Rescued threatened patients

2.	Evacuated patients
3.	Attempted rescue
4.	Got dressed
5.	Left building
6.	Got family
7.	Left area
8.	Got personal property
9.	Tried to exit
10.	Went to balcony

E. Protective Procedures

1.	Closed doors
2.	Directed operations
3.	Stood by
4.	Ventilated
5.	Performed first aid
6.	Turned off appliances
7.	Nothing
8.	Check on pets
9.	Await fire department arrival
10.	Removed by fire department

Summary of findings from USA studies

The particular cases examined by North American researchers cannot be regarded as representative of any known population of fires. Rather they are best regarded as illustrative examples of serious incidents to which public attention was drawn. They differ from the cases studied in Great Britain in being, in general, more severe with a greater loss of life involved. One reason for this is that the legal procedures and police activities in regard to fatal fires allows ready access to potential witnesses in the United States, but in Great Britain it is only after all legal proceedings have been completed that researchers are enabled to gain access to witnesses.

Nonetheless, despite the different context of the fires studied and their different nature, their details serve to complement the trends found in British fires rather than casting any doubt on the generality of these trends. In all the fires the confusions and ambiguities of the early stages are apparent, with the subsequent search for further information. This is followed by fire fighting or flight, depending on the particular circumstances. The part played by the existing communication pattern within the organisation in either helping or hindering coping with the fire is also clear in all incidents. Escape then appears to take place directly in relation to normal modes of entry and exit from the building. In this smoke plays a role of hindering egress but not necessarily preventing it, some people moving long distances through quite dense smoke. Furthermore, sensible actions are frequently found whereas irrational nonadaptive responses are never recorded. Where fires lead to loss of life there is frequently not only a slow response to early cues but also

administrative confusion in terms of who should take what actions.

Recent examples

This summary of what happens in fires is derived in the main from studies of fires that took place in the 1970s, yet it is distressing to see how accurately it describes incidents that have continued to occur since then. The most tragic example is the fire at Kings Cross underground station. Here a small fire under a moving escalator was allowed to develop to the extent that it flashed over into an entrance hall killing 31 people. There appears to have been no stage at which the entrance hall was evacuated and isolated and there were a number of stages in the development of the fire at which time was lost in seeking further information and deciding what actions were to be taken.

   At Kings Cross the routes people took out of the fire also appear to have related very closely to the routes that were normally taken by people. The position of the bodies found seemed to relate directly to where people were intending to go. Members of the public, further, responded without demure to the authority of the police officers present, although in a number of cases this lead people to their death.

   The role of authority figures was also apparent at the Bradford City football ground fire in 1985 (discussed in Canter et al, 1989). There an initial reluctance to climb from the stands onto the pitch and the use of the normal route out, up along a passage behind the stands, probably both contributed to the loss of life in the very rapid development of the fire. Here again the authority of the police, in stopping the game and calling spectators onto the pitch, was crucial.

   The Bradford disaster may be contrasted with the one that occurred at Hillsborough football ground in 1989. For although there was no fire the need to manage the emergency and deal with sudden crowd flows had many parallels to dealing with similar problems in a fire. As the official enquiry made clear, it was the inept policing of this incident that was a major contribution to the loss of life.

A general model of human behaviour in fires

The Bradford loss of life. The inquiry that followed the Hillsborough Stadium Disaster (HMSO, 1990) did lead to questioning of the fundamental issue of why a major recreational activity should rely so heavily on police management (Canter et al, 1989). The result of this was a major rethink of the design and management of sporting facilities which has had marked benefits in turning football grounds from fortresses into places of entertainment.

   In his extensive comparisons of the various models available of human behaviour in fires and the checking of their validity against his own Project People data, summarised above, Bryan (1983a) states:

> 'The behavioural models of Withey and the heuristic systems model of Canter appear to have the most validity in the understanding and

organisation of human behaviour in fire incidents' (p. 195).

Withey's work (1962) is concerned, in the main, with modelling the processes internal to the individual in an emergency situation without drawing on quantitative data. Canter's model does attempt also to incorporate the action sequences as they relate directly to behaviour in fires, which is why Bryan refers to it as 'systems' model.

Furthermore, the model in Canter, 1990 (chapter 8) does derive directly from the transitional probabilities found from case studies. It is this extrapolation from existing records which gives their model its 'heuristic' qualities. In the present summary, then, that model will form the basis for the general account of human behaviour in fires.

This account sees human behaviour passing through a number of identifiable stages, with the possibility of various routes from one stage to the next. In summary the fire is seen as having three broad stages:

i.   the individual receives initial cues and investigates or misinterprets these initial cues,

ii.   once the fire is apparent the individual will try to obtain further information, contacts others or leave

iii.   thereafter the individual will deal with the fire, interact with others or escape.

To develop these stages in more detail, each will be considered separately.

1. Pre-fire activity. It seems that pre fire activity is an important factor in predicting subsequent actions. If a person is engaged in an activity with a well known preset/prescribed 'script' e.g., eating a meal in a restaurant, the implications for subsequent behaviour are considerable.

Additionally, from research, the pre-fire activity can be seen to influence the type of cue received and readiness with which people react. For example noise and smells are more likely to be the initial cues for a waking/alert population. This may lead to earlier recognition and so to a less severe fire.

2. Cue reception. Cue reception may be a function of pre-fire activity. There may be a tendency for sex differences with females more likely to be recipient of noises and odours, though the effect is only slight and may be a result of an over sampling of domestic fires with an alert population. In larger establishments the cue may be an alarm warning.

There are role differences in initial response to the cue. If it is in an environment with an organisational hierarchy or structure there will be an alerting of senior members of staff after an investigation by the recipient. In domestic fires if the female receives the cue and investigates, the male when told is likely to 'have a look' and delay further actions.

Initial cues are usually ambiguous. To resolve ambiguity investigation takes

place. This helps establish the nature of the situation and provide more detailed information on which to act.

Information may come from others and has been found in fires that prove to be dangerous to be frequently inadequate for effective behaviour (cf. USA hospital case studies).

3. Interpretation: definition of the situation. Individuals may or may not have realised there is a fire. An understanding of their behaviour must take account of whether or not they have defined their situation correctly. Because people act on *their* definition of a situation the clues and information that lead to this must be taken into account, with due consideration of the influence of both the place and roles of the people concerned.

A person may assume that staff in a public building are in control or that cues perceived are indications of something already under control e.g., burned toast in a restaurant which poses no threat and so will not be interpreted as indicating a dangerous situation. If staff do not inform the people present appropriately, ineffective behaviour on the part of the public will ensue.

In a domestic fire the presence of smoke is a clear indicator of the need for 'fire related' activity which is more likely to follow as there is no reliance on others for action. In an organisation a fire will be correctly interpreted if a strict hierarchy is already in existence, with a senior member clearly responsible for defining the actions of his/her juniors.

4. Prepare. Once the fire has been defined the 'prepare' stage occurs which includes 'instruct', 'explore', 'withdraw'. The particular type of occupancy is likely to have a great influence on exactly how this stage develops.
'Instruct' Who does the instructing depends almost entirely on their existing role in an organisation.
'Explore' consists of a variety of activities associated with establishing exactly what is happening. It frequently consists of going to the room of fire origin and trying to see the fire directly, being a development of other less intrusive investigations.
'Withdraw' The phenomenon of withdraw/wait is most typical in the context of hotels where the privacy and self-reliance associated with being a hotel guest seems crucial.

5. Act. The final stage depends considerably upon role, occupancy and earlier behaviour and experience. With early definition it may be possible for early evacuation or effective fire fighting to occur. Both males and females will fight the fire but a more dynamic role is apparent for males.

'Wait' may be confined to hotels and guests, however in other circumstances people may wait after giving instructions.

Instruction leading to fire-fighting/evacuation are dependent on hierarchy in organisations where staff members will be told whether to evacuate or fight the fire.

The increasing complexity of the fire as it develops is best seen from the spatial representation in *Figure 1* of the major sequence of events.
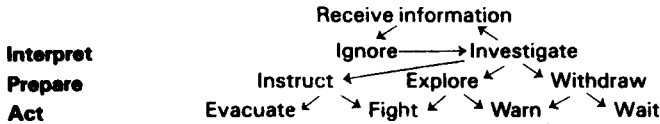
Stage							
			Receive information				
Interpret			Ignore ——→ Investigate				
Prepare		Instruct ← Explore ↙ ↘ Withdraw					
Act	Evacuate ↙ ↘ Fight ↙ ↘ Warn ↙ ↘ Wait						

Figure1 Model of human behaviour in fire

A number of points about this model are worth emphasising.

1.   The triangular shape of this diagram is symptomatic of the fact that the potential actions increase in variety as the experience of fire event develops. Thus the later the stage of the fire the more difficult it is to predict the individual's behaviour, and the more likely are the experience and behaviour to be specific to a particular occupancy.
2.   Influences on the sequence should be examined in relation to the three stages, i.e., whether they are derived from the building and its fire protection system or from the people and their previous training, or the organisational influences.
3.   Regarding the 'Prepare' stage, the particular occupancy is likely to have a great influence. The roles and associated rules which people regard as relevant to their situation have an influence on the particular outcome and experience of this stage in the sequence.

Role/rule model

People can best be understood as being goal-oriented. The goals provide the motivation and explanation for behaviour.

It is the nature of the social quality of human activities that the goals which people have at any point in time are a function of their role in the setting. Moreover roles have certain expectations associated with them, notably expected actions. These role or situation related expectations may be referred to as 'rules'. These are the principles of action which typically underlie behaviour in any given situation.

As a consequence, the roles and their associated rules, provide an important guide to understanding and prediction of their actions.

From case studies it can be seen that commonly occurring rules can be established for different classes of occupancy and fire.

Conclusions

From case studies a full and coherent account can be given for the sequence of actions without recourse to 'panic' as any form of explanation. Though fire is a complex process, a valid summary of types of fire can be made. Behaviour sequences appear to be a product of attempts to cope with ambiguous, rapidly changing information. Much of the observed variation in behaviour can be accounted for by considering the role of the person carrying out the acts and attempting to postulate rules which may be associated with those roles.

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